

ENERFLEX

Compression and
power generation.
Proven solutions.
Anywhere.

Maintenance and Instruction Manual Unit # 060158

CANADIAN LOCATIONS:

Bonnyville	Tel: 780.826.7570
Calgary	Tel: 403.236.1900
Drumheller	Tel: 403.823.9834
Edmonton	Tel: 780.465.5371
Edson	Tel: 780.723.7292
Fort McMurray	Tel: 780.790.9612
Fort Nelson	Tel: 250.774.2895
Fort St. John	Tel: 250.785.1171
Grande Prairie	Tel: 780.539.5974
Kindersley	Tel: 306.463.4838
Lloydminster	Tel: 306.825.9800
London	Tel: 519.455.5600
Medicine Hat	Tel: 403.526.1866
Red Deer	Tel: 403.341.3900
Slave Lake	Tel: 780.849.6555

INTERNATIONAL LOCATIONS:

Moomba, Australia	Tel: 61.8.8867.6000
Perth, Australia	Tel: 61.8.9456.0457
Sydney, Australia	Tel: 61.2.9624.7000
Jakarta, Indonesia	Tel: 62.21.7279.7575
Vianen, Netherlands	Tel: 31.0.347.329.429
Aberdeen, Scotland	Tel: 44.1224.827.000
Odessa, USA	Tel: 915.381.0011
Havre, USA	Tel: 406.265.6664

ENERFLEX

4700 47 Street SE, Calgary, Alberta T2B 3R1
Tel: 1.403.236.6800 Fax: 1.403.279.0367
Toll Free: 1.800.242.3178

Website: www.enerflex.com



ENERFLEX

MAINTENANCE AND INSTRUCTION MANUAL

Table of Contents

EnCana Corporation Job # 060158		
SECTION	CONTENTS	VDRL CODE
GENERAL	<ul style="list-style-type: none">• Project Scope Summary	
WARRANTY	<ul style="list-style-type: none">• EFX Warranty• Engine Warranty	
TECHNICAL DATA	<ul style="list-style-type: none">• Unit Commissioning Data Sheet• Pressure Relief Valve Specification Sheets (PSV)	
PERFORMANCE	<ul style="list-style-type: none">• Ariel Performance Data Sheets• Performance Curves	
OPERATING INFORMATION	<ul style="list-style-type: none">• Unit Operating Instructions	
MAINTENANCE INFORMATION	<ul style="list-style-type: none">• Routine Maintenance & Lubrication Guidelines for Driver, Compressor, Process and Instrumentation	
COMPRESSOR	<ul style="list-style-type: none">• Operator's Manual• Frame (with Balance & Lube)• Cylinders	
DRIVER	<ul style="list-style-type: none">• Operation and Maintenance Manual• Parts Manual	
COOLER	<ul style="list-style-type: none">• Operation Manual• Parts List• Data Sheet• Vendor Information	
CONTROL PANEL	<ul style="list-style-type: none">• Operation Manual	
DRAWINGS	<ul style="list-style-type: none">• General Arrangement• Process and Instrumentation Diagram• Service Flows• Cooler Drawing• Control Panel	

MAINTENANCE AND INSTRUCTION MANUAL

Table of Contents

EnCana Corporation Job # 060158		
SECTION	CONTENTS	VDRL CODE
VENDOR PARTS INFORMATION	<ul style="list-style-type: none"> • Alta-Strainer YS600 Strainer • Apollo Ball Valve • Browing-Belts • Burkert 2-Way Solenoid Valve • C & C Butterfly Valve • Catadyne-Heater • CE Niehoff Brushless Alternators • Century-Needle Valve • Cloverdale-Paint • Daniel-ITC • Donaldson Rubber Elbow • Dresser-Coupling • Farris-PSV • Fisher-Regulator • FloPro Type D2 Control Valve • Flrmflex-Coupling • Goodyear • Kenco-Level Switch • Kito • Linc L471 Level Switch • Lincoln Couble Ball Check Valve • Lube Devices • Mas • Mercer-PSV Valve • Metrix-Transmitter • MP Filtri LVA 30 TA Level Indicator • Murphy-Vibration Switch • Navco-Ball Valve • Newco-Valve • Noco Marine • Nutron-Valve • Sor 1510 Level Switch • Swagelok • TDI-Valve • TDI Turbostart • Thermal Transfer-Cooler 	

ENERFLEX

MAINTENANCE AND INSTRUCTION MANUAL

Table of Contents

	<ul style="list-style-type: none">• Thermo Kinetics K125 Thermocouple• Waren Rupp• Wika-Pressure Gauge	
QC DATA	<ul style="list-style-type: none">• Vessel(s) Certificate• Manufacturer's Data Reports for Vessel and Cooler (UIA)• Nameplate Facsimiles for Vessel(s) and Cooler• Construction Data Reports for Piping (CB83)• Boiler And Pressure Vessel Status Reports (AB-10)• ABSA Registration Letters• PSV Data Sheets	

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GENERAL

GENERAL INFORMATION

Model A1478X
Elevation.....(2500')
Customer Spec.....N/A
Pile Layout..... Yes
Pad Installation Guide..... Yes

COMPRESSOR

Reciprocating Ariel JGK/4

Table with 5 columns: Cylinder, Stage, Model, Bore, MAWP(psig), HCVA, Clear. Pocket, Valve Un'lder, Wear Bands. Rows include specifications for 2, 4, 1, and 3 cylinders.

Cylinder Options

Table with 5 columns: Select....., Sweet, 0-2%PPM, 2-5%, 5+ %. Rows include Distance, Piece type, Purge Packing, SS Rods, PV&D to, Cyl Lube Separate, Cyl Flushing Oil, * Vacuum Pump.

* Vacuum pump required where flare back-pressure exceeds 10" wc
Packing Failure (TE)Std
Seal Pot Heater (recom'd)..... Opt
Nace Bolting Opt
Filter diff pressure Ind. Opt

Frame Options

Bearing Temp Sensors Opt
316 SST Tube/Fittings.....Std
Crankcase Rel'f Door..... Opt
C'Case immersion htr..... Opt
Vibration Transmitter Analog...Std

Tests & Inspections

Special Hydro Tests No
Material Certificates..... No

DRIVER

EngineWaukesha L7042GL

Site Rating @ speed..... 1478 @ 1200
Hospital grade Silencer..... Opt
Engine C'Case immer. Htr..... Opt
Warm Air MakeupStd
Glycol transfer system.....Std
Fuel Scrub EFX Lev'l Ind/SD.....Std
Filter Diff P/sensor Opt
Fuel Meter Opt
Utility gas ESD valve..... Opt
Utility gas ESD valve..... Opt
LP starter Opt

Electric Motor N/A

COOLER

Model.....Air-X-Hemphill 144EF-102-24

Enerflex Spec.....Applicable
Customer Spec.....N/A

Performance

Table with 6 columns: Service, EJW, AUX, IC-1, IC-2, AC. Rows include Temp Out (F), Fouling Factor, Design Press @ Temp (psig/degF), Nozzle Rating.

Table with 5 columns: Tube Material PWHT, SA214 No, SA214 No, SA179 Yes, SA179 Yes. Rows include 100% Xray/UT, Special Chemistry, Cold Temp Material, Louvre Type, Corrosion Allowance.

* 100% X-Ray of all nozzle butt welds.
** 100% UT of all header seam, attachment & nozzle butt welds.

Design

Fan TypeMoore
No. Fans 1
Fan Power on Stg 1/2 cooler... 61 HP
Fan Noise 1/2 cooler 87dba @ 1m
Ambient Design......95 deg F
Add Temp control on EJW.....Opt
Warm Air RecircOpt

PROCESS FLOW

Gas Analysis

Table with 4 columns: Provided, H2S Content, CO2 Content, Free H2O. Row shows 5% H2S Content.

Process Conditions

Table with 3 columns: Gas Flow, Number of Stages, Specific Gravity, Suction Temperature, Suction Pressure, Discharge Pressure. Rows show Start-up and Design conditions.

Table with 4 columns: Stage, Suction MAWP, Discharge MAWP, PSV Set. Rows show suction and discharge MAWP for stages 1 and 2.

PROCESS VALVING

Auto Suction Control..... Std
Suction BlockOpt
Auto Bypass Std
Auto By-pass block..... Std
Suction Thermal PSV Opt
Auto Blowdown valve Std
Discharge Block Opt
Suction/Discharge block Valves to be Auto and Fire rated for ESD

SERVICE PIPING

Enerflex Spec Applicable
Fuel Gas2000# NPT
Engine Lube Oil2000# NPT
Engine/Comp Glycol2000# NPT
Scrubber LCV3000# NPT
Scrubber Manual drains 1.5" Flanged with 1" header, 1.5" skid edge connection
Fuel/Start also from HP Disch..Opt
Start Gas Exhaust to FlareOpt
Cooler Butterfly Valves Std

Table with 5 columns: Tubing, Process, Control, Primary, *Control, Secondary, **PV&D. Rows include Size (in), Material, Fittings.

* used only between controller and actuator. Disabled on ESD, 1200psi burst
** 1/2", through 1/2" have burst in excess of 2000 psi
Note: Engine & Compressor manufacturer may supply CS fittings & tubing.

DRIVE TRAIN EQUIPMENT

CouplingFlexible Disc
Torsional StudyNo

SKID

Enerflex Spec Applicable
Skid Type... Single block, Three Piece
Concrete Type.....30 MPA/Fiber

Flux Core Welding Yes
Drip Lip..... No
Skid Drip Pan..... Wing Section Std
Waste OilStd
PVD Tank.....Std
Concrete..... Installed at EFX
Grating 1" Painted Steel
Skid Drip Pan..... Center Section Std
Glycol Transfer Tank..... Std

PROCESS VESSELS

Enerflex Spec Applicable
Long Seam Flux Core..... Yes
*Corrosion Allowance 1/8"
Sandblast (internal/external) Yes
Charpy Tested..... No
Oiling..... Yes
*Radiography 100%
Mag Particle No
*(Note: Std. Vessels are built to facilitate Sour spec)

Liquid Removal

Table with 6 columns: Stage, Type, Dia., Length, MAWP, Orientation. Rows show Mesh scrubbers for stages 1 and 2.

Slugcatcher in lieu of scrubberOpt
BlowcaseOpt
Mini BlowcaseOpt

Pulsation Control

Table with 4 columns: Stage, Type, Dia., Length. Rows show suction and discharge pulsation control for stages 1 and 2.

PROCESS PIPING

Enerflex Spec Applicable
Flux Core Welding Yes
On Vessel Butt Welds..... Yes
Charpy Tested..... No
Internal Oil..... Yes
Sandblast Yes

Acoustical

Acoustical Study Opt
By.....N/A

Other (Sweet)

Stress Relief Butt Weld No
X-Ray Butt Weld..... Partial
UT Testing (CAT D) No

Other (Sour)

Stress Relief Butt Weld Yes
X-Ray Butt Weld 100%
Stress Relief SW Piping No
UT Testing (CAT D) No

CONTROL SYSTEM

ModelRC2000

Enerflex Spec Applicable
Cabinet Type Carbon Steel
Remote Shutdown Yes
Inst. Gas supply from Fuel Opt
Inst. Air supply Std
Power Supply (by Customer)..... Std
Power Supply EFX 30A Alternator installed, wired with Batteries)..... Std
All Control Connections run to JB on back wall..... Std

BUILDING

Customer Spec..... Opt
Engineering Certification..... Opt
Exhaust Fan (2) Opt
Exterior Finish (Color, Spec) Std
Perforated Liner Opt
Perforated Liner Opt
Heaters Catadyne, 120VAC Opt
Heaters , Ruffneck Glycol..... Opt
Gas Detection (required)..... Opt
Fire Detection Opt
Canopies and ice rakes Std
Ergonomic Package (HD Work/storage bench, White board)..... Opt

ELECTRICAL

Enerflex Spec Applicable
Non-Incendive Wiring By.....Enerflex
Power Wiring By Others
Lighting Package (4) 120VAC HP Sodium, 175W run Div 1 to JB Opt
Lighting Package (4) 12VDC Incandescent, 150W run Div 1 to JB Opt

Table with 2 columns: Electric Motor Drive (if applicable), Low Horsepower (<1/2 hp) Motors, High Horsepower (>1/2 hp) Motors. Values: N/A, TBD, TBD.

Electrical Classifications

Heaters/Lights..... CSA Class 1 Div.1
Gas/Fire Det. CSA Class 1 Div.1
Pre inspection of electrical Yes
Fugitive emissions study Yes
(process options may require a revised FE study at an additional cost)

PAINT

Enerflex Spec Applicable
Primer Coats 1
Note: Enerflex standard is warm gray with grating in black.

CRANE

Enerflex Spec Applicable
2 Ton Bridge (P.Eng Stamp).....
3 Ton Bridge (P.Eng Stamp).... Std

SHIPPING

Freight No
Loading No
Ship To (By Others)
Internal Preservation Enerflex domestic standard
Main unit Ship specs (LxWxH,lb)..... 38'5" x 23' 6" x 17'11", 149,000 lb
Cooler Ship spec (LxWxH,lb) 25' 8" x 9' 6" x 13'5", 29,000 lb
Lugs for tarping open bottom..... Std

RUN TEST AND INSPECTION

Enerflex Spec Applicable
Comprehensive Run Test... Full Load
Witnessed Opt
Witnessed Opt
Panel Function Test Yes
Hold Point Opt
Instrument Calibration Yes

DOCUMENTATION

Enerflex Spec Applicable
Customer Spec N/A

Drawing Units Imp / SI
Manuals (Hard Copy) 2
Data Sheets No
Electrical Certificates..... No
Spare Parts Branch..... Pamco, Calgary, (403) 236-1900

CONTACT LIST

Table with 5 columns: Company, Name, Title, Phone, Fax. Row includes Steve Suski, Project Manager, (403) 236 6882, (403) (403).

ENERFLEX PROJECT SCOPE SUMMARY
EnCana Stock A1478X/2
Ariel JGK/4, Waukesha L7042GL, AXH 144EF
Customer: EnCana Corporation
Location: TBA
Consultant: N/A
P.O.: LSD:TBA Enerflex No:060700

ENERFLEX

WARRANTY

1. **Warranty** - EFX Compression Enerflex, a division of Enerflex Systems Ltd. (hereinafter referred to as "EFX Compression"), warrants new products designed, manufactured and sold by EFX Compression, separately or as part of packaged equipment to be free of defects in material or workmanship. This warranty, including any implied warranties of merchantability and fitness for purpose, is limited in duration for a period of 12 months from the date of initial start-up or 18 months from the date the equipment is ready to ship, whichever comes first. The Customer is responsible for all costs associated with the extension of the major equipment OEM warranty including unit preservation prior to and during storage. Failure to extend OEM warranty will result in loss of coverage for major equipment.
2. **Commissioning** - In order to validate full warranty coverage on the equipment, an initial start-up service must be performed by an authorized agent of EFX Compression.
3. **Repair & Replacement** - EFX Compression's New Equipment Warranty is limited to repair or replacement of defective parts or components at EFX Compression's nearest repair facility. This does not apply if the equipment has been damaged as a result of excessive loading, over or under speeding, heating, fire or abnormal combustion, ingestion of foreign materials, inadequate maintenance, misalignment, accident, improper installations, improper storage, improper use or any other condition or event not within the control of EFX Compression. The warranty on replacement parts or components is limited in duration for a period of 90 days from the replacement date or the duration of the original warranty period, whichever is longer. Customer is responsible to pay for any equipment and transportation costs to and from an EFX Compression repair facility. Customer is also responsible to pay EFX Compression's out-of-pocket costs for transportation, lodging and subsistence, as well as additional and premium labour for any repairs taking place at other than an EFX Compression repair facility and/or being performed outside of normal business hours.
4. **Third Party Performance Guarantees** - EFX Compression's New Equipment Warranty includes all performance guarantees provided from third party product supplier(s) to EFX Compression wherein that supplier's product is distributed or resold separately or as part of an EFX Compression product. Copies of formal written performance guarantees of third party supplier(s) to EFX Compression are available on request.
5. **Limited Warranty** - The warranty provided herein by EFX Compression is the sole and exclusive warranty provided to the Customer and is in lieu of all other warranties, whether expressed or implied, including those found in the Sale of Goods Act (Alberta). EFX Compression is not responsible for any consequential, indirect or special damages whatsoever. In addition, EFX Compression shall not be liable for, including without limitation, lost revenues, downtime, diminished goodwill and damage to, or replacement of other equipment and property, whether such damages are consequential, indirect, special or otherwise, EFX Compression is not responsible for any punitive damages that may arise due to damage or loss.
6. **Modifications and Repair by Others** - EFX Compression shall not be responsible for modifications or repairs made to the equipment by others unless EFX Compression authorizes such actions in writing prior to the time such modifications or repairs are made. Such modifications and repairs made by other than EFX Compression shall, unless authorized by EFX Compression, void EFX Compression's New Equipment Warranty on the equipment.
7. **Analytical Study Exclusion** - EFX Compression's New Equipment Warranty specifically excludes pulsation, acoustical-related vibration and torsional vibration related problems except where equipment is manufactured in accordance to and operated within independent mechanical, acoustical and torsional studies purchased on behalf of customer. In the absence of formal studies, EFX Compression will not be responsible for any on-site machinery analysis, post-shipment analytical studies or any repairs resulting from damage due to pulsation, acoustical vibration or torsional vibration.
8. **Transferability** - Subject to EFX Compression's approval, which shall not unreasonably be withheld, EFX Compression's New Equipment Warranty may be transferred to subsequent owners within the original warranty period.
9. **Claims** - All warranty claims must be filed with EFX Compression in writing within thirty (30) days after the claim arises.
10. **Unit Storage** - EFX Compression's New Equipment Warranty specifically excludes damage, deterioration and theft as a result of equipment storage regardless of storage location. The Customer will be responsible to ensure that the unit is properly stored and the equipment properly secured, protected and preserved. Damage due to water ingress, rust, dust, debris or improper security will not be covered by the New Equipment Warranty.

WAUKESHA ENGINE DIVISION, DRESSER EQUIPMENT GROUP, INC.
EXPRESS LIMITED WARRANTY FOR PRODUCTS USED IN CONTINUOUS DUTY APPLICATIONS

INTRODUCTION

CONTINUOUS DUTY DEFINITION: The highest load and speed which can be applied, subject to Waukesha's approved ratings in effect at time of sale.

I. TERMS OF EXPRESS LIMITED WARRANTY

Waukesha Engine Division warrants that it will repair or replace, AT ITS ELECTION AND EXPENSE, any part of an engine, or Enginator[®], or product (hereinafter referred to as "Products") manufactured by Waukesha, which proves to have had a defect in material or workmanship.

II. TERM LIMITATIONS OF EXPRESS LIMITED WARRANTY

A. This coverage shall commence upon initial new Products start-up date and shall expire upon the earlier of the following:

1. 12 months after the initial new Products start-up date; or
2. 24 months after the original shipment date of the covered Products by Waukesha Engine Division.

B. Notwithstanding the foregoing, Waukesha further warrants that the cylinder block casting, cylinder head castings, connecting rod forgings, and crankshaft forging will be free from defects in material or workmanship. This additional warranty only covers failure of the specific items noted within this subparagraph.

This coverage shall expire upon the earlier of the following:

1. 60 months after the initial new Products start-up date; or
2. 25,000 hours of operation of the covered Products; or
3. 72 months after the original shipment date of the covered Products by Waukesha Engine Division.

NOTE: No damage from other sources, such as damage from the loss of a crankshaft bearing, shall be considered as a forging defect.

III. WAUKESHA'S RESPONSIBILITIES UNDER THE EXPRESS LIMITED WARRANTY

Waukesha shall be responsible for:

- A. The repair or replacement, at Waukesha's election, of covered defective parts and all reasonable labor required regarding a warranted failure during the express limited warranty term. All such labor shall be provided by Waukesha's authorized contractor or distributor.
- B. Reasonable and necessary travel and expenses incurred by Waukesha's authorized contractor or distributor.
- C. Replacement of lubricating oil, coolant, filter elements, or other normal maintenance items that are contaminated and/or damaged as a direct result of a warranted failure.

NOTWITHSTANDING THE FOREGOING, WAUKESHA SHALL NOT BE RESPONSIBLE FOR LABOR COSTS ASSOCIATED WITH WARRANTY CLAIMS BROUGHT PURSUANT TO SUB-PARAGRAPH II (B).

IV. OWNER'S RESPONSIBILITIES UNDER THE EXPRESS LIMITED WARRANTY

Owner shall be responsible for:

- A. The operation and maintenance of the Products within the guidelines established by Waukesha.
- B. Making the Products available to Waukesha or Waukesha's authorized contractors or distributors for any warranty repair, during normal business hours.
- C. All additional costs incurred for premium or overtime labor, should owner request that repairs be made on a premium or overtime schedule.
- D. All costs incurred as the result of removal or reinstallation of the Products as may be required to effect any warranted repair.
- E. All administrative costs and expenses resulting from a warranted failure.
- F. Any costs of transportation, towing, repair facilities, or associated costs.
- G. All labor, travel, mileage, and other related costs and expenses associated with a claim made pursuant to subparagraph II (B) above.
- H. Loss of revenue and loss of/or damage to real and/or personal property.

V. LIMITATION OF WAUKESHA'S OBLIGATIONS

The obligations of Waukesha under this express limited warranty shall be waived and voided, and Waukesha shall not, thereafter, be responsible for:

- A. Any failure resulting from owner or operator abuse or neglect, including but not by way of limitation, any operation, installation, application, or maintenance practice not in accordance with guidelines or specifications established by Waukesha; or
- B. Any failure resulting from unauthorized modifications or repairs of the Products; or
- C. Any failure resulting from overload, overspeed, overheat, accident, improper storage; or
- D. Failure of owner to promptly provide notice of a claimed defect; or
- E. Failure of Products for which Waukesha did not receive properly completed start-up reports; or
- F. Repairs of a covered failure performed with non-genuine Waukesha parts; or
- G. Repairs of a covered failure performed by non-authorized contractors or distributors; or
- H. Failure to make Products available to Waukesha or its authorized representatives; or
- I. Failure to supply documents such as drawings and specifications relating to the specific application of the Products.

VI. APPLICABILITY AND EXPIRATION

The warranties set out above are extended to all owners in the original chain of distribution. The warranties and obligations of Waukesha shall expire and be of no further effect upon the dates of expiration of the applicable warranty periods.

THE FOREGOING SETS FORTH WAUKESHA'S ONLY OBLIGATIONS AND OWNERS' EXCLUSIVE REMEDY FOR BREACH OF WARRANTY, WHETHER SUCH CLAIMS ARE BASED ON BREACH OF CONTRACT, TORT (INCLUDING NEGLIGENCE AND STRICT LIABILITY), OR OTHER THEORIES, AND THE FOREGOING IS EXPRESSLY IN LIEU OF OTHER WARRANTIES WHATSOEVER EXPRESSED, IMPLIED, AND STATUTORY, INCLUDING WITHOUT LIMITATION, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

Notwithstanding the preceding, in no event shall Waukesha be liable for any direct, special, incidental, or consequential damages (whether denominated in contract, tort strict liability, negligence, or other theories) arising out of this Agreement or the use of any Products provided under this Agreement.

Any action arising hereunder or relating hereto, whether based on breach of contract, tort (including negligence and strict liability), or other theories must be commenced within two (2) years after the cause of action accrues or it shall be barred.

All disputes and claims between the parties, which may arise out of or in connection with this Contract, shall be settled by good faith negotiation between an executive level representative of each party. If the parties are nonetheless unable to reach agreement, such dispute shall be resolved by binding arbitration. The American Arbitration Association according to its rules of Commercial Arbitration then in force shall administer the arbitration. The arbitration shall take place in Milwaukee, Wisconsin, before one arbitrator. The language to be used in the arbitration shall be English. The law of Texas shall govern. Judgment upon the award of the arbitrators may be entered in any court of competent jurisdiction.

See Form M-464 for the most current warranty terms. Effective November 1, 1999.

WAUKESHA ENGINE DIVISION, DRESSER EQUIPMENT GROUP, INC.
EXPRESS LIMITED WARRANTY FOR PRODUCTS OPERATED IN EXCESS OF CONTINUOUS DUTY RATINGS

INTRODUCTION

This warranty only applies to engines which Waukesha Engine Division has approved to operate in excess of the continuous duty rating.

APPLICATIONS COVERED BY THIS WARRANTY

Standby Service Applications:

This rating applies to those systems used as a secondary or backup source of electrical power. This rating is the output the system will produce continuously (no overload), 24 hours per day for the duration of the prime power source outage.

Intermittent Service Applications:

This rating is the highest load and speed that can be applied in variable speed mechanical system applications only (i.e., blowers, pumps, compressors, etc.). Operation at this rating is limited to a maximum of 3500 hours/year. For continuous operation for any length of time between the continuous and intermittent ratings, see the Peak Shaving Application rating procedure.

Peak Shaving Applications:

The rating for a peak shaving application is based on the number of horsepower-hours available per year at site specific conditions. All applications using a peak shaving rating require a signed Special Application Approval (SAA) from Waukesha's Application Engineering Department.

I. TERMS OF EXPRESS LIMITED WARRANTY

Waukesha Engine Division warrants that it will repair or replace, AT ITS ELECTION AND EXPENSE, any part of an engine, or engine powered Enginor™ (hereinafter referred to as "Products") manufactured by Waukesha, which proves to have had a defect in material or workmanship.

II. TERM LIMITATIONS OF EXPRESS LIMITED WARRANTY

- A. This coverage shall commence upon initial new Products start-up date and shall expire upon the earlier of the following:
1. 60 months or 3500 hours, whichever occurs first, after the initial new Products start-up date; or
 2. 72 months after the original shipment date of the covered Service Parts by Waukesha Engine Division.
- B. Notwithstanding the foregoing, Waukesha further warrants that the cylinder block casting, cylinder head castings, connecting rod forgings, and crankshaft forging will be free from defects in material or workmanship. This additional warranty only covers failure of the specific items noted within this subparagraph. This coverage shall expire upon the earlier of the following:
1. 60 months after the initial new Products start-up date; or
 2. 25,000 hours of operation of the covered Products; or
 3. 72 months after the original shipment date of the covered Products by Waukesha Engine Division.

NOTE: No damage from other sources, such as damage from the loss of a crankshaft bearing, shall be considered as a forging defect.

III. WAUKESHA'S RESPONSIBILITIES UNDER THE EXPRESS LIMITED WARRANTY

Waukesha shall be responsible for:

- A. The repair or replacement, at Waukesha's election, of covered defective parts and all reasonable labor required regarding a warranted failure during the express limited warranty term. All such labor shall be provided by Waukesha's authorized contractor or distributor.
- B. Reasonable and necessary travel and expenses incurred by Waukesha's authorized contractors or distributor.
- C. Replacement of lubricating oil, coolant, filter elements, or other normal maintenance items that are contaminated and/or damaged as a direct result of a warranted failure.

NOTWITHSTANDING THE FOREGOING, WAUKESHA SHALL NOT BE RESPONSIBLE FOR LABOR COSTS ASSOCIATED WITH WARRANTY CLAIMS BROUGHT PURSUANT TO SUB-PARAGRAPH II (B).

IV. OWNER'S RESPONSIBILITIES UNDER THE EXPRESS LIMITED WARRANTY

Owner shall be responsible for:

- A. The operation of the product within the allowable HP-HR/YR rating granted by the specific Special Application Approval for the product.
- B. The operation and maintenance of the Products within the guidelines established by Waukesha.
- C. Making the Products available to Waukesha or Waukesha's authorized contractors or distributors for any warranty repair, during normal business hours.
- D. All additional costs incurred for premium or overtime labor, should owner request that repairs be made on a premium or overtime schedule.
- E. All costs incurred as the result of removal or reinstallation of the Products as may be required to effect any warranted repair.
- F. All administrative costs and expenses resulting from a warranted failure.
- G. Any costs of transportation, towing, repair facilities, or associated costs.
- H. All labor, travel, mileage, and other related costs and expenses associated with a claim made pursuant to subparagraph II (B) above.
- I. Loss of revenue and loss of or damage to real and/or personal property.

V. LIMITATION OF WAUKESHA'S OBLIGATIONS

The obligations of Waukesha under this express limited warranty shall be waived and voided, and Waukesha shall not, thereafter, be responsible for:

- A. Any failure resulting from owner or operator abuse or neglect, including but not by way of limitation, any operation, installation, application, or maintenance practice not in accordance with guidelines or specifications established by Waukesha; or
- B. Any failure resulting from unauthorized modifications or repairs of the Products; or
- C. Any failure resulting from overload, overspeed, overheat, accident, improper storage; or
- D. Failure of owner to promptly provide notice of a claimed defect; or
- E. Failure of Products for which Waukesha did not receive properly completed start-up reports; or
- F. Repairs of a covered failure performed with non-genuine Waukesha parts; or
- G. Repairs of a covered failure performed by non-authorized contractors or distributors; or
- H. Failure to make Products available to Waukesha or its authorized representatives; or
- I. Failure to supply documents such as drawings and specifications relating to the specific application of the Products.

VI. APPLICABILITY AND EXPIRATION

The warranties set out above are extended to all owners in the original chain of distribution. The warranties and obligations of Waukesha shall expire and be of no further effect upon the dates of expiration of the applicable warranty periods.

THE FOREGOING SETS FORTH WAUKESHA'S ONLY OBLIGATIONS AND OWNERS' EXCLUSIVE REMEDY FOR BREACH OF WARRANTY, WHETHER SUCH CLAIMS ARE BASED ON BREACH OF CONTRACT, TORT (INCLUDING NEGLIGENCE AND STRICT LIABILITY), OR OTHER THEORIES, AND THE FOREGOING IS EXPRESSLY IN LIEU OF OTHER WARRANTIES WHATSOEVER EXPRESSED, IMPLIED, AND STATUTORY, INCLUDING WITHOUT LIMITATION, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

Notwithstanding the preceding, in no event shall Waukesha be liable for any direct, special, incidental, or consequential damages (whether denominated in contract, tort strict liability, negligence, or other theories) arising out of this Agreement or the use of any Products provided under this Agreement.

Any action arising hereunder or relating hereto, whether based on breach of contract, tort (including negligence and strict liability), or other theories must be commenced within two (2) years after the cause of action accrues or it shall be barred.

All disputes and claims between the parties, which may arise out of or in connection with this Contract, shall be settled by good faith negotiation between an executive level representative of each party. If the parties are nonetheless unable to reach agreement, such dispute shall be resolved by binding arbitration. The American Arbitration Association according to its rules of Commercial Arbitration then in force shall administer the arbitration. The arbitration shall take place in Milwaukee, Wisconsin, before one arbitrator. The language to be used in the arbitration shall be English. The law of Texas shall govern. Judgment upon the award of the arbitrators may be entered in any court of competent jurisdiction.

See Form M-467 for the most current warranty terms. Effective November 1, 1999.

WAUKESHA ENGINE DIVISION, DRESSER EQUIPMENT GROUP, INC.
EXPRESS LIMITED WARRANTY FOR GENUINE WAUKESHA SERVICE PARTS

INTRODUCTION

This warranty only applies to Genuine Waukesha Service Parts (to include assemblies and short blocks) sold by Waukesha Engine and used for repair, maintenance, or overhaul of Waukesha Products.

I. TERMS OF EXPRESS LIMITED WARRANTY

A. Waukesha Engine Division warrants that it will repair or replace, AT ITS ELECTION AND EXPENSE, any Genuine Waukesha Service Part installed on an engine, or Enginator[®], or product (hereinafter referred to as "Products") manufactured by Waukesha, which proves to have had a defect in material or workmanship.

II. TERM LIMITATIONS OF EXPRESS LIMITED WARRANTY

This coverage shall begin on the purchase date from an authorized Waukesha Distributor and will expire twelve (12) months after the purchase date.

III. WAUKESHA'S RESPONSIBILITIES UNDER THE EXPRESS LIMITED WARRANTY

Waukesha shall be responsible for:

- A. The repair or replacement, at Waukesha's election, of covered defective Service Parts.
- B. Labor time to repair or replace the defective part as established by the Waukesha Labor Guide. All reimbursable labor costs shall be provided by Waukesha's authorized distributor.
- C. The reimbursement of documented Distributor expenses covering Freight, Customs, Brokers Fees, and Import Duties to obtain the replacement Service Part from Waukesha.

IV. OWNER'S RESPONSIBILITIES UNDER THE EXPRESS LIMITED WARRANTY

Owner shall be responsible for:

- A. The operation and maintenance of the Products/Service Parts within the guidelines established by Waukesha.
- B. Making the Products/Service Parts available to Waukesha or Waukesha's authorized Distributors for any warranty repair, during normal business hours.
- C. All additional costs incurred for premium or overtime labor, should owner request that repairs be made on a premium or overtime schedule.
- D. All costs incurred as the result of removal or reinstallation of the Products as may be required to effect any warranted repairs.
- E. All administrative costs and expenses resulting from a warranted failure.
- F. Any costs of transportation, towing, repair facilities, or associated costs.
- G. All travel, mileage, and other related Distributor costs and expenses associated with repair under the terms of this Service Parts Warranty.
- H. All additional labor time in excess of Waukesha's Labor Guide for the warrantable repair.
- I. Loss of revenue and loss of/or damage to real and/or personal property.

V. LIMITATION OF WAUKESHA'S OBLIGATIONS

The obligations of Waukesha under this express limited warranty shall be waived and voided, and Waukesha shall not, thereafter, be responsible for:

- A. Any failure resulting from owner or operator abuse or neglect, including but not by way of limitation, any operation, installation, application, maintenance, or assembly practice not in accordance with guidelines or specifications established by Waukesha; or
- B. Any failure resulting from unauthorized modifications or repairs of the Products or Service Parts; or
- C. Any failure resulting from overload, overspeed, overheat, accident; or
- D. Failure of owner to promptly provide notice of a claimed defect; or
- E. Failure of Service Parts for which Waukesha did not receive proper documentation concerning the Service Parts purchase date from an authorized Waukesha Engine Distributor; or
- F. Repairs of a covered failure performed with non-genuine Waukesha parts; or
- G. Repairs of a covered failure performed by non-authorized Contractors or Distributors; or
- H. Failure to make Products and Service Parts available to Waukesha or its authorized representative; or
- I. Failure to supply documents such as drawings and specifications relating to the specific application of the Products; or
- J. Any failure of Service Parts resulting from misapplication or improper repair procedures; or
- K. Any failure or damage resulting from the improper or extended storage of a Service Part; or
- L. Freight, Customs, Broker Fees, and Import Duties if appropriate documentation is not provided; or
- M. Normal wear items or consumable parts such as belts, spark plugs, lubricating oil filters, air filters, etc. are not considered defective if in need of routine replacement, rebuild, or maintenance during the term of the warranty.

VI. APPLICABILITY AND EXPIRATION

The warranty set out above is extended to the original purchaser of the Genuine Waukesha Service Parts. The warranty and obligations of Waukesha shall expire and be of no further effect upon the date of expiration of the applicable warranty period.

VII. WARRANTY ADMINISTRATION

This warranty is administered exclusively by an authorized Waukesha Distributor. The invoice for the failed Service Parts must be provided to the Distributor to determine whether the warranty is applicable.

Contact the nearest authorized Waukesha Distributor for assistance with warranty matters or questions. The location of the nearest authorized Distributor is available by contacting Waukesha Engine Division at 414-547-3311.

THE FOREGOING SETS FORTH WAUKESHA'S ONLY OBLIGATIONS AND OWNERS' EXCLUSIVE REMEDY FOR BREACH OF WARRANTY, WHETHER SUCH CLAIMS ARE BASED ON BREACH OF CONTRACT, TORT (INCLUDING NEGLIGENCE AND STRICT LIABILITY), OR OTHER THEORIES, AND THE FOREGOING IS EXPRESSLY IN LIEU OF OTHER WARRANTIES WHATSOEVER EXPRESSED, IMPLIED, AND STATUTORY, INCLUDING WITHOUT LIMITATION, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

Notwithstanding the preceding, in no event shall Waukesha be liable for any direct, special, incidental, or consequential damages (whether denominated in contract, tort strict liability, negligence, or other theories) arising out of this Agreement or the use of any Products provided under this Agreement.

Any action arising hereunder or relating hereto, whether based on breach of contract, tort (including negligence and strict liability), or other theories must be commenced within two (2) years after the cause of action accrues or it shall be barred.

BINDING ARBITRATION

Buyer and Seller shall attempt, in good faith, to resolve any dispute arising out of or relating to this agreement, or the products and/or services provided hereunder, promptly by negotiation between executives. If the matter has not been resolved within sixty (60) days of a party's request for negotiation, either party may initiate arbitration as herein after provided.

- (a) **Any dispute arising out of or related to this agreement or the products and/or services provided hereunder which has not been resolved by the negotiation procedure described above, shall be settled by binding arbitration administered by the American Arbitration Association in accordance with its Commercial Arbitration Rules and judgment on the award rendered by the arbitrator(s) may be entered in any court having jurisdiction thereof.**
- (b) **Unless Buyer and Seller otherwise agree in writing, the arbitration panel shall consist of three arbitrators. The arbitrator(s) shall have no authority to award punitive or other damages not measured by the prevailing party's actual damages and may not, in any event, make any ruling, finding or award that does not conform to the terms and condition of this agreement. The law of Texas shall govern.**
- (c) **The arbitration proceeding shall be conducted in English, in Dallas, Texas.**

See form M-463 for the most current warranty terms. Effective November 1, 1999.

**WAUKESHA ENGINE DIVISION, DRESSER EQUIPMENT GROUP, INC.
EXPRESS LIMITED WARRANTY FOR CUSTOM ENGINE CONTROLS[®]**

INTRODUCTION

The Custom Engine Control[®] (CEC) are sold as standard, or as options on new Engines or as Genuine Service Parts, and includes the Detonation Sensing Module (DSM), Air Fuel Module (AFM), Turbocharger Control Module (TCM), and Ignition Module (IM), or any other control device identified as a CEC product.

I. TERMS OF EXPRESS LIMITED WARRANTY

Waukesha Engine Division warrants that it will repair or replace, AT ITS ELECTION AND EXPENSE, any CEC installed on an engine, or Enginator[®], or product (hereinafter referred to as "Products") manufactured by Waukesha, or purchased as a Genuine Service Part, which proves to have had a defect in material or workmanship.

II. TERM LIMITATIONS OF EXPRESS LIMITED WARRANTY

- A. This coverage shall commence upon initial new Products start-up date or the purchase date, in the case of service parts sales, and shall expire upon the earlier of the following:
 - 1. New Products
 - A. 12 months after the initial new Product start-up date; or
 - B. 24 months after the original shipment date of the covered Products by Waukesha Engine Division.
 - 2. Genuine Service Parts
 - A. 12 months from the date the CEC is put into service; or
 - B. 18 months from the purchase date.
- B. Notwithstanding the foregoing, Waukesha further warrants that it will repair or replace, AT ITS ELECTION AND EXPENSE, any component of the Waukesha Product damaged as the direct result of a warrantable defect in a CEC product.

III. WAUKESHA'S RESPONSIBILITIES UNDER THE EXPRESS LIMITED WARRANTY

Waukesha shall be responsible for:

- A. The repair or replacement, at Waukesha's election, of covered defective parts and all reasonable labor required regarding a warranted failure during the express limited warranty term. All such labor shall be provided by Waukesha's authorized contractor or distributor.
- B. For the repair of CECs installed on Products shipped from Waukesha, reasonable and necessary travel and expenses incurred by Waukesha's authorized contractor or distributor.
- C. Replacement of lubricating oil, coolant, filter elements, Waukesha supplied engine components, or other normal maintenance items that are contaminated and/or damaged as a direct result of a warranted failure.

IV. OWNER'S RESPONSIBILITIES UNDER THE EXPRESS LIMITED WARRANTY

Owner shall be responsible for:

- A. The operation and maintenance of the Products within the guidelines established by Waukesha.
- B. Making the Products available to Waukesha or Waukesha's authorized contractors or distributors for any warranty repair, during normal business hours.
- C. All additional costs incurred for premium or overtime labor, should owner request that repairs be made on a premium or overtime schedule.
- D. All costs incurred as the result of removal or reinstallation of the Products as may be required to effect any warranted repair.
- E. All administrative costs and expenses resulting from a warranted failure.
- F. Any costs of transportation, towing, repair facilities, or associated costs.
- G. All travel, mileage, and other related Distributor costs and expenses associated with repair under the terms of the Service Parts Warranty.
- H. All additional labor time in excess of Waukesha's Labor Guide for the warrantable repair.
- I. Loss of revenue and loss of or damage to real and/or personal property.

V. LIMITATION OF WAUKESHA'S OBLIGATIONS

The obligations of Waukesha under this express limited warranty shall be waived and voided, and Waukesha shall not, thereafter, be responsible for:

- A. Any failure resulting from owner or operator abuse or neglect, including but not by way of limitation, any operation, installation, application, or maintenance practice not in accordance with guidelines or specifications established by Waukesha; or
- B. Any failure resulting from unauthorized modifications or repairs of the Products; or
- C. Any failure resulting from overload, overspeed, overheat, accident, improper storage; or
- D. Failure of owner to promptly provide notice of a claimed defect; or
- E. Failure of Products for which Waukesha did not receive properly completed start-up reports; or
- F. Repairs of a covered failure performed with non-genuine Waukesha parts; or
- G. Repairs of a covered failure performed by non-authorized contractors or distributors; or
- H. Failure to make Products available to Waukesha or its authorized representatives; or
- I. Failure to supply documents such as drawings and specifications relating to the specific application of the Products; or
- J. Improper diagnosis of a Product problem for which a CEC product is replaced.
- K. Failure of Service Parts for which Waukesha did not receive proper documentation concerning the Service Parts purchase date from an authorized Waukesha Engine Distributor; or
- L. Any failure of a Service Part resulting from misapplication or improper repair procedures; or
- M. Any failure or damage resulting from the improper or extended storage of a Service Part; or
- N. Freight, Customs, Broker Fees, and Import Duties if appropriate documentation is not provided.

VI. APPLICABILITY AND EXPIRATION

The warranties set out above are extended to all owners in the original chain of distribution. The warranties and obligations of Waukesha shall expire and be of no further effect upon the dates of expiration of the applicable warranty periods.

VII. WARRANTY ADMINISTRATION

This warranty is administered exclusively by an authorized Waukesha Distributor. The invoice for the failed Service Parts must be provided to the Distributor to determine whether the warranty is applicable.

Contact the nearest authorized Waukesha Distributor for assistance with warranty matters or questions. The location of the nearest authorized Distributor is available by contacting Waukesha Engine Division at (414) 547-3311.

THE FOREGOING SETS FORTH WAUKESHA'S ONLY OBLIGATIONS AND OWNERS' EXCLUSIVE REMEDY FOR BREACH OF WARRANTY, WHETHER SUCH CLAIMS ARE BASED ON BREACH OF CONTRACT, TORT (INCLUDING NEGLIGENCE AND STRICT LIABILITY), OR OTHER THEORIES, AND THE FOREGOING IS EXPRESSLY IN LIEU OF OTHER WARRANTIES WHATSOEVER EXPRESSED, IMPLIED, AND STATUTORY, INCLUDING WITHOUT LIMITATION, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

Notwithstanding the preceding, in no event shall Waukesha be liable for any direct, special, incidental, or consequential damages (whether denominated in contract, tort strict liability, negligence, or other theories) arising out of this Agreement or the use of any Products provided under this Agreement.

Any action arising hereunder or relating hereto, whether based on breach of contract, tort (including negligence and strict liability), or other theories must be commenced within two (2) years after the cause of action accrues or it shall be barred.

BINDING ARBITRATION

- (a) Buyer and Seller shall attempt, in good faith, to resolve any dispute arising out of or relating to this agreement, or the products and/or services provided hereunder, promptly by negotiation between executives. If the matter has not been resolved within sixty (60) days of a party's request for negotiation, either party may initiate arbitration as herein after provided.
- (b) Any dispute arising out of or related to this agreement or the products and/or services provided hereunder which has not been resolved by the negotiation procedure described above, shall be settled by binding arbitration administered by the American Arbitration Association in accordance with its Commercial Arbitration Rules and judgment on the award rendered by the arbitrator(s) may be entered in any court having jurisdiction thereof.
- (c) Unless Buyer and Seller otherwise agree in writing, the arbitration panel shall consist of three arbitrators. The arbitrator(s) shall have no authority to award punitive or other damages not measured by the prevailing party's actual damages and may not, in any event, make any ruling, finding or award that does not conform to the terms and condition of this agreement. The law of Texas shall govern.
- (d) The arbitration proceeding shall be conducted in English, in Dallas, Texas.

See Form M-462 for the most current warranty terms. Effective November 1, 1999

ENERFLEX

TECHNICAL DATA

Unit No: 060158 A 1478 SOUR	Manufactured Date: Sept. 25,2006	Date: JAN. 25,2007
Send to Pamco: Ft.St.John	Attention:	Revision No.: 0
Project Manager: STEVE SUSKI	Project Engineer: STEVE SUSKI	Sales: STUART WENAAS

Customer: ENCANA CORPORATION	Address: P.O. Box 2850 150-9 th Ave SW Calgary, AB, T2P-2S5
Contact: Will Thompson	
Phone No: (403)645-4599	

Unit Location: L.S.D.: d-85-G/93-P-7	Site Contact: TBD	Phone No.:
	Contact for Spare Parts: PAMCO	Phone No.:

Start-Up	As per sales order: <input type="checkbox"/>	No Allowance in sales order: <input checked="" type="checkbox"/>	Details:
Field Completion	As per sales order: <input type="checkbox"/>	No Allowance in sales order: <input checked="" type="checkbox"/>	Details:
Site Re-assembly	As per sales order: <input type="checkbox"/>	No Allowance in sales order: <input checked="" type="checkbox"/>	Details:
Performance Data	See Manual		
Parts Manuals	Shipping Date: TBD	Blueprints/Drawings: See Manual	
Parts Shortages: NA			

DRIVER MANUFACTURER: WAUKESHA	Model No.: L 7042 GL ESM	S/ N: C - 16624 / 1
	Starter Mfg: TDI	P/N: T112 - 60001 - BIR

COMPRESSOR: ARIEL	Model No.: JGK / 4	S/ N: F - 24069
THROW #1 S/N: C - 77671 (Stg. 2)	THROW #2 S/N: C - 77672 (Stg. 1)	THROW #3 S/N: C - 77673 (Stg. 2)
THROW #4 S/N: C - 77674 (Stg. 1)		
COOLER: AIR - X - HEMPHILL	Model No.: 144 EF	Serial No.: 64468 F
CONTROL PANEL: SYNTECH	Model No.: RC 2000	Serial No.: 000312

SCRUBBERS	STAGE 1 S/N : 060550 - 01	CRN# R 8707.213	MAWP: 1315 psig
	STAGE 2 S/N : 060552 - 01	CRN# R 7478.213	MAWP: 1315 psig
	FUEL GAS S/N : 06 - 250	CRN# L 7030.213	MAWP: 285 psig

SUCTION BOTTLES	STAGE 1 S/N : 051210 - 01	CRN# T 1174.213	MAWP: 1315 psig
	STAGE 2 S/N : 060554 - 01	CRN# R 0778.213	MAWP: 1315 psig

DISCHARGE BOTTLES	STAGE 1 S/N : 2725 - 2	CRN# R 0780.213	MAWP: 1292 psig
	STAGE 2 S/N : 060760 - 01	CRN# R 7655.213	MAWP: 1935 psig

PSV [SET PRESSURE]

STG. # 1 S/N: 505149 - 2 - A10 [1270 psig]	STG. #2 S/N: 506862-1-DA [1440 psig]	FUEL GAS S/N: 250473 [165 psig]
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Pressure Relief Valve Specification Sheet

Date Prepared: 2006-10-31 07:51

General Job Data

Customer	Requisition #	Job #	Job Description	
Enerflex Systems Ltd.		-	Encana	
Prepared By	Checked By	Approved By	Job Status	Revision #
Greg St.Laurent			Sizing/Selecting	0

PSV Identification

Tag #	Tag Description	Tag Status	P / ID	Discharge To	Revision #		
Stage 1		Valve Selected			0		
Plant #	Drawing #	Index #	Issue For	Service	Inlet Line #	Outlet Line #	Revised By
							Greg St.Laurent

Sizing Basis

ASME Code	Cause of Over Pressure	Fluid State	Rupture Disk Coeff.	NACE
ASME Sec. VIII	-	Gas (Volume)	No Rupture Disk, 1	Yes

Process Parameters

MAWP	- PSIG	Design Temp.	- °F	Constant Back P.	0 PSIG
Operating Pressure	350 PSIG	Operating Temp.	350 °F	Variable Back P.	0 PSIG
Set Pressure	1270 PSIG	Relief Temp.	350 °F	Over Pressure	127 PSIG
Operating to Set %	27.559 %	Percent Over P.	10 %	Cold Diff. Test P.	1282.7 PSIG
Atm Pressure	14.697 PSIA	Relief Pressure	1411.7 PSIA		

Compressible State

Fluid	Sour Gas	Molecular Weight	18.509 Mol Wt	Gas Flow Const.	347.01
Req. Flow Cap.	23.668 M ft ³ /day	Specific Gravity	0.6389 sp gr	Compressibility	0.9196
Calculated Area	0.72613 in ²	Specific Heat Ratio	1.3001		

Resolved ASME Area: 0.72613 in² (Resolved by Maximum) Resolved API Area: 0.65351 in²

Model Selection

Manufacturer	Farris	API Letter	H	Inlet Size	2.0 in	Outlet Size	3.0 in
Model Number	26HA13-120	API Area	0.785 in ²	In. Rating	600 #	Out. Rating	150 #
Valve Design	Conventional	ASME Area	0.873 in ²	In. Facing	RF	Out. Facing	RF
Cap Constrn	Screwed Cap	Max. Cap.	28.455 M ft ³ /day	Test Gag	No	Quantity	1
React. Force	1512.2 lbs	Noise	116.85 dBa				

Model Materials

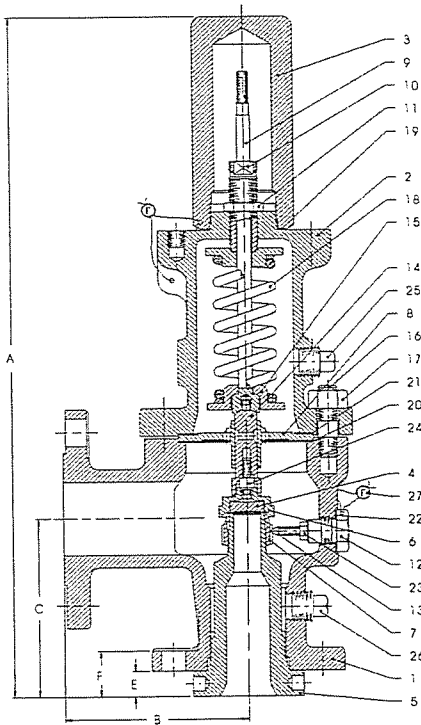
Body	Carbon Steel	Bonnet	Carbon Steel	Nozzle	316 ss
Disc	316 ss	Guide	316 ss	Spring	Chrome Alloy
Bellows	N/A				

Pressure Relief Valve Reference Drawing

Date Prepared: 2006-10-31 07:51

PSV Identification

Customer	Requisition #	Job #	Job Description	
Enerflex Systems Ltd.			Encana	
Tag #	Tag Description	P / ID	NACE	
Stage 1			Yes	
ASME Code	Fluid State	Resolved ASME Area	Resolved API Area	Rupture Disk Coeff.
ASME Sec. VIII	Gas (Volume)	0.72613 in ²	0.65351 in ²	No Rupture Disk, 1
Operating Pressure	Set Pressure	Constant Back P.	Variable Back P.	Cold Diff. Test P.
350 PSIG	1270 PSIG	0 PSIG	0 PSIG	1282.7 PSIG
Operating Temp.	Relief Temp.	Operating to Set %	Over Pressure	Percent Over P.
350 °F	350 °F	27.559 %	127 PSIG	10 %



Dimensions

Weight	Dimension A	Dimension B
70 lb	24 in	6 3/8 in
Dimension C	Dimension E	Dimension F
6 1/16 in	1 1/16 in	1 11/16 in

Farris 26HA13-120

API Letter	API Area	ASME Area
H	0.785 in ²	0.873 in ²

	Size	Rating	Facing
Inlet:	2.0 in	600 #	RF
Outlet:	3.0 in	150 #	RF

Valve Design	Cap Constrn	Test Gag
Conventional	Screwed Cap	No
Max. Rel. Cap.	React. Force	Noise
28.455 M ft ³ /day	1512.2 lbs	116.85 dBa

Materials

Body (1)	Bonnet (2)
Carbon Steel	Carbon Steel
Nozzle (5)	Disc (4)
316 ss	316 ss
Guide (8)	Spring (18)
316 ss	Chrome Alloy
Bellows (15)	
N/A	

ENCANA
06 0158

Pressure Relief Valve Specification Sheet

Date Prepared: 2007-06-25 13:56

General Job Data

Customer	Requisition #	Job #	Job Description	
Enerflex Systems Ltd.		060158		
Prepared By	Checked By	Approved By	Job Status	Revision #
Greg St.Laurent			Sizing/Selecting	0

PSV Identification

Tag #	Tag Description	Tag Status	P / ID	Discharge To	Revision #		
Stage 2		Valve Selected			0		
Plant #	Drawing #	Index #	Issue For	Service	Inlet Line #	Outlet Line #	Revised By
							Greg St.Laurent

Sizing Basis

ASME Code	Cause of Over Pressure	Fluid State	Rupture Disk Coeff.	NACE
ASME Sec. VIII	-	Gas (Volume)	No Rupture Disk, 1	No

Process Parameters

MAWP	- PSIG	Design Temp.	- °F	Constant Back P.	0 PSIG
Operating Pressure	- PSIG	Operating Temp.	350 °F	Variable Back P.	0 PSIG
Set Pressure	1440 PSIG	Relief Temp.	350 °F	Over Pressure	144 PSIG
Operating to Set %	- %	Percent Over P.	10 %	Cold Diff. Test P.	1454.4 PSIG
Atm Pressure	14.697 PSIA	Relief Pressure	1598.7 PSIA		

Compressible State

Fluid	Sweet Gas	Molecular Weight	18.831 Mol Wt	Gas Flow Const.	345
Req. Flow Cap.	15 M ft ³ /day	Specific Gravity	0.65 sp gr	Compressibility	0.98
Calculated Area	0.42559 in ²	Specific Heat Ratio	1.28		

Resolved ASME Area: 0.42559 in² (Resolved by Maximum) Resolved API Area: 0.38303 in²

Model Selection

Selection Warning: selected valve not valid for Kd parameter.

Manufacturer	Farris	API Letter	G	Inlet Size	1.50 in	Outlet Size	3.00 in
Model Number	38GC14-120	API Area	0.503 in ²	In. Rating	900 #	Out. Rating	300 #
Valve Design	Pilot	ASME Area	0.559 in ²	In. Facing	RF	Out. Facing	RF
Pilot Control	Snap Acting	Max. Cap.	19.702 M ft ³ /day	Test Gag	No	Quantity	1
React. Force	1067 lbs	Noise	115.19 dBa				

Model Materials

Body	Carbon Steel	Cover	316 ss	Nozzle	316 ss
Piston	316 ss	Spring	316 ss	Pilot	316 ss
O-Ring	Viton				

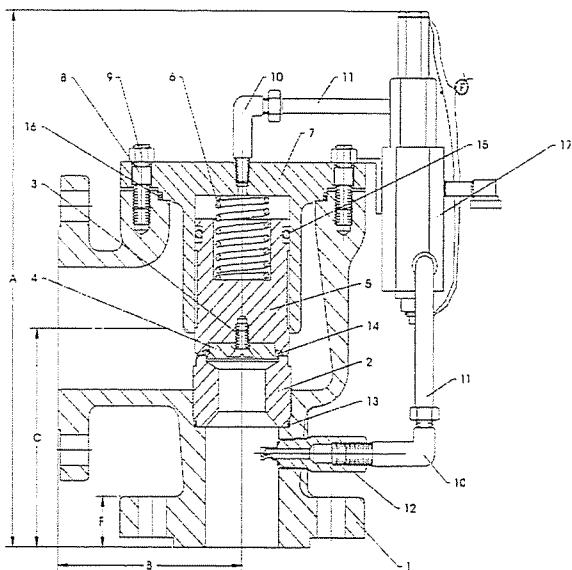
Pressure Relief Valve Reference Drawing

Date Prepared: 2007-06-25 13:56

PSV Identification

Customer	Requisition #	Job #	Job Description	
Enerflex Systems Ltd.		060158		
Tag #	Tag Description		P / ID	NACE
Stage 2				No
ASME Code	Fluid State	Resolved ASME Area	Resolved API Area	Rupture Disk Coeff.
ASME Sec. VIII	Gas (Volume)	0.42559 in ²	0.38303 in ²	No Rupture Disk, 1
Operating Pressure	Set Pressure	Constant Back P.	Variable Back P.	Cold Diff. Test P.
- PSIG	1440 PSIG	0 PSIG	0 PSIG	1454.4 PSIG
Operating Temp.	Relief Temp.	Operating to Set %	Over Pressure	Percent Over P.
350 °F	350 °F	- %	144 PSIG	10 %

Selection Warning: selected valve not valid for Kd parameter.



Farris 38GC14-120

API Letter	API Area	ASME Area
G	0.503 in ²	0.559 in ²

	Size	Rating	Facing
Inlet:	1.50 in	900 #	RF
Outlet:	3.00 in	300 #	RF

Valve Design	Pilot Control	Test Gag
Pilot	Snap Acting	No

Max. Rel. Cap.	React. Force	Noise
19.702 M ft ³ /day	1067 lbs	115.19 dBa

Dimensions

Weight	Dimension A	Dimension B
81 lb	15 in	6 3/4 in
Dimension C	Dimension E	Dimension F
6 3/8 in	1/4 in	1 9/16 in

Materials

Body (1)	Cover (7)
Carbon Steel	316 ss
Nozzle (2)	Piston (5)
316 ss	316 ss
Spring (6)	Pilot (17)
316 ss	316 ss
O-Ring (14)	
Viton	

ENERFLEX

PERFORMANCE

COMPRESSOR PERFORMANCE SUMMARY

Compressor: Ariel JGK-4 c/w (2) 9.125" K + (2) 5.875" K cylinders x 5-1/2" stroke.
 Engine: Waukesha L7042GL rated 1448 HP @ 1200 rpm @ 2500 Ft., 90°F.
 Cooler: Air-X-Hemphill 144EF requires approximately 60 HP to drive.

Page No.	Suction Pressure (psig)	Discharge Pressure (psig)	Capacity (mmscfd)	Compression Horsepower	Operating Mode
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1.	300	1400	14.777	1385	CE, DBL + DBL, DBL
2.	275	1400	14.036	1385	CE, DBL + DBL, DBL
3.	250	1400	13.838	1385	DBL, DBL + DBL, DBL
4.	225	1400	12.632	1385	DBL, DBL + DBL, DBL
5.	200	1400	11.683	1385	DBL, DBL + DBL, DBL
6.	175	1400	10.957	1385	DBL, DBL + DBL, DBL
7.	150	1400	10.224	1385	DBL, DBL + DBL, DBL
*8.	139.90	1400	9.924	1385	DBL, DBL + DBL, DBL
9.	125	1400	8.731	1281	DBL, DBL + DBL, DBL
10.	100	1400	6.753	1088	DBL, DBL + DBL, DBL
11.	Gas Analysis Used For Pd=1400 psig				
12.	300	1200	16.291	1385	CE, DBL + DBL, DBL
13.	275	1200	15.398	1385	CE, DBL + DBL, DBL
14.	250	1200	14.614	1385	DBL, DBL + DBL, DBL
15.	225	1200	13.565	1385	DBL, DBL + DBL, DBL
16.	200	1200	12.713	1385	DBL, DBL + DBL, DBL
17.	175	1200	11.870	1385	DBL, DBL + DBL, DBL
*18.	150.15	1200	11.027	1385	DBL, DBL + DBL, DBL
19.	150	1200	11.015	1384	DBL, DBL + DBL, DBL
20.	125	1200	9.001	1233	DBL, DBL + DBL, DBL
21.	100	1200	7.017	1060	DBL, DBL + DBL, DBL
22.	Gas Analysis Used For Pd=1200 psig				
23.	300	1000	18.597	1385	DBL, DBL + DBL, DBL
24.	275	1000	17.458	1385	DBL, DBL + DBL, DBL
25.	250	1000	16.255	1385	DBL, DBL + DBL, DBL
26.	225	1000	15.187	1385	DBL, DBL + DBL, DBL
27.	200	1000	14.149	1385	DBL, DBL + DBL, DBL
28.	175	1000	13.127	1385	DBL, DBL + DBL, DBL
*29.	169.60	1000	12.908	1385	DBL, DBL + DBL, DBL
30.	150	1000	11.304	1297	DBL, DBL + DBL, DBL
31.	125	1000	9.283	1168	DBL, DBL + DBL, DBL
32.	100	1000	7.291	1017	DBL, DBL + DBL, DBL
33.	Gas Analysis Used For Pd=1000 psig				
34.	300	800	21.965	1385	DBL, DBL + DBL, DBL
35.	275	800	20.444	1385	DBL, DBL + DBL, DBL
36.	250	800	18.991	1385	DBL, DBL + DBL, DBL
37.	225	800	17.595	1385	DBL, DBL + DBL, DBL
*38.	216.25	800	17.114	1385	DBL, DBL + DBL, DBL
39.	200	800	15.745	1343	DBL, DBL + DBL, DBL
40.	175	800	13.660	1269	DBL, DBL + DBL, DBL
41.	150	800	11.604	1182	DBL, DBL + DBL, DBL
42.	125	800	9.575	1078	DBL, DBL + DBL, DBL
43.	100	800	7.575	953	DBL, DBL + DBL, DBL
44.	Gas Analysis Used For Pd=800 psig				



COMPRESSOR PERFORMANCE SUMMARY

Compressor: Ariel JGK-4 c/w (2) 9.125" K + (2) 5.875" K cylinders x 5-1/2" stroke.
 Engine: Waukesha L7042GL rated 1448 HP @ 1200 rpm @ 2500 Ft., 90°F.
 Cooler: Air-X-Hemphill 144EF requires approximately 60 HP to drive.

Page No.	Suction Pressure (psig)	Discharge Pressure (psig)	Capacity (mmscfd)	Compression Horsepower	Operating Mode
----------	-------------------------	---------------------------	-------------------	------------------------	----------------

- * minimum suction pressure to load HP
- ** minimum suction pressure
- *** maximum suction pressure

Operating Conditions		Site Conditions	
Speed =	1200 rpm	Elevation =	2500 feet
Gas is Sour, S.G. =	0.6766	Ambient Temperature =	90°F.
Suction Temperature =	60°F.		
IC Cooling Temperature =	120°F.		
AC Cooling Temperature =	120°F.		

Legend

- CE - crank end single acting cylinder (head end valves manually removed from cylinder)
- DBL - double acting cylinder (all valves in cylinder)
- Blank - cylinder/piston has been removed from throw (ie. 4 throw frame operating with only 3 throws)
- DIS - cylinder disabled (head end valves and crank end valves manually removed from cylinder)





Ariel Performance

Company: EFX Compression
 Quote: 060158, 060159, 060160
 Remarks: Sour Gas Compressor

Customer: EnCana Corporation
 Inquiry: Darryl Burns
 Project: Stock Units



Compressor Data:

Elevation,ft: 2500.0 Barmtr,psia: 13.400
 Frame: JGK/4 Stroke, in: 5.50
 Max RL Tot, lbf: 74000 Max RL Tens, lbf: 37000
 Rated RPM: 1200 Rated BHP: 2540.0
 Calc RPM: 1200.0 Calc BHP: 1385

Driver Data:

Ambient, °F: 90.00 Type: Nat. Gas
 Rod Dia, in: 2.000 Mfg: Waukesha
 Max RL Comp, lbf: 40000 Model: L7042GL
 Rated PS FPM: 1100.0 BHP: 1448
 Calc PS FPM: 1100.0 Avail: 1385 (63)

CUSTOM LIMITS SOUR GAS-2

Services

Gathering

Stage Data:	#1	---	#2	---
Flow Req'd, MMSCFD	0.000	---	0.000	---
Flow Calc, MMSCFD	14.777	---	14.777	---
Cyl BHP per Stage	701.5	---	659.5	---
Specific Gravity	0.6767	---	0.6767	---
Ratio of Sp Ht (N)	1.2845	---	1.2832	---
Comp Suct (Zs)	0.9369	---	0.9087	---
Comp Disch (Zd)	0.9293	---	0.9165	---
Pres Suct Line, psig	300.00	---	N/A	---
Pres Suct Flg, psig	300.00	---	670.13	---
Pres Disch Flg, psig	680.13	---	1414.13	---
Pres Disch Line, psig	N/A	---	1400.00	---
Pres Ratio F/F	2.213	---	2.088	---
Temp Suct, °F	60.00	---	120.00	---
Temp Clr Disch, °F	120.00	---	120.00	---

Cylinder Data:

Throw 2

Throw 4

Throw 1

Throw 3

Cyl Model	9-5/8K	9-5/8K	6-1/4K	6-1/4K
Cyl Bore, in	9.125	9.125	5.875	5.875
Cyl RDP (API), psig	1154.5	1154.5	1863.6	1863.6
Cyl MAWP, psig	1270.0	1270.0	2050.0	2050.0
Cyl Action	CE(HEVR)	DBL	DBL	DBL
Cyl Disp, CFM	237.8	487.6	195.1	195.1
Pres Suct Intl, psig	276.81	275.44	638.00	638.00
Temp Suct Intl, °F	69	65	124	124
Suct Zsph	0.9405	0.9390	0.9111	0.9111
Pres Disch Intl, psig	734.08	737.16	1504.60	1504.60
Temp Disch Intl, °F	192	188	243	243
HE Suct Gas Vel, FPM	N/A	8673	7217	7217
HE Disch Gas Vel, FPM	N/A	8197	7702	7702
HE Spcrrs Used/Max	N/A	0/4	0/2	0/2
HE Vol Pkt Avail, %	N/A	0.86+49.13	0.64+45.20	0.64+45.20
Vol Pkt Used, %	N/A	95.52 (V)	100.00 (V)	100.00 (V)
HE Min Clr, %	N/A	17.39	21.95	21.95
HE Total Clr, %	N/A	65.18	67.78	67.78
CE Suct Gas Vel, FPM	8256	8256	6381	6381
CE Disch Gas Vel, FPM	7803	7803	6809	6809
CE Spcrrs Used/Max	1/4	0/4	0/2	0/2
CE Min Clr, %	19.03	19.03	26.69	26.69
CE Total Clr, %	22.54	19.03	26.69	26.69
Suct Vol Eff HE/CE, %	N/A/74.7	38.3/77.6	43.5/74.1	43.5/74.1
Disch Event HE/CE, ms	N/A/11.8	6.9/11.9	7.6/11.9	7.6/11.9
Suct Pseudo-Q HE/CE	N/A/8.1	8.5/8.1	5.6/4.5	5.6/4.5
Gas Rod Ld Comp, lbf	2656 C	31161 C	25695 C	25695 C
Gas Rod Ld Tens, lbf	26268 T	27789 T	18612 T	18612 T
Gas Rod Ld Total, lbf	28924	58950	44307	44307
Xhd Pin Deg/%RvrsI lbf	115/51.8	159/83.2	164/52.1	164/52.1
Flow Calc, MMSCFD	5.700	9.077	7.388	7.388
Cyl BHP	275.8	425.8	329.7	329.7



Ariel Performance

Company: EFX Compression
 Quote: 060158, 060159, 060160
 Remarks: Sour Gas Compressor

Customer: EnCana Corporation
 Inquiry: Darryl Burns
 Project: Stock Unjts



Compressor Data:

Elevation,ft:	2500.0	Barmtr,psia:	13.400	Ambient,°F:	90.00
Frame:	JGK/4	Stroke, in:	5.50	Rod Dia, in:	2.000
Max RL Tot, lbf:	74000	Max RL Tens, lbf:	37000	Max RL Comp, lbf:	40000
Rated RPM:	1200	Rated BHP:	2540.0	Rated PS FPM:	1100.0
Calc RPM:	1200.0	Calc BHP:	1385	Calc PS FPM:	1100.0

Driver Data:

Type:	Nat. Gas
Mfg:	Waukesha
Model:	L7042GL
BHP:	1448
Avail:	1385 (63)

CUSTOM LIMITS SOUR GAS-2

Services

Gathering

Stage Data:	#1	---	#2	---
Flow Req'd, MMSCFD	0.000	---	0.000	---
Flow Calc, MMSCFD	14.036	---	14.036	---
Cyl BHP per Stage	716.2	---	645.2	---
Specific Gravity	0.6767	---	0.6767	---
Ratio of Sp Ht (N)	1.2822	---	1.2824	---
Comp Suct (Zs)	0.9420	---	0.9106	---
Comp Disch (Zd)	0.9341	---	0.9183	---
Pres Suct Line, psig	275.00	---	N/A	---
Pres Suct Flg, psig	275.00	---	655.12	---
Pres Disch Flg, psig	665.12	---	1414.13	---
Pres Disch Line, psig	N/A	---	1400.00	---
Pres Ratio F/F	2.353	---	2.135	---
Temp Suct, °F	60.00	---	120.00	---
Temp Clr Disch, °F	120.00	---	120.00	---

Cylinder Data:

Throw 2

Throw 4

Throw 1

Throw 3

Cyl Model	9-5/8K	9-5/8K	6-1/4K	6-1/4K
Cyl Bore, in	9.125	9.125	5.875	5.875
Cyl RDP (API), psig	1154.5	1154.5	1863.6	1863.6
Cyl MAWP, psig	1270.0	1270.0	2050.0	2050.0
Cyl Action	CE(HEVR)	DBL	DBL	DBL
Cyl Disp, CFM	237.8	487.6	195.1	195.1
Pres Suct Intl, psig	253.79	252.53	623.77	623.77
Temp Suct Intl, °F	69	65	124	124
Suct Zsph	0.9454	0.9440	0.9131	0.9131
Pres Disch Intl, psig	716.98	719.94	1504.00	1504.00
Temp Disch Intl, °F	200	196	246	246
HE Suct Gas Vel, FPM	N/A	8673	7217	7217
HE Disch Gas Vel, FPM	N/A	8197	7702	7702
HE Spcrrs Used/Max	N/A	0/4	0/2	0/2
HE Vol Pkt Avail, %	N/A	0.86+49.13	0.64+45.20	0.64+45.20
Vol Pkt Used, %	N/A	58.86 (V)	100.00 (V)	100.00 (V)
HE Min Clr, %	N/A	17.39	21.95	21.95
HE Total Clr, %	N/A	47.16	67.78	67.78
CE Suct Gas Vel, FPM	8256	8256	6381	6381
CE Disch Gas Vel, FPM	7803	7803	6809	6809
CE Spcrrs Used/Max	1/4	0/4	0/2	0/2
CE Min Clr, %	19.03	19.03	26.69	26.69
CE Total Clr, %	22.54	19.03	26.69	26.69
Suct Vol Eff HE/CE, %	N/A/72.5	49.2/75.8	41.4/73.3	41.4/73.3
Disch Event HE/CE, ms	N/A/11.3	7.8/11.5	7.4/11.8	7.4/11.8
Suct Pseudo-Q HE/CE	N/A/8.0	8.9/8.1	5.5/4.5	5.5/4.5
Gas Rod Ld Comp, lbf	2432 C	31461 C	26020 C	26020 C
Gas Rod Ld Tens, lbf	26823 T	28215 T	18983 T	18983 T
Gas Rod Ld Total, lbf	29255	59676	45003	45003
Xhd Pin Deg/%Rvrsl lbf	102/48.3	149/89.9	164/51.4	164/51.4
Flow Calc, MMSCFD	5.060	8.976	7.018	7.018
Cyl BHP	263.0	453.2	322.6	322.6



Ariel Performance

Company: EFX Compression
 Quote: 060158, 060159, 060160
 7.5.1.1 Remarks: Sour Gas Compressor

Customer: EnCana Corporation
 Inquiry: Darryl Burns
 Project: Stock Units



Compressor Data:

Elevation,ft:	2500.0	Barmtr,psia:	13.400	Ambient,°F:	90.00
Frame:	JGK/4	Stroke, in:	5.50	Rod Dia, in:	2.000
Max RL Tot, lbf:	74000	Max RL Tens, lbf:	37000	Max RL Comp, lbf:	40000
Rated RPM:	1200	Rated BHP:	2540.0	Rated PS FPM:	1100.0
Calc RPM:	1200.0	Calc BHP:	1385	Calc PS FPM:	1100.0

Driver Data:

Type:	Nat. Gas
Mfg:	Waukesha
Model:	L7042GL
BHP:	1448
Avail:	1385 (63)

CUSTOM LIMITS SOUR GAS-2

Services

Gathering

Stage Data:

#1

#2

Flow Req'd, MMSCFD	0.000	---	0.000	---
Flow Calc, MMSCFD	13.383	---	13.383	---
Cyl BHP per Stage	729.8	---	631.6	---
Specific Gravity	0.6767	---	0.6767	---
Ratio of Sp Ht (N)	1.2797	---	1.2817	---
Comp Suct (Zs)	0.9471	---	0.9123	---
Comp Disch (Zd)	0.9391	---	0.9200	---
Pres Suct Line, psig	250.00	---	N/A	---
Pres Suct Flg, psig	250.00	---	641.82	---
Pres Disch Flg, psig	651.82	---	1414.13	---
Pres Disch Line, psig	N/A	---	1400.00	---
Pres Ratio F/F	2.526	---	2.179	---
Temp Suct, °F	60.00	---	120.00	---
Temp Clr Disch, °F	120.00	---	120.00	---

Cylinder Data:

Throw 2

Throw 4

Throw 1

Throw 3

Cyl Model	9-5/8K	9-5/8K	6-1/4K	6-1/4K
Cyl Bore, in	9.125	9.125	5.875	5.875
Cyl RDP (API), psig	1154.5	1154.5	1863.6	1863.6
Cyl MAWP, psig	1270.0	1270.0	2050.0	2050.0
Cyl Action	DBL	DBL	DBL	DBL
Cyl Disp, CFM	487.6	487.6	195.1	195.1
Pres Suct Intl, psig	229.61	229.61	611.15	611.15
Temp Suct Intl, °F	66	66	124	124
Suct Zsph	0.9490	0.9490	0.9148	0.9148
Pres Disch Intl, psig	704.53	704.53	1503.47	1503.47
Temp Disch Intl, °F	205	205	249	249
HE Suct Gas Vel, FPM	8673	8673	7217	7217
HE Disch Gas Vel, FPM	8197	8197	7702	7702
HE Spcrrs Used/Max	0/4	0/4	0/2	0/2
HE Vol Pkt Avail, %	0.86+49.13	0.86+49.13	0.64+45.20	0.64+45.20
Vol Pkt Used, %	85.84 (V)	85.84 (V)	100.00 (V)	100.00 (V)
HE Min Clr, %	17.39	17.39	21.95	21.95
HE Total Clr, %	60.42	60.42	67.78	67.78
CE Suct Gas Vel, FPM	8256	8256	6381	6381
CE Disch Gas Vel, FPM	7803	7803	6809	6809
CE Spcrrs Used/Max	0/4	0/4	0/2	0/2
CE Min Clr, %	19.03	19.03	26.69	26.69
CE Total Clr, %	19.03	19.03	26.69	26.69
Suct Vol Eff HE/CE, %	29.7/73.4	29.7/73.4	39.4/72.5	39.4/72.5
Disch Event HE/CE, ms	5.7/11.0	5.7/11.0	7.1/11.7	7.1/11.7
Suct Pseudo-Q HE/CE	7.7/8.0	7.7/8.0	5.4/4.5	5.4/4.5
Gas Rod Ld Comp, lbf	31880 C	31880 C	26309 C	26309 C
Gas Rod Ld Tens, lbf	28754 T	28754 T	19311 T	19311 T
Gas Rod Ld Total, lbf	60634	60634	45620	45620
Xhd Pin Deg/%Rvrsl lbf	145/79.7	145/79.7	165/50.9	165/50.9
Flow Calc, MMSCFD	6.691	6.691	6.691	6.691
Cyl BHP	364.9	364.9	315.8	315.8



Ariel Performance

Company: EFX Compression
 Quote: 060158, 060159, 060160
 Remarks: Sour Gas Compressor

Customer: EnCana Corporation
 Inquiry: Darryl Burns
 Project: Stock Units

EFX Compression

Compressor Data:

Elevation,ft:	2500.0	Barmtr,psia:	13.400	Ambient,°F:	90.00
Frame:	JGK/4	Stroke, in:	5.50	Rod Dia, in:	2.000
Max RL Tot, lbf:	74000	Max RL Tens, lbf:	37000	Max RL Comp, lbf:	40000
Rated RPM:	1200	Rated BHP:	2540.0	Rated PS FPM:	1100.0
Calc RPM:	1200.0	Calc BHP:	1385	Calc PS FPM:	1100.0

Driver Data:

Type:	Nat. Gas
Mfg:	Waukesha
Model:	L7042GL
BHP:	1448
Avail:	1385 (63)

CUSTOM LIMITS SOUR GAS-2

Services

Gathering

Stage Data:

	#1		#2	
Flow Req'd, MMSCFD	0.000	---	0.000	---
Flow Calc, MMSCFD	12.632	---	12.632	---
Cyl BHP per Stage	746.9	---	614.5	---
Specific Gravity	0.6767	---	0.6767	---
Ratio of Sp Ht (N)	1.2771	---	1.2809	---
Comp Suct (Zs)	0.9522	---	0.9143	---
Comp Disch (Zd)	0.9441	---	0.9219	---
Pres Suct Line, psig	225.00	---	N/A	---
Pres Suct Flg, psig	225.00	---	626.43	---
Pres Disch Flg, psig	636.43	---	1414.13	---
Pres Disch Line, psig	N/A	---	1400.00	---
Pres Ratio F/F	2.726	---	2.231	---
Temp Suct, °F	60.00	---	120.00	---
Temp Clr Disch, °F	120.00	---	120.00	---

Cylinder Data:

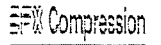
	Throw 2	Throw 4	Throw 1	Throw 3
Cyl Model	9-5/8K	9-5/8K	6-1/4K	6-1/4K
Cyl Bore, in	9.125	9.125	5.875	5.875
Cyl RDP (API), psig	1154.5	1154.5	1863.6	1863.6
Cyl MAWP, psig	1270.0	1270.0	2050.0	2050.0
Cyl Action	DBL	DBL	DBL	DBL
Cyl Disp, CFM	487.6	487.6	195.1	195.1
Pres Suct Intl, psig	206.65	206.65	596.55	596.55
Temp Suct Intl, °F	66	66	124	124
Suct Zsph	0.9540	0.9540	0.9167	0.9167
Pres Disch Intl, psig	686.87	686.87	1502.85	1502.85
Temp Disch Intl, °F	216	216	253	253
HE Suct Gas Vel, FPM	8673	8673	7217	7217
HE Disch Gas Vel, FPM	8197	8197	7702	7702
HE Spcrs Used/Max	0/4	0/4	0/2	0/2
HE Vol Pkt Avail, %	0.86+49.13	0.86+49.13	0.64+45.20	0.64+45.20
Vol Pkt Used, %	59.45 (V)	59.45 (V)	100.00 (V)	100.00 (V)
HE Min Clr, %	17.39	17.39	21.95	21.95
HE Total Clr, %	47.46	47.46	67.78	67.78
CE Suct Gas Vel, FPM	8256	8256	6381	6381
CE Disch Gas Vel, FPM	7803	7803	6809	6809
CE Spcrs Used/Max	0/4	0/4	0/2	0/2
CE Min Clr, %	19.03	19.03	26.69	26.69
CE Total Clr, %	19.03	19.03	26.69	26.69
Suct Vol Eff HE/CE, %	37.1/70.8	37.1/70.8	37.0/71.5	37.0/71.5
Disch Event HE/CE, ms	6.2/10.4	6.2/10.4	6.8/11.4	6.8/11.4
Suct Pseudo-Q HE/CE	8.3/8.0	8.3/8.0	5.3/4.4	5.3/4.4
Gas Rod Ld Comp, lbf	32154 C	32154 C	26642 C	26642 C
Gas Rod Ld Tens, lbf	29156 T	29156 T	19692 T	19692 T
Gas Rod Ld Total, lbf	61310	61310	46334	46334
Xhd Pin Deg/%Rvrsl lbf	143/86.8	143/86.8	166/50.3	166/50.3
Flow Calc, MMSCFD	6.316	6.316	6.316	6.316
Cyl BHP	373.5	373.5	307.2	307.2



Ariel Performance

Company: EFX Compression
 Quote: 060158, 060159, 060160
 7.5.1.1 Remarks: Sour Gas Compressor

Customer: EnCana Corporation
 Inquiry: Darryl Burns
 Project: Stock Units



Compressor Data:

Elevation,ft:	2500.0	Barmtr,psia:	13.400	Ambient,°F:	90.00
Frame:	JGK/4	Stroke, in:	5.50	Rod Dia, in:	2.000
Max RL Tot, lbf:	74000	Max RL Tens, lbf:	37000	Max RL Comp, lbf:	40000
Rated RPM:	1200	Rated BHP:	2540.0	Rated PS FPM:	1100.0
Calc RPM:	1200.0	Calc BHP:	1385	Calc PS FPM:	1100.0

Driver Data:

Type:	Nat. Gas
Mfg:	Waukesha
Model:	L7042GL
BHP:	1448
Avail:	1385 (63)

CUSTOM LIMITS SOUR GAS-2

Services

Gathering

Stage Data:

#1

#2

Flow Req'd, MMSCFD	0.000	---	0.000	---
Flow Calc, MMSCFD	11.683	---	11.683	---
Cyl BHP per Stage	614.0	---	747.4	---
Specific Gravity	0.6767	---	0.6767	---
Ratio of Sp Ht (N)	1.2764	---	1.2729	---
Comp Suct (Zs)	0.9572	---	0.9318	---
Comp Disch (Zd)	0.9497	---	0.9391	---
Pres Suct Line, psig	200.00	---	N/A	---
Pres Suct Flg, psig	200.00	---	492.82	---
Pres Disch Flg, psig	502.82	---	1414.13	---
Pres Disch Line, psig	N/A	---	1400.00	---
Pres Ratio F/F	2.419	---	2.820	---
Temp Suct, °F	60.00	---	120.00	---
Temp Clr Disch, °F	120.00	---	120.00	---

Cylinder Data:

Throw 2

Throw 4

Throw 1

Throw 3

Cyl Model	9-5/8K	9-5/8K	6-1/4K	6-1/4K
Cyl Bore, in	9.125	9.125	5.875	5.875
Cyl RDP (API), psig	1154.5	1154.5	1863.6	1863.6
Cyl MAWP, psig	1270.0	1270.0	2050.0	2050.0
Cyl Action	DBL	DBL	DBL	DBL
Cyl Disp, CFM	487.6	487.6	195.1	195.1
Pres Suct Intl, psig	183.64	183.64	469.67	469.67
Temp Suct Intl, °F	65	65	125	125
Suct Zsph	0.9587	0.9587	0.9342	0.9342
Pres Disch Intl, psig	543.76	543.76	1497.27	1497.27
Temp Disch Intl, °F	197	197	287	287
HE Suct Gas Vel, FPM	8673	8673	7217	7217
HE Disch Gas Vel, FPM	8197	8197	7702	7702
HE Spcrrs Used/Max	0/4	0/4	0/2	0/2
HE Vol Pkt Avail, %	0.86+49.13	0.86+49.13	0.64+45.20	0.64+45.20
Vol Pkt Used, %	78.77 (V)	78.77 (V)	0.00 (V)	0.00 (V)
HE Min Clr, %	17.39	17.39	21.95	21.95
HE Total Clr, %	56.95	56.95	22.58	22.58
CE Suct Gas Vel, FPM	8256	8256	6381	6381
CE Disch Gas Vel, FPM	7803	7803	6809	6809
CE Spcrrs Used/Max	0/4	0/4	0/2	0/2
CE Min Clr, %	19.03	19.03	26.69	26.69
CE Total Clr, %	19.03	19.03	26.69	26.69
Suct Vol Eff HE/CE, %	37.1/74.8	37.1/74.8	65.8/60.9	65.8/60.9
Disch Event HE/CE, ms	6.5/11.3	6.5/11.3	8.3/9.4	8.3/9.4
Suct Pseudo-Q HE/CE	8.3/8.0	8.3/8.0	5.6/4.4	5.6/4.4
Gas Rod Ld Comp, lbf	24204 C	24204 C	29534 C	29534 C
Gas Rod Ld Tens, lbf	21773 T	21773 T	22991 T	22991 T
Gas Rod Ld Total, lbf	45977	45977	52525	52525
Xhd Pin Deg/%RvrsI lbf	177/68.9	177/68.9	177/73.4	177/73.4
Flow Calc, MMSCFD	5.841	5.841	5.841	5.841
Cyl BHP	307.0	307.0	373.7	373.7



Ariel Performance

Company: EFX Compression
 Quote: 060158, 060159, 060160
 Remarks: Sour Gas Compressor

Customer: EnCana Corporation
 Inquiry: Darryl Burns
 Project: Stock Units



Compressor Data:

Elevation,ft:	2500.0	Barmtr,psia:	13.400	Ambient, °F:	90.00
Frame:	JGK/4	Stroke, in:	5.50	Rod Dia, in:	2.000
Max RL Tot, lbf:	74000	Max RL Tens, lbf:	37000	Max RL Comp, lbf:	40000
Rated RPM:	1200	Rated BHP:	2540.0	Rated PS FPM:	1100.0
Calc RPM:	1200.0	Calc BHP:	1385	Calc PS FPM:	1100.0

Driver Data:

Type:	Nat. Gas
Mfg:	Waukesha
Model:	L7042GL
BHP:	1448
Avail:	1385 (63)

CUSTOM LIMITS SOUR GAS-2

Services

Gathering

Stage Data:

#1

#2

Flow Req'd, MMSCFD	0.000	---	0.000	---
Flow Calc, MMSCFD	10.957	---	10.957	---
Cyl BHP per Stage	634.8	---	726.6	---
Specific Gravity	0.6767	---	0.6767	---
Ratio of Sp Ht (N)	1.2735	---	1.2717	---
Comp Suct (Zs)	0.9623	---	0.9341	---
Comp Disch (Zd)	0.9548	---	0.9414	---
Pres Suct Line, psig	175.00	---	N/A	---
Pres Suct Flg, psig	175.00	---	475.35	---
Pres Disch Flg, psig	485.35	---	1414.13	---
Pres Disch Line, psig	N/A	---	1400.00	---
Pres Ratio F/F	2.647	---	2.921	---
Temp Suct, °F	60.00	---	120.00	---
Temp Clr Disch, °F	120.00	---	120.00	---

Cylinder Data:

Throw 2

Throw 4

Throw 1

Throw 3

Cyl Model	9-5/8K	9-5/8K	6-1/4K	6-1/4K
Cyl Bore, in	9.125	9.125	5.875	5.875
Cyl RDP (API), psig	1154.5	1154.5	1863.6	1863.6
Cyl MAWP, psig	1270.0	1270.0	2050.0	2050.0
Cyl Action	DBL	DBL	DBL	DBL
Cyl Disp, CFM	487.6	487.6	195.1	195.1
Pres Suct Intl, psig	160.65	160.65	453.06	453.06
Temp Suct Intl, °F	66	66	125	125
Suct Zsph	0.9637	0.9637	0.9364	0.9364
Pres Disch Intl, psig	524.00	524.00	1496.51	1496.51
Temp Disch Intl, °F	209	209	293	293
HE Suct Gas Vel, FPM	8673	8673	7217	7217
HE Disch Gas Vel, FPM	8197	8197	7702	7702
HE Spcrrs Used/Max	0/4	0/4	0/2	0/2
HE Vol Pkt Avail, %	0.86+49.13	0.86+49.13	0.64+45.20	0.64+45.20
Vol Pkt Used, %	44.88 (V)	44.88 (V)	0.00 (V)	0.00 (V)
HE Min Clr, %	17.39	17.39	21.95	21.95
HE Total Clr, %	40.29	40.29	22.58	22.58
CE Suct Gas Vel, FPM	8256	8256	6381	6381
CE Disch Gas Vel, FPM	7803	7803	6809	6809
CE Spcrrs Used/Max	0/4	0/4	0/2	0/2
CE Min Clr, %	19.03	19.03	26.69	26.69
CE Total Clr, %	19.03	19.03	26.69	26.69
Suct Vol Eff HE/CE, %	47.5/71.7	47.5/71.7	64.3/59.1	64.3/59.1
Disch Event HE/CE, ms	7.2/10.6	7.2/10.6	8.2/9.2	8.2/9.2
Suct Pseudo-Q HE/CE	8.7/7.9	8.7/7.9	5.6/4.3	5.6/4.3
Gas Rod Ld Comp, lbf	24343 C	24343 C	29911 C	29911 C
Gas Rod Ld Tens, lbf	22047 T	22047 T	23422 T	23422 T
Gas Rod Ld Total, lbf	46390	46390	53333	53333
Xhd Pin Deg/%Rvrs lbf	178/72.9	178/72.9	180/73.9	180/73.9
Flow Calc, MMSCFD	5.479	5.479	5.479	5.479
Cyl BHP	317.4	317.4	363.3	363.3



Ariel Performance

Company: EFX Compression
 Quote: 060158, 060159, 060160
 Remarks: Sour Gas Compressor

Customer: EnCana Corporation
 Inquiry: Darryl Burns
 Project: Stock Units



7.5.1.1

Compressor Data:

Elevation,ft:	2500.0	Barmtr,psia:	13.400	Ambient,°F:	90.00
Frame:	JGK/4	Stroke, in:	5.50	Rod Dia, in:	2.000
Max RL Tot, lbf:	74000	Max RL Tens, lbf:	37000	Max RL Comp, lbf:	40000
Rated RPM:	1200	Rated BHP:	2540.0	Rated PS FPM:	1100.0
Calc RPM:	1200.0	Calc BHP:	1385	Calc PS FPM:	1100.0

Driver Data:

Type:	Nat. Gas
Mfg:	Waukesha
Model:	L7042GL
BHP:	1448
Avail:	1385 (63)

CUSTOM LIMITS SOUR GAS-2

Services

Gathering

Stage Data:

	#1		#2	
Flow Req'd, MMSCFD	0.000	---	0.000	---
Flow Calc, MMSCFD	10.224	---	10.224	---
Cyl BHP per Stage	658.0	---	703.4	---
Specific Gravity	0.6767	---	0.6767	---
Ratio of Sp Ht (N)	1.2705	---	1.2704	---
Comp Suct (Zs)	0.9673	---	0.9364	---
Comp Disch (Zd)	0.9600	---	0.9437	---
Pres Suct Line, psig	150.00	---	N/A	---
Pres Suct Flg, psig	150.00	---	457.58	---
Pres Disch Flg, psig	467.19	---	1414.13	---
Pres Disch Line, psig	N/A	---	1400.00	---
Pres Ratio F/F	2.941	---	3.031	---
Temp Suct, °F	60.00	---	120.00	---
Temp Clr Disch, °F	120.00	---	120.00	---

Cylinder Data:

	Throw 2	Throw 4	Throw 1	Throw 3
Cyl Model	9-5/8K	9-5/8K	6-1/4K	6-1/4K
Cyl Bore, in	9.125	9.125	5.875	5.875
Cyl RDP (API), psig	1154.5	1154.5	1863.6	1863.6
Cyl MAWP, psig	1270.0	1270.0	2050.0	2050.0
Cyl Action	DBL	DBL	DBL	DBL
Cyl Disp, CFM	487.6	487.6	195.1	195.1
Pres Suct Intl, psig	137.63	137.63	436.16	436.16
Temp Suct Intl, °F	66	66	126	126
Suct Zsph	0.9687	0.9687	0.9388	0.9388
Pres Disch Intl, psig	503.47	503.47	1495.72	1495.72
Temp Disch Intl, °F	224	224	298	298
HE Suct Gas Vel, FPM	8673	8673	7217	7217
HE Disch Gas Vel, FPM	8197	8197	7702	7702
HE Spcrs Used/Max	0/4	0/4	0/2	0/2
HE Vol Pkt Avail, %	0.86+49.13	0.86+49.13	0.64+45.20	0.64+45.20
Vol Pkt Used, %	12.61 (V)	12.61 (V)	0.00 (V)	0.00 (V)
HE Min Clr, %	17.39	17.39	21.95	21.95
HE Total Clr, %	24.44	24.44	22.58	22.58
CE Suct Gas Vel, FPM	8256	8256	6381	6381
CE Disch Gas Vel, FPM	7803	7803	6809	6809
CE Spcrs Used/Max	0/4	0/4	0/2	0/2
CE Min Clr, %	19.03	19.03	26.69	26.69
CE Total Clr, %	19.03	19.03	26.69	26.69
Suct Vol Eff HE/CE, %	60.7/67.9	60.7/67.9	62.6/57.1	62.6/57.1
Disch Event HE/CE, ms	7.9/9.9	7.9/9.9	7.9/8.9	7.9/8.9
Suct Pseudo-Q HE/CE	8.7/7.9	8.7/7.9	5.5/4.3	5.5/4.3
Gas Rod Ld Comp, lbf	24432 C	24432 C	30295 C	30295 C
Gas Rod Ld Tens, lbf	22275 T	22275 T	23860 T	23860 T
Gas Rod Ld Total, lbf	46707	46707	54155	54155
Xhd Pin Deg/%Rvrsl lbf	179/87.2	179/87.2	177/74.4	177/74.4
Flow Calc, MMSCFD	5.112	5.112	5.112	5.112
Cyl BHP	329.0	329.0	351.7	351.7



Ariel Performance



Company: EFX Compression
 Quote: 060158, 060159, 060160
 Remarks: Sour Gas Compressor

Customer: EnCana Corporation
 Inquiry: Darryl Burns
 Project: Stock Units

7.5.1.1

Compressor Data:

Elevation,ft: 2500.0 Barmtr,psia: 13.400 Ambient,°F: 90.00
 Frame: JGK/4 Stroke, in: 5.50 Rod Dia, in: 2.000
 Max RL Tot, lbf: 74000 Max RL Tens, lbf: 37000 Max RL Comp, lbf: 40000
 Rated RPM: 1200 Rated BHP: 2540.0 Rated PS FPM: 1100.0
 Calc RPM: 1200.0 Calc BHP: 1385 Calc PS FPM: 1100.0

Driver Data:

Type: Nat. Gas
 Mfg: Waukesha
 Model: L7042GL
 BHP: 1448
 Avail: 1385 (63)

CUSTOM LIMITS SOUR GAS-2

Services

Gathering

Stage Data:	#1	---	#2	---
Flow Req'd, MMSCFD	0.000	---	0.000	---
Flow Calc, MMSCFD	9.924	---	9.924	---
Cyl BHP per Stage	668.1	---	693.3	---
Specific Gravity	0.6767	---	0.6767	---
Ratio of Sp Ht (N)	1.2691	---	1.2699	---
Comp Suct (Zs)	0.9694	---	0.9374	---
Comp Disch (Zd)	0.9621	---	0.9446	---
Pres Suct Line, psig	139.90	---	N/A	---
Pres Suct Flg, psig	139.90	---	450.26	---
Pres Disch Flg, psig	459.57	---	1414.13	---
Pres Disch Line, psig	N/A	---	1400.00	---
Pres Ratio F/F	3.085	---	3.079	---
Temp Suct, °F	60.00	---	120.00	---
Temp Clr Disch, °F	120.00	---	120.00	---

Cylinder Data:

Throw 2

Throw 4

Throw 1

Throw 3

Cyl Model	9-5/8K	9-5/8K	6-1/4K	6-1/4K
Cyl Bore, in	9.125	9.125	5.875	5.875
Cyl RDP (API), psig	1154.5	1154.5	1863.6	1863.6
Cyl MAWP, psig	1270.0	1270.0	2050.0	2050.0
Cyl Action	DBL	DBL	DBL	DBL
Cyl Disp, CFM	487.6	487.6	195.1	195.1
Pres Suct Intl, psig	128.32	128.32	429.20	429.20
Temp Suct Intl, °F	67	67	126	126
Suct Zsph	0.9707	0.9707	0.9397	0.9397
Pres Disch Intl, psig	494.86	494.86	1495.39	1495.39
Temp Disch Intl, °F	230	230	300	300
HE Suct Gas Vel, FPM	8673	8673	7217	7217
HE Disch Gas Vel, FPM	8197	8197	7702	7702
HE Spcrs Used/Max	0/4	0/4	0/2	0/2
HE Vol Pkt Avail, %	0.86+49.13	0.86+49.13	0.64+45.20	0.64+45.20
Vol Pkt Used, %	0.00 (V)	0.00 (V)	0.00 (V)	0.00 (V)
HE Min Clr, %	17.39	17.39	21.95	21.95
HE Total Clr, %	18.25	18.25	22.58	22.58
CE Suct Gas Vel, FPM	8256	8256	6381	6381
CE Disch Gas Vel, FPM	7803	7803	6809	6809
CE Spcrs Used/Max	0/4	0/4	0/2	0/2
CE Min Clr, %	19.03	19.03	26.69	26.69
CE Total Clr, %	19.03	19.03	26.69	26.69
Suct Vol Eff HE/CE, %	67.1/66.0	67.1/66.0	61.9/56.3	61.9/56.3
Disch Event HE/CE, ms	8.2/9.4	8.2/9.4	7.8/8.8	7.8/8.8
Suct Pseudo-Q HE/CE	8.7/7.8	8.7/7.8	5.5/4.3	5.5/4.3
Gas Rod Ld Comp, lbf	24447 C	24447 C	30453 C	30453 C
Gas Rod Ld Tens, lbf	22348 T	22348 T	24041 T	24041 T
Gas Rod Ld Total, lbf	46795	46795	54494	54494
Xhd Pin Deg/%Rvrs lbf	180/97.6	180/97.6	176/74.6	176/74.6
Flow Calc, MMSCFD	4.962	4.962	4.962	4.962
Cyl BHP	334.0	334.0	346.6	346.6



Ariel Performance



Company: EFX Compression
 Quote: 060158, 060159, 060160
 7.5.1.1 Remarks: Sour Gas Compressor

Customer: EnCana Corporation
 Inquiry: Darryl Burns
 Project: Stock Units

Compressor Data:

Elevation,ft:	2500.0	Barmtr,psia:	13.400	Ambient,°F:	90.00
Frame:	JGK/4	Stroke, in:	5.50	Rod Dia, in:	2.000
Max RL Tot, lbf:	74000	Max RL Tens, lbf:	37000	Max RL Comp, lbf:	40000
Rated RPM:	1200	Rated BHP:	2540.0	Rated PS FPM:	1100.0
Calc RPM:	1200.0	Calc BHP:	1281	Calc PS FPM:	1100.0

Driver Data:

Type:	Nat. Gas
Mfg:	Waukesha
Model:	L7042GL
BHP:	1448
Avail:	1385 (63)

CUSTOM LIMITS SOUR GAS-2

Services

Gathering

Stage Data:

#1

#2

Flow Req'd, MMSCFD	0.000	---	0.000	---
Flow Calc, MMSCFD	8.731	---	8.731	---
Cyl BHP per Stage	608.5	---	648.8	---
Specific Gravity	0.6767	---	0.6767	---
Ratio of Sp Ht (N)	1.2674	---	1.2677	---
Comp Suct (Zs)	0.9724	---	0.9413	---
Comp Disch (Zd)	0.9654	---	0.9486	---
Pres Suct Line, psig	125.00	---	N/A	---
Pres Suct Flg, psig	125.00	---	420.94	---
Pres Disch Flg, psig	429.78	---	1414.13	---
Pres Disch Line, psig	N/A	---	1400.00	---
Pres Ratio F/F	3.202	---	3.287	---
Temp Suct, °F	60.00	---	120.00	---
Temp Clr Disch, °F	120.00	---	120.00	---

Cylinder Data:

Throw 2

Throw 4

Throw 1

Throw 3

Cyl Model	9-5/8K	9-5/8K	6-1/4K	6-1/4K
Cyl Bore, in	9.125	9.125	5.875	5.875
Cyl RDP (API), psig	1154.5	1154.5	1863.6	1863.6
Cyl MAWP, psig	1270.0	1270.0	2050.0	2050.0
Cyl Action	DBL	DBL	DBL	DBL
Cyl Disp, CFM	487.6	487.6	195.1	195.1
Pres Suct Intl, psig	114.59	114.59	401.30	401.30
Temp Suct Intl, °F	67	67	126	126
Suct Zsph	0.9736	0.9736	0.9436	0.9436
Pres Disch Intl, psig	462.52	462.52	1494.06	1494.06
Temp Disch Intl, °F	235	235	310	310
HE Suct Gas Vel, FPM	8673	8673	7217	7217
HE Disch Gas Vel, FPM	8197	8197	7702	7702
HE Spcrrs Used/Max	0/4	0/4	0/2	0/2
HE Vol Pkt Avail, %	0.86+49.13	0.86+49.13	0.64+45.20	0.64+45.20
Vol Pkt Used, %	0.00 (V)	0.00 (V)	0.00 (V)	0.00 (V)
HE Min Clr, %	17.39	17.39	21.95	21.95
HE Total Clr, %	18.25	18.25	22.58	22.58
CE Suct Gas Vel, FPM	8256	8256	6381	6381
CE Disch Gas Vel, FPM	7803	7803	6809	6809
CE Spcrrs Used/Max	0/4	0/4	0/2	0/2
CE Min Clr, %	19.03	19.03	26.69	26.69
CE Total Clr, %	19.03	19.03	26.69	26.69
Suct Vol Eff HE/CE, %	65.7/64.5	65.7/64.5	58.8/52.7	58.8/52.7
Disch Event HE/CE, ms	7.9/9.2	7.9/9.2	7.4/8.2	7.4/8.2
Suct Pseudo-Q HE/CE	8.6/7.8	8.6/7.8	5.5/4.3	5.5/4.3
Gas Rod Ld Comp, lbf	23183 C	23183 C	31086 C	31086 C
Gas Rod Ld Tens, lbf	21237 T	21237 T	24764 T	24764 T
Gas Rod Ld Total, lbf	44420	44420	55850	55850
Xhd Pin Deg/%RvrsI lbf	177/97.7	177/97.7	164/75.5	164/75.5
Flow Calc, MMSCFD	4.365	4.365	4.365	4.365
Cyl BHP	304.3	304.3	324.4	324.4



Ariel Performance

Company: EFX Compression
 Quote: 060158, 060159, 060160
 7.5.1.1 Remarks: Sour Gas Compressor

Customer: EnCana Corporation
 Inquiry: Darryl Burns
 Project: Stock Units



Compressor Data:

Elevation,ft:	2500.0	Barmtr,psia:	13.400	Ambient,°F:	90.00
Frame:	JGKJ4	Stroke, in:	5.50	Rod Dia, in:	2.000
Max RL Tot, lbf:	74000	Max RL Tens, lbf:	37000	Max RL Comp, lbf:	40000
Rated RPM:	1200	Rated BHP:	2540.0	Rated PS FPM:	1100.0
Calc RPM:	1200.0	Calc BHP:	1088	Calc PS FPM:	1100.0

Driver Data:

Type:	Nat. Gas
Mfg:	Waukesha
Model:	L7042GL
BHP:	1448
Avail:	1385 (63)

CUSTOM LIMITS SOUR GAS-2

Services

Gathering

Stage Data:

	#1	---	#2	---
Flow Req'd, MMSCFD	0.000	---	0.000	---
Flow Calc, MMSCFD	6.753	---	6.753	---
Cyl BHP per Stage	504.8	---	558.8	---
Specific Gravity	0.6766	---	0.6766	---
Ratio of Sp Ht (N)	1.2644	---	1.2636	---
Comp Suct (Zs)	0.9774	---	0.9479	---
Comp Disch (Zd)	0.9710	---	0.9553	---
Pres Suct Line, psig	100.00	---	N/A	---
Pres Suct Flg, psig	100.00	---	371.46	---
Pres Disch Flg, psig	379.47	---	1414.13	---
Pres Disch Line, psig	N/A	---	1400.00	---
Pres Ratio F/F	3.464	---	3.709	---
Temp Suct, °F	60.00	---	120.00	---
Temp Clr Disch, °F	120.00	---	120.00	---

Cylinder Data:

Throw 2

Throw 4

Throw 1

Throw 3

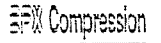
Cyl Model	9-5/8K	9-5/8K	6-1/4K	6-1/4K
Cyl Bore, in	9.125	9.125	5.875	5.875
Cyl RDP (API), psig	1154.5	1154.5	1863.6	1863.6
Cyl MAWP, psig	1270.0	1270.0	2050.0	2050.0
Cyl Action	DBL	DBL	DBL	DBL
Cyl Disp, CFM	487.6	487.6	195.1	195.1
Pres Suct Intl, psig	91.52	91.52	354.20	354.20
Temp Suct Intl, °F	67	67	127	127
Suct Zsph	0.9784	0.9784	0.9501	0.9501
Pres Disch Intl, psig	407.91	407.91	1491.73	1491.73
Temp Disch Intl, °F	245	245	327	327
HE Suct Gas Vel, FPM	8673	8673	7217	7217
HE Disch Gas Vel, FPM	8197	8197	7702	7702
HE Spcrrs Used/Max	0/4	0/4	0/2	0/2
HE Vol Pkt Avail, %	0.86+49.13	0.86+49.13	0.64+45.20	0.64+45.20
Vol Pkt Used, %	0.00 (V)	0.00 (V)	0.00 (V)	0.00 (V)
HE Min Clr, %	17.39	17.39	21.95	21.95
HE Total Clr, %	18.25	18.25	22.58	22.58
CE Suct Gas Vel, FPM	8256	8256	6381	6381
CE Disch Gas Vel, FPM	7803	7803	6809	6809
CE Spcrrs Used/Max	0/4	0/4	0/2	0/2
CE Min Clr, %	19.03	19.03	26.69	26.69
CE Total Clr, %	19.03	19.03	26.69	26.69
Suct Vol Eff HE/CE, %	62.5/61.2	62.5/61.2	52.6/45.4	52.6/45.4
Disch Event HE/CE, ms	7.4/8.6	7.4/8.6	6.5/7.2	6.5/7.2
Suct Pseudo-Q HE/CE	8.6/7.8	8.6/7.8	5.5/4.3	5.5/4.3
Gas Rod Ld Comp, lbf	21041 C	21041 C	32151 C	32151 C
Gas Rod Ld Tens, lbf	19352 T	19352 T	25984 T	25984 T
Gas Rod Ld Total, lbf	40393	40393	58135	58135
Xhd Pin Deg/%Rvrsl lbf	174/89.9	174/89.9	147/76.8	147/76.8
Flow Calc, MMSCFD	3.377	3.377	3.377	3.377
Cyl BHP	252.4	252.4	279.4	279.4



Gas Analysis Data

Company: EFX Compression
 Quote: 060158, 060159, 060160
 Remarks: Sour Gas Compressor

Customer: EnCana Corporation
 Inquiry: Darryl Burns
 Project: Stock Units



7.5.1.1

Services	Gathering				
Gas Model	Hall				
Stage	# 1	# 1	# 2	Final	Final
Stream	Main	Vapor	Vapor	Liq1	Vapor
Suction Press, psig	100.00	100.00	371.46		
Disch Press, psig		379.47	1414.13		1400.00
Suction Temp, °F	60.00	60.00	120.00		120.00
Disch Temp, °F		244.79	327.30		120.00
Flow, MMSCFD	6.753	6.753	6.753	0.007	6.746
Flow, lb/h	14531.1	14531.8	14531.8	14.4	14517.4
Flow, GPM				0.029	
Dropout, %				0.107	
Specific Gravity	0.6766	0.6766	0.6766		0.6767
Ratio of Sp Ht (N)		1.2644	1.2636		
Comp Suct (Zs)		0.9774	0.9479		0.8242
Comp Disch (Zd)		0.9710	0.9553		
Mole Weight		19.60	19.60		19.60
Density, lb/ft3		0.408	1.279		5.458
Density @ Std, lb/ft3		0.052	0.052		0.052
Enthaply, Btu/lb		-1661.30	-1631.38		-1627.30
Entropy, Btu/lbmol·F		0.0000	0.0000		0.0000
Speed of Sound (Suct), ft/s		N/A	N/A		N/A
Pseudo-Pc, psig		N/A	N/A		N/A
Pseudo-Tc, °F		N/A	N/A		N/A
γp, Btu/lb·°F		N/A	N/A		N/A
nHV Mass, BTU/ft3		0.00	0.00		0.00
Speed of Sound (Disch), ft/s		N/A	N/A		N/A
Viscosity, lb/ft·s		N/A	N/A		N/A
Thermal Cond., Btu/ft·h·°F		N/A	N/A		N/A
Heat Load, BTU/h		N/A	N/A		N/A
Humidity	100.00	100.00			
WATER	0.22603	0.22603	0.22603	100.00000	0.11867
METHANE	84.39694	84.27510	84.27510		84.36558
ETHANE	4.99591	4.98870	4.98870		4.99405
PROPANE	3.39528	3.39038	3.39038		3.39402
ISOBUTANE					
N-BUTANE	1.79465	1.79206	1.79206		1.79398
ISOPENTANE					
N-PENTANE	0.48504	0.48434	0.48434		0.48486
N-HEXANE					
N-HEPTANE					
NITROGEN					
CARBON DIOXIDE					
HYDROGEN SULFIDE	4.85040	4.84340	4.84340		4.84860



Ariel Performance



Company: EFX Compression
 Quote: 060158, 060159, 060160

Customer: EnCana Corporation
 Inquiry: Darryl Burns

7.5.1.1 Remarks: Sour Gas Compressor

Project: Stock Units

Compressor Data:

Elevation,ft:	2500.0	Barmtr,psia:	13.400	Ambient,°F:	90.00
Frame:	JGK/4	Stroke, in:	5.50	Rod Dia, in:	2.000
Max RL Tot, lbf:	74000	Max RL Tens, lbf:	37000	Max RL Comp, lbf:	40000
Rated RPM:	1200	Rated BHP:	2540.0	Rated PS FPM:	1100.0
Calc RPM:	1200.0	Calc BHP:	1385	Calc PS FPM:	1100.0

Driver Data:

Type:	Nat. Gas
Mfg:	Waukesha
Model:	L7042GL
BHP:	1448
Avail:	1385 (63)

CUSTOM LIMITS SOUR GAS-2

Services

Gathering

Stage Data:

	#1		#2	
Flow Req'd, MMSCFD	0.000	---	0.000	---
Flow Calc, MMSCFD	16.291	---	16.291	---
Cyl BHP per Stage	750.0	---	611.4	---
Specific Gravity	0.6767	---	0.6767	---
Ratio of Sp Ht (N)	1.2847	---	1.2839	---
Comp Suct (Zs)	0.9369	---	0.9110	---
Comp Disch (Zd)	0.9293	---	0.9143	---
Pres Suct Line, psig	300.00	---	N/A	---
Pres Suct Flg, psig	300.00	---	652.20	---
Pres Disch Flg, psig	662.20	---	1212.13	---
Pres Disch Line, psig	N/A	---	1200.00	---
Pres Ratio F/F	2.156	---	1.841	---
Temp Suct, °F	60.00	---	120.00	---
Temp Clr Disch, °F	120.00	---	120.00	---

Cylinder Data:

	Throw 2	Throw 4	Throw 1	Throw 3
Cyl Model	9-5/8K	9-5/8K	6-1/4K	6-1/4K
Cyl Bore, in	9.125	9.125	5.875	5.875
Cyl RDP (API), psig	1154.5	1154.5	1863.6	1863.6
Cyl MAWP, psig	1270.0	1270.0	2050.0	2050.0
Cyl Action	CE(HEVR)	DBL	DBL	DBL
Cyl Disp, CFM	237.8	487.6	195.1	195.1
Pres Suct Intl, psig	276.80	275.43	620.96	620.96
Temp Suct Intl, °F	68	65	123	123
Suct Zsph	0.9403	0.9389	0.9130	0.9130
Pres Disch Intl, psig	715.08	718.08	1292.20	1292.20
Temp Disch Intl, °F	188	184	224	224
HE Suct Gas Vel, FPM	N/A	8673	7217	7217
HE Disch Gas Vel, FPM	N/A	8197	7702	7702
HE Spcrrs Used/Max	N/A	0/4	0/2	0/2
HE Vol Pkt Avail, %	N/A	0.86+49.13	0.64+45.20	0.64+45.20
Vol Pkt Used, %	N/A	65.96 (V)	100.00 (V)	100.00 (V)
HE Min Clr, %	N/A	17.39	21.95	21.95
HE Total Clr, %	N/A	50.65	67.78	67.78
CE Suct Gas Vel, FPM	8256	8256	6381	6381
CE Disch Gas Vel, FPM	7803	7803	6809	6809
CE Spcrrs Used/Max	0/4	0/4	0/2	0/2
CE Min Clr, %	19.03	19.03	26.69	26.69
CE Total Clr, %	19.03	19.03	26.69	26.69
Suct Vol Eff HE/CE, %	N/A/78.4	52.6/78.4	54.2/78.5	54.2/78.5
Disch Event HE/CE, ms	N/A/12.2	8.3/12.2	9.2/13.1	9.2/13.1
Suct Pseudo-Q HE/CE	N/A/8.1	9.0/8.1	5.7/4.5	5.7/4.5
Gas Rod Ld Comp, lbf	2658 C	29910 C	20314 C	20314 C
Gas Rod Ld Tens, lbf	25086 T	26605 T	14011 T	14011 T
Gas Rod Ld Total, lbf	27744	56515	34325	34325
Xhd Pin Deg/%RvrsI lbf	131/57.2	171/89.5	158/72.5	158/72.5
Flow Calc, MMSCFD	5.992	10.299	8.145	8.145
Cyl BHP	280.8	469.2	305.7	305.7



Ariel Performance

Company: EFX Compression
 Quote: 060158, 060159, 060160
 7.5.1.1 Remarks: Sour Gas Compressor

Customer: EnCana Corporation
 Inquiry: Darryl Burns
 Project: Stock Units



Compressor Data:

Elevation,ft:	2500.0	Barmtr,psia:	13.400	Ambient, °F:	90.00
Frame:	JGK/4	Stroke, in:	5.50	Rod Dia, in:	2.000
Max RL Tot, lbf:	74000	Max RL Tens, lbf:	37000	Max RL Comp, lbf:	40000
Rated RPM:	1200	Rated BHP:	2540.0	Rated PS FPM:	1100.0
Calc RPM:	1200.0	Calc BHP:	1385	Calc PS FPM:	1100.0

Driver Data:

Type:	Nat. Gas
Mfg:	Waukesha
Model:	L7042GL
BHP:	1448
Avail:	1385 (63)

CUSTOM LIMITS SOUR GAS-2

Services

Gathering

Stage Data:

#1

#2

Flow Req'd, MMSCFD	0.000	---	0.000	---
Flow Calc, MMSCFD	15.398	---	15.398	---
Cyl BHP per Stage	759.1	---	602.3	---
Specific Gravity	0.6767	---	0.6767	---
Ratio of Sp Ht (N)	1.2824	---	1.2829	---
Comp Suct (Zs)	0.9420	---	0.9133	---
Comp Disch (Zd)	0.9342	---	0.9166	---
Pres Suct Line, psig	275.00	---	N/A	---
Pres Suct Flg, psig	275.00	---	634.36	---
Pres Disch Flg, psig	644.36	---	1212.13	---
Pres Disch Line, psig	N/A	---	1200.00	---
Pres Ratio F/F	2.281	---	1.892	---
Temp Suct, °F	60.00	---	120.00	---
Temp Clr Disch, °F	120.00	---	120.00	---

Cylinder Data:

Throw 2

Throw 4

Throw 1

Throw 3

Cyl Model	9-5/8K	9-5/8K	6-1/4K	6-1/4K
Cyl Bore, in	9.125	9.125	5.875	5.875
Cyl RDP (API), psig	1154.5	1154.5	1863.6	1863.6
Cyl MAWP, psig	1270.0	1270.0	2050.0	2050.0
Cyl Action	CE(HEVR)	DBL	DBL	DBL
Cyl Disp, CFM	237.8	487.6	195.1	195.1
Pres Suct Intl, psig	253.78	252.53	604.04	604.04
Temp Suct Intl, °F	69	65	123	123
Suct Zsph	0.9453	0.9439	0.9153	0.9153
Pres Disch Intl, psig	694.98	697.87	1291.56	1291.56
Temp Disch Intl, °F	195	192	228	228
HE Suct Gas Vel, FPM	N/A	8673	7217	7217
HE Disch Gas Vel, FPM	N/A	8197	7702	7702
HE Spcrrs Used/Max	N/A	0/4	0/2	0/2
HE Vol Pkt Avail, %	N/A	0.86+49.13	0.64+45.20	0.64+45.20
Vol Pkt Used, %	N/A	33.69 (V)	100.00 (V)	100.00 (V)
HE Min Clr, %	N/A	17.39	21.95	21.95
HE Total Clr, %	N/A	34.80	67.78	67.78
CE Suct Gas Vel, FPM	8256	8256	6381	6381
CE Disch Gas Vel, FPM	7803	7803	6809	6809
CE Spcrrs Used/Max	0/4	0/4	0/2	0/2
CE Min Clr, %	19.03	19.03	26.69	26.69
CE Total Clr, %	19.03	19.03	26.69	26.69
Suct Vol Eff HE/CE, %	N/A/76.7	62.5/76.7	51.8/77.5	51.8/77.5
Disch Event HE/CE, ms	N/A/11.8	9.0/11.8	8.8/12.9	8.8/12.9
Suct Pseudo-Q HE/CE	N/A/8.0	8.9/8.1	5.7/4.5	5.7/4.5
Gas Rod Ld Comp, lbf	2433 C	30014 C	20703 C	20703 C
Gas Rod Ld Tens, lbf	25453 T	26845 T	14453 T	14453 T
Gas Rod Ld Total, lbf	27886	56859	35156	35156
Xhd Pin Deg/%Rvrsl lbf	126/54.0	167/84.5	159/72.0	159/72.0
Flow Calc, MMSCFD	5.362	10.036	7.699	7.699
Cyl BHP	269.0	490.1	301.2	301.2



Ariel Performance



Company: EFX Compression
 Quote: 060158, 060159, 060160
 Remarks: Sour Gas Compressor

Customer: EnCana Corporation
 Inquiry: Darryl Burns
 Project: Stock Units

7.5.1.1

Compressor Data:

Elevation,ft:	2500.0	Barmtr,psia:	13.400	Ambient,°F:	90.00
Frame:	JGK/4	Stroke, in:	5.50	Rod Dia, in:	2.000
Max RL Tot, lbf:	74000	Max RL Tens, lbf:	37000	Max RL Comp, lbf:	40000
Rated RPM:	1200	Rated BHP:	2540.0	Rated PS FPM:	1100.0
Calc RPM:	1200.0	Calc BHP:	1385	Calc PS FPM:	1100.0

Driver Data:

Type:	Nat. Gas
Mfg:	Waukesha
Model:	L7042GL
BHP:	1448
Avail:	1385 (63)

CUSTOM LIMITS SOUR GAS-2

Services

Gathering

Stage Data:

	#1	---	#2	---
Flow Req'd, MMSCFD	0.000	---	0.000	---
Flow Calc, MMSCFD	14.614	---	14.614	---
Cyl BHP per Stage	768.5	---	592.9	---
Specific Gravity	0.6767	---	0.6767	---
Ratio of Sp Ht (N)	1.2800	---	1.2821	---
Comp Suct (Zs)	0.9471	---	0.9153	---
Comp Disch (Zd)	0.9391	---	0.9185	---
Pres Suct Line, psig	250.00	---	N/A	---
Pres Suct Flg, psig	250.00	---	618.57	---
Pres Disch Flg, psig	628.57	---	1212.13	---
Pres Disch Line, psig	N/A	---	1200.00	---
Pres Ratio F/F	2.437	---	1.939	---
Temp Suct, °F	60.00	---	120.00	---
Temp Clr Disch, °F	120.00	---	120.00	---

Cylinder Data:

	Throw 2	Throw 4	Throw 1	Throw 3
Cyl Model	9-5/8K	9-5/8K	6-1/4K	6-1/4K
Cyl Bore, in	9.125	9.125	5.875	5.875
Cyl RDP (API), psig	1154.5	1154.5	1863.6	1863.6
Cyl MAWP, psig	1270.0	1270.0	2050.0	2050.0
Cyl Action	DBL	DBL	DBL	DBL
Cyl Disp, CFM	487.6	487.6	195.1	195.1
Pres Suct Intl, psig	229.60	229.60	589.06	589.06
Temp Suct Intl, °F	65	65	124	124
Suct Zsph	0.9490	0.9490	0.9174	0.9174
Pres Disch Intl, psig	679.84	679.84	1290.98	1290.98
Temp Disch Intl, °F	200	200	231	231
HE Suct Gas Vel, FPM	8673	8673	7217	7217
HE Disch Gas Vel, FPM	8197	8197	7702	7702
HE Spcrrs Used/Max	0/4	0/4	0/2	0/2
HE Vol Pkt Avail, %	0.86+49.13	0.86+49.13	0.64+45.20	0.64+45.20
Vol Pkt Used, %	76.64 (V)	76.64 (V)	100.00 (V)	100.00 (V)
HE Min Clr, %	17.39	17.39	21.95	21.95
HE Total Clr, %	55.90	55.90	67.78	67.78
CE Suct Gas Vel, FPM	8256	8256	6381	6381
CE Disch Gas Vel, FPM	7803	7803	6809	6809
CE Spcrrs Used/Max	0/4	0/4	0/2	0/2
CE Min Clr, %	19.03	19.03	26.69	26.69
CE Total Clr, %	19.03	19.03	26.69	26.69
Suct Vol Eff HE/CE, %	37.7/74.6	37.7/74.6	49.6/76.6	49.6/76.6
Disch Event HE/CE, ms	6.5/11.3	6.5/11.3	8.5/12.6	8.5/12.6
Suct Pseudo-Q HE/CE	8.4/8.0	8.4/8.0	5.7/4.4	5.7/4.4
Gas Rod Ld Comp, lbf	30262 C	30262 C	21047 C	21047 C
Gas Rod Ld Tens, lbf	27222 T	27222 T	14844 T	14844 T
Gas Rod Ld Total, lbf	57484	57484	35891	35891
Xhd Pin Deg/%RvrsI lbf	156/79.1	156/79.1	159/71.4	159/71.4
Flow Calc, MMSCFD	7.307	7.307	7.307	7.307
Cyl BHP	384.3	384.3	296.4	296.4



Ariel Performance

Company: EFX Compression
 Quote: 060158, 060159, 060160

Customer: EnCana Corporation
 Inquiry: Darryl Burns



7.5.1.1 Remarks: Sour Gas Compressor

Project: Stock Units

Compressor Data:

Elevation,ft:	2500.0	Barmtr,psia:	13.400	Ambient,°F:	90.00
Frame:	JGK/4	Stroke, in:	5.50	Rod Dia, in:	2.000
Max RL Tot, lbf:	74000	Max RL Tens, lbf:	37000	Max RL Comp, lbf:	40000
Rated RPM:	1200	Rated BHP:	2540.0	Rated PS FPM:	1100.0
Calc RPM:	1200.0	Calc BHP:	1385	Calc PS FPM:	1100.0

Driver Data:

Type:	Nat. Gas
Mfg:	Waukesha
Model:	L7042GL
BHP:	1448
Avail:	1385 (63)

CUSTOM LIMITS SOUR GAS-2

Services

Gathering

Stage Data:

	#1	---	#2	---
Flow Req'd, MMSCFD	0.000	---	0.000	---
Flow Calc, MMSCFD	13.565	---	13.565	---
Cyl BHP per Stage	650.9	---	710.5	---
Specific Gravity	0.6767	---	0.6767	---
Ratio of Sp Ht (N)	1.2790	---	1.2756	---
Comp Suct (Zs)	0.9522	---	0.9296	---
Comp Disch (Zd)	0.9448	---	0.9325	---
Pres Suct Line, psig	225.00	---	N/A	---
Pres Suct Flg, psig	225.00	---	509.41	---
Pres Disch Flg, psig	519.41	---	1212.13	---
Pres Disch Line, psig	N/A	---	1200.00	---
Pres Ratio F/F	2.235	---	2.344	---
Temp Suct, °F	60.00	---	120.00	---
Temp Clr Disch, °F	120.00	---	120.00	---

Cylinder Data:

Throw 2

Throw 4

Throw 1

Throw 3

	Throw 2	Throw 4	Throw 1	Throw 3
Cyl Model	9-5/8K	9-5/8K	6-1/4K	6-1/4K
Cyl Bore, in	9.125	9.125	5.875	5.875
Cyl RDP (API), psig	1154.5	1154.5	1863.6	1863.6
Cyl MAWP, psig	1270.0	1270.0	2050.0	2050.0
Cyl Action	DBL	DBL	DBL	DBL
Cyl Disp, CFM	487.6	487.6	195.1	195.1
Pres Suct Intl, psig	206.62	206.62	485.41	485.41
Temp Suct Intl, °F	65	65	124	124
Suct Zsph	0.9537	0.9537	0.9317	0.9317
Pres Disch Intl, psig	562.58	562.58	1286.86	1286.86
Temp Disch Intl, °F	187	187	259	259
HE Suct Gas Vel, FPM	8673	8673	7217	7217
HE Disch Gas Vel, FPM	8197	8197	7702	7702
HE Spcrs Used/Max	0/4	0/4	0/2	0/2
HE Vol Pkt Avail, %	0.86+49.13	0.86+49.13	0.64+45.20	0.64+45.20
Vol Pkt Used, %	92.43 (V)	92.43 (V)	0.00 (V)	0.00 (V)
HE Min Clr, %	17.39	17.39	21.95	21.95
HE Total Clr, %	63.66	63.66	22.58	22.58
CE Suct Gas Vel, FPM	8256	8256	6381	6381
CE Disch Gas Vel, FPM	7803	7803	6809	6809
CE Spcrs Used/Max	0/4	0/4	0/2	0/2
CE Min Clr, %	19.03	19.03	26.69	26.69
CE Total Clr, %	19.03	19.03	26.69	26.69
Suct Vol Eff HE/CE, %	38.4/77.3	38.4/77.3	72.9/69.1	72.9/69.1
Disch Event HE/CE, ms	6.9/11.9	6.9/11.9	9.7/11.0	9.7/11.0
Suct Pseudo-Q HE/CE	8.4/8.0	8.4/8.0	5.6/4.4	5.6/4.4
Gas Rod Ld Comp, lbf	24005 C	24005 C	23423 C	23423 C
Gas Rod Ld Tens, lbf	21442 T	21442 T	17548 T	17548 T
Gas Rod Ld Total, lbf	45447	45447	40971	40971
Xhd Pin Deg/%RvrsI lbf	176/67.0	176/67.0	164/81.5	164/81.5
Flow Calc, MMSCFD	6.782	6.782	6.782	6.782
Cyl BHP	325.4	325.4	355.3	355.3



Ariel Performance

Company: EFX Compression
 Quote: 060158, 060159, 060160
 Remarks: Sour Gas Compressor

Customer: EnCana Corporation
 Inquiry: Darryl Burns
 Project: Stock Units



Compressor Data:

Elevation,ft:	2500.0	Barmtr,psia:	13.400	Ambient,°F:	90.00
Frame:	JGK/4	Stroke, in:	5.50	Rod Dia, in:	2.000
Max RL Tot, lbf:	74000	Max RL Tens, lbf:	37000	Max RL Comp, lbf:	40000
Rated RPM:	1200	Rated BHP:	2540.0	Rated PS FPM:	1100.0
Calc RPM:	1200.0	Calc BHP:	1385	Calc PS FPM:	1100.0

Driver Data:

Type:	Nat. Gas
Mfg:	Waukesha
Model:	L7042GL
BHP:	1448
Avail:	1385 (63)

CUSTOM LIMITS SOUR GAS-2

Services

Gathering

Stage Data:

	#1	---	#2	---
Flow Req'd, MMSCFD	0.000	---	0.000	---
Flow Calc, MMSCFD	12.713	---	12.713	---
Cyl BHP per Stage	663.9	---	697.5	---
Specific Gravity	0.6767	---	0.6767	---
Ratio of Sp Ht (N)	1.2764	---	1.2743	---
Comp Suct (Zs)	0.9572	---	0.9323	---
Comp Disch (Zd)	0.9498	---	0.9352	---
Pres Suct Line, psig	200.00	---	N/A	---
Pres Suct Flg, psig	200.00	---	489.33	---
Pres Disch Flg, psig	499.33	---	1212.13	---
Pres Disch Line, psig	N/A	---	1200.00	---
Pres Ratio F/F	2.403	---	2.438	---
Temp Suct, °F	60.00	---	120.00	---
Temp Clr Disch, °F	120.00	---	120.00	---

Cylinder Data:

Throw 2

Throw 4

Throw 1

Throw 3

	Throw 2	Throw 4	Throw 1	Throw 3
Cyl Model	9-5/8K	9-5/8K	6-1/4K	6-1/4K
Cyl Bore, in	9.125	9.125	5.875	5.875
Cyl RDP (API), psig	1154.5	1154.5	1863.6	1863.6
Cyl MAWP, psig	1270.0	1270.0	2050.0	2050.0
Cyl Action	DBL	DBL	DBL	DBL
Cyl Disp, CFM	487.6	487.6	195.1	195.1
Pres Suct Intl, psig	183.64	183.64	466.32	466.32
Temp Suct Intl, °F	65	65	125	125
Suct Zsph	0.9587	0.9587	0.9343	0.9343
Pres Disch Intl, psig	540.05	540.05	1286.07	1286.07
Temp Disch Intl, °F	197	197	265	265
HE Suct Gas Vel, FPM	8673	8673	7217	7217
HE Disch Gas Vel, FPM	8197	8197	7702	7702
HE Spcrs Used/Max	0/4	0/4	0/2	0/2
HE Vol Pkt Avail, %	0.86+49.13	0.86+49.13	0.64+45.20	0.64+45.20
Vol Pkt Used, %	60.70 (V)	60.70 (V)	0.00 (V)	0.00 (V)
HE Min Clr, %	17.39	17.39	21.95	21.95
HE Total Clr, %	48.07	48.07	22.58	22.58
CE Suct Gas Vel, FPM	8256	8256	6381	6381
CE Disch Gas Vel, FPM	7803	7803	6809	6809
CE Spcrs Used/Max	0/4	0/4	0/2	0/2
CE Min Clr, %	19.03	19.03	26.69	26.69
CE Total Clr, %	19.03	19.03	26.69	26.69
Suct Vol Eff HE/CE, %	46.5/75.0	46.5/75.0	71.4/67.4	71.4/67.4
Disch Event HE/CE, ms	7.4/11.4	7.4/11.4	9.4/10.6	9.4/10.6
Suct Pseudo-Q HE/CE	8.7/8.0	8.7/8.0	5.6/4.4	5.6/4.4
Gas Rod Ld Comp, lbf	23961 C	23961 C	23859 C	23859 C
Gas Rod Ld Tens, lbf	21543 T	21543 T	18046 T	18046 T
Gas Rod Ld Total, lbf	45504	45504	41905	41905
Xhd Pin Deg/%RvrsI lbf	177/69.4	177/69.4	164/82.3	164/82.3
Flow Calc, MMSCFD	6.357	6.357	6.357	6.357
Cyl BHP	332.0	332.0	348.7	348.7



Ariel Performance

Company: EFX Compression
 Quote: 060158, 060159, 060160
 7.5.1.1 Remarks: Sour Gas Compressor

Customer: EnCana Corporation
 Inquiry: Darryl Burns
 Project: Stock Units



Compressor Data:

Elevation,ft:	2500.0	Barmtr,psia:	13.400	Ambient,°F:	90.00
Frame:	JGK/4	Stroke, in:	5.50	Rod Dia, in:	2.000
Max RL Tot, lbf:	74000	Max RL Tens, lbf:	37000	Max RL Comp, lbf:	40000
Rated RPM:	1200	Rated BHP:	2540.0	Rated PS FPM:	1100.0
Calc RPM:	1200.0	Calc BHP:	1385	Calc PS FPM:	1100.0

Driver Data:

Type:	Nat. Gas
Mfg:	Waukesha
Model:	L7042GL
BHP:	1448
Avail:	1385 (63)

CUSTOM LIMITS SOUR GAS-2

Services

Gathering

Stage Data:

	#1	---	#2	---
Flow Req'd, MMSCFD	0.000	---	0.000	---
Flow Calc, MMSCFD	11.870	---	11.870	---
Cyl BHP per Stage	679.2	---	682.2	---
Specific Gravity	0.6767	---	0.6767	---
Ratio of Sp Ht (N)	1.2736	---	1.2730	---
Comp Suct (Zs)	0.9623	---	0.9349	---
Comp Disch (Zd)	0.9549	---	0.9378	---
Pres Suct Line, psig	175.00	---	N/A	---
Pres Suct Flg, psig	175.00	---	469.28	---
Pres Disch Flg, psig	478.84	---	1212.13	---
Pres Disch Line, psig	N/A	---	1200.00	---
Pres Ratio F/F	2.613	---	2.539	---
Temp Suct, °F	60.00	---	120.00	---
Temp Clr Disch, °F	120.00	---	120.00	---

Cylinder Data:

Throw 2

Throw 4

Throw 1

Throw 3

	Throw 2	Throw 4	Throw 1	Throw 3
Cyl Model	9-5/8K	9-5/8K	6-1/4K	6-1/4K
Cyl Bore, in	9.125	9.125	5.875	5.875
Cyl RDP (API), psig	1154.5	1154.5	1863.6	1863.6
Cyl MAWP, psig	1270.0	1270.0	2050.0	2050.0
Cyl Action	DBL	DBL	DBL	DBL
Cyl Disp, CFM	487.6	487.6	195.1	195.1
Pres Suct Intl, psig	160.65	160.65	447.26	447.26
Temp Suct Intl, °F	66	66	125	125
Suct Zsph	0.9637	0.9637	0.9369	0.9369
Pres Disch Intl, psig	517.09	517.09	1285.28	1285.28
Temp Disch Intl, °F	208	208	270	270
HE Suct Gas Vel, FPM	8673	8673	7217	7217
HE Disch Gas Vel, FPM	8197	8197	7702	7702
HE Spcrs Used/Max	0/4	0/4	0/2	0/2
HE Vol Pkt Avail, %	0.86+49.13	0.86+49.13	0.64+45.20	0.64+45.20
Vol Pkt Used, %	29.81 (V)	29.81 (V)	0.00 (V)	0.00 (V)
HE Min Clr, %	17.39	17.39	21.95	21.95
HE Total Clr, %	32.89	32.89	22.58	22.58
CE Suct Gas Vel, FPM	8256	8256	6381	6381
CE Disch Gas Vel, FPM	7803	7803	6809	6809
CE Spcrs Used/Max	0/4	0/4	0/2	0/2
CE Min Clr, %	19.03	19.03	26.69	26.69
CE Total Clr, %	19.03	19.03	26.69	26.69
Suct Vol Eff HE/CE, %	56.7/72.2	56.7/72.2	69.8/65.5	69.8/65.5
Disch Event HE/CE, ms	7.9/10.7	7.9/10.7	9.2/10.3	9.2/10.3
Suct Pseudo-Q HE/CE	8.7/7.9	8.7/7.9	5.6/4.3	5.6/4.3
Gas Rod Ld Comp, lbf	23890 C	23890 C	24295 C	24295 C
Gas Rod Ld Tens, lbf	21618 T	21618 T	18542 T	18542 T
Gas Rod Ld Total, lbf	45508	45508	42837	42837
Xhd Pin Deg/%RvrsI lbf	177/77.7	177/77.7	165/83.1	165/83.1
Flow Calc, MMSCFD	5.935	5.935	5.935	5.935
Cyl BHP	339.6	339.6	341.1	341.1



Ariel Performance

Company: EFX Compression
 Quote: 060158, 060159, 060160
 7.5.1.1 Remarks: Sour Gas Compressor

Customer: EnCana Corporation
 Inquiry: Darryl Burns
 Project: Stock Units

EFX Compression

Compressor Data:

Elevation, ft: 2500.0 Barmtr, psia: 13.400 Ambient, °F: 90.00
 Frame: JGK/4 Stroke, in: 5.50 Rod Dia, in: 2.000
 Max RL Tot, lbf: 74000 Max RL Tens, lbf: 37000 Max RL Comp, lbf: 40000
 Rated RPM: 1200 Rated BHP: 2540.0 Rated PS FPM: 1100.0
 Calc RPM: 1200.0 Calc BHP: 1385 Calc PS FPM: 1100.0

Driver Data:

Type: Nat. Gas
 Mfg: Waukesha
 Model: L7042GL
 BHP: 1448
 Avail: 1385 (63)

CUSTOM LIMITS SOUR GAS-2

Services

Gathering

Stage Data:

	#1	---	#2	---
Flow Req'd, MMSCFD	0.000	---	0.000	---
Flow Calc, MMSCFD	11.027	---	11.027	---
Cyl BHP per Stage	696.8	---	664.3	---
Specific Gravity	0.6767	---	0.6767	---
Ratio of Sp Ht (N)	1.2707	---	1.2715	---
Comp Suct (Zs)	0.9673	---	0.9376	---
Comp Disch (Zd)	0.9600	---	0.9404	---
Pres Suct Line, psig	150.15	---	N/A	---
Pres Suct Flg, psig	150.15	---	449.07	---
Pres Disch Flg, psig	457.98	---	1212.13	---
Pres Disch Line, psig	N/A	---	1200.00	---
Pres Ratio F/F	2.882	---	2.650	---
Temp Suct, °F	60.00	---	120.00	---
Temp Clr Disch, °F	120.00	---	120.00	---

Cylinder Data:

Throw 2

Throw 4

Throw 1

Throw 3

	9-5/8K	9-5/8K	6-1/4K	6-1/4K
Cyl Model	9-5/8K	9-5/8K	6-1/4K	6-1/4K
Cyl Bore, in	9.125	9.125	5.875	5.875
Cyl RDP (API), psig	1154.5	1154.5	1863.6	1863.6
Cyl MAWP, psig	1270.0	1270.0	2050.0	2050.0
Cyl Action	DBL	DBL	DBL	DBL
Cyl Disp, CFM	487.6	487.6	195.1	195.1
Pres Suct Intl, psig	137.77	137.77	428.03	428.03
Temp Suct Intl, °F	66	66	125	125
Suct Zsph	0.9686	0.9686	0.9396	0.9396
Pres Disch Intl, psig	493.71	493.71	1284.46	1284.46
Temp Disch Intl, °F	221	221	277	277
HE Suct Gas Vel, FPM	8673	8673	7217	7217
HE Disch Gas Vel, FPM	8197	8197	7702	7702
HE Spcrrs Used/Max	0/4	0/4	0/2	0/2
HE Vol Pkt Avail, %	0.86+49.13	0.86+49.13	0.64+45.20	0.64+45.20
Vol Pkt Used, %	0.00 (V)	0.00 (V)	0.00 (V)	0.00 (V)
HE Min Clr, %	17.39	17.39	21.95	21.95
HE Total Clr, %	18.25	18.25	22.58	22.58
CE Suct Gas Vel, FPM	8256	8256	6381	6381
CE Disch Gas Vel, FPM	7803	7803	6809	6809
CE Spcrrs Used/Max	0/4	0/4	0/2	0/2
CE Min Clr, %	19.03	19.03	26.69	26.69
CE Total Clr, %	19.03	19.03	26.69	26.69
Suct Vol Eff HE/CE, %	69.7/68.7	69.7/68.7	68.1/63.5	68.1/63.5
Disch Event HE/CE, ms	8.6/10.0	8.6/10.0	8.8/9.9	8.8/9.9
Suct Pseudo-Q HE/CE	8.7/7.9	8.7/7.9	5.5/4.3	5.5/4.3
Gas Rod Ld Comp, lbf	23783 C	23783 C	24734 C	24734 C
Gas Rod Ld Tens, lbf	21660 T	21660 T	19043 T	19043 T
Gas Rod Ld Total, lbf	45443	45443	43777	43777
Xhd Pin Deg/%RvrsI lbf	178/96.6	178/96.6	167/83.9	167/83.9
Flow Calc, MMSCFD	5.514	5.514	5.514	5.514
Cyl BHP	348.4	348.4	332.1	332.1



Ariel Performance

Company: EFX Compression
 Quote: 060158, 060159, 060160
 7.5.1.1 Remarks: Sour Gas Compressor

Customer: EnCana Corporation
 Inquiry: Darryl Burns
 Project: Stock Units



Compressor Data:

Elevation,ft:	2500.0	Barmtr,psia:	13.400	Ambient,°F:	90.00
Frame:	JGK/4	Stroke, in:	5.50	Rod Dia, in:	2.000
Max RL Tot, lbf:	74000	Max RL Tens, lbf:	37000	Max RL Comp, lbf:	40000
Rated RPM:	1200	Rated BHP:	2540.0	Rated PS FPM:	1100.0
Calc RPM:	1200.0	Calc BHP:	1384	Calc PS FPM:	1100.0

Driver Data:

Type:	Nat. Gas
Mfg:	Waukesha
Model:	L7042GL
BHP:	1448
Avail:	1385 (63)

CUSTOM LIMITS SOUR GAS-2

Services

Gathering

Stage Data:

	#1		#2	
Flow Req'd, MMSCFD	0.000	---	0.000	---
Flow Calc, MMSCFD	11.015	---	11.015	---
Cyl BHP per Stage	696.2	---	664.0	---
Specific Gravity	0.6767	---	0.6767	---
Ratio of Sp Ht (N)	1.2707	---	1.2715	---
Comp Suct (Zs)	0.9673	---	0.9376	---
Comp Disch (Zd)	0.9600	---	0.9405	---
Pres Suct Line, psig	150.00	---	N/A	---
Pres Suct Flg, psig	150.00	---	448.77	---
Pres Disch Flg, psig	457.68	---	1212.13	---
Pres Disch Line, psig	N/A	---	1200.00	---
Pres Ratio F/F	2.883	---	2.652	---
Temp Suct, °F	60.00	---	120.00	---
Temp Clr Disch, °F	120.00	---	120.00	---

Cylinder Data:

Throw 2

Throw 4

Throw 1

Throw 3

Cyl Model	9-5/8K	9-5/8K	6-1/4K	6-1/4K
Cyl Bore, in	9.125	9.125	5.875	5.875
Cyl RDP (API), psig	1154.5	1154.5	1863.6	1863.6
Cyl MAWP, psig	1270.0	1270.0	2050.0	2050.0
Cyl Action	DBL	DBL	DBL	DBL
Cyl Disp, CFM	487.6	487.6	195.1	195.1
Pres Suct Intl, psig	137.63	137.63	427.76	427.76
Temp Suct Intl, °F	66	66	125	125
Suct Zsph	0.9686	0.9686	0.9396	0.9396
Pres Disch Intl, psig	493.39	493.39	1284.45	1284.45
Temp Disch Intl, °F	221	221	277	277
HE Suct Gas Vel, FPM	8673	8673	7217	7217
HE Disch Gas Vel, FPM	8197	8197	7702	7702
HE Spcrrs Used/Max	0/4	0/4	0/2	0/2
HE Vol Pkt Avail, %	0.86+49.13	0.86+49.13	0.64+45.20	0.64+45.20
Vol Pkt Used, %	0.00 (V)	0.00 (V)	0.00 (V)	0.00 (V)
HE Min Clr, %	17.39	17.39	21.95	21.95
HE Total Clr, %	18.25	18.25	22.58	22.58
CE Suct Gas Vel, FPM	8256	8256	6381	6381
CE Disch Gas Vel, FPM	7803	7803	6809	6809
CE Spcrrs Used/Max	0/4	0/4	0/2	0/2
CE Min Clr, %	19.03	19.03	26.69	26.69
CE Total Clr, %	19.03	19.03	26.69	26.69
Suct Vol Eff HE/CE, %	69.7/68.7	69.7/68.7	68.1/63.5	68.1/63.5
Disch Event HE/CE, ms	8.6/10.0	8.6/10.0	8.8/9.9	8.8/9.9
Suct Pseudo-Q HE/CE	8.7/7.9	8.7/7.9	5.5/4.3	5.5/4.3
Gas Rod Ld Comp, lbf	23771 C	23771 C	24740 C	24740 C
Gas Rod Ld Tens, lbf	21649 T	21649 T	19050 T	19050 T
Gas Rod Ld Total, lbf	45420	45420	43790	43790
Xhd Pin Deg/%Rvrsl lbf	178/96.6	178/96.6	167/83.9	167/83.9
Flow Calc, MMSCFD	5.508	5.508	5.508	5.508
Cyl BHP	348.1	348.1	332.0	332.0



Ariel Performance

Company: EFX Compression
 Quote: 060158, 060159, 060160
 Remarks: Sour Gas Compressor

Customer: EnCana Corporation
 Inquiry: Darryl Burns
 Project: Stock Units



Compressor Data:

Elevation,ft: 2500.0 Barmtr,psia: 13.400 Ambient,°F: 90.00
 Frame: JGK/4 Stroke, in: 5.50 Rod Dia, in: 2.000
 Max RL Tot, lbf: 74000 Max RL Tens, lbf: 37000 Max RL Comp, lbf: 40000
 Rated RPM: 1200 Rated BHP: 2540.0 Rated PS FPM: 1100.0
 Calc RPM: 1200.0 Calc BHP: 1233 Calc PS FPM: 1100.0

Driver Data:

Type: Nat. Gas
 Mfg: Waukesha
 Model: L7042GL
 BHP: 1448
 Avail: 1385 (63)

CUSTOM LIMITS SOUR GAS-2

Services

Gathering

Stage Data:

	#1	---	#2	---
Flow Req'd, MMSCFD	0.000	---	0.000	---
Flow Calc, MMSCFD	9.001	---	9.001	---
Cyl BHP per Stage	600.1	---	609.2	---
Specific Gravity	0.6767	---	0.6767	---
Ratio of Sp Ht (N)	1.2680	---	1.2678	---
Comp Suct (Zs)	0.9724	---	0.9441	---
Comp Disch (Zd)	0.9655	---	0.9471	---
Pres Suct Line, psig	125.00	---	N/A	---
Pres Suct Flg, psig	125.00	---	399.75	---
Pres Disch Flg, psig	407.94	---	1212.13	---
Pres Disch Line, psig	N/A	---	1200.00	---
Pres Ratio F/F	3.044	---	2.966	---
Temp Suct, °F	60.00	---	120.00	---
Temp Clr Disch, °F	120.00	---	120.00	---

Cylinder Data:

Throw 2

Throw 4

Throw 1

Throw 3

	Throw 2	Throw 4	Throw 1	Throw 3
Cyl Model	9-5/8K	9-5/8K	6-1/4K	6-1/4K
Cyl Bore, in	9.125	9.125	5.875	5.875
Cyl RDP (API), psig	1154.5	1154.5	1863.6	1863.6
Cyl MAWP, psig	1270.0	1270.0	2050.0	2050.0
Cyl Action	DBL	DBL	DBL	DBL
Cyl Disp, CFM	487.6	487.6	195.1	195.1
Pres Suct Intl, psig	114.58	114.58	381.11	381.11
Temp Suct Intl, °F	66	66	125	125
Suct Zsph	0.9735	0.9735	0.9461	0.9461
Pres Disch Intl, psig	439.39	439.39	1282.40	1282.40
Temp Disch Intl, °F	227	227	293	293
HE Suct Gas Vel, FPM	8673	8673	7217	7217
HE Disch Gas Vel, FPM	8197	8197	7702	7702
HE Spcrs Used/Max	0/4	0/4	0/2	0/2
HE Vol Pkt Avail, %	0.86+49.13	0.86+49.13	0.64+45.20	0.64+45.20
Vol Pkt Used, %	0.00 (V)	0.00 (V)	0.00 (V)	0.00 (V)
HE Min Clr, %	17.39	17.39	21.95	21.95
HE Total Clr, %	18.25	18.25	22.58	22.58
CE Suct Gas Vel, FPM	8256	8256	6381	6381
CE Disch Gas Vel, FPM	7803	7803	6809	6809
CE Spcrs Used/Max	0/4	0/4	0/2	0/2
CE Min Clr, %	19.03	19.03	26.69	26.69
CE Total Clr, %	19.03	19.03	26.69	26.69
Suct Vol Eff HE/CE, %	67.6/66.5	67.6/66.5	63.3/57.8	63.3/57.8
Disch Event HE/CE, ms	8.2/9.6	8.2/9.6	8.1/9.0	8.1/9.0
Suct Pseudo-Q HE/CE	8.6/7.8	8.6/7.8	5.5/4.3	5.5/4.3
Gas Rod Ld Comp, lbf	21667 C	21667 C	25803 C	25803 C
Gas Rod Ld Tens, lbf	19801 T	19801 T	20263 T	20263 T
Gas Rod Ld Total, lbf	41468	41468	46066	46066
Xhd Pin Deg/%RvrsI lbf	174/95.6	174/95.6	170/85.9	170/85.9
Flow Calc, MMSCFD	4.500	4.500	4.500	4.500
Cyl BHP	300.0	300.0	304.6	304.6



Ariel Performance

Company: EFX Compression
 Quote: 060158, 060159, 060160
 7.5.1.1 Remarks: Sour Gas Compressor

Customer: EnCana Corporation
 Inquiry: Darryl Burns
 Project: Stock Units



Compressor Data:

Elevation,ft:	2500.0	Barmtr,psia:	13.400	Ambient,°F:	90.00
Frame:	JGK/4	Stroke, in:	5.50	Rod Dia, in:	2.000
Max RL Tot, lbf:	74000	Max RL Tens, lbf:	37000	Max RL Comp, lbf:	40000
Rated RPM:	1200	Rated BHP:	2540.0	Rated PS FPM:	1100.0
Calc RPM:	1200.0	Calc BHP:	1060	Calc PS FPM:	1100.0

Driver Data:

Type:	Nat. Gas
Mfg:	Waukesha
Model:	L7042GL
BHP:	1448
Avail:	1385 (63)

CUSTOM LIMITS SOUR GAS-2

Services

Gathering

Stage Data:

	#1	---	#2	---
Flow Req'd, MMSCFD	0.000	---	0.000	---
Flow Calc, MMSCFD	7.017	---	7.017	---
Cyl BHP per Stage	500.2	---	535.6	---
Specific Gravity	0.6766	---	0.6766	---
Ratio of Sp Ht (N)	1.2650	---	1.2638	---
Comp Suct (Zs)	0.9774	---	0.9507	---
Comp Disch (Zd)	0.9711	---	0.9539	---
Pres Suct Line, psig	100.00	---	N/A	---
Pres Suct Flg, psig	100.00	---	350.35	---
Pres Disch Flg, psig	357.77	---	1212.13	---
Pres Disch Line, psig	N/A	---	1200.00	---
Pres Ratio F/F	3.273	---	3.369	---
Temp Suct, °F	60.00	---	120.00	---
Temp Clr Disch, °F	120.00	---	120.00	---

Cylinder Data:

Throw 2

Throw 4

Throw 1

Throw 3

	9-5/8K	9-5/8K	6-1/4K	6-1/4K
Cyl Model	9-5/8K	9-5/8K	6-1/4K	6-1/4K
Cyl Bore, in	9.125	9.125	5.875	5.875
Cyl RDP (API), psig	1154.5	1154.5	1863.6	1863.6
Cyl MAWP, psig	1270.0	1270.0	2050.0	2050.0
Cyl Action	DBL	DBL	DBL	DBL
Cyl Disp, CFM	487.6	487.6	195.1	195.1
Pres Suct Intl, psig	91.51	91.51	334.07	334.07
Temp Suct Intl, °F	67	67	126	126
Suct Zsph	0.9784	0.9784	0.9526	0.9526
Pres Disch Intl, psig	384.96	384.96	1280.24	1280.24
Temp Disch Intl, °F	237	237	311	311
HE Suct Gas Vel, FPM	8673	8673	7217	7217
HE Disch Gas Vel, FPM	8197	8197	7702	7702
HE Spcrs Used/Max	0/4	0/4	0/2	0/2
HE Vol Pkt Avail, %	0.86+49.13	0.86+49.13	0.64+45.20	0.64+45.20
Vol Pkt Used, %	0.00 (V)	0.00 (V)	0.00 (V)	0.00 (V)
HE Min Clr, %	17.39	17.39	21.95	21.95
HE Total Clr, %	18.25	18.25	22.58	22.58
CE Suct Gas Vel, FPM	8256	8256	6381	6381
CE Disch Gas Vel, FPM	7803	7803	6809	6809
CE Spcrs Used/Max	0/4	0/4	0/2	0/2
CE Min Clr, %	19.03	19.03	26.69	26.69
CE Total Clr, %	19.03	19.03	26.69	26.69
Suct Vol Eff HE/CE, %	64.8/63.6	64.8/63.6	57.2/50.8	57.2/50.8
Disch Event HE/CE, ms	7.8/9.0	7.8/9.0	7.1/7.9	7.1/7.9
Suct Pseudo-Q HE/CE	8.6/7.8	8.6/7.8	5.4/4.3	5.4/4.3
Gas Rod Ld Comp, lbf	19536 C	19536 C	26872 C	26872 C
Gas Rod Ld Tens, lbf	17927 T	17927 T	21485 T	21485 T
Gas Rod Ld Total, lbf	37463	37463	48357	48357
Xhd Pin Deg/%RvrsI lbf	170/88.1	170/88.1	174/88.3	174/88.3
Flow Calc, MMSCFD	3.508	3.508	3.508	3.508
Cyl BHP	250.1	250.1	267.8	267.8



Gas Analysis Data

Company: EFX Compression
 Quote: 060158, 060159, 060160
 Remarks: Sour Gas Compressor

Customer: EnCana Corporation
 Inquiry: Darryl Burns
 Project: Stock Units



7.5.1.1

Services	Gathering				
Gas Model	Hall				
Stage	# 1	# 1	# 2	Final	Final
Stream	Main	Vapor	Vapor	Liq1	Vapor
Suction Press, psig	100.00	100.00	350.35		
Disch Press, psig		357.77	1212.13		1200.00
Suction Temp, °F	60.00	60.00	120.00		120.00
Disch Temp, °F		236.56	311.22		120.00
Flow, MMSCFD	7.017	7.017	7.017	0.006	7.011
Flow, lb/h	15097.9	15098.8	15098.8	12.2	15086.6
Flow, GPM				0.024	
Dropout, %				0.088	
Specific Gravity	0.6766	0.6766	0.6766		0.6767
Ratio of Sp Ht (N)		1.2650	1.2638		
Comp Suct (Zs)		0.9774	0.9507		0.8439
Comp Disch (Zd)		0.9711	0.9539		
Mole Weight		19.60	19.60		19.60
Density, lb/ft3		0.408	1.205		4.576
Density @ Std, lb/ft3		0.052	0.052		0.052
Enthaply, Btu/lb		-1661.30	-1631.38		-1628.05
Entropy, Btu/lbmol·F		0.0000	0.0000		0.0000
Speed of Sound (Suct), ft/s		N/A	N/A		N/A
Pseudo-Pc, psig		N/A	N/A		N/A
Pseudo-Tc, °F		N/A	N/A		N/A
cp, Btu/lb·°F		N/A	N/A		N/A
NHV Mass, BTU/ft3		0.00	0.00		0.00
Speed of Sound (Disch), ft/s		N/A	N/A		N/A
Viscosity, lb/ft·s		N/A	N/A		N/A
Thermal Cond., Btu/ft·h·°F		N/A	N/A		N/A
Heat Load, BTU/h		N/A	N/A		N/A
Humidity	100.00	100.00			
WATER	0.22603	0.22603	0.22603	100.00000	0.13823
METHANE	84.39694	84.27510	84.27510		84.34910
ETHANE	4.99591	4.98870	4.98870		4.99308
PROPANE	3.39528	3.39038	3.39038		3.39335
ISOBUTANE					
N-BUTANE	1.79465	1.79206	1.79206		1.79363
ISOPENTANE					
N-PENTANE	0.48504	0.48434	0.48434		0.48476
N-HEXANE					
N-HEPTANE					
NITROGEN					
CARBON DIOXIDE					
HYDROGEN SULFIDE	4.85040	4.84340	4.84340		4.84765



Ariel Performance



Company: EFX Compression
 Quote: 060158, 060159, 060160
 Remarks: Sour Gas Compressor

Customer: EnCana Corporation
 Inquiry: Darryl Burns
 Project: Stock Units

7.5.1.1

Compressor Data:

Elevation,ft:	2500.0	Barmtr,psia:	13.400	Ambient,°F:	90.00
Frame:	JGK/4	Stroke, in:	5.50	Rod Dia, in:	2.000
Max RL Tot, lbf:	74000	Max RL Tens, lbf:	37000	Max RL Comp, lbf:	40000
Rated RPM:	1200	Rated BHP:	2540.0	Rated PS FPM:	1100.0
Calc RPM:	1200.0	Calc BHP:	1385	Calc PS FPM:	1100.0

Driver Data:

Type:	Nat. Gas
Mfg:	Waukesha
Model:	L7042GL
BHP:	1448
Avail:	1385 (63)

CUSTOM LIMITS SOUR GAS-2

Services

Gathering

Stage Data:

#1

#2

Flow Req'd, MMSCFD	0.000	---	0.000	---
Flow Calc, MMSCFD	18.597	---	18.597	---
Cyl BHP per Stage	839.4	---	522.0	---
Specific Gravity	0.6767	---	0.6767	---
Ratio of Sp Ht (N)	1.2847	---	1.2853	---
Comp Suct (Zs)	0.9369	---	0.9116	---
Comp Disch (Zd)	0.9294	---	0.9119	---
Pres Suct Line, psig	300.00	---	N/A	---
Pres Suct Flg, psig	300.00	---	647.63	---
Pres Disch Flg, psig	657.63	---	1010.13	---
Pres Disch Line, psig	N/A	---	1000.00	---
Pres Ratio F/F	2.141	---	1.548	---
Temp Suct, °F	60.00	---	120.00	---
Temp Clr Disch, °F	120.00	---	120.00	---

Cylinder Data:

Throw 2

Throw 4

Throw 1

Throw 3

Cyl Model	9-5/8K	9-5/8K	6-1/4K	6-1/4K
Cyl Bore, in	9.125	9.125	5.875	5.875
Cyl RDP (API), psig	1154.5	1154.5	1863.6	1863.6
Cyl MAWP, psig	1270.0	1270.0	2050.0	2050.0
Cyl Action	DBL	DBL	DBL	DBL
Cyl Disp, CFM	487.6	487.6	195.1	195.1
Pres Suct Intl, psig	275.43	275.43	616.58	616.58
Temp Suct Intl, °F	65	65	122	122
Suct Zsph	0.9389	0.9389	0.9131	0.9131
Pres Disch Intl, psig	713.21	713.21	1079.83	1079.83
Temp Disch Intl, °F	183	183	198	198
HE Suct Gas Vel, FPM	8673	8673	7217	7217
HE Disch Gas Vel, FPM	8197	8197	7702	7702
HE Spcrrs Used/Max	0/4	0/4	0/2	0/2
HE Vol Pkt Avail, %	0.86+49.13	0.86+49.13	0.64+45.20	0.64+45.20
Vol Pkt Used, %	98.93 (V)	98.93 (V)	100.00 (V)	100.00 (V)
HE Min Clr, %	17.39	17.39	21.95	21.95
HE Total Clr, %	66.85	66.85	67.78	67.78
CE Suct Gas Vel, FPM	8256	8256	6381	6381
CE Disch Gas Vel, FPM	7803	7803	6809	6809
CE Spcrrs Used/Max	0/4	0/4	0/2	0/2
CE Min Clr, %	19.03	19.03	26.69	26.69
CE Total Clr, %	19.03	19.03	26.69	26.69
Suct Vol Eff HE/CE, %	40.1/78.6	40.1/78.6	67.6/83.9	67.6/83.9
Disch Event HE/CE, ms	7.2/12.2	7.2/12.2	11.4/14.9	11.4/14.9
Suct Pseudo-Q HE/CE	8.6/8.1	8.6/8.1	5.7/4.5	5.7/4.5
Gas Rod Ld Comp, lbf	29591 C	29591 C	14629 C	14629 C
Gas Rod Ld Tens, lbf	26303 T	26303 T	9069 T	9069 T
Gas Rod Ld Total, lbf	55894	55894	23698	23698
Xhd Pin Deg/%RvrsI lbf	173/79.3	173/79.3	155/92.4	155/92.4
Flow Calc, MMSCFD	9.298	9.298	9.298	9.298
Cyl BHP	419.7	419.7	261.0	261.0



Ariel Performance

Company: EFX Compression
 Quote: 060158, 060159, 060160
 7.5.1.1 Remarks: Sour Gas Compressor

Customer: EnCana Corporation
 Inquiry: Darryl Burns
 Project: Stock Units



Compressor Data:

Elevation, ft:	2500.0	Barmtr, psia:	13.400	Ambient, °F:	90.00
Frame:	JGK/4	Stroke, in:	5.50	Rod Dia, in:	2.000
Max RL Tot, lbf:	74000	Max RL Tens, lbf:	37000	Max RL Comp, lbf:	40000
Rated RPM:	1200	Rated BHP:	2540.0	Rated PS FPM:	1100.0
Calc RPM:	1200.0	Calc BHP:	1385	Calc PS FPM:	1100.0

Driver Data:

Type:	Nat. Gas
Mfg:	Waukesha
Model:	L7042GL
BHP:	1448
Avail:	1385 (63)

CUSTOM LIMITS SOUR GAS-2

Services

Gathering

Stage Data:

#1

#2

Flow Req'd, MMSCFD	0.000	---	0.000	---
Flow Calc, MMSCFD	17.458	---	17.458	---
Cyl BHP per Stage	838.0	---	523.4	---
Specific Gravity	0.6767	---	0.6767	---
Ratio of Sp Ht (N)	1.2826	---	1.2841	---
Comp Suct (Zs)	0.9420	---	0.9145	---
Comp Disch (Zd)	0.9343	---	0.9147	---
Pres Suct Line, psig	275.00	---	N/A	---
Pres Suct Flg, psig	275.00	---	625.32	---
Pres Disch Flg, psig	635.32	---	1010.13	---
Pres Disch Line, psig	N/A	---	1000.00	---
Pres Ratio F/F	2.249	---	1.602	---
Temp Suct, °F	60.00	---	120.00	---
Temp Clr Disch, °F	120.00	---	120.00	---

Cylinder Data:

Throw 2

Throw 4

Throw 1

Throw 3

Cyl Model	9-5/8K	9-5/8K	6-1/4K	6-1/4K
Cyl Bore, in	9.125	9.125	5.875	5.875
Cyl RDP (API), psig	1154.5	1154.5	1863.6	1863.6
Cyl MAWP, psig	1270.0	1270.0	2050.0	2050.0
Cyl Action	DBL	DBL	DBL	DBL
Cyl Disp, CFM	487.6	487.6	195.1	195.1
Pres Suct Intl, psig	252.52	252.52	595.42	595.42
Temp Suct Intl, °F	65	65	123	123
Suct Zsph	0.9439	0.9439	0.9160	0.9160
Pres Disch Intl, psig	688.25	688.25	1079.11	1079.11
Temp Disch Intl, °F	190	190	203	203
HE Suct Gas Vel, FPM	8673	8673	7217	7217
HE Disch Gas Vel, FPM	8197	8197	7702	7702
HE Spcrs Used/Max	0/4	0/4	0/2	0/2
HE Vol Pkt Avail, %	0.86+49.13	0.86+49.13	0.64+45.20	0.64+45.20
Vol Pkt Used, %	77.29 (V)	77.29 (V)	100.00 (V)	100.00 (V)
HE Min Clr, %	17.39	17.39	21.95	21.95
HE Total Clr, %	56.22	56.22	67.78	67.78
CE Suct Gas Vel, FPM	8256	8256	6381	6381
CE Disch Gas Vel, FPM	7803	7803	6809	6809
CE Spcrs Used/Max	0/4	0/4	0/2	0/2
CE Min Clr, %	19.03	19.03	26.69	26.69
CE Total Clr, %	19.03	19.03	26.69	26.69
Suct Vol Eff HE/CE, %	44.5/77.1	44.5/77.1	65.0/82.9	65.0/82.9
Disch Event HE/CE, ms	7.5/11.8	7.5/11.8	11.0/14.4	11.0/14.4
Suct Pseudo-Q HE/CE	8.8/8.1	8.8/8.1	5.7/4.5	5.7/4.5
Gas Rod Ld Comp, lbf	29383 C	29383 C	15118 C	15118 C
Gas Rod Ld Tens, lbf	26249 T	26249 T	9623 T	9623 T
Gas Rod Ld Total, lbf	55632	55632	24741	24741
Xhd Pin Deg/%RvrsI lbf	171/81.0	171/81.0	155/91.6	155/91.6
Flow Calc, MMSCFD	8.729	8.729	8.729	8.729
Cyl BHP	419.0	419.0	261.7	261.7



Ariel Performance

Company: EFX Compression
 Quote: 060158, 060159, 060160
 Remarks: Sour Gas Compressor

Customer: EnCana Corporation
 Inquiry: Darryl Burns
 Project: Stock Units



7.5.1.1

Compressor Data:

Elevation,ft:	2500.0	Barmtr,psia:	13.400	Ambient,°F:	90.00
Frame:	JGKJ4	Stroke, in:	5.50	Rod Dia, in:	2.000
Max RL Tot, lbf:	74000	Max RL Tens, lbf:	37000	Max RL Comp, lbf:	40000
Rated RPM:	1200	Rated BHP:	2540.0	Rated PS FPM:	1100.0
Calc RPM:	1200.0	Calc BHP:	1385	Calc PS FPM:	1100.0

Driver Data:

Type:	Nat. Gas
Mfg:	Waukesha
Model:	L7042GL
BHP:	1448
Avail:	1385 (63)

CUSTOM LIMITS SOUR GAS-2

Services

Gathering

Stage Data:

	#1	---	#2	---
Flow Req'd, MMSCFD	0.000	---	0.000	---
Flow Calc, MMSCFD	16.255	---	16.255	---
Cyl BHP per Stage	742.6	---	618.8	---
Specific Gravity	0.6767	---	0.6767	---
Ratio of Sp Ht (N)	1.2812	---	1.2794	---
Comp Suct (Zs)	0.9471	---	0.9253	---
Comp Disch (Zd)	0.9397	---	0.9251	---
Pres Suct Line, psig	250.00	---	N/A	---
Pres Suct Flg, psig	250.00	---	542.47	---
Pres Disch Flg, psig	552.47	---	1010.13	---
Pres Disch Line, psig	N/A	---	1000.00	---
Pres Ratio F/F	2.148	---	1.841	---
Temp Suct, °F	60.00	---	120.00	---
Temp Clr Disch, °F	120.00	---	120.00	---

Cylinder Data:

Throw 2

Throw 4

Throw 1

Throw 3

	9-5/8K	9-5/8K	6-1/4K	6-1/4K
Cyl Model	9-5/8K	9-5/8K	6-1/4K	6-1/4K
Cyl Bore, in	9.125	9.125	5.875	5.875
Cyl RDP (API), psig	1154.5	1154.5	1863.6	1863.6
Cyl MAWP, psig	1270.0	1270.0	2050.0	2050.0
Cyl Action	DBL	DBL	DBL	DBL
Cyl Disp, CFM	487.6	487.6	195.1	195.1
Pres Suct Intl, psig	229.57	229.57	516.78	516.78
Temp Suct Intl, °F	65	65	123	123
Suct Zsph	0.9487	0.9487	0.9269	0.9269
Pres Disch Intl, psig	598.91	598.91	1076.38	1076.38
Temp Disch Intl, °F	182	182	223	223
HE Suct Gas Vel, FPM	8673	8673	7217	7217
HE Disch Gas Vel, FPM	8197	8197	7702	7702
HE Spcrrs Used/Max	0/4	0/4	0/2	0/2
HE Vol Pkt Avail, %	0.86+49.13	0.86+49.13	0.64+45.20	0.64+45.20
Vol Pkt Used, %	82.73 (V)	82.73 (V)	0.00 (V)	0.00 (V)
HE Min Clr, %	17.39	17.39	21.95	21.95
HE Total Clr, %	58.89	58.89	22.58	22.58
CE Suct Gas Vel, FPM	8256	8256	6381	6381
CE Disch Gas Vel, FPM	7803	7803	6809	6809
CE Spcrrs Used/Max	0/4	0/4	0/2	0/2
CE Min Clr, %	19.03	19.03	26.69	26.69
CE Total Clr, %	19.03	19.03	26.69	26.69
Suct Vol Eff HE/CE, %	46.0/78.5	46.0/78.5	80.7/78.2	80.7/78.2
Disch Event HE/CE, ms	7.8/12.2	7.8/12.2	11.7/13.1	11.7/13.1
Suct Pseudo-Q HE/CE	8.8/8.1	8.8/8.1	5.6/4.4	5.6/4.4
Gas Rod Ld Comp, lbf	24955 C	24955 C	16932 C	16932 C
Gas Rod Ld Tens, lbf	22200 T	22200 T	11683 T	11683 T
Gas Rod Ld Total, lbf	47155	47155	28615	28615
Xhd Pin Deg/%Rvrsl lbf	176/67.1	176/67.1	158/91.0	158/91.0
Flow Calc, MMSCFD	8.127	8.127	8.127	8.127
Cyl BHP	371.3	371.3	309.4	309.4



Ariel Performance



Company: EFX Compression
 Quote: 060158, 060159, 060160
 Remarks: Sour Gas Compressor

Customer: EnCana Corporation
 Inquiry: Darryl Burns
 Project: Stock Units

7.5.1.1

Compressor Data:

Elevation,ft:	2500.0	Barmtr,psia:	13.400	Ambient,°F:	90.00
Frame:	JGKJ4	Stroke, in:	5.50	Rod Dia, in:	2.000
Max RL Tot, lbf:	74000	Max RL Tens, lbf:	37000	Max RL Comp, lbf:	40000
Rated RPM:	1200	Rated BHP:	2540.0	Rated PS FPM:	1100.0
Calc RPM:	1200.0	Calc BHP:	1385	Calc PS FPM:	1100.0

Driver Data:

Type:	Nat. Gas
Mfg:	Waukesha
Model:	L7042GL
BHP:	1448
Avail:	1385 (63)

CUSTOM LIMITS SOUR GAS-2

Services

Gathering

Stage Data:

#1

#2

Flow Req'd, MMSCFD	0.000	---	0.000	---
Flow Calc, MMSCFD	15.187	---	15.187	---
Cyl BHP per Stage	742.7	---	618.7	---
Specific Gravity	0.6767	---	0.6767	---
Ratio of Sp Ht (N)	1.2788	---	1.2779	---
Comp Suct (Zs)	0.9522	---	0.9285	---
Comp Disch (Zd)	0.9447	---	0.9283	---
Pres Suct Line, psig	225.00	---	N/A	---
Pres Suct Flg, psig	225.00	---	517.96	---
Pres Disch Flg, psig	527.79	---	1010.13	---
Pres Disch Line, psig	N/A	---	1000.00	---
Pres Ratio F/F	2.270	---	1.926	---
Temp Suct, °F	60.00	---	120.00	---
Temp Clr Disch, °F	120.00	---	120.00	---

Cylinder Data:

Throw 2

Throw 4

Throw 1

Throw 3

Cyl Model	9-5/8K	9-5/8K	6-1/4K	6-1/4K
Cyl Bore, in	9.125	9.125	5.875	5.875
Cyl RDP (API), psig	1154.5	1154.5	1863.6	1863.6
Cyl MAWP, psig	1270.0	1270.0	2050.0	2050.0
Cyl Action	DBL	DBL	DBL	DBL
Cyl Disp, CFM	487.6	487.6	195.1	195.1
Pres Suct Intl, psig	206.62	206.62	493.50	493.50
Temp Suct Intl, °F	65	65	123	123
Suct Zsph	0.9537	0.9537	0.9301	0.9301
Pres Disch Intl, psig	571.49	571.49	1075.54	1075.54
Temp Disch Intl, °F	189	189	229	229
HE Suct Gas Vel, FPM	8673	8673	7217	7217
HE Disch Gas Vel, FPM	8197	8197	7702	7702
HE Spcrrs Used/Max	0/4	0/4	0/2	0/2
HE Vol Pkt Avail, %	0.86+49.13	0.86+49.13	0.64+45.20	0.64+45.20
Vol Pkt Used, %	57.48 (V)	57.48 (V)	0.00 (V)	0.00 (V)
HE Min Clr, %	17.39	17.39	21.95	21.95
HE Total Clr, %	46.49	46.49	22.58	22.58
CE Suct Gas Vel, FPM	8256	8256	6381	6381
CE Disch Gas Vel, FPM	7803	7803	6809	6809
CE Spcrrs Used/Max	0/4	0/4	0/2	0/2
CE Min Clr, %	19.03	19.03	26.69	26.69
CE Total Clr, %	19.03	19.03	26.69	26.69
Suct Vol Eff HE/CE, %	52.2/76.8	52.2/76.8	79.3/76.6	79.3/76.6
Disch Event HE/CE, ms	8.1/11.8	8.1/11.8	11.3/12.6	11.3/12.6
Suct Pseudo-Q HE/CE	8.8/8.0	8.8/8.0	5.6/4.4	5.6/4.4
Gas Rod Ld Comp, lbf	24589 C	24589 C	17469 C	17469 C
Gas Rod Ld Tens, lbf	21995 T	21995 T	12293 T	12293 T
Gas Rod Ld Total, lbf	46584	46584	29762	29762
Xhd Pin Deg/%Rvrsl lbf	177/67.0	177/67.0	158/91.0	158/91.0
Flow Calc, MMSCFD	7.594	7.594	7.594	7.594
Cyl BHP	371.3	371.3	309.4	309.4



Ariel Performance

Company: EFX Compression
 Quote: 060158, 060159, 060160
 7.5.1.1 Remarks: Sour Gas Compressor

Customer: EnCana Corporation
 Inquiry: Darryl Burns
 Project: Stock Units



Compressor Data:

Elevation,ft:	2500.0	Barmtr,psia:	13.400	Ambient, °F:	90.00
Frame:	JGK/4	Stroke, in:	5.50	Rod Dia, in:	2.000
Max RL Tot, lbf:	74000	Max RL Tens, lbf:	37000	Max RL Comp, lbf:	40000
Rated RPM:	1200	Rated BHP:	2540.0	Rated PS FPM:	1100.0
Calc RPM:	1200.0	Calc BHP:	1385	Calc PS FPM:	1100.0

Driver Data:

Type:	Nat. Gas
Mfg:	Waukesha
Model:	L7042GL
BHP:	1448
Avail:	1385 (63)

CUSTOM LIMITS SOUR GAS-2

Services

Gathering

Stage Data:

#1

#2

Flow Req'd, MMSCFD	0.000	---	0.000	---
Flow Calc, MMSCFD	14.149	---	14.149	---
Cyl BHP per Stage	745.6	---	615.8	---
Specific Gravity	0.6767	---	0.6767	---
Ratio of Sp Ht (N)	1.2764	---	1.2764	---
Comp Suct (Zs)	0.9572	---	0.9317	---
Comp Disch (Zd)	0.9497	---	0.9313	---
Pres Suct Line, psig	200.00	---	N/A	---
Pres Suct Flg, psig	200.00	---	493.91	---
Pres Disch Flg, psig	503.21	---	1010.13	---
Pres Disch Line, psig	N/A	---	1000.00	---
Pres Ratio F/F	2.421	---	2.018	---
Temp Suct, °F	60.00	---	120.00	---
Temp Clr Disch, °F	120.00	---	120.00	---

Cylinder Data:

Throw 2

Throw 4

Throw 1

Throw 3

Cyl Model	9-5/8K	9-5/8K	6-1/4K	6-1/4K
Cyl Bore, in	9.125	9.125	5.875	5.875
Cyl RDP (API), psig	1154.5	1154.5	1863.6	1863.6
Cyl MAWP, psig	1270.0	1270.0	2050.0	2050.0
Cyl Action	DBL	DBL	DBL	DBL
Cyl Disp, CFM	487.6	487.6	195.1	195.1
Pres Suct Intl, psig	183.64	183.64	470.64	470.64
Temp Suct Intl, °F	65	65	124	124
Suct Zsph	0.9587	0.9587	0.9333	0.9333
Pres Disch Intl, psig	544.18	544.18	1074.71	1074.71
Temp Disch Intl, °F	198	198	236	236
HE Suct Gas Vel, FPM	8673	8673	7217	7217
HE Disch Gas Vel, FPM	8197	8197	7702	7702
HE Spcrrs Used/Max	0/4	0/4	0/2	0/2
HE Vol Pkt Avail, %	0.86+49.13	0.86+49.13	0.64+45.20	0.64+45.20
Vol Pkt Used, %	31.73 (V)	31.73 (V)	0.00 (V)	0.00 (V)
HE Min Clr, %	17.39	17.39	21.95	21.95
HE Total Clr, %	33.84	33.84	22.58	22.58
CE Suct Gas Vel, FPM	8256	8256	6381	6381
CE Disch Gas Vel, FPM	7803	7803	6809	6809
CE Spcrrs Used/Max	0/4	0/4	0/2	0/2
CE Min Clr, %	19.03	19.03	26.69	26.69
CE Total Clr, %	19.03	19.03	26.69	26.69
Suct Vol Eff HE/CE, %	60.0/74.8	60.0/74.8	77.8/74.9	77.8/74.9
Disch Event HE/CE, ms	8.6/11.3	8.6/11.3	11.0/12.2	11.0/12.2
Suct Pseudo-Q HE/CE	8.8/8.0	8.8/8.0	5.6/4.4	5.6/4.4
Gas Rod Ld Comp, lbf	24231 C	24231 C	17995 C	17995 C
Gas Rod Ld Tens, lbf	21799 T	21799 T	12891 T	12891 T
Gas Rod Ld Total, lbf	46030	46030	30886	30886
Xhd Pin Deg/%Rvrsl lbf	178/73.3	178/73.3	158/91.5	158/91.5
Flow Calc, MMSCFD	7.074	7.074	7.074	7.074
Cyl BHP	372.8	372.8	307.9	307.9



Ariel Performance

Company: EFX Compression
 Quote: 060158, 060159, 060160
 7.5.1.1 Remarks: Sour Gas Compressor

Customer: EnCana Corporation
 Inquiry: Darryl Burns
 Project: Stock Units



Compressor Data:

Elevation, ft:	2500.0	Barmtr, psia:	13.400	Ambient, °F:	90.00
Frame:	JGK/4	Stroke, in:	5.50	Rod Dia, in:	2.000
Max RL Tot, lbf:	74000	Max RL Tens, lbf:	37000	Max RL Comp, lbf:	40000
Rated RPM:	1200	Rated BHP:	2540.0	Rated PS FPM:	1100.0
Calc RPM:	1200.0	Calc BHP:	1385	Calc PS FPM:	1100.0

Driver Data:

Type:	Nat. Gas
Mfg:	Waukesha
Model:	L7042GL
BHP:	1448
Avail:	1385 (63)

CUSTOM LIMITS SOUR GAS-2

Services

Gathering

Stage Data:

#1

#2

Flow Req'd, MMSCFD	0.000	---	0.000	---
Flow Calc, MMSCFD	13.127	---	13.127	---
Cyl BHP per Stage	751.6	---	609.8	---
Specific Gravity	0.6767	---	0.6767	---
Ratio of Sp Ht (N)	1.2736	---	1.2749	---
Comp Suct (Zs)	0.9623	---	0.9348	---
Comp Disch (Zd)	0.9549	---	0.9345	---
Pres Suct Line, psig	175.00	---	N/A	---
Pres Suct Flg, psig	175.00	---	470.00	---
Pres Disch Flg, psig	478.73	---	1010.13	---
Pres Disch Line, psig	N/A	---	1000.00	---
Pres Ratio F/F	2.612	---	2.117	---
Temp Suct, °F	60.00	---	120.00	---
Temp Clr Disch, °F	120.00	---	120.00	---

Cylinder Data:

Throw 2

Throw 4

Throw 1

Throw 3

Cyl Model	9-5/8K	9-5/8K	6-1/4K	6-1/4K
Cyl Bore, in	9.125	9.125	5.875	5.875
Cyl RDP (API), psig	1154.5	1154.5	1863.6	1863.6
Cyl MAWP, psig	1270.0	1270.0	2050.0	2050.0
Cyl Action	DBL	DBL	DBL	DBL
Cyl Disp, CFM	487.6	487.6	195.1	195.1
Pres Suct Intl, psig	160.65	160.65	447.91	447.91
Temp Suct Intl, °F	66	66	124	124
Suct Zsph	0.9637	0.9637	0.9365	0.9365
Pres Disch Intl, psig	516.98	516.98	1073.87	1073.87
Temp Disch Intl, °F	208	208	243	243
HE Suct Gas Vel, FPM	8673	8673	7217	7217
HE Disch Gas Vel, FPM	8197	8197	7702	7702
HE Spcrrs Used/Max	0/4	0/4	0/2	0/2
HE Vol Pkt Avail, %	0.86+49.13	0.86+49.13	0.64+45.20	0.64+45.20
Vol Pkt Used, %	5.68 (V)	5.68 (V)	0.00 (V)	0.00 (V)
HE Min Clr, %	17.39	17.39	21.95	21.95
HE Total Clr, %	21.04	21.04	22.58	22.58
CE Suct Gas Vel, FPM	8256	8256	6381	6381
CE Disch Gas Vel, FPM	7803	7803	6809	6809
CE Spcrrs Used/Max	0/4	0/4	0/2	0/2
CE Min Clr, %	19.03	19.03	26.69	26.69
CE Total Clr, %	19.03	19.03	26.69	26.69
Suct Vol Eff HE/CE, %	70.0/72.2	70.0/72.2	76.2/73.0	76.2/73.0
Disch Event HE/CE, ms	9.0/10.7	9.0/10.7	10.6/11.8	10.6/11.8
Suct Pseudo-Q HE/CE	8.7/7.9	8.7/7.9	5.6/4.3	5.6/4.3
Gas Rod Ld Comp, lbf	23882 C	23882 C	18518 C	18518 C
Gas Rod Ld Tens, lbf	21611 T	21611 T	13485 T	13485 T
Gas Rod Ld Total, lbf	45493	45493	32003	32003
Xhd Pin Deg/%Rvrsl lbf	177/88.4	177/88.4	159/92.3	159/92.3
Flow Calc, MMSCFD	6.563	6.563	6.563	6.563
Cyl BHP	375.8	375.8	304.9	304.9



Ariel Performance

Company: EFX Compression
 Quote: 060158, 060159, 060160
 Remarks: Sour Gas Compressor

Customer: EnCana Corporation
 Inquiry: Darryl Burns
 Project: Stock Units



7.5.1.1

Compressor Data:

Elevation,ft:	2500.0	Barmtr,psia:	13.400	Ambient,°F:	90.00
Frame:	JGKJ4	Stroke, in:	5.50	Rod Dia, in:	2.000
Max RL Tot, lbf:	74000	Max RL Tens, lbf:	37000	Max RL Comp, lbf:	40000
Rated RPM:	1200	Rated BHP:	2540.0	Rated PS FPM:	1100.0
Calc RPM:	1200.0	Calc BHP:	1385	Calc PS FPM:	1100.0

Driver Data:

Type:	Nat. Gas
Mfg:	Waukesha
Model:	L7042GL
BHP:	1448
Avail:	1385 (63)

CUSTOM LIMITS SOUR GAS-2

Services

Gathering

Stage Data:

#1

#2

Flow Req'd, MMSCFD	0.000	---	0.000	---
Flow Calc, MMSCFD	13.007	---	13.007	---
Cyl BHP per Stage	751.7	---	608.9	---
Specific Gravity	0.6767	---	0.6767	---
Ratio of Sp Ht (N)	1.2733	---	1.2747	---
Comp Suct (Zs)	0.9628	---	0.9352	---
Comp Disch (Zd)	0.9554	---	0.9348	---
Pres Suct Line, psig	172.25	---	N/A	---
Pres Suct Flg, psig	172.25	---	467.18	---
Pres Disch Flg, psig	475.86	---	1010.13	---
Pres Disch Line, psig	N/A	---	1000.00	---
Pres Ratio F/F	2.635	---	2.130	---
Temp Suct, °F	60.00	---	120.00	---
Temp Clr Disch, °F	120.00	---	120.00	---

Cylinder Data:

Throw 2

Throw 4

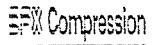
Throw 1

Throw 3

Cyl Model	9-5/8K	9-5/8K	6-1/4K	6-1/4K
Cyl Bore, in	9.125	9.125	5.875	5.875
Cyl RDP (API), psig	1154.5	1154.5	1863.6	1863.6
Cyl MAWP, psig	1270.0	1270.0	2050.0	2050.0
Cyl Action	DBL	DBL	DBL	DBL
Cyl Disp, CFM	487.6	487.6	195.1	195.1
Pres Suct Intl, psig	158.12	158.12	445.23	445.23
Temp Suct Intl, °F	66	66	124	124
Suct Zsph	0.9642	0.9642	0.9368	0.9368
Pres Disch Intl, psig	513.79	513.79	1073.77	1073.77
Temp Disch Intl, °F	209	209	243	243
HE Suct Gas Vel, FPM	8673	8673	7217	7217
HE Disch Gas Vel, FPM	8197	8197	7702	7702
HE Spcrrs Used/Max	0/4	0/4	0/2	0/2
HE Vol Pkt Avail, %	0.86+49.13	0.86+49.13	0.64+45.20	0.64+45.20
Vol Pkt Used, %	6.00 (V)	0.00 (V)	0.00 (V)	0.00 (V)
HE Min Clr, %	17.39	17.39	21.95	21.95
HE Total Clr, %	21.19	18.25	22.58	22.58
CE Suct Gas Vel, FPM	8256	8256	6381	6381
CE Disch Gas Vel, FPM	7803	7803	6809	6809
CE Spcrrs Used/Max	0/4	0/4	0/2	0/2
CE Min Clr, %	19.03	19.03	26.69	26.69
CE Total Clr, %	19.03	19.03	26.69	26.69
Suct Vol Eff HE/CE, %	69.4/71.9	72.8/71.9	76.0/72.8	76.0/72.8
Disch Event HE/CE, ms	8.9/10.7	9.2/10.7	10.4/11.8	10.4/11.8
Suct Pseudo-Q HE/CE	8.7/7.9	8.7/7.9	5.6/4.3	5.6/4.3
Gas Rod Ld Comp, lbf	23831 C	23831 C	18579 C	18579 C
Gas Rod Ld Tens, lbf	21578 T	21578 T	13555 T	13555 T
Gas Rod Ld Total, lbf	45409	45409	32134	32134
Xhd Pin Deg/%Rvrsl lbf	177/88.7	177/92.5	159/92.4	159/92.4
Flow Calc, MMSCFD	6.426	6.581	6.503	6.503
Cyl BHP	371.3	380.4	304.5	304.5



Ariel Performance



Company: EFX Compression
 Quote: 060158, 060159, 060160
 7.5.1.1 Remarks: Sour Gas Compressor

Customer: EnCana Corporation
 Inquiry: Darryl Burns
 Project: Stock Units

Compressor Data:

Elevation,ft:	2500.0	Barmtr,psia:	13.400	Ambient,°F:	90.00
Frame:	JGK/4	Stroke, in:	5.50	Rod Dia, in:	2.000
Max RL Tot, lbf:	74000	Max RL Tens, lbf:	37000	Max RL Comp, lbf:	40000
Rated RPM:	1200	Rated BHP:	2540.0	Rated PS FPM:	1100.0
Calc RPM:	1200.0	Calc BHP:	1297	Calc PS FPM:	1100.0

Driver Data:

Type:	Nat. Gas
Mfg:	Waukesha
Model:	L7042GL
BHP:	1448
Avail:	1385 (63)

CUSTOM LIMITS SOUR GAS-2

Services

Stage Data:

	Gathering #1		#2	
Flow Req'd, MMSCFD	0.000	---	0.000	---
Flow Calc, MMSCFD	11.304	---	11.304	---
Cyl BHP per Stage	681.8	---	590.8	---
Specific Gravity	0.6767	---	0.6767	---
Ratio of Sp Ht (N)	1.2712	---	1.2718	---
Comp Suct (Zs)	0.9673	---	0.9405	---
Comp Disch (Zd)	0.9602	---	0.9401	---
Pres Suct Line, psig	150.00	---	N/A	---
Pres Suct Flg, psig	150.00	---	426.79	---
Pres Disch Flg, psig	434.93	---	1010.13	---
Pres Disch Line, psig	N/A	---	1000.00	---
Pres Ratio F/F	2.744	---	2.325	---
Temp Suct, °F	60.00	---	120.00	---
Temp Clr Disch, °F	120.00	---	120.00	---

Cylinder Data:

	Throw 2	Throw 4	Throw 1	Throw 3
Cyl Model	9-5/8K	9-5/8K	6-1/4K	6-1/4K
Cyl Bore, in	9.125	9.125	5.875	5.875
Cyl RDP (API), psig	1154.5	1154.5	1863.6	1863.6
Cyl MAWP, psig	1270.0	1270.0	2050.0	2050.0
Cyl Action	DBL	DBL	DBL	DBL
Cyl Disp, CFM	487.6	487.6	195.1	195.1
Pres Suct Intl, psig	137.62	137.62	406.81	406.81
Temp Suct Intl, °F	66	66	124	124
Suct Zsph	0.9686	0.9686	0.9422	0.9422
Pres Disch Intl, psig	469.26	469.26	1072.31	1072.31
Temp Disch Intl, °F	214	214	256	256
HE Suct Gas Vel, FPM	8673	8673	7217	7217
HE Disch Gas Vel, FPM	8197	8197	7702	7702
HE Spcrs Used/Max	0/4	0/4	0/2	0/2
HE Vol Pkt Avail, %	0.86+49.13	0.86+49.13	0.64+45.20	0.64+45.20
Vol Pkt Used, %	0.00 (V)	0.00 (V)	0.00 (V)	0.00 (V)
HE Min Clr, %	17.39	17.39	21.95	21.95
HE Total Clr, %	18.25	18.25	22.58	22.58
CE Suct Gas Vel, FPM	8256	8256	6381	6381
CE Disch Gas Vel, FPM	7803	7803	6809	6809
CE Spcrs Used/Max	0/4	0/4	0/2	0/2
CE Min Clr, %	19.03	19.03	26.69	26.69
CE Total Clr, %	19.03	19.03	26.69	26.69
Suct Vol Eff HE/CE, %	71.4/70.5	71.4/70.5	72.9/69.1	72.9/69.1
Disch Event HE/CE, ms	8.9/10.3	8.9/10.3	9.7/11.0	9.7/11.0
Suct Pseudo-Q HE/CE	8.7/7.9	8.7/7.9	5.5/4.3	5.5/4.3
Gas Rod Ld Comp, lbf	22189 C	22189 C	19461 C	19461 C
Gas Rod Ld Tens, lbf	20152 T	20152 T	14559 T	14559 T
Gas Rod Ld Total, lbf	42341	42341	34020	34020
Xhd Pin Deg/%Rvrsl lbf	175/98.7	175/98.7	160/94.3	160/94.3
Flow Calc, MMSCFD	5.652	5.652	5.652	5.652
Cyl BHP	340.9	340.9	295.4	295.4



Ariel Performance



Company: EFX Compression
 Quote: 060158, 060159, 060160
 Remarks: Sour Gas Compressor

Customer: EnCana Corporation
 Inquiry: Darryl Burns
 Project: Stock Units

7.5.1.1

Compressor Data:

Elevation,ft:	2500.0	Barmtr,psia:	13.400	Ambient,°F:	90.00
Frame:	JGK/4	Stroke, in:	5.50	Rod Dia, in:	2.000
Max RL Tot, lbf:	74000	Max RL Tens, lbf:	37000	Max RL Comp, lbf:	40000
Rated RPM:	1200	Rated BHP:	2540.0	Rated PS FPM:	1100.0
Calc RPM:	1200.0	Calc BHP:	1168	Calc PS FPM:	1100.0

Driver Data:

Type:	Nat. Gas
Mfg:	Waukesha
Model:	L7042GL
BHP:	1448
Avail:	1385 (63)

CUSTOM LIMITS SOUR GAS-2

Services

Gathering

Stage Data:

#1

#2

Flow Req'd, MMSCFD	0.000	---	0.000	---
Flow Calc, MMSCFD	9.283	---	9.283	---
Cyl BHP per Stage	588.7	---	554.9	---
Specific Gravity	0.6767	---	0.6767	---
Ratio of Sp Ht (N)	1.2686	---	1.2681	---
Comp Suct (Zs)	0.9724	---	0.9471	---
Comp Disch (Zd)	0.9657	---	0.9466	---
Pres Suct Line, psig	125.00	---	N/A	---
Pres Suct Flg, psig	125.00	---	377.94	---
Pres Disch Flg, psig	385.43	---	1010.13	---
Pres Disch Line, psig	N/A	---	1000.00	---
Pres Ratio F/F	2.882	---	2.615	---
Temp Suct, °F	60.00	---	120.00	---
Temp Clr Disch, °F	120.00	---	120.00	---

Cylinder Data:

Throw 2

Throw 4

Throw 1

Throw 3

Cyl Model	9-5/8K	9-5/8K	6-1/4K	6-1/4K
Cyl Bore, in	9.125	9.125	5.875	5.875
Cyl RDP (API), psig	1154.5	1154.5	1863.6	1863.6
Cyl MAWP, psig	1270.0	1270.0	2050.0	2050.0
Cyl Action	DBL	DBL	DBL	DBL
Cyl Disp, CFM	487.6	487.6	195.1	195.1
Pres Suct Intl, psig	114.57	114.57	360.32	360.32
Temp Suct Intl, °F	66	66	125	125
Suct Zsph	0.9735	0.9735	0.9487	0.9487
Pres Disch Intl, psig	415.54	415.54	1070.47	1070.47
Temp Disch Intl, °F	220	220	273	273
HE Suct Gas Vel, FPM	8673	8673	7217	7217
HE Disch Gas Vel, FPM	8197	8197	7702	7702
HE Spcrs Used/Max	0/4	0/4	0/2	0/2
HE Vol Pkt Avail, %	0.86+49.13	0.86+49.13	0.64+45.20	0.64+45.20
Vol Pkt Used, %	0.00 (V)	0.00 (V)	0.00 (V)	0.00 (V)
HE Min Clr, %	17.39	17.39	21.95	21.95
HE Total Clr, %	18.25	18.25	22.58	22.58
CE Suct Gas Vel, FPM	8256	8256	6381	6381
CE Disch Gas Vel, FPM	7803	7803	6809	6809
CE Spcrs Used/Max	0/4	0/4	0/2	0/2
CE Min Clr, %	19.03	19.03	26.69	26.69
CE Total Clr, %	19.03	19.03	26.69	26.69
Suct Vol Eff HE/CE, %	69.6/68.6	69.6/68.6	68.4/63.8	68.4/63.8
Disch Event HE/CE, ms	8.6/10.0	8.6/10.0	8.9/10.0	8.9/10.0
Suct Pseudo-Q HE/CE	8.6/7.8	8.6/7.8	5.5/4.3	5.5/4.3
Gas Rod Ld Comp, lbf	20103 C	20103 C	20527 C	20527 C
Gas Rod Ld Tens, lbf	18320 T	18320 T	15773 T	15773 T
Gas Rod Ld Total, lbf	38423	38423	36300	36300
Xhd Pin Deg/%Rvrsl lbf	171/93.6	171/93.6	163/96.8	163/96.8
Flow Calc, MMSCFD	4.641	4.641	4.641	4.641
Cyl BHP	294.3	294.3	277.4	277.4



Ariel Performance

Company: EFX Compression
 Quote: 060158, 060159, 060160
 Remarks: Sour Gas Compressor

Customer: EnCana Corporation
 Inquiry: Darryl Burns
 Project: Stock Units



Compressor Data:

Elevation,ft:	2500.0	Barmtr,psia:	13.400	Ambient,°F:	90.00
Frame:	JGK/4	Stroke, in:	5.50	Rod Dia, in:	2.000
Max RL Tot, lbf:	74000	Max RL Tens, lbf:	37000	Max RL Comp, lbf:	40000
Rated RPM:	1200	Rated BHP:	2540.0	Rated PS FPM:	1100.0
Calc RPM:	1200.0	Calc BHP:	1017	Calc PS FPM:	1100.0

Driver Data:

Type:	Nat. Gas
Mfg:	Waukesha
Model:	L7042GL
BHP:	1448
Avail:	1385 (63)

CUSTOM LIMITS SOUR GAS-2

Services

Gathering

Stage Data:	#1	---	#2	---
Flow Req'd, MMSCFD	0.000	---	0.000	---
Flow Calc, MMSCFD	7.291	---	7.291	---
Cyl BHP per Stage	492.5	---	500.3	---
Specific Gravity	0.6766	---	0.6766	---
Ratio of Sp Ht (N)	1.2657	---	1.2639	---
Comp Suct (Zs)	0.9774	---	0.9536	---
Comp Disch (Zd)	0.9713	---	0.9534	---
Pres Suct Line, psig	100.00	---	N/A	---
Pres Suct Flg, psig	100.00	---	328.71	---
Pres Disch Flg, psig	335.49	---	1010.13	---
Pres Disch Line, psig	N/A	---	1000.00	---
Pres Ratio F/F	3.077	---	2.992	---
Temp Suct, °F	60.00	---	120.00	---
Temp Clr Disch, °F	120.00	---	120.00	---
Cylinder Data:	Throw 2	Throw 4	Throw 1	Throw 3
Cyl Model	9-5/8K	9-5/8K	6-1/4K	6-1/4K
Cyl Bore, in	9.125	9.125	5.875	5.875
Cyl RDP (API), psig	1154.5	1154.5	1863.6	1863.6
Cyl MAWP, psig	1270.0	1270.0	2050.0	2050.0
Cyl Action	DBL	DBL	DBL	DBL
Cyl Disp, CFM	487.6	487.6	195.1	195.1
Pres Suct Intl, psig	91.51	91.51	313.43	313.43
Temp Suct Intl, °F	66	66	125	125
Suct Zsph	0.9783	0.9783	0.9552	0.9552
Pres Disch Intl, psig	361.37	361.37	1068.51	1068.51
Temp Disch Intl, °F	228	228	292	292
HE Suct Gas Vel, FPM	8673	8673	7217	7217
HE Disch Gas Vel, FPM	8197	8197	7702	7702
HE Spcrs Used/Max	0/4	0/4	0/2	0/2
HE Vol Pkt Avail, %	0.86+49.13	0.86+49.13	0.64+45.20	0.64+45.20
Vol Pkt Used, %	0.00 (V)	0.00 (V)	0.00 (V)	0.00 (V)
HE Min Clr, %	17.39	17.39	21.95	21.95
HE Total Clr, %	18.25	18.25	22.58	22.58
CE Suct Gas Vel, FPM	8256	8256	6381	6381
CE Disch Gas Vel, FPM	7803	7803	6809	6809
CE Spcrs Used/Max	0/4	0/4	0/2	0/2
CE Min Clr, %	19.03	19.03	26.69	26.69
CE Total Clr, %	19.03	19.03	26.69	26.69
Suct Vol Eff HE/CE, %	67.2/66.1	67.2/66.1	62.6/57.0	62.6/57.0
Disch Event HE/CE, ms	8.2/9.4	8.2/9.4	7.9/8.9	7.9/8.9
Suct Pseudo-Q HE/CE	8.6/7.8	8.6/7.8	5.4/4.3	5.4/4.3
Gas Rod Ld Comp, lbf	17990 C	17990 C	21598 C	21598 C
Gas Rod Ld Tens, lbf	16463 T	16463 T	16995 T	16995 T
Gas Rod Ld Total, lbf	34453	34453	38593	38593
Xhd Pin Deg/%RvrsI lbf	169/86.3	169/86.3	156/99.7	156/99.7
Flow Calc, MMSCFD	3.646	3.646	3.646	3.646
Cyl BHP	246.2	246.2	250.2	250.2



Gas Analysis Data

Company: EFX Compression
 Quote: 060158, 060159, 060160
 7.5.1.1 Remarks: Sour Gas Compressor

Customer: EnCana Corporation
 Inquiry: Darryl Burns
 Project: Stock Units



Services	Gathering				
Gas Model	Hall				
Stage	# 1	# 1	# 2	Final	Final
Stream	Main	Vapor	Vapor	Liq1	Vapor
Suction Press, psig	100.00	100.00	328.71		
Disch Press, psig		335.49	1010.13		1000.00
Suction Temp, °F	60.00	60.00	120.00		120.00
Disch Temp, °F		227.66	291.81		120.00
Flow, MMSCFD	7.291	7.291	7.291	0.004	7.287
Flow, lb/h	15688.0	15688.6	15688.6	8.7	15679.9
Flow, GPM				0.017	
Dropout, %				0.061	
Specific Gravity	0.6766	0.6766	0.6766		0.6767
Ratio of Sp Ht (N)		1.2657	1.2639		
Comp Suct (Zs)		0.9774	0.9536		0.8663
Comp Disch (Zd)		0.9713	0.9534		
Mole Weight		19.60	19.60		19.60
Density, lb/ft3		0.408	1.130		3.723
Density @ Std, lb/ft3		0.052	0.052		0.052
Enthaply, Btu/lb		-1661.30	-1631.38		-1629.08
Entropy, Btu/lbmol-F		0.0000	0.0000		0.0000
Speed of Sound (Suct), ft/s		N/A	N/A		N/A
Pseudo-Pc, psig		N/A	N/A		N/A
Pseudo-Tc, °F		N/A	N/A		N/A
γp, Btu/lb-°F		N/A	N/A		N/A
ΔHv Mass, BTU/ft3		0.00	0.00		0.00
Speed of Sound (Disch), ft/s		N/A	N/A		N/A
Viscosity, lb/ft-s		N/A	N/A		N/A
Thermal Cond., Btu/ft-h-°F		N/A	N/A		N/A
Heat Load, BTU/h		N/A	N/A		N/A
Humidity	100.00	100.00			
WATER	0.22603	0.22603	0.22603	100.00000	0.16551
METHANE	84.39694	84.27510	84.27510		84.32611
ETHANE	4.99591	4.98870	4.98870		4.99172
PROPANE	3.39528	3.39038	3.39038		3.39243
ISOBUTANE					
N-BUTANE	1.79465	1.79206	1.79206		1.79314
ISOPENTANE					
N-PENTANE	0.48504	0.48434	0.48434		0.48463
N-HEXANE					
N-HEPTANE					
NITROGEN					
CARBON DIOXIDE					
HYDROGEN SULFIDE	4.85040	4.84340	4.84340		4.84633



Ariel Performance

Company: EFX Compression
 Quote: 060158, 060159, 060160
 Remarks: Sour Gas Compressor

Customer: EnCana Corporation
 Inquiry: Darryl Burns
 Project: Stock Units



Compressor Data:

Elevation,ft:	2500.0	Barmtr,psia:	13.400	Ambient,°F:	90.00
Frame:	JGK/4	Stroke, in:	5.50	Rod Dia, in:	2.000
Max RL Tot, lbf:	74000	Max RL Tens, lbf:	37000	Max RL Comp, lbf:	40000
Rated RPM:	1200	Rated BHP:	2540.0	Rated PS FPM:	1100.0
Calc RPM:	1200.0	Calc BHP:	1385	Calc PS FPM:	1100.0

Driver Data:

Type:	Nat. Gas
Mfg:	Waukesha
Model:	L7042GL
BHP:	1448
Avail:	1385 (63)

CUSTOM LIMITS SOUR GAS-2

Services

Gathering

Stage Data:

	#1	---	#2	---
Flow Req'd, MMSCFD	0.000	---	0.000	---
Flow Calc, MMSCFD	21.965	---	21.965	---
Cyl BHP per Stage	978.0	---	383.4	---
Specific Gravity	0.6767	---	0.6767	---
Ratio of Sp Ht (N)	1.2849	---	1.2868	---
Comp Suct (Zs)	0.9369	---	0.9127	---
Comp Disch (Zd)	0.9294	---	0.9118	---
Pres Suct Line, psig	300.00	---	N/A	---
Pres Suct Flg, psig	300.00	---	639.02	---
Pres Disch Flg, psig	649.02	---	810.00	---
Pres Disch Line, psig	N/A	---	800.00	---
Pres Ratio F/F	2.114	---	1.262	---
Temp Suct, °F	60.00	---	120.00	---
Temp Clr Disch, °F	120.00	---	120.00	---
Cylinder Data:	Throw 2	Throw 4	Throw 1	Throw 3
Cyl Model	9-5/8K	9-5/8K	6-1/4K	6-1/4K
Cyl Bore, in	9.125	9.125	5.875	5.875
Cyl RDP (API), psig	1154.5	1154.5	1863.6	1863.6
Cyl MAWP, psig	1270.0	1270.0	2050.0	2050.0
Cyl Action	DBL	DBL	DBL	DBL
Cyl Disp, CFM	487.6	487.6	195.1	195.1
Pres Suct Intl, psig	275.43	275.43	608.36	608.36
Temp Suct Intl, °F	65	65	122	122
Suct Zsph	0.9389	0.9389	0.9136	0.9136
Pres Disch Intl, psig	704.04	704.04	868.71	868.71
Temp Disch Intl, °F	182	182	169	169
HE Suct Gas Vel, FPM	8673	8673	7217	7217
HE Disch Gas Vel, FPM	8197	8197	7702	7702
HE Spcrs Used/Max	0/4	0/4	0/2	0/2
HE Vol Pkt Avail, %	0.86+49.13	0.86+49.13	0.64+45.20	0.64+45.20
Vol Pkt Used, %	49.33 (V)	49.33 (V)	0.00 (V)	0.00 (V)
HE Min Clr, %	17.39	17.39	21.95	21.95
HE Total Clr, %	42.49	42.49	22.58	22.58
CE Suct Gas Vel, FPM	8256	8256	6381	6381
CE Disch Gas Vel, FPM	7803	7803	6809	6809
CE Spcrs Used/Max	0/4	0/4	0/2	0/2
CE Min Clr, %	19.03	19.03	26.69	26.69
CE Total Clr, %	19.03	19.03	26.69	26.69
Suct Vol Eff HE/CE, %	60.5/79.0	60.5/79.0	90.4/89.6	90.4/89.6
Disch Event HE/CE, ms	9.2/12.4	9.2/12.4	16.0/17.2	16.0/17.2
Suct Pseudo-Q HE/CE	9.0/8.1	9.0/8.1	5.7/4.5	5.7/4.5
Gas Rod Ld Comp, lbf	28990 C	28990 C	9068 C	9068 C
Gas Rod Ld Tens, lbf	25734 T	25734 T	4262 T	4262 T
Gas Rod Ld Total, lbf	54724	54724	13330	13330
Xhd Pin Deg/%RvrsI lbf	175/86.4	175/86.4	153/91.2	153/91.2
Flow Calc, MMSCFD	10.983	10.983	10.983	10.983
Cyl BHP	489.0	489.0	191.7	191.7



Ariel Performance

Company: EFX Compression
 Quote: 060158, 060159, 060160
 Remarks: Sour Gas Compressor

Customer: EnCana Corporation
 Inquiry: Darryl Burns
 Project: Stock Units



Compressor Data:

Elevation, ft:	2500.0	Barmtr, psia:	13.400	Ambient, °F:	90.00
Frame:	JGK/4	Stroke, in:	5.50	Rod Dia, in:	2.000
Max RL Tot, lbf:	74000	Max RL Tens, lbf:	37000	Max RL Comp, lbf:	40000
Rated RPM:	1200	Rated BHP:	2540.0	Rated PS FPM:	1100.0
Calc RPM:	1200.0	Calc BHP:	1385	Calc PS FPM:	1100.0

Driver Data:

Type:	Nat. Gas
Mfg:	Waukesha
Model:	L7042GL
BHP:	1448
Avail:	1385 (63)

CUSTOM LIMITS SOUR GAS-2

Services

Gathering

Stage Data:

#1

#2

Flow Req'd, MMSCFD	0.000	---	0.000	---
Flow Calc, MMSCFD	20.444	---	20.444	---
Cyl BHP per Stage	948.3	---	413.1	---
Specific Gravity	0.6767	---	0.6767	---
Ratio of Sp Ht (N)	1.2828	---	1.2850	---
Comp Suct (Zs)	0.9420	---	0.9170	---
Comp Disch (Zd)	0.9344	---	0.9159	---
Pres Suct Line, psig	275.00	---	N/A	---
Pres Suct Flg, psig	275.00	---	605.77	---
Pres Disch Flg, psig	615.46	---	810.00	---
Pres Disch Line, psig	N/A	---	800.00	---
Pres Ratio F/F	2.181	---	1.330	---
Temp Suct, °F	60.00	---	120.00	---
Temp Clr Disch, °F	120.00	---	120.00	---

Cylinder Data:

Throw 2

Throw 4

Throw 1

Throw 3

Cyl Model	9-5/8K	9-5/8K	6-1/4K	6-1/4K
Cyl Bore, in	9.125	9.125	5.875	5.875
Cyl RDP (API), psig	1154.5	1154.5	1863.6	1863.6
Cyl MAWP, psig	1270.0	1270.0	2050.0	2050.0
Cyl Action	DBL	DBL	DBL	DBL
Cyl Disp, CFM	487.6	487.6	195.1	195.1
Pres Suct Intl, psig	252.52	252.52	576.82	576.82
Temp Suct Intl, °F	65	65	122	122
Suct Zsph	0.9438	0.9438	0.9180	0.9180
Pres Disch Intl, psig	667.12	667.12	867.79	867.79
Temp Disch Intl, °F	185	185	176	176
HE Suct Gas Vel, FPM	8673	8673	7217	7217
HE Disch Gas Vel, FPM	8197	8197	7702	7702
HE Spcrrs Used/Max	0/4	0/4	0/2	0/2
HE Vol Pkt Avail, %	0.86+49.13	0.86+49.13	0.64+45.20	0.64+45.20
Vol Pkt Used, %	36.67 (V)	36.67 (V)	0.00 (V)	0.00 (V)
HE Min Clr, %	17.39	17.39	21.95	21.95
HE Total Clr, %	36.26	36.26	22.58	22.58
CE Suct Gas Vel, FPM	8256	8256	6381	6381
CE Disch Gas Vel, FPM	7803	7803	6809	6809
CE Spcrrs Used/Max	0/4	0/4	0/2	0/2
CE Min Clr, %	19.03	19.03	26.69	26.69
CE Total Clr, %	19.03	19.03	26.69	26.69
Suct Vol Eff HE/CE, %	63.7/78.0	63.7/78.0	89.2/88.2	89.2/88.2
Disch Event HE/CE, ms	9.3/12.1	9.3/12.1	15.3/16.5	15.3/16.5
Suct Pseudo-Q HE/CE	8.9/8.1	8.9/8.1	5.7/4.4	5.7/4.4
Gas Rod Ld Comp, lbf	27998 C	27998 C	9801 C	9801 C
Gas Rod Ld Tens, lbf	24937 T	24937 T	5092 T	5092 T
Gas Rod Ld Total, lbf	52935	52935	14893	14893
Xhd Pin Deg/%RvrsI lbf	177/80.4	177/80.4	153/93.0	153/93.0
Flow Calc, MMSCFD	10.222	10.222	10.222	10.222
Cyl BHP	474.1	474.1	206.6	206.6



Ariel Performance

Company: EFX Compression
 Quote: 060158, 060159, 060160
 Remarks: Sour Gas Compressor

Customer: EnCana Corporation
 Inquiry: Darryl Burns
 Project: Stock Units



7.5.1.1

Compressor Data:

Elevation,ft:	2500.0	Barmtr,psia:	13.400	Ambient,°F:	90.00
Frame:	JGK/4	Stroke, in:	5.50	Rod Dia, in:	2.000
Max RL Tot, lbf:	74000	Max RL Tens, lbf:	37000	Max RL Comp, lbf:	40000
Rated RPM:	1200	Rated BHP:	2540.0	Rated PS FPM:	1100.0
Calc RPM:	1200.0	Calc BHP:	1385	Calc PS FPM:	1100.0

Driver Data:

Type:	Nat. Gas
Mfg:	Waukesha
Model:	L7042GL
BHP:	1448
Avail:	1385 (63)

CUSTOM LIMITS SOUR GAS-2

Services

Gathering

Stage Data:

#1

#2

Flow Req'd, MMSCFD	0.000	---	0.000	---
Flow Calc, MMSCFD	18.991	---	18.991	---
Cyl BHP per Stage	923.4	---	438.0	---
Specific Gravity	0.6767	---	0.6767	---
Ratio of Sp Ht (N)	1.2807	---	1.2832	---
Comp Suct (Zs)	0.9471	---	0.9212	---
Comp Disch (Zd)	0.9394	---	0.9198	---
Pres Suct Line, psig	250.00	---	N/A	---
Pres Suct Flg, psig	250.00	---	573.65	---
Pres Disch Flg, psig	582.91	---	810.00	---
Pres Disch Line, psig	N/A	---	800.00	---
Pres Ratio F/F	2.264	---	1.403	---
Temp Suct, °F	60.00	---	120.00	---
Temp Clr Disch, °F	120.00	---	120.00	---

Cylinder Data:

Throw 2

Throw 4

Throw 1

Throw 3

Cyl Model	9-5/8K	9-5/8K	6-1/4K	6-1/4K
Cyl Bore, in	9.125	9.125	5.875	5.875
Cyl RDP (API), psig	1154.5	1154.5	1863.6	1863.6
Cyl MAWP, psig	1270.0	1270.0	2050.0	2050.0
Cyl Action	DBL	DBL	DBL	DBL
Cyl Disp, CFM	487.6	487.6	195.1	195.1
Pres Suct Intl, psig	229.58	229.58	546.34	546.34
Temp Suct Intl, °F	65	65	122	122
Suct Zsph	0.9488	0.9488	0.9223	0.9223
Pres Disch Intl, psig	631.29	631.29	866.89	866.89
Temp Disch Intl, °F	190	190	183	183
HE Suct Gas Vel, FPM	8673	8673	7217	7217
HE Disch Gas Vel, FPM	8197	8197	7702	7702
HE Spcrrs Used/Max	0/4	0/4	0/2	0/2
HE Vol Pkt Avail, %	0.86+49.13	0.86+49.13	0.64+45.20	0.64+45.20
Vol Pkt Used, %	22.15 (V)	22.15 (V)	0.00 (V)	0.00 (V)
HE Min Clr, %	17.39	17.39	21.95	21.95
HE Total Clr, %	29.13	29.13	22.58	22.58
CE Suct Gas Vel, FPM	8256	8256	6381	6381
CE Disch Gas Vel, FPM	7803	7803	6809	6809
CE Spcrrs Used/Max	0/4	0/4	0/2	0/2
CE Min Clr, %	19.03	19.03	26.69	26.69
CE Total Clr, %	19.03	19.03	26.69	26.69
Suct Vol Eff HE/CE, %	67.9/76.9	67.9/76.9	87.9/86.7	87.9/86.7
Disch Event HE/CE, ms	9.4/11.8	9.4/11.8	14.6/16.0	14.6/16.0
Suct Pseudo-Q HE/CE	8.9/8.1	8.9/8.1	5.7/4.4	5.7/4.4
Gas Rod Ld Comp, lbf	27079 C	27079 C	10510 C	10510 C
Gas Rod Ld Tens, lbf	24209 T	24209 T	5894 T	5894 T
Gas Rod Ld Total, lbf	51288	51288	16404	16404
Xhd Pin Deg/%Rvrs lbf	179/73.6	179/73.6	154/94.6	154/94.6
Flow Calc, MMSCFD	9.495	9.495	9.495	9.495
Cyl BHP	461.7	461.7	219.0	219.0



Ariel Performance

Company: EFX Compression
 Quote: 060158, 060159, 060160
 Remarks: Sour Gas Compressor

Customer: EnCana Corporation
 Inquiry: Darryl Burns
 Project: Stock Units



Compressor Data:

Elevation,ft: 2500.0 Barmtr,psia: 13.400 Ambient,°F: 90.00
 Frame: JGK/4 Stroke, in: 5.50 Rod Dia, in: 2.000
 Max RL Tot, lbf: 74000 Max RL Tens, lbf: 37000 Max RL Comp, lbf: 40000
 Rated RPM: 1200 Rated BHP: 2540.0 Rated PS FPM: 1100.0
 Calc RPM: 1200.0 Calc BHP: 1385 Calc PS FPM: 1100.0

Driver Data:

Type: Nat. Gas
 Mfg: Waukesha
 Model: L7042GL
 BHP: 1448
 Avail: 1385 (63)

CUSTOM LIMITS SOUR GAS-2

Services

Gathering

Stage Data:

#1

#2

Flow Req'd, MMSCFD	0.000	---	0.000	---
Flow Calc, MMSCFD	17.595	---	17.595	---
Cyl BHP per Stage	903.1	---	458.3	---
Specific Gravity	0.6767	---	0.6767	---
Ratio of Sp Ht (N)	1.2784	---	1.2813	---
Comp Suct (Zs)	0.9522	---	0.9253	---
Comp Disch (Zd)	0.9445	---	0.9237	---
Pres Suct Line, psig	225.00	---	N/A	---
Pres Suct Flg, psig	225.00	---	542.45	---
Pres Disch Flg, psig	551.26	---	810.00	---
Pres Disch Line, psig	N/A	---	800.00	---
Pres Ratio F/F	2.369	---	1.481	---
Temp Suct, °F	60.00	---	120.00	---
Temp Clr Disch, °F	120.00	---	120.00	---

Cylinder Data:

Throw 2

Throw 4

Throw 1

Throw 3

Cyl Model	9-5/8K	9-5/8K	6-1/4K	6-1/4K
Cyl Bore, in	9.125	9.125	5.875	5.875
Cyl RDP (API), psig	1154.5	1154.5	1863.6	1863.6
Cyl MAWP, psig	1270.0	1270.0	2050.0	2050.0
Cyl Action	DBL	DBL	DBL	DBL
Cyl Disp, CFM	487.6	487.6	195.1	195.1
Pres Suct Intl, psig	206.63	206.63	516.72	516.72
Temp Suct Intl, °F	65	65	122	122
Suct Zsph	0.9538	0.9538	0.9264	0.9264
Pres Disch Intl, psig	596.44	596.44	866.00	866.00
Temp Disch Intl, °F	196	196	191	191
HE Suct Gas Vel, FPM	8673	8673	7217	7217
HE Disch Gas Vel, FPM	8197	8197	7702	7702
HE Spcrs Used/Max	0/4	0/4	0/2	0/2
HE Vol Pkt Avail, %	0.86+49.13	0.86+49.13	0.64+45.20	0.64+45.20
Vol Pkt Used, %	5.94 (V)	5.94 (V)	0.00 (V)	0.00 (V)
HE Min Clr, %	17.39	17.39	21.95	21.95
HE Total Clr, %	21.17	21.17	22.58	22.58
CE Suct Gas Vel, FPM	8256	8256	6381	6381
CE Disch Gas Vel, FPM	7803	7803	6809	6809
CE Spcrs Used/Max	0/4	0/4	0/2	0/2
CE Min Clr, %	19.03	19.03	26.69	26.69
CE Total Clr, %	19.03	19.03	26.69	26.69
Suct Vol Eff HE/CE, %	73.4/75.5	73.4/75.5	86.6/85.1	86.6/85.1
Disch Event HE/CE, ms	9.7/11.4	9.7/11.4	13.9/15.3	13.9/15.3
Suct Pseudo-Q HE/CE	8.8/8.0	8.8/8.0	5.6/4.4	5.6/4.4
Gas Rod Ld Comp, lbf	26225 C	26225 C	11197 C	11197 C
Gas Rod Ld Tens, lbf	23544 T	23544 T	6672 T	6672 T
Gas Rod Ld Total, lbf	49769	49769	17869	17869
Xhd Pin Deg/%RvrsI lbf	179/80.4	179/80.4	155/95.7	155/95.7
Flow Calc, MMSCFD	8.797	8.797	8.797	8.797
Cyl BHP	451.5	451.5	229.2	229.2



Ariel Performance



Company: EFX Compression
 Quote: 060158, 060159, 060160
 Remarks: Sour Gas Compressor

Customer: EnCana Corporation
 Inquiry: Darryl Burns
 Project: Stock Units

7.5.1.1

Compressor Data:

Elevation,ft:	2500.0	Barmtr,psia:	13.400	Ambient,°F:	90.00
Frame:	JGK/4	Stroke, in:	5.50	Rod Dia, in:	2.000
Max RL Tot, lbf:	74000	Max RL Tens, lbf:	37000	Max RL Comp, lbf:	40000
Rated RPM:	1200	Rated BHP:	2540.0	Rated PS FPM:	1100.0
Calc RPM:	1200.0	Calc BHP:	1385	Calc PS FPM:	1100.0

Driver Data:

Type:	Nat. Gas
Mfg:	Waukesha
Model:	L7042GL
BHP:	1448
Avail:	1385 (63)

CUSTOM LIMITS SOUR GAS-2

Services

Gathering

Stage Data:	#1	---	#2	---
Flow Req'd, MMSCFD	0.000	---	0.000	---
Flow Calc, MMSCFD	17.114	---	17.114	---
Cyl BHP per Stage	896.6	---	464.4	---
Specific Gravity	0.6767	---	0.6767	---
Ratio of Sp Ht (N)	1.2776	---	1.2807	---
Comp Suct (Zs)	0.9539	---	0.9267	---
Comp Disch (Zd)	0.9463	---	0.9250	---
Pres Suct Line, psig	216.25	---	N/A	---
Pres Suct Flg, psig	216.25	---	531.62	---
Pres Disch Flg, psig	540.26	---	810.00	---
Pres Disch Line, psig	N/A	---	800.00	---
Pres Ratio F/F	2.411	---	1.511	---
Temp Suct, °F	60.00	---	120.00	---
Temp Clr Disch, °F	120.00	---	120.00	---
Cylinder Data:	Throw 2	Throw 4	Throw 1	Throw 3
Cyl Model	9-5/8K	9-5/8K	6-1/4K	6-1/4K
Cyl Bore, in	9.125	9.125	5.875	5.875
Cyl RDP (API), psig	1154.5	1154.5	1863.6	1863.6
Cyl MAWP, psig	1270.0	1270.0	2050.0	2050.0
Cyl Action	DBL	DBL	DBL	DBL
Cyl Disp, CFM	487.6	487.6	195.1	195.1
Pres Suct Intl, psig	198.59	198.59	506.43	506.43
Temp Suct Intl, °F	65	65	122	122
Suct Zsph	0.9555	0.9555	0.9278	0.9278
Pres Disch Intl, psig	584.33	584.33	865.68	865.68
Temp Disch Intl, °F	198	198	194	194
HE Suct Gas Vel, FPM	8673	8673	7217	7217
HE Disch Gas Vel, FPM	8197	8197	7702	7702
HE Spcrrs Used/Max	0/4	0/4	0/2	0/2
HE Vol Pkt Avail, %	0.86+49.13	0.86+49.13	0.64+45.20	0.64+45.20
Vol Pkt Used, %	0.00 (V)	0.00 (V)	0.00 (V)	0.00 (V)
HE Min Clr, %	17.39	17.39	21.95	21.95
HE Total Clr, %	18.25	18.25	22.58	22.58
CE Suct Gas Vel, FPM	8256	8256	6381	6381
CE Disch Gas Vel, FPM	7803	7803	6809	6809
CE Spcrrs Used/Max	0/4	0/4	0/2	0/2
CE Min Clr, %	19.03	19.03	26.69	26.69
CE Total Clr, %	19.03	19.03	26.69	26.69
Suct Vol Eff HE/CE, %	75.7/74.9	75.7/74.9	86.1/84.6	86.1/84.6
Disch Event HE/CE, ms	9.9/11.3	9.9/11.3	13.7/15.0	13.7/15.0
Suct Pseudo-Q HE/CE	8.8/8.0	8.8/8.0	5.6/4.4	5.6/4.4
Gas Rod Ld Comp, lbf	25932 C	25932 C	11436 C	11436 C
Gas Rod Ld Tens, lbf	23316 T	23316 T	6943 T	6943 T
Gas Rod Ld Total, lbf	49248	49248	18379	18379
Xhd Pin Deg/%Rvrsl lbf	180/85.1	180/85.1	155/96.0	155/96.0
Flow Calc, MMSCFD	8.557	8.557	8.557	8.557
Cyl BHP	448.3	448.3	232.2	232.2



Ariel Performance

Company: EFX Compression
 Quote: 060158, 060159, 060160
 Remarks: Sour Gas Compressor

Customer: EnCana Corporation
 Inquiry: Darryl Burns
 Project: Stock Units



Compressor Data:

Elevation,ft:	2500.0	Barmtr,psia:	13.400	Ambient, °F:	90.00
Frame:	JGK/4	Stroke, in:	5.50	Rod Dia, in:	2.000
Max RL Tot, lbf:	74000	Max RL Tens, lbf:	37000	Max RL Comp, lbf:	40000
Rated RPM:	1200	Rated BHP:	2540.0	Rated PS FPM:	1100.0
Calc RPM:	1200.0	Calc BHP:	1343	Calc PS FPM:	1100.0

Driver Data:

Type:	Nat. Gas
Mfg:	Waukesha
Model:	L7042GL
BHP:	1448
Avail:	1385 (63)

CUSTOM LIMITS SOUR GAS-2

Services

Gathering

Stage Data:

	#1	---	#2	---
Flow Req'd, MMSCFD	0.000	---	0.000	---
Flow Calc, MMSCFD	15.745	---	15.745	---
Cyl BHP per Stage	840.2	---	479.1	---
Specific Gravity	0.6767	---	0.6767	---
Ratio of Sp Ht (N)	1.2762	---	1.2788	---
Comp Suct (Zs)	0.9572	---	0.9308	---
Comp Disch (Zd)	0.9497	---	0.9289	---
Pres Suct Line, psig	200.00	---	N/A	---
Pres Suct Flg, psig	200.00	---	500.55	---
Pres Disch Flg, psig	508.88	---	810.00	---
Pres Disch Line, psig	N/A	---	800.00	---
Pres Ratio F/F	2.447	---	1.602	---
Temp Suct, °F	60.00	---	120.00	---
Temp Clr Disch, °F	120.00	---	120.00	---
Cylinder Data:	Throw 2	Throw 4	Throw 1	Throw 3
Cyl Model	9-5/8K	9-5/8K	6-1/4K	6-1/4K
Cyl Bore, in	9.125	9.125	5.875	5.875
Cyl RDP (API), psig	1154.5	1154.5	1863.6	1863.6
Cyl MAWP, psig	1270.0	1270.0	2050.0	2050.0
Cyl Action	DBL	DBL	DBL	DBL
Cyl Disp, CFM	487.6	487.6	195.1	195.1
Pres Suct Intl, psig	183.65	183.65	476.91	476.91
Temp Suct Intl, °F	65	65	123	123
Suct Zsph	0.9587	0.9587	0.9320	0.9320
Pres Disch Intl, psig	550.20	550.20	864.77	864.77
Temp Disch Intl, °F	199	199	202	202
HE Suct Gas Vel, FPM	8673	8673	7217	7217
HE Disch Gas Vel, FPM	8197	8197	7702	7702
HE Spcrrs Used/Max	0/4	0/4	0/2	0/2
HE Vol Pkt Avail, %	0.86+49.13	0.86+49.13	0.64+45.20	0.64+45.20
Vol Pkt Used, %	0.00 (V)	0.00 (V)	0.00 (V)	0.00 (V)
HE Min Clr, %	17.39	17.39	21.95	21.95
HE Total Clr, %	18.25	18.25	22.58	22.58
CE Suct Gas Vel, FPM	8256	8256	6381	6381
CE Disch Gas Vel, FPM	7803	7803	6809	6809
CE Spcrrs Used/Max	0/4	0/4	0/2	0/2
CE Min Clr, %	19.03	19.03	26.69	26.69
CE Total Clr, %	19.03	19.03	26.69	26.69
Suct Vol Eff HE/CE, %	75.2/74.4	75.2/74.4	84.5/82.7	84.5/82.7
Disch Event HE/CE, ms	9.7/11.3	9.7/11.3	13.1/14.4	13.1/14.4
Suct Pseudo-Q HE/CE	8.8/8.0	8.8/8.0	5.6/4.4	5.6/4.4
Gas Rod Ld Comp, lbf	24626 C	24626 C	12120 C	12120 C
Gas Rod Ld Tens, lbf	22173 T	22173 T	7719 T	7719 T
Gas Rod Ld Total, lbf	46799	46799	19839	19839
Xhd Pin Deg/%Rvrsl lbf	178/87.7	178/87.7	155/96.5	155/96.5
Flow Calc, MMSCFD	7.872	7.872	7.872	7.872
Cyl BHP	420.1	420.1	239.5	239.5



Ariel Performance

Company: EFX Compression
 Quote: 060158, 060159, 060160
 Remarks: Sour Gas Compressor

Customer: EnCana Corporation
 Inquiry: Darryl Burns
 Project: Stock Units



Compressor Data:

Elevation,ft: 2500.0 Barmtr,psia: 13.400
 Frame: JGK/4 Stroke, in: 5.50
 Max RL Tot, lbf: 74000 Max RL Tens, lbf: 37000
 Rated RPM: 1200 Rated BHP: 2540.0
 Calc RPM: 1200.0 Calc BHP: 1269

Driver Data:

Ambient, °F: 90.00 Type: Nat. Gas
 Rod Dia, in: 2.000 Mfg: Waukesha
 Max RL Comp, lbf: 40000 Model: L7042GL
 Rated PS FPM: 1100.0 BHP: 1448
 Calc PS FPM: 1100.0 Avail: 1385 (63)

CUSTOM LIMITS SOUR GAS-2

Services

Gathering

Stage Data:

	#1		#2	
Flow Req'd, MMSCFD	0.000	---	0.000	---
Flow Calc, MMSCFD	13.660	---	13.660	---
Cyl BHP per Stage	752.6	---	492.6	---
Specific Gravity	0.6767	---	0.6767	---
Ratio of Sp Ht (N)	1.2740	---	1.2756	---
Comp Suct (Zs)	0.9623	---	0.9371	---
Comp Disch (Zd)	0.9550	---	0.9349	---
Pres Suct Line, psig	175.00	---	N/A	---
Pres Suct Flg, psig	175.00	---	452.54	---
Pres Disch Flg, psig	460.37	---	810.00	---
Pres Disch Line, psig	N/A	---	800.00	---
Pres Ratio F/F	2.515	---	1.767	---
Temp Suct, °F	60.00	---	120.00	---
Temp Clr Disch, °F	120.00	---	120.00	---

Cylinder Data:

Throw 2

Throw 4

Throw 1

Throw 3

	Throw 2	Throw 4	Throw 1	Throw 3
Cyl Model	9-5/8K	9-5/8K	6-1/4K	6-1/4K
Cyl Bore, in	9.125	9.125	5.875	5.875
Cyl RDP (API), psig	1154.5	1154.5	1863.6	1863.6
Cyl MAWP, psig	1270.0	1270.0	2050.0	2050.0
Cyl Action	DBL	DBL	DBL	DBL
Cyl Disp, CFM	487.6	487.6	195.1	195.1
Pres Suct Intl, psig	160.64	160.64	431.27	431.27
Temp Suct Intl, °F	65	65	123	123
Suct Zsph	0.9636	0.9636	0.9384	0.9384
Pres Disch Intl, psig	497.48	497.48	863.32	863.32
Temp Disch Intl, °F	202	202	215	215
HE Suct Gas Vel, FPM	8673	8673	7217	7217
HE Disch Gas Vel, FPM	8197	8197	7702	7702
HE Spcrs Used/Max	0/4	0/4	0/2	0/2
HE Voi Pkt Avail, %	0.86+49.13	0.86+49.13	0.64+45.20	0.64+45.20
Vol Pkt Used, %	0.00 (V)	0.00 (V)	0.00 (V)	0.00 (V)
HE Min Clr, %	17.39	17.39	21.95	21.95
HE Total Clr, %	18.25	18.25	22.58	22.58
CE Suct Gas Vel, FPM	8256	8256	6381	6381
CE Disch Gas Vel, FPM	7803	7803	6809	6809
CE Spcrs Used/Max	0/4	0/4	0/2	0/2
CE Min Clr, %	19.03	19.03	26.69	26.69
CE Total Clr, %	19.03	19.03	26.69	26.69
Suct Vol Eff HE/CE, %	74.3/73.5	74.3/73.5	81.8/79.5	81.8/79.5
Disch Event HE/CE, ms	9.4/11.0	9.4/11.0	12.1/13.5	12.1/13.5
Suct Pseudo-Q HE/CE	8.7/7.9	8.7/7.9	5.6/4.3	5.6/4.3
Gas Rod Ld Comp, lbf	22604 C	22604 C	13177 C	13177 C
Gas Rod Ld Tens, lbf	20401 T	20401 T	8917 T	8917 T
Gas Rod Ld Total, lbf	43005	43005	22094	22094
Xhd Pin Deg/%RvrsI lbf	174/93.6	174/93.6	156/96.2	156/96.2
Flow Calc, MMSCFD	6.830	6.830	6.830	6.830
Cyl BHP	376.3	376.3	246.3	246.3



Ariel Performance

Company: EFX Compression
 Quote: 060158, 060159, 060160
 Remarks: Sour Gas Compressor

Customer: EnCana Corporation
 Inquiry: Darryl Burns
 Project: Stock Units



7.5.1.1

Compressor Data:

Elevation,ft:	2500.0	Barmtr,psia:	13.400	Ambient, °F:	90.00
Frame:	JGK/4	Stroke, in:	5.50	Rod Dia, in:	2.000
Max RL Tot, lbf:	74000	Max RL Tens, lbf:	37000	Max RL Comp, lbf:	40000
Rated RPM:	1200	Rated BHP:	2540.0	Rated PS FPM:	1100.0
Calc RPM:	1200.0	Calc BHP:	1182	Calc PS FPM:	1100.0

Driver Data:

Type:	Nat. Gas
Mfg:	Waukesha
Model:	L7042GL
BHP:	1448
Avail:	1385 (63)

CUSTOM LIMITS SOUR GAS-2

Services

Gathering

Stage Data:

	#1	---	#2	---
Flow Req'd, MMSCFD	0.000	---	0.000	---
Flow Calc, MMSCFD	11.604	---	11.604	---
Cyl BHP per Stage	664.0	---	493.6	---
Specific Gravity	0.6767	---	0.6767	---
Ratio of Sp Ht (N)	1.2717	---	1.2722	---
Comp Suct (Zs)	0.9673	---	0.9436	---
Comp Disch (Zd)	0.9605	---	0.9411	---
Pres Suct Line, psig	150.00	---	N/A	---
Pres Suct Flg, psig	150.00	---	404.25	---
Pres Disch Flg, psig	411.55	---	810.00	---
Pres Disch Line, psig	N/A	---	800.00	---
Pres Ratio F/F	2.601	---	1.971	---
Temp Suct, °F	60.00	---	120.00	---
Temp Clr Disch, °F	120.00	---	120.00	---

Cylinder Data:

Throw 2

Throw 4

Throw 1

Throw 3

	Throw 2	Throw 4	Throw 1	Throw 3
Cyl Model	9-5/8K	9-5/8K	6-1/4K	6-1/4K
Cyl Bore, in	9.125	9.125	5.875	5.875
Cyl RDP (API), psig	1154.5	1154.5	1863.6	1863.6
Cyl MAWP, psig	1270.0	1270.0	2050.0	2050.0
Cyl Action	DBL	DBL	DBL	DBL
Cyl Disp, CFM	487.6	487.6	195.1	195.1
Pres Suct Intl, psig	137.61	137.61	385.33	385.33
Temp Suct Intl, °F	66	66	124	124
Suct Zsph	0.9685	0.9685	0.9448	0.9448
Pres Disch Intl, psig	444.46	444.46	861.80	861.80
Temp Disch Intl, °F	206	206	230	230
HE Suct Gas Vel, FPM	8673	8673	7217	7217
HE Disch Gas Vel, FPM	8197	8197	7702	7702
HE Spcrs Used/Max	0/4	0/4	0/2	0/2
HE Vol Pkt Avail, %	0.86+49.13	0.86+49.13	0.64+45.20	0.64+45.20
Vol Pkt Used, %	0.00 (V)	0.00 (V)	0.00 (V)	0.00 (V)
HE Min Clr, %	17.39	17.39	21.95	21.95
HE Total Clr, %	18.25	18.25	22.58	22.58
CE Suct Gas Vel, FPM	8256	8256	6381	6381
CE Disch Gas Vel, FPM	7803	7803	6809	6809
CE Spcrs Used/Max	0/4	0/4	0/2	0/2
CE Min Clr, %	19.03	19.03	26.69	26.69
CE Total Clr, %	19.03	19.03	26.69	26.69
Suct Vol Eff HE/CE, %	73.2/72.3	73.2/72.3	78.4/75.6	78.4/75.6
Disch Event HE/CE, ms	9.3/10.7	9.3/10.7	11.1/12.4	11.1/12.4
Suct Pseudo-Q HE/CE	8.7/7.9	8.7/7.9	5.5/4.3	5.5/4.3
Gas Rod Ld Comp, lbf	20563 C	20563 C	14239 C	14239 C
Gas Rod Ld Tens, lbf	18612 T	18612 T	10123 T	10123 T
Gas Rod Ld Total, lbf	39175	39175	24362	24362
Xhd Pin Deg/%Rvrsl lbf	171/99.0	171/99.0	157/94.4	157/94.4
Flow Calc, MMSCFD	5.802	5.802	5.802	5.802
Cyl BHP	332.0	332.0	246.8	246.8



Ariel Performance

Company: EFX Compression
 Quote: 060158, 060159, 060160
 Remarks: Sour Gas Compressor

Customer: EnCana Corporation
 Inquiry: Darryl Burns
 Project: Stock Units

EFX Compression

7.5.1.1

Compressor Data:

Elevation,ft:	2500.0	Barmtr,psia:	13.400	Ambient,°F:	90.00
Frame:	JGK/4	Stroke, in:	5.50	Rod Dia, in:	2.000
Max RL Tot, lbf:	74000	Max RL Tens, lbf:	37000	Max RL Comp, lbf:	40000
Rated RPM:	1200	Rated BHP:	2540.0	Rated PS FPM:	1100.0
Calc RPM:	1200.0	Calc BHP:	1078	Calc PS FPM:	1100.0

Driver Data:

Type:	Nat. Gas
Mfg:	Waukesha
Model:	L7042GL
BHP:	1448
Avail:	1385 (63)

CUSTOM LIMITS SOUR GAS-2

Services

Gathering

Stage Data:

#1

#2

Flow Req'd, MMSCFD	0.000	---	0.000	---
Flow Calc, MMSCFD	9.575	---	9.575	---
Cyl BHP per Stage	573.9	---	479.8	---
Specific Gravity	0.6767	---	0.6767	---
Ratio of Sp Ht (N)	1.2693	---	1.2684	---
Comp Suct (Zs)	0.9724	---	0.9500	---
Comp Disch (Zd)	0.9660	---	0.9475	---
Pres Suct Line, psig	125.00	---	N/A	---
Pres Suct Flg, psig	125.00	---	355.65	---
Pres Disch Flg, psig	362.36	---	810.00	---
Pres Disch Line, psig	N/A	---	800.00	---
Pres Ratio F/F	2.715	---	2.231	---
Temp Suct, °F	60.00	---	120.00	---
Temp Clr Disch, °F	120.00	---	120.00	---

Cylinder Data:

Throw 2

Throw 4

Throw 1

Throw 3

Cyl Model	9-5/8K	9-5/8K	6-1/4K	6-1/4K
Cyl Bore, in	9.125	9.125	5.875	5.875
Cyl RDP (API), psig	1154.5	1154.5	1863.6	1863.6
Cyl MAWP, psig	1270.0	1270.0	2050.0	2050.0
Cyl Action	DBL	DBL	DBL	DBL
Cyl Disp, CFM	487.6	487.6	195.1	195.1
Pres Suct Intl, psig	114.57	114.57	339.06	339.06
Temp Suct Intl, °F	66	66	124	124
Suct Zsph	0.9734	0.9734	0.9513	0.9513
Pres Disch Intl, psig	391.08	391.08	860.19	860.19
Temp Disch Intl, °F	211	211	248	248
HE Suct Gas Vel, FPM	8673	8673	7217	7217
HE Disch Gas Vel, FPM	8197	8197	7702	7702
HE Spcrrs Used/Max	0/4	0/4	0/2	0/2
HE Vol Pkt Avail, %	0.86+49.13	0.86+49.13	0.64+45.20	0.64+45.20
Vol Pkt Used, %	0.00 (V)	0.00 (V)	0.00 (V)	0.00 (V)
HE Min Clr, %	17.39	17.39	21.95	21.95
HE Total Clr, %	18.25	18.25	22.58	22.58
CE Suct Gas Vel, FPM	8256	8256	6381	6381
CE Disch Gas Vel, FPM	7803	7803	6809	6809
CE Spcrrs Used/Max	0/4	0/4	0/2	0/2
CE Min Clr, %	19.03	19.03	26.69	26.69
CE Total Clr, %	19.03	19.03	26.69	26.69
Suct Vol Eff HE/CE, %	71.7/70.8	71.7/70.8	74.2/70.6	74.2/70.6
Disch Event HE/CE, ms	9.0/10.4	9.0/10.4	10.0/11.3	10.0/11.3
Suct Pseudo-Q HE/CE	8.6/7.8	8.6/7.8	5.5/4.3	5.5/4.3
Gas Rod Ld Comp, lbf	18500 C	18500 C	15306 C	15306 C
Gas Rod Ld Tens, lbf	16802 T	16802 T	11335 T	11335 T
Gas Rod Ld Total, lbf	35302	35302	26641	26641
Xhd Pin Deg/%Rvrsl lbf	169/91.6	169/91.6	158/92.2	158/92.2
Flow Calc, MMSCFD	4.788	4.788	4.788	4.788
Cyl BHP	286.9	286.9	239.9	239.9



Ariel Performance

Company: EFX Compression
 Quote: 060158, 060159, 060160
 Remarks: Sour Gas Compressor

Customer: EnCana Corporation
 Inquiry: Darryl Burns
 Project: Stock Units



Compressor Data:

Elevation, ft: 2500.0 Barmtr, psia: 13.400 Ambient, °F: 90.00
 Frame: JGK/4 Stroke, in: 5.50 Rod Dia, in: 2.000
 Max RL Tot, lbf: 74000 Max RL Tens, lbf: 37000 Max RL Comp, lbf: 40000
 Rated RPM: 1200 Rated BHP: 2540.0 Rated PS FPM: 1100.0
 Calc RPM: 1200.0 Calc BHP: 953 Calc PS FPM: 1100.0

Driver Data:

Type: Nat. Gas
 Mfg: Waukesha
 Model: L7042GL
 BHP: 1448
 Avail: 1385 (63)

CUSTOM LIMITS SOUR GAS-2

Services

Stage Data:

	Gathering			
	#1	---	#2	---
Flow Req'd, MMSCFD	0.000	---	0.000	---
Flow Calc, MMSCFD	7.575	---	7.575	---
Cyl BHP per Stage	481.3	---	447.8	---
Specific Gravity	0.6766	---	0.6766	---
Ratio of Sp Ht (N)	1.2665	---	1.2642	---
Comp Suct (Zs)	0.9774	---	0.9566	---
Comp Disch (Zd)	0.9716	---	0.9541	---
Pres Suct Line, psig	100.00	---	N/A	---
Pres Suct Flg, psig	100.00	---	306.66	---
Pres Disch Flg, psig	312.73	---	810.00	---
Pres Disch Line, psig	N/A	---	800.00	---
Pres Ratio F/F	2.876	---	2.573	---
Temp Suct, °F	60.00	---	120.00	---
Temp Clr Disch, °F	120.00	---	120.00	---

Cylinder Data:

	Throw 2	Throw 4	Throw 1	Throw 3
Cyl Model	9-5/8K	9-5/8K	6-1/4K	6-1/4K
Cyl Bore, in	9.125	9.125	5.875	5.875
Cyl RDP (API), psig	1154.5	1154.5	1863.6	1863.6
Cyl MAWP, psig	1270.0	1270.0	2050.0	2050.0
Cyl Action	DBL	DBL	DBL	DBL
Cyl Disp, CFM	487.6	487.6	195.1	195.1
Pres Suct Intl, psig	91.50	91.50	292.39	292.39
Temp Suct Intl, °F	66	66	125	125
Suct Zsph	0.9783	0.9783	0.9579	0.9579
Pres Disch Intl, psig	337.26	337.26	858.47	858.47
Temp Disch Intl, °F	218	218	268	268
HE Suct Gas Vel, FPM	8673	8673	7217	7217
HE Disch Gas Vel, FPM	8197	8197	7702	7702
HE Spcrs Used/Max	0/4	0/4	0/2	0/2
HE Vol Pkt Avail, %	0.86+49.13	0.86+49.13	0.64+45.20	0.64+45.20
Vol Pkt Used, %	0.00 (V)	0.00 (V)	0.00 (V)	0.00 (V)
HE Min Clr, %	17.39	17.39	21.95	21.95
HE Total Clr, %	18.25	18.25	22.58	22.58
CE Suct Gas Vel, FPM	8256	8256	6381	6381
CE Disch Gas Vel, FPM	7803	7803	6809	6809
CE Spcrs Used/Max	0/4	0/4	0/2	0/2
CE Min Clr, %	19.03	19.03	26.69	26.69
CE Total Clr, %	19.03	19.03	26.69	26.69
Suct Vol Eff HE/CE, %	69.7/68.7	69.7/68.7	68.8/64.3	68.8/64.3
Disch Event HE/CE, ms	8.6/10.0	8.6/10.0	9.0/10.1	9.0/10.1
Suct Pseudo-Q HE/CE	8.6/7.8	8.6/7.8	5.4/4.2	5.4/4.2
Gas Rod Ld Comp, lbf	16409 C	16409 C	16379 C	16379 C
Gas Rod Ld Tens, lbf	14966 T	14966 T	12556 T	12556 T
Gas Rod Ld Total, lbf	31375	31375	28935	28935
Xhd Pin Deg/%RvrsI lbf	166/84.6	166/84.6	148/89.6	148/89.6
Flow Calc, MMSCFD	3.787	3.787	3.787	3.787
Cyl BHP	240.6	240.6	223.9	223.9



Gas Analysis Data

Company: EFX Compression
 Quote: 060158, 060159, 060160
 Remarks: Sour Gas Compressor

Customer: EnCana Corporation
 Inquiry: Darryl Burns
 Project: Stock Units



7.5.1.1

Services	Gathering				
Gas Model	Hall				
Stage	# 1	# 1	# 2	Final	Final
Stream	Main	Vapor	Vapor	Liq1	Vapor
Suction Press, psig	100.00	100.00	306.66		
Disch Press, psig		312.73	810.00		800.00
Suction Temp, °F	60.00	60.00	120.00		120.00
Disch Temp, °F		218.07	267.92		120.00
Flow, MMSCFD	7.575	7.575	7.575	0.002	7.573
Flow, lb/h	16298.3	16299.2	16299.2	3.0	16296.1
Flow, GPM				0.006	
Dropout, %				0.020	
Specific Gravity	0.6766	0.6766	0.6766		0.6767
Ratio of Sp Ht (N)		1.2665	1.2642		
Comp Suct (Zs)		0.9774	0.9566		0.8905
Comp Disch (Zd)		0.9716	0.9541		
Mole Weight		19.60	19.60		19.60
Density, lb/ft3		0.408	1.054		2.913
Density @ Std, lb/ft3		0.052	0.052		0.052
Enthaply, Btu/lb		-1661.30	-1631.38		-1630.61
Entropy, Btu/lbmol-F		0.0000	0.0000		0.0000
Speed of Sound (Suct), ft/s		N/A	N/A		N/A
Pseudo-Pc, psig		N/A	N/A		N/A
Pseudo-Tc, °F		N/A	N/A		N/A
cp, Btu/lb-°F		N/A	N/A		N/A
ΔHV Mass, BTU/ft3		0.00	0.00		0.00
Speed of Sound (Disch), ft/s		N/A	N/A		N/A
Viscosity, lb/ft-s		N/A	N/A		N/A
Thermal Cond., Btu/ft-h-°F		N/A	N/A		N/A
Heat Load, BTU/h		N/A	N/A		N/A
Humidity	100.00	100.00			
WATER	0.22603	0.22603	0.22603	100.00000	0.20574
METHANE	84.39694	84.27510	84.27510		84.29220
ETHANE	4.99591	4.98870	4.98870		4.98971
PROPANE	3.39528	3.39038	3.39038		3.39107
ISOBUTANE					
N-BUTANE	1.79465	1.79206	1.79206		1.79242
ISOPENTANE					
N-PENTANE	0.48504	0.48434	0.48434		0.48444
N-HEXANE					
N-HEPTANE					
NITROGEN					
CARBON DIOXIDE					
HYDROGEN SULFIDE	4.85040	4.84340	4.84340		4.84438

Encana Corporation

RPM: 1200.0, Pd, psig: 1400.00

Driver: Waukesha Model: L7042GL

Frame: JGK/4MMSCFD at 14.70 psia, 60.0 °F

v2: 9-5/8K (9.125) Stage: 1, Service: Gathering, SG: 0.6767, Suct Temp (°F): 60

4: 9-5/8K (9.125) Stage: 1

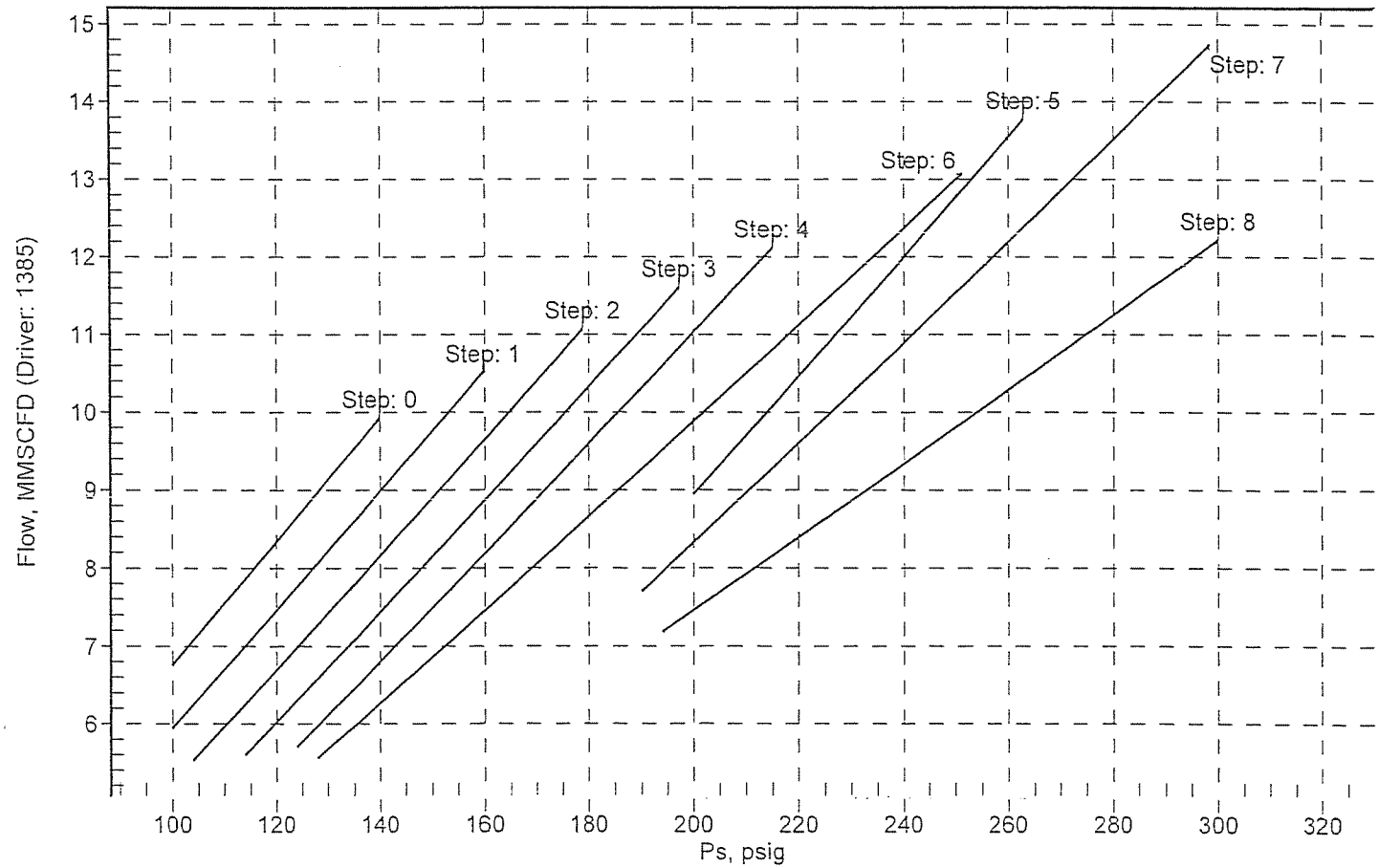
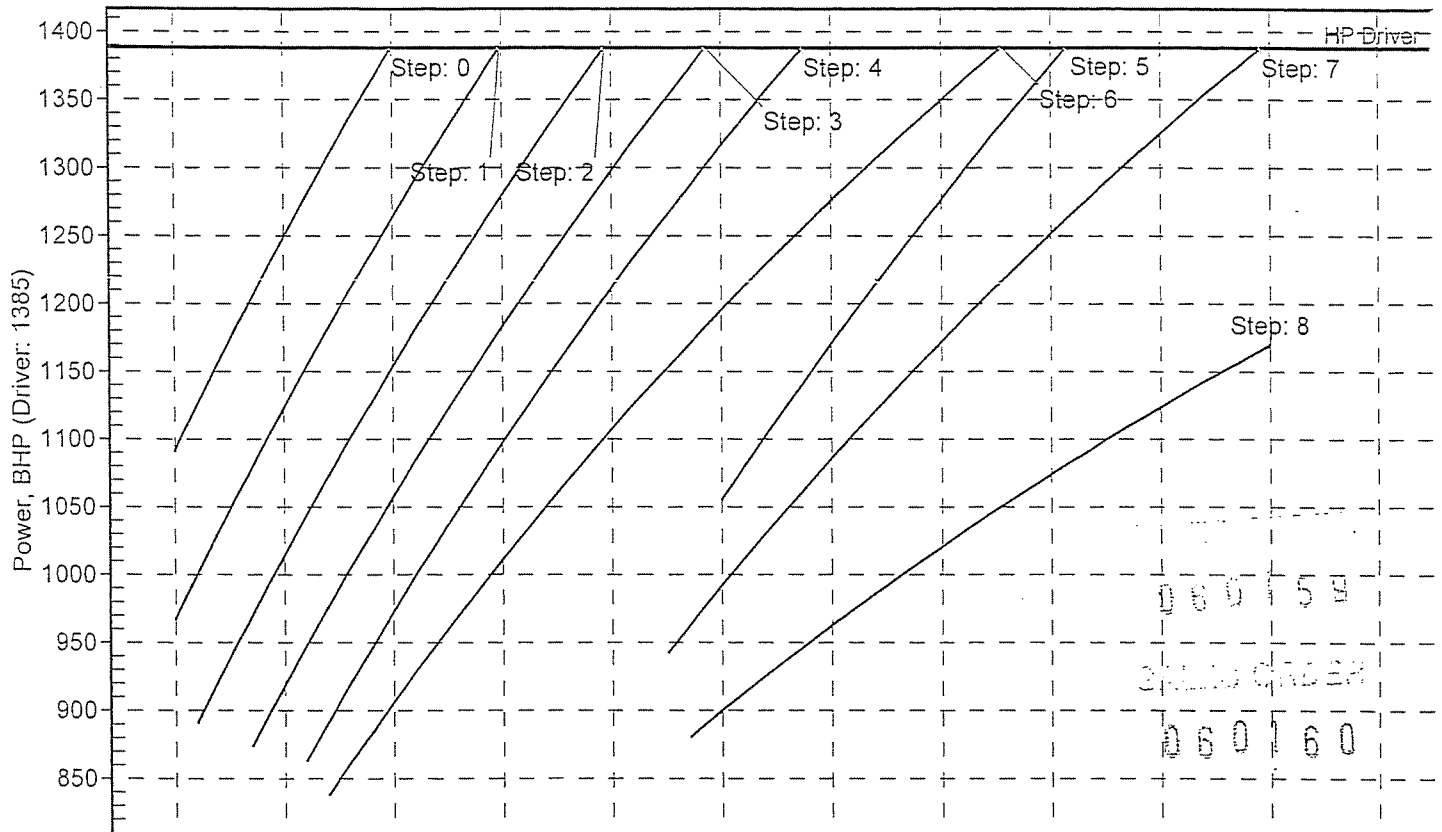
i: 6-1/4K (5.875) Stage: 2

inw3: 6-1/4K (5.875) Stage: 2

Ariel 7.5.1 MRV 1.3.8

CP051467.run

040471RS_MR - Stock EnCana Curves - Modified.csv



Encana Corporation
 RPM: 1200.0, Pd, psig: 1200.00

Driver: Waukesha Model: L7042GL

Frame: JGK/4MMSCFD at 14.70 psia, 60.0 °F

W2: 9-5/8K (9.125) Stage: 1, Service: Gathering, SG: 0.6767, Suct Temp (°F): 60

4: 9-5/8K (9.125) Stage: 1

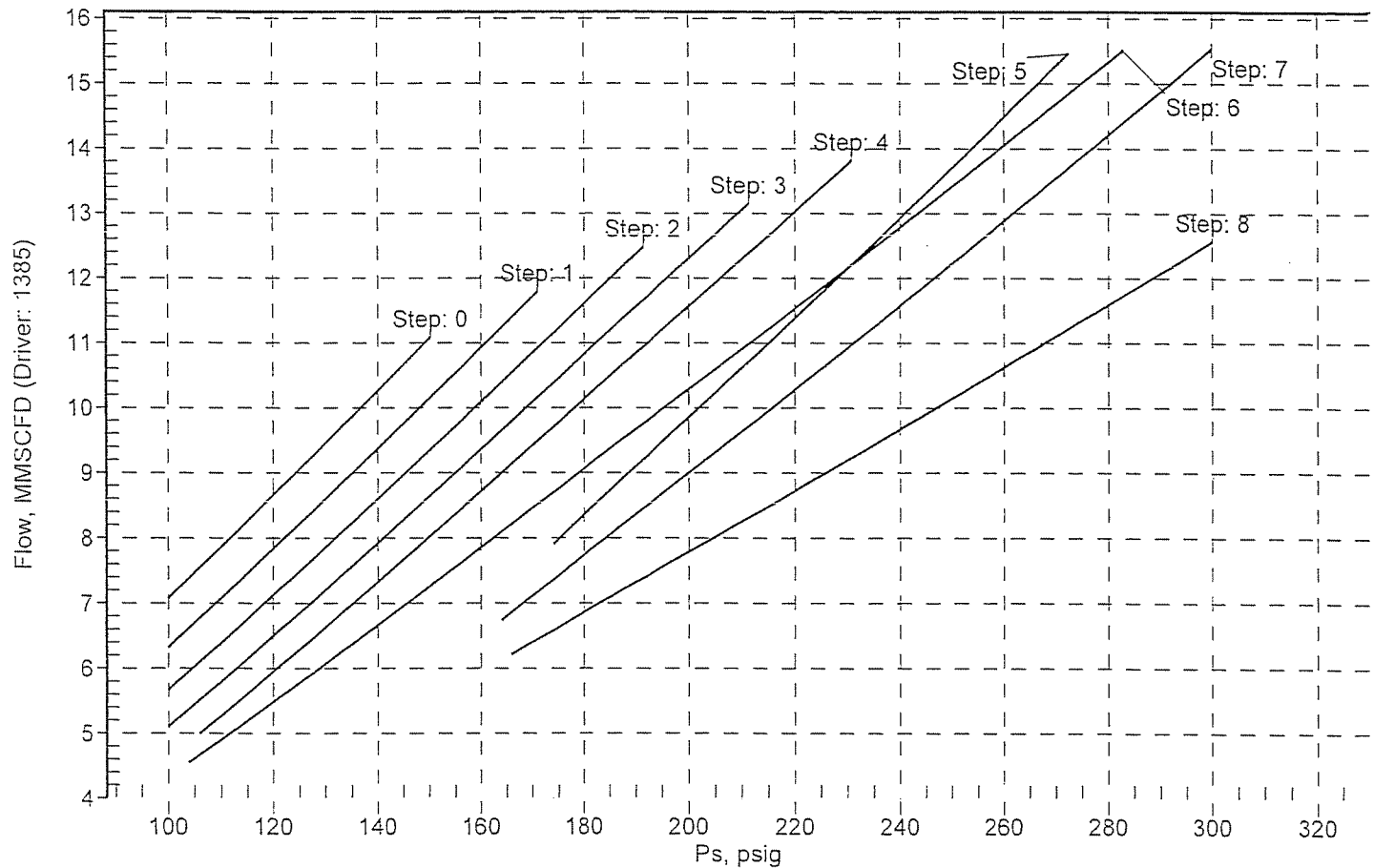
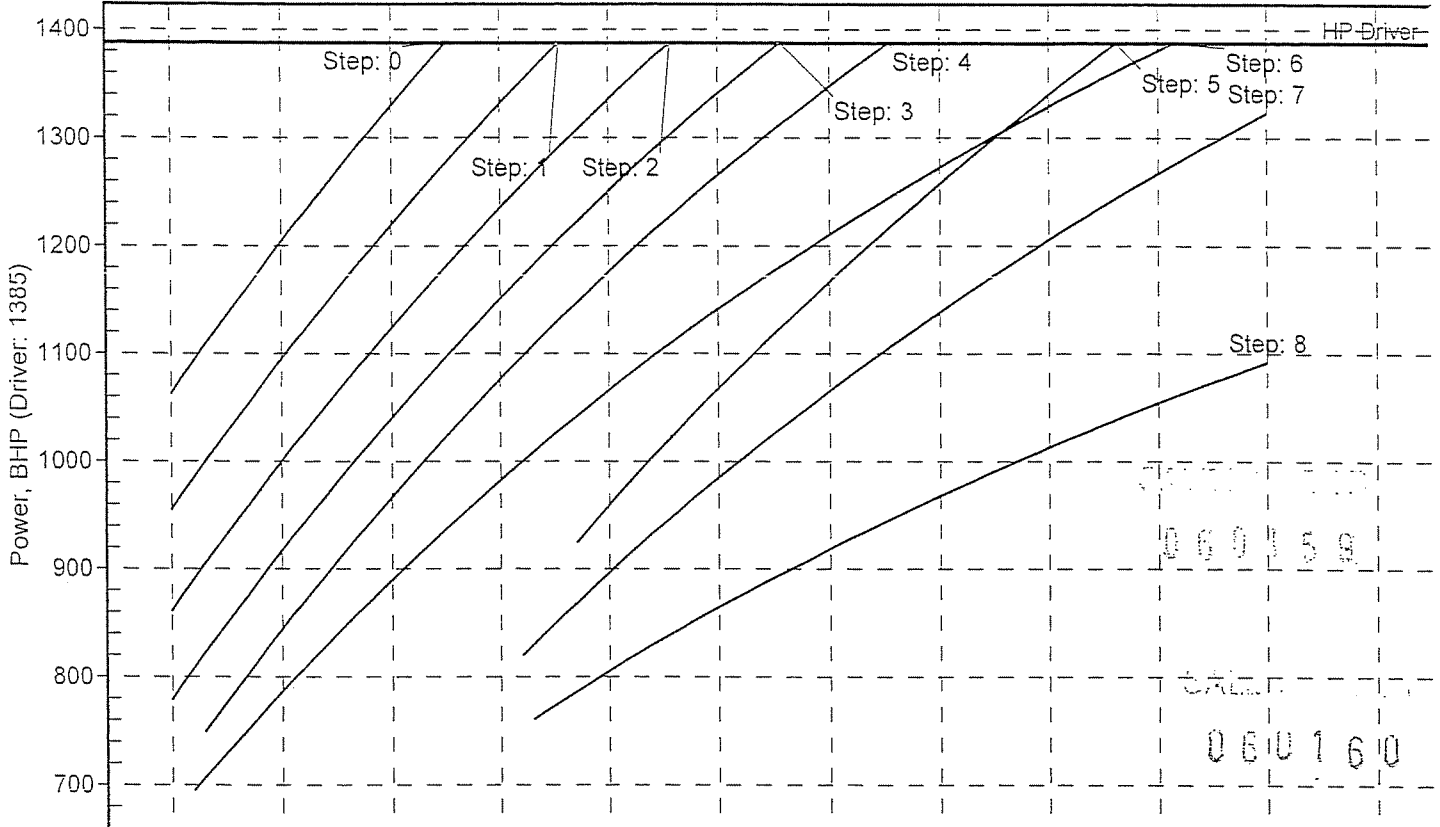
1: 6-1/4K (5.875) Stage: 2

W3: 6-1/4K (5.875) Stage: 2

Ariel 7.5.1 MRV 1.3.8

CP051467.run

040471RS_MR - Stock EnCana Curves - Modified.csv



Encana Corporation

RPM: 1200.0, Pd, psig: 1000.00

Ariel 7.5.1 MRV 1.3.8

CP051467.run

040471RS_MR - Stock EnCana Curves - Modified.csv

Driver: Waukesha Model: L7042GL

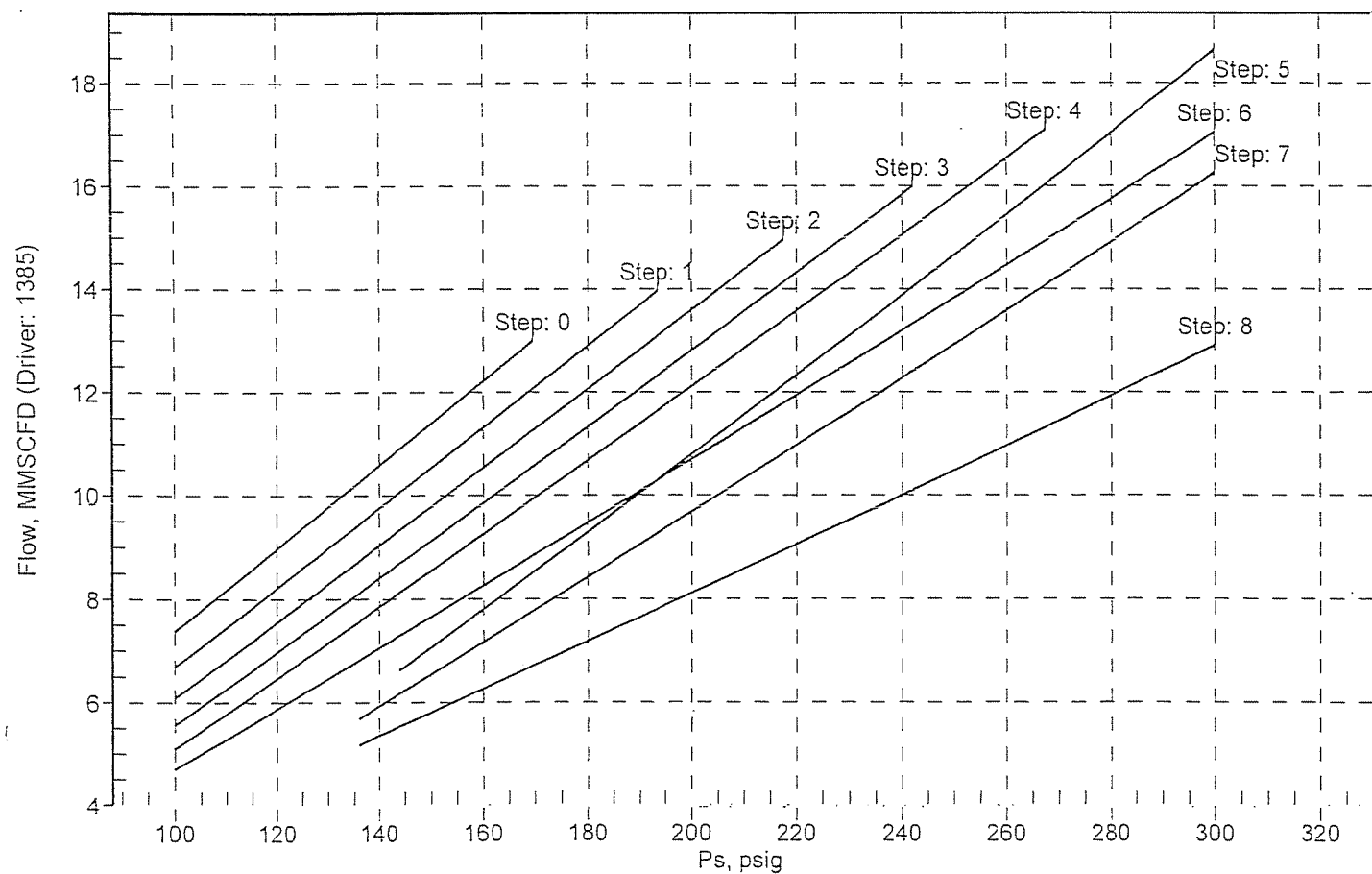
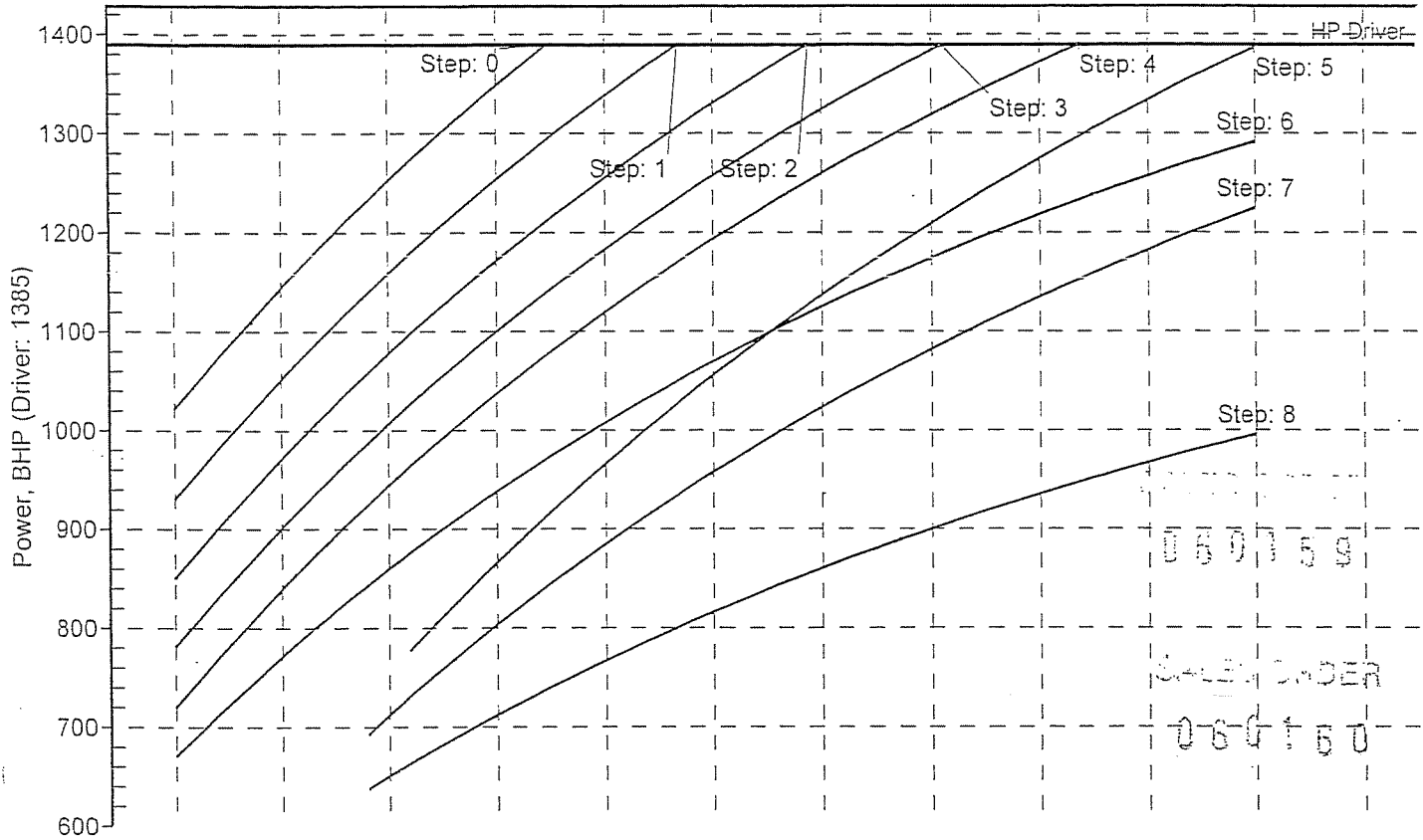
me: JGK/4MMSCFD at 14.70 psia, 60.0 °F

2: 9-5/8K (9.125) Stage: 1, Service: Gathering, SG: 0.6767, Suct Temp (°F): 60

4: 9-5/8K (9.125) Stage: 1

1: 6-1/4K (5.875) Stage: 2

1nw3: 6-1/4K (5.875) Stage: 2



Encana Corporation

RPM: 1200.0, Pd, psig: 800.00

Ariel 7.5.1 MRV 1.3.8

CP051467.run

Driver: Waukesha Model: L7042GL

me: JGK/4MMSCFD at 14.70 psia, 60.0 °F

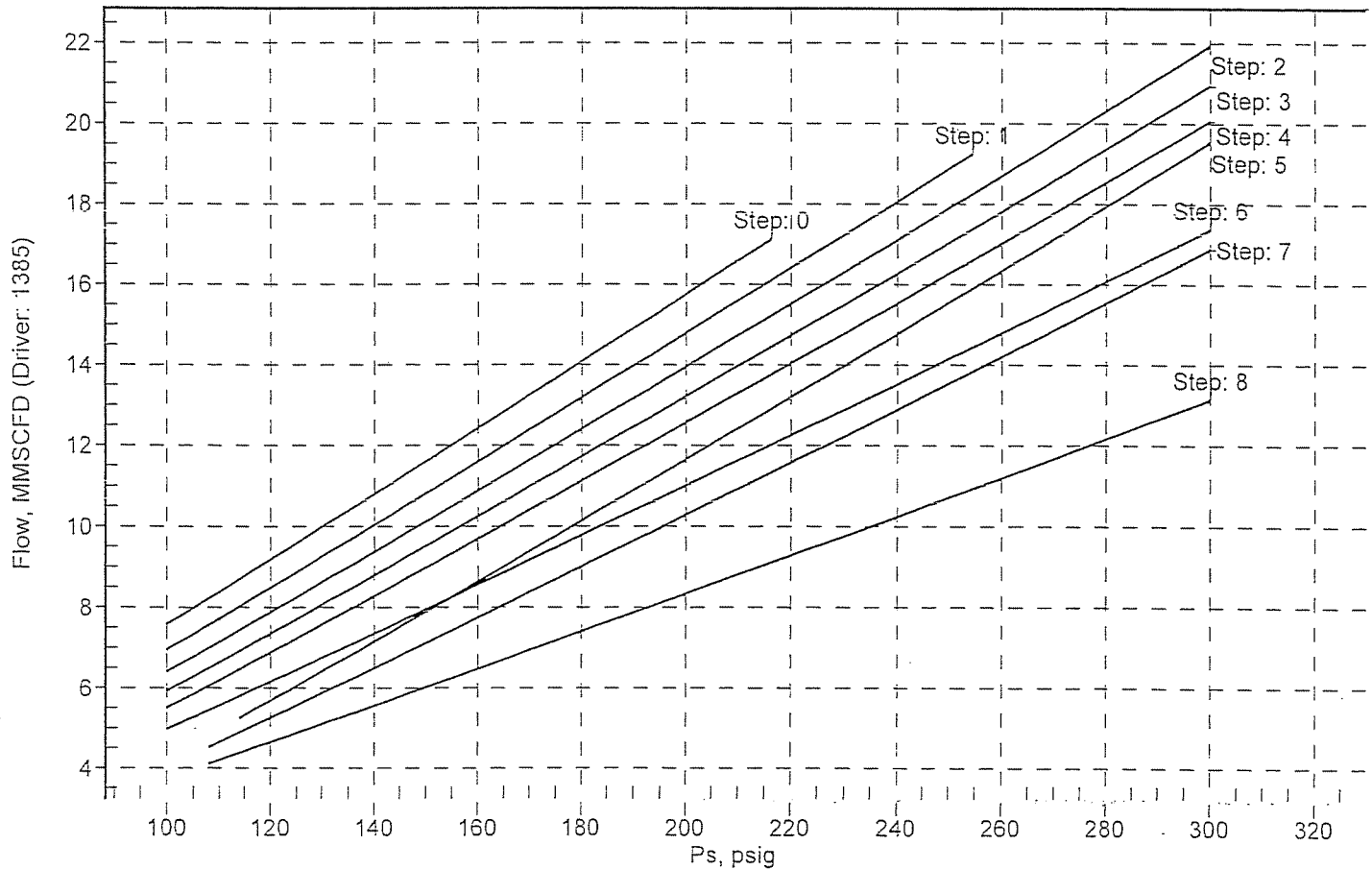
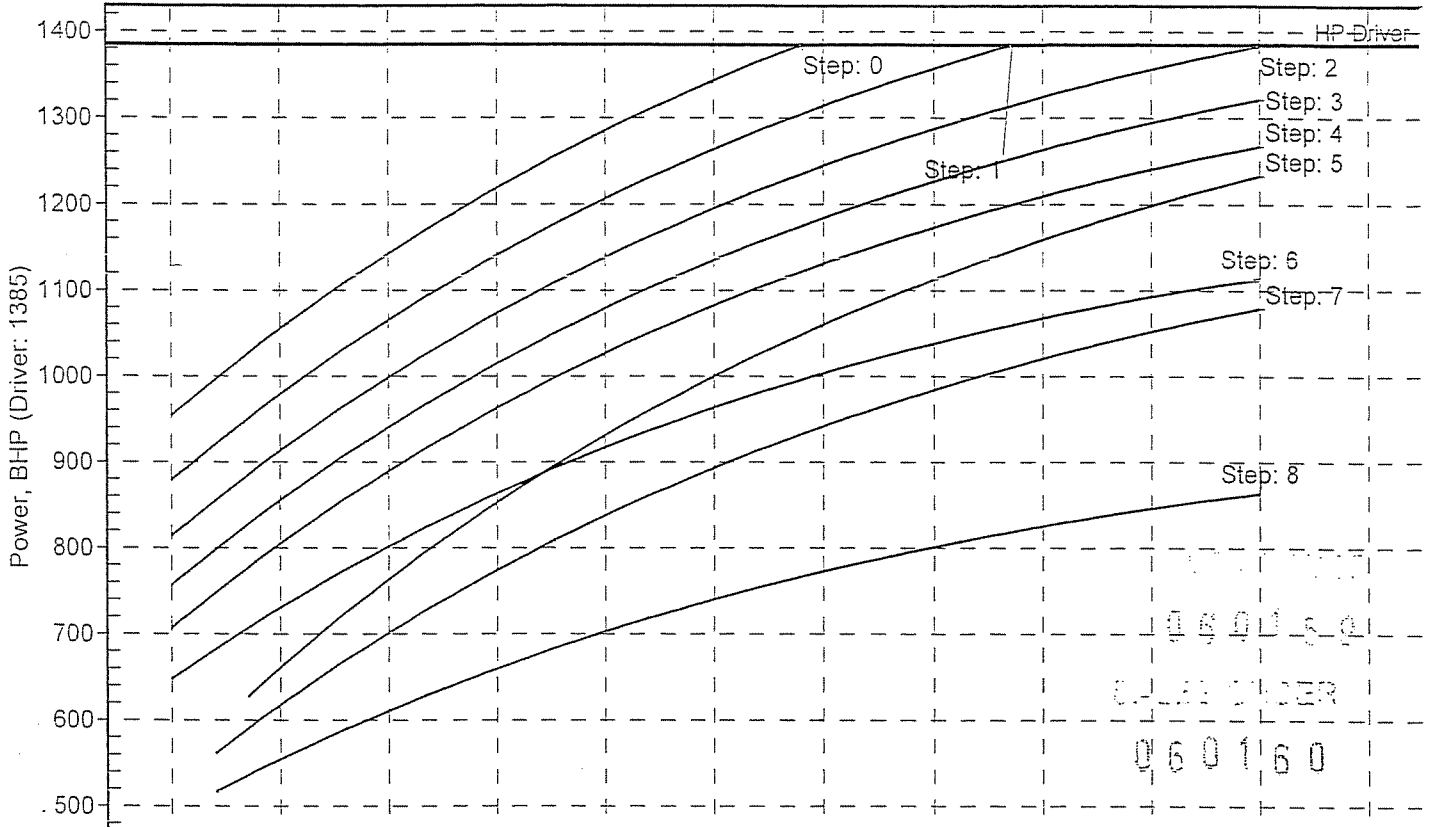
2: 9-5/8K (9.125) Stage: 1, Service: Gathering, SG: 0.6767, Suct Temp (°F): 60

040471RS_MR - Stock EnCana Curves - Modified.csv

4: 9-5/8K (9.125) Stage: 1

i: 6-1/4K (5.875) Stage: 2

mw3: 6-1/4K (5.875) Stage: 2





Company: EFX Compression
 Quote: 060158, 060159, 060160
 Remarks: Sour Gas Compressor

Load Steps

Customer: EnCana Corporation
 Inquiry: Darryl Burns
 Project: Stock Units



Stp	Thr	Model	Action	VVCP %	HE/CE Spcrs	Desc
0	1	5.875K	DBL	0.00	0/0	Load Steps For Pd=1400, Pd=1200, Pd=1000 & Pd=800 psig
0	2	9.125K	DBL	0.00	0/0	
0	3	5.875K	DBL	0.00	0/0	
0	4	9.125K	DBL	0.00	0/0	
1	1	5.875K	DBL	0.00	0/0	
1	2	9.125K	DBL	25.00	0/0	
1	3	5.875K	DBL	0.00	0/0	
1	4	9.125K	DBL	25.00	0/0	
2	1	5.875K	DBL	0.00	0/0	
2	2	9.125K	DBL	50.00	0/0	
2	3	5.875K	DBL	0.00	0/0	
2	4	9.125K	DBL	50.00	0/0	
3	1	5.875K	DBL	0.00	0/0	
3	2	9.125K	DBL	75.00	0/0	
3	3	5.875K	DBL	0.00	0/0	
3	4	9.125K	DBL	75.00	0/0	
4	1	5.875K	DBL	0.00	0/0	
4	2	9.125K	DBL	100.00	0/0	
	3	5.875K	DBL	0.00	0/0	
	4	9.125K	DBL	100.00	0/0	
5	1	5.875K	DBL	100.00	0/0	
5	2	9.125K	DBL	100.00	0/0	
5	3	5.875K	DBL	100.00	0/0	
5	4	9.125K	DBL	100.00	0/0	
6	1	5.875K	DBL	0.00	0/0	
6	2	9.125K	DBL	100.00	0/0	
6	3	5.875K	DBL	0.00	0/0	
6	4	9.125K	CE(HEVR)	0.00	0/0	
7	1	5.875K	DBL	100.00	0/0	
7	2	9.125K	DBL	100.00	0/0	
7	3	5.875K	DBL	100.00	0/0	
7	4	9.125K	CE(HEVR)	0.00	0/0	
8	1	5.875K	DBL	100.00	0/0	
8	2	9.125K	CE(HEVR)	0.00	0/0	
8	3	5.875K	DBL	100.00	0/0	
8	4	9.125K	CE(HEVR)	0.00	0/0	



Ariel Frame Data Sheet



Model: JGK/4

Stroke: 5.50 in

Class: (JGK)

Frame:

Number of Throws: 4
 Rated Power: 2540.00 BHP
 Frame Friction Power: 24.00 BHP
 Cyl Friction Factor: 0.95

Weights:

Avg. Weight without Cylinders: 8500.00 lbs
 Maximum Recip: 612.10 lbs
 Maximum Imbalance: 2.50 lbs
 Connecting Rod: 94.30 lbs
 Pin Assembly: 31.65 lbs
 Stub Shaft: 2.20 lbs

Speed Ratings:

Rated Piston Speed @ 1200 RPM: 1100.00 FPM
 Maximum Speed: 1200.00 RPM
 Minimum Speed: 600.00 RPM
 Minimum PRC Speed: 600.00 RPM
 Maximum Non-Lube Speed: 750.00 RPM
 Maximum Process Speed: 900.00 RPM

Frame Dimensions:

Center Line Height: 17.00 in
 Max. Overall Height: 29.00 in
 Max. Width with Cylinders: 154.00 in
 Length: 101.00 in

Component Dimensions:

Piston Rod Diameter: 2.000 in
 Connecting Rod Center Distance: 13.750 in
 Crankshaft Pin Diameter: 5.625 in
 Crankshaft Journal Diameter: 5.625 in
 Main Bearing Length: 3.375 in

Internal Gas Rod Loads:

Total: 74000 lbf
 Compression: 40000 lbf
 Tension: 37000 lbf
 Single Acting Tension: 37000 lbf

Lubrication:

Oil Pump Flow Rate: 26.0 GPM
 Oil Sump Capacity: 37.0 gal
 Oil Heat Rejection: 56000.0 BTU/h

Material Specifications:

Crankcase:	Gray Iron	12G	(ASTM A278 Class 30)
Crosshead Guide:	Gray Iron	12G	(ASTM A278 Class 30)
Crankshaft:	Forged Carbon Steel	11N	(ASTM A668 Class DH)
Connecting Rod:	Forged Carbon Steel	11N	(AISI 1045)
Main Bearing:	Tri-metal		(Tri-metal)
Thrust Bearing:	Bronze	10B	(SAE 660)
Connecting Rod Bearing:	Tri-metal		(Tri-metal)
Crosshead:	Ductile Iron	16D	(ASTM A536 Grade 65-45-12)
Crosshead Pin:	Alloy Steel		(AISI 8620)
Crosshead Pin Bushing:	Bronze	10B	(SAE 660)
Stress Bolts, standard:	Grade 8		(Grade 8)

Outline Drawings:

Duplex Oil Filter	A-4155
Frame Outline - Dry Sump	A-4194
Frame Feet Dimensions	A-12831
Notes/Options	A-4186s1
Notes/Options - Sheet 2	A-4186s2
Frame Outline	A-4181s1
Crosshead Guide Connections	A-4185s1
Lube Oil Cooler	A-4154

SALES ORDER

060160

060158

060159

060158

060159



Ariel Cylinder Data Sheet



Model: 9-5/8K

Bore: 9.125in

MAWP: 1270.0 psig

Flange: 6"- 600 FF

Stroke: 5.50 in
Maximum Speed: 1200 RPM

Cyl Assembly Wt: 2700.00 lbs
Piston/Rod Std Wt: 157.15 lbs
Piston/Rod Heavy Wt: 193.10 lbs

Pressure Ratings:

MAWP: 1270.0 psig

RDP: 1154.5 psig

HTP: 1905.0 psig

Piston and Velocity Data:

	HE	CE	Total
Piston Area, in2	65.40	62.26	
Piston Displacement at 1200 RPM, CFM	249.78	237.78	487.56
API Suct Valve Velocity at 1200 RPM, FPM	7794.85	7420.39	

Clearance:

		w/Vlvs		w/Vlvs
Normal Clearance, % (in3)	9.45 (33.974)	17.39	10.68 (36.576)	19.03
Non-Std Clearance, % (in3)	0.00 (0.000)		0.00 (0.000)	

Spacer Data:

	Suction	Discharge	Suction	Discharge
Spacers (Maximum)	2	2	2	2
Spacer Clearance, % (in3)	3.341 (12.016)		12.016 (3.509)	

Cylinder ADJ Equivalent Area, in2

14.733	21.115	14.733	21.115
--------	--------	--------	--------

Valve Data:	HE	Suction	CE	HE	Discharge	CE
Num valves/Corner:	2	2	2	2	2	2
Nominal Diameter, in:	4.90	4.90	4.90	4.90	4.90	4.90
Model:	102CT	102CT	102CT	102CT	102CT	102CT
Clearance, % (in3):	1.87 (6.716)	1.96 (6.716)	2.10 (7.570)	2.21 (7.570)		
Lift, in (Area, in2):	0.102 (4.614)	0.102 (4.614)	0.094 (4.259)	0.094 (4.259)		
Adj Equivalent, in2:	5.018	5.018	4.824	4.824		
Plate Material:	Nylon	Nylon	Med temp nylon	Med temp nylon		
Seat/Guard Material:	AISI 416	AISI 416	AISI 416	AISI 416		
Spring Material(s):	17-7PH	17-7PH	17-7PH	17-7PH		
Bolt Material:	AISI 410	AISI 410	AISI 410	AISI 410		

Variable Volume Clearance Pockets:

Minimum	Pocket	Total	Total	Total	Total	Chg per	Chg per	Weight		
in3	%	in3	%	Turns	Stk.in	Pos.in	in. %	turn. %	lbs	
3.08	0.86	176.71	49.13	32.00	4.00	8.63	49.99	12.3	1.5	308.00

Fixed Volume Clearance Pockets:

Pocket 1				Pocket 2				Pocket 3			
Min	Pocket	Min	Pocket	Min	Pocket	Min	Pocket	Min	Pocket	Min	Pocket
in3	%	in3	%	in3	%	in3	%	in3	%	in3	%
15.50	4.31	73.00	20.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15.50	4.31	107.00	29.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15.50	4.31	135.00	37.53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15.50	4.31	177.00	49.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Material Specifications:

Body:	Ductile Iron	14D	(ASTM A395 Grade 60-40-18)
Piston:	Gray Iron	12G	(ASTM A278 Class 30)
Piston Rod:	Alloy Steel	13C	(AISI 4100 Series)
Piston Ring:	GMFTFE		(Glass Moly Filled Teflon)
Piston Wear Band:	GMFTFE		(Glass Moly Filled Teflon)
Rod Packing Case:	Gray Iron	12G	(ASTM A278 Class 30)
Rod Packing Rings:	CFTFE		(Carbon Filled Teflon)
Stress Bolt:	Grade 8		(Grade 8)

Outline Drawings:
Cylinder Outline

06018358

060159

060160



Ariel Cylinder Data Sheet



Model: 6-1/4K

Bore: 6.250in

MAWP: 2050.0 psig

Flange: 4"- 1500 FF

Stroke: 5.50 in
Maximum Speed: 1200 RPM

Cyl Assembly Wt: 2110.00 lbs
Piston/Rod Std Wt: 101.70 lbs

Pressure Ratings:

MAWP: 2050.0 psig

RDP: 1863.6 psig

HTP: 3075.0 psig

Piston and Velocity Data:

	HE	CE	Total
Piston Area, in2	30.68	27.54	
Piston Displacement at 1200 RPM, CFM	117.18	105.18	222.36
API Suct Valve Velocity at 1200 RPM, FPM	7313.62	6564.70	

Clearance:

		w/Vlvs		w/Vlvs
Normal Clearance, % (in3)	8.95 (15.096)	17.41	11.58 (17.546)	21.02
Non-Std Clearance, % (in3)	0.00 (0.000)		0.00 (0.000)	

Spacer Data:

	Suction	Discharge	Suction	Discharge
Spacers (Maximum)	1	1	1	1
Spacer Clearance, % (in3)	5.002 (8.441)		8.441 (5.573)	

Cylinder ADJ Equivalent Area, in2

7.280	6.490	7.280	6.490
-------	-------	-------	-------

Valve Data:	HE	Suction	CE	HE	Discharge	CE
Num valves/Corner:	1	1	1	1	1	1
Nominal Diameter, in:	4.90	4.90	4.90	4.90	4.90	4.90
Model:	102CT	102CT	102CT	102CT	102CT	102CT
Clearance, % (in3):	3.98 (6.716)	4.43 (6.716)	4.49 (7.570)	5.00 (7.570)	5.00 (7.570)	5.00 (7.570)
Lift, in (Area, in2):	0.102 (4.614)	0.102 (4.614)	0.094 (4.259)	0.094 (4.259)	0.094 (4.259)	0.094 (4.259)
Adj Equivalent, in2:	5.018	5.018	4.824	4.824	4.824	4.824
Gate Material:	Nylon	Nylon	Med temp nylon	Med temp nylon	Med temp nylon	Med temp nylon
Seat/Guard Material:	AISI 416	AISI 416	AISI 416	AISI 416	AISI 416	AISI 416
Spring Material(s):	17-7PH	17-7PH	17-7PH	17-7PH	17-7PH	17-7PH
Bolt Material:	AISI 410	AISI 410	AISI 410	AISI 410	AISI 410	AISI 410

Variable Volume Clearance Pockets:

Minimum	Pocket	Total	Total	Total	Total	Chg per	Chg per	Weight		
in3	%	in3	%	Turns	Stk.in	Pos.in	in. %	turn. %	lbs	
0.95	0.56	67.38	39.93	38.00	4.75	9.38	40.50	8.4	1.1	199.00

Fixed Volume Clearance Pockets:

Pocket 1		Pocket 2		Pocket 3	
Min	Pocket	Min	Pocket	Min	Pocket
in3	%	in3	%	in3	%
4.30	2.55	37.00	21.93	0.00	0.00
4.30	2.55	67.00	39.71	0.00	0.00
4.30	2.55	78.00	46.23	0.00	0.00

Material Specifications:

Body:	Ductile Iron	14D	(ASTM A395 Grade 60-40-18)
Piston:	Gray Iron	12G	(ASTM A278 Class 30)
Piston Rod:	Alloy Steel	13C	(AISI 4100 Series)
Piston Ring:	GMFTFE		(Glass Moly Filled Teflon)
Piston Wear Band:	GMFTFE		(Glass Moly Filled Teflon)
Rod Packing Case:	Gray Iron	12G	(ASTM A278 Class 30)
Rod Packing Rings:	CFTFE		(Carbon Filled Teflon)
Stress Bolt:	Grade 8		(Grade 8)

Outline Drawings:
Cylinder Outline

060158

OL0176

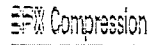
060160



Weights & Couples Data

Company: EFX Compression
 Quote: 060158, 060159, 060160
 7.5.1.1 Remarks: Sour Gas Compressor

Customer: EnCana Corporation
 Inquiry: Darryl Burns
 Project:



Frame: JGK/4 Stroke, in: 5.50 ConRod Center Dist, in: 13.75
 Unit Weight: 18666.00 lbs Max Recip Weight (lbs) at 1200.0 RPM: 612.10

Install Weights:

Throw	Cyl Model	Bore in	C-Rod lbs	Piston + Rod	X-Head Part #	X-Head lbs	Bal Nut Part #	Bal Nut lbs	Recip Weight	Imb
1	6-1/4K	5.875	94.30	99.90	D-0870	133.20	S B-0783	17.90	S 345.30	2.5
2	9-5/8K	9.125	94.30	165.00	D-0868	78.30	S B-0781	10.10	S 347.70	2.4
3	6-1/4K	5.875	94.30	99.90	D-0870	133.20	S B-0783	17.90	S 345.30	
4	9-5/8K	9.125	94.30	165.00	D-0868	78.30	S B-0781	10.10	S 347.70	2.4

LEGEND:

Imb - Opposing Throws are NOT Balanced

Recip Weight - Can't exceed max recip weight @ rated speed.

X-Head and Nut Part Legend:

A - Part is from Available Parts List

NS - Non-Standard Part

SP - Non-Standard Part: Guide (JG:A) or crankshaft (M:N:P:Q) must be removed to install.

S - Standard Part

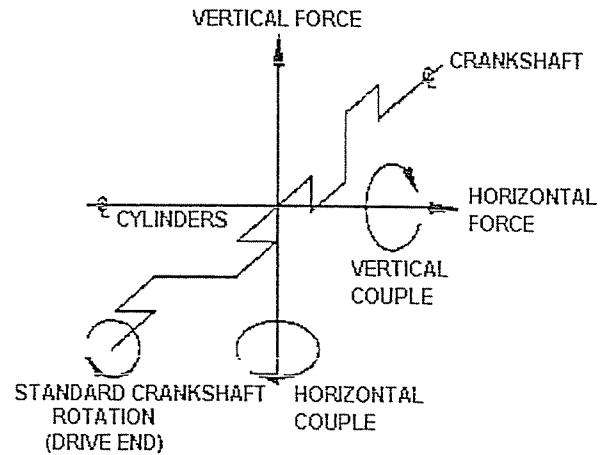
B is in front of any above if Balancing X-Head

Legend - Manual Part Selection

UNBALANCED FORCES & COUPLES

Horizontal	Primary	Secondary
Force, KIP at Max Imb: 2.50 lbs	0.398	0.112
Force, KIP (actual weights)	0.382	0.000
Couple, KIP-ft	12.946	0.189
Vertical	Primary	
Force, KIP	0.000	
Couple, KIP-ft	16.905	

COMPRESSOR INERTIAL FORCE & TORQUE REACTIONS



CROSSHEAD GUIDE DEFLECTION

Throw	Guide Type	Cyl Wt lbs	Pkt Wt lbs	Other Wt lbs	Total Wt lbs	Deflection in
1	L2C	2110.00	199.00	0.00	2309.00	0.014
2	L2C	2450.00	308.00	0.00	2758.00	0.016
3	L2C	2110.00	199.00	0.00	2309.00	0.014
4	L2C	2450.00	308.00	0.00	2758.00	0.016

IMPORTANT NOTE: Crosshead top and bottom clearance and Piston Rod Run-out should be measured after shimming.

ENERFLEX

OPERATING INFORMATION

The packaged compressor is essentially a gas pump and is primarily designed to provide an increase in the pressure of the gas being pumped.

This is accomplished by a reciprocating piston within a cylinder (or series of cylinders), which draws the gas into a chamber and simply compresses it into a smaller actual volume. As this compression process takes place, the gas pressure continues to rise until it reaches a point slightly greater than the line pressure down-stream. At this point the gas discharges out of the compressor at the desired higher pressure. Valves within the compressor cylinder act like check valves to allow the gas to flow in and out of the cylinder in one direction and to prevent the gas from flowing backwards as it naturally would from a high pressure to a low pressure state.

As this equipment is intended for continuous duty, a maintenance program consistent with this requirement is highly recommended. Several items mentioned in this instruction may assist you in developing and applying such a program.

The compressor driver is an internal combustion engine. It is important for the sake of the driver to unload the compressor as much as possible prior to start-up. This can be partially accomplished by temporarily connecting the downstream or discharge side of the compressor to the upstream or suction side thereby placing the unit in a "bypassed" mode. This results in maintaining suction pressure throughout the compressor. The load can only be further decreased by reducing the internal pressure close to atmospheric. This reduction in load is necessary to insure that the torque required to rotate the combined compressor and driver shafts is not greater than the starting and accelerating torque of the driver.

1.0 SAFETY INSTRUCTIONS AND WARNINGS

The unit is designed to operate normally unmanned, with periodic checks, inspection, and replenishment of engine and compressor fluids and coolant. The unit is designed assuming that all personnel working with the unit have been properly trained for the duties they are to perform.

**** WARNING ****

It is essential that the proper Personal Protective Equipment (PPE) is used when around, operating or maintaining equipment. Examples of the safety equipment required are: safety shoes, gloves, eye and hearing protection, and temperature appropriate clothing.

**** WARNING ****

Any activity performed on the unit during transportation, assembly, operation and maintenance should be done by properly trained personnel.

**** CAUTION ****

The skid is designed to be installed at grade level. Please consult local regulations for elevated work platforms.

NOTE: The user is responsible for location and elevation of equipment foundation and any required platforms resulting from location.

**** WARNING ****

When grating is removed for any reason, warning tape is to be placed around openings.

**** WARNING ****

Due to the operating noise level of the equipment, the user must install acoustical and visual evacuation warnings.

**** WARNING ****

User **MUST** refer to the applicable Material Safety Data Sheets (MSDS) prior to handling engine/compressor fluids.

The following are general safety rules and requirements to be adhered to during the different phases of the life of the unit:

1.1 TRANSPORTATION

Do not stand under any suspended lifts.

1.2 LIFTING

Lifting of skid and major equipment is to be done using the lifting lugs provided. Note: Purchased machinery components are provided with threaded holes and/or shoulder eyebolts for lifting components. Any loose lifting gear required is not supplied by Enerflex. This is the responsibility of the owner.

Lifting of pulsation bottles is accomplished through the use of two nylon slings positioned at points equidistant from the center of the bottle. Slings are to be tightened around the bottle circumference prior to lift.

**** CAUTION ****

Lifting gear and practices are to be in accordance with local regulations and are to be done by properly trained personnel.

1.3 ASSEMBLY

Do not stand under any suspended lifts.

Insulation for piping is shown on P&ID's and is the responsibility of the customer. Installation of the insulation is to be performed to company specifications and local regulations.

EFX has provided a skid that will act with the customer's foundation as a system to support the static weight of the packages and transmit the dynamic forces into the platform structure. Anchor bolt holes and jacking bolt holes have been provided at specific locations. The customer is to provide support at these locations as a minimum.

1.4 OPERATION**** WARNING ****

1. This unit requires proper ventilation. Operator is instructed to ensure proper ventilation is used in enclosed areas. Ventilation is to be done in accordance with local regulations.
2. User must conduct a walk around inspection prior to equipment start-up.

1.5 MAINTENANCE

Depressurizing the system:

For maintenance purposes the unit must be depressurized using the following procedure:

1. Ensure unit is locked-out prior to performing any maintenance activity (see note below).
2. Close process inlet and discharge isolation ball valves.
3. Open the by-pass valve.
4. Open the unit blowdown valves specific to each stage to reduce the unit pressure to atmospheric.

Note: The owner of the unit must devise and implement a permit/lock-out procedure to be used prior to any work being done on the unit.

Maintenance must be done under well-lit or daytime conditions. Lighting is the responsibility of the owner where permanent lighting is unavailable or insufficient. The owner must provide temporary portable lighting to illuminate the task area. Lighting must be suitable for the hazardous area present.

Fluid fills:

All fluid levels should be filled while the machine is at a standstill.

2.0 PUTTING THE UNIT IN SERVICE

1. Open any compressor bypass valves available and momentarily open any blow-down valves with which the unit is equipped. Automatic bypass valves are normally supplied with a manual over-ride or a parallel manual bypass valve to insure the unit is bypassed during start-up.
2. Make sure the entire unit is free to rotate and that all rotating portions are safely enclosed by protective guards. Most engines are equipped with a barring device on their flywheel. The unit is supplied complete with protective guards over all rotating parts. A quick glance over the unit prior to start-up will insure that none of these guards have been removed.
3. If the unit is equipped with a forced air cooler, examine the air inlet screens to insure that they are free from debris that would seriously block the flow of air.
4. Check that all liquid levels are satisfactory. Lube oil levels, such as in crankcases and force feed lubricators, may be regulated by an automatic control device and should correspond to a full level reading. The jacket-water level(s), as displayed on the surge tank gauge glass(es), should register slightly below the indicated normal operating level on a cold unit so as to allow for expansion in the system during warm-up. Scrubbers and separators whose gauge glasses indicate a high liquid level should be manually drained to the normal operating level. Pot-type oil reservoirs, servicing lubrication points such as a gas-driven starter, should be checked for adequate level.
5. Engine driven units may be supplied with a manual remote or auto/manual remote speed control (usually panel-mounted) in which cases the desired warm-up speed of the engine should be selected prior to starting. In the manual remote case, rotate the manual speed control regulator knob until a signal of 0 psi is indicated on the adjacent gauge. This will allow manual throttling of the engine for warm-up. In the auto/manual remote case, position the auto/manual selector valve to "manual" and proceed as described above. If the engine tachometer is equipped with a clutch, it

should be engaged so that start-up and loading speeds can be observed.

6. Check that the process valves are in the correct start-up position:

<u>VALVE</u>	<u>POSITION FOR START-UP</u>
Suction Block	Closed*
Discharge Block	Closed**
Bypass	Open
Blowdown	Closed***

*The suction block valve may be left cracked open on an engine-driven unit provided the resulting cranking speed is adequate to readily start the unit. This condition will allow the compressor to be pressured up to suction pressure throughout.

**On units equipped with a discharge check valve, the discharge block valve may be left open.

*** If any of the compressor cylinders have been opened for servicing, it is essential to purge the compressor of air. To accomplish this:

- a. Crack open the suction block valve.
 - b. Open the blowdown valve(s).
 - c. Close the suction block valve.
 - d. Close the blowdown valve(s).
7. Energize the control panel. See description of the panel operation and controls operation section 3.3.4.
 8. Upon start-up, first check that the oil pressures have reached a satisfactory level, 40-50 psi. As the unit reaches idle speed, shut-down points "Class B" circuits that were automatically bypassed by the control panel during start-up will now begin to be satisfied.

Check that the jacket-water levels are being maintained and that the jacket-water and lube oil temperatures are increasing at a normal rate.

Check that the compressor force feed lubricator pumps are operating normally. See section 3.3.1 (Compressor Operation and Parts Manual) for a more complete description of lubricator operation and adjustment.

Examine any belt-driven arrangements for excessive belt slop on the slack side of the drive. If necessary, correct the belt tension using the adjustment mechanism provided. See section 3.3.2 (Driver Operations and Parts Manuals) for proper belt tension instructions. Cooler belt drives may be adjusted to slip slightly during start-up and shutdown to avoid imposing a shock-load torque on the engine shaft.

Walk around the unit while checking for any unusual noises or vibrations. If detected, attempt to locate the source and determine whether or not the unit can continue to run safely.

If for any reason it is decided that the unit should not continue to run, press the Emergency stop button to stop the equipment.

3.0 LOADING THE COMPRESSOR

1. Once the driver is ready to accept the torque and horsepower requirements of a loaded compressor, i.e. motor up to speed or engine up to temperature, proceed as follows:
 - a. Open the discharge valve.
 - b. Slowly open the suction valve, gradually increasing the suction pressure at the compressor (indicated on the panel "suction pressure" gauge) to the design operating point. For units equipped with an automatic suction pressure controller, open the suction block valve fully.
 - c. Slowly close the bypass valve. This is the step which actually places the demand on the driver to produce horsepower and which allows the compressor to pump gas. For units equipped with automatic bypass valves, the manual over-ride may prohibit closing the bypass valve slowly, however, this will not adversely affect the compressor. As the unit continues to run, the suction pressure may begin to fall off. Open the suction block valve until the suction pressure holds at the design operating point.
2. If no remote speed control is being used adjust the speed to the desired RPM by manual throttle. If manual remote speed control is being used, fully open the engine manual throttle and increase the manual remote signal to the desired operating RPM. If the unit is equipped with automatic speed control, and it is desirable to leave it under automatic control, increase or decrease the manual remote signal to match the automatic signal and then position the auto/manual selector valve to "auto".

The automatic speed controller usually senses suction pressure and varies the engine speed directly. When changing from automatic to manual remote speed control, always match the signals prior to switching the selector valve.

3. While most coolers are equipped with automatic louver positioners, any manually adjusted louvers should be positioned to suit ambient air temperatures from wide open on the hottest day in the summer to near-closed on the coldest day in the winter. Remote electric drive coolers should be placed in the "run" condition at this point and any manual air louvers positioned as above.

4. Compare all indicated pressures, temperatures and levels to those normally encountered. Determine the cause of and record any unusual differences and correct all unsatisfactory conditions.
5. Take a final walk around the unit checking for any sounds or vibrations abnormal to this loaded condition.

A good deal of skill and care has gone into the design and manufacture of this equipment. Providing these qualities are applied in its operation and maintenance, a long and successful record of production should be obtained.

Should you require any additional information not covered in this manual, please do not hesitate to call or write:

**ENERFLEX SYSTEMS LTD.
4700 - 47 Street S.E.
Calgary, AB
T2B 3R1**

PH #: (403) 236-6800

Attention: Engineering Department

While any immediate operation problems should be reported to the nearest Pamco Service Branch (see inside front cover), we welcome any suggestions which may assist us in continually refining and improving our products.

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MAINTENANCE INFORMATION

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MAINTENANCE GUIDELINES FOR COMPRESSION PACKAGES - Engine Drive

In situations where a conflict may arise regarding acceptable service intervals, the manufacturers recommendations will be referred to.

Specific instructions pertaining to procedures, may be found in the unit manuals. Maintenance must be performed by qualified personnel. In all circumstances, safe work procedures are to be followed in the maintenance, assembly or disassembly of components. Questions regarding unit operation or maintenance can be referred to the Pamco, Division of Enerflex, Parts & Service outlet nearest your location. Compressor performance data supplied with the unit manual identifies specific sold operating conditions. Requests for additional compressor performance information will be directed to Enerflex Systems Ltd.'s customer service manager.

GROUPS

- 1) Engine Driver
- 2) Compressor
- 3) Cooling System
- 4) Exhaust System
- 5) Process System

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MAINTENANCE GUIDELINE FOR COMPRESSION PACKAGES

ENGINE DRIVER ROUTINE MAINTENANCE

Group 1

1/2

ITEM	SERVICE	AS REQ.	DAILY	WEEKLY	MONTHLY / 720 HRS	3 MONTHS / 2500 HRS	6 MONTHS / 4000 HRS	ANNUALLY 8000 HRS
Air Cleaner Filter Element	Clean or Replace	x						
Pre-Cleaner Element	Clean	x						
Oil Bath Air Cleaner	Oil Change					Seasonal		
Exhaust Backpressure	Check					x		
Intercooler Cores	Visual Check							x
Turbochargers	Inspect						x	
Crankcase Oil Level	Check		x					
Crankcase Pressure	Check					x		
Crankcase Breather	Clean						x	
Oil Pressure Setting	Verify					x		
Crankcase Oil Pick-up Screens	Clean							x
Oil Pan	Clean Sump							x
Governor Oil Level	Check		x					
Eng. Oil (Continuous Duty)	Oil Analysis				x			
Eng. Oil (Continuous Duty)	Oil Change	x			x			
Oil Filter Elements	Change	At Oil Change						
Magnetic Lube Oil Strainer Element	Clean	At Oil Change						
Oil Cooler (Oil Side)	Drain	At Oil Change						
Hydraulic Governor Oil	Change						x	
Main and Rod Bearings	Inspect							x
Air Starter Lubricator	Check Level		x					
Prelube Motor Reservoir Level	Check		x					
Ignition Timing	Check/Verify				x			
Spark Plugs - Dependent upon Type of Service	Clean/Gap/Replace	x			x	x		
Control Rod Ends & Linkage	Lubricate	x		x				
Governor Rod Ends	Lubricate			x				

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Cylinder Compression	Check					x		
Ignition Cables, Primary & Secondary Connections	Inspect					x		
Prechamber Regulator	Adjust					x		
ITEM	SERVICE	AS REQ.	DAILY	WEEKLY	MONTHLY / 720 HRS	3 MONTHS / 2500 HRS	6 MONTHS / 4000 HRS	ANNUALLY 8000 HRS
Main Chamber Regulator	Check/Adjust					x		
Prechamber Regulator Filter	Clean or Replace						x	
Main Chamber Regulator Filter	Clean or Replace						x	
Valve Cover Gasket	Replace							x
Governor-Synchronizer or Speed Control	Adjust						x	
Admission Valve Assembly	Clean or Replace	x				x		
Admission Valve O-ring	Replace					x		
Carburetor, Air-Gas Valve	Clean/Inspect						x	
Carburetor, Diaphragm	Inspect						x	
Governor Compensating Needle Valve	Adjust As Required						x	
Carburetor, Air-Gas Valve	Replace	x						
Carburetor, Diaphragm	Replace							x
Magneto Drive Disc	Replace						x	
Cooling System Level	Check		x					
Cooling Water Analysis	Check							x
Cooling System Thermostats	Remove & Test							x
Cooling System Tube Bundle	Clean							x
Engine Mounting & Align.	Check						x	

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MAINTENANCE GUIDELINE FOR COMPRESSION PACKAGES

COMPRESSOR ROUTINE MAINTENANCE

Group 2

1/1

ITEM	SERVICE	AS REQ.	DAILY	WEEKLY	MONTHLY / 720 HRS	3 MONTHS / 2500 HRS	6 MONTHS / 4000 HRS	ANNUALLY 8000 HRS
Crankcase Oil Level	Check		x					
Crankcase Oil	Analysis				x			
Crankcase Oil	Change					x		
Crankcase Oil Strainer						x		
Crankcase Oil Filter	Replace					x		
Lubricator Box Oil Level	Check		x					
Lubricator Box Oil	Change						x	
Lube Rate Cycle Time/Flow	Check		x					
Waste Oil Tank Storage	Drain	x						
Lubricator Drive Box	Inspect for Wear						x	
Lubricator Drive Gear/Chain	Inspect for wear						x	
Prelube Motor Reservoir Level	Check		x					
Vacuum Pump Lube Oil Reservoir Level	Check		x					
Vacuum Pump System Setting	Check				x			
Compressor Valves	Inspect						x	
Compressor Valves	Recondition							x
Valve Cap Seal Rings	Inspect						x	
Valve Gaskets - Internal	Check						x	
Piston Rod	Visually Inspect for Wear					x		x
Piston Rod Packing	Replace							x
Piston Rings/Wear Bands	Replace							x
Compressor Packing Vents	Check for Venting		x					
Cross-Head Clearance	Check						x	
Main/Con Bearings	Inspect							x
Drive Coupling - Main	Inspect/Torque Bolts					x		
Comp. Alignment/Mount.	Check						x	
Comp. Anchor Bolt Torque	Check						x	

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MAINTENANCE GUIDELINES FOR COMPRESSION PACKAGES

COOLING SYSTEM ROUTINE MAINTENANCE

Group 3

1/1

ITEM	SERVICE	AS REQ.	DAILY	WEEKLY	MONTHLY / 720 HRS	3 MONTHS / 2500 HRS	6 MONTHS / 4000 HRS	ANNUALLY 8000 HRS
Guard/Screens	Check		x				x	
Finned Cooler Tubes	Ext. Cleaning	x						x
Louvres	Inspect						x	
Actuators/Linkages	Check & Lubricate				x			
Fan Blade Pitce	Seasonal Setting	x						
Fan Hub Blade Retainers	Check						x	
Fan Blades	Inspect						x	
Fan Hub Taper Lock	Check						x	
Fan Shaft Bearings	Grease			x				
Drive Belts	Check				x			
Drive Couplings	Check					x		
Electric Motor Drive	Check Mounts						x	

EXHAUST SYSTEM ROUTINE MAINTENANCE

Group 4

1/1

ITEM	SERVICE	AS REQ.	DAILY	WEEKLY	MONTHLY / 720 HRS	3 MONTHS / 2500 HRS	6 MONTHS / 4000 HRS	ANNUALLY 8000 HRS
System Backpressure	Check				x			
Exhaust Insulation	Inspect							x
System Man Guards	Check				x			
Moisture Traps	Check			x				
Muffler/Mounts	Check				x			
Silencer/Mounts	Check				x			
Uninsulated Expansion Bellows	Visual Check		x					
Flanged Connections	Check Bolt Torque						x	

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MAINTENANCE GUIDELINES FOR COMPRESSION PACKAGES

PROCESS SYSTEM ROUTINE MAINTENANCE

Group 5

1/1

ITEM	SERVICE	AS REQ.	DAILY	WEEKLY	MONTHLY / 720 HRS	3 MONTHS / 2500 HRS	6 MONTHS / 4000 HRS	ANNUALLY 8000 HRS
in-Line Screens	Clean	x						
Inlet Separator Filters	Replace	x						
Scrubber Dumps (Auto)	Activate Manually			x				
Scrubber Drain Valve	Manually Drain				x			
Temperature Indicators	Check Calibration						x	
Suction/Discharge Block Valves	Exercise/Grease						x	
PSV's	Service							x
PSV Flexline Connections	Inspect							x
Vibration/Pulsation	Monitor	x						
Suction/ Discharge Bottle Flange Torque	Check						x	
Flanged/Screwed Connections	Leak Check					x		
Vessel Hold Down Bolt Torque	Check						x	
Piping Flange Torque	Check						x	
Pip Clamps/Brackets	Check						x	
Skid Anchor Bolt Nut - Check After 100 Hours of Initial Operation Following Commissioning.								

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COMPRESSOR

ARIEL Heavy Duty Balanced Opposed Compressors

TECHNICAL MANUAL
For Models:

JGE, JGH, JGK and JGT



ARIEL CORPORATION
35 BLACKJACK ROAD, MOUNT VERNON, OHIO 43050
TELEPHONE: 740-397-0311 FAX: 740-397-3856

MORE INFORMATION AND RESOURCES ARE AVAILABLE
ON OUR WEB SITE: www.arielcorp.com

REV: 1/06



CAUTION

GAS COMPRESSOR UNITS ARE COMPLICATED AND DANGEROUS PIECES OF EQUIPMENT, IF YOU ARE NOT FULLY TRAINED AND FAMILIAR WITH THEIR OPERATION.

BEFORE STARTING THIS UNIT:

FAMILIARIZE YOURSELF WITH THE UNIT.

READ AND STUDY START-UP AND SHUT-DOWN INFORMATION FOR BOTH PACKAGE AND COMPRESSOR CAREFULLY!

A GAS/AIR MIXTURE UNDER PRESSURE CAN EXPLODE! YOU CAN BE SEVERELY INJURED OR KILLED. MAKE SURE THE COMPRESSOR IS SUFFICIENTLY PURGED OF ANY EXPLOSIVE MIXTURE BEFORE LOADING.

AFTER COMPLETING THE ABOVE, BEGIN PROPER STARTING PROCEDURE.



CAUTION

DO NOT ATTEMPT TO START-UP UNIT WITHOUT REFERRING TO THIS MANUAL SECTION 3: START-UP. IT IS ALSO ESSENTIAL TO REFER TO THE PACKAGER'S OPERATING MANUAL.



CAUTION

THIS MANUAL EDITION IS BASED ON THE CURRENT DESIGN AND BUILD PRACTICES. THIS MANUAL MAY NOT BE APPLICABLE TO EQUIPMENT BUILT PRIOR TO THE DATE ON FRONT COVER AND IS SUBJECT TO CHANGE WITHOUT NOTICE. CONTACT ARIEL WITH ANY QUESTIONS. REFER TO LAST PAGE OF THIS MANUAL FOR CONTACT INFORMATION.



WHEN THIS SYMBOL APPEARS ON THE COMPRESSOR OR CONTROL PANEL, THIS TECHNICAL MANUAL IS TO BE CONSULTED FOR SPECIFIC INFORMATION BEFORE PROCEEDING. IF MORE INFORMATION IS NEEDED CONTACT YOUR PACKAGER AND/OR ARIEL CORPORATION.

TABLE OF CONTENTS

Design Specifications & Data	1-1
General	1-1
Opposed Throw - Reciprocating Weight Balancing	1-1
Specifications	1-4
Product Information and Safety Plates	1-8
Important Safety Information	1-9
Clearances	1-15
Piston Ring, Packing Ring and Wearband Side Clearances	1-17
Fastener Tightening Torque	1-24
Tightening Torque Procedures	1-30
Ariel Bolting	1-32
Optional Main Bearing Temperature Instrumentation - Alarm & Shutdown	1-34
Alarm and Shutdown Limits	1-35
Zone 1 Environment	1-35
Installation	2-1
General	2-1
Electrical Grounding	2-1
Procedure For Setting and Aligning	2-1
Lifting the Compressor	2-2
Setting	2-2
Alignment	2-4
Pneumatically Actuated Unloaders & Clearance Devices	2-5
Vents and Drains	2-5
Distance Piece and Packing Illustrations:	2-6
Start Up	3-1
General	3-1
Start Up Check List	3-2
Maximum Allowable Working Pressure	3-8
Relief Valve Settings	3-8
Filling Sump & Priming the Main Lube Oil System - Before Starting	3-9
Filling The Sump	3-9
Priming - Main Lube Oil System	3-10
Compressor Prelube	3-10
Force Feed Lubricator Adjustment	3-10
Compressor Re-Application	3-10
Lubrication	4-1
Lubrication Functions	4-1
Lubrication Deserves Special Attention	4-1
Oil Cooler	4-1

Cold Starting 4-2

Compressor Prelube 4-2

Lubricants 4-3

 Petroleum Based Oils - Also Referred to as Mineral Oils: 4-3

 Compounded Cylinder Oil Additives 4-3

 Animal Fats 4-4

 Vegetable Oils 4-4

 Synthetic Lubricants 4-4

Compressor Frame Lubricants 4-5

 Minimum Oil Viscosity 4-5

 Pipeline Quality Gas 4-5

 Ash Level 4-5

 Oil Additives 4-5

 Oil Pump Pressures 4-5

 Cold Start-up Viscosity 4-6

 Minimum Oil Temperature 4-6

 Oil Heating 4-6

 Oil Filtration 4-6

 Oil Maintenance 4-6

 Oil Sampling 4-6

Cylinder And Packing Lubrication Requirements 4-8

 Oil Dilution 4-8

 Cylinder Oil Lubrication Examples 4-8

 Common Oil Supply 4-8

 Independent Oil Supply 4-9

 Under/Over Lube 4-10

 Gas Inlet Debris Screens to Maintain Lube Performance 4-11

 Lubrication Quantity - Paper Test Method 4-11

 Inadequate Lubrication Symptoms 4-11

 Lubricator Cycle Time 4-12

 Cycle Time Indication 4-12

 Force Feed Lubrication System Monitoring: 4-12

 Minimum Requirements 4-12

 Devices 4-13

 Choosing a Lube System Monitor 4-13

 Break-in Rate 4-16

 Lubricant Supplied From Engine Oil 4-16

 Liquids in Gas 4-17

 Lube Type & Rate Recommendations 4-17

 RATE CALCULATION NOTES: 4-20

Water Cooled Packing 4-21

 Coolant System Requirements 4-23

Dry Sump Applications 4-24

Oil System Cleanliness 4-26

Force Feed Lubrication System - Description 4-27

 Force Feed Lubricator Adjustment 4-28

 Blow-Out Fittings, Rupture Disks and Tubing 4-28

 Divider Valves 4-30

 Description 4-30

Divider Valve Block Assembly Instructions	4-31
Operation - (see Figure 4-13: and Figure 4-14:.)	4-31
Pressure Testing For Divider Valve By-Passing	4-35
Electronic Lubricator Fluid-Flow Monitor/No-Flow Timer Switch - Proflo	4-36
Proflo Monitor wiring identification and instructions for electronic indication: ..	4-37
Proflo Button Operation:	4-38
Downloading Proflo Data:	4-39
Proflo Setup Alarm Time and Mode:	4-39
Proflo Battery Replacement:	4-40
Proflo Display Errors:	4-41
Proflo Operation Notes:	4-42
Proflo Normally Open and Normally Closed Definition:	4-42
Proflo - Using Pulse Output and Alarm Circuit at Same Time:	4-43
Proflo - Using PLC to Calculate Oil Consumption:	4-45
Proflo Accessories Available From CCT:	4-45
Protection of Electronics & the Compressor When Arc Welding	4-46
Electronic-Lubricator Digital No-Flow Timer Switch - DNFT	4-46
Replacing the (Field-Replaceable) Battery in the DNFT:	4-46
Oil Head at Lube Points	4-47
Force Feed Lubrication System and Running Conditions	4-48
Force Feed Lubrication System	4-48
Running Conditions	4-48
System Design Considerations and Operating Parameters	4-49
Force Feed Balance Valves	4-49
Setting and Maintaining Balance Valves	4-49
Checking/Adjusting Balance Valves on Subsequent Start-up	4-50
Frame Lubricating System - Description	4-51
Lube Oil Strainer, Filter & Filter Installation Instructions	4-51
Lube Oil Strainer	4-51
Lube Oil Filter	4-52
Filter Installation for Spin-On Filters	4-52
Filter Element Installation Instructions for Cartridge Type Filters	4-52
Lube Oil Pump & Lube Oil Pressure	4-54
Description & Adjustment	4-54
Lube Oil Pressure Regulating Valve	4-54
Low Oil Pressure Shutdown	4-55
Maintenance	5-1
General Introduction	5-1
Connecting Rod	5-2
Connecting Rod - Removal	5-2
Connecting Rod (Crank Pin) Bearing - Removal & Installation	5-3
Connecting Rod Bushing - Removal & Installation	5-5
Connecting Rod - Installation	5-6
Crosshead	5-8
Crosshead - Removal	5-8
Crosshead - Installation	5-10
Main Bearings - Checking Clearances	5-13

Crankshaft - Removal	5-15
Oil Slinger - Removal:	5-17
Oil Slinger - Installation:	5-17
Chain Sprocket - Removal:	5-18
Chain Sprocket - Installation:	5-18
Main Bearings - Removal/Installation w/Crankshaft Removed	5-18
Main Bearings - Removal/Installation w/Crankshaft In Place	5-19
Crankshaft - Installation	5-22
Torsional Vibration Detuners - Installation on Crankshaft	5-23
Chain Drive System	5-26
Description - JGE/2/4, JGH/2/4, JGK/2/4 & JGT/2/4	5-26
Description - JGE/6, JGK/6 & JGT/6	5-27
Chain Adjustment	5-28
Chain and Sprocket Replacement	5-31
Chain Idler Sprockets Replacement - (Eccentric Adjustment Caps)	5-31
Lube Oil Pump Chain Sprocket Replacement	5-32
Force Feed Lubricator Chain Sprocket Replacement	5-33
Piston And Rod - Removal	5-35
Piston And Rod	5-36
Piston and Rod - Disassembly	5-36
Piston and Rod - Reassembly	5-36
Piston and Rod - Installation	5-39
Piston Rod Run Out	5-40
Piston Rings	5-42
Determining Ring Wear:	5-42
Removal:	5-42
Wear Bands	5-42
Determining Wear Band Wear:	5-42
Piston Rings - Installation	5-42
Wear Band - Installation	5-44
Piston Rod Pressure Packing - Removal	5-44
Piston Rod Packing - Reassembly	5-44
Long Two-Compartment Intermediate Packing	5-47
Types of Piston Rod Packing Rings	5-47
Type "P" Pressure Breaker	5-47
Type "UP" Pressure Breaker	5-48
Type "P1U" Pressure Breaker	5-48
Type "BTR" Single Acting Seal Set	5-49
Type "BD" Double Acting Seal Set	5-49
Type "WAT" Double Acting Seal Set	5-50
Type "AL" Double Acting Seal Set	5-50
Type "BTU" Single Acting Seal Set	5-51
Type BTUU Single Acting Seal Set	5-51
Type "CU" Single Acting Seal Set	5-52
Type "STU" Single Acting Seal Set	5-52
Type "CR" Single Acting Seal Set	5-53
Type "3RWS" Oil Wiper Set	5-53
Arrangement of Piston Rod Packing Rings	5-54
Piston Rod Packing Ring Material	5-54

Water-Cooled Piston Rod Packing	5-54
Re-assembly	5-54
Testing	5-56
Valves	5-56
Valves - Removal	5-56
Valves - Maintenance	5-57
Valves - Reassembly	5-57
Bolt Tightening for Valve Caps	5-59
VVCP - Variable Volume Clearance Pocket Head End Unloader	5-61
Removal	5-61
Disassembly	5-61
Maintenance	5-62
Adjustment	5-63
Ethylene Glycol Contamination	5-63
Cleaning Components & Thread Lube for Non-Lube Compressor Cylinders	5-64
Maintenance Intervals & Trouble Shooting	6-1
Recommended Maintenance Intervals	6-1
Daily	6-2
Monthly ¹ (in addition to Daily Requirements)	6-2
Every 6 Months or 4,000 Hours (plus Daily/Monthly)	6-3
Yearly or 8,000 Hours (plus Daily/Monthly/6 Months)	6-3
Every 2 Years or 16,000 Hours (plus Daily/Monthly/6 Months/Yearly)	6-4
Every 4 Years or 32,000 Hours (plus Daily/Monthly/6 Months/1 & 2 Years)	6-4
Every 6 Years or 48,000 hours (plus Daily/Monthly/6 Months/1, 2 & 4 Years)	6-4
Trouble Shooting	6-5
Appendices	7-1
Ariel Tools	7-1
Ariel Furnished Tools	7-1
Ariel Tools - Purchased Separately	7-4
Minimum Hand & Commercial Tools Required	7-5
Terms, Abbreviations and Conversion to SI Metric	7-6
Area	7-6
Flow - Gas	7-7
Flow - Liquid	7-7
Force	7-7
Heat	7-7
Length	7-7
Mass	7-7
Moment or Torque	7-7
Power	7-7
Pressure or Stress	7-8
Speed	7-8
Temperature	7-8
Time	7-8
Viscosity	7-8

Volume	7-9
Other Abbreviations	7-9
Gas Analysis Common Abbreviations	7-17
Technical and Service Schools on Ariel Compressors	7-18
Ariel Customer Technical Bulletins	7-18
Vendor Literature	7-19
Ariel Telephone, Fax, E-Mail and Web Site Numbers	7-19

SECTION 1 - DESIGN SPECIFICATIONS & DATA

General

Ariel compressors are designed for ease of operation and maintenance. Experience has shown that an Ariel compressor will normally provide years of satisfactory performance with minimal proper maintenance.

While Ariel compressors share many similarities, each model has aspects that are unique to the particular type. If you, as an operator, are familiar with Ariel compressors, it is still important to review this manual to determine the differences. If you are new to Ariel compressors, it is critical that you become very familiar with this manual prior to operating the compressor.

This manual is designed to provide information on installation, start up, operation and maintenance of a JGE, JGH, JGK or JGT compressor. If you have any questions please contact your packager. If they are unable to provide resolution, they will refer your concerns to Ariel Corporation. If you prefer, you may always contact Ariel directly¹.

This manual provides design specifications for standard current production equipment at publication date. Do not exceed information plates ratings for a particular compressor.

The location of the throws and the data shown on the Information Plates is very important when communicating questions concerning an Ariel compressor.

Opposed Throw - Reciprocating Weight Balancing

Ariel recommends that the reciprocating weight differential between opposing throws be 2.5 pounds (1.1 kg) or less for JGE, JGH, JGK and JGT compressors.

If replacing any major reciprocating component, that is; a connecting rod assembly, piston, piston & rod assembly, crosshead-balance nuts or crosshead, weigh component parts on a calibrated scale to 0.1 pounds (0.05 kg) and compare to the Compressor Balancing Record sheet that comes in the parts manual with each compressor. If there are weight changes, recalculate opposing throw reciprocating weight differentials¹. If not within the recommended limit, new balance nuts and/or crossheads are to be selected to provide the least possible differential.

If it is desirable to exchange opposing throw compressor cylinder locations¹, all reciprocating components must be exchanged to the opposite throw, except the connecting rod assemblies. Check the Balancing Record sheet and recalculate reciprocating weight differ-

1. Contact your Packager or the Ariel Response Center for detailed information. Refer to the last page of this manual for contact information.

ential, with the connecting rod weights included. If not within the recommended limit, new balance nuts are to be selected to provide the least possible differential.

If opposing throws can not be balanced within the recommended reciprocating weight differential limit, contact your packager and/or Ariel¹. When applying or re-applying a different cylinder to a throw¹, the opposing throw reciprocating weight differential must be re-calculated and new crosshead-balance nuts and/or crossheads may be required. The force feed oil distribution system may also need to be resized.

TABLE 1-1: APPROXIMATE COMPONENT WEIGHTS

COMPONENT	POUNDS	(KILOGRAMS)
Frame Assembly w/o Cylinders	See Ariel Electronic Data Book ^a	
Main/Connecting Rod Bearing	2	(1)
Top Cover 2-Throw	55	(25)
Top Cover 4-Throw	115	(52)
Top Cover 6-Throw	190	(90)
Spacer Bar	20	(10)
End Cover Drive End	85	(40)
End Cover Auxiliary End	130	(60)
Crankshaft 2-Throw ^b	450	(200)
Crankshaft 4-Throw ^b	900	(400)
Crankshaft 6-Throw ^b	1350	(600)
Main Journal Caps	30	(15)
Connecting Rod	100	(45)
Crosshead Guide	850	(390)
Crosshead	See Balancing Record sheet ^c for Weights	
Crosshead Pin	25	(12)
VVCP	See Ariel Electronic Data Book ^a	
Cylinder Assembly	See Ariel Electronic Data Book ^a	
Piston & Rod Assembly	See Ariel Electronic Data Book ^a	
Lube Oil Pump 2-Throw	36	(16)
Lube Oil Pump 4-Throw	36	(16)
Lube Oil Pump 6-Throw	110	(50)

a. The Electronic Data Book is Available in the Ariel Performance Program.

b. Crankshaft weight is without flywheel, vibration detuner donuts or damper.

c. Provided by Ariel in the Parts Book for each compressor.

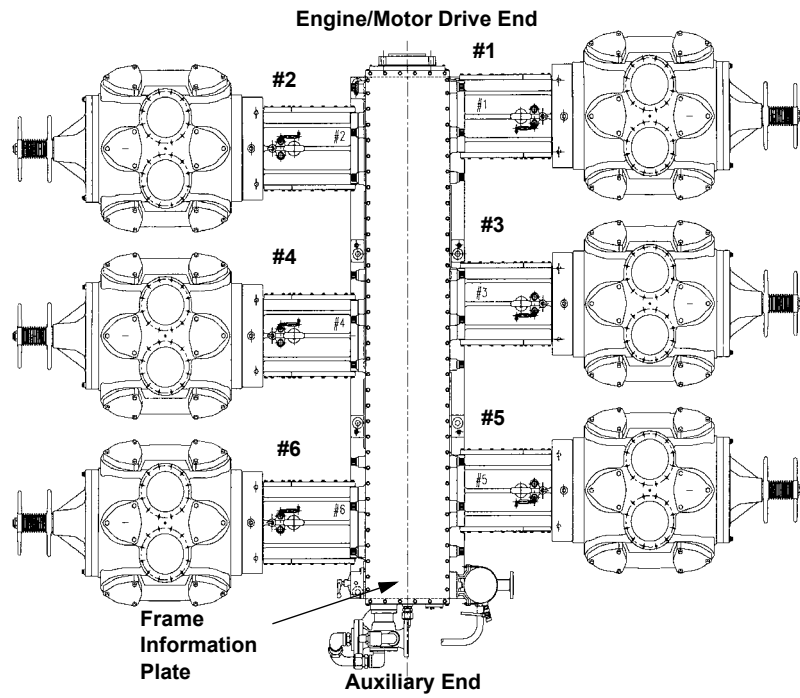


FIGURE 1-1: COMPRESSOR THROW NUMBERING & FRAME INFORMATION PLATE LOCATION - TYPICAL

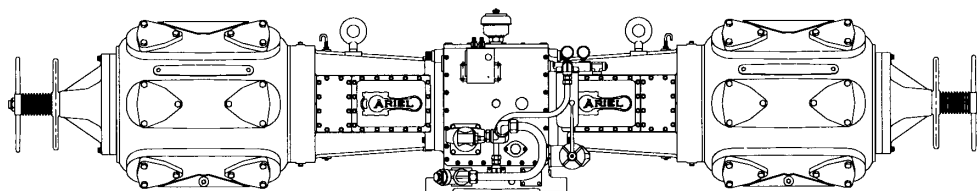


FIGURE 1-2: AUXILIARY END VIEW - TYPICAL (STANDARD ROTATION)

Specifications

Table 1-2: JGE FRAME SPECIFICATIONS^a

MODEL	JGE/2	JGE/4	JGE/6
Stroke, inches (mm)	4-1/2 (114)	4-1/2 (114)	4-1/2 (114)
Speed, RPM ^b	750 To 1500	750 To 1500	750 To 1500
Piston Speed, FPM (m/s)	To 1125 (5.72)	To 1125 (5.72)	To 1125 (5.72)
Number of Throws	2	4	6
Horsepower (kW)	To 1070 (798)	To 2140 (1596)	To 3210 (2394)
Height - Bottom to Crankshaft Centerline, in. (mm)	17 (432)	17 (432)	17 (432)
Connecting Rod Centerline to Centerline, in. (mm)	13.75 (349)	13.75 (349)	13.75 (349)
Maximum Width, in. (m)	139 (3.53)	139 (3.53)	139 (3.53)
Maximum Length, in. (m)	56 (1.42)	101 (2.57)	138 (3.51)
Approximate Weight with Cylinders, lb. (kg)	8000 (3630)	17,000 (7710)	25,000 (11 340)
Oil Pump Flow Rate @ Max. Rated Speed & 180°F (82°C), GPM (L/s)	17 (1.1)	32 (2.0)	58 (3.7)
Oil Heat Rejection, BTU/hr. (kW)	34,000 (10.0)	68,000 (19.9)	102,000 (29.9)
Sump Capacity, US gallons (L)	15 (57)	37 (140)	56 (212)
Piston Rod Diameter, in. (mm)	2.000 (51)	2.000 (51)	2.000 (51)
Internal Rod Load - Double Acting:			
Compression + Tension, lbf. (kN)	60,000 (267)	60,000 (267)	60,000 (267)
Tension, lbf. (kN)	30,000 (133)	30,000 (133)	30,000 (133)
Compression, lbf. (kN)	32,000 (142)	32,000 (142)	32,000 (142)
Internal Rod Load - Single Acting:			
Tension, lbf. (kN)	30,000 (133)	30,000 (133)	30,000 (133)

a. For more information, see the Electronic Databook available in the Ariel Performance Program.

b. Rated speeds for non-lube, and lubricated process applications may vary.

Table 1-3: JGH FRAME SPECIFICATIONS^a

MODEL	JGH/2	JGH/4
Stroke, inches (mm)	4-1/2 (114)	4-1/2 (114)
Speed, RPM ^b	600 To 1200	600 To 1200
Piston Speed, FPM (m/s)	To 900 (4.57)	To 900 (4.57)
Number of Throws	2	4
Horsepower (kW)	To 680 (507)	To 1360 (1014)
Height - Bottom to Crankshaft Centerline, in. (mm)	17 (432)	17 (432)
Connecting Rod Centerline to Centerline, in. (mm)	13.75 (349)	13.75 (349)
Maximum Width, in. (m)	139 (3.53)	139 (3.53)
Maximum Length, in. (m)	56 (1.42)	100 (2.54)
Approximate Average Weight with Cylinders, lb. (kg)	8000 (3630)	17,000 (7710)
Oil Pump Flow Rate @ Max. Rated Speed & 180°F (82°C), GPM (L/s)	13 (0.82)	26 (1.6)
Oil Heat Rejection, BTU/hr. (kW)	25,000 (7.3)	50,000 (14.7)
Sump Capacity, US gallons (L)	15 (57)	37 (140)
Piston Rod Diameter, in. (mm)	2.000 (51)	2.000 (51)
Internal Rod Load - Double Acting:		
Compression + Tension, lbf. (kN)	48,000 (214)	48,000 (214)
Tension, lbf. (kN)	24,000 (107)	24,000 (107)
Compression, lbf. (kN)	30,000 (133)	30,000 (133)
Internal Rod Load - Single Acting:		
Tension, lbf. (kN)	24,000 (107)	24,000 (107)

a. For more information, see the Electronic Databook available in the Ariel Performance Program.

b. Rated speeds for non-lube, and lubricated process applications may vary.

Table 1-4: JGK FRAME SPECIFICATIONS^a

MODEL	JGK/2	JGK/4	JGK/6
Stroke, inches (mm)	5-1/2 (140)	5-1/2 (140)	5-1/2 (140)
Speed, RPM ^b	600 To 1200	600 To 1200	600 To 1200
Piston Speed, FPM (m/s)	To 1100 (5.59)	To 1100 (5.59)	To 1100 (5.59)
Number of Throws	2	4	6
Horsepower (kW)	To 1270 (947)	To 2540 (1894)	To 3810 (2841)
Height - Bottom to Crankshaft Centerline, in. (mm)	17 (432)	17 (432)	17 (432)
Connecting Rod Centerline to Centerline, in. (mm)	13.75 (349)	13.75 (349)	13.75 (349)
Maximum Width, in. (m)	157 (3.99)	157 (3.99)	157 (3.99)
Maximum Length, in. (m)	57 (1.45)	101 (2.57)	140.5 (3.57)
Approximate Average Weight with Cylinders, lb. (kg)	10,000 (4540)	21,000 (9530)	31,000 (14 075)
Oil Pump Flow Rate @ Max. Rated Speed & 180°F (82°C), GPM (L/s)	13 (0.82)	26 (1.6)	46 (2.9)
Oil Heat Rejection, BTU/hr. (kW)	28,000 (8.2)	56,000 (16.4)	84,000 (24.6)
Sump Capacity, US gallons (L)	15 (57)	37 (140)	56 (212)
Piston Rod Diameter, in. (mm)	2.000 (51)	2.000 (51)	2.000 (51)
Internal Rod Load - Double Acting:			
Compression + Tension, lbf. (kN)	74,000 (329)	74,000 (329)	74,000 (329)
Tension, lbf. (kN)	37,000 (165)	37,000 (165)	37,000 (165)
Compression, lbf. (kN)	40,000 (178)	40,000 (178)	40,000 (178)
Internal Rod Load - Single Acting:			
Tension, lbf. (kN)	37,000 (165)	37,000 (165)	37,000 (165)

a. For more information, see the Electronic Databook available in the Ariel Performance Program.

b. Rated speeds for non-lube, and lubricated process applications may vary.

Table 1-5: JGT FRAME SPECIFICATIONS^a

MODEL	JGT/2	JGT/4	JGT/6
Stroke, inches (mm)	4-1/2 (114)	4-1/2 (114)	4-1/2 (114)
Speed, RPM ^b	750 To 1500	750 To 1500	750 To 1500
Piston Speed, FPM (m/s)	To 1125 (5.72)	To 1125 (5.72)	To 1125 (5.72)
Number of Throws	2	4	6
Horsepower (kW)	To 1300 (969)	To 2600 (1939)	To 3900 (2908)
Height - Bottom to Crankshaft Centerline, in. (mm)	17 (432)	17 (432)	17 (432)
Connecting Rod Centerline to Centerline, in. (mm)	13.75 (349)	13.75 (349)	13.75 (349)
Maximum Width, in. (m)	157 (3.99)	157 (3.99)	157 (3.99)
Maximum Length, in. (m)	57 (1.45)	101 (2.57)	140.5 (3.57)
Approximate Weight with Cylinders, lb. (kg)	10,000 (4540)	21,000 (9530)	31,000 (14 075)
Oil Pump Flow Rate @ Max. Rated Speed & 180°F (82°C), GPM (L/s)	17 (1.1)	32 (2.0)	58 (3.7)
Oil Heat Rejection, BTU/hr. (kW)	34,000 (10.0)	68,000 (19.9)	102,000 (29.9)
Sump Capacity, US gallons (L)	15 (57)	37 (140)	56 (212)
Piston Rod Diameter, in. (mm)	2.000 (51)	2.000 (51)	2.000 (51)
Internal Rod Load - Double Acting:			
Compression + Tension, lbf. (kN)	74,000 (329)	74,000 (329)	74,000 (329)
Tension, lbf. (kN)	37,000 (165)	37,000 (165)	37,000 (165)
Compression, lbf. (kN)	40,000 (178)	40,000 (178)	40,000 (178)
Internal Rod Load - Single Acting:			
Tension, lbf. (kN)	37,000 (165)	37,000 (165)	37,000 (165)

a. For more information, see the Electronic Databook available in the Ariel Performance Program.

b. Rated speeds for non-lube and lubricated process applications may vary.

Product Information and Safety Plates

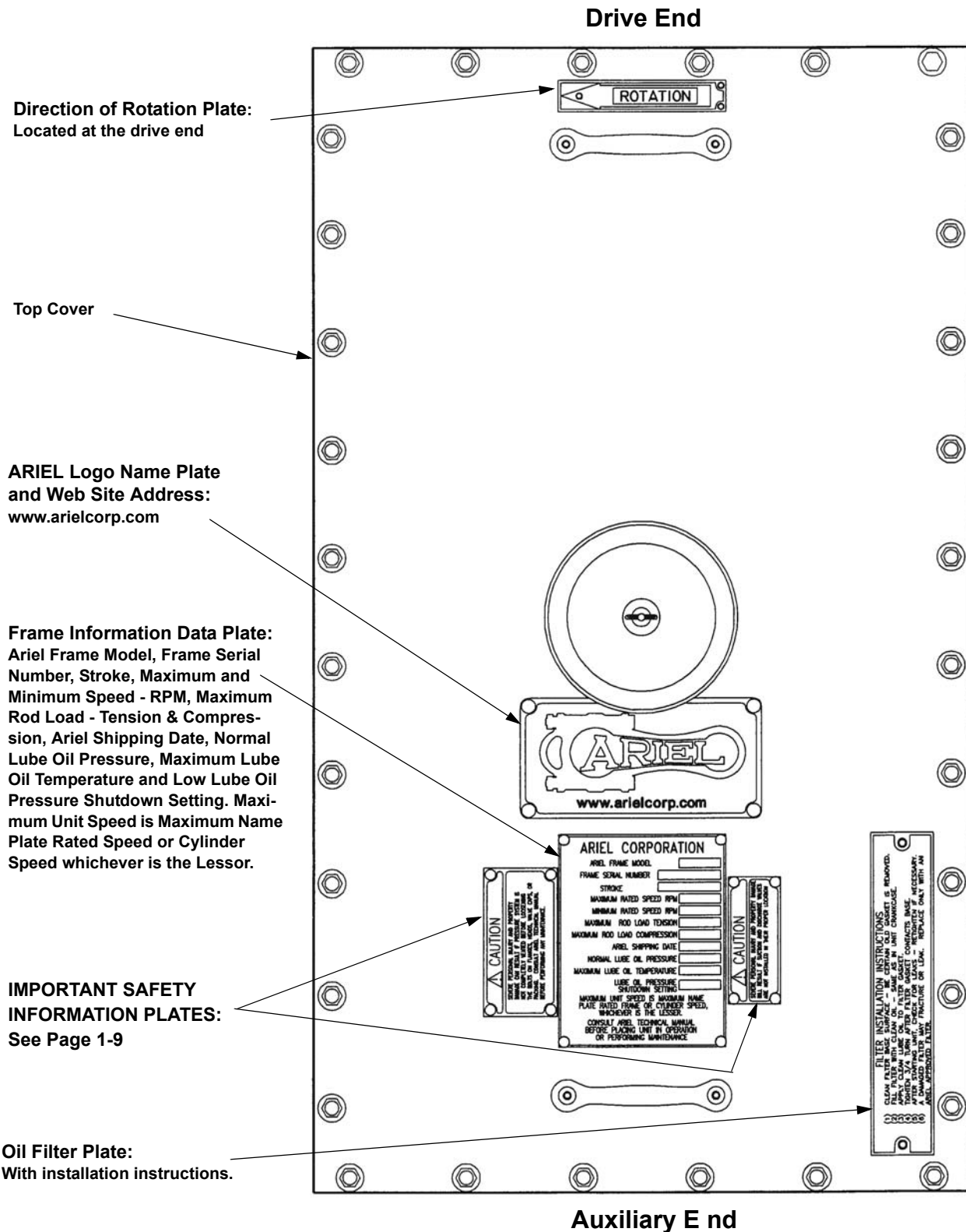


FIGURE 1-3: TOP COVER - TYPICAL

Important Safety Information

 **CAUTION**

SEVERE PERSONAL INJURY AND PROPERTY DAMAGE CAN RESULT IF PRESSURE SYSTEM IS NOT COMPLETELY VENTED BEFORE LOOSENING THE BOLTS ON FLANGES, HEADS, VALVE CAPS, OR PACKING. CONSULT ARIEL TECHNICAL MANUAL BEFORE PERFORMING ANY MAINTENANCE.

 **CAUTION**

SEVERE PERSONAL INJURY AND PROPERTY DAMAGE WILL RESULT IF SUCTION AND DISCHARGE VALVES ARE NOT INSTALLED IN THEIR PROPER LOCATION.

 **CAUTION**

NOISE GENERATED BY RECIPROCATING MACHINERY CAN BE A SOURCE FOR HEARING INJURY. SEE PACKAGER'S INFORMATION FOR ANY SPECIFIC RECOMMENDATIONS. WEAR HEARING PROTECTION WHEN UNIT IS RUNNING.

 **CAUTION**

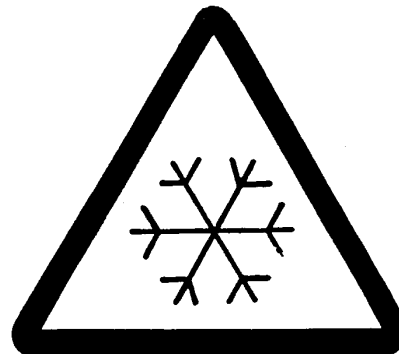
HOT GAS TEMPERATURES ESPECIALLY THE CYLINDER DISCHARGE AREAS, 190°F (88°C) OIL AND HIGH FRICTION AREAS CAN BE A SOURCE FOR BURNS. WEAR PROPER INSULATION WHEN WORKING AROUND THESE AREAS. SHUT DOWN UNIT AND ALLOW TO COOL BEFORE DOING MAINTENANCE IN THESE AREAS.

! **CAUTION**

WHEN ET CLASS COMPRESSOR CYLINDERS ARE SUPPLIED, DO NOT REMOVE THE PIN FROM THE CROSS-HEAD GUIDE TO COMPRESSOR CYLINDER MOUNTING FACE. IT IS INSTALLED TO PREVENT THE INSTALLATION OF MISAPPLIED CYLINDERS AND AVOID PERSONAL INJURY.



CAUTION Hot Surfaces



CAUTION Cold Surfaces

Where these CAUTION symbols appear on the compressor, the surfaces are hot or cold when compressor is operating and can cause injury if touched without proper insulated protective clothing. If servicing the compressor, allow these surfaces to cool or warm to safe temperatures or wear protective clothing before proceeding. When applied to compressor cylinders, the temperature CAUTION applies to all connected piping and equipment.

FIGURE 1-4: HOT & COLD SURFACES - CAUTION SYMBOLS

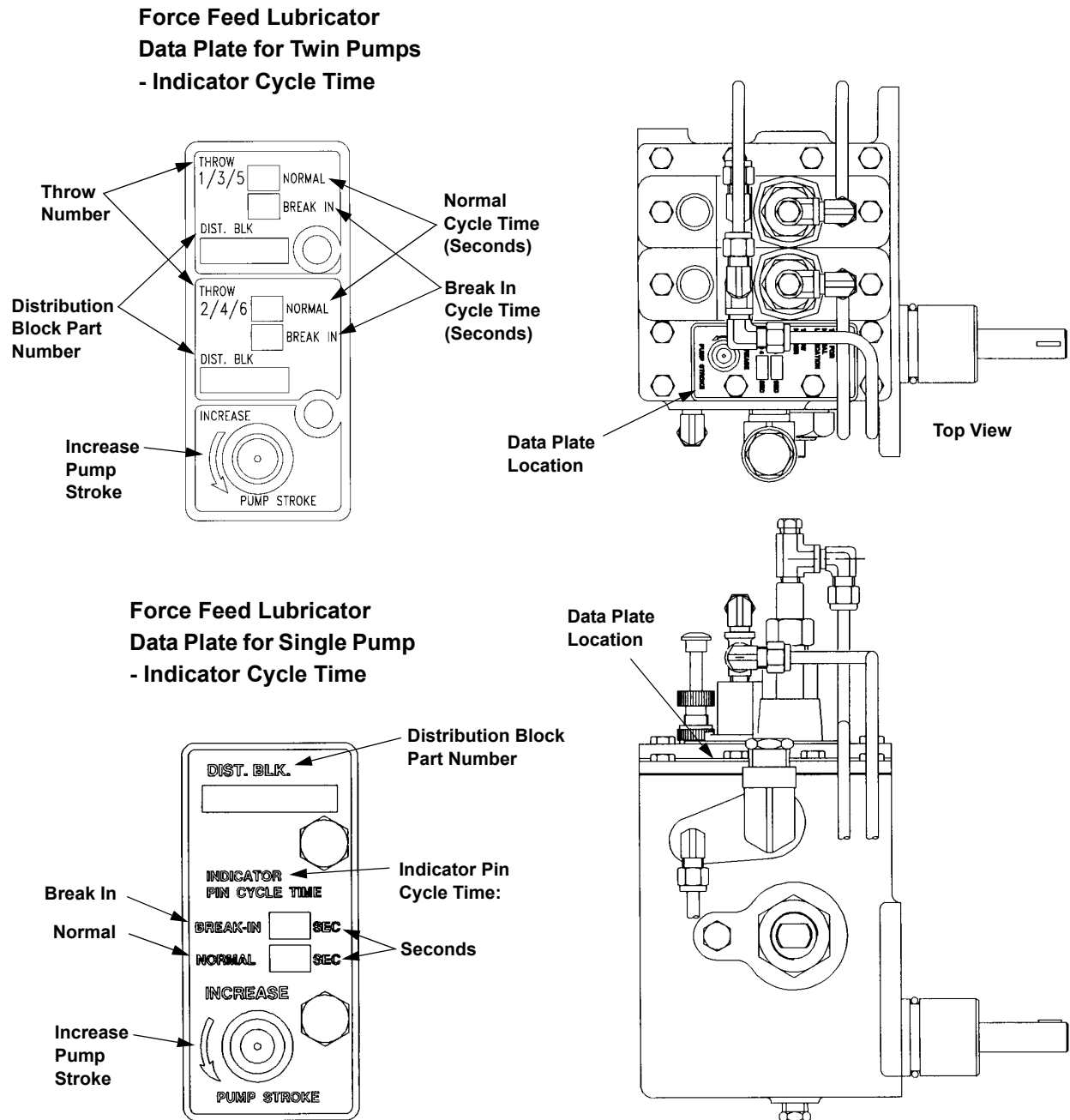


FIGURE 1-5: FORCE FEED LUBRICATOR DATA PLATES - TYPICAL SINGLE & TWIN PUMPS

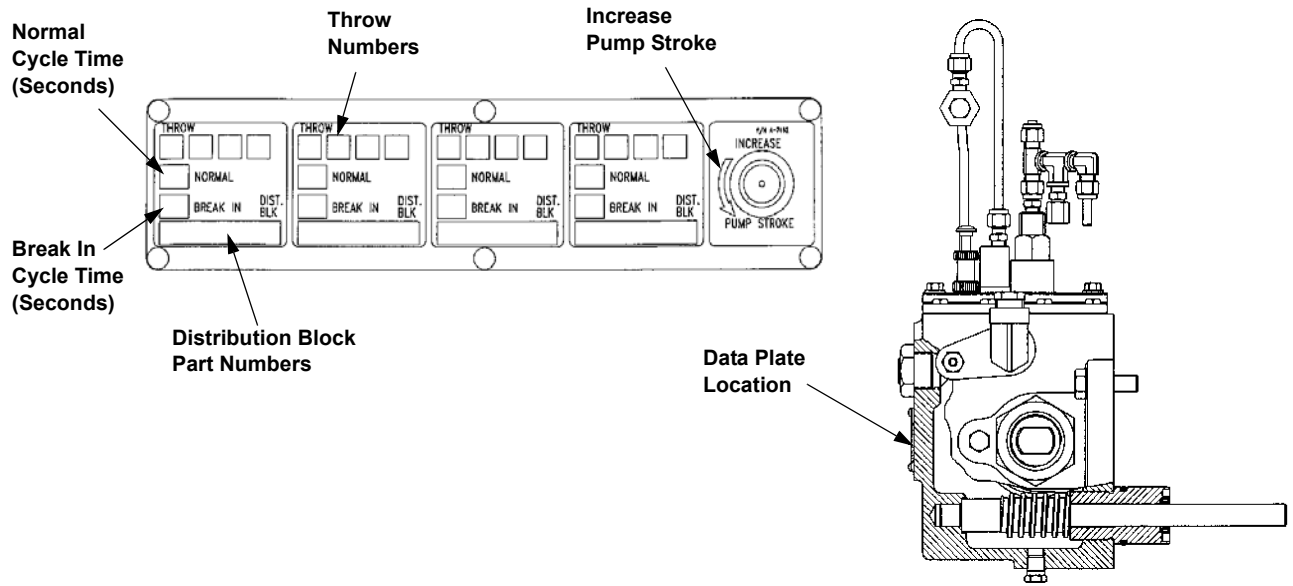
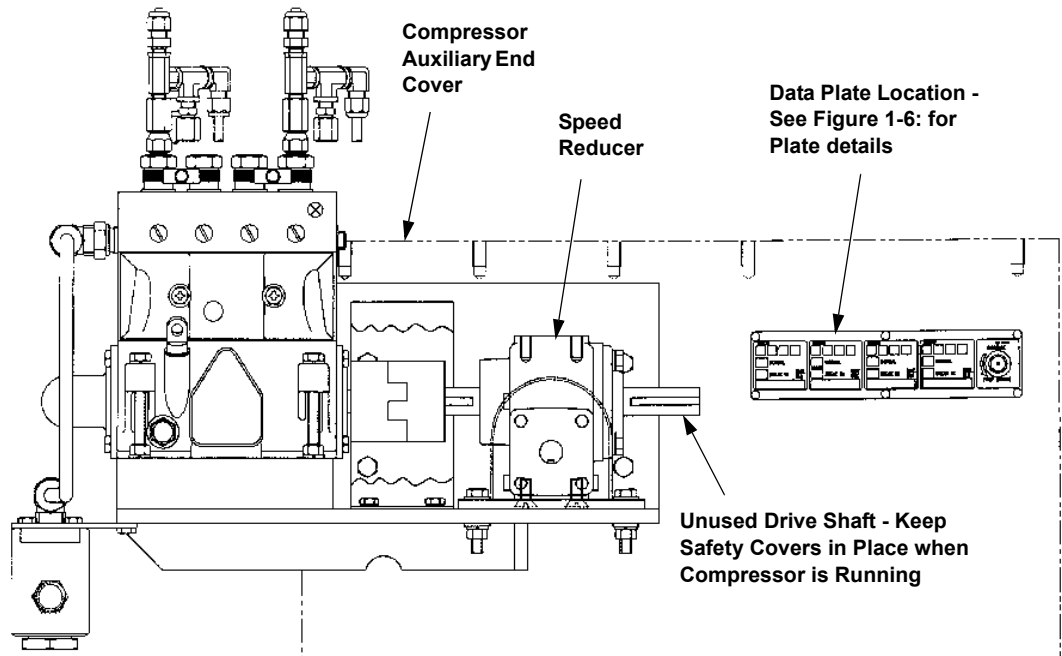


FIGURE 1-6: FORCE FEED LUBRICATOR DATA PLATE - TYPICAL FOUR PUMPS



Gerhardt Force Feed Lubricator w/up to four pump capacity - Optional for High Pressure Cylinders
 For more information on the Gerhardt Lubricator, see the Ariel web site under Vendor Literature

FIGURE 1-7: FORCE FEED LUBRICATOR DATA PLATE - TYPICAL GERHARDT

The Force Feed Lubricator provides oil to the piston rod packing and the compressor pistons. The Lubricator Data Plate gives directions for adjusting the flow of oil. If this plate is missing, please contact Ariel Corporation, Mount Vernon, Ohio for a replacement or specific directions. See "Ariel Telephone, Fax, E-Mail and Web Site Numbers" on page 7-19 for contact information.

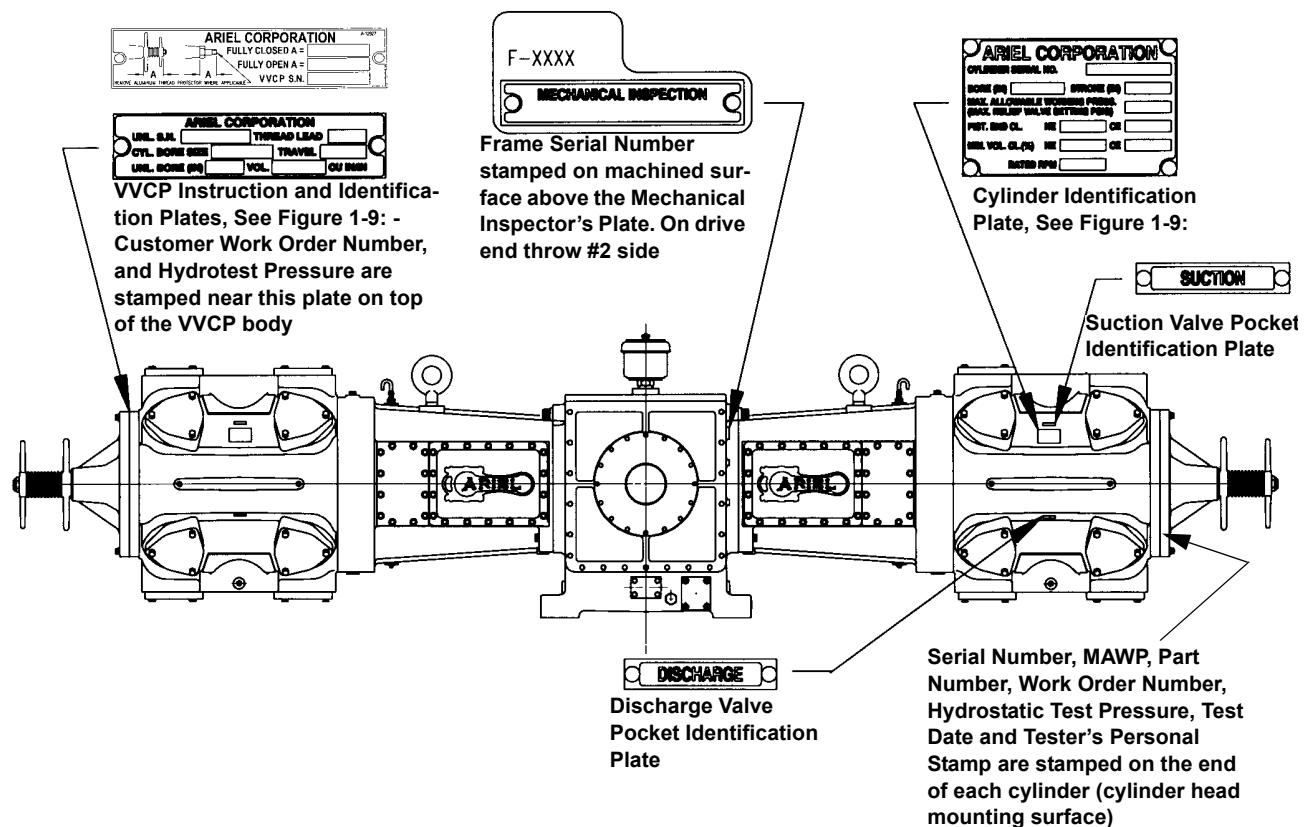
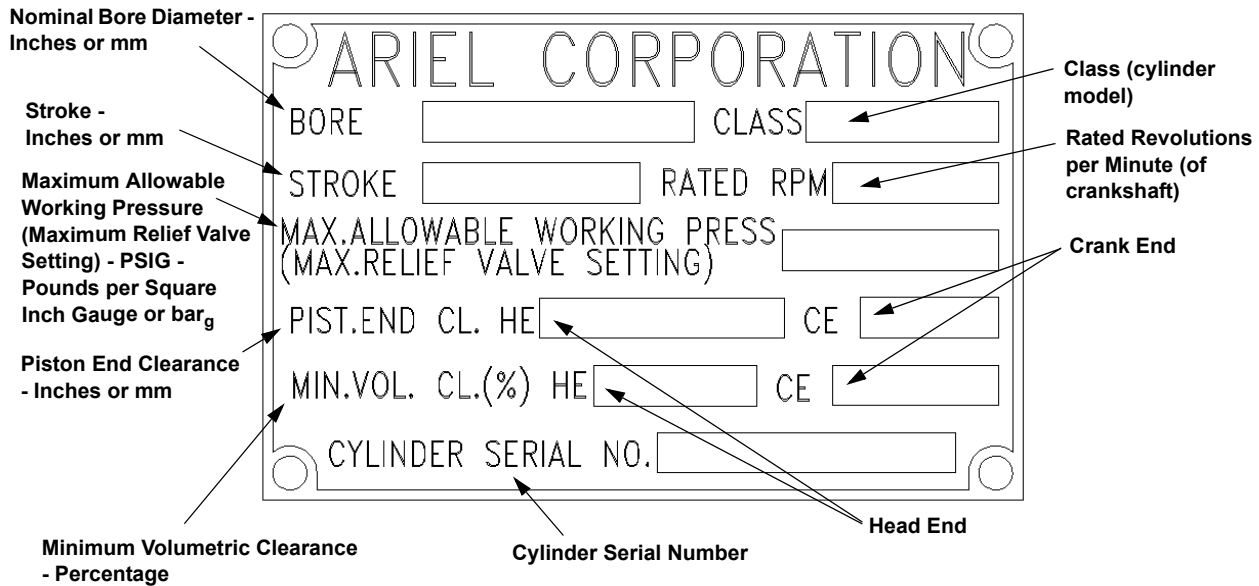


FIGURE 1-8: IDENTIFICATION PLATES - TYPICAL

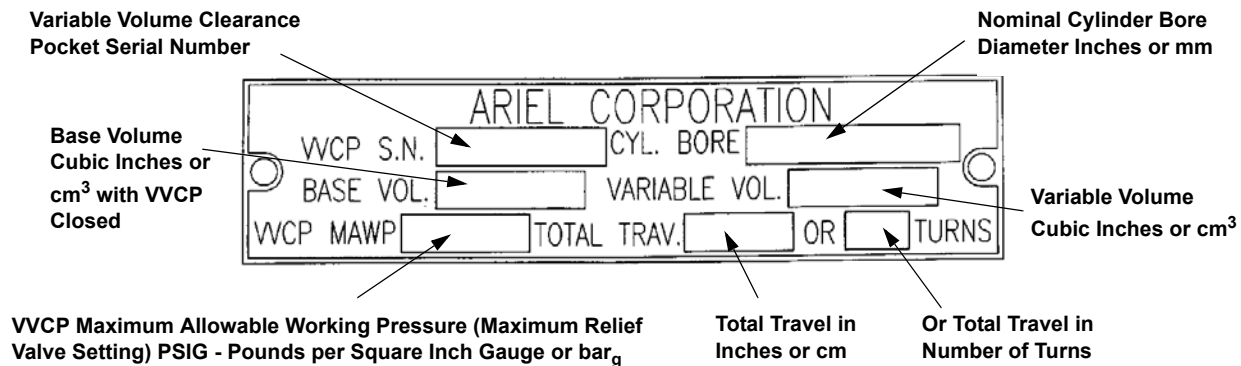
Cylinder Identification Plates appear on each cylinder. The serial number is also stamped on the end of each cylinder. If any plate is missing, please contact Ariel for a replacement or specific directions.

NOTE: USE THE CYLINDER AND FRAME SERIAL NUMBERS IN ALL CORRESPONDENCE.

CYLINDER IDENTIFICATION PLATE:



HEAD-END VARIABLE VOLUME CLEARANCE POCKET (VVCP) IDENTIFICATION PLATE



HEAD-END VARIABLE VOLUME CLEARANCE POCKET (VVCP) INSTRUCTION PLATE

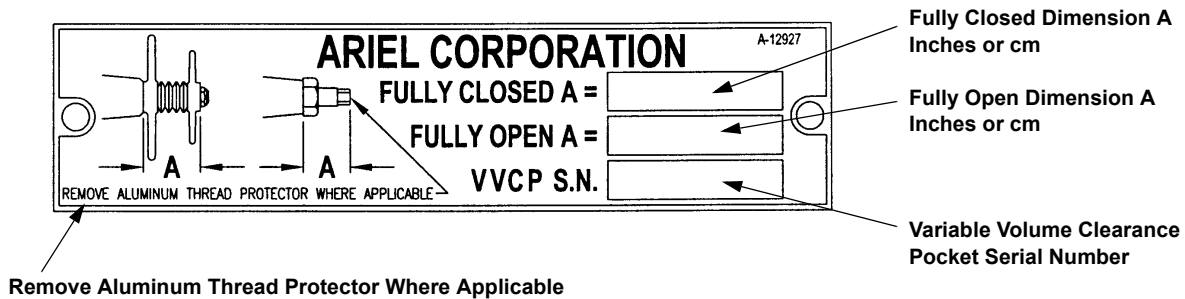


FIGURE 1-9: CYLINDER AND VVCP PLATES

Clearances

TABLE 1-6: FRAME CLEARANCES

DESCRIPTION	CLEARANCE, IN.	(CLEARANCE, mm)
Crankshaft Dust Seal JGE:H:K:T/2/4 (Feeler Gauge - Centered)	0.008 to 0.010	(0.20 to 0.25)
Crankshaft Dust Seal JGE:K:T/6(Feeler Gauge - Centered)	0.010 to 0.018	(0.25 to 0.46)
Crankshaft Thrust JGE:H:K:T/2/4 (End)	0.0085 to 0.0200	(0.21 to 0.51)
Crankshaft Thrust JGE:K:T/6 (End)	0.014 to 0.033	(0.36 to 0.84)
Crankshaft Journal Bearing (Jack)	0.0015 to 0.0050	(0.04 to 0.13)
Crankshaft Pin to Connecting Rod Bearing (Vertical Jack) ^a	0.0035 to 0.0070	(0.09 to 0.18)
Connecting Rod Thrust (Side)	0.007 to 0.018	(0.18 to 0.46)
Connecting Rod Bushing to Crosshead Pin	0.002 to 0.004	(0.05 to 0.10)
Crosshead Bronze-Bushing to Crosshead Pin - Ductile and ADI Iron Crosshead	0.0020 to 0.0042	(0.05 to 0.11)
Crosshead (Gray Iron) to Crosshead Pin (JGH)	0.0020 to 0.0035	(0.05 to 0.09)
Crosshead (Bronze Crosshead) to Crosshead Pin	0.0020 to 0.0035	(0.05 to 0.09)
Crosshead to Guide - Babbitted Gray & Ductile Iron (Feeler Gauge) ^b	0.007 to 0.012	(0.18 to 0.30)
Crosshead to Guide - Babbitted ADI Iron (Feeler Gauge) ^b	0.009 to 0.014	(0.23 to 0.36)
Crosshead to Guide - Babbitted Bronze (Feeler Gauge) ^b	0.011 to 0.016	(0.28 to 0.41)

a. For compressors and/or connecting rod replacement bearing shells, supplied after 2/1/97.

b. Crosshead guide to crosshead clearance at the top is to be checked by inserting a standard 0.5 inches (13 mm) wide feeler stock from one side edge of the crosshead across to the opposite side. This is to be done at both ends. The bottom clearance is to be checked with 0.0015 inches (0.038 mm) feeler stock at the four corners. If the feeler at the bottom can be inserted more than 0.5 inches (13 mm), the assembly is not acceptable.

Table 1-7: PISTON END CLEARANCES^a

CYLINDER CLASS	CRANK END		HEAD END		TOTAL ^b	
	IN.	mm	IN.	mm	IN.	mm
22-1/2E:ET:H	0.050	(1.3)	0.070 to 0.130	(1.8 to 3.3)	0.120 to 0.180	(3.0 to 4.6)
All Other E:ET:H Cylinders	0.040	(1.0)	0.050 to 0.110	(1.3 to 2.8)	0.090 to 0.150	(2.3 to 3.8)
17-7/8, 20-1/8, 22, 24-1/8 & 22-1/2 K:T	0.055	(1.4)	0.095 to 0.155	(2.4 to 3.9)	0.150 to 0.210	(3.8 to 5.3)
5-3/8K:T Tandem	0.040	(1.0)	0.060 to 0.160	(1.5 to 4.1)	0.100 to 0.200	(2.5 to 5.1)
All KL:TL Cylinders	0.300	(7.6)	No Set		0.620 to 0.680	(15.7 to 17.3)
All KM:TM Cylinders	0.040	(1.0)	0.080 to 0.140	(2.0 to 3.6)	0.120 to 0.180	(3.0 to 4.6)
All Other K:T Cylinders	0.040	(1.0)	0.080 to 0.140	(2.0 to 3.6)	0.120 to 0.180	(3.0 to 4.6)

a. Refer to Piston and Rod - Installation on Page 5-39 for setting instructions.

b. If your total piston end clearance is not within table tolerance, contact your Packager or Ariel.

NOTE: MEASURED CLEARANCES WILL NOT NECESSARILY AGREE BECAUSE OF OIL FILMS, ASSEMBLY TOLERANCES, WEAR, ETC. PLASTIGAGES, SOLDER, ETC. ARE NOT TO BE USED.

Piston Ring, Packing Ring and Wearband Side Clearances

The standard side clearance in inches for JGE, JGH, JGK and JGT compressor piston rings, packing rings and wearbands when new are as follows:

TABLE 1-8: PISTON RING SIDE CLEARANCE, INCHES (mm)

NOMINAL WIDTH	ACTUAL GROOVE WIDTH	TEFLON	PEEK	BRONZE
3/16 (4.76)	0.187 to 0.189 (4.75/4.80)	0.0035 to 0.0075 (0.09/0.19)	---	0.004 to 0.008 (0.10/0.20)
1/4 (6.35)	0.250 to 0.252 (6.35/6.40)	0.005 to 0.011 (0.13/0.28)	0.005 to 0.008 (0.13/0.20)	0.004 to 0.008 (0.10/0.20)
5/16 (7.94)	0.312 to 0.314 (7.92/7.98)	0.006 to 0.012 (0.15/0.30)	0.005 to 0.008 (0.13/0.20)	0.004 to 0.008 (0.10/0.20)
3/8 (9.53)	0.375 to 0.377 (9.53/9.58)	0.007 to 0.013 (0.18/0.33)	0.005 to 0.008 (0.13/0.20)	0.004 to 0.008 (0.10/0.20)
1/2 (12.70)	0.500 to 0.502 (12.70/12.75)	0.009 to 0.015 (0.23/0.38)	0.005 to 0.008 (0.13/0.20)	0.004 to 0.008 (0.10/0.20)
5/8 (15.88)	0.625 to 0.627 (15.88/15.93)	0.011 to 0.016 (0.28/0.41)	0.006 to 0.009 (0.15/0.23)	0.005 to 0.009 (0.13/0.23)
3/4 (19.05)	0.750 to 0.752 (19.05/19.10)	0.013 to 0.020 (0.33/0.51)	0.008 to 0.011 (0.20/0.28)	0.006 to 0.010 (0.15/0.25)

TABLE 1-9: PACKING RING SIDE CLEARANCE, INCHES (mm)

ACTUAL GROOVE WIDTH	TEFLON	PEEK	BRONZE
0.375 to 0.377 (9.53 to 9.58)	0.011 to 0.015 (0.28 to 0.38)	0.011 to 0.015 (0.28 to 0.38)	0.006 to 0.008 (0.15 to 0.20)
0.572 to 0.574 (14.53 to 14.58)	0.017 to 0.022 (0.43 to 0.56)	0.017 to 0.022 (0.43 to 0.56)	

TABLE 1-10: WEARBAND SIDE CLEARANCE, INCHES (mm)

ACTUAL GROOVE WIDTH	TEFLON	PEEK
0.875 to 0.877 (22.23 to 22.28)	0.010 to 0.024 (0.25 to 0.51)	0.006 to 0.010 (0.15 to 0.25)
2.000 to 2.002 (50.80 to 50.85)	0.024 to 0.034 (0.61 to 0.86)	0.014 to 0.018 (0.36 to 0.46)
3.000 to 3.003 (76.20 to 76.28)	0.036 to 0.048 (0.91 to 1.22)	0.021 to 0.025 (0.53 to 0.64)

TABLE 1-11: PISTON TO BORE CLEARANCES AND PISTON RING/RIDER RING END GAPS, FOR H, E & ET CLASS CYLINDERS, INCHES

BORE DIAMETER	PISTON TO BORE CLEARANCE		CONVENTIONAL PISTON RING END GAP		PISTON/RIDER RING END GAP ^a
	WITH CONVENTIONAL PISTON RINGS	WITH PISTON/RIDER RINGS ^b	NEW	MAXIMUM	
4.25	0.011 to 0.016	0.090 to 0.096	0.051 to 0.075	0.225	0.050 to 0.066
4.625	0.012 to 0.017	0.090 to 0.096	0.056 to 0.080	0.240	0.056 to 0.072
5.125	0.012 to 0.017	0.090 to 0.096	0.061 to 0.085	0.255	0.062 to 0.078
5.5	0.013 to 0.018	0.090 to 0.096	0.066 to 0.090	0.270	0.068 to 0.084
6.0	0.013 to 0.018	0.090 to 0.096	0.072 to 0.112	0.336	0.074 to 0.090
6.375	0.014 to 0.019	0.090 to 0.096	0.077 to 0.117	0.351	0.073 to 0.103
7.0	0.015 to 0.020	0.090 to 0.096	0.084 to 0.124	0.372	0.091 to 0.121
7.375	0.015 to 0.020	0.090 to 0.096	0.089 to 0.129	0.387	0.097 to 0.127
8.0	0.016 to 0.022	0.090 to 0.096	0.096 to 0.136	0.408	0.095 to 0.125
8.375	0.017 to 0.023	0.090 to 0.096	0.101 to 0.141	0.423	0.100 to 0.130
9.25	0.019 to 0.025	0.090 to 0.096	0.111 to 0.151	0.453	0.112 to 0.142
9.75	0.020 to 0.026	0.090 to 0.096	0.117 to 0.157	0.471	0.119 to 0.149
11	0.022 to 0.028	0.090 to 0.096	0.131 to 0.179	0.537	0.136 to 0.166
11.5	0.023 to 0.029	0.090 to 0.096	0.138 to 0.186	0.558	0.143 to 0.173
13	0.026 to 0.032	0.090 to 0.096	0.156 to 0.204	0.612	0.182 to 0.212
13.5	0.027 to 0.033	0.090 to 0.096	0.162 to 0.210	0.630	0.190 to 0.220
15.250	0.030 to 0.037	0.090 to 0.097	0.183 to 0.231	0.693	0.216 to 0.246
15.75	0.031 to 0.038	0.090 to 0.097	0.189 to 0.237	0.711	0.224 to 0.254
16.75	0.033 to 0.040	0.090 to 0.097	0.201 to 0.251	0.753	0.239 to 0.269
17.25	0.034 to 0.041	0.090 to 0.097	0.207 to 0.259	0.777	0.247 to 0.277
19	0.038 to 0.046	0.090 to 0.098	0.228 to 0.292	0.876	0.273 to 0.303
19.5	0.039 to 0.047	0.090 to 0.098	0.234 to 0.298	0.894	0.281 to 0.311
22.5	Uses Wearbands, see Table 1-13 on page 20				

a. Piston/rider ring radial projection is 0.026" to 0.033" and side clearance is 0.008" to 0.013".

b. Piston/rider rings are standard on all ET & were standard on E Class cylinders except the 22.5". Conventional piston rings were standard on H Class cylinders and piston/rider rings optional on bore diameters of 4.25" to 11.5" with the exception of bore diameters 4.625", 5.5" and 6.375". Piston/rider rings were standard on H Class cylinders with bore diameters of 4.625", 5.5", 6.375" and 13" to 19.5". H & E Class Cylinders are out-of-production; existing H & E cylinders may be used if application requirements are met. Consult your packager and/or Ariel when re-applying cylinders. See "Compressor Re-Application" on page 3-10.

TABLE 1-12: PISTON TO BORE CLEARANCES AND PISTON RING/RIDER RING END GAPS, FOR H, E & ET CLASS CYLINDERS, (MILLIMETERS)

BORE DIAMETER (MM) [INCHES]	PISTON TO BORE CLEARANCE		CONVENTIONAL PISTON RING END GAP		PISTON/RIDER RING END GAP ^a
	WITH CONVENTIONAL PISTON RINGS	WITH PISTON/RIDER RINGS ^b	NEW	MAXIMUM	
(108) [4.25]	(0.28 to 0.41)	(2.29 to 2.44)	(1.30 to 1.91)	(5.72)	(1.27 to 1.68)
(117) [4.625]	(0.30 to 0.43)	(2.29 to 2.44)	(1.42 to 2.03)	(6.10)	(1.42 to 1.83)
(130) [5.125]	(0.30 to 0.43)	(2.29 to 2.44)	(1.55 to 2.16)	(6.48)	(1.57 to 1.98)
(140) [5.5]	(0.33 to 0.46)	(2.29 to 2.44)	(1.68 to 2.29)	(6.86)	(1.73 to 2.13)
(152) [6]	(0.33 to 0.46)	(2.29 to 2.44)	(1.83 to 2.84)	(8.53)	(1.88 to 2.29)
(162) [6.375]	(0.36 to 0.48)	(2.29 to 2.44)	(1.96 to 2.97)	(8.92)	(1.85 to 2.62)
(178) [7]	(0.38 to 0.51)	(2.29 to 2.44)	(2.13 to 3.15)	(9.45)	(2.31 to 3.07)
(187) [7.375]	(0.38 to 0.51)	(2.29 to 2.44)	(2.26 to 3.28)	(9.83)	(2.46 to 3.23)
(203) [8]	(0.41 to 0.56)	(2.29 to 2.44)	(2.44 to 3.45)	(10.36)	(2.41 to 3.18)
(213) [8.375]	(0.43 to 0.58)	(2.29 to 2.44)	(2.57 to 3.58)	(10.74)	(2.54 to 3.30)
(235) [9.25]	(0.48 to 0.64)	(2.29 to 2.44)	(2.82 to 3.84)	(11.51)	(2.84 to 3.61)
(248) [9.75]	(0.51 to 0.66)	(2.29 to 2.44)	(2.97 to 3.99)	(11.96)	(3.02 to 3.78)
(279) [11]	(0.56 to 0.71)	(2.29 to 2.44)	(3.33 to 4.55)	(13.64)	(3.45 to 4.22)
(292) [11.5]	(0.58 to 0.74)	(2.29 to 2.44)	(3.51 to 4.72)	(14.17)	(3.63 to 4.39)
(330) [13]	(0.66 to 0.81)	(2.29 to 2.44)	(3.96 to 5.18)	(15.54)	(4.62 to 5.38)
(343) [13.5]	(0.69 to 0.84)	(2.29 to 2.44)	(4.11 to 5.33)	(16.00)	(4.83 to 5.59)
(387) [15.25]	(0.76 to 0.94)	(2.29 to 2.46)	(4.65 to 5.87)	(17.60)	(5.49 to 6.25)
(400) [15.75]	(0.79 to 0.97)	(2.29 to 2.46)	(4.80 to 6.02)	(18.06)	(5.69 to 6.45)
(425) [16.75]	(0.84 to 1.02)	(2.29 to 2.46)	(5.11 to 6.38)	(19.13)	(6.07 to 6.83)
(438) [17.25]	(0.86 to 1.04)	(2.29 to 2.46)	(5.26 to 6.58)	(19.74)	(6.27 to 7.04)
(483) [19]	(0.97 to 1.17)	(2.29 to 2.49)	(5.79 to 7.42)	(22.25)	(6.93 to 7.70)
(495) [19.5]	(0.99 to 1.19)	(2.29 to 2.49)	(5.94 to 7.57)	(22.71)	(7.14 to 7.90)
(572) [22.5]	Uses Wearbands, see Table 1-14 on page 23				

a. Rider ring radial projection is 0.66mm to 0.84mm and side clearance is 0.20mm to 0.33mm.

b. Piston/rider rings are standard on all E & ET Class cylinders. Piston/rider rings were optional on H Class cylinders with bore diameters of 108mm to 292mm with the exception of bore diameters 130mm, 140mm and 162mm. Piston/rider rings were standard on H Class cylinders with bore diameters of 130mm, 140mm, 162mm and 330mm to 495mm. H & E Class Cylinders are out-of-production; existing H & E cylinders may be used if application requirements are met. Consult your packager and/or Ariel when re-applying cylinders. See "Compressor Re-Application" on page 3-10.

Table 1-13: PISTON, PISTON RING AND WEARBAND CLEARANCES FOR K&T CLASS AND 22-1/2 E^a:ET:H CLASS CYLINDERS, INCHES

PISTON TO CYLINDER CLEARANCE		PISTON RING END GAPS - FILLED TEFLON ^b		WEAR BANDS NEW		
BORE	CLEARANCE	NEW	MAXIMUM	MINIMUM END GAP		RADIAL PROJECTION
				45°	70°	
2.5	0.055 to 0.063	0.015 to 0.025	0.075	0.080	0.106	0.018 to 0.025
2.625	0.055 to 0.063	0.015 to 0.025	0.075	0.084	0.111	0.018 to 0.025
3	0.055 to 0.063	0.017 to 0.027	0.081	0.096	0.128	0.018 to 0.025
3.5	0.060 to 0.068	0.011 to 0.018	0.054	---	0.118	0.018 to 0.026
3.875	0.060 to 0.068	0.012 to 0.019	0.057	---	0.131	0.018 to 0.026
4.25	0.071 to 0.079	0.051 to 0.061	0.183	---	0.136	0.023 to 0.031
4.375	0.071 to 0.079	0.053 to 0.063	0.189	---	0.140	0.026 to 0.033
4.625	0.071 to 0.079	0.056 to 0.066	0.198	---	0.197	0.023 to 0.031
5	0.081 to 0.089	0.050 to 0.060	0.180	0.160	0.213	0.027 to 0.035
5.375	0.081 to 0.089	0.065 to 0.077	0.231	0.172	0.229	0.027 to 0.035
5.875	0.081 to 0.089	0.059 to 0.071	0.213	0.188	0.250	0.027 to 0.035
6.25	0.081 to 0.089	0.063 to 0.138	0.414	0.200	0.266	0.027 to 0.035
6.75	0.087 to 0.096	0.068 to 0.081	0.243	0.216	0.287	0.029 to 0.037
7.00	0.087 to 0.096	0.070 to 0.084	0.252	0.224	0.298	0.029 to 0.037
7.25	0.087 to 0.096	0.072 to 0.087	0.261	0.232	0.308	0.029 to 0.037
7.875	0.092 to 0.101	0.079 to 0.095	0.285	0.252	0.335	0.031 to 0.040
8.375	0.092 to 0.101	0.084 to 0.100	0.300	0.268	0.356	0.031 to 0.040
8.75	0.090 to 0.098	0.105 to 0.125	0.375	---	0.280	0.030 to 0.039
9.125	0.096 to 0.105	0.091 to 0.110	0.330	0.292	0.388	0.033 to 0.042
9.25	0.090 to 0.098	0.111 to 0.131	0.393	---	0.296	0.030 to 0.039
9.625	0.096 to 0.105	0.096 to 0.116	0.346	0.308	0.410	0.033 to 0.042
9.75	0.090 to 0.098	0.117 to 0.137	0.411	---	0.312	0.030 to 0.039
9.875	0.109 to 0.118	0.099 to 0.119	0.357	0.316	0.420	0.037 to 0.047
10.25	0.090 to 0.098	0.110 to 0.132	0.396	---	0.468	0.033 to 0.040
10.375	0.109 to 0.118	0.104 to 0.125	0.375	0.332	0.442	0.037 to 0.047
10.5	0.114 to 0.123	0.105 to 0.126	0.378	0.336	0.447	0.039 to 0.049
10.75	0.090 to 0.098	0.110 to 0.132	0.396	---	0.468	0.033 to 0.040
10.875	0.114 to 0.123	0.108 to 0.130	0.393	0.348	0.463	0.039 to 0.049
11	0.114 to 0.123	0.110 to 0.132	0.396	0.352	0.468	0.039 to 0.049
11 (L&M)	0.090 to 0.098	0.110 to 0.132	0.396	---	0.468	0.033 to 0.040
11.25	0.100 to 0.108	0.135 to 0.159	0.477	---	0.360	0.036 to 0.042
11.375	0.114 to 0.123	0.114 to 0.137	0.411	0.364	0.484	0.039 to 0.049
11.75	0.100 to 0.108	0.141 to 0.165	0.495	---	0.376	0.036 to 0.044
12	0.117 to 0.128	0.120 to 0.144	0.432	0.384	0.511	0.039 to 0.050
12.25	0.117 to 0.127	0.123 to 0.147	0.441	0.392	0.521	0.039 to 0.050
12.375	0.100 to 0.108	0.148 to 0.172	0.516	---	0.376	0.036 to 0.042

Table 1-13: PISTON, PISTON RING AND WEARBAND CLEARANCES FOR K&T CLASS AND 22-1/2 E^a:ET:H CLASS CYLINDERS, INCHES

PISTON TO CYLINDER CLEARANCE		PISTON RING END GAPS - FILLED TEFLON ^b		WEAR BANDS NEW		
BORE	CLEARANCE	NEW	MAXIMUM	MINIMUM END GAP		RADIAL PROJECTION
				45°	70°	
12.5	0.117 to 0.128	0.125 to 0.150	0.450	0.400	0.532	0.039 to 0.050
13.125	0.126 to 0.137	0.131 to 0.158	0.474	0.420	0.558	0.043 to 0.053
13.625	0.126 to 0.137	0.136 to 0.164	0.490	0.436	0.580	0.043 to 0.053
14.125	0.126 to 0.137	0.141 to 0.170	0.508	0.452	0.601	0.043 to 0.053
14.25	0.126 to 0.137	0.171 to 0.195	0.585	0.456	0.606	0.042 to 0.052
14.75	0.126 to 0.137	0.177 to 0.201	0.603	0.472	0.627	0.042 to 0.052
15.375	0.127 to 0.138	0.154 to 0.185	0.555	0.492	0.654	0.038 to 0.050
15.875	0.127 to 0.138	0.159 to 0.191	0.573	0.508	0.675	0.038 to 0.050
17.375	0.179 to 0.191	0.174 to 0.209	0.627	0.556	0.740	0.044 to 0.057
17.875	0.181 to 0.193	0.179 to 0.215	0.645	0.572	0.761	0.044 to 0.057
19.625	0.187 to 0.199	0.236 to 0.268	0.804	0.628	0.835	0.050 to 0.063
20.125	0.185 to 0.197	0.242 to 0.274	0.822	0.644	0.857	0.050 to 0.063
22	0.213 to 0.225	0.264 to 0.304	0.912	0.704	0.936	0.059 to 0.072
22.5	0.152 to 0.164	0.270 to 0.310	0.930	0.734	0.976	0.059 to 0.072
24.125	0.214 to 0.226	0.290 to 0.330	0.990	0.772	1.027	0.056 to 0.069
26.5	0.226 to 0.238	0.320 to 0.360	1.080	0.848	1.128	0.058 to 0.071

a. E & H Class Cylinders are out-of-production; existing E & H cylinders may be used if application requirements are met. Consult your packager and/or Ariel when re-applying cylinders. See "Compressor Re-Application" on page 3-10.

b. For PEEK piston ring end gap values, multiply the table values by 0.3.

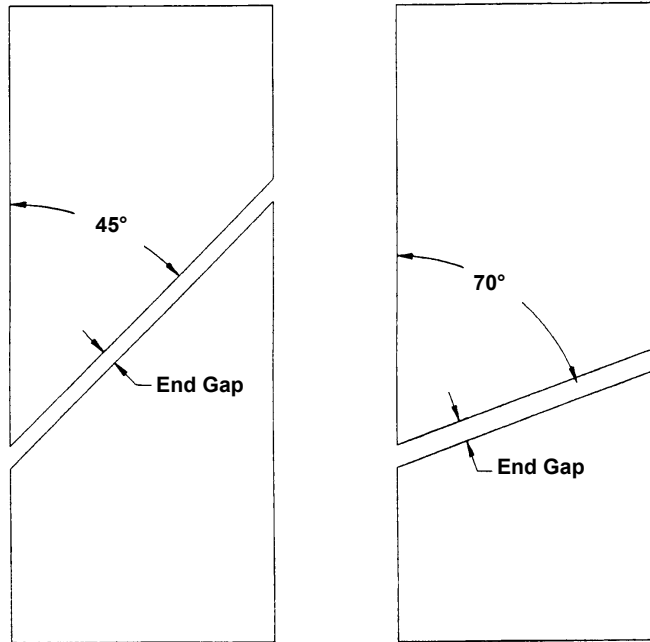


FIGURE 1-10: WEAR BAND CUT ANGLES

Table 1-14: PISTON, PISTON RING AND WEARBAND CLEARANCES FOR K&T CLASS AND 22-12 (572) E^a:ET:H CLASS CYLINDERS, (MILLIMETERS)

PISTON TO CYLINDER CLEARANCE		PISTON RING END GAPS - FILLED TEFLON ^b		WEARBANDS NEW		
BORE (mm) INCHES	CLEARANCE	NEW	MAXIMUM	MINIMUM END GAP		RADIAL PROJECTION
				45°	70°	
(63.5) 2.5	(1.40 to 1.60)	(0.38 to 0.64)	(1.91)	(2.03)	(2.69)	(0.46 to 0.64)
(66.7) 2.625	(1.40 to 1.60)	(0.38 to 0.64)	(1.91)	(2.13)	(2.82)	(0.46 to 0.64)
(76.2) 3	(1.40 to 1.60)	(0.43 to 0.69)	(2.06)	(2.44)	(3.25)	(0.46 to 0.64)
(88.9) 3.5	(1.52 to 1.73)	(0.28 to 0.46)	(1.37)	---	(3.00)	(0.46 to 0.66)
(98.4) 3.875	(1.52 to 1.73)	(0.30 to 0.48)	(1.45)	---	(3.33)	(0.46 to 0.66)
(108) 4.25	(1.80 to 2.01)	(1.30 to 1.55)	(4.65)	---	(3.45)	(0.58 to 0.79)
(111) 4.375	(1.80 to 2.01)	(1.35 to 1.60)	(4.80)	---	(3.56)	(0.66 to 0.84)
(117) 4.625	(1.80 to 2.01)	(1.42 to 1.68)	(5.03)	---	(5.00)	(0.58 to 0.79)
(127) 5	(2.06 to 2.26)	(1.27 to 1.52)	(4.57)	(4.06)	(5.41)	(0.69 to 0.89)
(137) 5.375	(2.06 to 2.26)	(1.65 to 1.96)	(4.88)	(4.37)	(5.82)	(0.69 to 0.89)
(149) 5.875	(2.06 to 2.26)	(1.50 to 1.80)	(5.41)	(4.78)	(6.35)	(0.69 to 0.89)
(159) 6.25	(2.06 to 2.26)	(1.60 to 3.50)	(10.52)	(5.08)	(6.76)	(0.69 to 0.89)
(171) 6.75	(2.21 to 2.44)	(1.73 to 2.06)	(6.17)	(5.49)	(7.29)	(0.74 to 0.94)
(178) 7	(2.21 to 2.44)	(1.78 to 2.13)	(6.40)	(5.69)	(7.57)	(0.74 to 0.94)
(184) 7.25	(2.21 to 2.44)	(1.83 to 2.21)	(6.63)	(5.89)	(7.82)	(0.74 to 0.94)
(200) 7.875	(2.34 to 2.57)	(2.00 to 2.41)	(7.24)	(6.40)	(8.51)	(0.79 to 1.02)
(213) 8.375	(2.34 to 2.57)	(2.13 to 2.54)	(7.62)	(6.81)	(9.04)	(0.79 to 1.02)
(222) 8.75	(2.29 to 2.51)	(2.67 to 3.18)	(9.53)	---	(7.11)	(0.76 to 0.99)
(232) 9.125	(2.44 to 2.67)	(2.31 to 2.79)	(8.38)	(7.42)	(9.86)	(0.84 to 1.07)
(235) 9.25	(2.29 to 2.51)	(2.82 to 3.33)	(9.98)	---	(7.52)	(0.76 to 0.99)
(244) 9.625	(2.44 to 2.67)	(2.44 to 2.95)	(8.79)	(7.82)	(10.41)	(0.84 to 1.07)
(248) 9.75	(2.29 to 2.51)	(2.97 to 3.49)	(10.44)	---	(7.92)	(0.76 to 0.99)
(251) 9.875	(2.77 to 3.00)	(2.51 to 3.02)	(9.07)	(8.03)	(10.67)	(0.94 to 1.19)
(260) 10.25	(2.29 to 2.51)	(2.79 to 3.35)	(10.06)	---	(11.89)	(0.84 to 1.02)
(264) 10.375	(2.77 to 3.00)	(2.64 to 3.18)	(9.53)	(8.43)	(11.23)	(0.94 to 1.19)
(267) 10.5	(2.90 to 3.12)	(2.67 to 3.20)	(9.60)	(8.53)	(11.35)	(0.99 to 1.24)
(273) 10.75	(2.29 to 2.51)	(2.79 to 3.35)	(10.06)	---	(11.89)	(0.84 to 1.02)
(276) 10.875	(2.90 to 3.12)	(2.74 to 3.30)	(9.98)	(8.84)	(11.76)	(0.99 to 1.24)
(279) 11	(2.90 to 3.12)	(2.79 to 3.35)	(10.06)	(8.94)	(11.89)	(0.99 to 1.24)
(279) 11L & M	(2.29 to 2.51)	(2.79 to 3.35)	(10.06)	---	(11.89)	(0.84 to 1.02)
(286) 11.25	(2.54 to 2.74)	(3.42 to 4.04)	(12.12)	---	(9.14)	(0.91 to 1.07)
(289) 11.375	(2.90 to 3.12)	(2.90 to 3.48)	(10.44)	(9.25)	(12.29)	(0.99 to 1.24)
(298) 11.75	(2.54 to 2.74)	(3.58 to 4.19)	(12.57)	---	(9.55)	(0.91 to 1.07)
(305) 12	(2.97 to 3.24)	(3.05 to 3.66)	(10.97)	(9.75)	(12.98)	(0.99 to 1.27)
(311) 12.25	(2.97 to 3.23)	(3.12 to 3.73)	(11.20)	(9.96)	(13.23)	(0.99 to 1.27)
(314) 12.375	(2.54 to 2.74)	(3.76 to 4.37)	(12.95)	---	(9.55)	(0.91 to 1.07)

Table 1-14: PISTON, PISTON RING AND WEARBAND CLEARANCES FOR K&T CLASS AND 22-12 (572) E^a:ET:H CLASS CYLINDERS, (MILLIMETERS)

PISTON TO CYLINDER CLEARANCE		PISTON RING END GAPS - FILLED TEFLON ^b		WEAR BANDS NEW		
BORE (mm) INCHES	CLEARANCE	NEW	MAXIMUM	MINIMUM END GAP		RADIAL PROJECTION
				45°	70°	
(318) 12.5	(2.97 to 3.24)	(3.18 to 3.81)	(11.43)	(10.16)	(13.51)	(0.99 to 1.27)
(333) 13.125	(3.20 to 3.48)	(3.33 to 4.01)	(12.04)	(10.67)	(14.17)	(1.09 to 1.35)
(346) 13.625	(3.20 to 3.48)	(3.45 to 4.17)	(12.45)	(11.07)	(14.73)	(1.09 to 1.35)
(359) 14.125	(3.20 to 3.48)	(3.58 to 4.32)	(12.90)	(11.48)	(15.27)	(1.09 to 1.35)
(362) 14.25	(3.20 to 3.48)	(4.34 to 4.95)	(14.86)	(11.58)	(15.39)	(1.07 to 1.32)
(375) 14.75	(3.20 to 3.48)	(4.50 to 5.11)	(15.32)	(11.99)	(15.93)	(1.07 to 1.32)
(391) 15.375	(3.23 to 3.50)	(3.91 to 4.70)	(14.10)	(12.50)	(16.61)	(0.97 to 1.27)
(403) 15.875	(3.23 to 3.50)	(4.04 to 4.85)	(14.55)	(12.90)	(17.15)	(0.97 to 1.27)
(441) 17.375	(4.55 to 4.85)	(4.42 to 5.31)	(15.93)	(14.12)	(18.80)	(1.12 to 1.45)
(454) 17.875	(4.60 to 4.90)	(4.55 to 5.46)	(16.38)	(14.53)	(19.33)	(1.12 to 1.45)
(498) 19.625	(4.75 to 5.05)	(5.99 to 6.81)	(20.42)	(15.95)	(21.21)	(1.27 to 1.60)
(511) 20.125	(4.70 to 5.00)	(6.15 to 6.96)	(20.88)	(16.36)	(21.77)	(1.27 to 1.60)
(559) 22	(5.41 to 5.72)	(6.71 to 7.72)	(23.16)	(17.88)	(23.77)	(1.50 to 1.83)
(572) 22.5	(3.86 to 4.17)	(6.86 to 7.87)	(23.62)	(18.64)	(24.79)	(1.50 to 1.83)
(613) 24.125	(5.44 to 5.74)	(7.36 to 8.38)	(25.15)	(19.61)	(26.09)	(1.42 to 1.75)
(673) 26.5	(5.74 to 6.05)	(8.13 to 9.14)	(27.43)	(21.54)	(28.65)	(1.47 to 1.80)

a. E & H Class Cylinders are out-of-production; existing E & H cylinders may be used if application requirements are met. Consult your packager and/or Ariel when re-applying cylinders. See "Compressor Re-Application" on page 3-10.

b. For PEEK piston ring end gap values, multiply the table values by 0.3.

Fastener Tightening Torque

Listed in the following tables are fastener tightening torque values, required for proper assembly of an Ariel JGE/JGH/JGK/JGT compressor. Refer to the section concerning a subject component for detailed assembly procedures.

Threads are to be clean and free of burrs.

Torque values are based on the use of petroleum type lubricants on both the threads and seating surfaces. Use lubricating oil or Lubriplate 630, except for compressor rods, both piston and crosshead threaded ends, and stainless steel fasteners which use "Never-Seez", Regular Grade (by Bostik, Boston St., Middleton, MA 01949, phone: 508-777-0100). Molybdenum disulfide lubricants and "Never-Seez" are not otherwise to be used for fastener lubrication, unless specified, or excessive stresses can result with the listed values.

For latest available torque values, see ER-63 at www.arielcorp.com.

TABLE 1-15: FASTENER TIGHTENING VALUES

FASTENER	NOMINAL SIZE INCH - TPI	TYPE	TORQUE, LB X FT (N·m)
Main Bearing Cap - Cap Screw	7/8 - 9	12 Point - Gr. 8	280 (380)
Connecting Rod Cap - Cap Screw ^a	7/8 - 14	12 Point - Gr. 8	80 (108) + 90°
	1 - 14		90 (122) + 90°
Torsional Vibration Detuner Donut - Cap Screw	1 - 14	12 Point - Gr. 8	530 (715)
Nut Plate to Crankshaft Flange - JGE:K:T/6	1/2 - 20	12 Point - Gr. 8	46 (62)
Crosshead Pin Through Cap Screw - Lock Nut	1/2 - 20	Hex - Prevailing	61 (83)
Spacer Bar - Cap Screw	1-1/8 - 12	12 Point - Gr. 8	560 (760)
Crosshead Guide to Frame - Cap Screw	7/8 - 9	12 Point - Gr. 8	280 (380)
Crosshead Guide to Cylinder - Cap Screw	5/8 - 11	12 Point - Gr. 8	97 (132)
	7/8 - 9		280 (380)
	7/8 - 14	Hex Stud - Nut	315 (425)
Crosshead Guide to Support - Cap Screw	7/8 - 9	Hex - Gr. 8 or 9	255 (346)
	1 - 8		380 (515)
Head End Cylinder Support to Cylinder	1/2 - 13	Hex - Gr. 8	44 (60)
	5/8 - 11		88 (120)
	3/4 - 10		160 (215)
	7/8 - 9		255 (345)
Eccentric Vernier Cap - Cap Screw	5/16 - 18	Hex - Gr. 8	Hand Wrench Tight
Idler Sprocket Through Cap Screw - Lock Nut	1/2 - 20	Hex - Prevailing	41 (55)
External Thrust Bearing Adapter to Crankshaft - Cap Screw	1/2 - 20	12 Point - Gr. 8	66 (90)
Rod Packing - Cap Screw	3/4 - 10	12 Point - Gr. 8 or 17-4PH	125 (170)
	3/4 - 16		145 (195)
	7/8 - 14		230 (310)
Rod Catcher to Packing	1/2 - 20	12Pt-Gr8/17-4PH	51 (69)
Piston Nut	1-5/8 - 12	Ariel Design	1590 (2155) ^b
Crosshead-Balance Nut	1-3/4 - 12	Ariel Design	1500 (2030) ^c

TABLE 1-15: FASTENER TIGHTENING VALUES

FASTENER	NOMINAL SIZE INCH - TPI	TYPE	TORQUE, LB X FT (N·m)
Roller Thrust Bearing Retainer Clamp Cap Screw	3/4 -16	Ariel Design	160 (220)
Rupture Disk - Blow-Out Fitting Cap	1/4 Nom. Tube	Hex - Tube Fitting	40 lb x in. (4.5)
Flywheel to Hub	1 - 8	Hex - Gr. 9	460 (620)
	1 - 14	Hex - Gr. 9	530 (715)
Piston Rod Oil Slinger Lock Nut	1/4-28	Hex - Jam	95 lb x in. (11)
Cylinder Mounting Flange to Forged Steel Cylinder	1-14	12 Point - Gr. 8 or 17-4PH	485 (655)
	1-1/4-12		955 (1290)
Hold Down - Stud Nut	1-1/8 - 7	Hex Stud - Nut	600 ^d (805)
Main Drive Coupling - Adapter to Crankshaft Flange	1 - 14	12 Point - Gr. 8	440 (600)
Lifting Bracket to Frame JGE:K:T/6	1 -1/4 - 7	12 Point - Gr. 8	690 (938)
Fenner Drive Ariel P/N A-7352	---	Hex	100 (135)
Valve Cap/Cylinder Head/Unloader/ VVCP/Gas Passage Cap/Ariel Sup- plied Companion Flange to Cylinder - Cap Screw ^e , Except "Peanut" Dual Nozzle Companion Flanges	1/2 - 13	Hex - Gr. 8 or 9 or 12 Point - Gr. 8 or 17-4PH	40 (54)
	5/8 -11		79 (105)
	3/4 - 10		140 (190)
	3/4 - 16		160 (215)
	7/8 - 9		230 (310)
	7/8 -14		260 (355)
	1 - 8		345 (470)
	1 - 14		395 (535)
	1-1/8 - 12		560 (760)
"Peanut" Dual Nozzle Companion Flanges	1/2-13	12 Point - Gr. 8 or 17-4PH	53 (71)
Tandem Cylinder to Cylinder - Cap Screw ^e	1/2 - 13	Hex - Gr. 8/9 or	44 (60)
	5/8 - 11		88 (120)
	3/4 - 10	12 Point - Gr. 8 or 17-4PH	160 (215)
	3/4 - 16		180 (245)

TABLE 1-15: FASTENER TIGHTENING VALUES

FASTENER	NOMINAL SIZE INCH - TPI	TYPE	TORQUE, LB X FT (N·m)
Seating Studs in Cylinder	1/2 - 13	Dog Point	22 (30)
	5/8 - 11		44 (60)
	3/4 - 10		79 (105)
	3/4 - 16		90 (120)
	7/8 - 9		130 (170)
	7/8 - 14		145 (195)
	1 - 8		190 (260)
	1 - 14		220 (300)
	1-1/8 - 12		310 (420)
Distribution Block Tie Rod - Nut	1/4 - 28	Hex	68 lb x in. (7.7)
Distribution Block Divider Valve - Cap Screw	1/4 - 28	Socket Head	75 lb x in. (8.5)
Grade 5 - Hex Cap Screw	ALL	Hex - Gr. 5	Hand Wrench Tight

- See page 5-6 for complete instructions.
- Or use 3500 psig (241 bar_g) hydraulic pressure and 50 lb-ft (68 N-m) tightening torque on separately purchased piston nut torquing tool G-12643. **Tighten, loosen and re-tighten piston nut to be sure of proper tightening.** See "Piston and Rod - Reassembly" on Page 5-36.
- Or use 3500 psig (241 bar_g) hydraulic pressure on separately purchased crosshead (balance) nut torquing tool G-7583.
- Minimum torque for recommended 1-1/8"-7TPI hold down stud size to provide stress in stud of 55,000 psi (380 MPa). Stud must have an ultimate strength of 100,000 psi (690 MPa) or greater. If greater, increase torque to stress the stud to about 55% of the ultimate strength of the stud material, as specified by packager.
- When studs and nuts are specified for cylinder applications, tighten the nuts to the same values as cap screws in similar applications. Reference Figure 1-11:

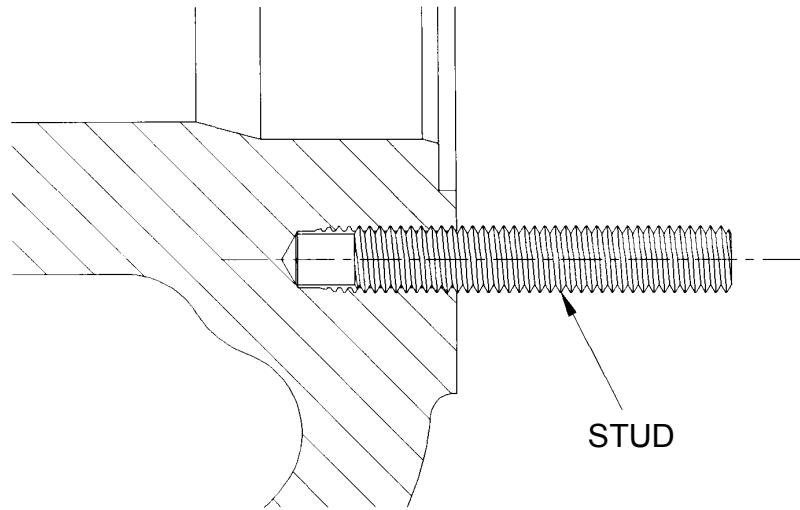


FIGURE 1-11: DOG POINT STUDS

TABLE 1-16: HOERBIGER VALVE ASSEMBLY FASTENERS - TIGHTENING VALUES

FASTENER	NOMINAL SIZE INCH - TPI	TYPE	TORQUE, LB X FT (N·m)
Center Cap Screw ^{a b}	5/16 - 24	12 Point - Steel Grade 5, Material Parts: SPL3 & 4	144 lb x in. (16)
	3/8 - 24		21 (28)
	7/16 - 20		30 (41)
	5/16 - 24	12 Point - Steel Grade 5, Material Parts: SPL5	18 (24)
	3/8 - 24		32 (43)
	7/16 - 20		50 (68)
	5/16 - 24	12 Point - Stainless Steel Grade B8M, Material Parts: SPL6	120 lb x in. (14)
	3/8 - 24		192 lb x in. (22)
	7/16 - 20		24 (33)
	5/16 - 24	12 Point - Steel Grade 8	26 (35)
	3/8 - 24		45 (61)
	7/16 - 20		62 (83)
Center Stud - Drake Lock Nut	1/4 - 28	Bottom Half	103 lb x in. (12)
		Top Half	66 lb x in. (8)
	5/16 - 24	Bottom Half	120 lb x in. (14)
		Top Half	66 lb x in. (8)
	3/8 - 24	Bottom Half	192 lb x in. (22)
		Top Half	96 lb x in. (11)
	1/2 - 20	Bottom Half	36 ^c (49)
		Top Half	20 (27)
	5/8 - 18	Bottom Half	73 (99)
		Top Half	40 (54)
	3/4 - 16	Bottom Half	130 (176)
		Top Half	70 (95)
Peripheral Cap Screws	10 - 32	Hex Socket Head	25 lb x in. (3)
	12-28		43 lb x in. (5)
	1/4		110 lb x in. (12)
	5/16		176 lb x in. (20)
	3/8		21 (28)

- a. 12 Point Cap Screw Center Fasteners in Valve Assemblies not marked SPL (Spirallock Threads), must be cleaned with Loctite Safety Solvent and locked with one or two drops of Loctite #272 thread locking compound. Do not use petroleum lubricants.
- b. 12 Point Cap Screws in Valve Assemblies with Spirallock Threads and marked SPL (see Figure 1-12:) are lubricated, both threads and seating surfaces, with a petroleum type lubricant only.

- c. 29 lb x ft (39 N·m) for 1/2 - 20 Bottom Half - Drake Lock Nut with non-metallic Plates in Liftwasher Type Valves.

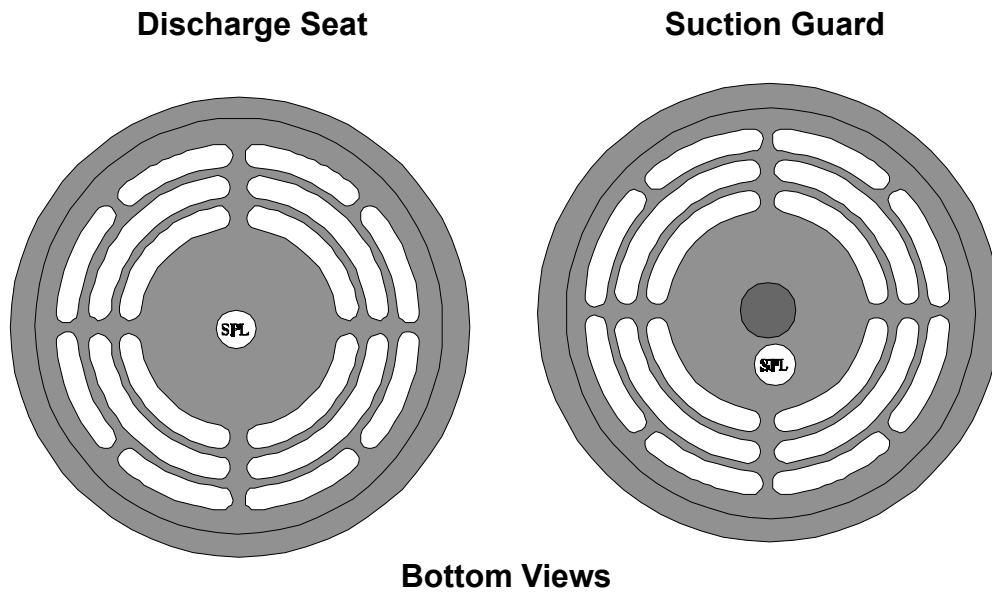


FIGURE 1-12: SPIRALOCK THREADED VALVE ASSEMBLY - MARKED “SPL”

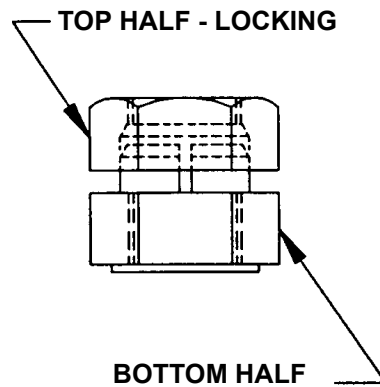


FIGURE 1-13: DRAKE LOCK NUT

Tightening Torque Procedures

Listed below are some procedures which make fastener tightening more accurate and will help to be sure that the proper torque is being applied.

1. Be sure that the torque wrench is properly calibrated and used by qualified personnel to achieve the required fastener tightening torque for all critical parts. The exception is the crosshead balance/lock nut which may be tightened using the “tried and true” slugging procedure.
2. Always check to determine over what range the torque wrench is accurate, since

- most torque wrenches are not accurate over their entire range.
3. Tighten all multi-bolt assemblies in steps (need not apply to Grade 5 cap screws). Tighten each cap screw until snug using an alternating (criss-cross) pattern. Next, tighten each cap screw to 25% of full torque, moving across from cap screw to cap screw, in an alternating (criss-cross) pattern. Repeat this step for 50%, 75%, and 100% of full torque.
 4. Always apply a steady slow force to a torque wrench, and stop force immediately when click is felt, do not jerk it. When a torque wrench is jerked the amount of torque applied can be as much as one and a half times the amount set on the wrench. For example, if a wrench is set at 80 lb x ft (108 N·m) but is jerked, 120 lb x ft (163 N·m) torque can be applied.
 5. Always do the final tightening with a torque wrench. Do not tighten the fastener with a ratchet or impact wrench and then "check" the torque with a torque wrench.
 6. Do not double tap a torque wrench. Rapidly double tapping a torque wrench will make the torque on the cap screw more than what is set by a significant amount.
 7. When checking a tightened fastener torque, set torque wrench to proper required torque value, slowly apply a steady force to torque wrench until click is felt.
 8. Always reset the torque wrench to its lowest setting when the job is complete. If the torque wrench is left in a high setting the spring in it is stressed and will become inaccurate with time. If the torque wrench is put back to its lowest setting the spring will relax and retain its accuracy.
 9. Do not use a torque wrench to break fasteners loose as it may overload the torque wrench and/or cause loss of calibration.
 10. For applications requiring the use of a boxed end or crowsfoot adapter with a torque wrench to reach not readily accessible fasteners, the torque wrench setting will not be the actual torque applied to the fastener.¹
 11. The ratio of actual torque at the fastener with that on the wrench scale is a function of the adapter's length (A) and its position in relation to the torque wrench beam and the location where the force is applied (see Figure 1-14:).

$$T_w = T_a \left(\frac{L}{L + A} \right)$$

T_w = Torque wrench setting, lb x ft or N·m

T_a = Torque required at fastener, lb x ft or N·m

L = Length of wrench, ft or m (from square drive end to center point of force on handle)

A = Length of adapter, ft or m (measured through end of adapter on a line parallel to the center line of the wrench)

These are general guidelines to assist in the proper use of torque wrenches. Consult with your torque wrench dealer for more detailed information.

1. The exception is when the adapter is 90° to the torque wrench. The torque will be the same as on the wrench scale (see Figure 1-15:).

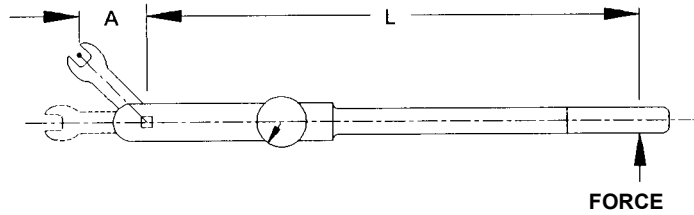


FIGURE 1-14: TORQUE WRENCH WITH ADAPTER AT ANY ANGLE

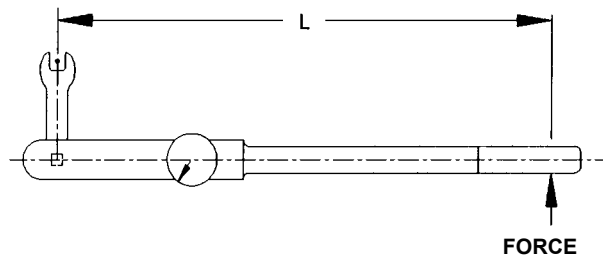
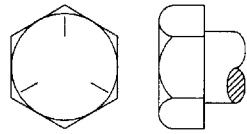


FIGURE 1-15: TORQUE WRENCH WITH ADAPTER AT RIGHT ANGLE

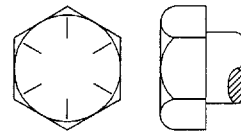
Ariel Bolting

The bolting has been selected that meet Ariel's strength, elongation, sealing and locking requirements. Proper bolting must be used and tightened to the values listed in Table 1-15 on page 25. Figure 1-16: is provided to assist in the identification of cap screws used in an Ariel compressor.

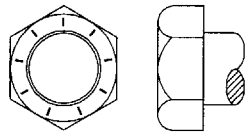
Connecting rod, detuner donuts, valve cap and suction/discharge nozzle (Ariel supplied specialized companion flange) bolting is modified to prevent fatigue and cannot be replaced with standard cap screws. If attempting to replace other bolting with standard cap screws and there is any question, contact your packager or Ariel. Ariel supplied replacement bolting is recommended.



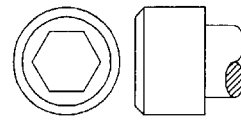
Hex head Grade 5



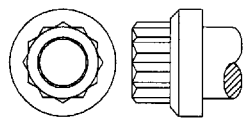
Hex head Grade 8



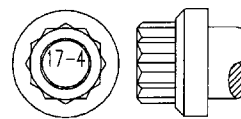
Hex head Grade 9



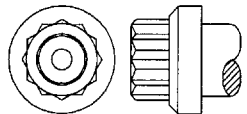
Hex Socket Head Grade 8



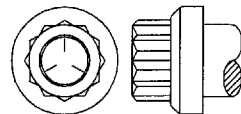
12 Point Grade 8



12 Point Stainless Steel
Grade 17-4PH



12 Point Interim Grade 5



12 Point Grade 5

CAUTION: WHEN RE-ASSEMBLING OR REPLACING BOLTING, SEE THE PARTS LIST TO DETERMINE THE PROPER FASTENER GRADE AND PART NUMBER. DO NOT USE A LESSER OR GREATER MATERIAL GRADE. ALL SPECIAL FASTENERS, AND ALL BOLTING THAT HAS BEEN MACHINED TO REDUCE THE BODY DIAMETER, FOR FATIGUE RESISTANCE, MUST BE REPLACED WITH ARIEL PARTS.

FIGURE 1-16: CAP SCREW IDENTIFICATION

Optional Main Bearing Temperature Instrumentation - Alarm & Shutdown

Main bearing temperature sensors can be ordered as an option from Ariel for JGK and JGT frames, as thermocouples or RTD's:

Thermocouples, Type J (Iron-Constantan) or K (Chromel-Alumel)

A thermocouple is two dissimilar conductors joined together at one end to form a sensor that produces a small self-generated thermoelectric voltage as an accurate function of temperature. When connected to the proper electronics, the thermocouple voltage is interpreted as temperature.

Wire: Must use proper thermocouple wire from sensor to control panel with each lead wire metal matching each conductor metal of sensor.

Sensor Accuracy = 4°F (2.2°C) or 0.75%.

Terminals: Must use proper terminals with metal matching each thermocouple sensor conductor/wire lead metal.

Resistance Temperature Devices (RTD's)

An RTD is a resistor type sensor, in which the electrical resistance accurately varies with temperature change. When connected to the proper electronics, the resistance is interpreted as temperature. When RTD's are ordered for the main bearings, Ariel supplies dual-element RTD instrument assemblies, consisting of two RTD's in each instrument for each main bearing. Each element is a three-wire, 100 ohms (at 0°C), Alpha = 0.00385 ohms/ohm/°C, platinum thin film type sensor.

Wire: Use standard 24 AWG (American Wire Gage) instrumentation wire from the junction box mounted on the side of the compressor frame to the sensor wiring. An RTD three-wire set may be wired using a 2, 3 or 4 wire lead system. More wires increases system accuracy. Ariel recommends using standard foil shielded instrumentation cable runs from the compressor frame to control panel. Shields should be grounded in the control panel.

Sensor Accuracy: 100 ± 0.12 ohms at 0°C = 1.1°F (0.6°C) or 0.6%.

Terminals: Can use any standard terminals.

For each instrument, one RTD three-wire set is used to connect to the monitoring circuit. Unused wire ends should be insulated from each other and conduit ground. Dual element RTDs are provided to allow for rewiring instead of replacing the instrument in the event of an element failure.

RTD's are furnished with two red wires and one white wire for the one element, and two black wires and one green wire for the other element to simplify the wiring requirements. The advantage of the dual-element RTD assembly is that the redundancy saves time by allowing the operator an opportunity to restore bearing temperature monitoring without entering the crankcase for each RTD failure. The wiring diagram and color codes are shown in Figure 1-17: on Page 1-35.

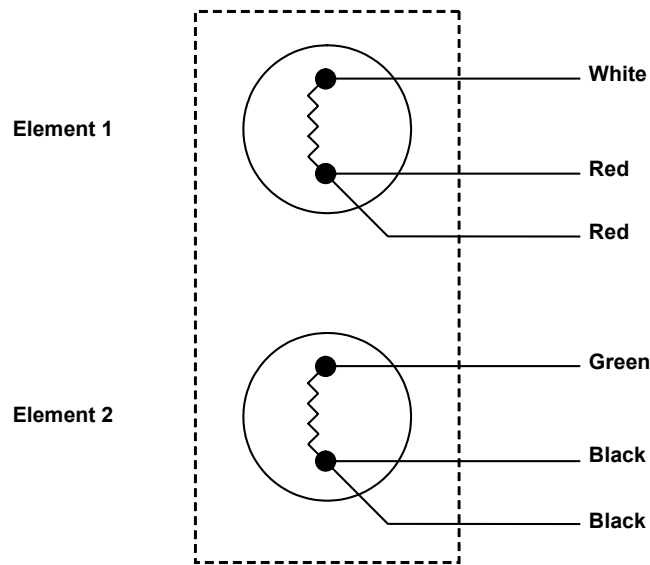


FIGURE 1-17: DUAL ELEMENT RTD WIRING DIAGRAM

Alarm and Shutdown Limits

One of the following, as a minimum, is to be provided when applying main bearing temperature alarm and shutdown to Ariel compressors:

1. **Main bearing temperature high alarm and shutdown.** - The alarm and shutdown should be set as close as practical above the normal operating temperature. Ariel recommends 20°F (12°C) over normal operating temperature for alarm and 30°F (18°C) for shutdown. Maximum values of 220°F (104°C) for alarm and 230°F (110°C) for shutdown apply. Normal operating temperature is the average of all main bearing temperatures at design load when oil temperature stabilizes and all components are heat soaked.

And/or

2. **High main bearing temperature differential alarm and shutdown.** - Main bearing differential temperature is defined as the difference between the maximum and minimum of all main bearing temperatures. Ariel recommends the alarm set to 20°F (12°C) and shutdown at 30°F (18°C). It is possible after a warm shutdown that main bearing number 1 will cool faster than the others. Provisions should be made such that a cooler number 1 bearing will not prevent a restart.

Zone 1 Environment

A Zone 1 environment requires the installation of proper intrinsically safe or equivalent protection to fulfill the electrical requirements, where applicable.

NOTES

SECTION 2 - INSTALLATION

General

The installation of the compressor with the associated driver and piping, is to be done with care and precision. This section does not attempt to address all of the concerns that can arise during installation. This section addresses some of the more critical installation considerations and requirements.

Electrical Grounding

CAUTION! THE COMPRESSOR SKID MUST BE GROUNDED TO A SUITABLE EARTH GROUND.

Procedure For Setting and Aligning

The following points deserve special attention during the setting and alignment of the compressor:

1. The skid design should:
 - Transmit compressor and driver reaction forces to the foundation.
 - Provide sufficient mismatch between the shaking forces and the natural frequency of the skid.
 - Have sufficient stiffness and strength so that the compressor can be mounted flat with no bending or twisting of the compressor frame, crosshead guides or cylinders. This can be accomplished by shims or careful grouting.
 - Have enough stiffness and mass to resist vibration induced by the unbalanced couples as specified in the **Ariel Application Manual (Packager's Standards)**.
2. The feet on the crosshead guides must be supported in a fashion that not only provides vertical support, but also prevents horizontal movement perpendicular to the piston rod.
3. Each crosshead guide will deflect an amount relative to the weight of the cylinder mounted on that throw. This deflection value is available in the **Electronic Databook in the Ariel Performance Program**. Shims equaling the deflection value as listed on the cylinder outline drawing are to be added to the shim pack under the crosshead guide, elevating the crosshead guide to a level position. The crosshead guide supports must be capable of carrying the combined weight of the cylinders, bottles and piping.
4. Reference Section 4 for protection of the Proflo when arc welding.

Lifting the Compressor

Determine the weight of the compressor, prior to lifting. For the approximate weight of the compressor with cylinders see Section 1, Frame Specifications tables, or to calculate a more accurate value see the Ariel Electronic Data Book with the Ariel Performance Program for frame and cylinder weights; also account for any extra weight such as a flywheel, etc. Spreader bars should be used to provide for a more vertical pull on the eyebolts or lifting lugs. Be sure that the eyebolts or lifting lugs, lifting tackle, spreader bars and crane capacity are adequate and properly rigged for the load. Keep compressor level when lifting and setting. Heavier cylinders and/or blank throws can significantly affect the center of gravity.

Do not attempt lifting by hooking to a compressor when the compressor is attached to the skid, driver or piping. If you are not experienced in lifting large compressors, the use of qualified professional riggers/movers is recommended.

On 6-throw frames designed for lifting lugs, install the lugs (4) with Grade 8 cap screws and tighten to the torque value given in Section 1 or to the tool box torque chart, when lifting the compressor. Only use Ariel supplied lugs. If lugs are already installed, recheck bolt torque. When lifting a compressor not provided with lifting lugs, lift by the eyebolts installed by Ariel at the crosshead guides. Eyebolts installed in crosshead guides by the Ariel Shop are locked with thread locking compound to help prevent them from turning.

Inspect eyebolts to be sure they are free of any visual defects that could affect serviceability. Remove and physically destroy all defective eyebolts and replace them with new. Eyebolts are to be forged steel and meet the requirements of ANSI/ASTM B18.15 latest edition. For eyebolt load capacity rating and if pulling on an eyebolt in a direction other than along the threaded axis, consult ANSI/ASME B18.15.

Setting

The following procedure is to be used for setting the compressor on the skid:

1. Move the compressor into place onto the skid. With the compressor cylinders mounted but unsupported and with no piping or pulsation damping bottles attached, tighten the frame hold down bolting to skid at full fastener torque.
2. Proper compressor to skid hold down bolting torque values are to be determined by the packager based on the bolt sizes and the bolt material strength used. The packager should see Ariel Corporation reference document ER-26 to determine proper hold down bolting torque values.
3. With the top cover(s) and gasket(s) removed, the top-cover-mounting surface of the frame should lie flat between two parallel planes separated by no more than than the value given in Table 2-1 on page 2-3 to be sure that the main bearing bores are sufficiently aligned (with compressor hold-down bolting properly tightened in place). If flatness is not within the limit, shim under the compressor feet to correct.

TABLE 2-1: COMPRESSOR FRAME FLATNESS TOLERANCE FOR MAIN BEARING BORE ALIGNMENT

COMPRESSOR FRAME	TOP-COVER-MOUNTING SURFACE FLATNESS TOLERANCE FOR ALIGNMENT	
	INCHES	mm
JGE:H:K:T/2/4	0.006	0.15
JGE:H:K:T/6	0.008	0.20

4. Or for JGE:H:K:T/2 and /4 throw compressors, soft foot check may be used to be sure that main bearing bores are in alignment. Loosen each hold down bolt individually while checking the frame foot to skid deflection with a dial indicator. Correct any hold down position that deflects more than 0.002 inches (0.05 mm) when released. Re-torque the hold down bolt and repeat at each frame to skid bolt.
5. With crosshead guides and cylinders unsupported, measure the clearance at a crosshead guide foot to the skid support. Completely fill the clearance with shim stock. Tighten the crosshead guide foot to skid support hold-down bolting to full fastener torque. Loosen the bolting while checking with a dial indicator to be sure that the clearance is completely filled and there is no deflection. Using the latest **Electronic Databook in the Ariel Performance Program**, select compressor frame size, go to the cylinder list, select the cylinder size and go to the cylinder details. Then go to the estimated guide foot deflection, select the type of crosshead guide used, (note that the estimated cylinder weight may be modified if required) and use the program to determine the estimated guide foot deflection. This calculated value is required to compensate for the deflection droop of the cantilevered weight of the guide and cylinder. Lift or jack cylinder slightly to allow insertion of additional shims based on calculated value. Re-tighten the crosshead guide hold down bolting. Repeat for each crosshead guide support.

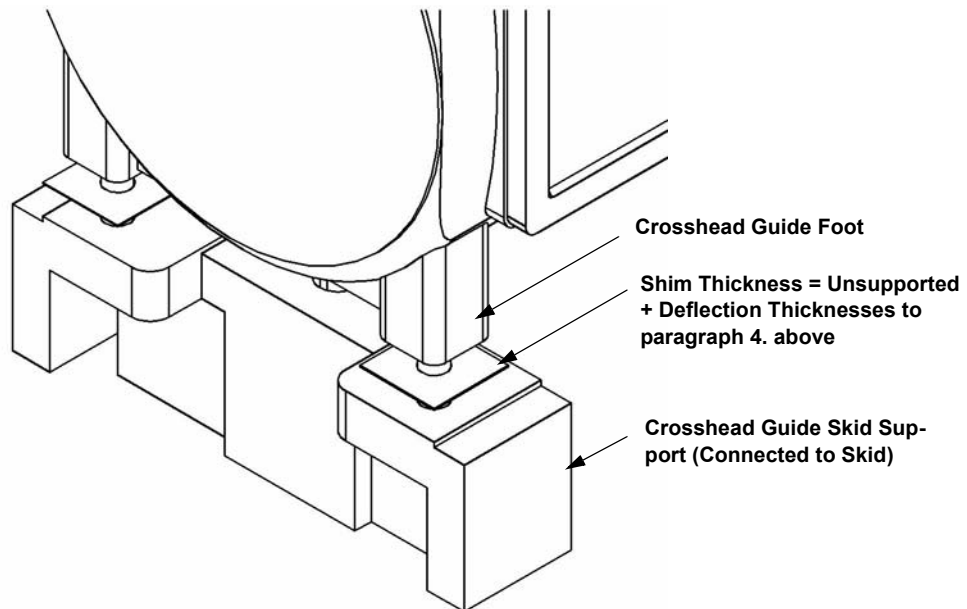


FIGURE 2-1: CROSSHEAD GUIDE FOOT TO SKID-SUPPORT SHIM - TYPICAL

Alignment

Proper alignment is necessary for satisfactory performance. Ariel requires alignment to be no greater than 0.005 inches (0.13 mm) TIR at the coupling face and rim, at normal operating temperatures. A flexible coupling will not make up for poor alignment. Misalignment can result in:

- High bending moment on the crankshaft
- Large axial forces
- Excessive bearing wear
- And if severe, probable damage to various components

An Ariel compressor may be aligned by any of a number of acceptable methods such as:

- Face/peripheral
- Reverse indicator
- Across the disc pack
- Optical
- Laser
- Mechanical direct to computer

When aligning a unit some procedural concerns are:

- Soft foot (compressor and driver are not laying flat)
- Repeatable readings
- Which way indicator moves (plus or minus)
- Thermal growth

- Indicator sag

When properly aligned the forces on the connected equipment will be at a minimum. This will result in long bearing life and a smooth running unit. Consult Packager's information for alignment procedure.

Pneumatically Actuated Unloaders & Clearance Devices

When compressor cylinders are equipped with pneumatically actuated unloaders or clearance devices, care must be taken to be sure that the actuating air or gas system is appropriately vented, and that the system incorporates provisions that will not allow the process gas to back flow into the actuating air or gas system.

The control media supply system and vent system for the un-loader must provide for the safe and effective operation of the unloader throughout the full range of compressor operating conditions. ACI, an Ariel supplier has published a document outlining system design and requirements. Please reference this document for system design and evaluation. The document may be found at vendor literature/ACI on the Ariel web site: www.arielcorp.com.

Vents and Drains

It is critical, for the safe operation of the compressor, to be sure that all vents and drains are open, functional and, if necessary, tubed off of the skid or out of the building to a safe atmosphere. The venting of gases and vapors, and the disposal of drained fluids should be environmentally safe. Depending upon your climate and insect population it can be necessary to install screens over the vents and drains to be sure that they do not become blocked. This can be essential if the compressor is shutdown for a long period of time.

Some other points are:

1. A blow-down vent must be provided to safely relieve pressure from the system for maintenance purposes. Any vent or blowdown line connected to a common vent or flare header must have a back-flow prevention check valve.
2. Adequate vents and drains will be provided for the distance piece, and primary packing vent. Primary vents and drains shall be independently vented from the secondary vents and drains. All vents and drains shall be installed in such a manner as to prevent the collection of liquids that could cause the build-up of either gas or liquid. When a heavier than air gas is involved, vent and drain design must be accommodating.
3. When the crankcase breather is mounted remotely, the piping must be configured so that there is no back pressure and condensation in the piping does not drain into the crankcase.

Distance Piece and Packing Illustrations:

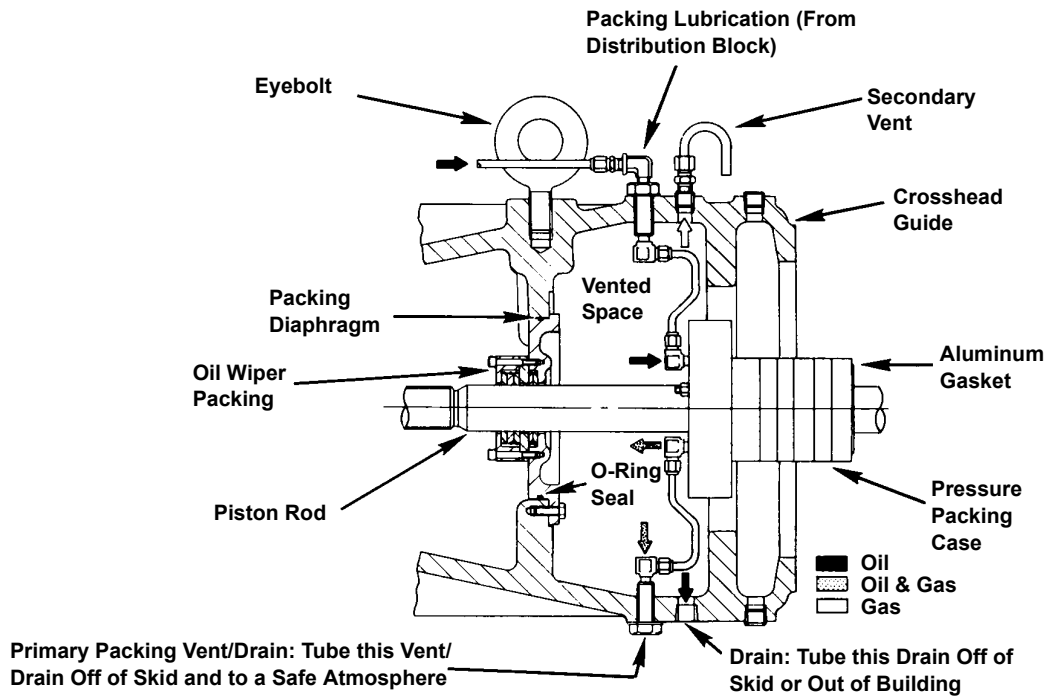


FIGURE 2-2: SINGLE COMPARTMENT DISTANCE PIECE - PACKING, TUBING & VENTING - TYPICAL

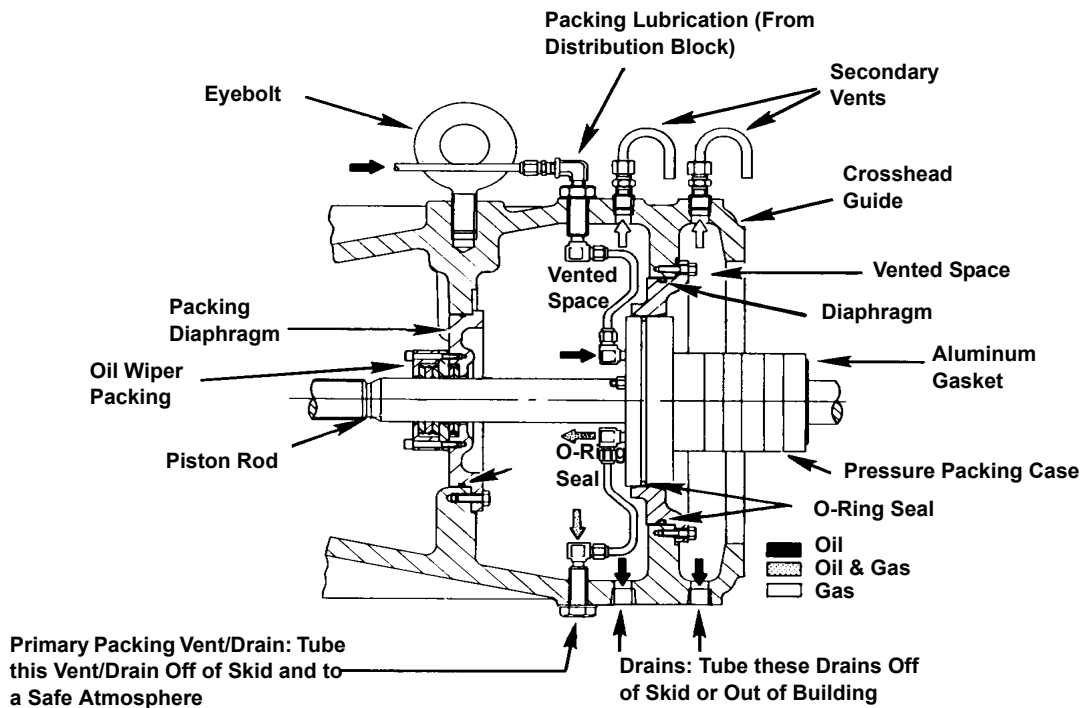


FIGURE 2-3: SHORT-TWO COMPARTMENT DISTANCE PIECE - PACKING, TUBING & VENTING - TYPICAL

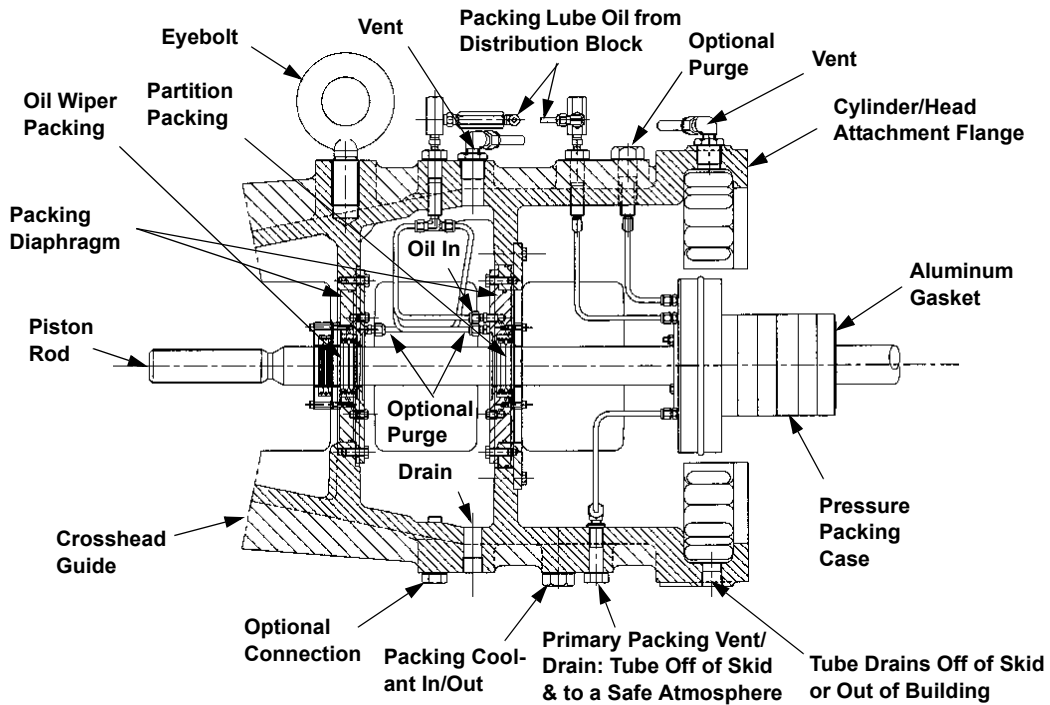


FIGURE 2-4: LONG-TWO COMPARTMENT DISTANCE PIECE - PACKING, TUBING & VENTING - TYPICAL

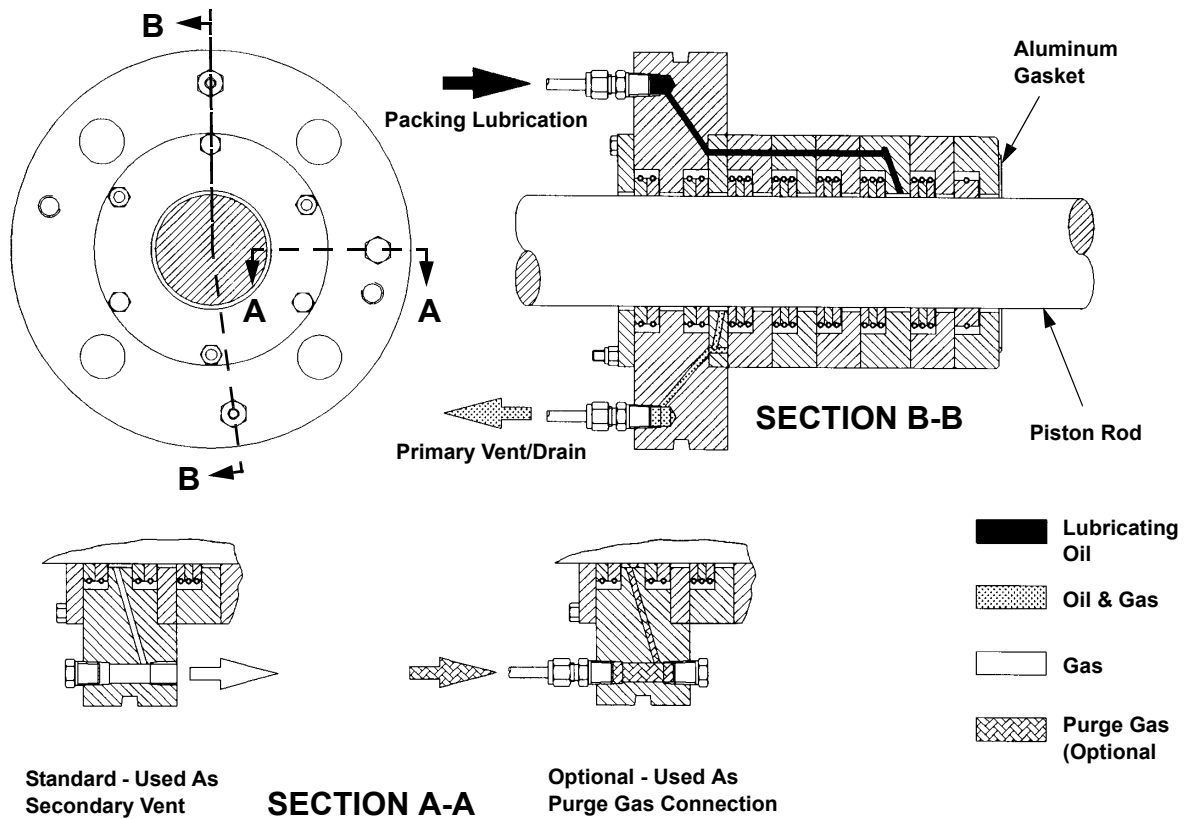


FIGURE 2-5: PACKING LUBRICATION AND VENTING - SINGLE & LONG TWO COMPARTMENT DISTANCE PIECE - TYPICAL

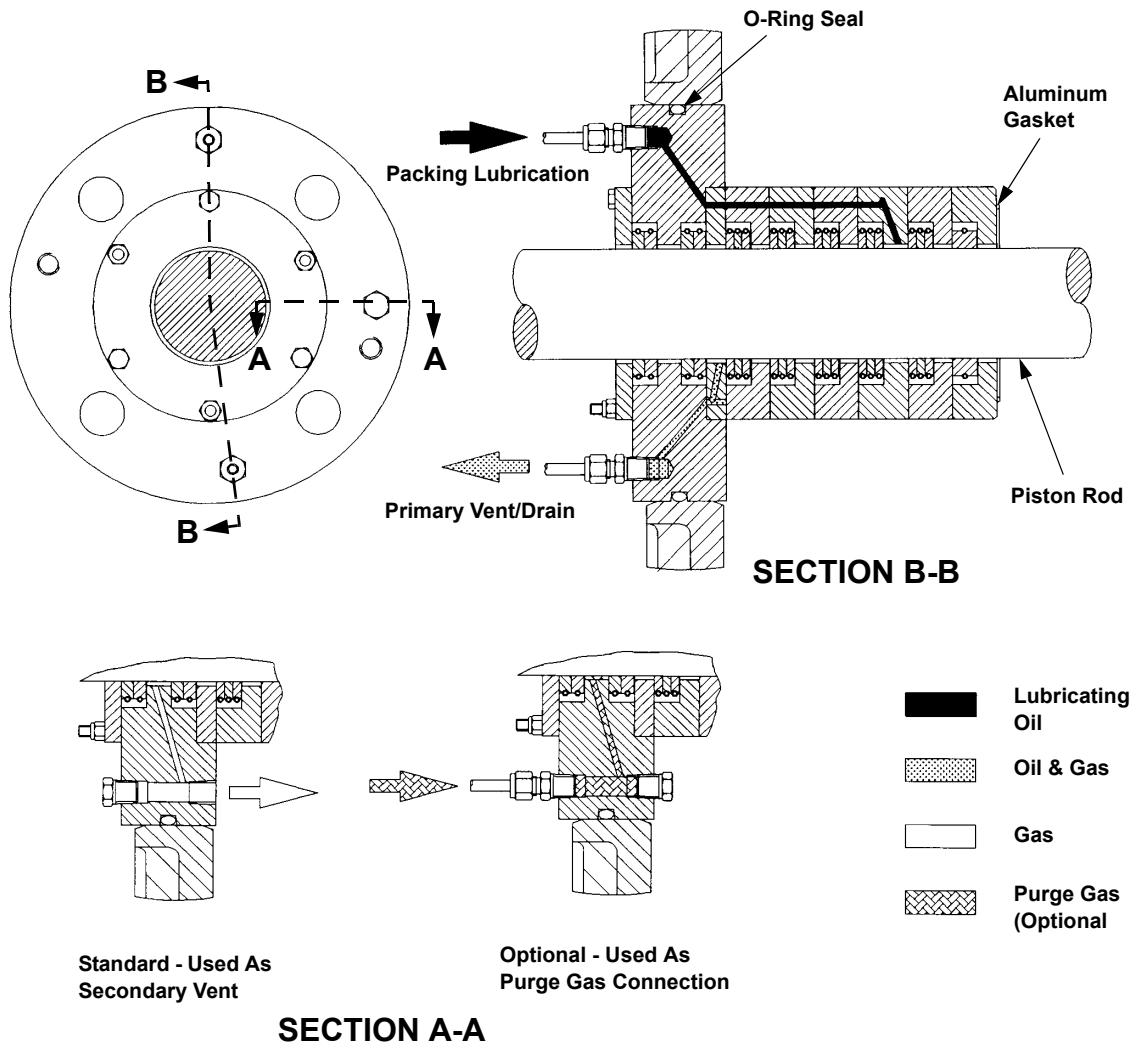


FIGURE 2-6: PACKING LUBRICATION AND VENTING - SHORT-TWO COMPARTMENT DISTANCE PIECE - TYPICAL

SECTION 3 - START UP

General

To be sure of proper start up, it is important to carefully follow the Start Up Check List provided in this section. It is also important that the operator be thoroughly familiar with this manual and with the Packager's Operating Manual.

CAUTION

BEFORE STARTING A NEW COMPRESSOR, OR AFTER RELOCATING OR RE-APPLYING A COMPRESSOR, OR AFTER MAJOR OVERHAUL, BE SURE TO COMPLETE AND CHECK OFF ALL THE ITEMS ON THE START UP CHECK LIST IN THIS SECTION. THIS LIST IS DESIGNED TO MAXIMIZE SAFETY IN STARTING AND OPERATING THE COMPRESSOR.

CAUTION

FOR SAFE OPERATION, DO NOT ATTEMPT TO START-UP THE UNIT WITHOUT BEING COMPLETELY KNOWLEDGEABLE OF THE INFORMATION CONTAINED IN THIS SECTION. IT IS ALSO ESSENTIAL TO REFER TO THE PACKAGER'S OPERATING MANUAL.

Start Up Check List

For latest available Start Up Check List, see ER-10.4.0 at www.arielcorp.com.

Compressor Model _____	Serial/No. F- _____
Cylinder S/N C-_____ C-_____ C-_____	C-_____ C-_____ C-_____
Driver _____	Rated Speed _____
Packager _____	Packager Unit No. _____
Date Packager Shipped _____	Start Up Date _____
Serviceman _____	Customer _____
Location _____	Field Contact _____
Field Telephone No. _____	Unit Location _____
Frame Oil - Make/Grade _____	_____
Cylinder Oil - Make/Grade _____	_____

Compressor Model _____	Serial/No. F- _____
-------------------------------	----------------------------

YES NO

Check List - Prior To Starting:

1. Are the correct Ariel parts book, technical manual, special tools, and spares available?	_____	_____
2. Have the design limitations for the compressor model such as rod load, maximum and minimum speed, discharge temperature been checked?	_____	_____
3. Have the design operating conditions been determined?	_____	_____
Pressure, psig (bar _g): Suction _____ Discharge _____		
Temperature, °F (°C): Suction _____ Discharge _____		
Maximum RPM _____ Minimum RPM _____		
4. Soft Foot Check: Have the compressor feet and crosshead guide supports been shimmed so the machine is not twisted or bent? More than 0.002 inches (0.05 mm) pull-down requires correction. Record compressor feet pull-down readings:	_____	_____
Drive-End	_____	_____
	_____	_____

Compressor Model _____ Serial/No. F- _____

YES NO

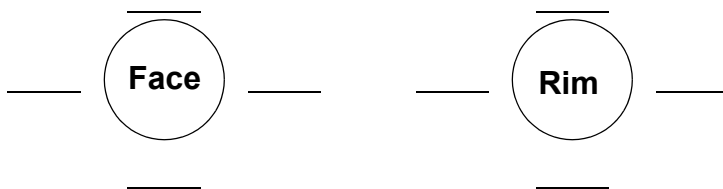
5. Have crosshead feeler gage clearances been checked with cylinders mounted? Top is checked by inserting 0.5 inch (12.7 mm) wide feelers from one side edge across to the opposite side, at both ends. See Technical Manual, Section 1, Clearances for limits. Bottom is checked with a 0.0015 inches (0.038 mm) feeler at the (4) corners. Feeler insertion is 0.50 inches (13 mm) maximum at each corner. Record feeler values below:

Throw Number	Record Crosshead to Guide Feeler Gage Clearances		
	Top minimum	Top maximum	Bottom max. Corner Insertion
1	_____	_____	_____
2	_____	_____	_____
3	_____	_____	_____
4	_____	_____	_____
5	_____	_____	_____
6	_____	_____	_____

6. Have the piping and supports been checked to be sure they do not bend or stress compressor? _____

7. Has the compressor to driver alignment been checked at site? Maximum allowable 0.005 inches (0.13 mm) TIR. _____

8. Have coupling dial indicator readings been taken? Record in inches (mm) at the 3, 6, 9 and 12 o'clock positions on lines provided below: _____



9. Has the compressor crankshaft thrust clearance been checked? See Technical Manual, Section 1, Clearances. Record compressor crankshaft thrust clearance here: _____ inches (mm)

10. Have piston end clearances been checked with feeler gages? See Technical Manual, Section 1, Clearances. Record below: _____

Throw No.	1	2	3	4	5	6
Head End	_____	_____	_____	_____	_____	_____
Crank End	_____	_____	_____	_____	_____	_____

Compressor Model _____ Serial/No. F- _____

					YES	NO
11. Has piston rod runout been checked? See Technical Manual, Section 5 for maximum acceptable readings. Record Below:					_____	_____
Throw No.	1	2	3	4	5	6
	Vertical:					
Piston @ CE	_____	_____	_____	_____	_____	_____
Mid-Stroke	_____	_____	_____	_____	_____	_____
Piston @ HE	_____	_____	_____	_____	_____	_____
	Horizontal:					
Piston @ CE	_____	_____	_____	_____	_____	_____
Mid-Stroke	_____	_____	_____	_____	_____	_____
Piston @ HE	_____	_____	_____	_____	_____	_____
12. Has the compressor crankcase been filled with oil to the proper level? Approximately 7/8 full in site glass, prior to starting.					_____	_____
13. Has proper oil been installed if extreme ambient conditions exist or special gases are compressed?					_____	_____
14. Is the compressor crankcase oil level control working and set at the proper level and properly vented?					_____	_____
15. Is the crankcase oil supply isolation valve open?					_____	_____
16. Does the crankcase low level shutdown work?					_____	_____
17. Has the recommended oil filter element been installed?					_____	_____
18. Are the oil filter element and all lube oil piping primed with oil?					_____	_____
19. Is the low oil pressure shutdown installed and tubed correctly to the downstream side of the oil filter?					_____	_____
20. Does the low oil pressure shutdown work?					_____	_____
21. Oil cooler? Compressor inlet oil temp. is 190°F (88°C) maximum.					_____	_____
22. Is the crankcase oil temperature shutdown installed, set and working?					_____	_____
23. If oil is cooled, is there a temperature control valve?					_____	_____
24. Is the crankcase breather element clean?					_____	_____
25. Is the force feed lubricator box filled with oil?					_____	_____
26. Is the force feed lubrication system primed?					_____	_____
27. Is the force feed lubrication system no flow shutdown installed and working?					_____	_____

Compressor Model _____ Serial/No. F- _____

	YES	NO
28. Is the force feed blow out assembly installed? Check rupture disc for color? See Lubrication section of the Technical Manual for disc color vs. rating table.	_____	_____
29. Has the lubricator instruction plate or "Parts Book" Cylinder Lubrication Sheet been checked for proper lube feed rate?	_____	_____
30. Is there a working vibration shutdown mounted on the compressor and adjusted properly?	_____	_____
31. Are the primary and secondary packing-case, and the cross-head-distance-piece vents and drains open, and when necessary, tubed off of the skid or out of the building?	_____	_____
32. Is there some method of suction pressure control?	_____	_____
33. Are the suction pressure, inter-stage pressure and discharge pressure shutdowns set and working?	_____	_____
34. Are the safety relief valves installed and working to protect cylinders and piping for each stage of compression?	_____	_____
35. Are the gas discharge temperature shutdowns installed, set and working?	_____	_____
36. Have the gas suction lines been blown out to remove water, slag, dirt, etc.?	_____	_____
37. Have temporary screens been installed at cylinder suction?	_____	_____
38. Has compressor been prelubed prior to starting? If motor driven, unattended or large frame models prelube at 10 psig (0.7 bar _g) & 30 seconds minimum?	_____	_____
39. For engine driven units, has the machine been rolled with the starter to make sure it is free? The oil pressure should come up noticeably while rolling on the starter.	_____	_____
40. For other drivers, has the machine been barred over by hand to ensure it is rolling free?	_____	_____
41. Does the driver rotation match the compressor rotation arrow?	_____	_____
42. Have torque values been checked on all critical fasteners where loosening could result in a safety hazard or equipment failure, and including: gas nozzle flange, valve cap, cylinder head, compressor rod packing, hold down, crosshead guide support and coupling bolting?	_____	_____
43. For machines compressing a combustible gas, have the piping and compressor been purged to remove all air?	_____	_____
44. Have start-up instructions for other package equipment been followed?	_____	_____

Compressor Model _____ **Serial/No. F-** _____

YES **NO**

45. Is the compressor skid properly grounded to a suitable earth ground? _____

46. Has the Packager's representative done the required review of the Packager's Start-Up and Operating Instructions for the unit with the unit operator? _____

Check List - After Starting:

1. Did the oil pressure come up immediately? _____

2. Are the oil filter pressure gauges working? _____

3. Is oil filter differential pressure less than filter change value? Reference value listed on filter information plate on compressor top cover. _____

4. Any strange noises or shaking in the compressor or piping? _____

5. Is low oil pressure shutdown set at 35 psig (2.4 bar_g)? _____

6. Is oil pressure set at 50 to 60 psig (3.5 to 4.2 bar) at operating speed and temperature? Reference Technical Manual, Section 4. _____

7. Are the high discharge gas temperature shutdowns set at approx. 10% above normal discharge temperature? To 350°F (177°C) maximum. _____

8. Is the distribution block indicator working and lubricator set for proper break-in flow rate? _____

9. Are there any oil leaks? If so, where? _____

10. Are the scrubber dumps and high level shutdowns working? _____

11. Are the scrubbers removing all liquids from the gas? How often do they dump? (_____ minutes) _____

12. Are there sands or oxides in the gas? _____

13. Is the overspeed shutdown set? _____

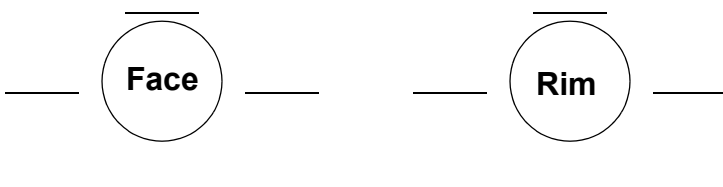
14. Are rod packings sealing properly? _____

15. Have all safety functions been tested to ensure shutdown of unit upon malfunction? _____

Compressor Model _____ Serial/No. F- _____

YES NO

16. Have coupling dial indicator readings been taken after reaching normal operating temperatures and components become heat soaked? Shutdown, vent gas system¹ and record dial indicator readings, in the hot condition within 30 minutes, in inches (mm) at the 3, 6, 9 and 12 o'clock positions on lines provided below:



17. If discharge bottle or head end cylinder supports are used, have they been adjusted when components are heat soaked to ensure there are no excessive forces that would cause detrimental cylinder deflection?

18. Has fastener torque on gas nozzle flange, valve cap, cylinder head and compressor rod packing flange bolting been re-checked¹ when components are heat soaked?

19. Complete Ariel's "Compressor Warranty Notification and Installation List Data", copy this completed "Start-up Checklist" and mail both to Ariel Corporation, 35 Blackjack Road, Mount Vernon, OH 43050, USA, Attention: Administrative Assistant - Sales or fax to Ariel at 740-397-3856, Attention: Administrative Assistant - Sales.

1. CAUTION!

BE SURE THAT THE COMPRESSOR IS COMPLETELY VENTED TO RELIEVE ALL GAS PRESSURE, AND THE DRIVER WILL NOT EXERT TORQUE ON THE COMPRESSOR CRANKSHAFT THAT COULD RESULT IN INJURY, PRIOR TO TAKING COUPLING READINGS, RE-CHECKING BOLTING TORQUES ON PRESSURE CONTAINING COMPONENTS OR REMOVING ACCESS COVERS FOR PERFORMING INTERNAL INSPECTION OR MAINTENANCE ON THE COMPRESSOR. IN THE CASE OF A DIRECT DRIVE MOTOR, THE BREAKER IS LOCKED OUT. FAILURE TO FOLLOW THESE STEPS CAN RESULT IN SERIOUS PERSONAL INJURY OR DEATH.

Maximum Allowable Working Pressure

All Ariel Compressor Cylinders have a "Maximum Allowable Working Pressure (MAWP)." The MAWP, the hydrostatic test pressure, and the test date are stamped on the end of every Ariel Cylinder (see Figure 1-8: on Page 1-13).



API Specification 11P, Second Edition, November 1989, Paragraph 1.10.4 defines "Maximum Allowable Working Pressure" as follows:

"Maximum allowable working pressure (MAWP) is the maximum continuous pressure for which the manufacturer has designed the equipment (or any part to which the term is referred), when handling the specified fluid at the maximum specified temperature."

API SPEC 11P, paragraph 2.5.1.1 defines "Maximum Allowable Working Pressure" for Compressor Cylinders as follows:

"The maximum allowable working pressure of the cylinder shall exceed the rated discharge pressure by at least 10 percent or 25 psig (1.7 bar_g), whichever is greater."

API SPEC 11P, paragraph 1.10.5 defines the rated discharge pressure as follows:

"Rated discharge pressure is the highest pressure required to meet the conditions specified by the purchaser for the intended service."

Relief Valve Settings

It is the responsibility of the packager to provide relief valves for every stage of compression in compliance with API SPEC 11P, paragraph 7.20.3, as follows:

"Relief valves setting shall take into consideration all possible types of equipment failure and the protection of the lowest pressure rated component in any continuous system. Relief valves shall be set to operate at not more than the maximum allowable working pressures but not less than the values following:

System Discharge Pressure psig (bar _g)	Relief Valve Margin Above System Discharge Pressure
-14.7 to 150 (-1.01 to 10.3)	15 psig (1.03 bar _g)
151 to 2500 (10.4 to 172.3)	10%
2501 to 3500 (172.4 to 241.3)	8%
3501 to 5000 (241.4 to 345)	6%

NOTE: For rated discharge pressures above 5000 psig (345 bar_g), the relief valve setting shall be agreed upon between the purchaser and the vendor.”

CAUTION

WHEN A BYPASS IS FURNISHED, A RELIEF VALVE MUST BE INSTALLED IMMEDIATELY DOWNSTREAM OF THE BYPASS VALVE OR ON THE INLET SCRUBBER OF THE DOWNSTREAM CYLINDER. THIS RELIEF VALVE MUST BE SET FOR THE MAXIMUM ALLOWABLE WORKING PRESSURE OF THE CYLINDER WHICH HAS THE LOWEST MAWP OF THOSE IN THE BYPASS CIRCUIT. THIS IS TO PROTECT AGAINST DISCHARGE CHECK-VALVE FAILURE WHEN OPERATING ON BYPASS. (SEE ARIEL PACKAGER'S STANDARDS, ER-56.04 "RELIEF VALVES").

Filling Sump & Priming the Main Lube Oil System - Before Starting

Filling The Sump

1. Remove breather and fill compressor sump through top cover.
2. Check sight glass on auxiliary end. Oil level at start-up should be near the top of the glass. DO NOT OVERFILL SUMP. The crankshaft will dip into the oil, churn it, and make it difficult to pump and to control the proper level. (After the machine is running, it may be necessary to add oil to bring up oil level to one-half the height of the sight glass; but it must never exceed two-thirds height, while running.)
3. When the sump is filled to the proper level, replace and snug up the breather cap by hand, to facilitate later removal.

Priming - Main Lube Oil System

NOTE: BE SURE THE OIL SYSTEM FROM THE LUBE OIL PUMP THROUGH THE COOLER AND OIL FILTER IS FILLED WITH OIL.

Remove cover doors and operate the prelube pump to verify that oil is dripping from the bearing and crosshead positions.

Compressor Prelube

See Section 4 “Compressor Prelube” for the prelube requirements for starting the compressor.

Force Feed Lubricator Adjustment

Be sure that the force feed lubricator is set at the break-in rate shown on the force feed lubricator plate (see Figure 1-5: on Page 1-11, Figure 1-6: on Page 1-12 or Figure 1-7: on Page 1-12). An indicator on the distributor block shows the rate at which the block is cycling. To adjust, loosen locknut and turn the feed regulator (pump plunger stroke adjustment screw) until the indicator strokes at the proper rate, tighten locknut. Run at this setting for 200 hours of operation. The lubricator adjustment may then be reduced to the normal operating rate (see Figure 1-5:, Figure 1-6: or Figure 1-7:).

Compressor Re-Application

NOTE: IF ANY OF THE CONDITIONS LISTED BELOW CHANGE, CONSULT YOUR PACKAGER AND/OR ARIEL FOR ANY HARDWARE AND/OR DOCUMENTATION CHANGES THAT ARE REQUIRED. PERFORMANCE, OPERATING PRESSURES AND LUBE RATE MUST BE RE-CALCULATED. A TORSIONAL VIBRATION ANALYSIS IS RECOMMENDED.

1. GAS PRESSURES, TEMPERATURES OR FLOW REQUIREMENTS
2. GAS PROPERTIES
3. DRIVER TYPE, SPEED OR TORQUE
4. RE-LOCATION OF COMPRESSOR TO A DIFFERENT SITE
5. CYLINDER RE-CONFIGURATION; FRAME OR CYLINDER RE-RATE
6. CHANGE OF CYLINDER AND PACKING LUBRICANT TYPE

SECTION 4 - LUBRICATION

Lubrication Functions

Lubrication performs at least six functions in a compressor:

1. Reduce friction - Decreasing friction decreases energy requirement and heat buildup.
2. Reduce wear - Decreasing wear increases equipment life and decreases maintenance costs.
3. Cool rubbing surfaces - Cooling of rubbing parts maintains working clearances, extends oil life, and removes heat from the system.
4. Prevent corrosion - Minimizing surface corrosion decreases friction, heat, and component wear. Generally provided by additives rather than the base lubricant.
5. Seal and reduce contaminant buildup - Improves gas seal on piston rings and packing rings, and flushes away contaminants from moving parts.
6. Dampen shock - Shock loads are cushioned, thereby reducing vibration and noise, and increasing component life.

Lubrication Deserves Special Attention

Lubrication is vital for successful operation of a compressor and deserves special attention in the package design:

Oil Cooler

All compressors must have an oil cooler. Maximum allowable oil temperature into the compressor frame is 190°F (88°C). The packager is responsible for sizing a proper oil cooler. Operating conditions which must be taken into account are; the cooling medium, cooling medium temperature, cooling medium flow rate, lube oil temperature, and lube oil flow rate. Oil heat rejection data for each frame are shown in the Ariel Electronic Databook in the frame details section (contact your Packager or Ariel when you need this information). The cooler should be mounted as close to the compressor as possible, with piping of adequate size, to minimize pressure drop of both the lubricating oil and the cooling medium.

1. **Oil Temperature Control Valve, 170°F (77°C) nominal rating** - For proper operation of the thermostatic valve, provided as an option by Ariel, the maximum differential pressure between the hot oil supply line and the cooled oil return line is 10 psid (0.7 bar_d).
2. **Mixing Mode** - Ariel recommends installation of the thermostatic valve in the mixing mode.

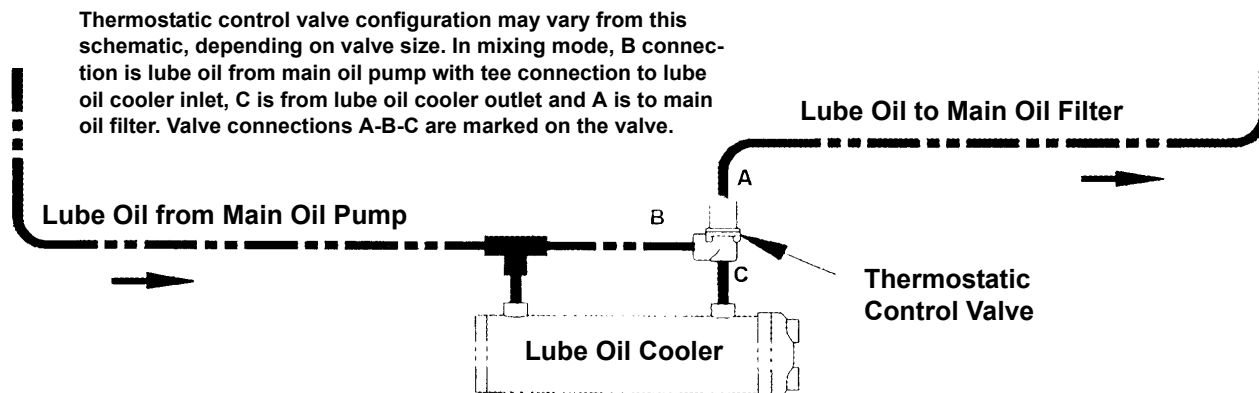


FIGURE 4-1: LUBE OIL THERMOSTATIC VALVE IN THE MIXING MODE

Cold Starting

If a compressor is exposed to cold ambient temperatures, the oil system must be designed so the unit may be safely started with adequate oil flow to the main bearings. Temperature controlled cooler by-pass valves, oil heaters, cooler louvers and even buildings may be needed to ensure successful operation. Cold weather installations may use multi-viscosity oils in the compressor frame if the oil supplier can certify that the oil is shear stable. The viscosity of shear stable oil does not degrade through use. Multi-viscosity oils are subject to a shorter oil life than single grade oils by 30% to 50%.

Compressor Prelube

An automated compressor pre-lube system is strongly recommended for all Ariel compressors to extend bearing life and reduce operating costs. Compressors that meet any of the following criteria are required to have an automated pre-lube system to help ensure oil flow prior to start-up:

1. Electric motor driven compressors.
2. Unattended-start compressors, regardless of driver type.
3. All large frame compressor models (JGC, JGD, JGZ, JGU, JGB and JGV).

Automated compressor pre-lube systems must be designed and sized to provide 10 psig (0.7 bar_g) minimum pressure for a minimum of 30 seconds prior to starting, at the inlet to the oil gallery (after the filter), with minimum start-up oil viscosity and maximum allowable filter differential pressure. The purpose is to help ensure there is oil flow to all bearings and bushings, and the clearances are filled with oil prior to start-up. A start permissive is desirable to sense for minimum required pressure/time at the inlet to the oil gallery.

Automated systems are to provide for shutdown if 35 psig (2.4 bar_g) oil pressure is not achieved within 10 seconds after the initiation of start-up (from when crankshaft starts to turn).

If a compressor will not start or shuts down at start-up due to low oil pressure, do not attempt to re-start until the cause of low pressure is corrected.

Engine driven compressors with manual pre-lube pumps are to be adequately pre-lubed prior to starting. If 35 psig (2.4 bar_g) oil pressure is not achieved within 10 seconds after reaching engine idle speed, shutdown the compressor and correct the cause. Repeat manual pre-lube prior to each cranking for start-up.

Pre-lube pumps are to be located prior to the oil filter. When oil pressure exceeds 35 psig (2.4 bar_g) at start-up, a low oil pressure shutdown set at 35 psig (2.4 bar_g) must be active for all compressors.

Lubricants

Lubricants commonly used in compressors include petroleum based oils and synthetic fluids. Lubricant additives are used to improve the viscosity index, inhibit oxidation, depress the lubricant pour point, inhibit rust formation, improve detergency, provide anti-wear protection, provide extreme pressure protection, improve “lubricity”, decrease effects of gas dilution, increase “wetability”, and resist “washing” of the lubricant due to water, wet or saturated gas, or diluent properties of the gas stream.

- *Viscosity index* is a measure of the ability of an oil to resist the thinning effect caused by increasing the oil temperature.
- *Lubricity* is the “slipperiness” or ability of a lubricant to decrease friction.
- *Wetability* is a measure of the ability of the lubricant to adhere to metal surfaces. An increase in wetability increases the lubricant’s resistance to “washing” effects.

Petroleum Based Oils - Also Referred to as Mineral Oils:

Paraffinic - higher wax content, better resistance to thinning at higher operating temperatures than naphthenic.

Naphthenic - (as compared to paraffinic) lower wax content, better flow ability at low temperatures for cold start-ups, lower resistance to thinning at higher operating temperatures, better solvency, lower life/oxidation stability. Naphthenic oils leave softer carbon deposits/residues on discharge valves, etc.

Compounded Cylinder Oil Additives

Cylinder oils are specially compounded lubricants designed for use in steam cylinders and/or compressor cylinders. Compounded lubricants can be petroleum or synthetic base. Additives can be animal, vegetable, or synthetic base. These lubricants are formulated to enhance oil film strength to counter the effects of water, wet gases, solvents, etc. present in the gas.

Animal Fats

Generally acidless tallow used as a compounding additive to petroleum lubricants to improve “slipperiness” at higher pressures and resist dilution in wet or saturated gases. They can solidify at low or high temperatures. Oils with these additives should not be used in the compressor frame.

Vegetable Oils

Rapeseed oil is an example. Used as a compounding additive in petroleum lubricants to improve “slipperiness” at higher pressures and resist dilution in wet or saturated gases. These additives are not high temperature oxidation stable and therefore additive life decreases rapidly above 170°F (77°C). Oils with these additives should not be used in the compressor frame.

Synthetic Lubricants

Man-made materials with more consistent, controlled chemical structures than petroleum lubricants. This improves predictability of viscosity and thermal stability. Synthetic lubricants can be designed with better oxidation resistance, better lubricity, better film strength, natural detergency, lower volatility, and results in decreased operating temperatures. These attributes can help to decrease cylinder feed rate requirements. Justification for the use of synthetic lubricants is based on energy savings, reduced lubricant usage, increased component life, decreased equipment downtime, and reduced maintenance/labor. Some synthetic lubricants can be used in the compressor frame.

Consult with the lubricant supplier before using these lubricants in the compressor frame:

Synthesized Hydrocarbons - polyalphaolefins (PAO) can be used as compressor lubricants:

1. Compatible with mineral oils.
2. Requires additives to improve detergent action and improve seal compatibility.
3. Soluble in some gases. Verify application with lubricant supplier.

Organic Esters - diesters and polyolesters:

1. Compatible with mineral, PAO and PAG oils.
2. Incompatible with some rubbers (O-rings), plastics, and paints. Compatible with Viton.
3. Primarily used in air compressors.

Polyglycols - polyalkylene glycols (PAG), polyethers, polyglycolethers, and polyalkylene glycol ethers:

1. Not compatible with mineral or PAO oils, some plastics and paints.
2. Requires complete system flush when changing to or from mineral or PAO oils.
3. Compatible with Viton and HNBR - Buna N (high end acrylonitrile-butadiene), diester and polyolester oils.
4. Resistant to hydrocarbon gas dilution. Excellent wetability.

5. Can be water soluble - must verify application with lubricant supplier.
6. Poor inherent oxidation stability and corrosion protection - requires additives.
7. Not recommended for air compressors

Compressor Frame Lubricants

Ariel recommends, for use in the compressor frame, a good quality mineral oil which provides proper lubrication and heat removal, as well as oxidation inhibition, rust and corrosion inhibition, and anti-wear properties.

Minimum Oil Viscosity

The minimum viscosity at operating temperature is 60 SUS (10 cSt).

Pipeline Quality Gas

For clean, dry, pipeline quality gas, the oil used in the natural gas fueled engine should be satisfactory. SAE 40 weight (ISO 150 grade) oil is recommended for normal operation.

Ash Level

Low ash or no ash oils are recommended as high ash oils can increase maintenance requirements.

Oil Additives

Additives must not be corrosive to lead or copper based bearing materials.

Oil Pump Pressures

The compressor frame driven lube oil pump maintains oil pressure with a spring loaded regulating valve within the pump head, or with a provided separate pressure regulating valve, depending on compressor model. Lube system pressure can be raised or lowered by adjusting the regulating valve (when a separate regulating valve is provided, the internal pump valve is used as a relief valve).

Normal pressure on the discharge side of the lube oil filter is factory set for 60 psig (4.1 bar_g) for compressors that were tested mechanically complete (has inspector tag). If tested at factory as mechanically incomplete (without inspector tag), normal oil pressure must be set by packager or at initial start-up to 60 psig (4.1 bar_g) at full rated speed. If the lube oil pressure drops below 50 psig (3.4 bar_g), the cause should be found and corrected. A low lube oil pressure shutdown, set at 35 psig (2.4 bar_g), is required for protection of the compressor.

Cold Start-up Viscosity

The maximum viscosity of the lube oil for cold ambient temperature starting is 15,000 SUS (3300 cSt), typically 40°F (4°C) for SAE 30 weight (ISO 100 grade) oil, or 55°F (13°C) for SAE 40 weight (ISO 150 grade) oil.

Minimum Oil Temperature

The minimum lube oil operating temperature is 150°F (66°C). This is the minimum temperature required to drive off water vapor.

Oil Heating

When frame lube oil immersion heaters are used, the watt density of the heater element should not exceed 8 watts per square inch (1.2 W/ cm²) for systems without circulating pumps. Oil coking will occur at the element with higher wattage heaters if a circulating pump is not used. When high wattage heaters are required, the heaters must be interlocked with an oil circulation pump to ensure that coking of the oil will not occur. Coked oil will form deposits, which can "insulate" the system and decrease heat removal. The deposits can also break loose and act as abrasives in the lubricating system.

Oil Filtration

Large frame compressors are equipped with simplex, cartridge style pleated synthetic type filters as standard (JGZ/2, JGU/2, JGC/4, JGD/4, JGZ/4, JGU/4, JGB/4, JGV/4, JGE/6, JGK/6, JGT/6, JGC/6, JGD/6, JGZ/6, JGU/6, JGB/6 and JGV/6). All other Ariel frames are equipped with simplex, spin-on resin-impregnated type filters as standard. Pressure gauges are provided for monitoring pressure drop across the filter.

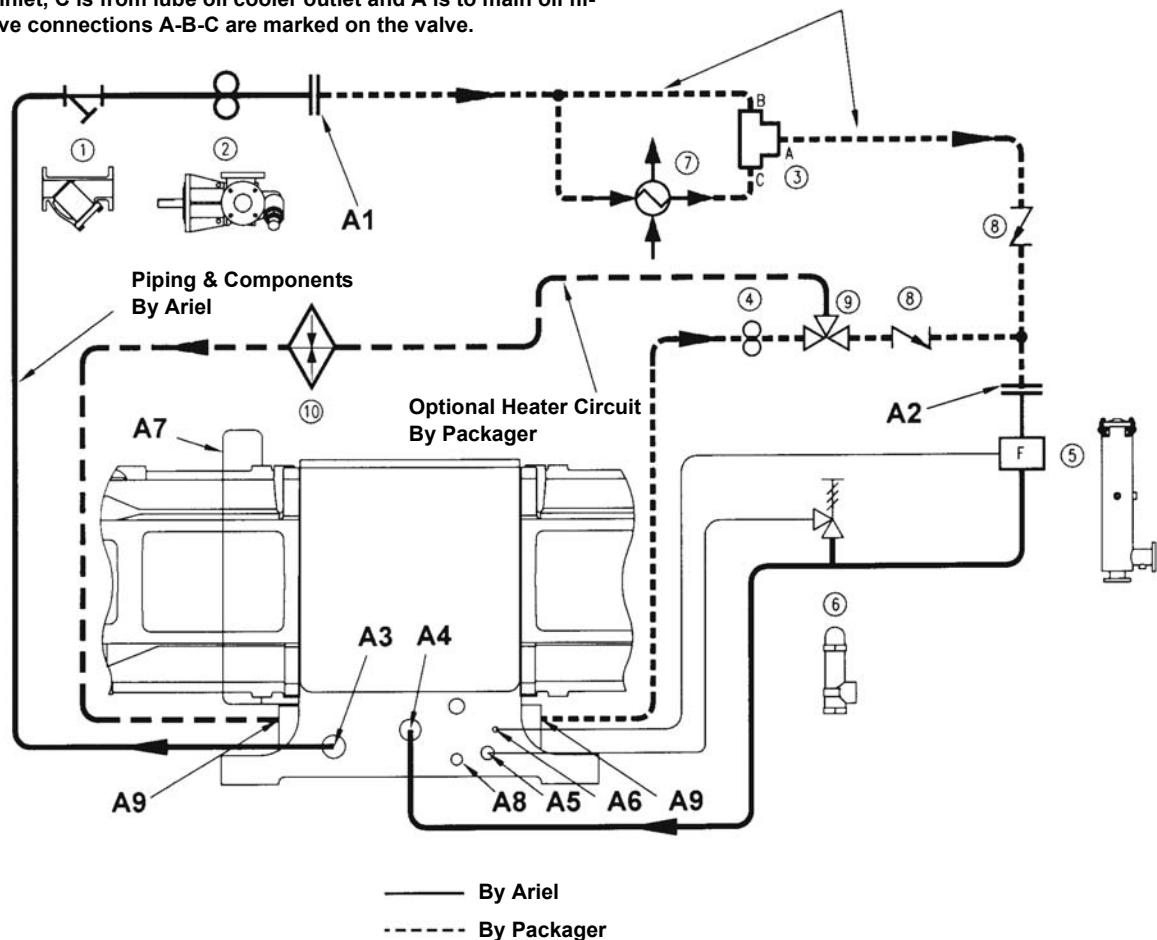
Oil Maintenance

Compressor frame lubricating oil should be changed at regular maintenance intervals (6 months or 4,000 hours), or with a filter change or when oil sample results indicate the need. A more frequent oil change interval may be required if operating in an extremely dirty environment or if the oil supplier recommends it.

Oil Sampling

Oil sampling should be performed on a regular basis to verify suitability of oil for continued service. Degradation to the next lower viscosity grade below the original viscosity or an increase in viscosity to the next higher grade requires a complete oil change. Viscosity testing should be performed at 212°F (100°C).

Thermostatic control valve (3) configuration may vary from this schematic, depending on valve size. In mixing mode, B connection is lube oil from main oil pump with tee connection to lube oil cooler inlet, C is from lube oil cooler outlet and A is to main oil filter. Valve connections A-B-C are marked on the valve.



Oil Connections (See Ariel Outline Drawing for Details)

- A1 Packager Connection from Oil Pump
- A2 Packager Connection to Oil Filter
- A3 Oil Connection from Compressor Crankcase (Oil Sump)
- A4 Lube Oil Compressor-Inlet-Connection to Gallery Tube. Oil Flows to the Crankshaft Main Bearings and through Drilled holes in the Crankshaft to Connecting Rod Bearings. From there, through Drilled Holes in the Connecting Rods to the Crosshead Pins and Crosshead Bushings.
- A5 Pressure Regulating Valve return Connection to Oil Sump, when applicable on some models
- A6 Filter Vent return Connection to the Oil Sump, when applicable on some models
- A7 Oil Tubing Connections from Frame Gallery Tube to Top & Bottom of the Crosshead Guides to Lubricate Crossheads
- A8 Compressor Crankcase Oil Drain (Oil Sump Drain)
- A9 Pre-Lube/Recirculation/Heater Connections (4)

System Components

- 1. Y - Strainer
- 2. Compressor Driven Oil Pump (w/ Safety Relief Valve - used as a pressure regulating valve, or for some models when a separate regulating valve (6) is provided, as a relief valve)
- 3. Thermostatic Control Valve, 170°F (77°C) nominal rating - Required (available as an option from Ariel)
- 4. Pre-Lube Oil Pump - Required (shown w/Oil Heating Circuit, when applicable)
- 5. Oil Filter
- 6. Pressure Regulating Valve (w/ Overflow Return to Oil Sump), when applicable for some models
- 7. Oil Cooler - Required
- 8. Check Valve
- 9. 3-Way Valve, when applicable for Heater Circuit
- 10. Heater (Optional)

FIGURE 4-2: FRAME LUBE OIL SYSTEM SCHEMATIC - TYPICAL (STANDARD)

Cylinder And Packing Lubrication Requirements

Oil Dilution

Cylinder lubrication requirements will vary with the operating conditions and the composition of the gas to be compressed. Careful consideration must be given to proper cylinder lubrication selection. The degree of cylinder oil lubrication dilution/saturation by the process gas stream is influenced by the following factors:

1. Process gas composition/Specific Gravity (SG) - usually the higher the SG, the greater the oil dilution.
2. Discharge gas pressure - the higher the pressure, the greater the oil dilution.
3. Discharge gas temperature - the higher the cylinder discharge temperature, the less the oil dilution.
4. Lubricant selection - some types of oil are more prone to dilution than others.

Cylinder Oil Lubrication Examples

Refer to Table 4-2 for lubrication recommendations for various gas compositions and various operating conditions. Note that lubrication rates can change with operating conditions. Lubricating oil type will also vary with the composition of the gas which is to be compressed.

Common Oil Supply

When process gas composition and cylinder operating conditions allow compressor frame lubricating oil to be used for cylinder and packing lubrication, the resulting force feed lube systems are installed as shown in the Figure below.

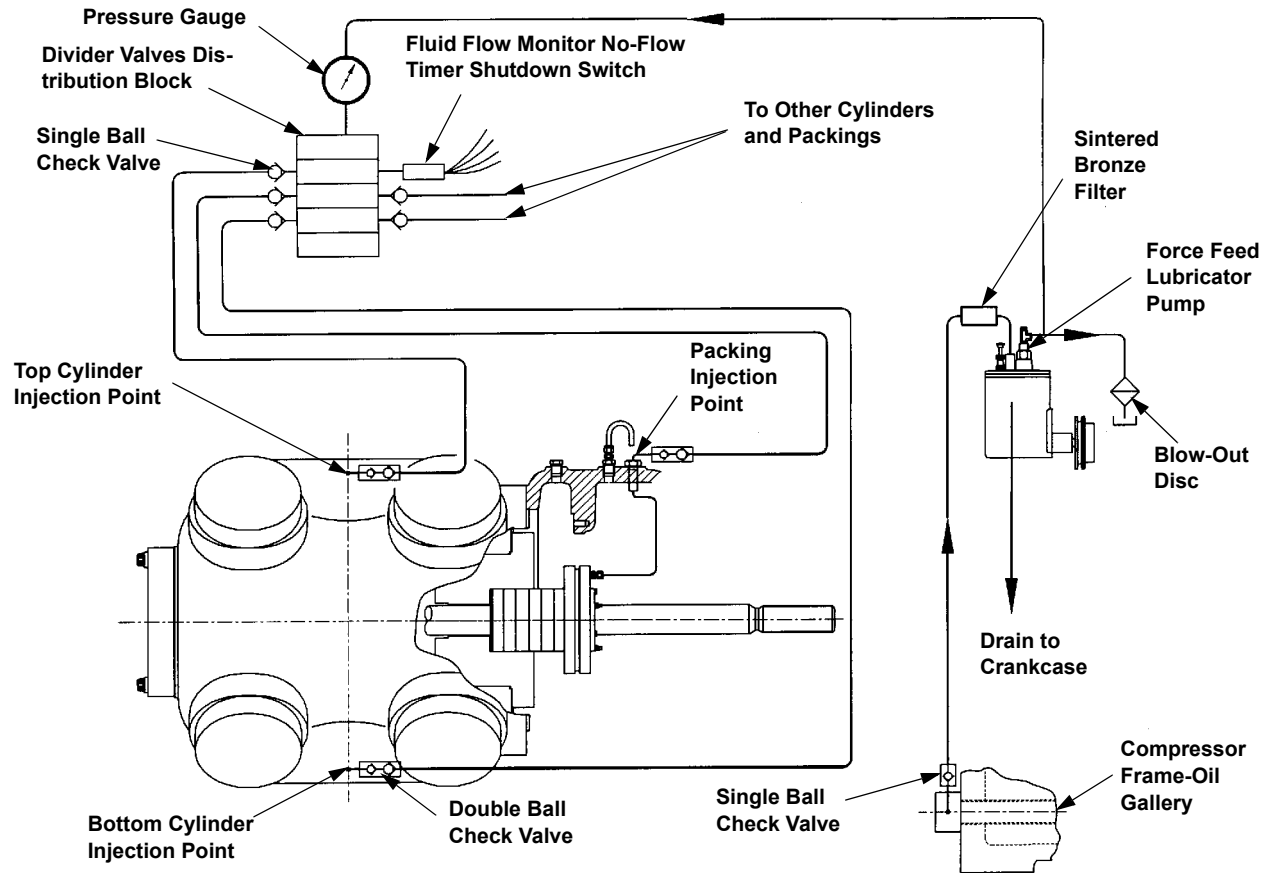


FIGURE 4-3: FORCE FEED LUBRICATION SYSTEM - COMMON OIL SUPPLY

Independent Oil Supply

When process gas composition and cylinder operating conditions require an independent cylinder oil supply, the resulting separate force feed lube systems require an oil supply. Lubricator oil is supplied under pressure from an elevated tank. To ensure that the compressor frame oil is not contaminated, be sure that the force feed lubricator box over flow does not drain into the crankcase. This over flow tubing must be disconnected from the compressor frame and directed to an appropriate drain system. See Figure 4-4:

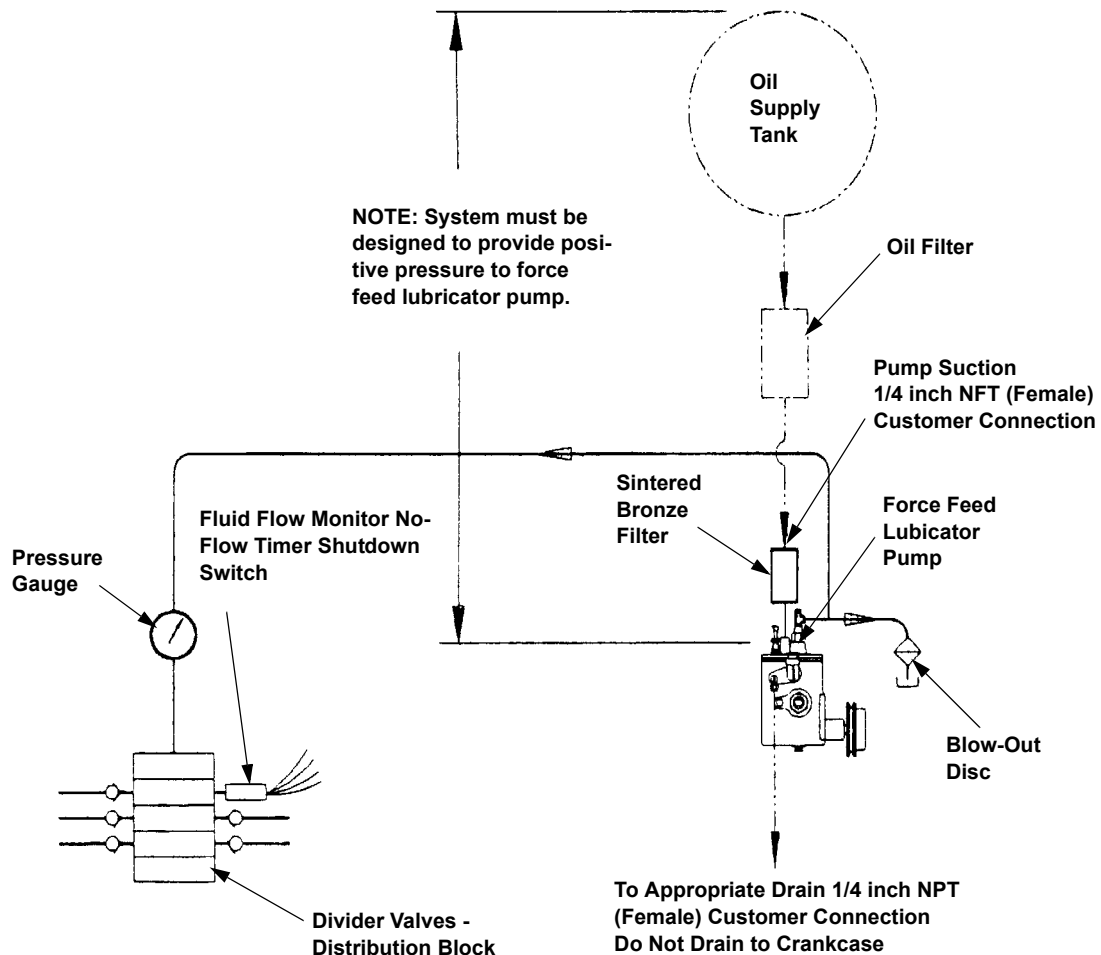


FIGURE 4-4: FORCE FEED LUBRICATION SYSTEM - INDEPENDENT OIL SUPPLY

Independent force feed lube systems require oil with a viscosity below 5000 SUS (1100 cSt) at the lubricator pump inlet. Measures which may be necessary to make sure that the force feed pump is filled with oil during the suction stroke include; appropriate pipe and fitting size from the tank to the force feed pump, heating the oil, and pressurizing the supply tank. An in-line oil filter or fine screen is required between the supply tank and the force feed lubricator pumps. Recommended filtration is 20 micron nominal.

Under/Over Lube

Inadequate - (under) lubrication results in a “mini-lube” condition. This condition results in extremely rapid breakdown of piston and packing ring materials. Black, gummy deposits which can be found in the distance piece, packing case, cylinder and valves are indicators of under lubrication.

Excessive - (over) lubrication can result in excessive oil carryover into the gas stream, and increased quantities of deposits in the valves and gas passages. Valve plate breakage and packing failure may also be symptoms of over lubrication. The packing case will “hydraulic”, which forces the packing rings to lift off of the rod enough to form a leak path. Increased gas

leakage then results in packing and rod overheating. A rod and packing case can turn blue even though the lubrication appears sufficient.

Gas Inlet Debris Screens to Maintain Lube Performance

Even when the proper rate and lubricating medium are in use, dirt and foreign matter in the gas will prevent the lubricant from performing properly. Cone type inlet gas debris strainers with 100 mesh per inch (150 micron) screen and perforated metallic backing are to be installed between the cylinder suction flange and connecting bottle or piping. Proper maintenance of the inlet screens is required. Inlet debris strainers should be monitored by differential pressure and cleaned before the differential pressure approaches the collapse pressure of the screens.

High differential pressure alarm/shutdown switches can be used to protect against screen collapse.

Lubrication Quantity - Paper Test Method

To check cylinders for the proper lubrication rates, the cigarette paper test method can provide a practical indication. Relieve and vent all pressure from all cylinders. Remove the head end head and position piston at inner center, for the cylinder to be checked. "Lock out" so that crankshaft can not be accidentally turned; see the "CAUTION" in Technical Manual Section 5 and refer to the Packager's Operation Manual for details. Use two layers of regular unwaxed commercial cigarette paper, together. Wipe the cylinder bore at top with both papers using light pressure in circumferential motion through about 20°. The paper next to the bore should be stained (wetted with oil), but the second paper should not be soaked through.

Repeat the test at both sides of the bore at about 90° from the top, using two new clean papers for each side. When the paper next to the bore is not stained through, it may be an indication of under lubrication. When both papers are stained through, it may be an indication of over lubrication. In either case, it is normally recommended that the lubrication rate be changed accordingly and that all cigarette paper tests be repeated until passed. Repeat for all cylinders. If a reduction or increase of the lubrication rate is indicated for a cylinder, change in 5% increments by adjusting cycle time at the force feed lube pump as discussed in "Force Feed Lubricator Adjustment" in Technical Manual Section 3. Repeat oil film testing, for the cylinders affected, after 24 hours of operation.

NOTE: THE CIGARETTE PAPER TEST ONLY GIVES AN INDICATION OF OIL FILM QUANTITY. AFTERMARKET DEVICES THAT MEASURE FLOW ARE ALSO AVAILABLE. NEITHER METHOD GIVES AN INDICATION OF VISCOSITY QUALITY. OILS DILUTED WITH WATER, HYDROCARBONS OR OTHER CONSTITUENTS MAY PRODUCE WHAT APPEARS TO BE AN ADEQUATE FILM OR FLOW. BUT THE OIL FILM MAY NOT HAVE THE REQUIRED LOAD-CARRYING CAPABILITY DUE TO THE DILUTION.

Inadequate Lubrication Symptoms

When observed symptoms indicate lack of lubrication; first verify that the force feed lubricator pumps are operating properly. Confirm that the distribution block cycle time matches the lube

sheet or lubrication box information plate provided by Ariel, and double check that all tubing and fittings are tight and no leaks are present. Do not overlook the fittings inside the cylinder gas passages. Pressure test or replace divider valves to be sure they are not bypassing.

Lubricator Cycle Time

The lubricant flow rates (measured in seconds per cycle) are generally so low that all of the required flow to a lube point may be observed as a drip at a loosened supply fitting. The break-in and normal lube timing rates which are stamped on the lubricator box information plate are calculated according to the Ariel Lube Specifications, as given in this document, to match the gas and operating conditions as supplied to Ariel with the compressor order. The lube sheets supplied in the Ariel Parts Book state gas conditions and list the base rate multiplier at each lube point. If gas conditions were not supplied with the compressor order, the information plate/lube sheets rates are for clean, dry, 0.65 specific gravity, sweet gas at rated speed and discharge pressures.

If the compressor operating conditions change (such as gas properties, gas pressures, temperatures or flow requirements or cylinder re-configuration) the lubrication rates must be recalculated and hardware changes may be necessary to the force-feed lubrication system. Consult Table 4-2 and your Packager and/or Ariel.

Cycle Time Indication

To set the proper force-feed lubricator pump flow rate, read the cycle time on the Proflo electronic lubricator fluid-flow monitor/no-flow timer switch located at the distribution block or in control panel, reference Technical Manual Section 5. Or if a digital no-flow timer switch (DNFT) is provided, time the cycle from flash to flash, or for a magnetic cycle indicator assembly, time the cycle from initial movement of the indicator pin at the fully retracted position to the time when the pin returns to the fully retracted position and just begins initial movement back out again. Adjust the lubricator pump to provide the required cycle time-flow rate.

NOTE: WHEN ADJUSTING THE FORCE FEED LUBRICATION PUMP SETTING FOR THE APPROPRIATE CYCLE TIME, DO NOT SET THE FLOW RATE TOO LOW. THE PUMPS CAN BECOME INCONSISTENT WHEN SET TOO LOW.

Force Feed Lubrication System Monitoring:

Minimum Requirements

Ariel requires the unit control panel to shutdown the unit if the master lube distribution block stops cycling while the compressor is running. The control panel is to wait for a maximum time of 3 minutes after the distribution block stops cycling to issue the shutdown. This is a class B shutdown. A class B shutdown is defined as a shutdown that is not armed until a short time after the compressor is started. Typically 2 minutes. This gives the divider blocks time to cycle the first time before the shutdown is activated.

Devices

Ariel offers several devices that can be used to obtain the lube system shutdown. There are two basic types. Note that some devices have both functions built in.

Choosing a Lube System Monitor

When ordering an Ariel compressor the packager must choose a lube system monitor. See the following table for the specifications on available types. For further information about each device visit the vendor literature section of the Ariel web site.

TABLE 4-1: FORCE FEED LUBE SYSTEM MONITORS - SPECIFICATIONS

ITEM	PROFLO	KENCO	DNFT	DNFT - PROGRAMMABLE
Shutdown Signal	YES	NO	YES	YES
Proximity Signal	YES (0.5 sec pulse)	YES (switch)	YES (switch)	YES (switch)
Local Data Storage	YES	NO	NO	Count Display
Infrared Port	YES	NO	NO	NO
PLC Creates Shutdown	NO	YES	NO	NO
Remote Mounting	YES	NO	NO	NO
Area Classification	CSA	CSA	CSA, CE, EX, ATEX	CSA, CE
CSA	203633 Class I, Div 2, Groups ABCD T4A	044787 Class I, Groups ABCD: Class II, Groups EFG: Class III	108334 Class I, Div 1 Groups ABCD T5; &/or Class I, Zone 1 Ex md IIC T5	108334 Class I, Div 1 Groups ABCD T5; &/or Class I, Zone 1 Ex md IIC T5
CE	N/A	N/A	0344 Class I Div 1; Groups ABCD T4	0344 Class I Div 1; Groups ABCD T4
EX	N/A	N/A	II 2G EEx mIIB T5	N/A
KEMA	N/A	N/A	00ATEX1090X/AMB. -40°C to +85°C	N/A
Battery	(2) Standard Alkaline "AA" Size	None	Ariel P/N A-10807	Ariel P/N A-10807
Cost Factor New Unit	\$0 Standard	Minus \$	\$0 Standard for CE	Plus \$
Shutdown Time	Programmable	PLC	3 minutes	Programmable 20 sec. to 4 minutes
Temperature	to 185°F (85°C)	to 220°F (104°C)	-40°F to +185°F (-40°C to +85°C)	-40°F to +185°F (-40°C to +85°C)
Max. Switch Voltage	36 VDC	200 VAC/VDC	240 VDC	10 to 120 VAC
Max. Switch Current	0.5 Amps	0.5 Amps	N/A	N/A
Max. Switch Power	N/A	10 Watts DC	2.5 VA	2.5 VA
Local Cycle Indicator	YES - LCD	Separate Indicator	YES - Flashing LED	YES - LCD Display +LED
De-bounce Included	NO	NO	YES	YES

I. Shutdown switch - This is a device that monitors the position of the divider block pin and supplies a shutdown contact. If the divider block stops cycling for a given time a shutdown signal will be sent to the control system.

APPLICATION NOTES - Shutdown Switch

Normally open (NO) vs. Normally closed (NC) Shutdown switch

Divider block monitoring devices define their operation opposite from other industries. Most other industries define the switch state as the state the switch is in when it is on the shelf. (That is: If a momentary push button switch is NO, then when it is taken out of the box the switch will be open until the button is pushed and the contact will close. If a momentary push button switch is NC then when it is taken out of the box the switch will be closed until the button is pushed.) This does not apply to divider block monitoring devices.

Divider block device manufacturers have "simplified" things for the mechanic. Normally Open (NO) refers to the state the switch is in when the divider block is cycling or the unit is running. An NO switch means that when the unit is running the shutdown switch is open or non-failsafe. If a wire falls off or is cut while the unit is running the control system will never stop the unit. If the device is damaged or a wire has come loose at startup the control system would never know there is a problem. An NC switch means that when the unit is running the shutdown switch is closed or failsafe. Now if a wire falls off or is cut the control system will detect that the switch is open and shutdown the unit.

Ariel recommends using a NC (failsafe) switch. However, when a NO (non-failsafe) switch is used, Ariel recommends testing the shutdown circuits at least once a month.

II. Proximity switch - This is a device that will sense the position of the divider block piston and will produce a switch change of state or a pulse every time the pin changes position. This device must be combined with a PLC or some other counter/timer device to produce the shutdown. Some devices on the market will open the switch when the pin is toward the left and close when the pin is toward the right. Others will produce a 0.5 second pulse when the pin moves from left to right. If this is used it is the responsibility of the control system to sense the switch cycling and stop the unit if a block stops cycling.

APPLICATION NOTES - Proximity Switch

Ariel recommends setting up the control system to find the time between cycles triggered when the switch transitions from off to on. See Figure 4-5: suggested control system block diagram.

1. Shutdown time with no lubrication - The distribution block cycle times will vary slightly from cycle to cycle. Seeing 12 seconds one cycle then 15 seconds the next then 14 the next is normal. The recommended shutdown time is: 2 times the design cycle time + 30 seconds limited between 30 seconds and 3 minutes.

LIMIT (2 x design cycle time + 30 seconds) 30, 180

Design cycle time is found on the compressor lube sheets or tag on the compressor.

2. DE-BOUNCE and latching circuits - Depending on the device and control system scan time it may be necessary to include de-bounce hardware and/or software. Some of the devices do not have built in de-bounce circuits and can cause a fast control system to double or triple count. Other times it may be necessary latch the

input thus allowing the control system to detect only the first transition from low to high. This becomes significant when displaying the cycle time for the operator to set the pump flow rates and when calculating the total oil through the divider block.

3. Suggested Operator Displays:

Divider block cycle time - The operator will need to set the lube system pumps according to the recommended divider block cycle times. It is helpful for the operator to have a display of divider block cycle time in seconds. This will be used to adjust the lube pumps as the pumps wear out and when the pumps are replaced to set divider block cycle times.

Time since last Pulse - It is helpful to have a display of the timer timing so the operator can see a change and show that something is happening.

Average Cycle Time - Cycle time will vary a few seconds from cycle to cycle. It is sometimes helpful to display a cycle time that has been averaged over 5 to 10 cycles.

Total Oil Consumed - Total oil consumed can be useful to the operator to know how much oil is being used for the lube system and thus how much oil to order.

4. EXAMPLE FLOW DIAGRAM TO CREATE SHUTDOWN

Figure 4-5: flow diagram is a suggested method of creating a shutdown within the PLC from a cycling digital input. This is only a suggestion as there is no way of providing logic for all control systems.

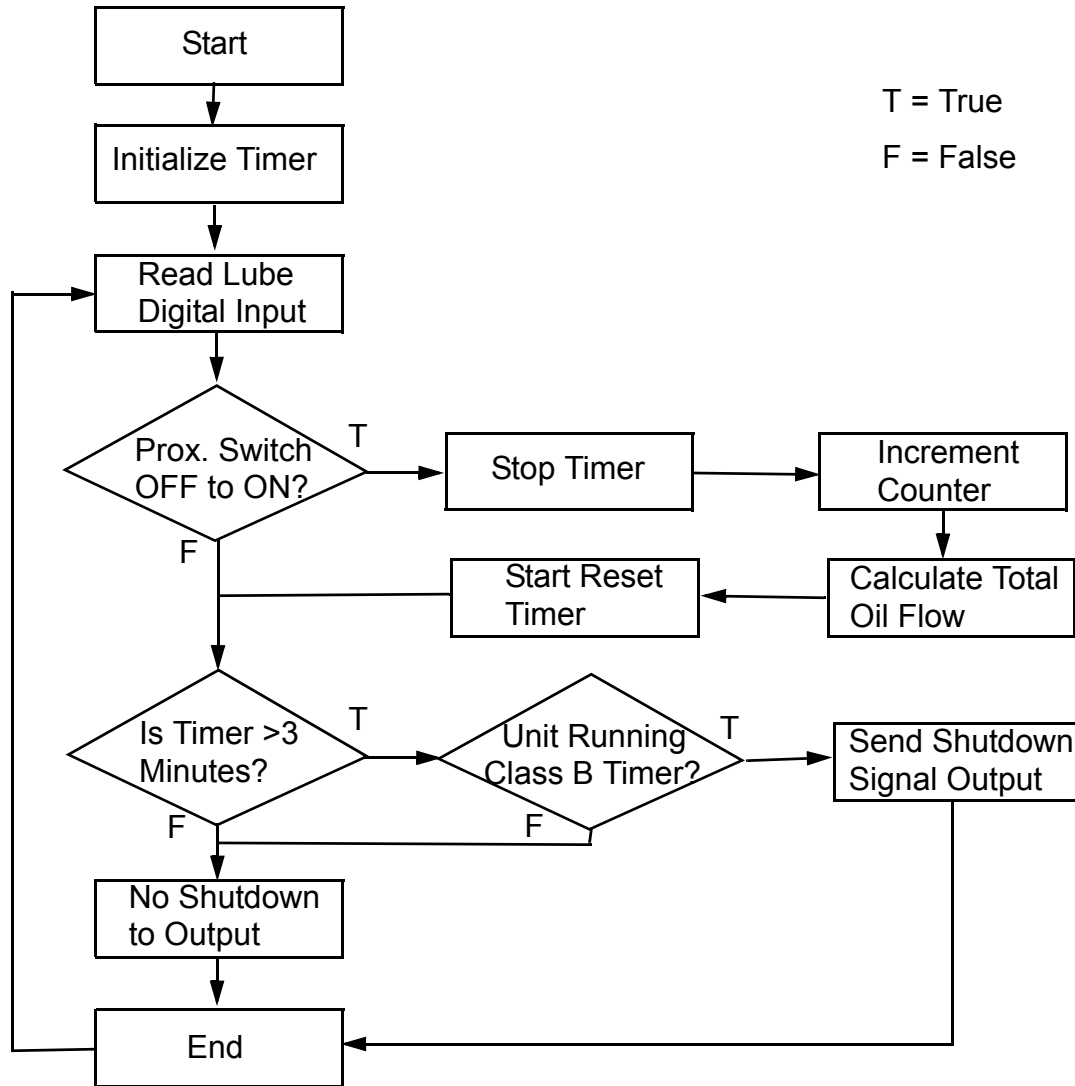


FIGURE 4-5: SUGGESTED FORCE FEED LUBE CONTROL SYSTEM PROXIMITY SWITCH SHUTDOWN LOGIC DIAGRAM

Break-in Rate

The force feed lubrication pumps should be capable of delivering 150% minimum of the “normal” required lube rate for the break in period (set as close as possible to twice the “normal” rate for 200 hours). Please contact Ariel for assistance if the existing pump is not capable of the minimum flow rate required.

Lubricant Supplied From Engine Oil

Oil supplied from the engine may be used in the force feed system as long as the new oil specifications meet the listed requirements, the oil is appropriately filtered (i.e. 20 micron nominal) and the lube application requirements are met. Oil viscosity must be monitored and

tested, for serviceability. Treat as an independent oil supply; see “Independent Oil Supply” in this section.

Liquids in Gas

The use of higher viscosity lubricants or specially compounded lubricants can compensate somewhat for the presence of liquids in the gas stream.

NOTE: WHEN THERE ARE LIQUIDS PRESENT IN THE GAS, THE MOST EFFECTIVE LUBRICATION OF CYLINDERS AND PACKING REQUIRES REMOVAL OF THE LIQUIDS BEFORE THE GAS ENTERS THE COMPRESSOR.

THESE LUBRICATION RECOMMENDATIONS ARE GENERAL GUIDELINES. IF THE RECOMMENDED LUBRICANTS OR FLOW RATES DO NOT APPEAR TO WORK ADEQUATELY, FLOW RATES AND/OR LUBRICANT TYPES MAY NEED TO BE CHANGED. PLEASE CONTACT THE LUBRICANT SUPPLIER FOR SPECIFIC LUBRICANT RECOMMENDATIONS.

WARRANTY OF COMPONENT FAILURES WHICH OCCUR WHILE USING LUBRICANTS WHICH DO NOT MEET THESE SPECIFICATIONS WILL BE SUBJECT TO REVIEW ON A CASE BY CASE BASIS.

Lube Type & Rate Recommendations

TABLE 4-2: CYLINDER/PACKING LUBE OIL RECOMMENDATIONS FOR VARIOUS GAS STREAM COMPONENTS

GAS STREAM	CYLINDER DISCHARGE PRESSURE				
	< 1000 PSIG < (70 bar _g)	1000 TO 2000 PSIG (70 to 140 bar _g)	2000 TO 3500 PSIG (140 TO 240 bar _g) ^A	3500 TO 5000 PSIG (240 to 345 bar _g) ^A	> 5000 PSIG > (345 bar _g) ^A
Pipeline Quality Natural Gas Including CNG (Dry)	SAE 40 wt. ISO 150 1 x Base Rate or Various Synthetics 1 x Base Rate	SAE 40-50 wt. ISO 150 - 220 1.25 x Base Rate or Various Synthetics 1 x Base Rate	SAE 50 wt. ISO 220 w/ Compounding 1.5 x Base Rate or Various Synthetics 1.25 x Base Rate	Cylinder Oil ISO 320 - 460 w/ Compounding 2 x Base Rate or Synthetic - Diester/Polyglycol 1.5 x Base Rate	Cylinder Oil ISO 460 - 680 w/ Compounding 3 x Base Rate or Synthetic - Polyglycol 2 x Base Rate
Natural Gas (Water Saturated, and/or Heavy Hydrocarbons ^B Methane < 90% Propane > 8% SG > 0.7)	SAE 40 - 50 wt. ISO 150 - 220 1.25 x Base Rate or Various Synthetics 1 x Base Rate	SAE 50 - 60 wt. ISO 220 - 320 or SAE 40 wt. ISO 150 w/ Compounding 1.5 x Base Rate or Var. Synthetics 1.25 x Base Rate	Cylinder Oil ISO 460 - 680 w/ Compounding 2 x Base Rate or Various Synthetics 1.5 x Base Rate	Cylinder Oil ISO 680 w/ Compounding 3 x Base Rate or Synthetic - Diester/Polyglycol 2 x Base Rate	Contact Lubricant Supplier

TABLE 4-2: CYLINDER/PACKING LUBE OIL RECOMMENDATIONS FOR VARIOUS GAS STREAM COMPONENTS

GAS STREAM	CYLINDER DISCHARGE PRESSURE				
	< 1000 PSIG < (70 bar _g)	1000 TO 2000 PSIG (70 to 140 bar _g)	2000 TO 3500 PSIG (140 TO 240 bar _g) ^A	3500 TO 5000 PSIG (240 to 345 bar _g) ^A	> 5000 PSIG > (345 bar _g) ^A
Natural Gas (Water Saturated and Carbon Dioxide > 2% to 10%)	SAE 40 - 50 wt. ISO 150 - 220 1.25 x Base Rate or Various Synthetics Base Rate	SAE 50 - 60 wt. ISO 220 - 320 or SAE 40 wt. ISO 150 w/ Compounding 1.5 x Base Rate or Var. Synthetics 1.25 x Base Rate	Cylinder Oil ISO 460-680 w/ Compounding 2 x Base Rate or Synthetic PAG 1.5 x Base Rate	Cylinder Oil ISO 680 w/ Compounding 3 x Base Rate or Synthetic PAG 2 x Base Rate	Contact Lubricant Supplier
Natural Gas (Water Saturated and Carbon Dioxide ≥ 10%)	SAE 40 - 50 wt. ISO 150 - 220 1.5 x Base Rate or Various Synthetics 1.25 Base Rate	SAE 50 - 60 wt. ISO 220 - 320 or SAE 40 weight ISO 150 w/ Compounding 2 x Base Rate or Var. Synthetics 1.5 x Base Rate	Cylinder Oil ISO 460-680 w/ Compounding 3 x Base Rate or Synthetic PAG 2 x Base Rate	Cylinder Oil ISO 680 w/ Compounding 4 x Base Rate or Synthetic PAG 3 x Base Rate	Contact Lubricant Supplier
Natural Gas (Water Saturated & H ₂ S > 2% to 30%)	SAE 40 wt. ISO 150 w/ Compounding 1.25 x Base Rate or Various Synthetics 1 x Base Rate	SAE 40 - 50 wt. ISO 150 - 220 w/ Compounding 1.5 x Base Rate or Various Synthetics 1.25 x Base Rate	SAE 50 wt. ISO 220 w/ Compounding 2 x Base Rate or Various Synthetics 1.5 x Base Rate	SAE 60 wt. ISO 320 w/ Compounding 3 x Base Rate or Various Synthetics 2 x Base Rate	Cylinder Oil ISO 460 - 680 w/ Compounding 4 x Base Rate or Various Synthetics 3 x Base Rate
Natural Gas (Water Saturated & H ₂ S ≥ 30%)	SAE 40 wt. ISO 150 w/ Compounding 1.5 x Base Rate or Various Synthetics 1.25 Base Rate	SAE 40 - 50 wt. ISO 150 - 220 w/ Compounding 2 x Base Rate or Various Synthetics 1.5 x Base Rate	SAE 50 wt. ISO 220 w/ Compounding 2.5 x Base Rate or Various Synthetics 2 x Base Rate	SAE 60 wt. ISO 320 w/ Compounding 3.5 x Base Rate or Various Synthetics 2.5 x Base Rate	Cylinder Oil ISO 460 - 680 w/ Compounding 5 x Base Rate or Various Synthetics 3 x Base Rate
Air	SAE 40 wt. ISO 150 Air Compressor Oil 1 x Base Rate or Various Synthetics 1 x Base Rate	SAE 50 wt. ISO 220 Air Compressor Oil w/ Compounding 1.5 x Base Rate or Various Synthetics 1.25 x Base Rate	Synthetic - Diester 1.5 x Base Rate	Contact Lubricant Supplier	Contact Lubricant Supplier

TABLE 4-2: CYLINDER/PACKING LUBE OIL RECOMMENDATIONS FOR VARIOUS GAS STREAM COMPONENTS

GAS STREAM	CYLINDER DISCHARGE PRESSURE				
	< 1000 PSIG < (70 bar _g)	1000 TO 2000 PSIG (70 to 140 bar _g)	2000 TO 3500 PSIG (140 TO 240 bar _g) ^A	3500 TO 5000 PSIG (240 to 345 bar _g) ^A	> 5000 PSIG > (345 bar _g) ^A
Wet Air (Water Saturated)	SAE 40 - 50 wt. ISO 150 - 220 Air Compressor Oil w/ Compounding 1 x Base Rate or Various Synthetics 1 x Base Rate	Synthetic - Diester 1.5 x Base Rate	Synthetic - Diester 2 x Base Rate	Contact Lubricant Supplier	Contact Lubricant Supplier
Nitrogen (Bone Dry - Contact Ariel)	SAE 40 wt. ISO 150 1 x Base Rate or Various Synthetics 1 x Base Rate	SAE 40 - 50 wt. ISO 150 - 220 1 x Base Rate or Various Synthetics 1 x Base Rate	SAE 50 wt. ISO 220 1 x Base Rate or Various Synthetics 1 x Base Rate	SAE 60 wt. ISO 320 1 x Base Rate or Various Synthetics 1 x Base Rate	Cylinder Oil ISO 460 - 680 1 x Base Rate or Various Synthetics 1 x Base Rate
Propane ^C (Refrigerant)	SAE 40 wt. ISO 150 or Refrigerant Oil 0.5 x Base Rate or Various Synthetics 0.5 x Base Rate	SAE 40 wt. ISO 150 or Refrigerant Oil 1 x Base Rate or Various Synthetics 1 x Base Rate	Refrigerant Oil Contact Lubricant Supplier	Refrigerant Oil Contact Lubricant Supplier	Refrigerant Oil Contact Lubricant Supplier

A. Also requires water cooled packing (except cylinders on JG, JGA, JGM, JGN, JGP, JGQ & JGI).

B. Lean burn engine oils contain detergents, dispersants and ash additives, which hold water in suspension. This suspension does not provide adequate lubrication in the cylinder and packings.

C. Verify oil pour point temperature is below inlet gas temperature.

D. Reference Table 4-3 for base rate.

TABLE 4-3: CYLINDER/PACKING LUBE OIL BASE RATE

FRAME MODEL	US PINTS/DAY/ INCH OF BORE DIAMETER	LITERS/DAY/mm OF BORE DIAMETER
JG:A:I:M:P:N:Q:R:S:W	0.3	0.0056
JGH:E:J:ACF	0.4	0.0074
JGK:T:C:D:Z:U:B:V	0.5	0.0093

RATE CALCULATION NOTES:

Packing Lube Rate - Piston rod diameter is doubled and treated like a cylinder for calculating packing lube rate. For cylinders with a tail rod, the lube rate for each of the (two) packings is to be calculated separately and both values added toward the recommended total daily lube rate.

Lube Points - Cylinders for JG:A:I:M:P:N:Q:R:W:H:E:J and ACF frames with bore diameters less than 13" (<330 mm) have one point bore lube as standard; top and bottom bore lube is available as an original purchase option, (except for all Class T cylinders and 1-3/4JG-FS-HE class cylinders, which have multi-point lube as standard). For all other frames, the cylinders have multiple bore lube points as standard. Piston rod packings for high-pressure cylinders have two point lube. For multiple lube points, the required lubricant for the cylinder or packing is divided equally among the lube points.

Break-in Lube Rate - The break-in lube rate should be approximately twice the recommended daily rate (150% minimum); i.e. the break-in cycle time should be approximately half the normal cycle time (67% max.) to increase lube rate. Break-in rate should be maintained for 200 hours of operation for new equipment, or when replacing packing and/or piston rings.

Lube Rate and Speed - The recommended lube rates for break-in or normal operation, in cycles per second (as stamped on the lubricator box information plate and in Lube sheets), are calculated at maximum rated compressor speed (as stamped on the compressor information plate). The lube rate is reduced with speed, (as compressor actual running speed is reduced, cycle time increases to reduce lube rate):

$(RPM_{\max} \div RPM_{\text{actual}}) \times \text{cycle time seconds from lube plate} = \text{cycle time seconds, running}^1$.

Or reference the "Lubrication sheets" in the Ariel "Parts Book" for the Cycle Time (seconds) vs. RPM (compressor speed) Table at various running speeds for your unit, at the stated gas operating conditions and lubricant.

Special Lubricant Certification - Special lubricant formulations are available from lubricant suppliers for specific applications. Suppliers who will certify suitability of the formulation for site conditions should provide appropriate documentation. Contact Ariel for verification of warranty coverage.

Calculation Example, recommended daily lube rate:

JGJ/2, with Pipeline Quality Natural Gas, and following cylinder bore diameters, and 1.5 inches (38.1 mm) diameter piston rod, with mineral oil type lubricant:

13.00"J (330 mm) at 100 psi discharge pressure (6.89 bar)

9.75"J-CE (248 mm) at 577 psi discharge pressure (39.8 bar)

5.125"J-HE (130 mm) at 1636 psi discharge pressure (112.8 bar)

1. Actual running speed.

TABLE 4-4: EXAMPLE CYLINDER & PACKING LUBE CALCULATION

ppd (US pints per day)			L/day (Liters per day)		
Cylinder Bore	Packing	Sub	Cylinder Bore	Packing	Sub
$13.00 \times 0.4 = 5.2$	$2 \times 1.5 \times 0.4 = 1.2$	6.4	$330 \times 0.0074 = 2.4$	$2 \times 38.1 \times 0.0074 = 0.56$	3.0
$9.75 \times 0.4 = 3.9$	$2 \times 1.5 \times 0.4 = 1.2$	5.1	$248 \times 0.0074 = 1.8$	$2 \times 38.1 \times 0.0074 = 0.56$	2.4
$5.125 \times 1.25 \times 0.4 = 2.6$	N/A	2.6	$130 \times 1.25 \times 0.0074 = 1.2$	N/A	1.2
Recommended Total, ppd =		14.1	Recommended Total, L/day =		6.6

Legend:

ppd = US pints/day

psi = pounds/square inch

CE = Crank End

HE = Head End

L = Liters

" = inches (actual inch bore diameter as shown on cylinder data name plate)

sec = seconds

Water Cooled Packing

Water cooled packing cases are required for compressor cylinders based upon the average piston speed and average cylinder pressure. Cooled packing cases are supplied to help remove heat generated as the piston rod/packing friction increases with the higher pressures and piston speed.

Cooled packing cases are required for cylinders in accordance with the following chart:

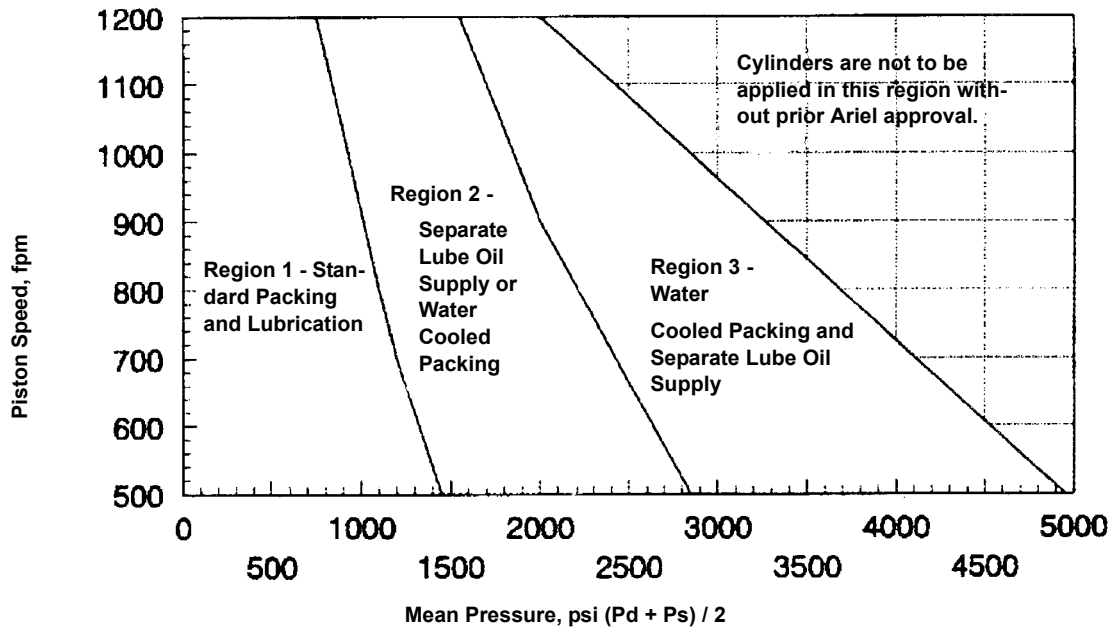


FIGURE 4-6: COMPRESSOR PACKING APPLICATION GUIDELINES FOR PIPELINE QUALITY NATURAL GAS

1. All cylinders capable of reaching Region 2 of the above chart are supplied with water cooled packing as standard equipment. If operating in Region 2, a lubricant consideration must be made or water cooling applied.
2. If a separate lube supply is required due to the gas analysis (H_2S , CO_2 , wet gas, air, etc.) this chart is not valid and approval from Ariel Field Service must be obtained if water cooling is not connected.
3. Cooling water quality and treatment is to be maintained to prevent corrosion and mineral or other deposits. Cooling water must be treated with appropriate anti-freeze if subject to freezing (treated 50/50% water/glycol solution).

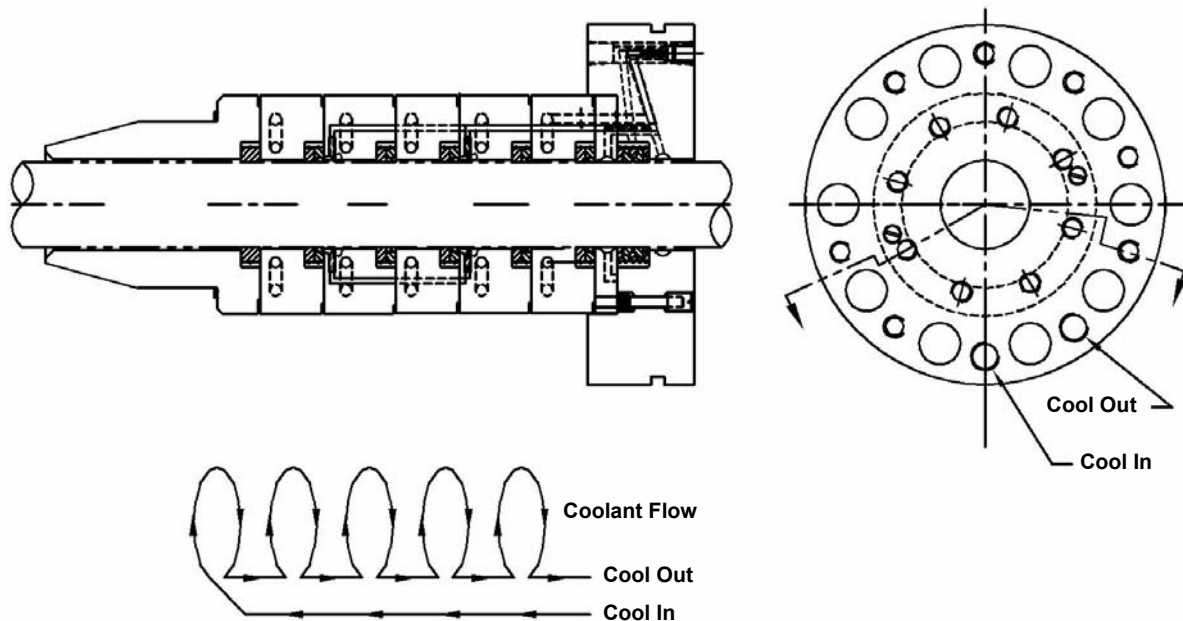


FIGURE 4-7: WATER COOLED PACKING CASE

Coolant System Requirements

The coolant flow is to be number of packing cases x 1 US gallon per minute, minimum for each inch of piston rod diameter (No. cases x 0.149 L/min for each mm of piston rod diameter). Based on using a treated 50/50% water/glycol solution.

Example: JGJ/2 with 1.5 inches (38.1 mm) diameter piston rod. $2 \times 1 \times 1.5 = 3$ gallons per minute ($2 \times 0.149 \times 38.1 = 11.3$ L per minute).

The cooler should be sized for number of cases x 70 BTU/minute/inch of rod diameter (No. cases x 31.3 kW/mm of rod diameter). The pressure drop across the system is to be greater than 30 psi (2.1 bar). The coolant into the packing is not to exceed 130°F maximum (54°C max.). A lower coolant temperature will increase the amount of heat that can be transferred to the coolant. A lower coolant temperature is better in high pressure applications.

The following is a schematic of a typical packing cooling system:

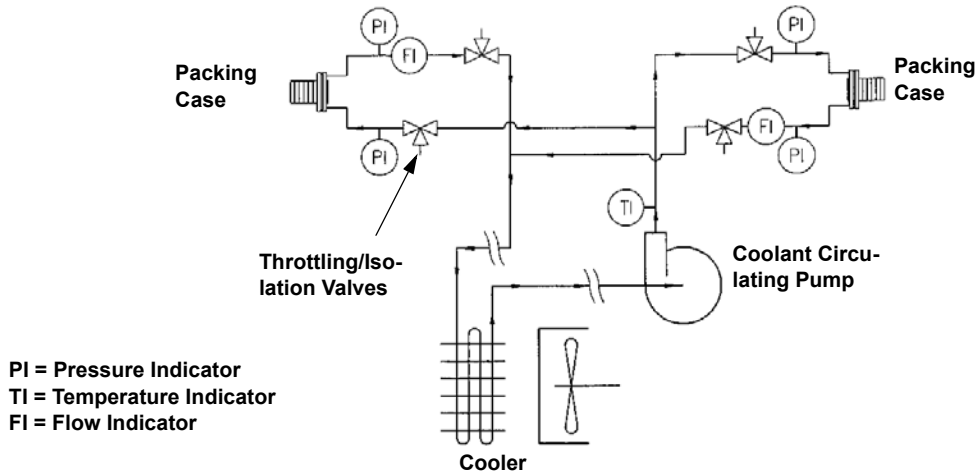


FIGURE 4-8: PACKING COOLING SYSTEM - TYPICAL

Dry Sump Applications

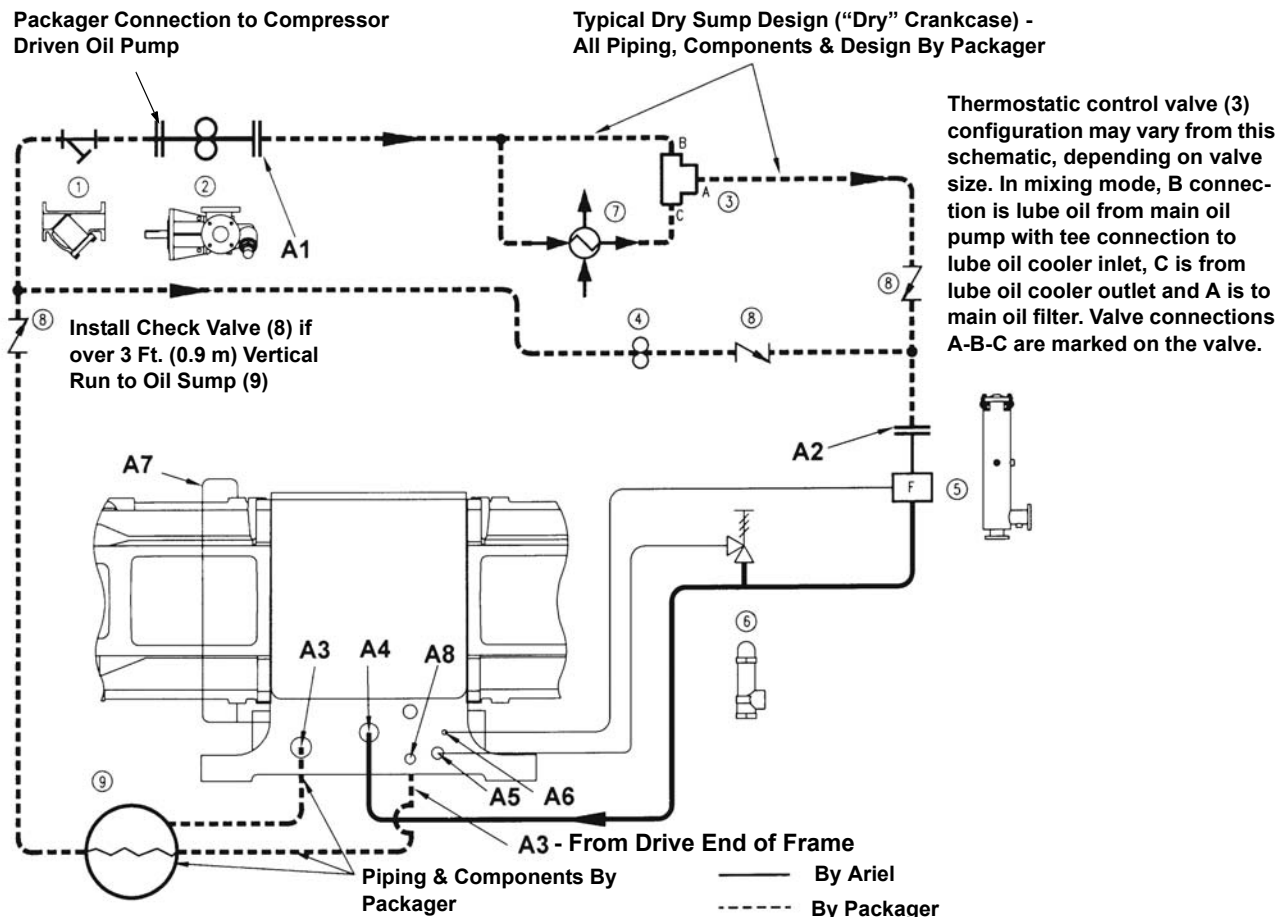
Compressor applications subject to roll and yaw on board a ship or a floating platform may require a dry sump (“dry” crankcase and separate oil reservoir); see table below for limits. The table limits are based on the angle where running gear will contact the oil level causing foaming with the running oil level being maintained between one half and two-thirds the height of the sight glass if the frame was level.

TABLE 4-5: LIMITS REQUIRING A DRY SUMP IN TRANSIENT MOTION

FRAME ^A	MAXIMUM ANGLE DEGREES FROM LEVEL TOLERABLE WITHOUT DRY SUMP		
	1 OR 2	4	6
JGM:N:P:Q	4°	N/A	N/A
JG	4°	2.5°	N/A
JGA	6.5°	3.5°	2°
JGW:R	1°	Use Dry Sump	N/A
JGJ	4°	1°	Use Dry Sump
JGH	3.5°	2°	N/A
JGE:T	4°	1.5°	1°
JGK	1°	Use Dry Sump	Use Dry Sump
JGC	4°	1°	Use Dry Sump
JGD	5.5°	2.5°	1°
JGZ:U	7°	4°	2.5°
JGB	N/A	4°	2.5°
JGV	N/A	3°	1.5°

A. The JGI frame, vertical non-balanced compressor, is not to be applied offshore.

With a dry sump, drains are supplied at each end of the compressor frame and an additional oil pump chain oiler is provided by Ariel. The packager must provide a lube oil reservoir sized and located so that the oil pump has oil suction regardless of the tilt of the ship or floating platform. An oil sump strainer must be installed in the pump suction line at the outlet of the separate lube oil reservoir (unmounted strainer is provided by Ariel with a new dry sump compressor). Refer to the Ariel outline drawings for connection sizes and locations.



- Oil Connections** (See Ariel Outline Drawing for Details)
- A1 Packager Connection from Compressor Driven Oil Pump
 - A2 Packager Connection to Oil Filter
 - A3 Packager Connection - Oil from Compressor Crankcase
 - A4 Lube Oil Compressor-Inlet-Connection to Gallery Tube. Oil Flows to the Crankshaft Main Bearings and through Drilled holes in the Crankshaft to Connecting Rod Bearings. From there, through Drilled Holes in the Connecting Rods to the Crosshead Pins and Crosshead Bushings.
 - A5 Pressure Regulating Valve Return Connection to Crankcase, when applicable on some models
 - A6 Filter Vent Return Connection to the Crankcase, when applicable on some models
 - A7 Oil Tubing Connections from Frame Gallery Tube to Top & Bottom of the Crosshead Guides to Lubricate Crossheads
 - A8 Compressor Crankcase Oil Drain

- System Components**
- 1. Y - Strainer - Required (supplied unmounted by Ariel)
 - 2. Compressor Driven Oil Pump (w/ Safety Relief Valve - used as a pressure regulating valve, or for some models when a separate regulating valve (6) is provided, as a relief valve)
 - 3. Thermostatic Control Valve, 170°F (77°C) nominal rating - Required (available as an option from Ariel)
 - 4. Pre-Lube Oil Pump - Required (with oil heating circuit when applicable)
 - 5. Oil Filter
 - 6. Pressure Regulating Valve (w/ Overflow Return to Crankcase), when applicable for some models
 - 7. Oil Cooler - Required
 - 8. Check Valve
 - 9. Separate Lube Oil Reservoir (Oil Sump) - Required

FIGURE 4-9: FRAME LUBE OIL SYSTEM SCHEMATIC - TYPICAL OPTIONAL DRY SUMP

Oil System Cleanliness

The compressor frame oil piping system and components are to be free of foreign matter including, but not limited to dirt, sand, rust, mill scale, metal chips, weld spatter, grease and paint. It is recommended that a commercial pipe cleaning service be used to clean the oil piping system. If that is not practical, proper cleaning procedures using cleaners, acids, and/or mechanical cleaning are to be used to meet the cleanliness requirements. Cleaning by-products are to be properly disposed; a disposal service is recommended. It is also recommended that all oil-piping systems be flushed using an electric or pneumatic driven pump and filtered clean production oil. All compressor frame cavities are thoroughly cleaned prior to assembly and compressors are test run with a filtered closed loop lube system at the Ariel factory.

For all compressors that are installed with an electric or pneumatic powered pre-lube pump, which have less than 50 feet (15 m) of oil piping are to be flushed as follows, prior to starting the compressor. The cooler oil passages are to be included in the flushing loop. Oil systems for compressors without an electric or pneumatic powered pre-lube pump, which have less than 50 feet (15 m) of oil piping, must be clean and while oil flushing is desirable for these systems, it is not a requirement.

Prior to assembling the lube oil piping remove scale, weld slag, rust and any other matter that could contaminate the lube oil.

Confirm:

- The entire lube oil system is complete and closed.
- The crankcase is filled to the correct level with the appropriate oil.
- The proper lube oil filters are installed correctly.
- The oil pressure transducer or gauge, oil filter differential-pressure transducers or gauges, and oil temperature RTD or indicator are operational and values are viewable.

Start the pre-lube pump, record the oil pressure, oil filter differential-pressure and oil temperature. Minimum measured oil pressure should be 30 psig (2.1 bar_g) for effective flushing. Do not exceed 90 psig (6.2 bar_g).

A continuous hour of pre-lube flushing time must be achieved with an oil filter differential-pressure increase less than 10% of the measured oil pressure into the filter. Record the oil pressure, oil filter differential pressure and oil temperature at 15 minute intervals. If the oil temperature increase is greater than 10°F (5.5°C) during an hour of run time, it is not a valid test of system cleanliness, due to oil viscosity change.

If the differential pressure or temperature increases exceed the limits in the paragraph above, after an hour of pre-lube flushing, continue the flushing operation. Whenever the lube oil filter differential pressure exceeds the change filter limits, stop the pre-lube pump and change the oil filter. Re-set time and continue the flushing operation until a continuous hour of flushing time is achieved within the differential pressure and temperature increase limits to ensure system cleanliness.

For all compressors with an oil piping system greater than 50 feet (15 m), cleaning and flushing must result in a cleanliness level to ISO-4406, Grade 13/10/9 and/or NAS-1638, Class 5 (reference Tables below), prior to starting the compressor.

See Tables below and ISO-4406 "International Standard - Hydraulic fluid power - Fluids - Method for coding level of contamination by solid particles" and/or NAS-1638 "National Aerospace Standard, Aerospace Industries Association of America, Inc. - Cleanliness Requirements for Parts Used in Hydraulic Systems" for complete information. Utilize a competent oil laboratory for sample testing.

TABLE 4-6: OIL FLUSHING CLEANLINESS REQUIREMENTS

ISO-4406 Grade 13/10/9		
Grade Requirements	Particle Size µm/mL Oil Sample	Number Particles Allowed
/13	Greater than 4	40 to 80
/10	Greater than 6	5 to 10
/9	Greater than 14	2.5 to 5
NAS-1638 Grade 5		
Particle Size Range µm/100mL Oil Sample	Grade 5 Maximum Number Particles	
5 to 15	8,000	
15 to 25	1,424	
25 to 50	253	
50 to 100	45	
Over 100	8	

Force Feed Lubrication System - Description

The force feed lubrication system provides oil to the compressor cylinders and the piston rod packings.

Oil is supplied to the 150 micron sintered bronze filter on the suction side of the force feed lubricator pump directly from the pressure side of the frame lube oil system, or from an overhead tank. Oil from the filter is supplied to a header and to the lubricator pumps on the lubricator box.

The lubricator box has its own oil reservoir to lubricate the worm gear and cam. The reservoir is self-contained and is not fed by the lube oil system. A sight glass on the lubricator box will show the oil level in the lubricator reservoir.

There are 1/4 inch tube fitting connections in the discharge lines near the force feed lubricator pumps through which the force feed lubrication system may be primed.

Next in the discharge lines are blow-out (rupture) disks. If there is a blockage in the system, the pressure build-up will rupture the disks. Venting the system through the blow-out disk causes the no-flow shutdown switch to close.

The oil then travels to the distribution blocks. It is here that the lubricating oil is apportioned to provide the exact amounts to the cylinders and packings. The pistons in the intermediate sections of the distribution block move back and forth in a continuous cycle, forcing lubricant successively through the several outlets as long as lubricant is supplied under pressure at the inlet.

Each outlet has a check valve to prevent oil from backing up in the block. An indicator on the block shows the rate at which the block is cycling.

From the distribution blocks, oil travels to the cylinders and packings. The system provides 1 inch min. (25 mm) of head at the guide and cylinder inlets to help ensure long check valve life.

Some of the oil to the packing travels through to the cylinders, but the bulk of it is drained out through the pressure vent/drain fitting on the bottom of the crosshead guide and through the atmospheric drain also in the bottom of the guide.

An oil level control valve, supplied by the packager and mounted on the skid, maintains proper level in the crankcase sump to replace oil used in cylinder lubrication.

Force Feed Lubricator Adjustment

See instructions under “Force Feed Lubricator Adjustment” in Technical Manual Section 3.

NOTE: THE FORCE FEED SYSTEM MUST HAVE A BLOW-OUT FITTING WITH A PROPERLY RATED RUPTURE DISK, INSTALLED BETWEEN THE FORCE FEED LUBRICATOR PUMP AND THE NO-FLOW SHUTDOWN. THE DISK COLOR SHOULD SHOW AT THE FITTING BLOW-OUT HOLE. THE FORCE FEED SYSTEM MUST HAVE A WORKING NO-FLOW SHUTDOWN SET TO ACTUATE WITHIN THREE TO FIVE MINUTES AFTER INTERRUPTION OF THE LUBRICATOR OIL FLOW.

CAUTION!: USE A MIRROR TO VISUALLY INSPECT FOR RUPTURE DISK COLOR, IF THE FORCE FEED SYSTEM IS PRESSURIZED. A RUPTURING DISK OR HIGH PRESSURE OIL CAN POTENTIALLY CAUSE PERSONAL INJURY.

Blow-Out Fittings, Rupture Disks and Tubing

TABLE 4-7: BLOW-OUT FITTINGS, REPLACEMENT RUPTURE DISKS & TUBING

BLOW-OUT FITTING ^A		REPLACEMENT RUPTURE DISK ^B			STANDARD TUBING - 304 SS ^C		
TYPE	ARIEL P/N	RATING psig (bar _g)	ARIEL P/N	COLOR	SIZE in. (mm)	RATING psig (bar _g)	ARIEL P/N
Lincoln	A-0080	3250 (224)	A-0124	Purple	1/4 x 0.035 wall (6.4 x 0.9)	5100 (352)	PT0200CB
Lubriquip	A-3531	3700 (255)	A-3536	Yellow			
Lubriquip	A-3532	4600 (317)	A-3537	Red			
Lubriquip	A-3533	5500 (379)	A-3538	Orange	1/4 x 0.065 wall (6.4 x 1.7)	10,200 (703)	PT0201CD
Lubriquip	A-3534	6400 (441)	A-3539	Pink ^D			
Lubriquip	A-3535	7300 (503)	A-3540	Blue			

A. Be sure to apply the proper rupture disk to match your blow-out fitting type (see Figure 4-10: on page 4-29 and Figure 4-11: on page 4-29), and application pressure. Generally the rupture disk should be rated about 1000 psig (70 bar_g) greater than the highest MAWP cylinder.

B. See Technical Manual Section 1, Fastener Tightening Values Table or the toolbox torque tables (ER-63) for blow-out fitting cap tightening torque. Do not over tighten cap or blow-out pressure can be reduced.

- C. All tubing down stream from a force feed pump for a pump circuit rated 5500 psig (380 bar_g) or greater (orange, pink and blue disks), that is circuits with any cylinders greater than 3600 psig MAWP (248 bar_g), should be 1/4 inch x 0.065 (6.4 x 1.7 mm) heavy wall stainless steel high pressure tubing. Rated tubing pressures are calculated from equations in ASME/ANSI B31.3 code for pressure piping, based on maximum outside diameter and minimum wall thickness. When grade 316 stainless steel tubing is specified on new compressor sales orders, 1/4 inch x 0.065 (6.4 x 1.7 mm) tubing is provided, regardless of rupture disk or cylinder ratings.
- D. Color code changed to pink (3/20/05) was uncoated aluminum.

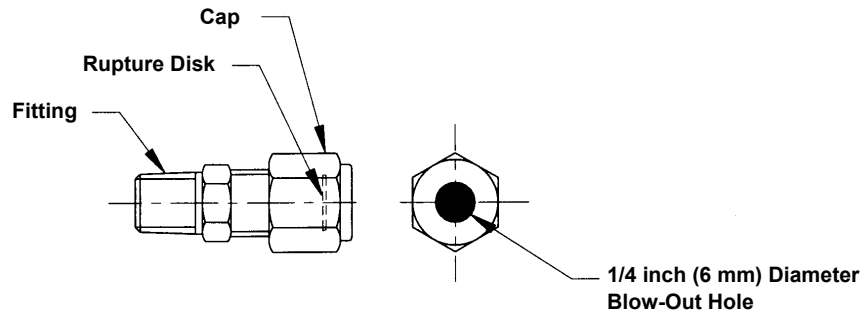


FIGURE 4-10: LINCOLN ST. LOUIS BLOW-OUT FITTING ASSEMBLY

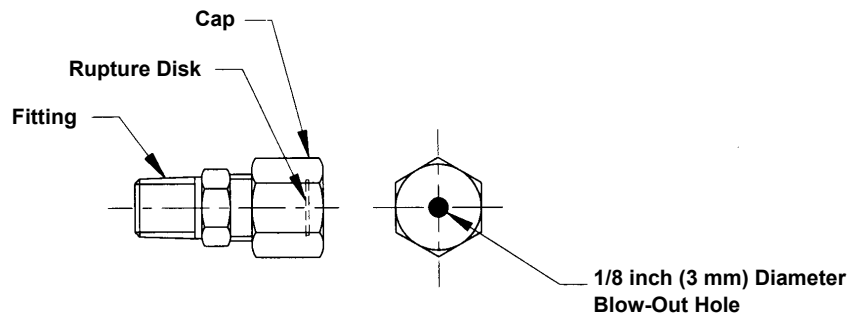


FIGURE 4-11: LUBRIQUIP BLOW-OUT FITTING ASSEMBLY

Divider Valves

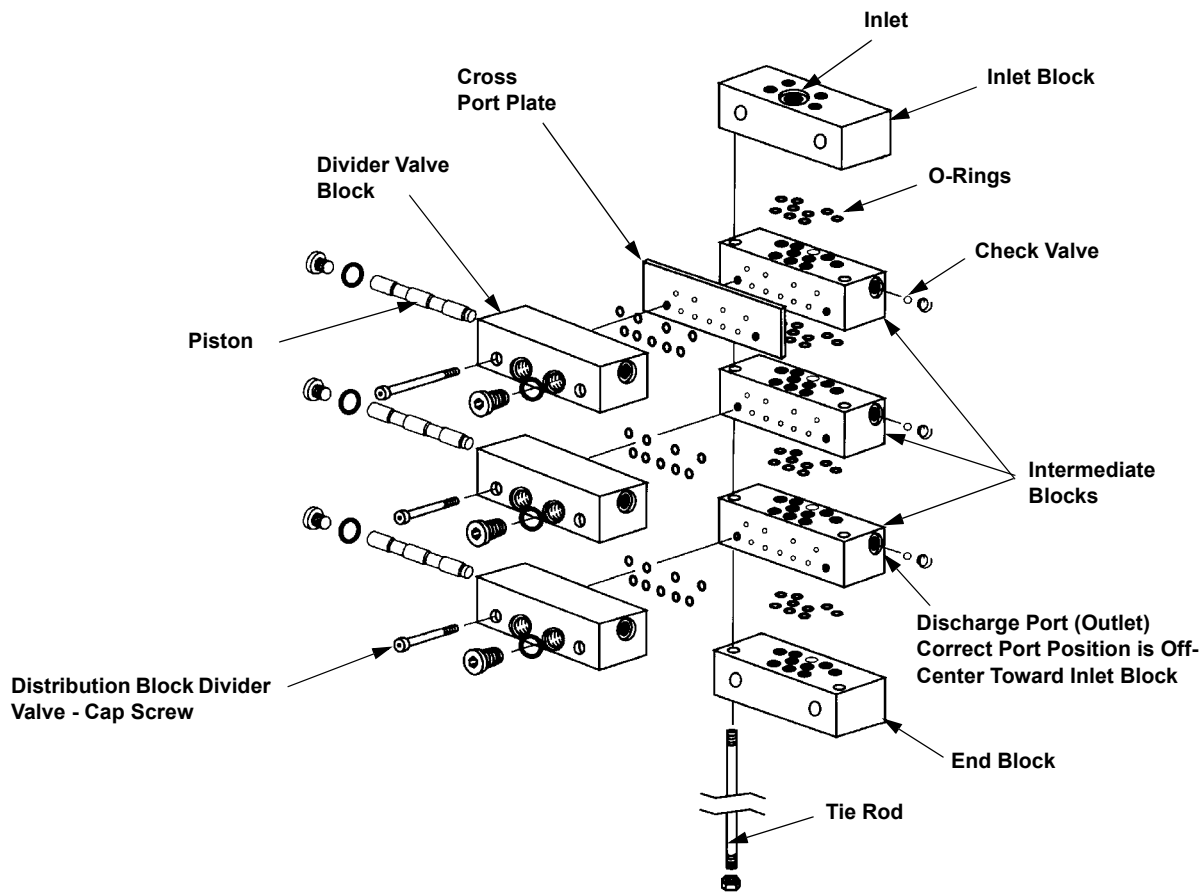


FIGURE 4-12: DIVIDER VALVES DISTRIBUTION BLOCK - TYPICAL

NOTE: REFER TO PARTS BOOK FOR THE FRAME BEING SERVICED FOR ASSEMBLY DRAWINGS, PARTS LIST AND REPAIR KITS THAT ARE AVAILABLE FOR DIVIDER VALVES.

Description

Divider valves are comprised of three to eight valve blocks fastened to a segmented baseplate. O-rings are used to seal between the valve blocks and the base plate and between the base plate segments. These divider valves are used in a single line, progressive lubrication system and can be used for dispensing oil or grease. Valves and base plate segments are supplied with Viton O-rings (90 Durometer).

Check valves are installed at the outlets of all lube ports.

Valve blocks containing metering pistons discharge a predetermined amount of lubricant with each cycle. Valve blocks can be single or twin and can be externally singled or cross-ported. Outlets not to be used when singling or cross-porting must be plugged.

A by-pass block can be used in any position on the base plate. The use of a by-pass block allows the addition or deletion of lubrication points without disturbing existing tubing. Both outlets

under a by-pass block must be plugged.

The valve blocks and by-pass blocks are fastened to a base plate mounted on the machine to be lubricated. The base plate contains the divider valve's inlet and outlet connections, interrelated passageways and built-in check valves. All piping of lubricant to and from the divider valve is connected to the base plate.

The base plate consists of one inlet block, three to eight intermediate blocks, one end block and three tie rods. O-ring seals are included with the base plate segments. The valve block capacity of each base plate is dependent upon the number of intermediate blocks in the base plate. There must be a minimum of three working valves on each valve and base plate assembly.

Divider Valve Block Assembly Instructions

1. Screw three tie rods into inlet block until ends are flush with surface of block. Reference Figure 4-12: on page 4-30.
2. Slide intermediate blocks onto tie rods being sure that all O-rings are installed, and the discharge ports are off center toward the inlet block.
3. Slide end block onto tie rods.
4. Lay base plate assembly on flat surface and tighten nuts to the torque value given in Section 1.
5. Mount divider valves with O-rings onto base plate and tightening mounting cap screws to the torque value given in Section 1, in alternating steps.

Operation - (see Figure 4-13: and Figure 4-14:)

The inlet passageway is connected to all piston bores at all times with only one piston free to move at any one time. All outlets are provided with check valves.

As section 3 piston moves to the right, to position all pistons at the far right, lubricant flows to Outlet 6, see illustration 1. In this position, high pressure lubricant from the inlet through interconnecting passages flows against the right end of the section 1 piston.

Lubricant flow shifts section 1 piston from right to left dispensing lubricant to Outlet 1 (see illustrations 2 & 3). Section 1 piston shift directs lubricant flow against the right side of section 2 piston (see illustration 3).

Lubricant flow shifts section 2 piston from right to left dispensing lubricant to Outlet 2 (see illustrations 4 & 5). Section 2 piston shift directs lubricant flow against the right side of section 3 piston (see illustration 5)

Lubricant flow shifts section 3 piston from right to left dispensing lube to Outlet 3 (see illustrations 6 & 7). Section 3 piston shift directs lubricant flow against the left side of section 1 piston (see illustration 7).

Lubricant flow against left side of section 1 piston begins the second half-cycle which shifts pistons from left to right dispensing lubricant through Outlets 4, 5 and 6 of the divider valve (see illustrations 8 through 12 and illustration 1).

If pistons refuse to move, bleed off pressure on divider block and check for air lock in one or more valve ports by manually shifting a piston from right to left. Remove end plug and push piston with a clean soft rod that will not damage the bore.

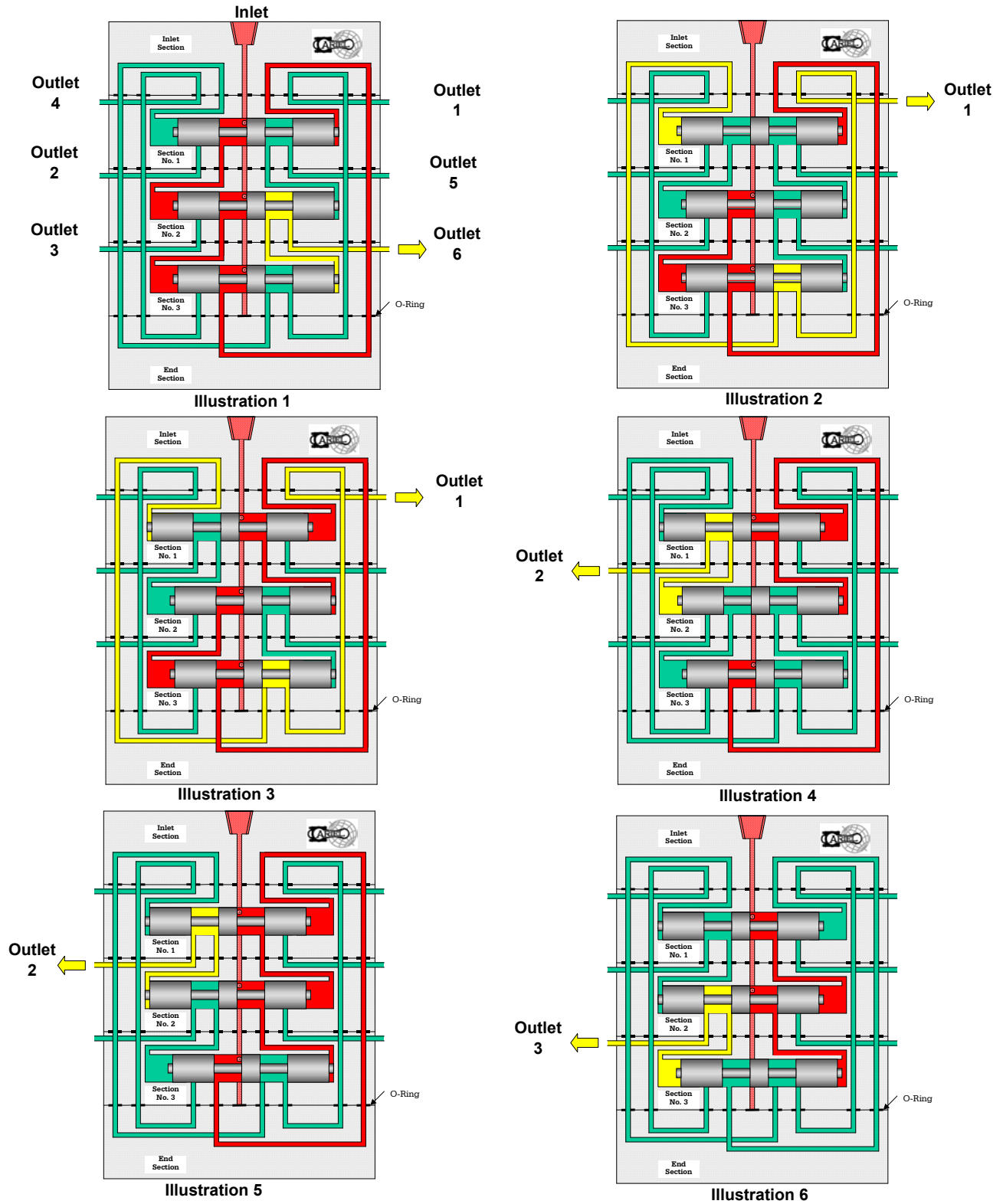


FIGURE 4-13: DIVIDER VALVE OPERATION SCHEMATIC - 1 THROUGH 6

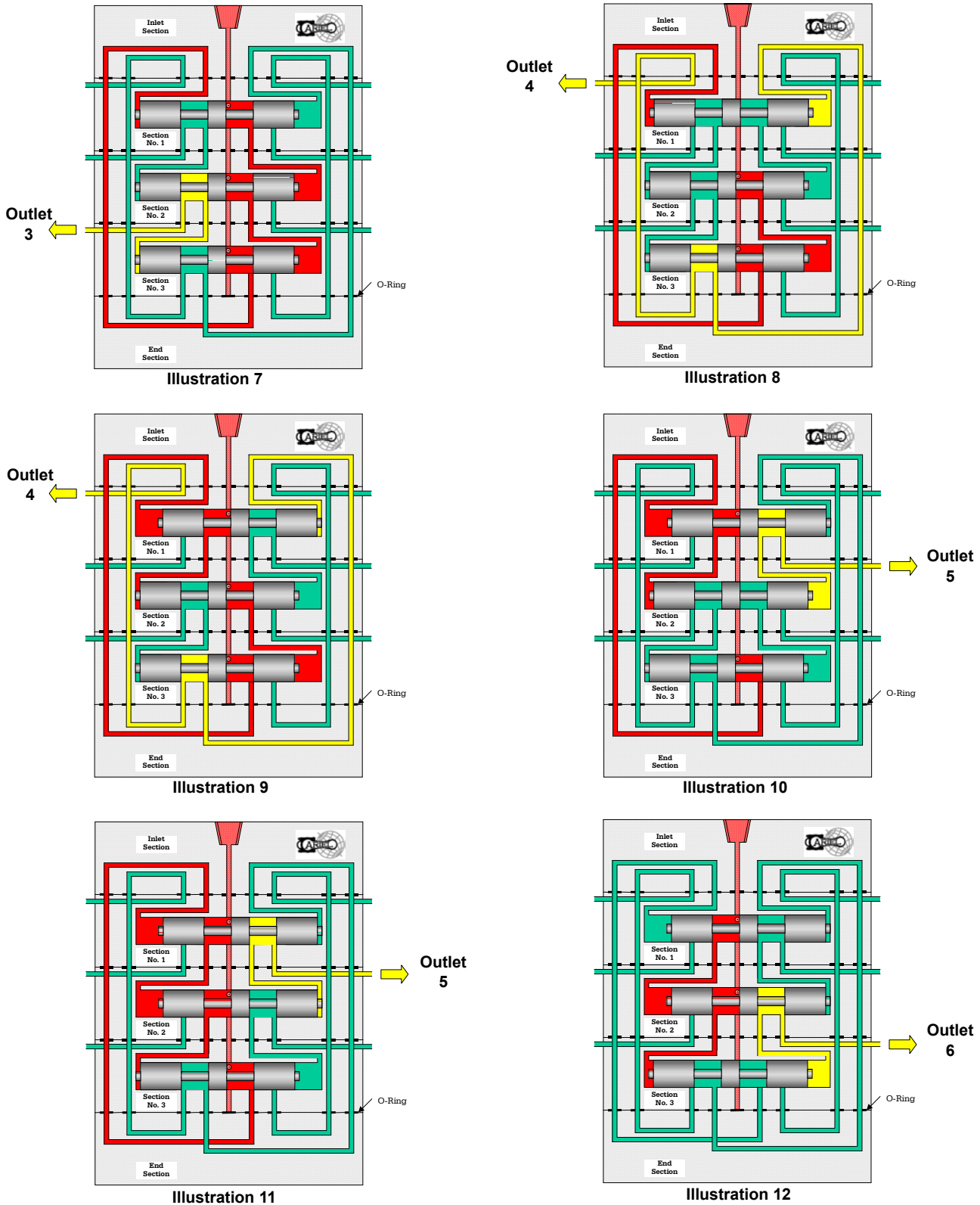


FIGURE 4-14: DIVIDER VALVE OPERATION SCHEMATIC - 7 THROUGH 12

Pressure Testing For Divider Valve By-Passing

Divider valve piston to bore are metal to metal sealing surfaces. Lubricant by-passing can result from excessive clearance between the piston and bore due to wear. Pressure test all divider blocks that are in service yearly, and replace any divider valves that fail to pass. Testing helps to ensure the piston to bore clearances are close enough to build adequate pressure to force oil into the injection point. All new Ariel divider valves are provided pressure tested by the supplier.

To test divider blocks for valve by-passing, a manual purge pump equipped with a pressure gauge, and capable of developing 5000 psig (350 bar_g) is necessary. Such a force feed lubrication hand purge pump with a pressure gauge is available from Ariel as an optional purchase tool. For pressure testing the divider block use a 10-weight oil at room temperature to simulate a hot lubricant. Test each divider block assembly complete with pin indicators installed. Test only one divider valve at a time.

Place the divider block assembly in an open container with all base outlets open. Connect the purge pump to the inlet of the divider block assembly. Operate the purge pump to cycle the divider block several times to purge air from the assembly and verify that oil will flow freely from all outlets. Divider blocks should cycle at less than 300 psig (21 bar_g). See Figure 4-15: "Divider Block All Outlets Open".

Divider valves stamped with a "T" are to have only one outlet on the base plugged during testing of that side of the piston. Each base outlet of the divider valves stamped with a "T" must be plugged and tested one side at a time. See Figure 4-15: "Testing "T" Divider Valve". Individual testing of each outlet ensures both sides of the piston will build adequate pressure. All divider valves stamped with an "S" on the front are to have both outlets on the base plugged to test for by-passing. See Figure 4-15: "Testing "S" Divider Valve". This will test both sides of the piston at the same time.

Plug the outlet on the base behind the divider valve being tested with a 1/8 inch pipe plug. If a tubing fitting is installed in the base, plug the fitting with a tubing plug. Leave all other outlets open. Operate the purge gun until the pressure gauge indicates 3000 psig (207 bar_g). The block may cycle once or twice, but should pressurize to 3500 psig (241 bar_g) immediately. Stop pumping oil into the divider block at 3500 psig (241 bar_g). Check the plug(s) in the discharge outlet(s) to confirm there are no external leaks. If the pressure gauge on the purge gun drops suddenly and oil squirts from the other outlets, a by-pass condition exists. The piston is worn and is allowing oil to by-pass. The pressure gauge should not lose more than 1000 psig (69 bar_g) during a 30-second test period. Note: Testing the divider blocks at higher pressures is necessary if the application dictates a higher system operating pressure.

If a divider valve does not pass, it must be replaced. Discard worn divider valves. If the tested valve does not lose more than 1000 psig (69 bar_g) in 30 seconds, relieve the pressure, move the plug to the next outlet and repeat the test for all divider valves. When divider valves have passed pressure testing to this procedure or have been replaced, a divider block may be reassembled, purged with the proper force feed lubricant being used and put into service.

By the nature of this divider block pressure testing procedure, in a static position through the divider valves above, it is not infallible. Periodic testing for proper lubrication rates in the cylinder bore and/or aftermarket devices that measure flow are recommended.

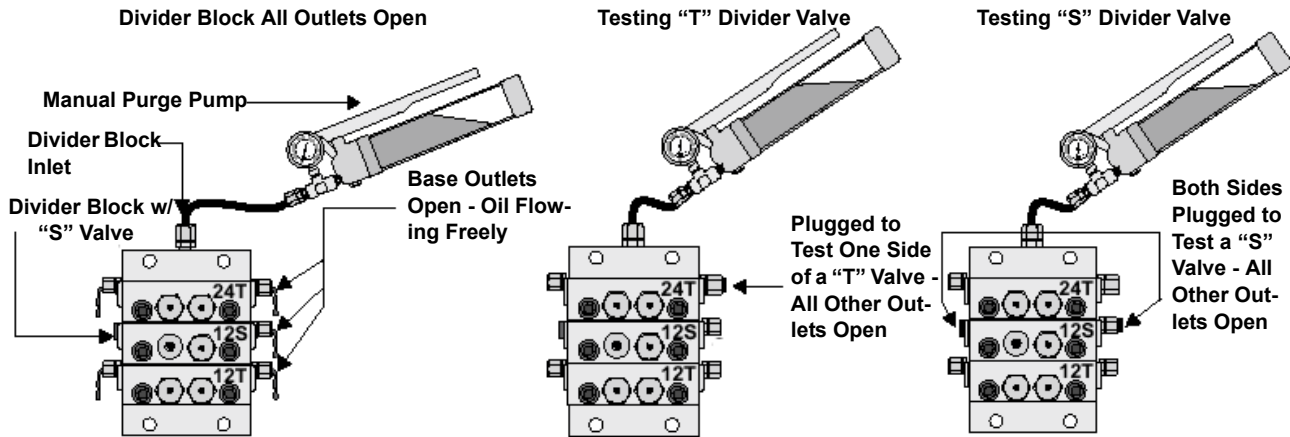


FIGURE 4-15: PRESSURE TESTING DIVIDER BLOCKS

Electronic Lubricator Fluid-Flow Monitor/No-Flow Timer Switch - Proflo

The **Proflo** is a battery powered programmable electronic microprocessor-based switch used to sense slow-flow or no-flow conditions in the compressor cylinder force feed lubrication system to facilitate alarm and/or shutdown. It also has many features that can help ease the operation of the force feed lube system by allowing accurate monitoring of the cycle time and system performance. This information may be used to optimize force feed lube and reduce operating costs. The Proflo fluid-flow monitor is shown in Figure 4-16: below.

If a DNFT (electronic-lubricator digital no-flow timer switch) is supplied in lieu of a Proflo, see “Electronic-Lubricator Digital No-Flow Timer Switch - DNFT” on Page 4-46.

The Proflo monitor works through a magnetic pin that cycles back and forth as the divider valve piston moves. The magnetic pin housing is normally screwed into the divider valve block, the monitor box housing slides on to the pin housing and is held in place by two (2) hexagon-socket set screws.

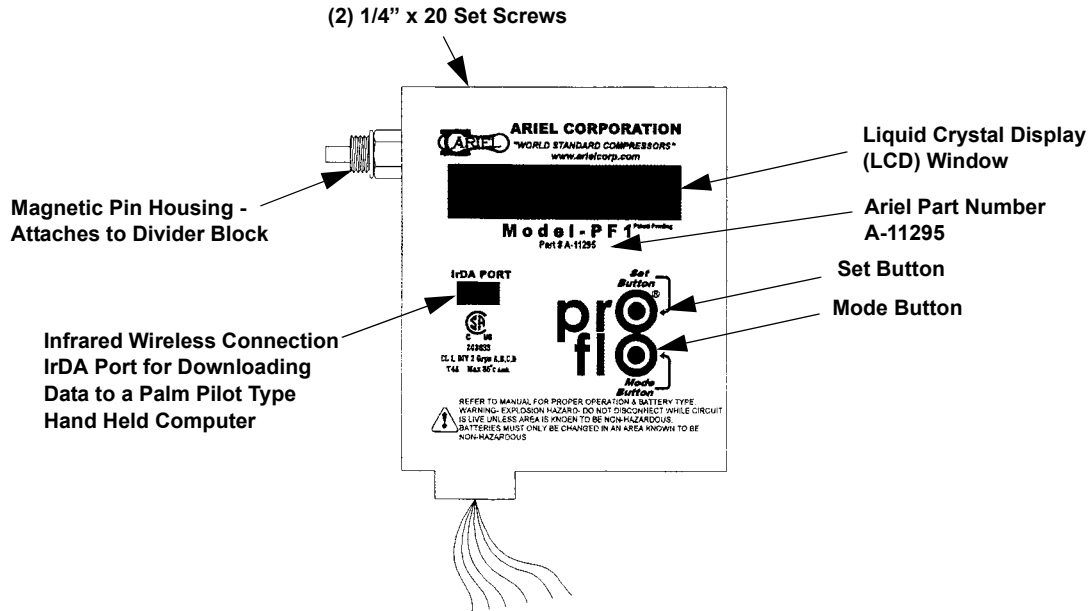


FIGURE 4-16: Electronic Lubricator Fluid-Flow Monitor & No-Flow Timer Switch - Proflo

The front face of the monitor box housing has a liquid crystal display (LCD) window to provide a visual indication of the following:

1. Total operating time of the force feed lube system in hours.
2. "Average", "Last" and "Current" cycle time of the divider block in seconds.
3. Total divider block cycles.
4. Remaining battery power life in percent.
5. Alarm set time for no-flow indication (programmable 30 to 240 seconds).
6. Alarm wiring mode: Normally Open or Normally Closed.

Proflo Monitor wiring identification and instructions for electronic indication:

NOTE: IF THE PULSE OUTPUT (BLUE WIRES) AND ALARM CIRCUIT (RED WIRES) ARE TO BE USED AT THE SAME TIME, PLEASE REFER TO "Proflo - Using Pulse Output and Alarm Circuit at Same Time:" on Page 4-43.

Blue Wires:

Pulse output. The two (2) blue wires can be used to send a transistor pulse output for each divider block cycle to a PLC (Programmable Logic Controller), Scada System, Digital Counter or Digital Control Panel. Maximum switching load is 36 Vdc @ 500mA. **Insulate blue wire ends from each other and conduit or compressor ground when not in use.** Pulse duration is 500 milliseconds. Switch output operation: Pulse represents 1 divider block cycle or period.

White Wires:

Switch input. Remote mounting Proflo display. The two (2) white wires can be connected to a dry contact proximity switch. This allows remote mounting of the monitor box housing in a convenient location on the compressor frame or in the control panel. Ariel recommends distance between proximity switch and the panel mounted Proflo should not exceed 600 feet (183 m). Please refer to Proflo operating notes for more information. **Insulate white wire ends, from each other and from ground, when not in use.** For panel mount kit, see "Proflo Accessories Available From CCT:" on Page 4-45.

Red Wires:

Alarm switch output. The two (2) red wires are for a no-flow alarm contact. This can be used for alarm or shutdown no-flow indication at a control panel. When the divider block cycles this contact closes when in Normally Closed (NC) operation and opens when in Normally Open (NO) operation. The contact returns to static state when the preset timer times out. Switching Capacity: 36 Vdc @ 500 mA max. **Insulate red wire ends from each other and from ground when not in use.** This output operation is programmable as NO or NC. Ariel recommends using a NC system for fail-safe operation. Red wires are not polarity sensitive. See "Proflo Normally Open and Normally Closed Definition:" on Page 4-42.

Green Wire:

The green wire must be securely grounded to an "earth ground" on the compressor frame or in the control panel. Do not ground to the electrical conduit. Improper grounding can result in unreliable operation of the monitor.

NOTE: TO SWITCH TO 120/240 VAC LOAD USING THE PROFLO OUTPUTS, A RELAY INTERFACE MUST BE USED. SEE "Proflo Accessories Available From CCT:" ON PAGE 4-45.

Proflo Button Operation:

Following is a description of how an operator can use the Proflo buttons.

1. First push set button on the front of the monitor box housing to clear ALARM and the LCD will display **LAST** and **AVE**. When this is done the alarm output contact will go to the as running state. If the operation is set to **NC** then the output alarm contact will close.
LAST is the last divider block cycle time in seconds.
AVG is the average time of the last six (6) divider block cycles in seconds.
2. Push the mode button once and the LCD will display **NOW**.
NOW is the current divider block cycle time in seconds.
This mode allows the operator to accurately change the cycle time by adjusting the force feed lubricator pump. Break-in and normal lube timing in seconds per cycle is given on the force feed lubricator data plate on the lubricator box at maximum rated speed, based on the gas operating conditions provided to Ariel (or clean, dry 0.65 S.G. sweet natural gas, rated speed and discharge pressures if no conditions were provided), when plate was installed. At reduced compressor speeds cycle time may be increased in a directly proportional relationship. At 50% rated speed the lube cycle time is doubled (see lube sheets provided in the Ariel Parts Manual for table of speeds vs. cycle timing).
3. Push the mode button again and the LCD will display **RUN TIME**.

- RUN TIME** is the total run time of the lube system in hours since the last reset.
4. Push the mode button a third time and the **LCD** will display **CYCLE TOTAL**.
CYCLE TOTAL is the total divider block cycles since the last reset.
 5. Push the mode button a fourth time and the **LCD** will display **BATTERY - PCNT** If battery voltage drops below safe operating levels the monitor will go into **ALARM** mode.
BATTERY - PCNT indicates percent of remaining battery life.

The display mode will change to alarm when the Proflo goes into alarm. The display will default to LAST and AVG display when the divider block is cycling.

Downloading Proflo Data:

A hand held Palm operating system computer equipped with an infrared (IrDA) port and running Palm Operating System can be used to interface with the Proflo. CCT Fluid Flow Trending (FFT) software can be used to download operating data. Using this feature is not essential for compressor operation, but recommended for evaluating the force feed lube operation and reducing operating costs. See "Proflo Accessories Available From CCT:" on Page 4-45, for more info on the FFT software. The following information may be obtained:

1. Oil consumption for each 30-minute interval, of compressor operation.
2. Days of over and under lubrication.
3. Total oil consumption of compressor lube system
4. Daily and total lost dollars (US) for over lubricating.
5. Total divider block cycles,
6. Total run time of the compressor.

The Proflo monitor can store one year's worth of operating data in a first in, first out (FIFO) memory.

The FFT software can be used to reset Proflo memory. The reset time and date is recorded to the Proflo's Electrical Erasable Programmable Read Only Memory, (EEPROM).

To start the download push the SET button then push the mode button 5 times until the LCD displays SEND DATA? then push the SET button. Set the FFT software to accept the Proflo data and hold the handheld computer in a position to communicate with the IrDA port. The LCD will display SENDING. If there is no device to receive the data the LCD will display FAILURE and after 30 seconds return to LAST and AVG default display.

The software provides for conversion to Microsoft Excel files for trending and graphing.

Hand held Palm operating system computers are available at most electronic or discount stores or on the Internet.

For more details on this product and other Proflo accessories, see the Ariel web at www.arielcorp.com and/or contact your packager or Ariel.

Proflo Setup Alarm Time and Mode:

To setup the Alarm contact output operation, red wires, first push the SET button. Push mode button six (6) times until LCD displays SETUP?. Push SET button and the LCD will scroll to 1.

SET ALARM TIME. Push and release set button to change alarm-shutdown from 30 to 240 seconds. When the compressors leave Ariel this time is set to 120 seconds. **Ariel recommends setting the alarm time to 2 times the normal cycle time rounded up to the nearest 5 seconds. This time should not be less than 30 seconds or greater than 180 seconds.** Normal design cycle time can be found on a nameplate on the lube oil pump box.

The control system must be configured to shutdown the compressor for a no-flow indication. Push the mode button, two (2) more times and the LCD will scroll to SET ALARM MODE. Push set button to toggle from N/O normally open or N/C normally closed. **Ariel recommends using the NC operation.**

After wiring mode is set the monitor will automatically return to the LAST and AVG display in 30 seconds.

Proflo Battery Replacement:



Remove the six (6) Phillips 4-40 x 3/16 screws located in the battery cover on the back of the monitor box housing. The hole drilling will also accept 4-40 x 1/4 screws. Remove cover and gasket. Remove old batteries; remove clear plastic protective sleeves from old batteries and save sleeves. Discard old batteries in a responsible manner. Reinstall the plastic sleeves on two (2) new standard AA alkaline batteries and insert new batteries into the battery holder at the back of the monitor. Be sure that batteries are fresh, not scratched, and the negative/positive orientation is correct as installed. Re-assemble gasket, cover and screws. Do not over tighten screws. After replacing the batteries, press the mode button until LCD displays BATTERY, to allow monitor to check battery power and reset to actual remaining battery power.

All trending and configuration data are stored in the Proflo's EEPROM. Memory is not lost due to battery failure or battery replacement.

Proper battery installation is important. The outer case of AA batteries is the positive terminal of the battery. If the outer cover of the battery is scratched and touches the metal battery holder the battery will run down very quickly. The Proflo will display LOW BATT. Under this condition it is possible for one battery to completely run down and the second battery to reverse charge. To correct this, ensure installed batteries are not scratched and the plastic covers are installed on the new batteries. The protective plastic cover on the batteries and the gasket on the bottom of the cover ensure a tight battery fit. If the batteries are not installed tightly the vibrating compressor can cause a premature battery failure.

Warranty will be voided if the Proflo faceplate is removed. This does not apply to the bat-

tery cover.

Proflo Display Errors:

ALARM - Displayed when divider blocks are not cycling. This is normal when the divider block is not cycling. Programmed divider block cycle time has expired.

OVERLOAD - The Proflo electronics are protected using self-resetting fuses on the inputs. This error indicates there is a short in the wiring or the circuit is switching too large a load. To correct this, check wiring insulation for bare wires that are touching ground or each other. Insulate un-used wires or re-terminate wires. Proflo fuses will auto reset 45 seconds after a short is corrected.

LOW BATT - Indicates the batteries need to be changed. Refer to “Proflo Battery Replacement:” on Page 4-40.

RESET x - This is an internal Proflo fault, the alarm condition will not be issued. The Proflo is still counting divider block cycles and controlling the inputs and outputs. When the divider block is cycling the Proflo counts pulses and measures the time between divider block cycles. At 30-minute intervals the processor takes the data stored in memory and writes this to the on board EEPROMS. If there is a problem with this the Proflo will issue a Reset error.

Try to correct the problem by:

1. Removing Proflo batteries.
2. Hold down the set button for 45 seconds. Holding the set button discharges internal capacitors and ensures a complete reset.
3. Re-insert the batteries to reboot the Proflo.

*If the error was a one-time problem the Proflo will reboot as normal.

*If on reboot the diagnostics detect an error, the Proflo will display the constant RESET error again. Replace the Proflo and contact Ariel Corporation. Sometimes on reboot the Proflo will flash reset. This is normal.

RESET 1 -The Proflo processor was not able to determine if the EEPROM contains valid configuration information. Reset 1 is most likely to occur after a RESET 3 is reported. Upon Proflo reboot the stored configuration data will be lost and the programmed information will need to be reentered.

RESET 2 - The Proflo processor was not able to determine if any data has been stored or where the next data should go. Upon Proflo reboot the stored data will be lost. Configuration data will still be there and the programmed information will not need to be reentered.

RESET 3 - This is an internal Proflo fault. The Proflo processor tried and failed three resets. The most likely cause is failure to write to the EEPROM.

NOTE: THE MOST LIKELY CAUSE OF RESET ERRORS IS MOISTURE ON THE PROFLO CIRCUIT BOARD. SEVERAL DESIGN PRECAUTIONS HAVE BEEN TAKEN TO KEEP WATER AND MOISTURE OUT OF THE CIRCUIT BOARD CHAMBER. THESE INCLUDE:

1. The Proflo housing has been completely sealed in a low humidity room and will survive a 2300 psi (160 bar) power wash.

2. There is a desiccant pack in the circuit board chamber.
3. The circuit boards have a protective conformal coating.

Proflo Operation Notes:

1. If the alarm output is set for NC operation and the batteries are removed or go dead the Proflo will open the alarm contact. If the alarm operation is set to NO operation and the batteries are removed the alarm contact will remain in the open condition and the control system will not be told to alarm. For this reason Ariel recommends using the NC contact operation.
2. Proflo Default programmable settings.
This is as delivered to Ariel or reset using the FFT software.
Alarm trip time = 120 seconds
NC/NO settings = NO or non-fail safe
Ariel shop work instructions set outputs to:
Alarm trip time = 120 seconds
NC/NO settings = NC or fail-safe
Please see "Proflo Normally Open and Normally Closed Definition:" on Page 4-42.
Also see "Proflo Setup Alarm Time and Mode:" on Page 4-39.
3. Remote mounted Proflo and proximity switch. The Proflo will excite the proximity switch circuit with 3 volt battery power to detect the state of the proximity switch. Ariel has defined a maximum wire distance between the proximity switch and the remote mounted Proflo:
Maximum DistanceCondition
600 feet (183 m)Using standard Proflo batteries
10,000 feet (3050 m)Powering Proflo from other power source
The above distances are conservatively calculated based on the following assumptions/considerations:
 1. Standard 22 gage instrumentation wire at 68°F (20°C) in a continuous run.
 2. Not significantly degrading battery life.
 No electrical noise injected into wire run.
If the Proflo is to be panel mounted, Ariel recommends removing the batteries and using the power supply from CCT. See "Proflo Accessories Available From CCT:" on Page 4-45.
4. The Proflo will record any setup changes to the EEPROM.
5. The white wires on the Proflo can be used for other applications than reading divider block cycle times. The Proflo can record history of any dry contact switch. Example: history of a liquid dump valve, history of a high temperature switch, history of a valve limit switch.
6. The Proflo electronics is equipped with reverse polarity protection/correction. The electronics will automatically correct a reverse polarity output connection on both the pulse and alarm outputs.

Proflo Normally Open and Normally Closed Definition:

There has been some confusion among PLC programmers and electrical people over the definition of Normally Open (NO) and Normally Closed (NC) as applied to the DNFT. Most elec-

trical components define NO or NC operation as the default state or on the shelf state.

Example: A NO solenoid valve is open when the coil is not energized. When the coil is energized the valve will close. A NC solenoid valve is closed when the coil is not energized. When the coil is energized the valve will open. This logic is not used when defining the DNFT or Proflo electrical contacts. The DNFT and the Proflo use the same definition of NO and NC switch contacts. Definitions for Proflo and DNFT contact are switch states after the divider block has cycled.

NO = Normally Open when Running. Switch is open when the divider block is cycling. This is a non-fail-safe operation because if the unit is running and a wire falls off, the control system will not alarm/shutdown.

NC = Normally Closed when Running. Switch is closed when the divider block is cycling. This is the fail-safe operation because if the unit is running and a wire falls off the control system will alarm/shutdown.

Ariel recommends using Normally Closed (NC) configuration. The Ariel Proflo is provided from the Ariel factory programmed for NC operation.

The reason NO and NC are defined this way is that it is easier for mechanics and operators who do not have an electrical background to understand the switch state when the divider block is cycling.

Proflo - Using Pulse Output and Alarm Circuit at Same Time:

If the control system needs to read both the block cycling, proximity switch, and the alarm contact the following things must be taken into consideration.

1. The Proflo has an on board processor and data acquisition system (DAQ). The DAQ system records the time for each divider block cycle and stores this data to EEPROM. The data is accessible and can be downloaded through the Proflo infrared port to a Palm Operating System handheld computer with FFT software. Therefore, it may not be necessary to have the control system read and count the number of times the divider block cycles.
2. If a PLC is used to read the pulse output, the PLC may be programmed to watch for the divider block cycling and issue a shutdown if the block does not cycle for a given time. This may eliminate the need to wire to both Proflo outputs and save on field wiring connections.
3. The Proflo alarm output, red wires, and the divider block cycle output, blue wires, are not isolated from each other. If it is necessary to read both Proflo outputs, the isolation must take place on the equipment that is reading the contacts. If the PLC input card is not isolated between channels both the alarm and pulse outputs will act as the alarm contact. These contacts must also be isolated from other inputs. See Figure 4-17:

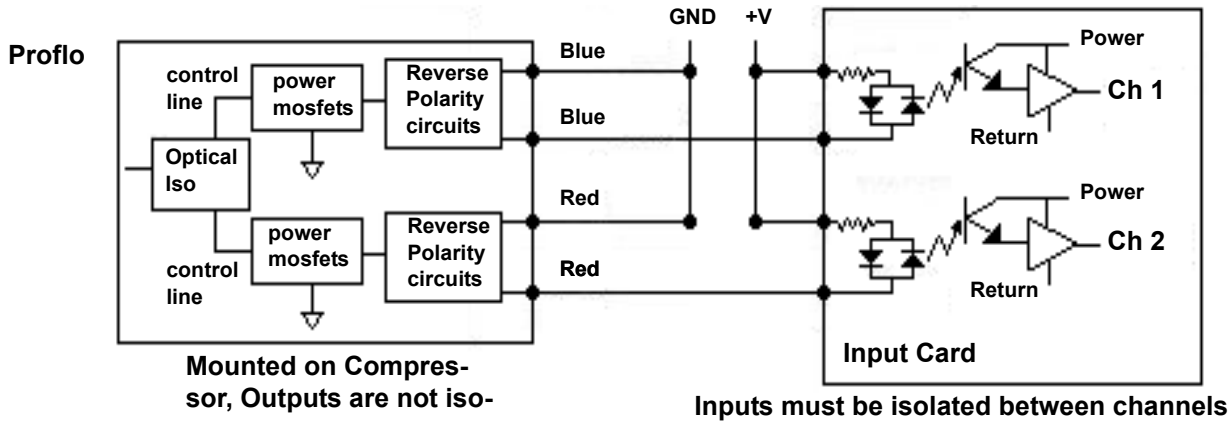


FIGURE 4-17: EXAMPLE DIAGRAM TO READ BOTH PULSE & ALARM CONTACTS

4. If Isolated inputs are not an option, another way to achieve the output signal isolation is to connect the alarm/shutdown contact to the safety system and install another proximity switch for the control system to read and calculate oil consumption. Refer to the “Proflo accessories available from CCT” section below for a CCT proximity switch part number.
5. If Isolated PLC inputs are not an option, yet another method of achieving isolation between the Proflo outputs and the PLC is to wire the Proflo to the "coil" side of a relay. Then use the contact side of the relay to the control system. There are relays on the market that are very cost effective. Ariel recommends using a solid state type relay for long life. See Figure 4-18:

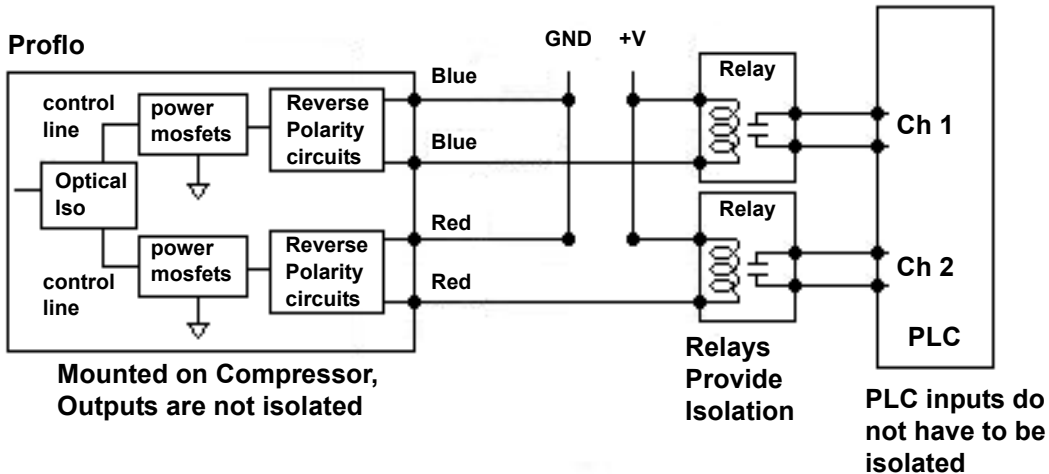


FIGURE 4-18: EXAMPLE DIAGRAM TO READ BOTH PULSE & ALARM CONTACTS - USING RELAYS

Some relays may require a current limiting resistor to keep from shorting the power supply through the relay coil. Many relays have a built in current limiting circuit. It is the responsibility of the control system designer to choose proper relay components.

Proflo - Using PLC to Calculate Oil Consumption:

Using the blue wires or the pulse output, it is possible for the control system to calculate the amount of oil the system uses. Following is an example of how to do this.

Example divider block:

<u>BLOCKS</u>	<u>IN³</u>	<u>X 2</u>
12T	0.012	0.024
18T	0.018	0.036
18T	0.018	0.036
6S	0.006	0.012
18T	0.018	<u>0.036</u>

$$0.144 \times 0.0346 = 0.004987 \text{ pints/cycle}$$

Blocks are numbers stamped into the divider blocks mounted on the compressor.

Block numbers divided by 1000 = volume, In³ (cubic inches).

x 2 are for each block moving in 1 full cycle.

0.0346 is the conversion from in³ to pints, US liquid (pints/in³).

(Divide pints by 8 = gallons, US liquid)

(Multiply gallons (US liquid) X 3.78541 = liters)

(Multiply pints (US liquid) X 0.47318 = liters)

The above calculation can be entered as a constant for each Proflo.

The PLC can then calculate a running total by adding 0.00497 pints, in this example, to a totalizer the whole time the compressor is running. This information can be used to track how much oil the compressor is using.

Proflo Accessories Available From CCT:

The following parts are available from CCT direct.

1. AC power supply for panel mount.
Panel mount power supply is for safe area only.
2. Panel mount kit. This kit includes the panel mount bracket and a proximity switch.
3. Relay interface module. Use this module if you want to switch an AC load 120/240 VAC @ 10 Amps.
4. Additional proximity switch.
5. Palm interface Fluid Flow Trending (FFT) software.

For more details on the Proflo and available accessories, see the vendor literature CCT on the Ariel web site at www.arielcorp.com and/or contact your packager or Ariel.

Protection of Electronics & the Compressor When Arc Welding

Any arc welding on the skid and/or associated equipment and piping can permanently damage solid-state electronic equipment. Welding can cause immediate failure or reduced life of such electronic equipment.

Protect the force feed lube flow monitor(s) prior to doing any arc welding (including repair welding) as follows: Disconnect all connections to the flow monitor including ground, and remove the batteries. Or completely remove the flow monitor from the compressor.

It is good practice to attach the welding ground clamp as close as possible to the area where the welding will occur and to use the lowest practical welder output setting. Welding must not cause a current flow across any compressor bearing surface, including but not limited to crankshaft and crosshead bearing surfaces.

Electronic-Lubricator Digital No-Flow Timer Switch - DNFT

When an Ariel DNFT is a microprocessor-based switch is supplied, it is used to sense no-flow or slow-flow conditions in the compressor cylinder lubrication system to facilitate alarm and/or shutdown. The DNFT also contains an amber light-emitting diode (LED) cycle indicator to provide a positive visual indication of system operation. The Ariel DNFT includes a proximity switch. The Ariel DNFT, usually supplied, is factory set for (3) three minutes from no-flow to alarm/shutdown signal and is not adjustable. Optional programmable models are also available. Introduced in September of 1996, the DNFT replaced the traditional mechanical no-flow switch and is optional on all new units. Since its introduction, the DNFT has undergone a series of design enhancements and several versions are in service. The current DNFT is shown in Figure 4-19:

The DNFT works through a magnetic pin which cycles back and forth as the divider valve piston moves, flashing the amber LED and indicating a complete cycle of the divider valve. The DNFT operates on a field-replaceable lithium battery. If battery voltage drops below normal operating levels, the DNFT goes into shutdown mode and compressor can not be re-started until battery is replaced.

Replacing the (Field-Replaceable) Battery in the DNFT:

1. Shut down the compressor
2. Disconnect wiring and loosen set screws. Remove DNFT housing to a safe atmosphere.
3. Use 3/8 inch ratchet wrench to remove the pipe plug.
4. Remove battery from the DNFT and disconnect from the polarized connector.
5. Connect the new battery (Ariel part number A-10807 or Radio Shack 960-0418) to the attached polarized plug.
6. Reinsert the battery and reinstall pipe plug.

7. Replace DNFT control housing on the magnet housing to original position and tighten set screws. Reattach wiring and conduit.
8. Verify the DNFT is working by pre-lubing the system and check for LED blink. See the Ariel web site - vendor literature - Whitlock for more details on DNFT's.

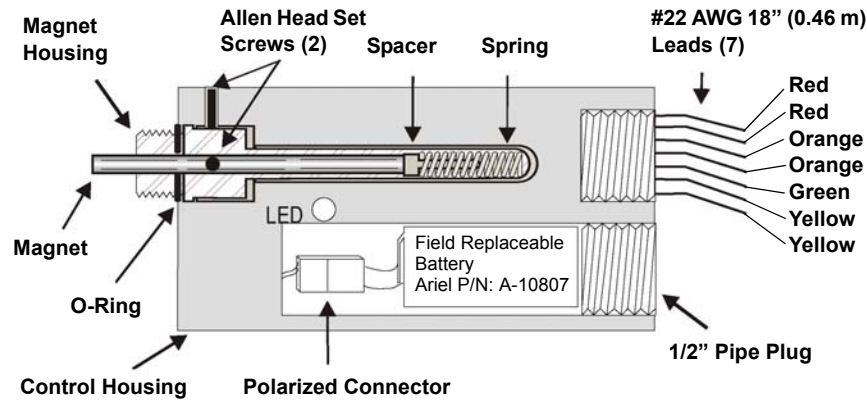


FIGURE 4-19: DIGITAL NO-FLOW TIMER SWITCH - (DNFT)

Oil Head at Lube Points

The force feed system provides a minimum of 1-inch (25 mm) of oil head at lube points to extend check valve life. Where the 1-inch (25 mm) of head is not inherent, an oil trap fitting is provided, see Figure 4-20: below.

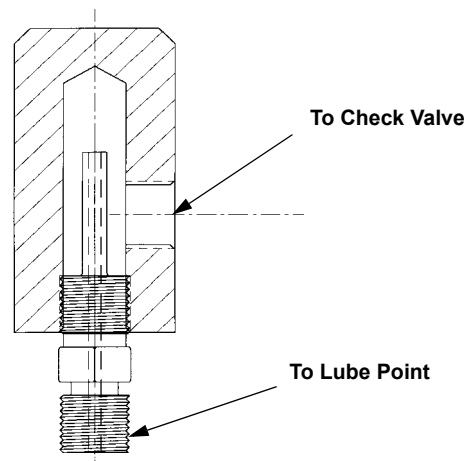


FIGURE 4-20: OIL HEAD TRAP FITTING

NOTE: PRESSURE IN FORCE FEED LUBE LINES IS, AS A MINIMUM, 110% OF THE CYLINDER SUCTION GAS PRESSURE.

Force Feed Lubrication System and Running Conditions

Force Feed Lubrication System

1. Check sight glass on lubricator reservoir to make sure it is properly filled with oil. The oil in the reservoir is used to lubricate the worm gear and cam; it does not flow through the system. The reservoir also catches lube pump overflow. Oil is added only if it becomes necessary to raise the reservoir oil level.

TABLE 4-8: FORCE FEED LUBRICATOR RESERVOIR OIL CAPACITY

LUBRICATOR TYPE - ARIEL DESIGNS	US GALLONS	LITERS
Single Pump	0.25	1
Dual Pump	0.5	1.75
Four Pump	0.8	3

2. The force feed system has been filled with mineral oil at the factory. If piping has been removed, or if the system has been drained, it can be filled and primed through a 1/8 inch plug on the discharge end of the lubricator pump.
3. Prime the force feed lubrication system just prior to starting the compressor using of a proper priming pump; refer to "Ariel Tools - Purchased Separately" in Technical Manual Section 7. Use clean force feed lubricating oil of same type and grade as being used in service. Do not use any other type or grade of fluid for priming.
4. If the unit has just been overhauled, adjust the lubricator for maximum delivery. Reference Technical Manual Section 5. Loosen the adjusting screw locknut. Turn the plunger stroke adjustment screw to the full up position. Tighten the adjusting screw locknut. Proper feed rate may be set after the machine is started.
5. When there are two or more pumps manifolded and feeding one distribution block, the best way to adjust them is equally. Start with pumps wide open, and adjust them together so that when the break-in cycle time is set, the pumps are stroking about the same. After break-in period, adjust the pumps in the same manner, provided that the final pump stroke is not too short. Try and keep the stroke greater than 20% of maximum; if set for less, the pump is not very reliable. If need be, one pump can be closed to stop its flow and the other pump(s) opened to make the "normal" cycle time, to maintain a stroke greater than 20% in the functioning pump(s).

Running Conditions

When the machine is running, make sure that the oil level in the lubricator reservoir is at least one-half way up the sight level, but does not exceed two-thirds.

See your packager's specific data to determine the normal operating conditions, the cylinder working pressures, and the rated speed.

System Design Considerations and Operating Parameters

To optimize force-feed lubrication system operation, Ariel uses the following general guidelines:

1. Minimal use of “master/slave” distribution blocks in favor of lubricator pumps dedicated to an individual distribution block.
2. Maintain lube ratios within prescribed limits and cycle times as low as possible (normally 10 sec minimum) to provide each point with lubrication as frequently as possible.
3. Multiple pumps with manifolding are used to ensure that 150% of the normal lubrication rate can be provided during break-in.
4. Pumps are not allowed to operate below 20% of full stroke, the point at which they become unreliable.
5. In some applications, to optimize operation of the lubrication system, a single divider section is used to deliver lubrication to both a packing and a cylinder.
6. In some applications, cross-porting of divider valves is used to deliver the proper proportion of lubricant to a given point.

Force Feed Balance Valves

Balance Valves may be used in high differential-pressure distribution-block applications to reduce system problems such as bypassing, no-flow switch errors or blown rupture discs. The force feed balance valve is shown in the figure below.

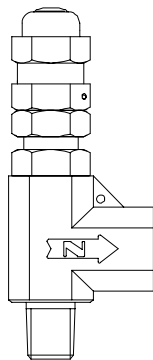


FIGURE 4-21: FORCE FEED BALANCE VALVE

Setting and Maintaining Balance Valves

Balance valves cannot be set prior to operating the unit. Ensure that all fittings are tight and any known leaks have been fixed.

Purge the force feed lube system with a high-pressure hand pump, using the same injection oil that is used in service, to remove any trapped air or gas in the system. See Technical Manual

Section 7 for pump illustration and part number. DO NOT USE ANY OTHER FLUIDS FOR PURGING!

Start up the compressor and bring up to normal operating pressure. After the operating pressures have stabilized, adjust the cap on the top of the balance valve if necessary. Loosen the locking nut on the top of the balance valve directly under the cap. Turn the cap clockwise to increase the pressure and counter clockwise to decrease the pressure. Retighten the locking nut against the cap.

Set the balance valves and maintain at approximately same pressure on each pressure gauge in the injection lines of the pump system affected. A system should be set and maintained within 500 psi (3400 kPa) total or less. The closer the individual line pressures are maintained, the more reliable the system will become.

Once the balance valves have been set, they should be checked 4 to 6 hours later to ensure the pressures have not changed and caused another imbalance. If readjustment is necessary the gauges should be checked again in 4 to 6 hours. If a pressure gauge in a line with a balance valve is reading more than 500 psi (3400 kPa) higher than the others, try to reduce the pressure on that particular injection line. If reducing the balancing pressure on the balance valve does not drop the pressure, then the other balance valves will need to be adjusted to match the highest pressure.

To set balance valves equipped with a distribution block inlet gauge only:

1. Start up the compressor and bring up to normal operating pressure. After the operating pressures have stabilized, with all balance valves backed off (zero spring load), note the highest gauge pressure reached in a complete block cycle.
2. Slowly increase the spring load on one balance valve, being careful to not exceed rupture disk rated pressure. Watch the gauge and if the maximum pressure increases, reduce the spring load until the highest pressure falls to the pressure noted in step 1, above. Tighten the lock nut against the cap, hand wrench tight.
3. Repeat step 2, for the remaining valve(s).

Maintain the system by recording the pressures and cycle times of the lubrication system at least once a day.

Checking/Adjusting Balance Valves on Subsequent Start-up

Ensure that all fittings are tight and any known leaks have been fixed. Purge the force feed system with a high-pressure hand pump, using the same injection oil that is used in service.

Start the compressor and bring up to normal operating pressure. After the operating pressures have stabilized, check the pressure gauges to ensure the system is still balanced. If one or more line pressures are out of balance, wait for 2 to 3 hours to see if they become balanced. DO NOT adjust the balancing valves immediately. It is possible that some lube points will increase in injection pressure after a short period of run time and the system will become balanced if it is not balanced on start up.

If a balance valve(s) was installed, but is not required, leave (or set) the spring adjustment at zero. If back-pressure on an unused balance valve is high enough, it may eventually begin to leak oil. In this case, replace the balance valve internal assembly with a plug assembly, Ariel

Part Number A-10330. DO NOT RUN UNIT WITH LEAKY BALANCE VALVES. A valve seal repair kit, Ariel Part Number A-8005-K, is also available.

Maintain the system by recording the pressures and cycle times of the lubrication system at least once a day. Readjust valves as required to keep pump systems pressure balanced for best results.

Frame Lubricating System - Description

The frame lubricating system supplies oil to the internal frame running gear. The cylinders are supplied with lubrication by the force feed system (see "Force Feed Lubrication System - Description" on Page 4-27). The oil level regulator outside of the crankcase, or separate oil sump in the case of a dry sump crankcase, maintains the proper oil level in the sump.

Frame lubrication is drawn from the sump through the suction strainer into the oil pump that is mounted on the crankcase auxiliary end cover. The pump's discharge is piped to an oil cooler mounted on the compressor skid and is temperature controlled with a thermostatic control valve. Oil returns from the cooler to the oil filter mounted on the auxiliary end of the crankcase. Pressure gauges are provided on the filter inlet and outlet. Normal pressure drop through a clean filter is 2 to 6 PSID (0.15 to 0.4 bar_d), at normal operating temperature.

From the filter, oil travels through a pressure regulator to an oil gallery cast in the crankcase and running the length of the crankcase.

Drilled holes from the gallery through the bearing saddles deliver oil to the crankshaft bearings.

Passages drilled diagonally through the crankshaft from the crank journals to the crank pins deliver oil to the connecting rod bearings.

Holes drilled through the length of the connecting rods deliver oil to the connecting rod bushing.

Oil travels from the bushing through holes drilled in the middle of the crosshead pin to the hollow crosshead pins, and from there to the crosshead bushings.

Drilled passages from the oil gallery deliver oil at full system pressure through external tubing to lubricate the top and bottom of each crosshead. Run-off from the shoes, crosshead, and connecting rod bushings collects in the crosshead guide and drains back to the crankcase.

Lube Oil Strainer, Filter & Filter Installation Instructions

Lube Oil Strainer

The strainer is located on the auxiliary end of the crankcase below the oil level. It is provided to protect the oil pump from debris that might cause damage. The strainer basket should be taken out and washed in an appropriate solvent whenever the lubricating oil is changed. For dry sump frames the lube oil strainer is shipped loose (not installed) from the Ariel factory.

Lube Oil Filter

Ariel recommends replacing the lube oil filter every 6 months, or 4000 hours, or when oil filter differential pressure reaches the value given in Table 4-9 or on the oil filter information plate located on the compressor frame top cover, at normal operating temperature; whichever comes first. Also clean the sintered element in the small oil filter supplied on the force feed lubrication system on the same schedule or every time main oil filter is changed.

TABLE 4-9: MAXIMUM DIFFERENTIAL PRESSURE TO CHANGE OIL FILTER OR ELEMENT(S)

TYPE FILTER	MAXIMUM P _D TO CHANGE FILTER ^A	
	PSID	bar _d
Spin-On Filter	10	(0.7)
Cartridge Type Element(s)	15	(1.0)

A. Or every six months, or 4000 hours, whichever comes first.

B. On start-up differential pressure may exceed the tabled limits until the oil reaches operating temperature.

Filter Installation for Spin-On Filters

1. Remove old filter, clean filter base surfaces, and be certain that old gasket is removed.
2. Fill filter with clean oil using same grade oil as in sump.
3. Apply clean oil to filter gasket.
4. After the filter gasket contacts the base, tighten one turn.
5. After starting the unit, check for leaks, and retighten if necessary.
6. Do not run unit with a damaged filter can. It can fracture or leak. Replace only with an Ariel approved filter.

Filter Element Installation Instructions for Cartridge Type Filters

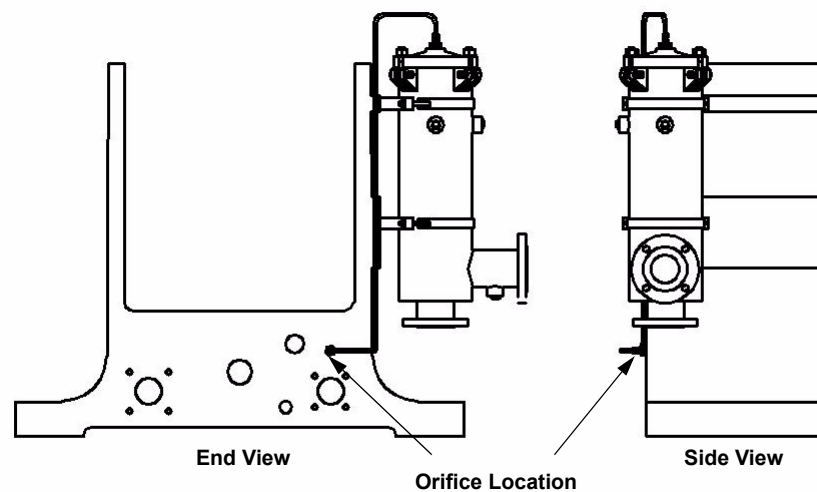
1. Remove drain plug and drain completely.
2. During draining, open vent and remove top cover. Remove spring plate assembly and strainer tube.

NOTE: REMOVAL OF THE ELEMENT PRIOR TO DRAINING THE HOUSING COMPLETELY, WILL ALLOW TRAPPED DEBRIS TO ENTER THE OIL HEADER AND CAN CAUSE SEVERE DAMAGE TO THE COMPRESSOR.

3. After oil has drained completely, remove old element and inspect interior of vessel. Clean as required.
4. Visually inspect the interior/exterior of the new element to ensure that it is free of any packaging/shipping materials.
5. Place new element over seat in bottom of vessel.
6. Insert strainer tube and reinstall spring plate assembly.

7. Inspect cover O-ring. Install cover. Tighten nuts to a torque setting of 70-80 lb-ft (95-110 N·m).
8. When changing the oil filter, remove flowing vent line and 1/16 in. (2 mm) orifice fitting, when supplied and blow out line with compressed air. Clean orifice with 1/32 in. (1 mm) diameter wire or standard paper clip (20/21 gage wire). Re-assemble vent line and orifice fitting.
9. Close drain and fill vessel with clean oil using the same grade oil as in the crankcase. Release trapped air through vent.
10. Check for leaks.

NOTE: FAILURE TO FILL FILTER VESSEL WITH OIL, PRIOR TO STARTING, CAN CAUSE SEVERE DAMAGE TO THE COMPRESSOR.



**FIGURE 4-22: OIL FILTER FLOWING VENT TO PREVENT AIR ENTRAPMENT
- TYPICAL WHEN PROVIDED**

Lube Oil Pump & Lube Oil Pressure

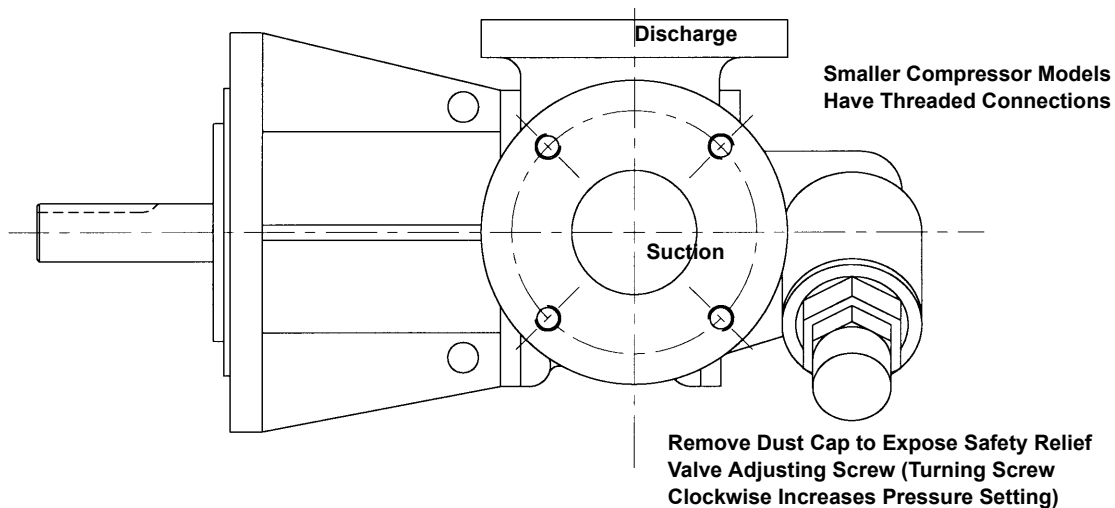


FIGURE 4-23: LUBE OIL PUMP - TYPICAL

Description & Adjustment

If there is a separate regulating valve, the spring loaded safety relief within the pump head is set at the Ariel factory to approximately 75 psig (5.2 bar_g) to prevent high oil pump discharge pressures that could damage the pump. In this case, do not adjust pump safety relief valve except when installing a new pump.

If there is no separate regulating valve, the pump safety relief valve is set by the factory to regulate pressure at 60 psig (4.1 bar_g) into the compressor when crankshaft speed equals or exceeds minimum normal operating speed. If oil pressure into the compressor while running at minimum operating speed and normal operating temperature does not read approximately 60 psig (4.1 bar_g) adjust the pump safety relief valve. With compressor running at minimum rated speed, remove the dust cap and adjust the screw to provide oil pressure into the compressor at 60 psig (4.1 bar_g), (turning the adjustment screw clockwise increases the pressure setting).

Lube Oil Pressure Regulating Valve

If there is a separate lube oil pressure regulating valve, normal oil pressure into the compressor is set at the regulating valve by the factory at 60 psig (4.1 bar_g) when crankshaft speed equals or exceeds minimum normal operating speed.

NOTE: IF OIL PRESSURE DROPS BELOW 50 PSIG (3.5 bar_g) WHEN CRANKSHAFT SPEED EQUALS OR EXCEEDS MINIMUM RATED OPERATING SPEED, THE CAUSE MUST BE FOUND AND CORRECTED.

Low Oil Pressure Shutdown

The low oil pressure shutdown is normally mounted by the packager and is supplied to customer specifications. Ariel provides an oil pressure pickup fitting on the oil gallery located after the cooler and filter. The electric or pneumatic oil pressure switch is to be set to actuate when oil pressure falls below 35 psig (2.4 bar_g). An alarm set to actuate when oil pressure falls below 50 psig (3.4 bar_g) is desirable.

NOTE:

- 1. THE COMPRESSOR MUST HAVE A WORKING LOW OIL PRESSURE SHUTDOWN. WHEN SHUTDOWN AS RESULT OF LOW OIL PRESSURE, DO NOT ATTEMPT TO RE-START UNTIL FAULT IS FOUND AND CORRECTED.**
- 2. DO NOT ATTEMPT TO ADD OIL TO THE CRANKCASE THROUGH THE BREATHER HOLE WHILE THE UNIT IS RUNNING. THIS WILL CAUSE OIL FOAMING, AND UNNECESSARY NO-FLOW SHUTDOWNS IN THE FORCE FEED LUBRICATION SYSTEM.**
- 3. WHEN THE FORCE FEED LUBRICATION SYSTEM HAS A COMMON SUPPLY (FROM THE CRANKCASE), IT IS CONSTANTLY USING OIL FROM THE CRANKCASE, A WORKING OIL SUMP LEVEL CONTROLLER IS NECESSARY. THIS MUST BE DESIGNED TO ALLOW OIL TO FLOW INTO THE CRANKCASE FROM AN OVERHEAD TANK AT ALL AMBIENT TEMPERATURE CONDITIONS.**

NOTES

SECTION 5 - MAINTENANCE

General Introduction

The major components of the frame assembly are the crankcase, crankshaft and bearings, connecting rods, chain drive system, crossheads and guides, and distance pieces.

A cast-in oil gallery runs the length of the crankcase. Drilled oil passages feed lubricating oil to the running gear.

Removable end covers, a top cover, and crosshead guide side covers provide generous access for inspecting and removing internal components. The top cover is made of aluminum for easy handling.

Absolute cleanliness, including the use of lint-free wiping cloths, is a necessity during any maintenance on the compressor. When access covers have been removed, keep the frame covered to protect the interior from dust except when actually working within it. Any components that have been removed should be protected from falling objects that might mar or chip running surfaces and protected from corrosion.

Whenever the machine is dismantled, gaskets at non-pressure positions are to be carefully inspected before reuse, if damaged they should be replaced. Gaskets at pressure locations should be replaced. During major overhauls, drain and flush the crankcase.

If replacing any major reciprocating component, that is; a connecting rod assembly, piston, piston and rod assembly, crosshead-balance nuts or crosshead, weigh component parts and compare to the Compressor Balancing Record sheet that comes in the parts manual with each compressor. If there are weight changes, recalculate opposing throw reciprocating weight differential. See "Opposed Throw - Reciprocating Weight Balancing" on Page 1-1.

CAUTION

TO PREVENT PERSONAL INJURY, BE SURE THAT COMPRESSOR CRANKSHAFT CANNOT BE TURNED BY THE DRIVER OR COMPRESSOR CYLINDER GAS PRESSURE DURING MAINTENANCE: -- ON ENGINE-DRIVEN COMPRESSORS, REMOVE THE CENTER COUPLING OR LOCK THE FLYWHEEL. -- ON ELECTRIC MOTOR-DRIVEN COMPRESSORS, IF IT IS INCONVENIENT TO DETACH THE DRIVER FROM THE COMPRESSOR, THE DRIVER SWITCH GEAR MUST BE LOCKED OUT DURING MAINTENANCE.

BEFORE STARTING ANY MAINTENANCE OR REMOVING ANY COMPONENTS, RELIEVE ALL PRESSURE FROM THE COMPRESSOR CYLINDERS. (SEE PACKAGER'S INSTRUCTIONS FOR COMPLETELY VENTING THE SYSTEM.)

**CAUTION**

AFTER PERFORMING ANY MAINTENANCE, THE ENTIRE SYSTEM MUST BE PURGED WITH GAS PRIOR TO OPERATION, TO AVOID A POTENTIALLY EXPLOSIVE AIR/GAS MIXTURE.

Connecting Rod

NOTE: UTILIZE A DIAL INDICATOR WITH MAGNETIC BASE TO INDICATE THE LOCATION OF THE CROSSHEAD WHEN FINDING EXACT INNER AND OUTER DEAD CENTER.

Connecting Rod - Removal

1. Remove the top cover from the crankcase and the side covers from the crosshead guides.
2. Remove the middle spacer bar on a 2-throw frame and the middle bar of each set of three on a 4- or 6- throw frame. Spacer bars are a sliding fit and should be capable of being removed by hand, without falling out or hammering to remove. If too loose or too tight contact your packager or Ariel before proceeding.
3. Move the throw to the outer dead center position
4. Remove the lock nut, bolt, end plates, and crosshead pin from the crosshead. Discard old lock nut.
5. Remove the crosshead as described in "Crosshead" on Page 5-8. Before removing the crosshead, refer to the CAUTION on page 5-8. **(CAUTION: CROSSHEADS ARE HEAVY. CARE MUST BE TAKEN WHEN HANDLING TO AVOID PERSONAL INJURY. THE WEIGHT OF EACH CROSSHEAD IS LISTED IN THE BALANCE SHEET THAT COMES IN THE MANUAL WITH EACH COMPRESSOR.)**
6. While supporting the connecting rod so it does not drop and damage the crosshead guide, turn the crankshaft until the throw is at its highest point. Loosen the connecting-rod-cap bolts and unscrew part way. Using the connecting rod cap removal tool (see Figure 7-2: on Page 7-3), jack against the bolt heads to pull the cap free from the dowels. Remove the top two connecting rod bolts and the rod bearing cap. The bottom two bolts remain in the cap while the cap is being removed.

NOTE: DO NOT PRY OR USE A CHISEL TO SEPARATE THE CAP FROM THE CONNECTING ROD OR DAMAGE WILL RESULT.

7. Half of the bearing shell will come out with the cap. The other half can be removed by sliding it out.
8. Turn the crankshaft until the rod can be taken out through the side cover openings in the crosshead guide.
9. After the removal of the connecting rods, be sure to protect the crank pins from

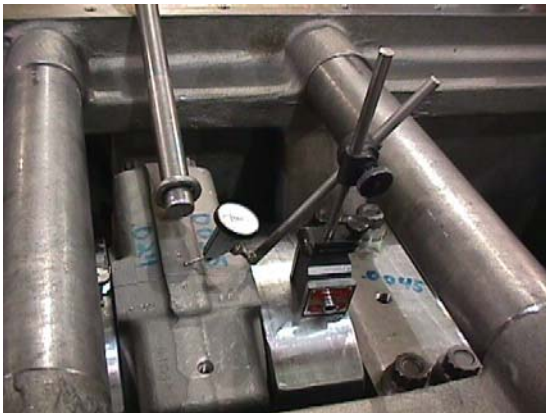
being nicked or scratched.

NOTE: IF ALL CONNECTING RODS ARE TO BE REMOVED, IT MAY BE MORE EXPEDIENT TO REMOVE THE CRANKSHAFT PRIOR TO REMOVING THE RODS FROM THE FRAME. ALL CONNECTING RODS MUST BE DETACHED FROM THE CRANKSHAFT AND RETRACTED INTO THE CROSSHEAD GUIDES PRIOR TO REMOVING THE CRANKSHAFT.

Connecting Rod (Crank Pin) Bearing - Removal & Installation

This bearing is a tri-metal (steel, bronze, and babbitt with a tin flash coat) precision split (2-shell) bearing. There are notches in the rod and rod cap for the bearing tabs in order to position and maintain the position of the bearing halves. See Connecting Rod Removal above for bearing removal.

1. Do not remove the connecting rod cap to check for bearing wear, if cap is removed it is recommended that a new bearing is installed, i.e. **DO NOT REUSE BEARING SHELLS.**
2. Determine bearing wear by checking actual jack and side clearances against the clearance limits given in Table 1-6 on Page 1-15. Also after installing a new bearing, check jack and side clearances against the clearance limits. Use calibrated dial indicators with 0.0005 inches (0.005 mm) increments and magnetic stands to check clearances. Check Jack clearance as follows:
 - Turn crankshaft pin up, install a magnetic stand on the top of adjacent crankshaft web, with a needle type dial indicator placed against the top of the connecting rod near the cap seam, as shown in Figure 5-1: on page 5-4.
 - Pry connecting rod up, use a large bar to pry against the frame and on an eye bolt installed in the rod, until needle on the face of the dial indicator stops moving.
3. Check thrust clearance as follows:
 - Install a magnetic stand on the side of crankshaft web, with a button type dial indicator placed against the side of the connecting rod, as shown in Figure 5-2: on page 5-5.
 - Use a large screw driver or pry bar to pry against the crankshaft web and thrust connecting rod (do not pry on rod cap) tight toward dial indicator, then pry on the connecting rod to thrust it tight in the opposite direction to determine clearance, repeat to be sure reading is accurate.
4. Be sure to remove eye bolts, magnetic stands, dial indicators and pry bars after taking readings.



Dial Indicator Magnetic Stand Placement on Top of Crankshaft Web, & Showing Eye Bolt and Pry Bar



Needle Type Dial Indicator Placement on Top of Connecting Rod



Using Pry Bar to Check Jack Clearance

FIGURE 5-1: MEASURING CONNECTING ROD BEARING VERTICAL JACK CLEARANCE - TYPICAL

5. Connecting rods need not be removed from the compressor to replace the crank pin bearings.

NOTE: CRANK PIN BEARINGS AND MAIN BEARINGS ARE NOT FUNCTIONALLY INTERCHANGEABLE. CRANK PIN (CONNECTING ROD) BEARINGS HAVE A NARROWER GROOVE. DO NOT PUT A CRANK PIN BEARING IN A MAIN BEARING LOCATION.

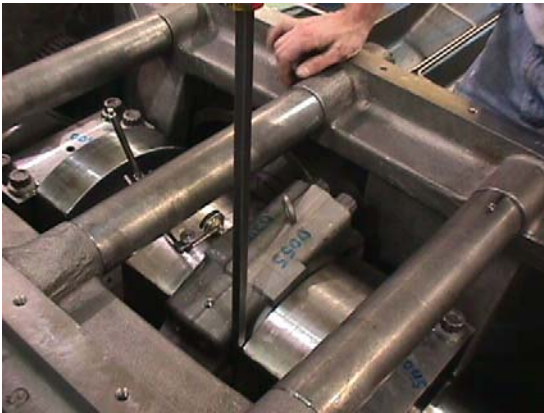
6. Refer to “Connecting Rod - Installation” on Page 5-6 for bearing shell installation. If clearance readings are not within tolerance after installing new bearings, contact your packager or Ariel before proceeding.



Dial Indicator Magnetic Stand Placement



Button Dial Indicator Placement



Rod Thrust Tight Toward Dial Indicator



Rod Thrust Tight Away from Dial Indicator

FIGURE 5-2: MEASURING CONNECTING ROD THRUST (SIDE) CLEARANCE - TYPICAL

Connecting Rod Bushing - Removal & Installation

1. Check crosshead pin to bushing clearance (see Table 1-6 on Page 1-15 for recommended clearance.) Wear on the pin can be determined by a visual inspection. Replace the pin if necessary.
2. If a replacement bushing is needed, the existing bushing should be filed or hacksawed to reduce the tightness of the shrink fit. From the inside diameter file or saw across the length of the bushing to within 1/32 inches (1 mm) of its radial thickness. It can then be easily drifted out. Be very careful, not to file or saw into the connecting rod, as any bore damage makes the rod unusable.
3. A hydraulic press in a qualified machine shop is recommended to install the new bushing. Do not use a hammer to force the bushing into place as this will distort the bushing's bore.
4. Before installation, the new bushing must be cooled in a 95% alcohol with dry ice and solution. The bushing needs to be left in the solution long enough to reach the same temperature as the solution, about -110°F (-80°C).

5. Position the connecting rod on the press table so that the chamfered edge of the rod bushing hole is on top. Be sure to locate the bushing oil hole at the connecting rod oil passage before pressing it in. The bushing has an annular groove around its outside diameter in line with the oil hole; therefore, if the bushing should shift in the connecting rod during operation, oil can still travel to the bushing inside diameter and to the crosshead pin. However, during installation of a new bushing, no more than 1/3 of the oil passage hole in the rod should be covered by the bushing after installation.

CAUTION: DO NOT TOUCH COLD SURFACES WITHOUT PROPER INSULATION TO PREVENT INJURY. ALCOHOL IS FLAMMABLE AND SHOULD ONLY BE USED IN OPEN AIR OR A WELL VENTILATED BUILDING. AVOID SPARKS AND OPEN FLAME. AVOID ALCOHOL VAPORS WHICH MAY CAUSE INJURY TO THE TISSUES OF THE NOSE AND EYES. DO NOT RETURN SOLUTION TO A CLOSED CONTAINER UNTIL IT HAS REACHED ROOM TEMPERATURE OR THE CONTAINER MAY EXPLODE.

NOTE: ABSOLUTE CLEANLINESS IS REQUIRED OF BOTH THE BUSHING AND THE CONNECTING ROD TO PREVENT DIRT FROM ACCUMULATING BETWEEN THE BUSHING AND CONNECTING ROD. ASSEMBLY MUST BE IMMEDIATE SO THAT BUSHING DOES NOT WARM-UP AND STICK BEFORE IT IS IN PLACE. IF STICKING A BUSHING, REMOVE BUSHING BY NOTCHING AS IN THE REMOVAL INSTRUCTIONS ABOVE.

Connecting Rod - Installation

1. If installing a new replacement connecting rod, stamp match mark numbers on the tops of the connecting rod and bearing cap, (with notches up), matching its throw location. See Figure 5-3: on Page 5-7.
2. Check new bearing shells to see they are free of handling damage, scratches, burrs, and loose material at the tabs. **DO NOT RUB BEARING SURFACE WITH FINGERNAIL.** New bearing shells and crankshaft crank pin bearing surfaces must be absolutely clean. Snap a new, dry half bearing shell into the rod with the bearing tab properly located in the notch in the rod. With the crankcase top cover off, turn the throw to the inner dead center position and slide the rod into the crosshead guide space. Oil crankshaft crank pin bearing surfaces with new clean lubricating oil, same type as is used in the frame, before installing connecting rod caps.

NOTE: MAIN BEARINGS AND CONNECTING ROD BEARINGS ARE NOT FUNCTIONALLY INTERCHANGABLE. MAIN BEARINGS HAVE A WIDER GROOVE. DO NOT PUT A MAIN BEARING IN A CONNECTING ROD BEARING LOCATION.

NOTE: THE CAPS AND RODS ARE NUMBERED BY THROW BEGINNING WITH NUMBER ONE AT THE DRIVE END. FOR THROW NUMBERING SEQUENCE, REFERENCE FIGURE 1-1: ON PAGE 1-3. ALWAYS INSTALL RODS WITH THE NUMBERS UP. BE SURE TO PROTECT CRANK PIN AT ALL TIMES.

3. Fit the connecting rod to the crank pin and turn to the highest position. Replace the cap, with a new half bearing shell properly located in the notch, and the bolts. Snug up all bolts. Do not tighten bolts to full torque at this point.
4. Reconnect the rod and the crosshead with the pin. Install the end plates, the through bolt and a new lock nut. Tighten the lock nut to the value listed in Table

1-15 on Page 1-25.

5. Tighten the connecting rod cap screws in an alternating (criss-cross) pattern in 25% increments for each cap to the recommended torque value, and then tighten the bolts in an alternating (criss-cross) pattern to the recommended turn value. See Table 1-15 on Page 1-25 and Figure 5-3: on Page 5-7. Utilize the turn indicator tool provided in the Ariel toolbox, as shown in Figure 7-1: on Page 7-2.
6. Measure each connecting rod bearing to crankshaft jack clearance and connecting rod thrust (side) clearance, see "Connecting Rod (Crank Pin) Bearing - Removal & Installation" on Page 5-3. Record readings on a copy of the form on page 5-21. If readings are not within tolerance after installing new bearings, contact your packager or ariel before proceeding.

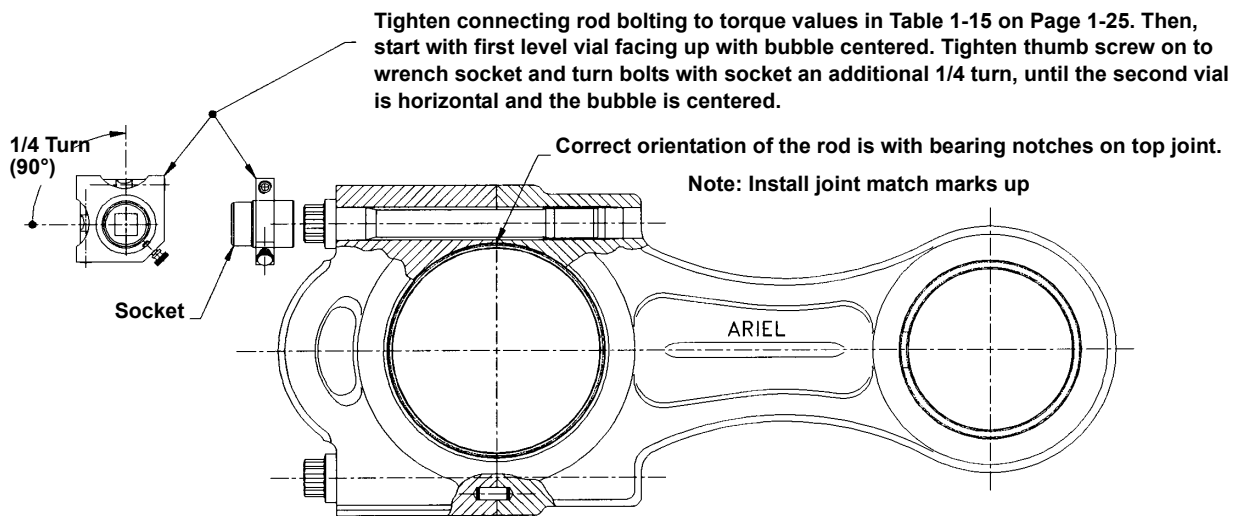


FIGURE 5-3: CONNECTING ROD -TYPICAL

7. Reinstall the spacer bars. All spacer bars are match-marked for proper location. They must be reinstalled in their original location. Tighten all spacer bar bolts to the value listed in Table 1-15 on Page 1-25.
8. Examine the removed top cover and side cover gaskets. If there is any doubt that they are not in a good usable condition, install new gaskets. Gaskets are provided with a non-stick coating to ease removal; additional lubrication is not required. Replace the top cover and crosshead guide cover. Tighten all cap-screws hand wrench tight.

Crosshead

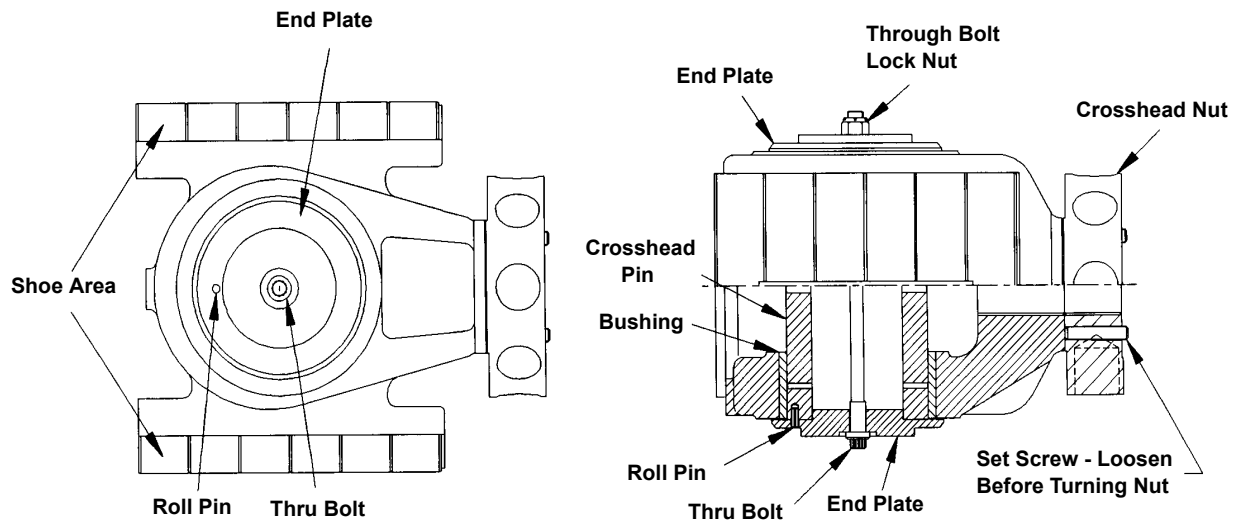


FIGURE 5-4: CROSSHEAD - TYPICAL

⚠ CAUTION

BEFORE REMOVING THE CYLINDER HEAD, BACK OFF ALL CAPSCREWS 1/8 INCH (3mm). MAKE SURE THAT THE HEAD IS LOOSE AND THE CYLINDER IS VENTED. SEE IMPORTANT SAFETY INFORMATION PLATES ON UNIT TOP COVER, (REFERENCE FIGURE 1-3: ON PAGE 1-8 FOR LOCATION.)

⚠ CAUTION

CROSSHEADS ARE HEAVY. CARE MUST BE TAKEN WHEN HANDLING TO AVOID PERSONAL INJURY. THE WEIGHT OF EACH CROSSHEAD IS LISTED IN THE BALANCE SHEET THAT COMES IN THE MANUAL WITH EACH COMPRESSOR.

Crosshead - Removal

1. Remove crosshead guide side covers and (head end) cylinder head or unloader.
2. Move the crosshead to its inner dead center position and back off, but do not remove, the crosshead nut set screws.
3. Loosen the crosshead nut with the special slugging Peg or Open End Wrench

(for hex nuts only) shown in Figure 7-1: on Page 7-2, depending on nut style. Or use purchased separately hydraulic crosshead nut torque tool, see Figure 5-8: on Page 5-13

4. Use the Piston Nut Torquing Adapter shown in Figure 7-1: to screw the piston rod out of the crosshead. The two dowels on the Adapter fit holes in the piston nut. Turn the crosshead nut off the piston rod. Push the rod end forward to the edge of the packing to provide a clearance for crosshead removal.
5. With the crosshead in its outer dead center position, remove the crosshead pin through bolt, lock nut, end-plates and pin. Discard the old lock nut.
6. Turn the crankshaft to its inner dead center position. Move the crosshead to its outer dead center position to be free of the connecting rod. Make sure the connecting rod does not drop and damage the crosshead guide surface.
7. Remove the oil wiper packing from the crosshead guide diaphragm.
8. Install the Crosshead Installation/Removal Tool as shown in Figure 5-6:.
9. Push the crosshead onto the Crosshead Installation Tool (see Figure 5-6:) and rotate the crosshead 90 degrees.
10. Slide a 3/16 inch (5 mm) thick plate into the gap between the crosshead and the crosshead guide (as shown in Figure 5-6:)
11. Remove the Diaphragm from the crosshead guide and slide the crosshead out of the crosshead guide on the plate.
12. Check the crosshead pin to bushing clearance. (See Table 1-6 on Page 1-15.) Wear on the pin can be determined by a visual inspection.
13. Replace the pin if necessary. If the bushings need to be replaced, hacksaw or file to within 1/32 inches (1 mm) of their thickness. They can be easily drifted out.
14. A press will be needed to install new bushings. The bushing can be installed in the crosshead by cooling the bushing in 95% alcohol with dry ice solution. The bushing needs to be left in the solution long enough to reach the same temperature as the solution, about -110°F (-80°C).

CAUTION: DO NOT TOUCH COLD SURFACES WITHOUT PROPER INSULATION TO PREVENT INJURY. ALCOHOL IS FLAMMABLE AND SHOULD ONLY BE USED IN OPEN AIR OR A WELL VENTILATED BUILDING. AVOID SPARKS AND OPEN FLAME. AVOID ALCOHOL VAPORS WHICH MAY CAUSE INJURY TO THE TISSUES OF THE NOSE AND EYES. DO NOT RETURN SOLUTION TO A CLOSED CONTAINER UNTIL IT HAS REACHED ROOM TEMPERATURE OR THE CONTAINER MAY EXPLODE.

NOTE: THE SIDE OF THE CROSSHEAD RECEIVING THE NEW BUSHING SHOULD BE SUPPORTED DIRECTLY TO PREVENT POSSIBLE CRUSHING OF THE CROSSHEAD BY THE PRESS. (SEE Figure 5-5:.)

ABSOLUTE CLEANLINESS IS REQUIRED OF BOTH BUSHING AND CROSS-HEAD TO PREVENT DIRT FROM ACCUMULATING BETWEEN THE BUSHING AND CROSSHEAD BORE.

15. Visually inspect the shoe surfaces for scoring. Since they are constantly lubricated under pressure during operation, there should be virtually no wear.

Approximately 3 Tons (27kN) Force Required

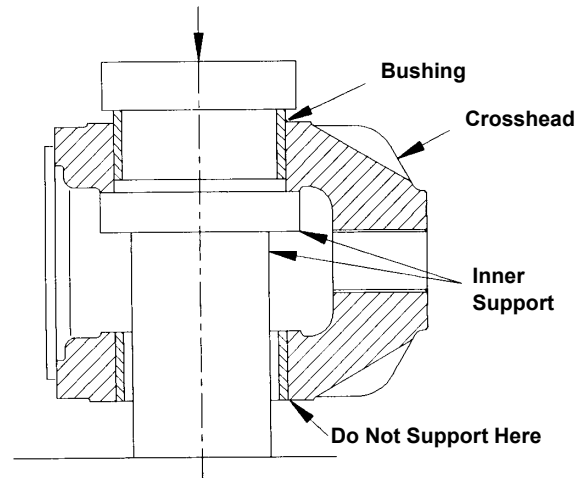


FIGURE 5-5: CROSSHEAD BUSHING REPLACEMENT

Crosshead - Installation

NOTE: BE SURE CROSSHEADS ARE RETURNED TO THEIR ORIGINAL THROW LOCATION. USE FRAME OIL FOR LUBRICATION WHERE NEEDED.

1. Lay a 3/16 inch (5 mm) thick plate in the bottom of the crosshead guide and lay the crosshead on its side as shown in Figure 5-6: on Page 5-12. Lubricate crosshead and guide surfaces with oil.
2. Mount the Crosshead Installation Tool onto the crosshead guide diaphragm and lubricate tool bearing surfaces with oil. Refer to Figure 5-6: on page 5-12. Install the diaphragm with this tool mounted into the crosshead guide. Slide the crosshead onto the tool.
3. Remove the 3/16 inch (5 mm) thick plate. Rotate the crosshead 90°. Slide the crosshead into the guide and off of the installation tool. Make sure it does not become cocked. Should the crosshead become wedged, do not force it. Ease it off and start again. Be careful not to damage the crosshead shoe surface during installation.
4. Remove the crosshead installation tool and reinstall the wiper packing.
5. Lift the crosshead end of the connecting rod and turn the crankshaft to its outer dead center position to locate the connecting rod in position and insert the crosshead pin. Use the Crosshead Pin Alignment Tool shown in Figure 5-7: on Page 5-12 on the opposite side of the crosshead to assist the insertion of the pin. Lubricate the crosshead pin and alignment tool with oil prior to installing. Install the crosshead pin end-plates, through cap screw, and a new lock nut. Tighten the through cap screw and lock nut to the value listed in Table 1-15 on Page 1-25. (TIP: If it is difficult to insert the pin, chill it first.)
6. The piston rod threads are to be lubricated with "Never-Seez" Regular Grade and the crosshead-balance nut seating surfaces are to be well lubricated with clean, fresh oil for proper assembly. Reinstall the crosshead-balance nut onto

the piston rod. Turn nut on to rod threads to allow enough clearance to attach the rod to the crosshead. Be sure to have setscrew cup points on the crosshead side of the nut. Position the crankshaft in the inner dead center position of the throw. Utilize a dial indicator with a magnetic base to indicate the location of the crosshead when finding exact inner and outer dead center positions. Remove a crank end bottom valve.

NOTE PISTON END CLEARANCE MUST NOW BE SET OR SERIOUS DAMAGE COULD OCCUR. (SEE REQUIRED PISTON CRANK END CLEARANCE AS SHOWN ON THE CYLINDER IDENTIFICATION PLATE. REFER TO TABLE 1-7 ON PAGE 1-16).

7. Insert a feeler gage, equal to the required crank end clearance, through an open bottom valve pocket. Use the tools illustrated in Figure 5-26: on Page 5-40 to screw the piston rod into the crosshead until piston is tight against the feeler gage, so that the feeler gage can not be removed by hand.
8. Tighten the crosshead-balance nut:
 - Use the special slugging peg or open end wrench shown in Figure 7-1: on Page 7-2 and a dead blow semi-soft faced hammer. Strike the wrench with the hammer until an audible difference can be heard, and/or on seeing the wrench “bounce” indicating that the nut is tight. Some mechanics can obtain the desired tightness in 3 to 4 strikes, while others may require more hammer blows.
 - Or tighten using the purchased separately crosshead-balance nut hydraulic torque tool and hand pump kit, see Figure 5-8: on Page 5-13. See Table 1-15 on Page 1-25 for the hydraulic pressure to be applied to the torque tool. When initially installing the tool, position the spanner wrench adapter open area toward the spanner wrench as shown in the Figure. Apply hydraulic pressure to the ram to tighten the crosshead-balance nut. When the ram moves to the end of its travel, release the pressure and index the ram to the spanner wrench slot and/or spanner wrench to adapter, until the nut stops moving at the specified hydraulic pressure. If during tightening, the adapter open area turns 90° before nut is tight, remove the spanner wrench. Remove the bolting in the spanner wrench adapter to the crosshead-balance nut and reposition the adapter so the open area again faces the spanner wrench.

CAUTION: DO NOT ALLOW THE OPEN AREAS OF THE SPANNER WRENCH AND THE ADAPTER TO OVERLAP AS THE SPANNER WRENCH CAN BE SPRUNG. IF THE SPANNER WRENCH BECOMES SPRUNG, DESTROY IT AND REPLACE IT.

- When the nut is tight, the feeler gage can be removed by hand. Be sure that all tools have been removed from the cylinder and crosshead.
9. With the head end head or unloader (closed position) properly installed and fasteners tightened, rotate the crankshaft 180° to the outer dead center position of the throw. Remove a top head end valve. Determine the required piston head end clearance limits from the cylinder identification plate, refer to Table 1-7 on Page 1-16. Measure head end clearance at the top of the head end. Using feeler gages through the open valve pocket, check the head end clearance. Determine that the measured clearance is within the required clearance limits. Tighten the set screws in the crosshead-balance nut. Re-install the valve assemblies and properly tighten the fasteners. See “Valves - Reassembly” on Page 5-57 and “Bolt Tightening for Valve Caps” on Page 5-59.

10. Check piston rod runout and crosshead clearances upon re-assembly, any time a piston rod is removed. See "Piston Rod Run Out" on Page 5-40, and Table 1-6 on Page 1-15 for crosshead clearances and checking procedure.
11. Replace the crosshead guide side covers and gaskets, tighten all capscrews hand wrench tight. Cover gaskets are provided with a non-stick coating to ease removal, additional lubrication is not required.

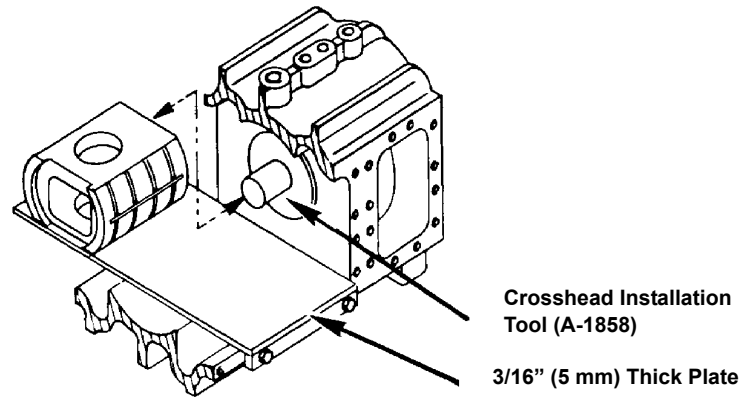


FIGURE 5-6: CROSSHEAD INSTALLATION

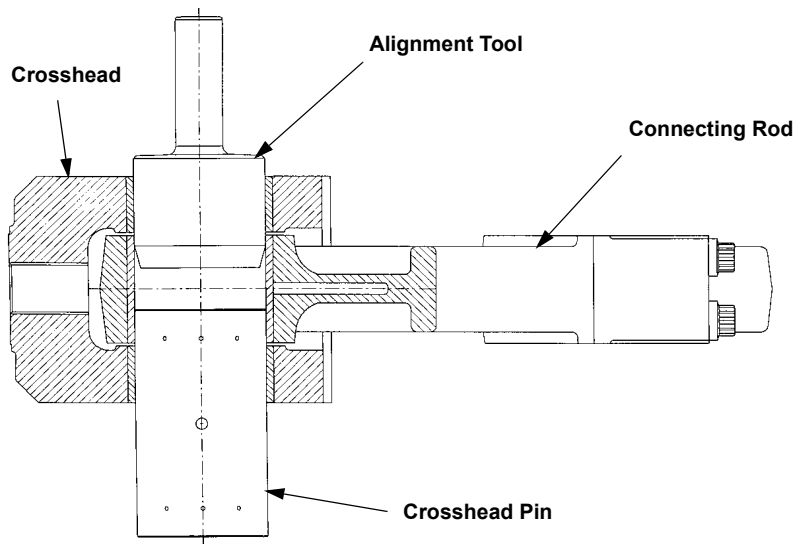


FIGURE 5-7: CROSSHEAD PIN ALIGNMENT TOOL (B-1989) - TYPICAL

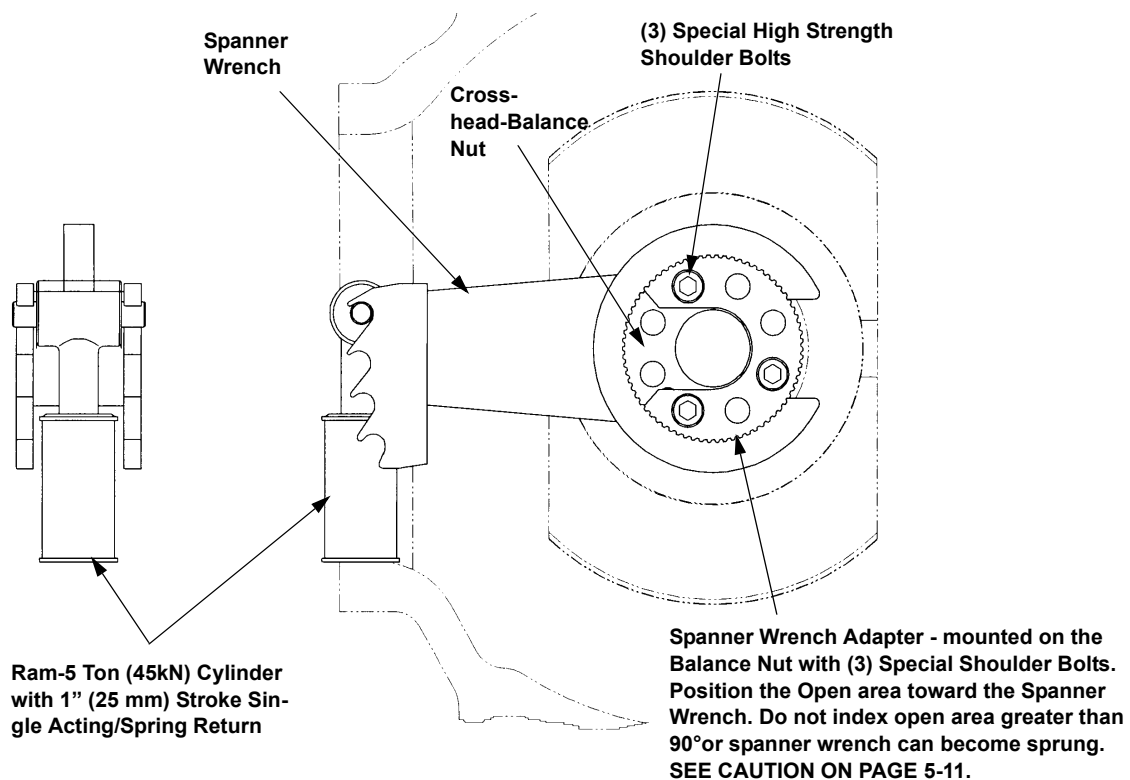


FIGURE 5-8: CROSSHEAD-BALANCE NUT HYDRAULIC TORQUE TOOL (G-7583) - SHOWN IN TIGHTENING POSITION - TYPICAL

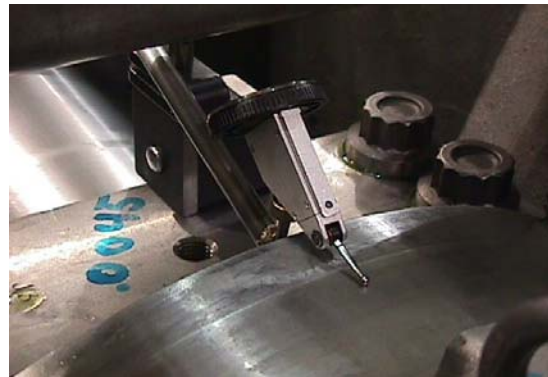
Main Bearings - Checking Clearances

1. Do not remove main bearing caps to check for bearing wear, if a cap is removed it is recommended that a new bearing be installed, i.e. **DO NOT REUSE BEARING SHELLS.**
2. Determine main bearing wear by checking actual journal bearing vertical jack (at each bearing), and crankshaft thrust clearances against the clearance limits given in Table 1-6 on Page 1-15. Use calibrated dial indicators with 0.0005 inches (0.005 mm) increments and magnetic stands to check clearances. Measure main bearing vertical jack clearances:
 - Turn an adjacent throw up, as shown in Figure 5-9: on Page 5-14.
 - Place lifting strap completely around the crankshaft at the adjacent web and attach strap to a crane.
 - Install a magnetic stand on the top of the main bearing cap, with a needle type dial indicator placed against the top of the crankshaft web of the adjacent turned up throw.
 - Gently lift crankshaft with the crane until needle on dial indicator stops moving.
 - Repeat for each main bearing.

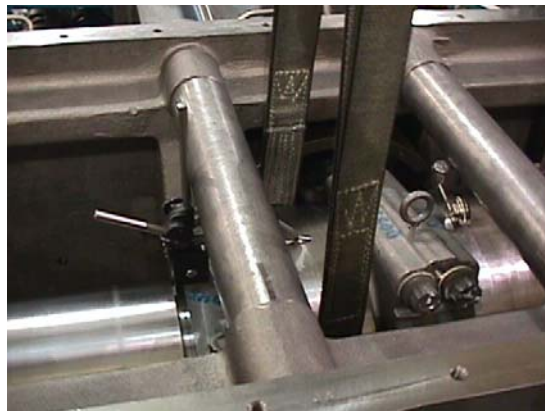
3. Measure the crankshaft thrust clearance as follows:
 - Install a magnetic stand on the top of #1 main bearing cap, with a button type dial indicator placed against the side of the adjacent crankshaft web, as shown in Figure 5-10: on page 5-15.
 - Thrust crankshaft back & forth using a large screwdriver or pry bar against the compressor frame, until an accurate reading is obtained.
 - If thrust clearance is out of limits, replace thrust plates at #1 main bearing cap.
4. After installing new bearings, check jack and thrust clearances against the clearance limits.



Dial Indicator Magnetic Stand Placement on Top of the Main Bearing Cap



Needle Type Dial Indicator Placement on Top of Crankshaft Web

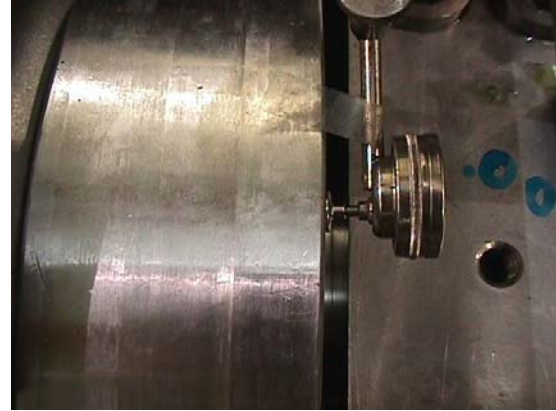


Lifting Strap Placement, Completely around Crankshaft Web - Attach Lifting Straps to Crane

FIGURE 5-9: MEASURING CRANKSHAFT JOURNAL BEARING VERTICAL JACK CLEARANCE - TYPICAL



Dial Indicator Magnetic Stand Placement
on Top of Main Bearing Cap



Button Type Dial Indicator Placement
against the side of Crankshaft Web



Use Large Screwdriver or Pry Bar against Compressor
Frame, Thrusting Crankshaft Back & Forth

FIGURE 5-10: MEASURING CRANKSHAFT THRUST CLEARANCE

Crankshaft - Removal

1. Remove the coupling disk pack. Remove the coupling hub. (In order to remove the coupling hub it may be necessary to heat it. Use insulated gloves to protect hands.) If the coupling hub is not removed, the drive end cover cannot be removed and will need to be lifted out with the crankshaft.
2. Remove the top cover, spacer bars, and drive end cover. Tip: If the spacer bar bolts are difficult to loosen, use a 12 point hammer wrench.
3. Be careful not to damage the sharp corners on each end of the top of the crankcase. These corners form the junction between the end covers, top cover, and base; thus they must be kept sharp and unmarred to prevent oil leaks.
4. Detach the connecting rods. (See "Connecting Rod" on Page 5-2.) Move the rods to their full outer position.

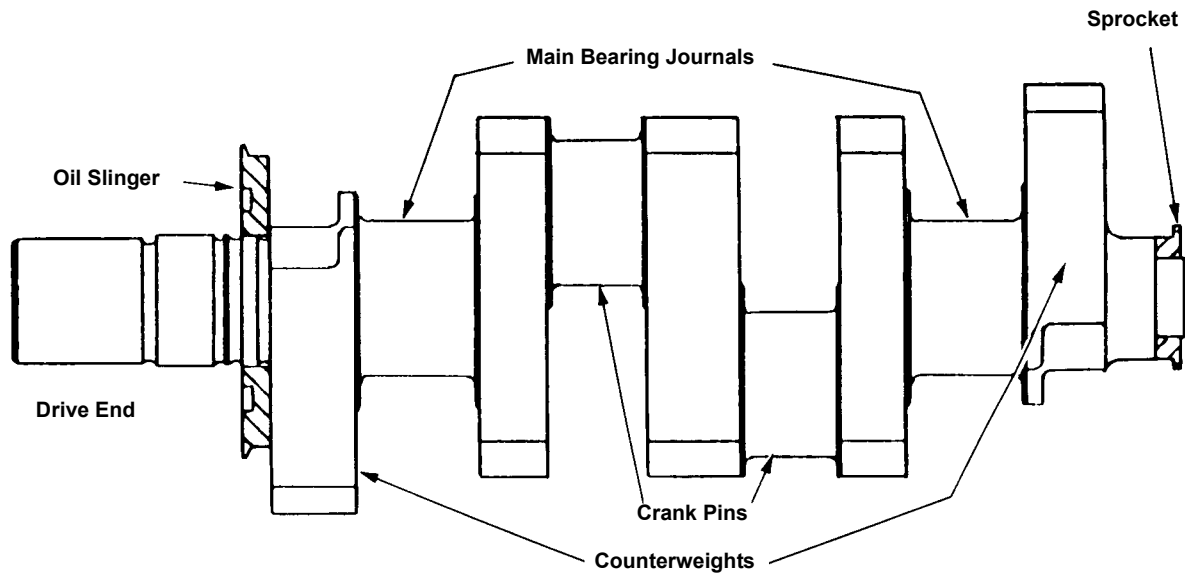


FIGURE 5-11: CRANKSHAFT

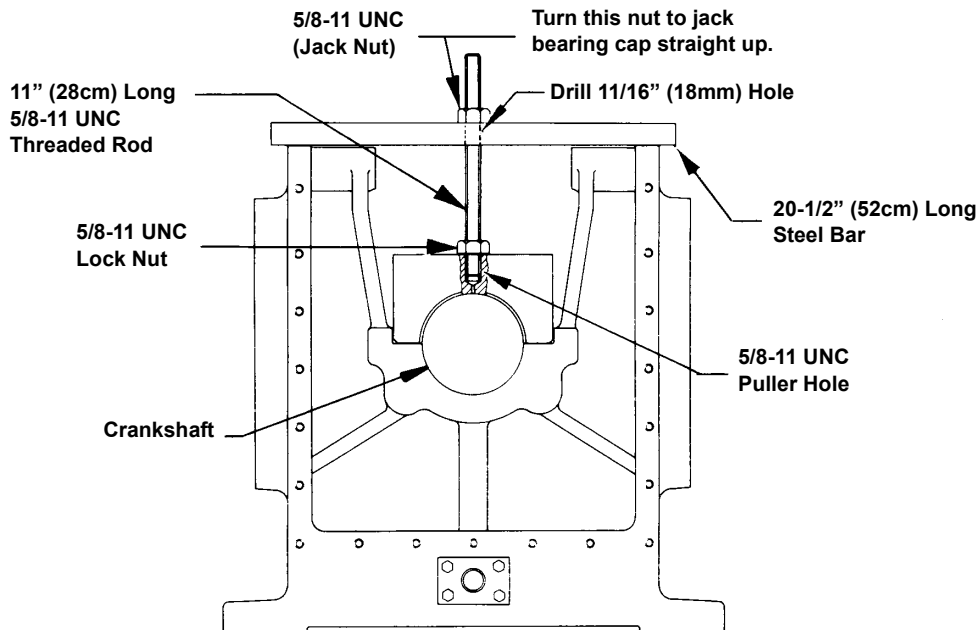


FIGURE 5-12: MAIN BEARING CAP PULLER

5. Remove the capscrews on the chain adjustment cap. Turn the cap to loosen the chain. Slip the chain off the crankshaft sprocket.
6. Remove the capscrews from the bearing caps. Pull the caps straight up to pre-

vent damage to the dowel fit. If the cap is tight, use a Bearing Cap Puller as illustrated.

7. Before removing the crankshaft from the crankcase, wooden saddles or a notched wooden crate with sides high enough to prevent the webs or oil slinger from touching bottom should be prepared in order to store the crankshaft during maintenance - even though it may be out for only a short time. In addition, the crankshaft should be adequately protected from above so that dropped tools or equipment cannot mar the surface of pins and journals.
8. Turn the crankshaft so that sling lifting points are above the center of gravity of the shaft, so that it does not want to rotate when lifted. Lift straight up with the ends of the crankshaft parallel to the frame. Two men will be needed to safely remove the crankshaft as well as a crane or lift due to the weight of the crankshaft (see Table 1-1 on Page 1-2). Appropriate sized nylon slings should be used during this operation so as not to mar the running surface of the crankshaft. Great care must be taken during this operation since the shaft could bind and become damaged.

NOTE: THE LOWER HALF BEARING SHELLS SOMETIMES HAVE A TENDENCY TO STICK TO THE SHAFT JOURNALS BECAUSE OF THE CLOSE FITTING OILY SURFACES OF THE TWO PARTS. THEREFORE, WHEN THE SHAFT HAS BEEN LIFTED CLEAR OF THE SADDLES (APPROXIMATELY 1/4 inches OR 6mm) CHECK TO MAKE SURE THAT THE LOWER HALF BEARING SHELLS HAVE NOT COME OUT WITH THE SHAFT. IF SO, THE BEARING SHELLS SHOULD BE TAPPED BACK ONTO THE SADDLES BEFORE LIFTING THE SHAFT ANY FURTHER.

9. While one person operates the crane, raising it very slowly, the second person must grasp the crankshaft at the drive end with one hand on the counterweight or one of the throws and the other hand on the end of the shaft to keep the crankshaft level. Wear gloves to avoid being cut by the slinger and to achieve a good grip. (As with each operation, the gloves should be clean to avoid marring the running surface.) As the shaft is being slowly raised, the drive and auxiliary ends should be lifted at the same rate. Again, care must be taken to avoid marring the crankshaft surfaces by carefully guiding the crankshaft.

Oil Slinger - Removal:

Although the slinger should last indefinitely with proper care, it can become nicked. Should it need replacing, suspend the crankshaft as in the CRANKSHAFT REMOVAL PROCEDURE and heat the slinger to 400°F (240°C), it will attain a yellow glow at this temperature. When it has expanded it should fall off by itself. **DO NOT TOUCH HOT SURFACES WITHOUT PROPER INSULATION TO PREVENT INJURY.**

Oil Slinger - Installation:

Put a rod at least 1/2 inches (13mm) in diameter through the slinger. (Special care should be exercised when handling the slinger, not only to keep its surfaces unmarred, but to avoid being cut by the outer sharp edge.) After the slinger is suspended heat it with a small torch. When it has attained a yellow glow, approximately 400°F (240°C) it can be slipped over the drive end of the crankshaft. Hold the slinger in position with high temperature gloves or two

pieces of clean wood, rotating it slightly to make sure it is square, until it has cooled enough to shrink onto the crankshaft. **DO NOT TOUCH HOT SURFACES WITHOUT PROPER INSULATION TO PREVENT INJURY.**

Chain Sprocket - Removal:

Examine the sprocket carefully for signs of wear. If it has been in operation for five years or more, it may be convenient to replace it if the crankshaft is removed from the frame.

Drill a hole in the sprocket hub. This hole should be parallel to the shaft centerline and big enough that it removes most of the hub cross section. (See Figure 5-13:) Be careful not to touch the shaft with the drill. Mark the drill with tape so you do not drill through the sprocket and into the crankshaft face.

The drilled hole will relieve most of the shrink, and a couple of good radial hits with a hammer and chisel will open the sprocket enough so it can be easily removed.

Chain Sprocket - Installation:

Encircle the sprocket with wire. Suspend the sprocket from the wire and heat it with a small propane torch. When it has attained a yellow glow, approximately 400°F (240°C) it can be slipped over the auxiliary end of the crankshaft. Hold the sprocket in position with high temperature gloves or two pieces of clean wood, rotating it slightly to make sure it is square, until it has cooled enough to shrink on the crankshaft. **DO NOT TOUCH HOT SURFACES WITHOUT PROPER INSULATION TO PREVENT INJURY.**

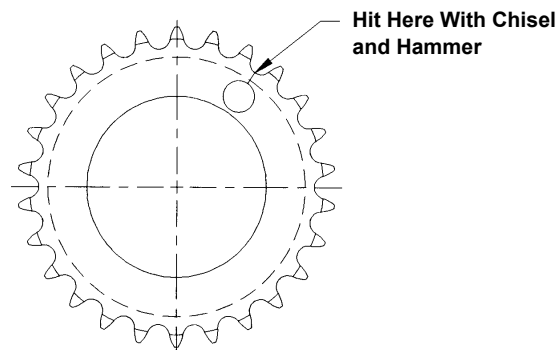


FIGURE 5-13: CRANKSHAFT CHAIN SPROCKET - TYPICAL

Main Bearings - Removal/Installation w/Crankshaft Removed

Do not remove a main bearing cap to check for bearing wear, if cap is removed it is recommended that a new bearing is installed, i.e. **DO NOT REUSE BEARING SHELLS.** Determine bearing wear by checking actual jack and crankshaft thrust clearances against the clearance limits given in Table 1-6 on Page 1-15. See Figure 5-9: on Page 5-14 and Figure 5-10: on Page 5-15.

There are notches in the frame and bearing cap for the bearing tabs in order to position and

maintain the position of the bearing halves. Check the new bearing shells for handling damage, scratches, burrs, and loose material at the tab. **DO NOT RUB BEARING SURFACE WITH FINGERNAIL.** The bearing shells must be absolutely clean. New bearing shells are marked with ink stamp pictographs of a frame or connecting rod, for main and connecting rods bearings respectively.

The old bearings halves are easily slid out, tab end first. Be sure both the main bearing saddles and crankshaft are absolutely clean, and free from nicks and burrs. New bearings are to be slid in (untabbed end first), and snapped into place. Locate tabs in the notches in the bearing saddles and bearing caps.

NOTE: MAIN BEARINGS AND CONNECTING ROD BEARINGS ARE NOT FUNCTIONALLY INTERCHANGABLE. MAIN BEARINGS HAVE A WIDER GROOVE. DO NOT PUT A MAIN BEARING IN A CONNECTING ROD BEARING LOCATION.

Main Bearings - Removal/Installation w/Crankshaft In Place

1. Follow instructions in Caution page 5-1. Remove coupling spacer or otherwise lockout.
2. Remove the top cover and spacer bars. Tip: If the spacer bar bolts are difficult to remove, use a 12 point slugging wrench and hammer. Spacer bars are a sliding fit and should be capable of being removed by hand, without falling out or hammering to remove. If too loose or too tight, contact your packager or Ariel before proceeding.
3. Detach the connecting rods. (See "Connecting Rod" on Page 5-2.) Move the rods to their full outer position, being careful not to damage the crosshead guide surfaces.
4. Remove the capscrews from the main (journal) bearing caps. Pull the caps straight up to prevent damage to the dowel fit. If the cap is tight, use a Bearing Cap Puller as illustrated in Figure 5-12: on Page 5-16.
5. If necessary, attach clean nylon lifting straps around the crankshaft and lift slightly to take some of the weight off the bearings and allow for easier disassembly of bearing shells.
6. Remove shells from the main bearing caps. Remove the main journal bearing shells from under the crankshaft one at a time, by rotating out. Start rotating shells under the crankshaft tab side out first, by pushing or tapping with a non-metallic tool on the opposite split face side. Once the bearing shell is completely loose, use Ariel optional tool (part number B-3340 or may be made from a print supplied by Ariel) to push out bearing shells. Once started the shell may be rotated out, by releasing the lifting straps and turning the crankshaft. Be careful not to damage the crankshaft bearing surfaces. (Replace with new bearing shell, prior to rotating out the next main bearing shell, see steps below).
7. Clean and dry main bearing cap to bearing surfaces.
8. Check the new bearing shells for handling damage, scratches, burrs, and loose material at the tab. **DO NOT RUB BEARING SURFACE WITH FINGERNAIL.** The bearing shells must be absolutely clean. New bearing shells are marked with ink stamp pictographs of a frame or connecting rod, for main and connecting rods bearings respectively. Do not mix up. Install bearing shells in caps, and frame journals, properly located in the tab notch, (rotate in the untabbed end

first), keeping the backs of the shells dry and clean.

9. Replace thrust plates on bearing cap #1, if crankshaft thrust clearance is not within tolerance.
10. Oil crankshaft bearing surfaces with new clean lubricating oil, same type as is used in the frame, before installing main bearing caps.
11. Install the bearing caps containing the new top halves of bearings with the cap-screws lightly snugged, in their proper locations. Install thrust plates on #1 bearing cap. Starting at the thrust end, tighten the bearing cap bolts to Table 1-15 on Page 1-25. Tighten in an alternating (criss-cross) pattern in 25% increments for each cap to the recommended torque value. Bearing caps are match-marked to their position, correspond with the spacer bar and spacer bar bosses on the frame.
12. Be sure the dowels in the bearing caps are aligned with the holes in the crankcase base. A set screw on top of each dowel prevents it from backing out.
13. Check crankshaft journal bearing jack (at each bearing) and crankshaft thrust clearances to values in Table 1-6 on Page 1-15. See and Figure 5-10: on Page 5-15. Record readings on a copy of form on page 5-21.
14. Install new connecting rod bearings and reattach the connecting rods (See "Connecting Rod - Installation" on Page 5-6), packing diaphragms, and unloaders/head end heads. Tighten fasteners to the torque values given in Table 1-15 on Page 1-25. Check connecting rod bearing jack and thrust clearances, see "Connecting Rod (Crank Pin) Bearing - Removal & Installation" on Page 5-3. Record readings on a copy of form on page 5-21.
15. If readings are not within tolerance after installing new bearings, contact your packager or Ariel before proceeding.
16. Replace the spacer bars. Install the spacer bar so that the match mark is up and next to the spacer bar boss with the same marking. Tighten all spacer-bar cap screws to value in Table 1-15 on Page 1-25.
17. Account for all tools, measuring and lifting equipment, supplies, replaced parts, etc. to be sure they have all been removed from inside the crankcase and then reinstall the gaskets and top cover(s). Tighten cover bolts hand wrench tight.

NOTE: MAIN BEARINGS AND CONNECTING ROD BEARINGS ARE NOT FUNCTIONALLY INTERCHANGABLE. MAIN BEARINGS HAVE A WIDER GROOVE. DO NOT PUT A MAIN BEARING IN A CONNECTING ROD BEARING LOCATION.

18. Replace coupling spacer to packager's recommendations or remove lockout.
19. After replacing bearings, thoroughly pre-lube compressor to be sure that bearings are lubricated and to help remove foreign materials from the lube system.
20. When starting the compressor after the first 10 minutes of run time, after one hour and after 4 hours, shutdown compressor and remove the frame top cover. Check the bearing cap temperatures using a temperature probe (hand held thermocouple probe or infrared thermometer), record on a copy of form on page 5-22. **DO NOT PLACE ANY PART OF YOUR BODY INSIDE THE CRANKCASE WITHOUT OBSERVING THE CAUTION ON PAGE 5-1.** Complete remaining information on the two pages of the "Bearing Log / Conditions After Replacing Bearings" form and fax copy to Ariel Field Service.

BEARING LOG / CONDITIONS AFTER REPLACING BEARINGS

SERIAL NO. F- _____ MODEL _____ Date _____

CRANKSHAFT THRUST (END) CLEARANCE:

CRANKSHAFT SERIAL NUMBER	THRUST CLEARANCE, Inches : mm

CONNECTING ROD THRUST (SIDE) CLEARANCE, Inches : mm:

THROW NUMBER:	1	2	3	4	5	6

JACK CLEARANCES, Inches : mm:

THROW NUMBER:	1	2	3	4	5	6
MAIN BEARINGS						
CONN. ROD BEARINGS						

If measured clearances exceed the tolerances in Table 1-6 on Page 1-15, after installing new bearings, contact your packager or Ariel before proceeding.

DATE	TIME	RPM	OIL PRESSURE FILTER INLET psig: bar _g	OIL PRESSURE FILTER OUTLET psig: bar _g	OIL TEMPERATURE INTO FRAME °F : °C	REMARKS

BEARING LOG / CONDITIONS AFTER REPLACING BEARINGS, continued

SERIAL NO. F- _____ MODEL _____ Date _____

BEARING CAP TEMPERATURES, °F : °C, AFTER RUN TIME OF:						
THROW	10 MINUTES		1 HOUR		4 HOURS	
	MAIN	ROD	MAIN	ROD	MAIN	ROD
1						
2						
3						
4						
5						
6						

Crankshaft - Installation

1. Be sure that the correct new main bearing half shells are in place in the frame saddles, absolutely clean and bearing surfaces lubricated with new clean crankcase oil.
2. Move the connecting rods to their full outer position. If the piston rods are still attached to the crossheads, the heads and wiper packing gland may have to be repositioned so the rods will clear the crankshaft. While the crankshaft is being lowered very slowly into the crankcase (suspended by a crane with a clean nylon sling), one man should grasp the drive end and slowly maneuver the drive end and auxiliary end straight down into the crankcase, wearing clean gloves as during removal. Both drive end and auxiliary end journals should touch the bottom bearing shells at the same time.
3. When the crankshaft is resting on the bottom bearing shells, lubricate upper crankshaft pin bearing surfaces with new clean crankcase oil and install the bearing caps (with their correct bearing half shells in place) with the capscrews lightly snugged. Then, starting at the thrust end, tighten the bolts in an alternating (criss-cross) pattern in 25% increments to the recommended torque value given in Table 1-15 on Page 1-25. Bearing caps are match-marked to correspond with the spacer bar and spacer bar bosses on the frame.
4. Be sure the dowels in the bearing caps are aligned with the holes in the crankcase base. A set screw on top of each dowel prevents it from backing out.
5. Measure each crankshaft journal bearing jack clearance, with a dial indicator and magnetic stand (see page 5-13 and the allowable clearance values in Table 1-6 on Page 1-15). To measure main bearing clearance, turn the adjacent crankshaft pin up and mount the indicator stand on the main bearing cap, with the indicator stem touching the web of the crank adjacent to the bearing cap. Push down on the crank, set indicator to zero, pry up, observe and record reading. This is best done before the connecting rods are installed by pulling a clean lifting strap around the adjacent pin and pulling up on the crankshaft with a

crane or bar on the strap.

6. Reattach the connecting rods (See "Connecting Rod - Installation" on Page 5-6), packing diaphragms, and unloaders/head end heads.
7. Reinstall the chain drive. (See "Chain Drive System" on Page 5-26).
8. Replace the spacer bars. Locate the match mark on the spacer bar. Install the spacer bar so that the match mark is up and next to the spacer bar boss with the same marking.
9. Install new end cover gaskets. Gaskets are provided with a non-stick coating to ease removal; additional lubrication is not required. Trim the excess from the new end cover gaskets flush to the base with a knife after end covers have been re-bolted.
10. Examine the top cover gasket. If there is any doubt that it is not in good usable condition, install a new gasket. Reinstall the top cover. Reinstall the coupling hub (if removed) and the coupling disk pack to coupling manufactures instructions.

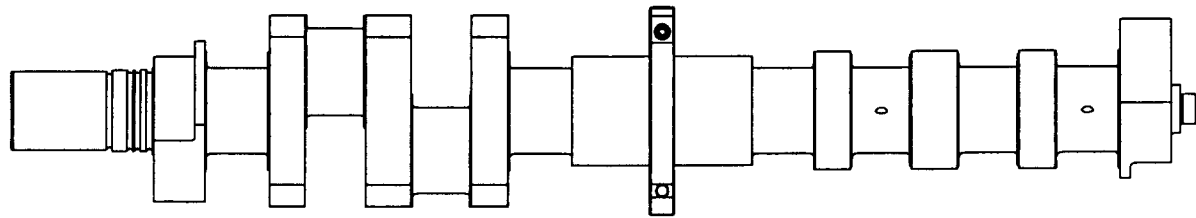
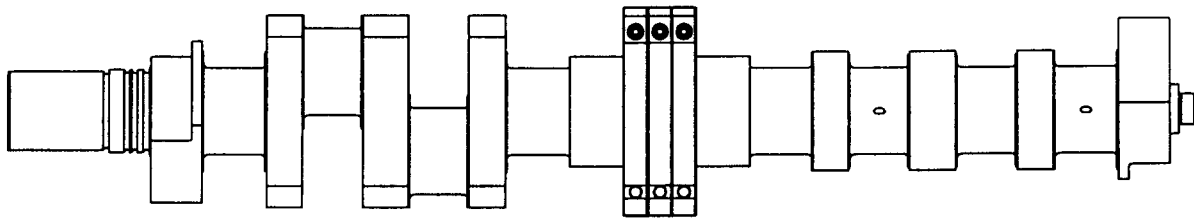
Torsional Vibration Detuners - Installation on Crankshaft

Torsional vibration in reciprocating compressors is a critical consideration. In a **given application** the drive train may require tuning to avoid resonance that can occur at the natural frequencies of the system, as determined by a qualified torsional vibration analysis provider, working closely with the packager, the driver manufacturer and Ariel.

Depending on the results of a torsional vibration analysis (TVA), the compressor may be equipped with or require the addition of torsional vibration detuners (donuts) on the compressor crankshaft. Detuner donuts are sized specifically for the compressor and application, and are custom bored for installation on a specific compressor crankshaft spreader section, see Figure 5-14: on page 5-24. **Do not order or install detuner donuts unless specifically required by the TVA report. An improperly tuned compressor package could cause severe damage to the compressor, coupling, and/or driver, and could potentially lead to personal injury.**

When the addition of detuner donut(s) is required, contact the Ariel Response Center and request Ariel Engineering Reference ER-42 "Determining Detuner Inside Diameter" so that properly fitted detuner donut(s) can be ordered. One or more detuners may be required for a specific application.

Detuner installation is a 2-person operation. Detuner parts are heavy and cumbersome and at least 2 persons are recommended for several of the following steps to avoid personal injury or damage to the equipment.

One Detuner Centered¹ in Spreader SectionThree Detuners Symmetrically Centered¹ in Spreader Section

¹ Unless dictated otherwise by the Torsional Vibration Analysis report.

FIGURE 5-14: LOCATING DETUNER(S) ON THE CRANKSHAFT SPREADER SECTION - TYPICAL

The following steps are used to install torsional vibration detuners on Ariel crankshafts:

1. Verify the correct number, type and mounting location(s) of the detuner(s) for the specific application. Ariel, the driver manufacturer, the packager and the torsional analysis provider cooperatively develop this information. The detailed location is to be provided by the report provider.
2. A finished detuner will have a custom finished bore with identification stamping as shown in Figure 5-15: on page 5-25. The stamping includes part number, the instruction "mount this face toward coupling" on both halves, final bore dimensions and frame serial number (or crankshaft serial number and nominal crankshaft diameter). Verify that this information is on the detuner and that it correlates with the compressor and crankshaft. If this information is in question or missing, contact Ariel Engineering before proceeding. **Detuner donuts are not interchangeable for use on other crankshafts, including replacement crankshafts.**

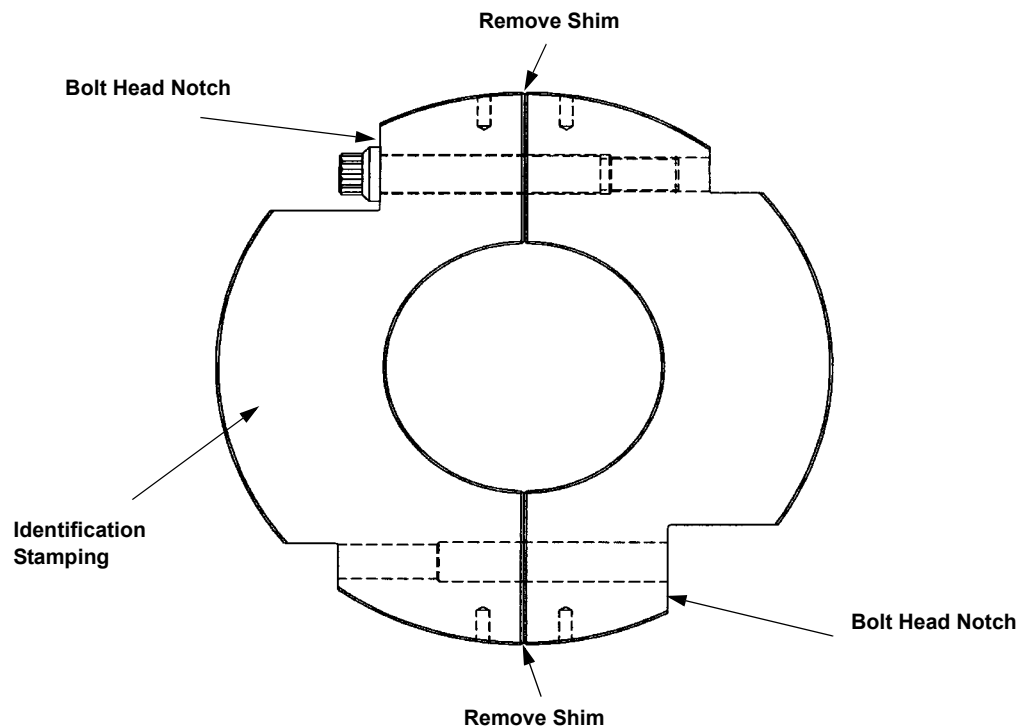


FIGURE 5-15: DETUNER DONUT - TYPICAL

3. Remove and **discard the two shims** that are located between the joints of a new detuner donut.
4. Clean each of the detuner parts thoroughly to remove any dirt or foreign material.
5. Remove the crankcase top cover.
6. Wipe crankshaft spreader section clean and dry.
7. For handling the detuners, an overhead crane is recommended. A forged steel eyebolt can be installed in one half of the detuner for easy handling by the overhead crane. The eyebolt should be installed in the side that is notched for the bolt head(s) as shown in Figure 5-15: on page 5-25. When a crane is not available, a second person is strongly recommended to help lift, lower into place and hold the detuner halves during installation.
8. Remove the bolts from both halves of the detuner and lower one half onto the crankshaft. Extreme care should be taken to prevent damage, such as nicks or scratches, to the crankshaft. **Care must be taken to prevent personal injury during this operation.** Position the piece into place on the top of the crankshaft.
9. Use the same procedure to position the other half of the detuner onto the top of the crankshaft, beside the first half. The two halves will now be side-by-side on top of the crankshaft.
10. Rotate one half of the detuner around the crankshaft by ninety degrees (90°). A crane will be useful to hold this half securely while the second half of the detuner is being rotated around the crankshaft, in the opposite direction, by ninety

degrees (90°).

11. Move one or both detuner halves axially along the crankshaft until they are exactly matched together and the bolt holes are aligned. Lubricate threads and bolt-head seating surfaces with lubricating oil or Lubriplate 630. Then install the top bolt to finger tight.
12. If only one detuner is required, it should be placed at the center of the crankshaft spreader section as shown in the top diagram of Figure 5-14: on page 5-24. If two or more detuners are to be used, position them centered symmetrically along the crankshaft spreader section, in contact with each other, as shown in the bottom diagram of the Figure.
13. Rotate the detuner 180° and install the remaining bolt. Tighten the bolt to finger tight. Remove lifting eyebolts from detuner halves, if used.
14. Tighten each of the bolts to the Section 1 "Fastener Tightening Values" table or the appropriate value on the Tool Box Chart "Ariel Bolting Required Tightening Torque", column 60 (Ariel part number ER-63; complete chart data also available on Ariel web site). Rotate the crankshaft 180° for easy access to the bolts as each bolt is tightened.
15. Check to be sure all tools and other materials have been removed, then replace the crankcase top cover.

Chain Drive System

Description - JGE/2/4, JGH/2/4, JGK/2/4 & JGT/2/4

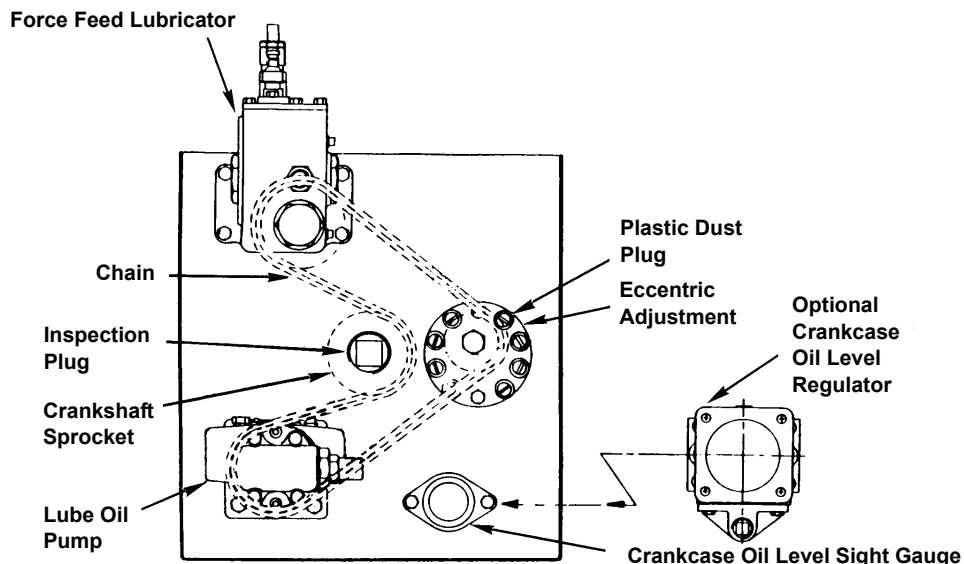


FIGURE 5-16: CHAIN DRIVE SYSTEM JGE:H:K:T/2/4

The chain drive system is crankshaft-driven at the auxiliary end of the frame. The chain runs the lube oil pump and force feed lubricator. Chain tightness is controlled by an idler sprocket attached to the eccentric adjustment cap. The chain dips into the crankcase oil and, as a

result, is constantly lubricated. See Figure 5-16: for the auxiliary end components and chain drive system for the JGE/2/4, JGH/2/4, JGK/2/4 & JGT/2/4 Models.

Description - JGE/6, JGK/6 & JGT/6

The chain drive system is crankshaft-driven at the auxiliary end of the frame. Two chains run the lube oil pump and force feed lubricator, respectively. Chain tightness is controlled by idler sprockets attached to the eccentric adjustment caps. The lube oil drive chain dips into the crankcase oil and the splash action provides oil to the force feed lubricator chain, as a result, both are constantly lubricated. See Figure 5-17: for the auxiliary end components and chain drive system for JGE/6, JGK/6 & JGT/6 Models.

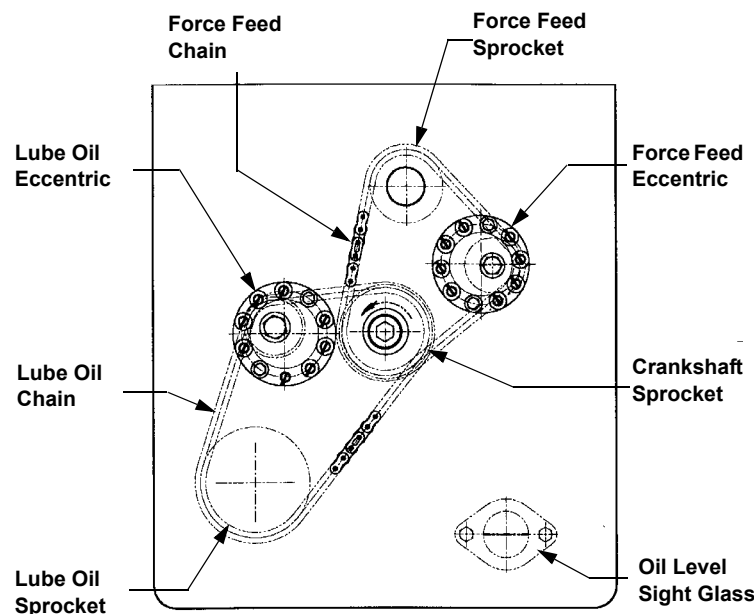


FIGURE 5-17: CHAIN DRIVE SYSTEM JGE:K:T/6 - TYPICAL (STANDARD ROTATION)

Replacement of any parts that can change the position of the drive sprocket on the crankshaft (i.e. crankshaft, drive sprocket, thrust plates), and/or loss of the as built sprocket position on driven components, can require repositioning the eccentric, lube oil pump and force feed lubricator sprockets. Center crankshaft in end play. With a good straight edge, check to see that sprockets are aligned within 1/32 inch (1mm). Or measure the distance between the inside face of the auxiliary end cover to the near faces of the drive sprockets on the crankshaft with a good machinist rule. Check the driven sprockets in the chain drive system against the measured dimensions at crankshaft drive sprockets. Special care must be taken when measuring and adjusting the force feed idler sprocket. This sprocket is thinner than the force feed lubricator and drive sprockets. To compensate, add a value of one half (1/2) of the difference between the drive sprocket thickness and the force feed idler sprocket thickness to the measurement from the inside face of the auxiliary end cover to the outside face of the force feed idler sprocket. Adjust the driven sprockets to the drive sprocket measurements to be aligned within 1/32 inch (1mm). If not in alignment, disassembly and shimming the eccentrics may be required.

Chain Adjustment

1. Roll the crankshaft to the tightest position of the chain. This prevents snugging up on the chain at a slack position and breaking rollers, or ruining the pump and lubricator bearings when the chain goes through its tightest position.
2. Measure the length of the longest most easily accessible span with a tape measure (sprocket center to center), where the deflection will be gauged. Determine the allowable deflection limits defined by the shaded areas in Figure 5-18: or Figure 5-19:, for the measured span (3 to 5% of the span).
3. Measure chain deflection from a straight edge held on the chain rollers where it wraps over the two sprockets of the span. Use a machinist's scale with 0.01 inch or (0.5 mm) increments to measure the deflection distance from the straight edge to a chain roller at the center of the span. Apply a force of 2 to 10 lb (9 to 45 N) finger pressure to take the slack out of the chain. Do not apply excessive force since a force feed lube box drive shaft can bend and provide an inaccurate deflection measurement. Finger pressure is adequate.
4. If adjustment is required, remove the capscrews and plastic plugs from the eccentric cap. Rotate the cap clockwise, facing cap from outside, to line up the first two new capscrew holes. If this makes the chain too tight, try turning the cap around in a counterclockwise direction for a different hole lineup.
5. Replace and tighten the two capscrews hand wrench tight.
6. Roll the crankshaft to check the tightness in a number of positions. At its tightest position, the chain is to be adjusted so that the deflection is within the shaded graph limits in the figures. Replace the plastic caps to keep the holes clean.

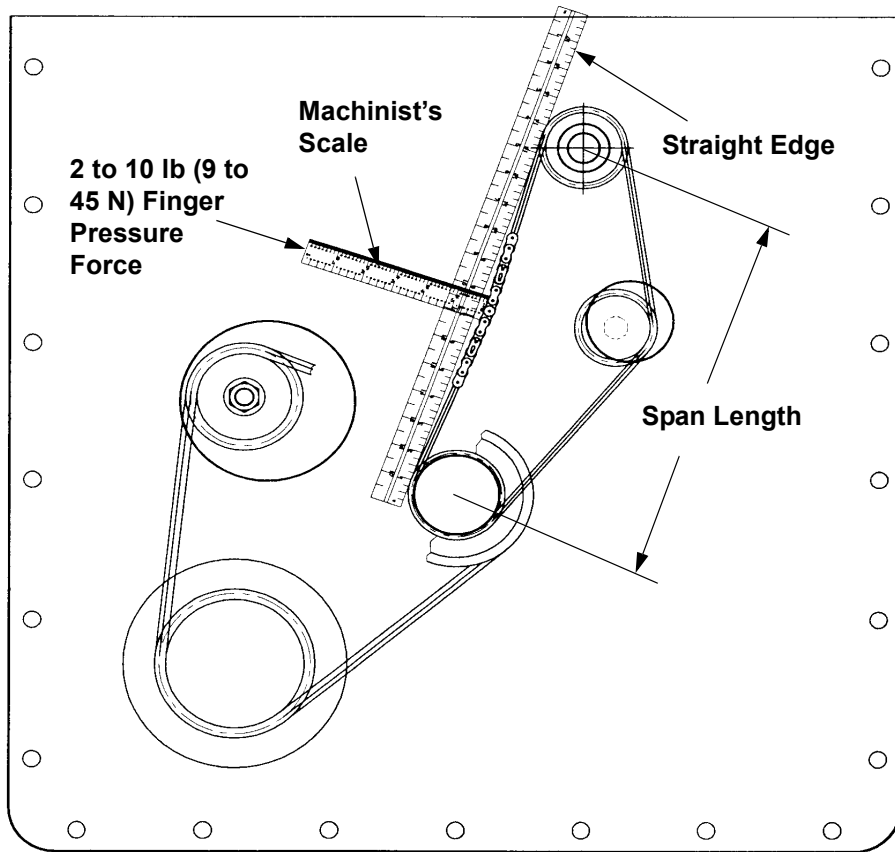


FIGURE 5: CHAIN DEFLECTION MEASUREMENT - TYPICAL

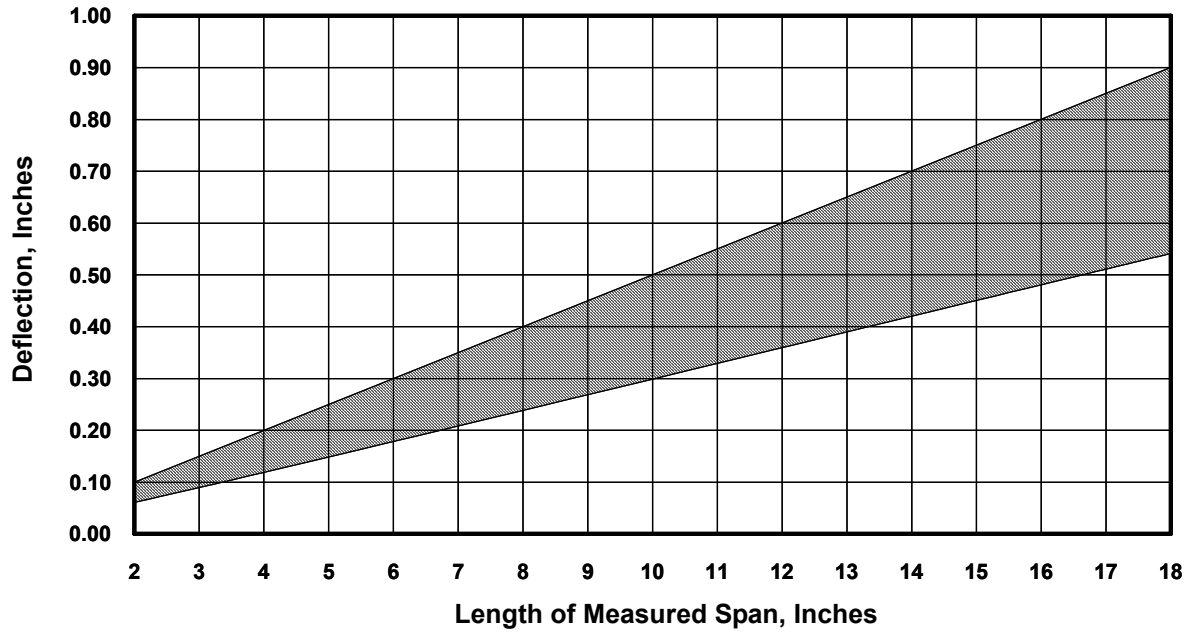


FIGURE 5-18: ALLOWABLE CHAIN DEFLECTION, INCHES

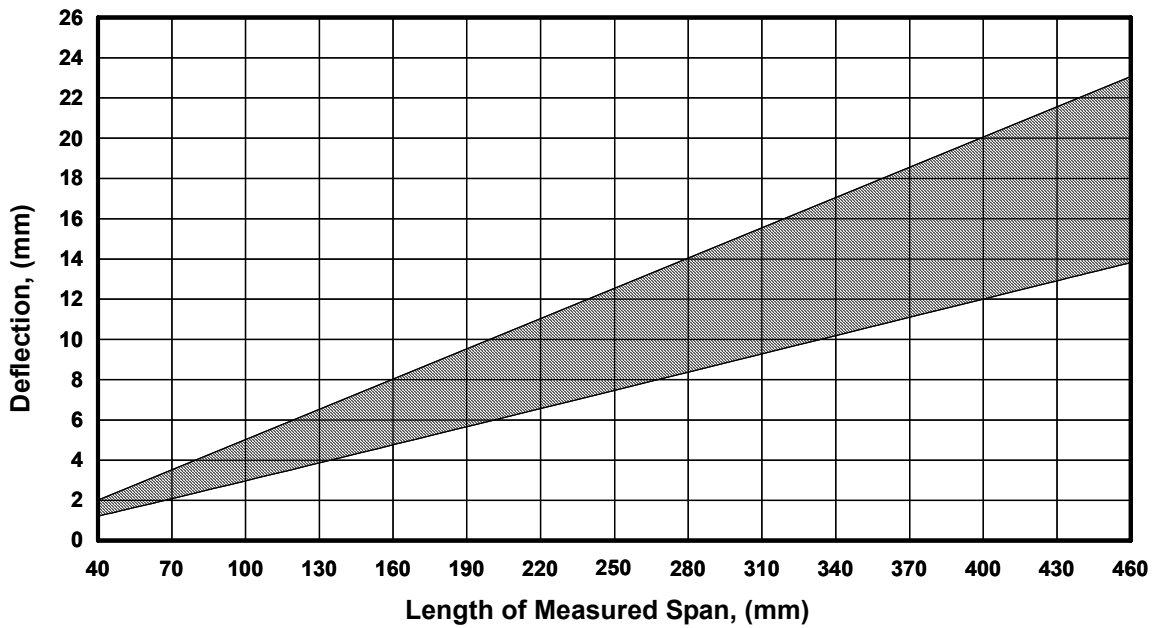


FIGURE 5-19: ALLOWABLE CHAIN DEFLECTION, (MILLIMETERS)

Chain and Sprocket Replacement

The chain(s) should be replaced if the elongation exceeds 0.084 inches (2.13 mm) over a 10 pitch length. The section of chain to be measured should be stretched tight, in place, in the compressor and measured with vernier calipers. A reading made outside of the rollers at 10 pitches should be added to a reading between the inside of the same rollers and then be divided by two. If the resulting calculation exceeds 5.084 inches (129.1 mm) for 1/2 pitch chain, the chain should be replaced. Sprockets showing any undercutting should be replaced.

Chain Idler Sprockets Replacement - (Eccentric Adjustment Caps)

1. The chain idler sprocket for the JGE:H:K:T/2/4 is shown in Figure 5-20: and the two chain idler sprockets for the JGE:K:T/6 & are shown in Figure 5-21:. Also, the location of the chain idler sprockets will vary for standard rotation versus reverse rotation with standard rotation defined as clockwise when viewed at the drive end (standing at the coupling).
2. Remove the frame top cover. Remove the two capscrews that hold the eccentric adjustment cap to the end cover. Rotate the eccentric cap to loosen the chain for removal. After dropping the chain off the idler sprocket, the entire assembly can be removed from the end cover.
3. Remove the lock nut, hex capscrew, and Stat-O-Seal washer. Discard all three items since they must be replaced with new parts. Remove and discard the cap O-ring.
4. Reassemble all parts using a new capscrew, Stat-O-Seal washer, sprocket, and lock nut. Tighten the idler lock nut to the recommended torque given in Table 1-15 on Page 1-25
5. Apply oil and install a new O-ring. Install the assembly and chain. Adjust the chain according to the instructions given in "Chain Adjustment" on Page 5-28.

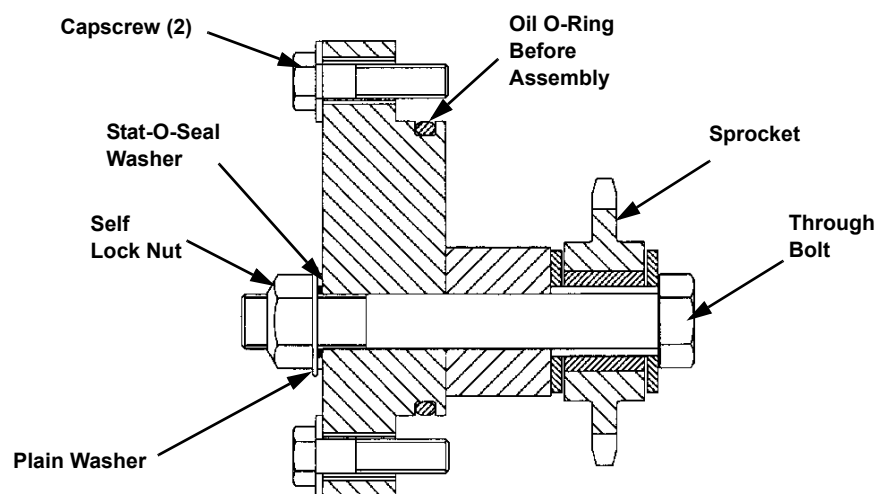


FIGURE 5-20: JGE:H:K:T/2/4 CHAIN IDLER SPROCKET (ECCENTRIC)

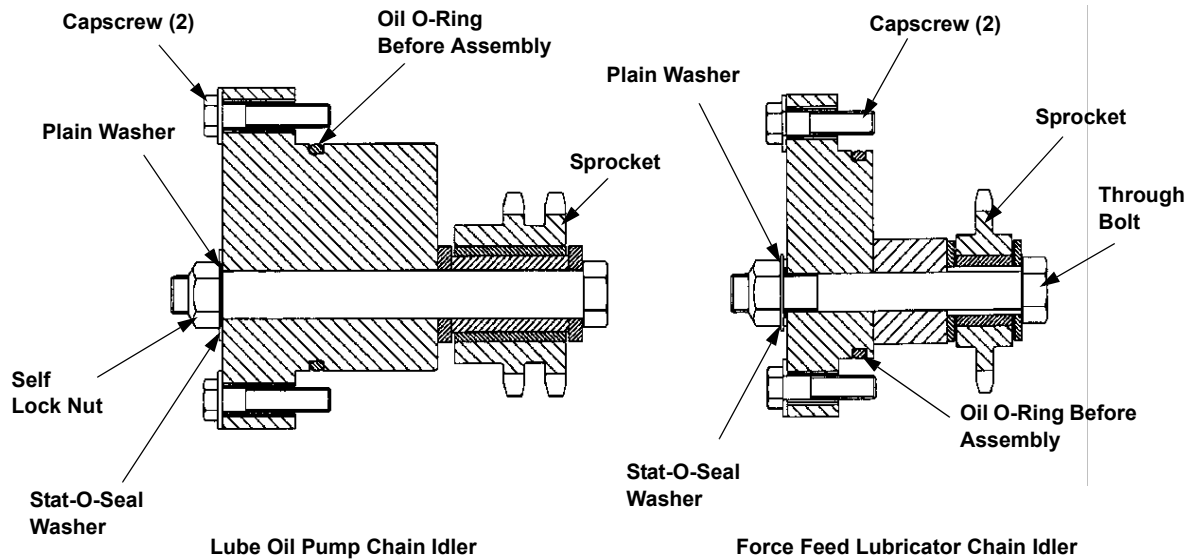


FIGURE 5-21: JGE:K:T/6 CHAIN IDLER SPROCKETS (ECCENTRICS)

Lube Oil Pump Chain Sprocket Replacement

1. Remove all piping from the pump. Remove fasteners from pump mounting flange and the pump with sprocket will come free through the hole in the end cover after the removal of the chain.
2. With a good machinist rule, measure the exact distance from the sprocket drive face to the pump mounting flange face, in order to position the new sprocket. Note this measurement for future reference.
3. With the oil pump on a bench, use an Allen Wrench to remove the sprocket set screws; then, pull the sprocket from its shaft.
4. Remove the square key, 3/16 x 1 inches (4.8 x 25 mm) long, from the shaft and file the shaft to smooth out any burrs raised by the cup point of the set screw.
5. Install a new square key, 3/16 x 1 inches (4.8 x 25 mm) long, after first checking to make sure the key will fit into the new sprocket. If the key is too thick, it can be polished with an emery cloth on a flat surface until it can easily slide into the notch. It may also be a little high and require filing of the top edge.
6. Install a new sprocket to the original measurement between the sprocket drive face and the pump mounting flange face. When it is in position, tighten the set screws.
7. Install new gaskets. Gaskets are provided with a non-stick coating to ease removal; additional lubrication is not required.
8. Reinstall the pump onto the end cover. Check the alignment to crankshaft drive sprocket, with crankshaft centered in end play, using a straight edge to within 1/32 inch (1 mm). If not in alignment, adjust sprocket position as necessary.
9. Adjust the chain according to the instructions in "Chain Adjustment" on Page 5-28.

10. Reinstall all piping to the pump

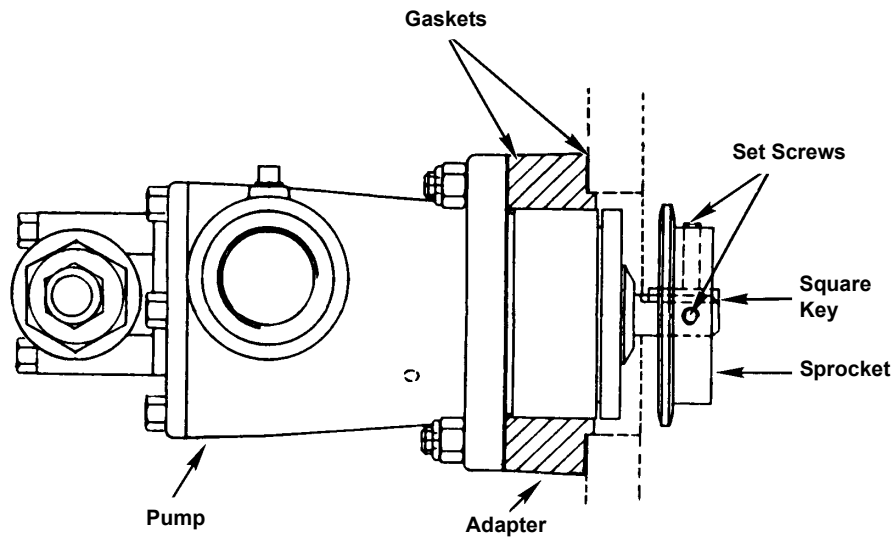


FIGURE 5-22: LUBE OIL PUMP CHAIN SPROCKET - TYPICAL

Force Feed Lubricator Chain Sprocket Replacement

1. For the following steps, refer to Figure 5-23: on Page 5-34.
2. With a good machinist rule, measure the exact distance from the inside face of the auxiliary end cover to the near face of the lubricator sprocket. Note the measurement for proper positioning of the new sprocket. Remove chain.
3. Remove the sprocket set screw and sprocket. Detach all tubing to the lubricator.
4. Remove the four mounting bracket capscrews and remove the lubricator.
5. With the lubricator on the bench, remove the Woodruff Key from the shaft and file the shaft to remove any burrs raised by the cup point of the set screw. Oil and install a new O-ring.
6. Install a new Woodruff Key after first checking to make sure the key will fit into the new sprocket. If it is too thick, it can be polished with an emery cloth on a flat surface until it can easily slide into the notch. It may also be a little high and require filing of the top edge.
7. After the new key has been installed and it has been determined that the new sprocket will fit, oil the new O-ring and remount the lubricator to the end cover.
8. Put the new sprocket onto the shaft and set to measured dimension. Tighten the set screw.
9. Check alignment to the crankshaft drive sprocket with crankshaft centered in end play, using a straight edge, to within 1/32 inch (mm). When aligning this sprocket with the idler sprocket, be sure to take into account that the idler sprocket is thinner than the other sprockets. If not in alignment, adjust sprocket position as necessary.

10. Install chain and adjust using the instructions given in "Chain and Sprocket Replacement" on Page 5-31.
11. Re-attach all tubing to the lubricator.

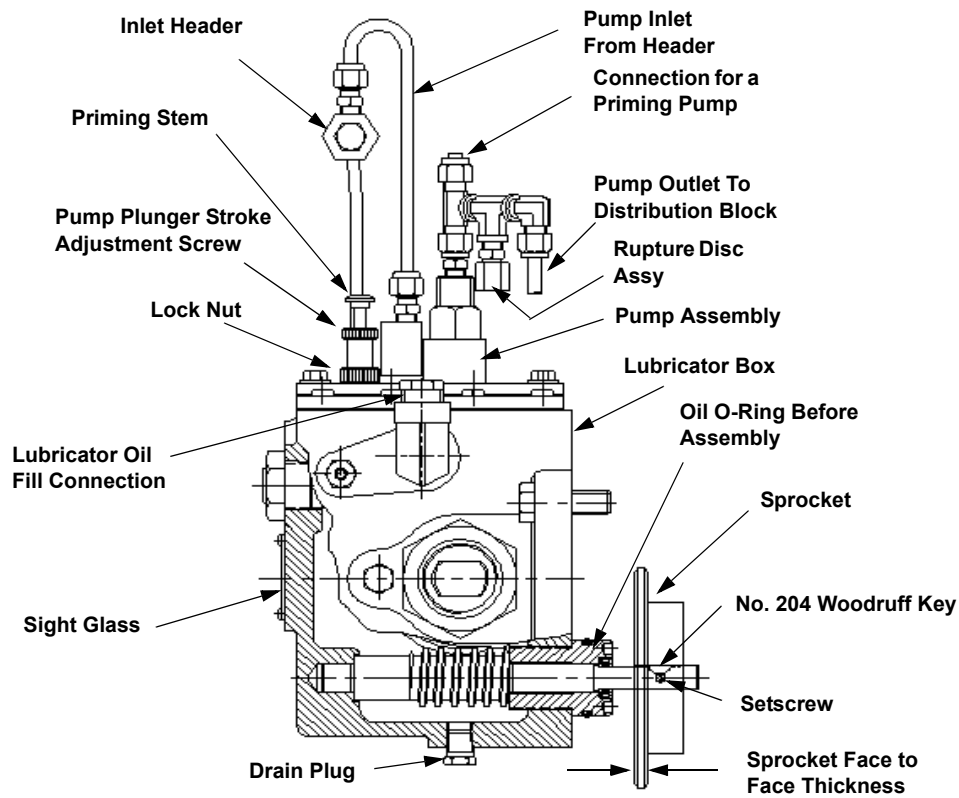


FIGURE 5-23: FORCE FEED LUBRICATOR CHAIN SPROCKET - TYPICAL

Piston And Rod - Removal

CAUTION

TO PREVENT PERSONAL INJURY, BE SURE THAT COMPRESSOR CRANKSHAFT CANNOT BE TURNED BY THE DRIVER OR COMPRESSOR CYLINDER GAS PRESSURE DURING MAINTENANCE: -- ON ENGINE-DRIVEN COMPRESSORS, REMOVE THE CENTER COUPLING OR LOCK THE FLYWHEEL. -- ON ELECTRIC MOTOR-DRIVEN COMPRESSORS, IF IT IS INCONVENIENT TO DETACH THE DRIVER FROM THE COMPRESSOR, THE DRIVER SWITCH GEAR MUST BE LOCKED OUT DURING MAINTENANCE.

BEFORE PERFORMING ANY MAINTENANCE, COMPLETELY VENT SYSTEM. BEFORE REMOVING A CYLINDER HEAD, BACK OFF ALL CAPSCREWS 1/8 INCHES (3 mm). MAKE SURE THE HEAD IS LOOSE AND THE CYLINDER IS COMPLETELY VENTED.

1. For non-lube cylinders, reference "Cleaning Components & Thread Lube for Non-Lube Compressor Cylinders" on Page 5-64.
2. Remove the crosshead guide side covers and the cylinder head. The cylinder head bolts should be loosened first to the Caution above.
3. Move the crosshead to its inner dead center position. Back off, but do not remove, the crosshead-balance nut set screws. Loosen the crosshead-balance nut with the special slugging wrench, see Figure 7-1: on Page 7-2. Use the open end wrench for hex nuts and the peg wrench for round nuts. Or use the separately purchased hydraulic crosshead-balance nut torque tool, G-7583, see Figure 5-8: on Page 5-13.
4. Remove the cylinder head. In the case of tandem cylinders where the outboard cylinder bore is smaller than the inboard bore, it is necessary to remove the outboard cylinder. Support such cylinders during removal and installation, as to not put excessive weight on the piston and rod assembly which might cause bending.
5. Use the Piston Nut Spanner or Turning Tool to screw the piston and rod assembly out of the crosshead, see Figure 5-26: on Page 5-40. The two dowels on the tool fit the holes in the piston nut. Turn the crosshead nut off the piston rod.
6. As the piston leaves the cylinder, be careful in handling the piston rings. Despite their toughness in service, rings are fragile with regard to removal. Always handle them with clean tools and hands protecting the rings from nicks, marring, and bending. Move the piston out of the cylinder until a fraction of the first ring clears the cylinder. Encircle the ring by hand (use a band for larger sizes) until it is clear and remove it. Use this same procedure to remove the succeeding rings and wear band.
7. Slide the piston rod out of the head end. The threaded crosshead end of the rod is 1/4 inches (6 mm) smaller in diameter than the inside diameter of the packing.

Using extreme care, slowly slide the piston rod through the packing so as not to damage the rod threads or the packing rings.

Piston And Rod

Piston and Rod - Disassembly

Older rods not drilled and threaded for the hydraulic torquing tool (see Figure 5-25: on Page 5-39), require a clamping fixture (see Figure 5-24: on Page 5-37) for proper piston and rod disassembly/reassembly. Rods which do not have the threaded hole may be reworked by a qualified machine shop. Contact your Distributor or Ariel for details. Remove the piston nut set screws (2) and reference the instructions in "Reassembly" below, before disassembly.



! CAUTION

TRAPPED GAS PRESSURE IN HOLLOW PISTONS CAN PRESENT A PERSONAL SAFETY HAZARD WHEN SERVICING THE PISTON AND ROD ASSEMBLY. WORK IN A WELL VENTILATED, NON SPARKING AREA. DO NOT BREATHE GAS EMITTED FROM PISTONS WHEN VENTING TRAPPED GAS.

Piston and Rod - Reassembly

1. Clean all piston and rod assembly parts thoroughly. Be sure piston is internally clean and dry.
2. Inspect parts for nicks, burrs or scratches and dress surfaces with a fine grit stone as required.
3. Inspect the piston rod threads and collar shoulder. Threads are to be clean and free of burrs. Fit the collar and nut into the piston to verify the outside diameter fits and rotates freely. Install the collar and nut onto the piston rod to verify that the inside diameter fits and rotates freely. Run the piston nut down by hand until the rod threads protrude to verify freedom of thread engagement. Remove nut and collar.
4. Check piston rings and wear band to determine wear (see "Determining Ring Wear:" on Page 5-42 and "Determining Wear Band Wear:" on Page 5-42). Replace piston rings and wear bands as required.
5. If the piston rod is not drilled and threaded for hydraulic torquing tool (see Figure 5-25: on Page 5-39), clamp the piston rod in a proper holding device, using clean and oil free PVC liners (see Figure 5-24: on Page 5-37). Clamp the piston rod as close to the collar as possible, but where holding device will not interfere with the piston. Older rods not drilled and threaded for the hydraulic torquing tool

are best done by a qualified service center.

6. Apply a thin coating of "Never-Seez" Regular Grade (anti-seize and lubricating compound) to the piston rod shoulder and rod collar locating bands, and collar face in contact with the piston, then slide collar onto rod. "Never-Seez" is manufactured by Bostick, Boston Street, Middleton, MA 01949 USA, Telephone: 508-777-0100.
7. Apply a thin coating of "Never-Seez" Regular Grade to piston rod threads at the piston end, then slide piston in place onto rod and collar. For two-piece pistons install a new O-ring between the piston halves.

NOTE: ONE END OF SINGLE PIECE PISTONS IS MACHINED 0.002 INCHES (0.05 mm) UNDERSIZE ACROSS A 3/4 INCH (20 mm) WIDE BAND FOR MANUFACTURING PURPOSES. IF THE PISTON IS SYMMETRICAL AND CAN BE INSTALLED IN EITHER DIRECTION, ASSEMBLE WITH THE UNDERSIZE BAND TOWARD THE HEAD END.

8. Apply a thin coating of "Never-Seez" Regular Grade to the piston nut threads and piston mating face. Install nut and hand tighten.
9. For piston rods not drilled and threaded for the hydraulic torquing tool, tighten the piston nut to the recommended torque found in Table 1-15 on Page 1-25, using the piston nut spanner (see Figure 7-1: on Page 7-2) and piston torquing fixture (see Figure 5-24:). It may be necessary to use a hydraulic torque wrench to achieve the required torque. Loosen nut without disassembling and retighten to required torque. Repeating the tightening procedure properly seats the components.

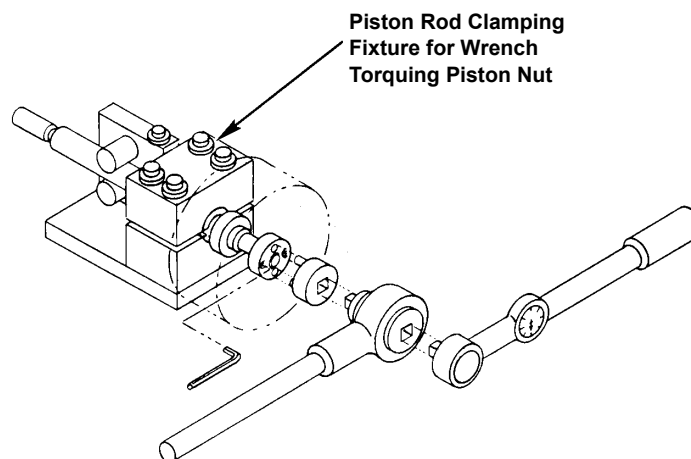


FIGURE 5-24: PISTON AND ROD CLAMPING FIXTURE (D-0961)

 **CAUTION**

DO NOT OVERPRESSURE THE HYDRAULIC TORQUING TOOL. OVERPRESSURE CAN CAUSE THE TORQUING TOOL TO FAIL AND/OR RESULT IN EXCESSIVE PRE-LOAD OF THE PISTON ROD. PISTON ROD FAILURE CAN OCCUR DUE TO EXCESSIVE PRE-LOAD. SUCH FAILURES CAN RESULT IN PERSONAL INJURY.

10. For piston rods drilled and threaded for the hydraulic torquing tool (see Figure 5-25: on Page 5-39). Properly configure the separately purchased hydraulic torquing tool with the 7/8"-9 puller-bolt insert, the smaller dowel drive pins and the 4.120 inches (106 mm) inside diameter adapter-base-plate installed, except 4-5/8ET class pistons use the 3.570 inches (91 mm) base plate. Other small diameter pistons may require special base plates. Put the torquing tool in place, with the two dowel drive pins placed into the piston rod nut. Tighten the puller bolt until torquing tool is tight against the piston rod assembly. **CAUTION! TIGHTEN A MINIMUM OF EIGHT TURNS TO PREVENT PISTON ROD TO PULLER-BOLT THREAD FAILURE. SUCH FAILURES CAN RESULT IN PERSONAL INJURY. TOOL MUST BE PROPERLY CONFIGURED.** Then back off 1/4 turn. Note that the puller bolt-nut is provided with barring holes to insert a 3/8" (9.5 mm) rod, to assist in tightening or loosening the puller bolt, if necessary. A hydraulic pressure of 3,500 psig (241 bar_g) is to be applied to the torquing tool to stretch the piston rod. Then 50 lb-ft (68 N·m) of torque is to be applied to the 9/16 inch hex pinion gear drive. The hydraulic pressure is then released. Re-apply hydraulic pressure and completely loosen piston nut without disassembling and release hydraulic pressure; repeat the tensioning/tightening procedure. Repeating the tightening procedure properly seats the components. The hydraulic torquing tool is also used and pressurized to disassemble a piston and rod.
11. After tightening, the piston rod should not protrude more than 0.010 inches (0.25 mm) past the piston face. If it does contact your packager and/or Ariel.
12. Apply a thin coating of "Never-Seez" Regular Grade to two new Allen set screws. Two new Allen wrenches are also required per nut at each tightening and are discarded after their one time destructive use. Install the set screws and tighten so that the Allen wrench is permanently deformed by tightening past its yield point (twisted through a 15 degree arc).
13. Prick-punch the piston nut, within 1/16 inches (1.5 mm) of the set screw threads, to lock the set screws in place.
14. Weigh the piston rod assembly with the piston rings and wear bands included. Weigh parts on a calibrated scale to 0.1 pounds (0.05 kg). Stamp the weight on the piston's head end. Flatten any raised lips to avoid end clearance measurement errors. Record this weight for future reference.

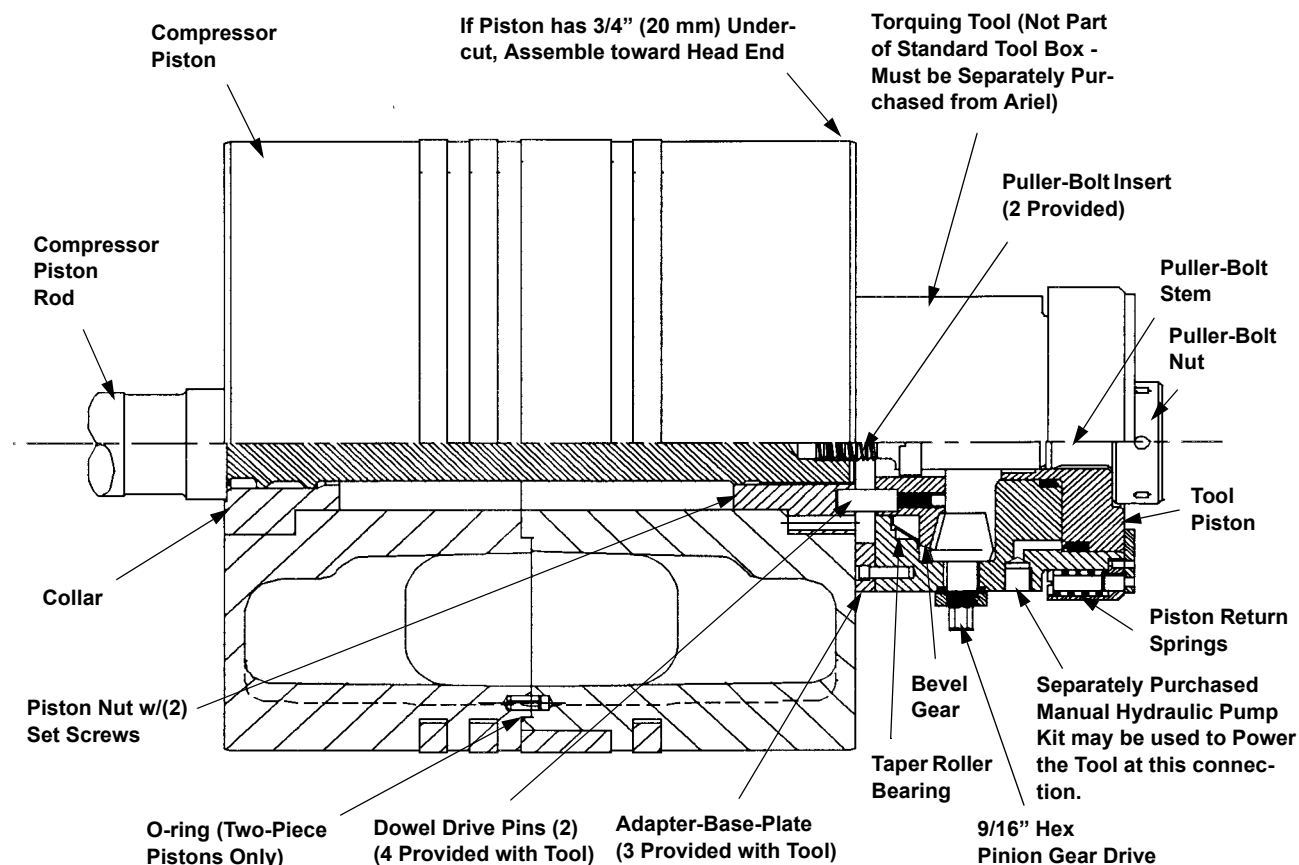


FIGURE 5-25: HYDRAULIC PISTON NUT TORQUING TOOL - TYPICAL

Piston and Rod - Installation

1. Install the piston/rod assembly with piston rings and wear band into the cylinder. The threaded crosshead end of the rod is 1/4 inches (6mm) smaller than the inside diameter of the packing. It is not necessary to use an entering sleeve if reasonable care is taken, but a plastic sleeve may be helpful to be sure that the packing rings are not damaged. A piston rod entering sleeve is provided in the Ariel tool box, see Figure 7-3: on Page 7-3. See "Piston Rings - Installation" on Page 5-42 and "Wear Band - Installation" on Page 5-44.
2. See "Crosshead - Installation" on Page 5-10 for details to re-attach piston rod to crosshead, check piston end clearance, piston rod runout and crosshead clearances, and re-assemble to close cylinder and crosshead guide.

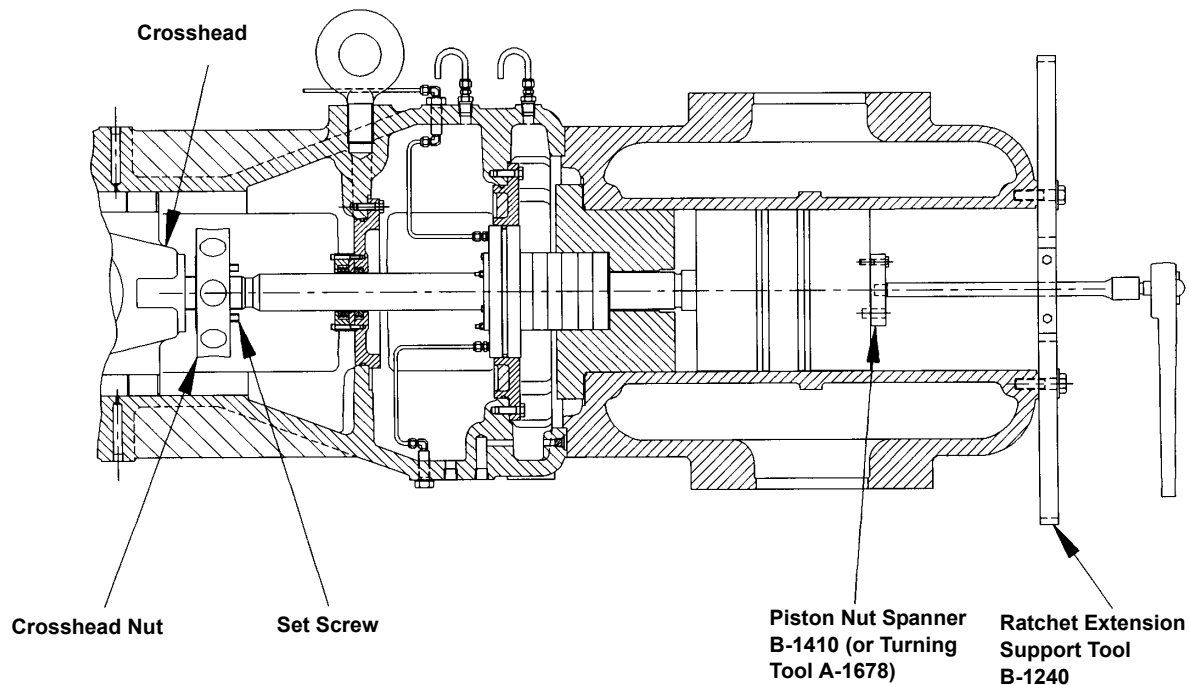


FIGURE 5-26: PISTON AND ROD INSTALLATION - TYPICAL

Piston Rod Run Out

Check piston rod run out after installing a new unit, after relocating a unit or after any maintenance that could affect rod run out.

Verify that the crosshead guides are properly shimmed to level. See “Procedure For Setting and Aligning” on Page 2-1. Verify that the crossheads are in direct contact with the bottom of the crosshead guide. A 0.0015 inches (0.04 mm) feeler stock should not be able to be inserted more than 1/2 inches (13 mm) at all four corners of the crosshead.

Position the dial indicator¹ stem against the piston rod, close to the packing case. Set the indicator to zero with the piston toward the crank end. Readings are to be taken in both the vertical and horizontal directions. When measuring vertical rod movement, upward movement will be recorded as positive, downward movement will be recorded as negative. When measuring horizontal rod movement, rod movement toward the auxiliary end of the frame, will be recorded as a positive reading, movement toward the drive end of the frame will be recorded as a negative reading. Copy Table 5-1 to record readings. Bar over crankshaft by hand and record readings at mid-stroke and with piston at the head end.

1. Use a 0.0001 inches (0.001 mm) increment calibrated dial indicator.

TABLE 5-1: PISTON ROD RUN OUT

THROW NUMBER:		1	2	3	4	5	6
VERTICAL	Piston @ CE	0	0	0	0	0	0
	Mid-Stroke						
	Piston @ HE						
HORIZONTAL	Piston @ CE	0	0	0	0	0	0
	Mid-Stroke						
	Piston @ HE						

Compare readings to Table 5-2.

TABLE 5-2: MAXIMUM ACCEPTABLE PISTON ROD RUN OUT READINGS

DIRECTION	INCHES	(mm)
Vertical	0.0020	(0.051)
Horizontal	0.0010	(0.025)

If a vertical reading is greater than the maximum acceptable reading, the following procedure is to be used to determine acceptability: With the piston at the head end, use feeler gages to determine clearance at the top of the piston. On wear band or rider ring pistons, this clearance is over the rings or band. Feeler top clearance is to be divided by two ($/2$) and then subtract ($-$) 0.005 inches (0.13 mm). Place a feeler of this calculated thickness under the bottom of the piston. Place the feeler under the wear band or rider ring on wear band or rider ring pistons. This feeler is to be long enough to stay under the piston as the piston is moved throughout its stroke. Re-measure vertical run out and compare to acceptable limits in the table above. The horizontal readings, taken without the use of feelers are to be used for acceptance. Copy Table 5-3 and record calculations and readings.

TABLE 5-3: FEELER THICKNESS TO CORRECT FOR PISTON WEIGHT

LINE	THROW NUMBER:	1	2	3	4	5	6
1	Top Feeler Clearance						
2	Line 1 ($/2$)						
3	Line 2 - 0.005 inches (-0.13mm)	- 0.005" (-0.13mm)	- 0.005" (-0.13mm)	- 0.005" (-0.13mm)	- 0.005" (-0.13mm)	- 0.005" (-0.13mm)	- 0.005" (-0.13mm)
4	Bottom Feeler Thickness						
5	Vertical, Piston @ CE	0	0	0	0	0	0
6	Vertical, Piston @ HE						

If readings are not within acceptable limits after replacing worn parts and correcting any piping misalignment, the piston rod assembly should be replaced.

Piston Rings

Most JGE:H:K:T cylinders use one-piece angle cut filled Teflon piston rings. High-pressure cylinders use two-piece thermoplastic rings, reference Figure 5-28: on Page 5-43.

Determining Ring Wear:

Ariel recommends replacing rings when the end gap has increased to three times the new dimension. To measure the end gaps, insert the rings in the cylinders without pistons. (See Table 1-13 on Page 1-20 for new and maximum end gap dimensions.)

Removal:

See paragraph 5. at “Piston And Rod - Removal” on Page 5-35 for piston ring removal.

Wear Bands

Most JGK and JGT pistons use one, one-piece angle cut filled Teflon wear band. High-pressure cylinders use two-piece thermoplastic wear bands, reference Figure 5-28: on Page 5-43.

Determining Wear Band Wear:

Since the wear band does not work as a sealing ring, end gap is not critical. The amount of wear band projection beyond the outer diameter of the piston is important. Wear band projection can be checked by measuring piston to cylinder bore clearance at the bottom of the bore. This can be done without removing the piston from the cylinder. Replace the wear band before it has worn enough to allow the piston to touch the cylinder bore.

Piston Rings - Installation

1. Place the rings in the grooves in the piston. Compress the rings by hand.
2. For seal-joint piston rings, be sure stamped side is toward pressure, reference Figure 5-27: on Page 5-43. For two-piece high-pressure face cut piston rings, be sure notches face toward the pressure (notches face away from wear band), reference Figure 5-28: on Page 5-43.
3. With the rings fully compressed in the grooves, insert the rod and piston into the cylinder. Make sure the rings stay in place while inserting the piston and rod.

NOTE: RING GAPS ARE TO BE STAGGERED AROUND THE PISTON, RATHER THAN IN LINE.

4. Follow the steps under “Piston and Rod - Installation” on Page 5-39.

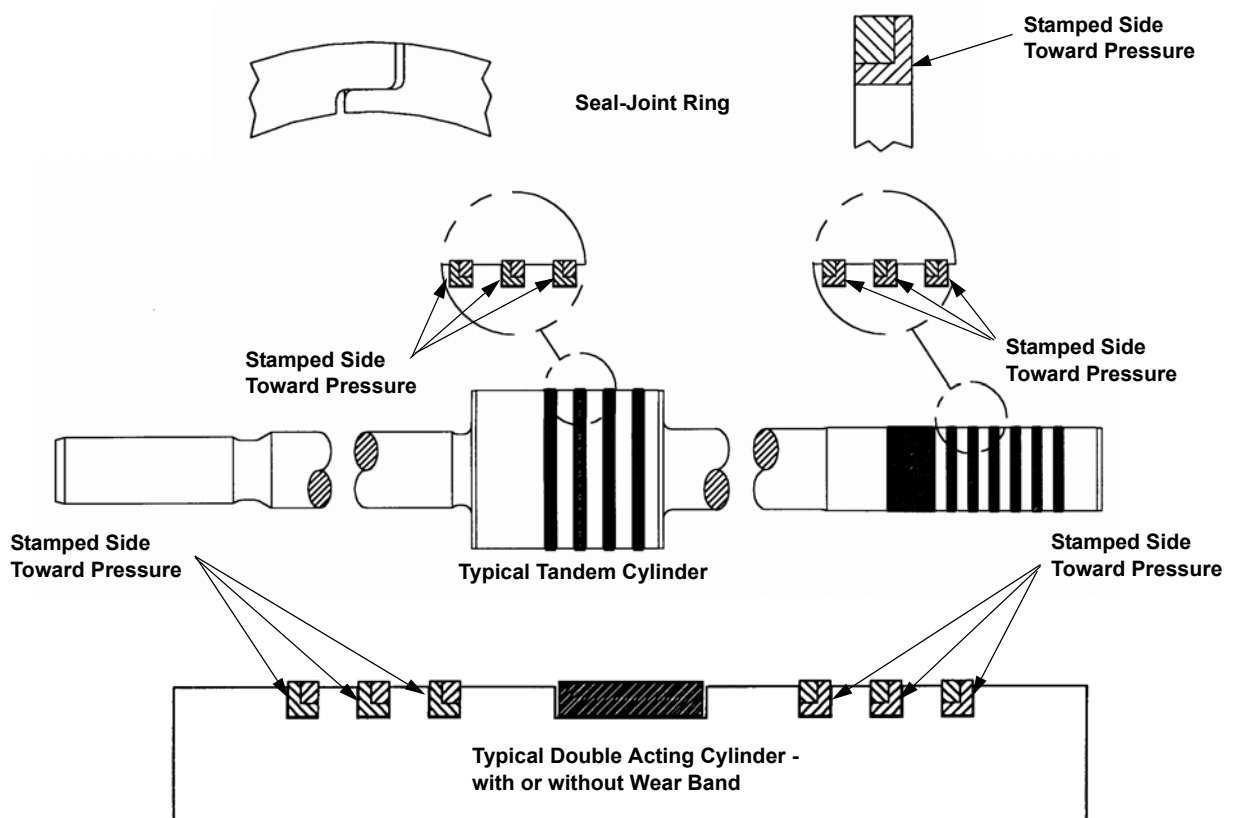


FIGURE 5-27: SEAL-JOINT PISTON RING INSTALLATION ORIENTATION

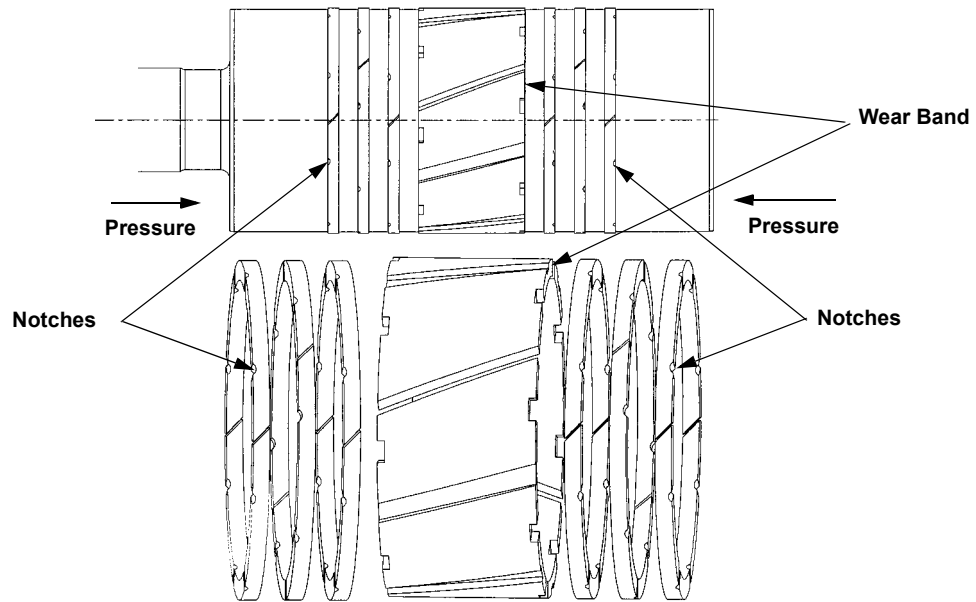


FIGURE 5-28: HIGH-PRESSURE FACE-CUT PISTON RING ORIENTATION

Wear Band - Installation

Install the wear band as if it were another piston ring as above.

Piston Rod Pressure Packing - Removal

1. Remove the piston and piston rod. See "Piston And Rod - Removal" on Page 5-35.
2. Remove packing diaphragm (if applicable) and oil wiper packing.
3. Disconnect all tubing and instrumentation (if applicable) from the packing flange. Remove the twelve point capscrews that hold the pressure packing gland to the crank end of the cylinder/head.
4. At this point do not remove the small nuts from the studs. These studs hold the entire packing case together so it can be removed as an assembly.
5. Pull the entire pressure packing out into the crosshead guide. It will then come out through the large side opening of the guide. The pressure packing may now be taken to a clean place for disassembly.
6. Set the pressure packing on a clean surface on its nose cup or cylinder end. Match mark the outside diameter of the cups for proper reassembly. Three long tie studs hold the pressure packing together. The stud holes are not equally spaced. This prevents the stack of parts from being aligned incorrectly. Remove the stud nuts and the pressure packing can be unstacked. Replace these nuts each time the pressure packing is serviced.
7. Ring wear can be determined by placing the assembled rings, (note match-marks), on the piston rod. Check end gap clearance. If the ends butt, or nearly butt, they should be replaced by new rings.
8. Fins or wire edges on the rings due to wear should be carefully filed off so that all matching edges will be square.
9. The metal gasket on the end cup can be pried loose with a sharp awl. Be careful not to scratch the sides of the gasket groove.
10. Before reassembly be certain all parts are perfectly clean.

Piston Rod Packing - Reassembly

1. Be sure to refer to the pressure packing assembly in your parts book. Ariel supplies parts books with each unit. Please contact your distributor if you do not have a parts book. A pressure packing assembly drawing also is packaged with each pressure packing re-build kit.
2. Care must be taken to prevent scratching the mating surfaces of the cups, which can cause problems. Cup surfaces must be clean and dry when being re-assembled.
3. If installing a new set of rod rings in an existing packing case, the case parts need to be inspected for wear. Cups should be smooth and flat on the back side where the rod rings must seal. If the cups or grooves have worn concave or tapered, they should be reground or relapped. Do not reduce the cup thickness

to less than the rework dimension shown on the packing assembly drawing in the Ariel Parts Book. It is rarely necessary to alter the crosshead side of the cups, however, if this is found necessary, care must be taken so that the correct side clearance for the renewal rings is not destroyed.

NOTE: IF PREMATURE WEAR IS SUSPECTED, REFER TO THE ARIEL “Cylinder And Packing Lubrication Requirements” in Section 4.

4. Before a packing case is installed, it should always be disassembled and thoroughly cleaned in an appropriate solvent for the intended service.
5. Before assembling the rings into the case, following is recommended: Put each ring set individually onto the rod and check the total end gap. See “Types of Piston Rod Packing Rings” on Page 5-47 for end gap tolerances. File at a gap to restore total end gap within tolerance. With the ring set on the rod, shine a light from behind the ring, if any light is observed between the ring and the rod, the ring set is not acceptable.
6. Make sure that each rod ring and cup is properly positioned and, unless non-lube, that rings are liberally coated with new clean lubricant before reassembly. Only use the same lubricant that is used in the force feed lube system. If non-lube, see “Cleaning Components & Thread Lube for Non-Lube Compressor Cylinders” on Page 5-64. Make sure the tie studs are completely screwed into the end cup. Examine all parts for unusual nicks or burrs which might interfere with the free floating of the rod ring in the cups. Particular care should be taken with rod rings made of soft materials, such as bronze or TFE, and it is extremely important that wiper rings be handled and installed so as to prevent damage to the scraping edges. If packing case is “water”-cooled, see “Water-Cooled Piston Rod Packing” on Page 5-54.

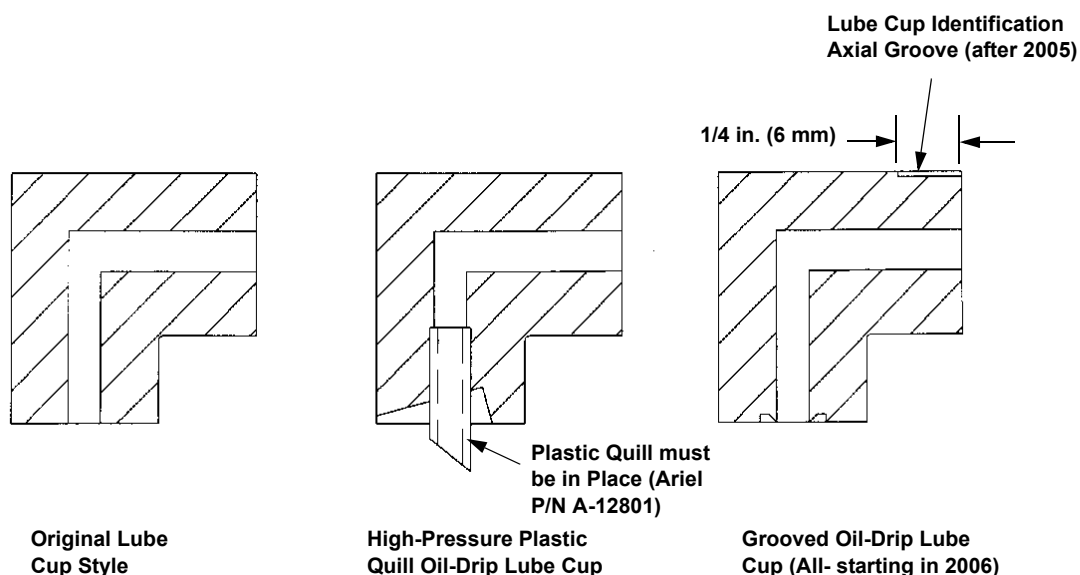


FIGURE 5-29: PISTON ROD PACKING CASE LUBE CUPS

7. Parts should be laid out on a work bench so that they can be installed progressively with each in its correct position and the rod rings with their proper faces toward the pressure. Three long tie studs hold the pressure packing together. The stud holes are not equally spaced. This prevents the stack of parts from being aligned incorrectly. Note that all rod ring segments are carefully lettered and must be assembled accordingly. This is most important for proper sealing. Center side-loaded WAT and AL rings prior to tightening tie stud nuts. Install tie stud-nuts and tighten to the values given in Table 1-15 on Page 1-25. Make sure that all rings move freely, radially, in their grooves using fingers. Side loaded rings will be snug, but should still move using your fingers. Be sure these rings are centered.
8. For new installations, care must be given to the cleaning of all accumulated dirt in the lines and compressor because foreign material will lodge in the packing to become destructively abrasive.
9. Prior to installing the packing case into the cylinder, the end cup gasket must be inspected for nicks and damage that would cause it to leak in service. When in doubt, replace the gasket with a new one.
10. Before installing the packing case into the cylinder, be sure the gasket surface in the packing counter bore on the crank end of the cylinder/head is clean and not scratched.
11. Reinstall the complete packing case assembly with the oil supply point on top. Using the rod packing bolts, pull the packing into place.
12. Reinstall the packing diaphragm (if applicable) and wiper packing.
13. Reinstall the piston and rod. Follow the steps under "Piston and Rod - Installation" on Page 5-39.
14. After the crosshead nut has been tightened, tighten the rod packing bolts evenly to the recommended torque in Table 1-15 on Page 1-25. This procedure will bring the pressure packing up square on its nose gasket. Alignment is accomplished by the use of feelers to maintain a uniform clearance all around between the case bore and the rod. Rod packing bolt tightening on high pressure cylinders requires the use of a torque multiplier.

NOTE: THE FINAL TORQUE FOR THE ROD PACKING BOLTS SHOULD BE REPEATED UNTIL NO TURNING OF THE FASTENERS IS OBSERVED. THE TORQUE ON THESE FASTENERS SHOULD BE RE-CHECKED AT THE NEXT SERVICE INTERVAL.

15. Retighten the small tie stud nuts. Reinstall the tubing connections and instruments (if applicable). Take care not to cross-thread the tubing nuts. Tubing nuts must be tight.

NOTE: AFTER INSTALLING THE PRESSURE PACKING, REFER TO "Force Feed Lubrication System" on Page 4-48 FOR INSTRUCTIONS FOR PRIMING THE FORCE FEED LUBE SYSTEM. PRIMING SHOULD BE REPEATED EACH TIME A COMPRESSOR IS STARTED BECAUSE OIL LINES MAY HAVE BEEN BLED DURING DOWN TIME. FOLLOW INSTRUCTIONS IN "Force Feed Lubricator Adjustment" ON PAGE 3-10 FOR LUBRICATION RATES THAT ARE RECOMMENDED FOR BREAK-IN OF A NEW MACHINE. BREAK-IN LUBE RATES ARE APPROXIMATELY TWICE THE NORMAL RATES - OR ONE-HALF THE NORMAL INDICATOR PIN CYCLE TIME.

Long Two-Compartment Intermediate Packing

Compressors supplied with long two-compartment distance pieces include an intermediate packing assembly that seals around the rod between the outboard and inboard distance pieces. This packing assembly includes a single AL ring set.

For lubricated service, force feed lube oil is supplied to the top of the ring set. The lube rate is very low because this ring set is not subjected to cylinder pressures and temperatures. Since the AL ring set seals end-to-end in the cup and with the low lube rate, newly installed rings could run virtually dry for the first few hours of operation. To avoid damage to the rings and rod, copiously oil the ring set during installation, before the rod is installed. Only use the same lubricant that is used in the force feed lube system. If non-lube, see "Cleaning Components & Thread Lube for Non-Lube Compressor Cylinders" on Page 5-64.

Types of Piston Rod Packing Rings

Type "P" Pressure Breaker

This is a single ring. It is cut radially into three equal segments. This ring breaks down or slows the gas flow without sealing it completely. See Figure 5-30:

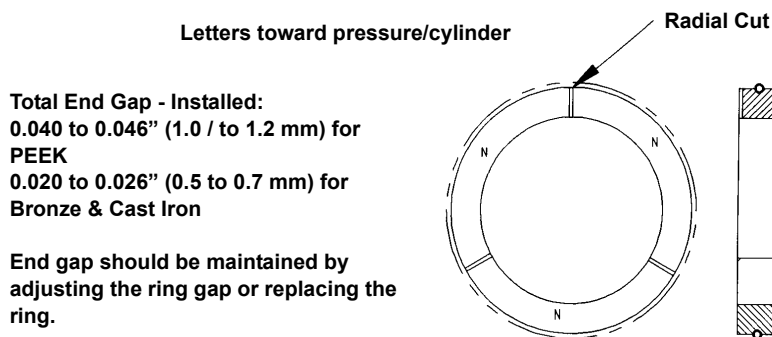


FIGURE 5-30: TYPE "P" PRESSURE BREAKER

Type "UP" Pressure Breaker

This is a single solid ring. This ring breaks down or slows the gas flow without sealing it completely. See Figure 5-31:

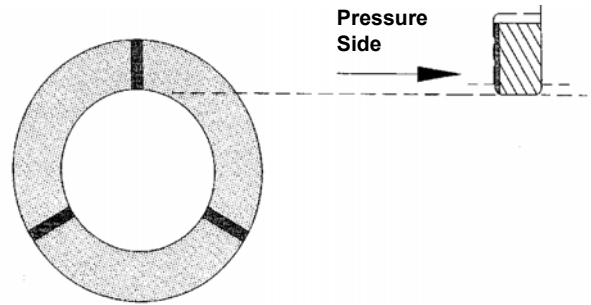


FIGURE 5-31: TYPE "UP" PRESSURE BREAKER

Type "P1U" Pressure Breaker

This set is made up of two rings. It allows controlled leakage in one direction only, and is installed in the first or second packing cup (closest to the piston). The first ring (pressure side) is one-piece with a single radial cut. The second ring is uncut (solid). The bore in the second ring is larger than the rod diameter. See Figure 5-32:

Total End Gap - Installed:
 0.040 to 0.046" (1.0 to 1.2 mm) for PEEK
 0.020 to 0.026" (0.5 to 0.7 mm) for Bronze and Cast Iron

End gap should be maintained by adjusting the ring gap or replacing the ring.

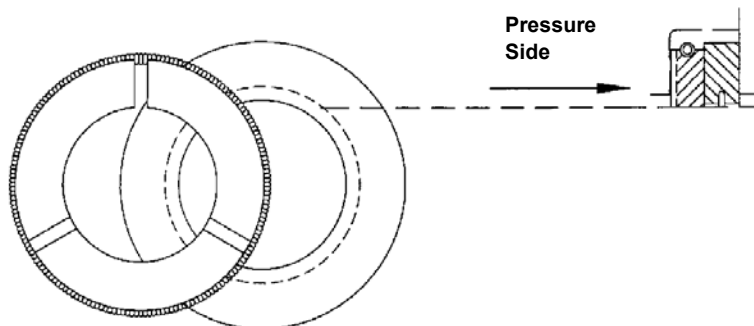


FIGURE 5-32: TYPE "P1U" PRESSURE BREAKER

Type "BTR" Single Acting Seal Set

This set is made up of three rings. It seals in one direction only. The first ring (pressure side) is radially cut. The second ring is a tangentially step cut ring and is made of the same material as the first ring. The first two rings are doweled so the cuts are staggered from one ring to the other. The total end gap installed is $3/8$ to $13/32$ in. (9.5 to 10.3 mm) for PEEK, Bronze & Cast Iron, and $3/16$ to $7/32$ in. (4.8 to 5.6 mm) for Teflon. The end gap should be maintained by adjusting the ring gap or replacing the ring. The third ring is called a back-up ring and is radially cut. The bore in this ring is larger than the rod diameter. This allows the radial joints to be tight together forming a gas seal. No dowel is necessary for this ring. See Figure 5-33:

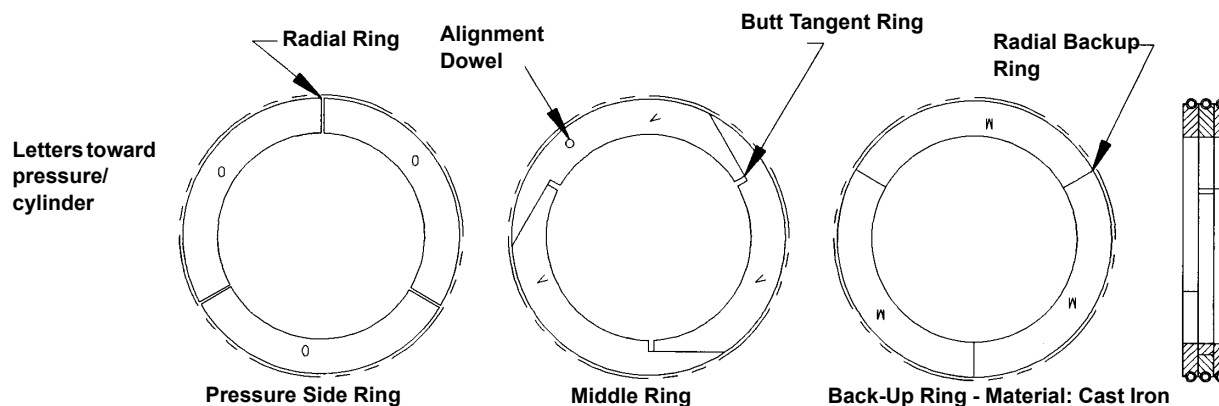


FIGURE 5-33: TYPE "BTR" SINGLE ACTING SEAL SET

Type "BD" Double Acting Seal Set

This set consists of two tangentially step cut rings. The rings are doweled so the tangential cuts are staggered from one ring to the other. The total end gap installed is $3/8$ to $13/32$ in. (9.5 to 10.3 mm) for PEEK, Bronze and Cast Iron, and $3/16$ to $7/32$ in. (4.8 to 5.6 mm) for Teflon. The end gap should be maintained by adjusting the ring gap or replacing the ring. The set is double acting in that it will seal in either direction. It is used in cylinders operating near atmospheric pressure to prevent air from entering the cylinder. Install with the match mark letters facing the pressure. See Figure 5-34:

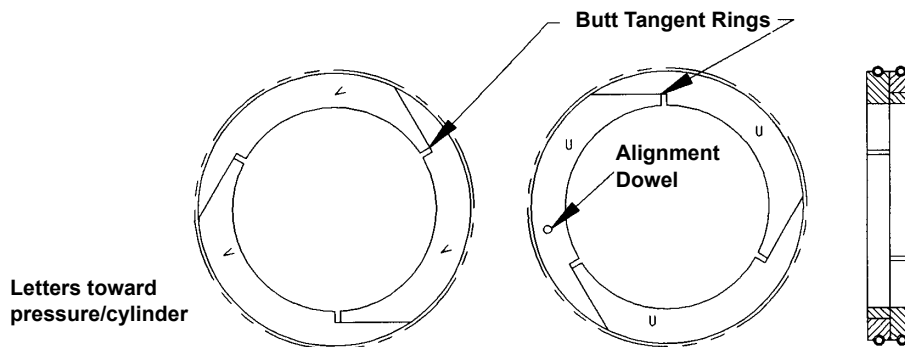


FIGURE 5-34: TYPE "BD" DOUBLE ACTING

Type "WAT" Double Acting Seal Set

This set is made up of three rings. The first two rings (pressure side) are radially cut. The third ring is a tangentially step cut ring. The last two rings are doweled so the cuts are staggered from one ring to the other. The total end gap installed is 3/16 to 7/32 in. (4.8 to 5.6 mm) for Teflon. The end gap should be maintained by adjusting the ring gap or replacing the ring. The first ring, along with the center ring, forms a wedge that overcomes rod friction and holds the ring set against both groove faces during either direction of rod travel. This ring set is intended primarily for low pressure application. WAT rings must be centered when installed in the packing case. See Figure 5-35:

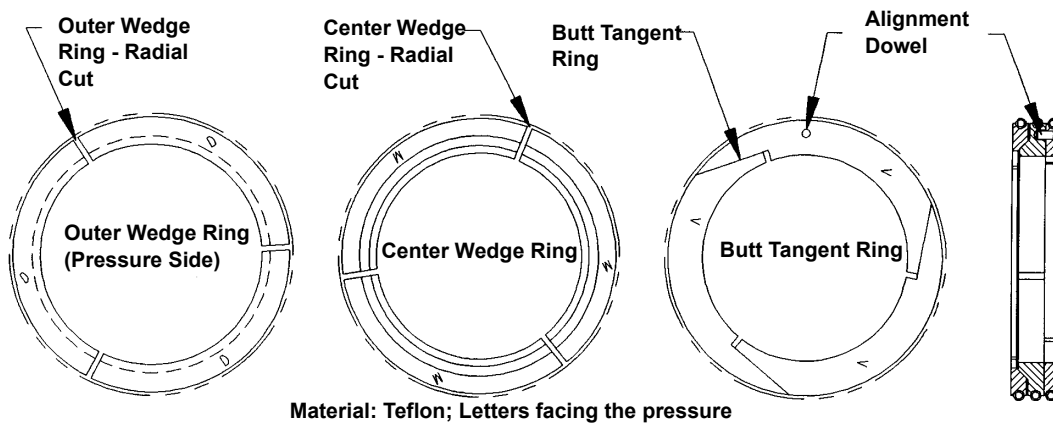


FIGURE 5-35: TYPE "WAT" DOUBLE ACTING SEAL SET

Type "AL" Double Acting Seal Set

This set is made up of five rings which function like a double ended "WAT" design ring set. The total end gap installed is 3/16 to 7/32 in. (4.8 to 5.6 mm) for Teflon. The end gap should be maintained by adjusting the ring gap or replacing the ring. It is meant to be used in a groove into which low-pressure fluid is supplied which serves to totally block leakage. AL rings must be centered when installed in the packing case. See Figure 5-36:

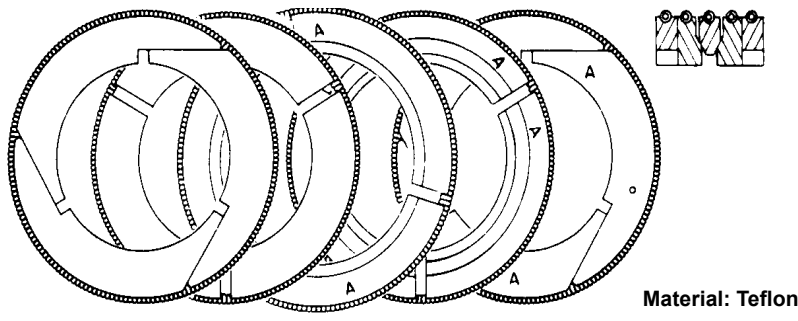


FIGURE 5-36: TYPE "AL" DOUBLE ACTING SEAL SET

Type "BTU" Single Acting Seal Set

This set is made up of three rings. It seals in one direction only. The first ring (pressure side) is radially cut. The second ring is a tangentially step cut ring. The first two rings are doweled so the cuts are staggered from one ring to the other. The total end gap installed is 3/8 to 13/32 in. (9.5 to 10.3 mm) for PEEK, Bronze and Cast Iron, and 3/16 to 7/32 in. (4.8 to 5.6 mm) for Teflon. The end gap should be maintained by adjusting the ring gap or replacing the ring. The third ring is called a back-up ring and is uncut (solid). The bore in this ring is larger than the rod diameter, allowing the radial joints to be tight together forming a gas seal. See Figure 5-37:

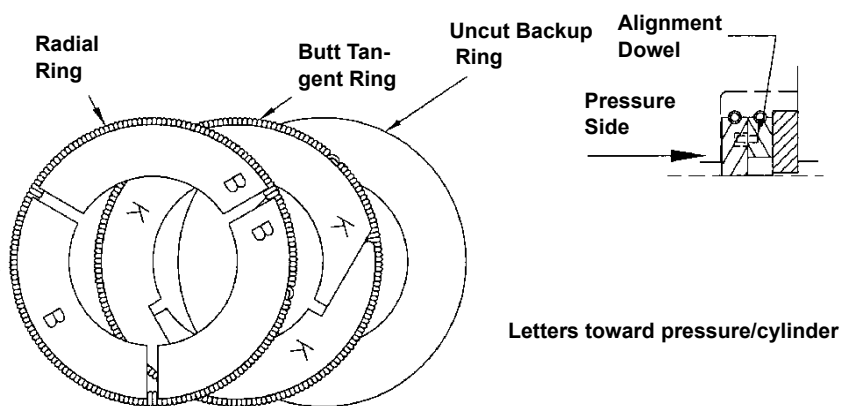


FIGURE 5-37: TYPE "BTU" SINGLE ACTING SEAL SET

Type BTUU Single Acting Seal Set

This set is made up of four rings. It seals in one direction only. The first ring (pressure side) is radially cut. The second ring is tangentially step cut. The first two rings are doweled so the cuts are staggered from one ring to the other. The total end gap installed is 3/8 to 13/32 in. (9.5 to 10.3 mm) for PEEK, and 3/16 to 7/32 in. (4.8 to 5.6 mm) for Teflon. The end gap should be maintained by adjusting the ring gap or replacing the ring. The third and fourth rings are uncut (solid). The bore in these last two rings is larger than the rod diameter and allow the radial joints of the sealing rings to be tight together forming a gas seal. See Figure 5-38:

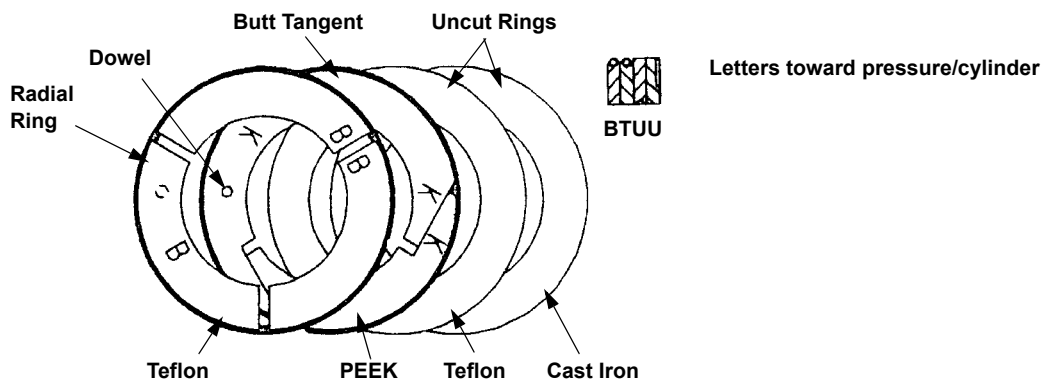


FIGURE 5-38: TYPE "BTUU" SINGLE ACTING SEAL SET

Type “CU” Single Acting Seal Set

This set is made up of three rings. It seals in one direction only. The first ring (pressure side) is radially cut. The total end gap installed is 3/8 to 13/32 in. (9.5 to 10.3 mm) for PEEK, Bronze and Cast Iron, and 3/16 to 7/32 in. (4.8 to 5.6 mm) for Teflon. The end gap should be maintained by adjusting the ring gap or replacing the ring. The second ring is a tangentially cut ring. The first two rings are doweled so the cuts are staggered from one ring to the other. The third ring is called a back-up ring and is uncut (solid). The bore in this ring is larger than the rod diameter. See Figure 5-39:

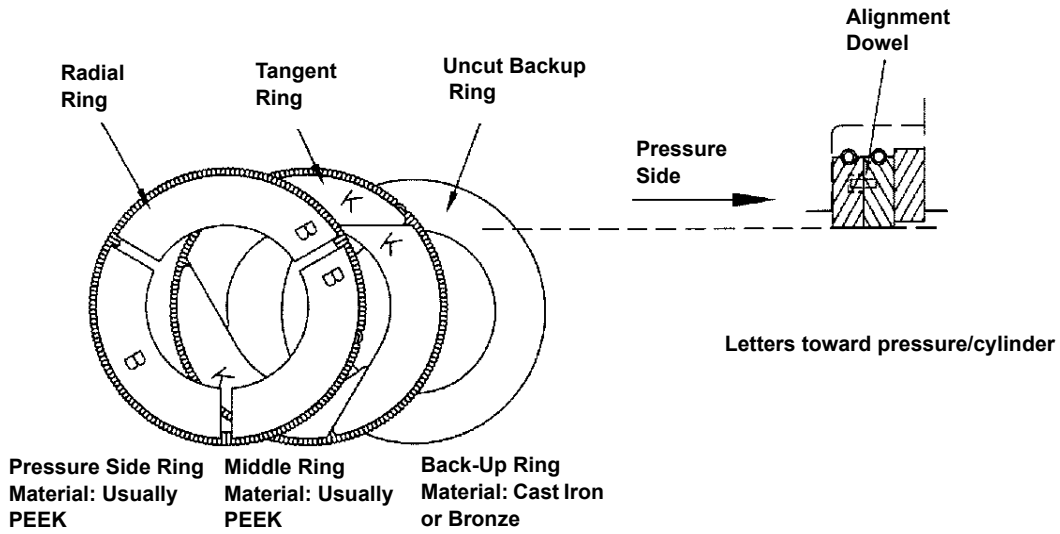


FIGURE 5-39: TYPE “CU” SINGLE ACTING SEAL SET

Type “STU” Single Acting Seal Set

This set is made up of three rings. It seals in one direction only. The first ring (pressure side) is uncut (solid), with radial grooves on the pressure side. The second ring is tangentially cut. The third ring is uncut (solid). See Figure 5-40:

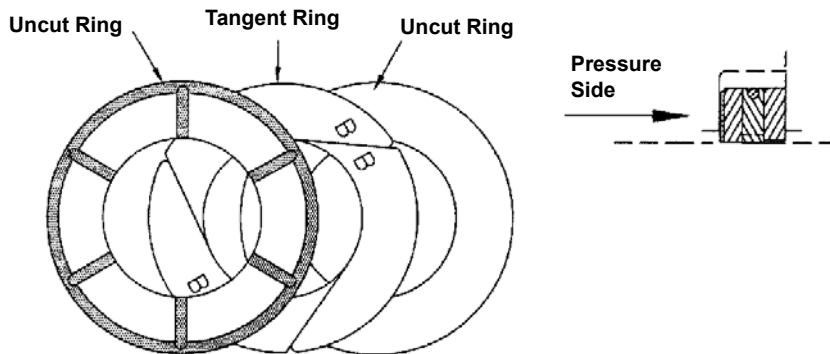


FIGURE 5-40: TYPE “STU SINGLE ACTING SEAL SET

Type "CR" Single Acting Seal Set

This set is made up of three rings. It seals in one direction only. The first ring (pressure side) is radially cut. The total end gap installed is $3/8$ to $13/32$ in. (9.5 to 10.3 mm) for PEEK, Bronze and Cast Iron, and $3/16$ to $7/32$ in. (4.8 to 5.6 mm) for Teflon. The end gap should be maintained by adjusting the ring gap or replacing the ring. The second ring is tangentially cut. The first two rings are doweled so the cuts are staggered from one ring to the other. The third ring is called a back-up ring and is radially cut. The bore in this ring is larger than the rod diameter. This allows the radial joints to be tight together forming a gas seal. See Figure 5-41:

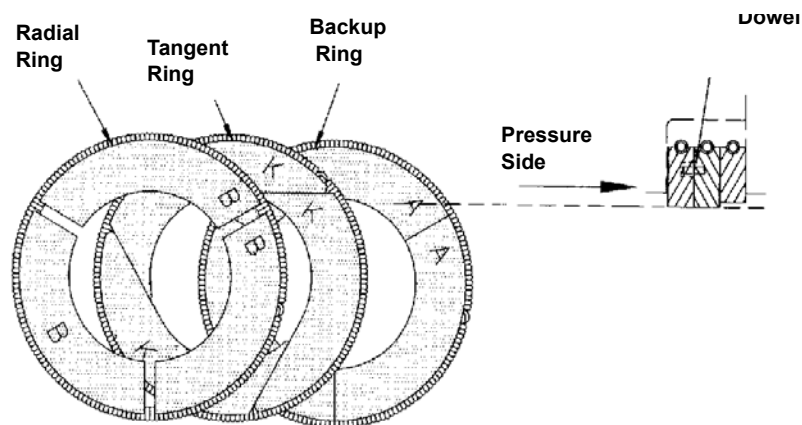


FIGURE 5-41: TYPE "CR" SINGLE ACTING SEAL SET

Type "3RWS" Oil Wiper Set

This set uses three radial cut rings. They are doweled to provide a staggered arrangement. Their purpose is to keep crankcase oil out of the packing and cylinder. Assemble with the blank face towards the oil (crankcase) and the slotted side towards the pressure packing. The total end gap installed is $3/16$ to $7/32$ in. (4.8 to 5.6 mm). The end gap should be maintained by adjusting the ring gap or replacing the ring. See Figure 5-42:

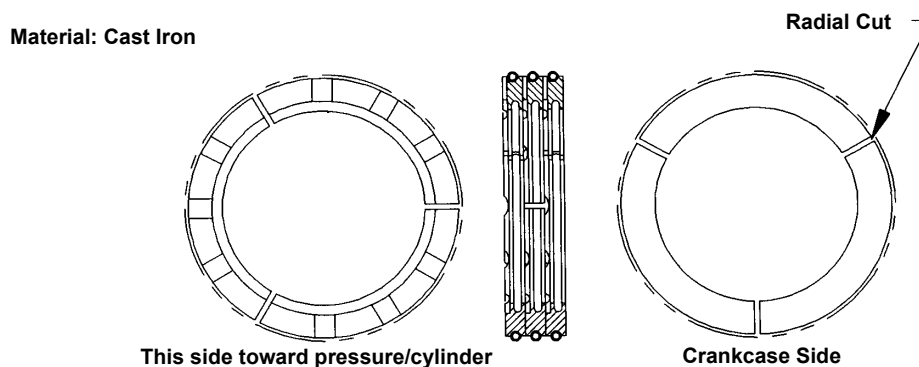
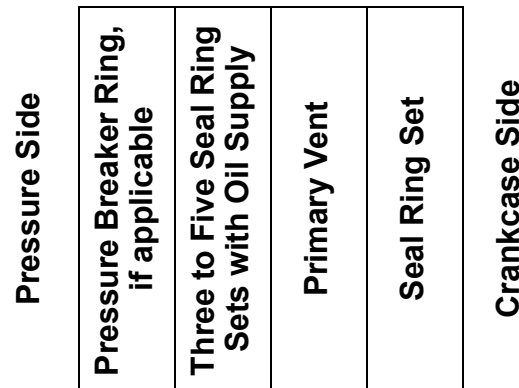


FIGURE 5-42: TYPE "3RWS" WIPER SET

Arrangement of Piston Rod Packing Rings

Ariel supplies JGE:H:K:T packings in five pressure ranges. The general arrangement of the oil supply, seal ring and vent locations is shown below:



The type of rings used will depend upon the pressure application.

The oil wiper rings and one seal ring set are carried on a separate diaphragm in the cross-head guide.

NOTE: SEE THE PACKING ASSEMBLY IN YOUR PARTS BOOK. SEE SECTION 4 FOR PACKING LUBRICATION AND SECTION 2 FOR VENTING.

Piston Rod Packing Ring Material

Some years ago bronze was the standard material for all Ariel packings. Bronze, however, is totally unsatisfactory for sour gas service, (hydrogen sulfide in the gas). PEEK, cast iron and Teflon provide outstanding service with sour gas, and since they perform equally well with sweet gas, they are now standard materials.

A typical packing will have a PEEK pressure breaker, Teflon/cast iron single acting rings, all Teflon double acting rings, and a cast iron wiper set. The Teflon is glass reinforced and impregnated with molybdenum disulfide. This provides a strong, slick material to reduce friction and wear.

Water-Cooled Piston Rod Packing

When any disassembly of (optional) “water”-cooled rod packing cases is required from the as supplied - as received condition from the manufacturer, proper re-assembly and testing is required. This is to test the cases for leaks.

Re-assembly

Reference “Piston Rod Packing - Reassembly” on Page 5-44 and “Types of Piston Rod Packing Rings” on Page 5-47.

Be sure to refer to the pressure packing assembly in your parts book. Ariel supplies parts books with each unit. Please contact your distributor if you do not have a parts book. A pressure packing assembly drawing also is packaged with each pressure packing re-build kit.

“Water”-cooled cases are lapped, and special care must be taken to prevent scratching the mating surfaces of the cups, which can cause significant problems. Cup surfaces must be clean and dry when being re-assembled.

The cups are numbered on the outside diameter and are to be assembled in consecutive order, starting with the end cup. Reference the pressure packing assembly in your parts book and Figure 5-43: The studs are offset so the cups will only fit one way.

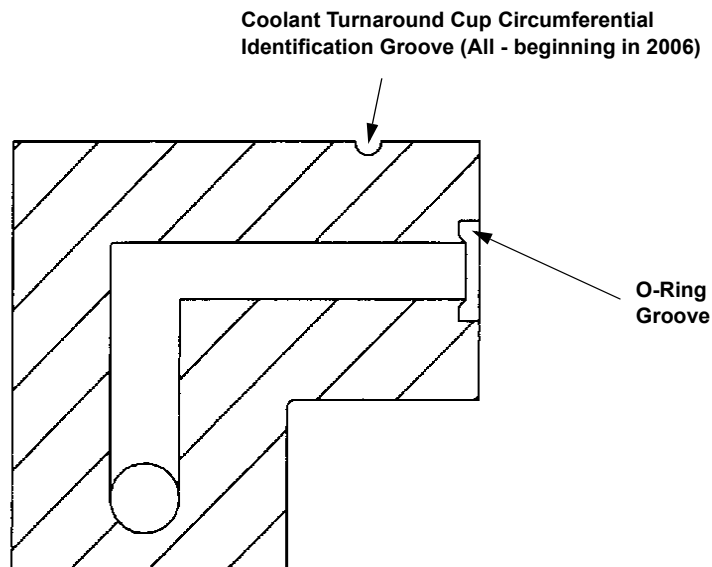


FIGURE 5-43: “WATER”-COOLED PACKING CASE TURNAROUND CUP

Make sure the tie studs are completely screwed into the end cup. Put the proper ring in the groove and facing the proper direction. Three long tie studs hold the pressure packing together. The stud holes are not equally spaced. This prevents the stack of parts from being aligned incorrectly. Three long tie studs hold the pressure packing together. The stud holes are not equally spaced. This prevents the stack of parts from being aligned incorrectly. Be careful when sliding parts onto the tie studs to be sure that no scratching occurs to the lapped faces. Unless non-lube, rings are to be lightly coated with new clean lubricant before reassembly. Only use the same lubricant that is used in the force feed lube system.

Install second cup next, put the rings in place, and make sure the two (2) small O-rings are in place around the coolant holes.

Continue assembling the remaining parts in the proper configuration to the packing case drawing, in consecutive order, by repeating the above step.

Install tie stud-nuts and tighten to the values given in Table 1-15 on Page 1-25. Make sure that all rings move freely, radially, in their grooves using fingers. Side loaded WAT and AL rings will be snug, but should still move using fingers.

Testing

100% verification of function is required for all internal passages.

The passages are to be checked by blowing dry compressed air thru the connection taps on the flange and verifying that air is exiting at the proper holes. When air is applied to the connection tap stamped “Coolant In”, air should be exiting the connection tap stamped “Coolant Out”, or if air is applied to the tap stamped “Lube”, air should be exiting at the appropriate cup on the inside diameter of the case.

Pressure leak test packing cases as follows:

1. Apply 60 to 100 psi (4 to 7 bar) dry, compressed air pressure to the “Coolant In” connection. For water cooled rod packing cases in non-lube service, compressed air is to be oil free. Air should exit at connection tap “Coolant Out”. Air applied to the tap stamped “Lube” should exit at the appropriate cup on the inside diameter of the case.
2. Plug the “Coolant Out” connection and apply 60 to 100 psi (4 to 7 bar) dry, compressed air pressure to the “Coolant In” connection through a ball valve with a calibrated pressure gauge located between the ball valve and packing case. Close the ball valve and disconnect the air supply. There should be no pressure drop for five minutes, minimum. Cases which fail this testing procedure are to be disassembled, inspected, repaired, re-assembled and re-tested. Packing cases may be bolted into place in a cylinder head to aid sealing, using proper bolting and tightening torques.

Valves

Most valves used in cylinders on JGE, JGH, JGK and JGT frames use non-metallic plates.

CAUTION

BEFORE ATTEMPTING TO REMOVE ANY VALVE CAP, BE CERTAIN THAT ALL PRESSURE HAS BEEN VENTED FROM THE COMPRESSOR CYLINDER. THE PRESSURE MUST BE COMPLETELY VENTED FROM BOTH THE SUCTION AND DISCHARGE PASSAGES OF THE CYLINDER. SEE FIGURE 1-3: ON PAGE 1-8 FOR LOCATION OF IMPORTANT SAFETY INFORMATION PLATES.

Valves - Removal

1. Loosen all of the cap screws slightly, on each valve cap. With all the cap screws loose, the cap should stay in its original position. If it pushes out on its own accord, **stop!** Take steps to completely vent the cylinder. See Caution above. A typical valve assembly is shown in Figure 5-45: on Page 5-59.
2. After all the above safety checks and with cap screws still in place but loosened,

move the valve-cap out until the O-ring clears the cylinder to be sure that the cylinder is properly vented. A pair of pry bars (or screwdrivers), one on each side of the cap, will help pry it out.

3. Remove cap screws and valve cap.

CAUTION! BE CAREFUL TO PREVENT THE VALVE CAP, RETAINER AND/OR VALVE FROM FALLING OUT OF BOTTOM VALVE POCKETS TO PREVENT THE POTENTIAL OF PERSONAL INJURY.

4. With the retainer still in place, screw a valve tool over the valve center bolt. See Figure 7-1: on Page 7-2.
5. It may be necessary to loosen the plastic thumb screw retainer-keeper in the valve retainers.
6. For high pressure applications that use a metallic wire gasket seal, the cylinder will vent when cap screws are first loosened. Use the valve removal tool shown in Figure 7-4: on Page 7-3 to unseat the metallic wire gasket.
7. Now the valve and retainer can be pulled out together.
8. For cylinder class 2-5/8K-FS-HE and 2-5/8T-FS-HE tandem cylinders, the suction and discharge piping and cylinder head must be removed to gain access to the concentric valve. A concentric valve combines the suction and discharge valves in one assembly. See Caution at "Piston And Rod - Removal" on Page 5-35.
9. In most cases the flat metal gasket will remain in the pocket. It is difficult to see. A flashlight and a small mirror on an adjustable rod are the best tools to see the gasket clearly. On cylinders with horizontal valves, the gasket may fall into the gas passage. A small magnet on a flexible extension rod will help fish it out. This gasket should be replaced if damaged.

Valves - Maintenance

Ariel uses valves manufactured by Hoerbiger Corporation. Before servicing any valve refer to the correct valve assembly drawing and parts list and Hoerbiger's literature in the Parts Book. On the valve assembly drawing you will notice that valves have different springing for different pressure levels. The cylinder cover sheet in the Parts Book lists the valve originally supplied with each cylinder. If different operating pressures are encountered, then different springing may be required.

The suction valve must be selected on the basis of operating suction pressure and the discharge valve for operating discharge pressure. Proper valve spring selection is also based upon the operating speed (RPM), gas specific gravity and the suction temperature of the gas.

Contact your Packager and/or Ariel, Mount Vernon, for assistance in valve selection.

Valves - Reassembly

1. The 1/32 inch (0.8 mm) or 1/16 inch (1.6 mm) thick soft metallic flat gasket should be coated with an anti-seize lubricant. It can then be either inserted into the valve pocket or stuck on the valve. In either case, care must be taken to keep this gasket from falling into the gas passage.

- Be sure that suction valves are installed only in suction pockets and discharge valves only in discharge pockets. The valve pockets have identification plates, see Figure 5-44: All valves are installed with the valve fastener(s) positioned away from the cylinder bore. If a valve is not marked for suction or discharge, or to verify the type, depress the valve plate by hand. It is recommended that a tool which is softer than the valve plate material be used or care be exercised to prevent damage to the plate. A suction valve plate can only be depressed from the valve fastener (bolting) side of the valve, and a discharge valve plate can only be depressed from the side of the valve that goes toward the cylinder bore. Reference Figure 5-45: on Page 5-59.

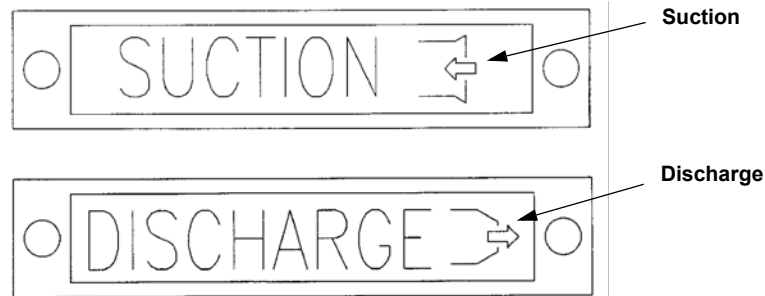


FIGURE 5-44: COMPRESSOR CYLINDER VALVE POCKET IDENTIFICATION PLATES

- Using the proper Valve Installation Tool, reference Section 7, the valve and the retainer may be inserted into the pocket together. Be sure that the valve is seated properly in the pocket. When installed correctly, the valve should rotate freely when turned by hand, and the distance from the outer retainer face to the surface of the valve boss on the cylinder will be 1/8 inches (3 mm) shorter than the length of the nose on the valve cap.
- A plastic thumb screw is used as a retainer-keeper in a threaded hole in valve retainers. These screws should be tightened just enough to provide friction so that retainers and valves in bottom pockets will not fall out while the valve caps are being installed.
- Lubricate and install a new O-ring in the groove on the nose of the valve cap. Some high pressure cylinders use a soft metallic wire gasket in lieu of the O-ring design. Insert the valve cap and tighten the bolts evenly to the recommended torque in Table 1-15 on Page 1-25. "Bolt Tightening for Valve Caps" on Page 5-59 If the assembly is correct, the distance from the underside of the cap to the valve boss surface on the cylinder will be a uniform 1/8 inches (3 mm).

NOTE: BE CERTAIN ALL PARTS, GASKET FACES, AND MATING SURFACES ARE ABSOLUTELY CLEAN AND ALWAYS USE CLEAN, FRESH OIL (EXCEPT FOR STAINLESS STEEL BOLTING, USE NEVER-SEEZ) ON THE THREADS BEFORE REINSTALLING BOLTS.

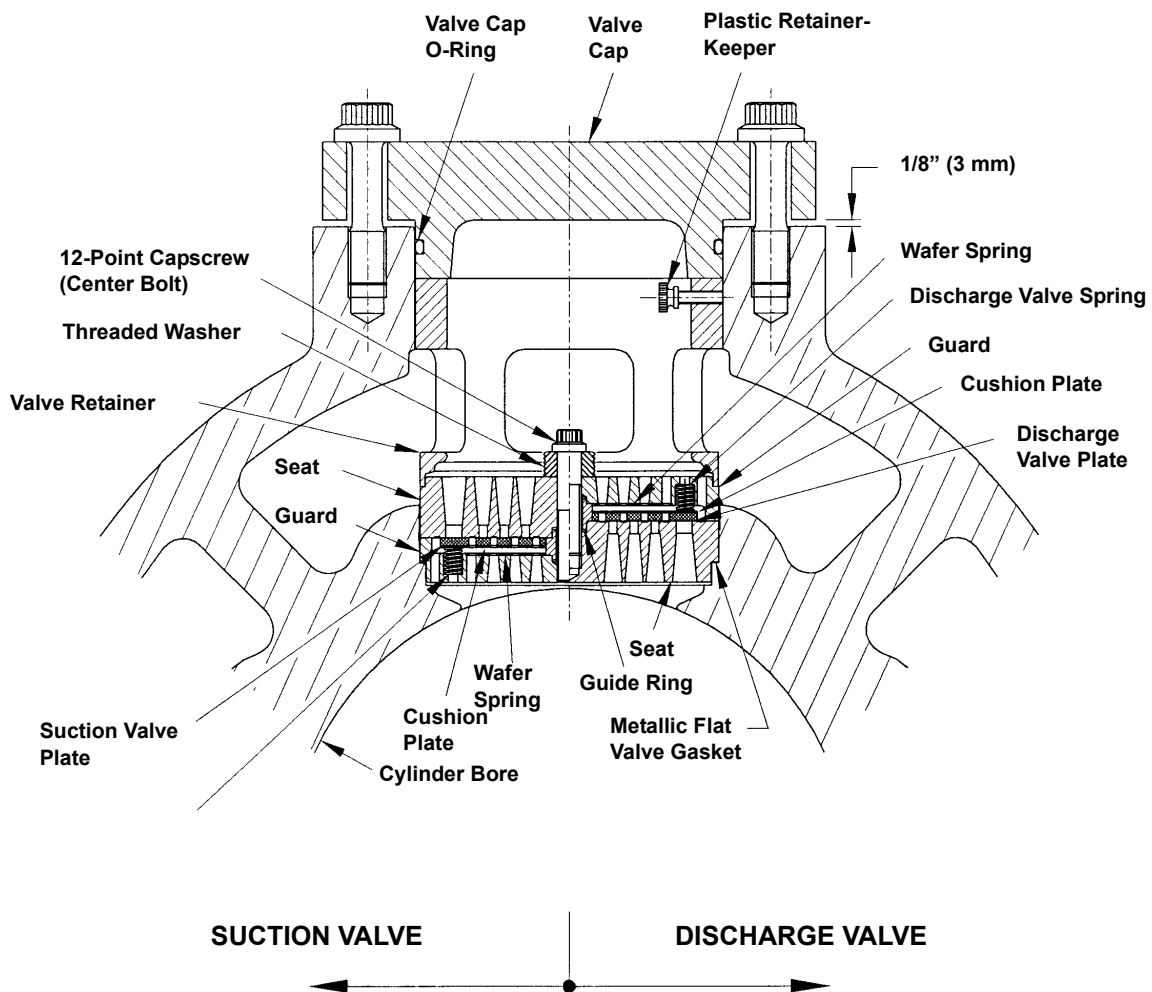


FIGURE 5-45: TYPICAL VALVE ASSEMBLIES

Bolt Tightening for Valve Caps

Proper fastener tightening technique is essential for sealing of valve caps with soft metallic wire gaskets used in some high pressure cylinders. It is important to draw up bolting to full torque in even and gradual steps. Do not allow the valve cap to be tightened with bias on one bolt or to become cocked in the bore. Such bias or cocking can cause uneven crush of a wire gasket that could cause a leak, and could also cause bolt failure. This step tightening procedure is also necessary for all valve caps.

Install the valve assembly (and high clearance spacer, when applicable), with the metallic preformed gasket and valve retainer, in the valve pocket. See "Valves - Reassembly" on Page 5-57. Lubricate and install a new O-ring, or for high pressure applications place a new, proper, soft metallic wire gasket on the retainer or cap and install the valve cap. Be careful not to gouge the bore, distort or damage the metallic wire gasket. Always use a new metallic wire gasket; wire gaskets are not reusable.

Lubricate threads and bolt seating surfaces with petroleum type lubricant (except for stainless steel bolting, use Never-Seez), and install bolts. Do not use anti-seize compounds on valve cap bolting. Tighten each bolt until snug using an alternating (criss-cross) pattern. Next, tighten each bolt to 25% of full torque, moving across from bolt to bolt, in an alternating (criss-cross) pattern. See Figure 5-46: 1-2-3-4-5-6. Repeat this step for 50%, 75% and 100% of full torque. If the assembly is correct, the distance from the underside of the cap to the valve pocket boss surface on the cylinder will be a uniform 1/8 inches (3 mm).

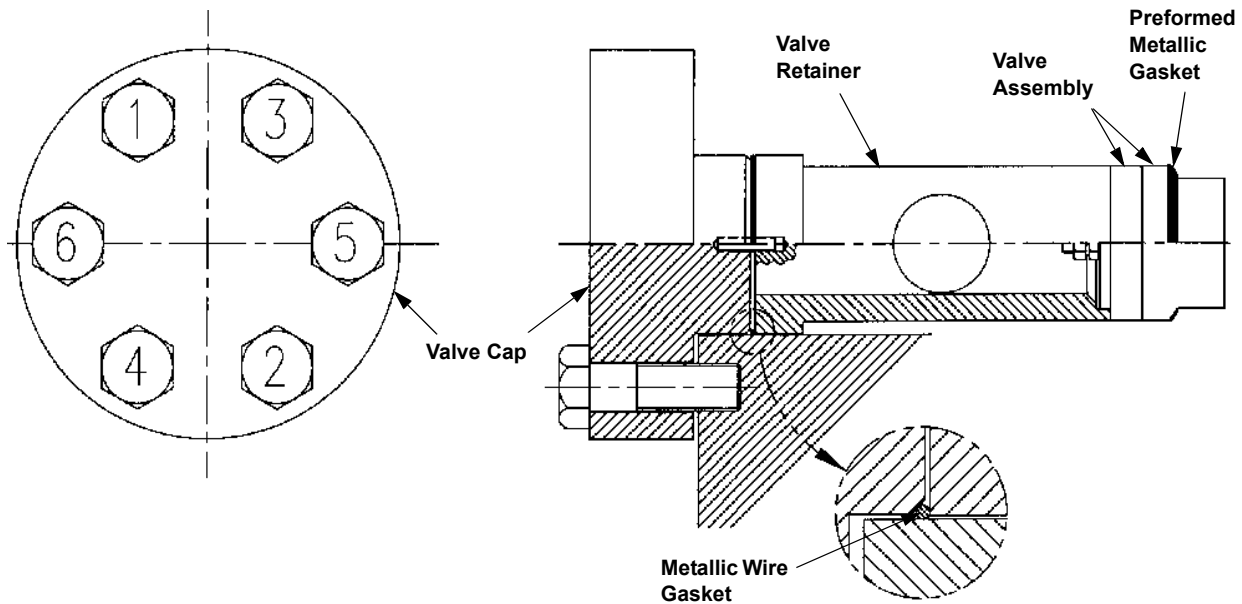


FIGURE 5-46: HIGH PRESSURE VALVE CAP ASSEMBLY

Proper tighten and torque procedures are important for all valve caps, but are particularly important for high pressure valve cap assemblies. High pressure applications have caution plates on the cylinders. These plates are stamped with proper torque values:

⚠ CAUTION

SEVERE PERSONAL INJURY AND PROPERTY DAMAGE CAN RESULT IF VALVE CAP BOLTING IS NOT INSTALLED TO PROPER TORQUE OF _____ FT.-LBS. _____ N·m. REFER TO TECHNICAL MANUAL FOR PROPER TORQUING PROCEDURE.

VVCP - Variable Volume Clearance Pocket Head End Unloader

Removal

Disconnect the VVCP packing vent. Remove the VVCP from the cylinder using similar procedures as when removing a cylinder head. The approximate weights of VVCP's for handling purposes can be found in the Ariel Data Book. The Electronic Data Book is available in the Ariel Performance Program.

Disassembly

Unsnap the thread protector bellows from the slot in the adjusting handle. Reference Figure 5-47: on Page 5-62. With the locking handle locked, remove lock nut and hand adjusting handle. A hammer or puller may be required to break adjusting handle to stem tapered fit. Loosen locking handle and unscrew to remove handle. Remove fasteners at inside of bolt flange and separate the halves of the VVCP. Unscrew the VVCP stem and piston assembly to remove.

**CAUTION**

TRAPPED GAS PRESSURE CAN PRESENT A PERSONAL SAFETY HAZARD WHEN SERVICING THE VVCP. WORK IN A WELL VENTILATED, NON SPARKING AREA. DO NOT BREATHE GAS EMITTED FROM VVCP WHEN VENTING TRAPPED GAS.

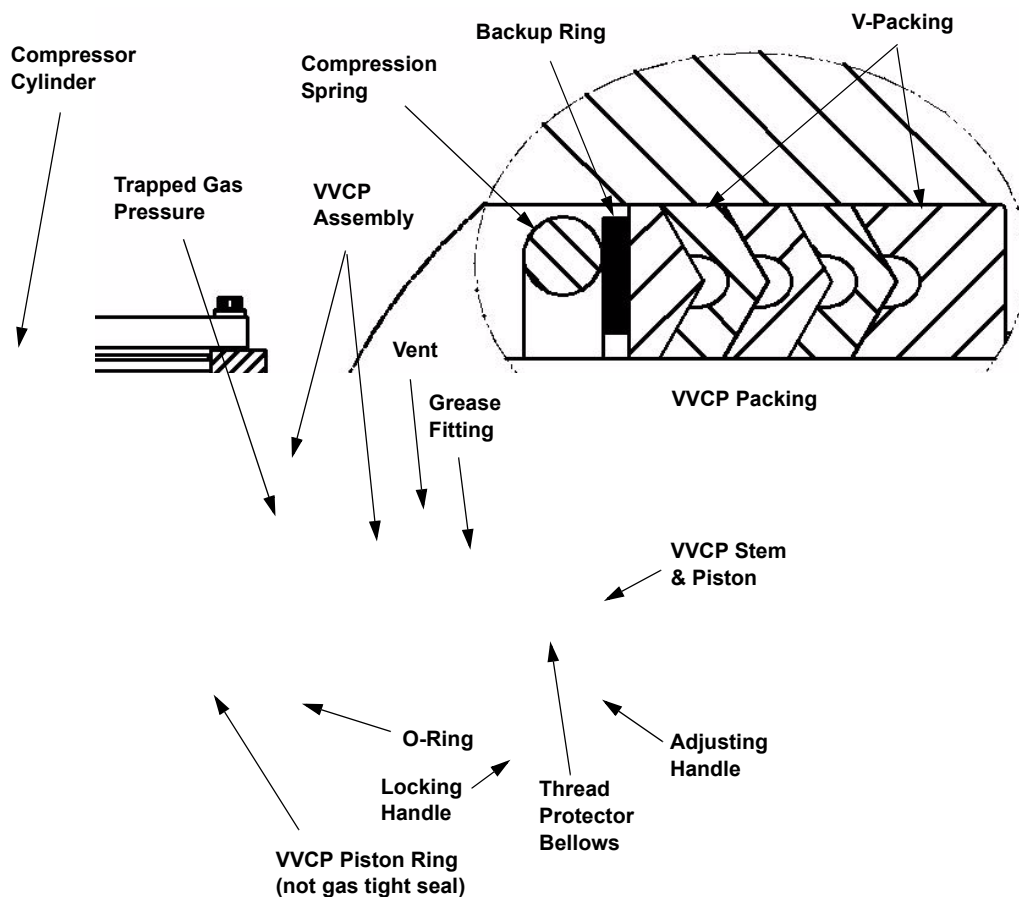


FIGURE 5-47: COMPRESSOR CYLINDER WITH VVCP - TYPICAL

Maintenance

To replace or clean the VVCP packing, remove the capscrews, flange, spring and v-packing, or mechanically depress the packing assembly spring and remove the snap ring depending on the design. A piece of all thread rod, two hex nuts and two heavy washers may be used to compress the packing assembly. The inner washer must be large enough to catch the packing assembly, and small enough to allow the snap ring to be compressed and removed. Use proper snap ring pliers. Replace the VVCP packing when excessive leakage is noted at the vent. Remove the VVCP piston ring; replace as necessary.

Clean all parts to remove all debris, rust, etc. The stem and piston are permanently assembled with an interference fit, do not attempt to disassemble. When replacing the VVCP packing, place new packing between two flat surfaces, such as two pieces of wood and tap wood with hammer to relax the packing elements prior to assembly.

Reassemble the VVCP in reverse order, lubricate and install a new O-ring at the bolt flange. Be sure that thread protector bellows are properly aligned when installing adjusting handle. Lubricate stem with 3-4 pumps of all-purpose petroleum grease with a hand pump grease gun at the grease fitting.

To re-install the VVCP on the cylinder, use a new head gasket. Lubricate threads and bolting seating surfaces with petroleum type lubricant and install bolting. Tighten each fastener until snug using an alternating (criss-cross) pattern. Next tighten each fastener to 25% of full torque, moving from fastener to fastener in an alternating (criss-cross) pattern. Repeat this step for 50%, 75% and 100% of full torque. See Table 1-15 on Page 1-25 for tightening torque value. Reconnect VVCP packing vent. When installing a new VVCP, check total piston end clearance and re-set crank end/head end feeler clearances with VVCP completely closed. See Table 1-7 on Page 1-16 for clearances.

Adjustment

VVCP clearance volume may be changed with the compressor running or stopped. Consult the Packager's instructions regarding where to set the VVCP. Also reference the VVCP data sheet in the Ariel Technical Manual Parts Book.

The VVCP piston ring is designed not to be gas tight, to allow a nearly balanced gas pressure for ease of VVCP adjustment with the cylinder pressurized. Gas pressure behind the VVCP piston normally vents when cylinder is vented. Process debris or rust around the piston ring can make a seal that takes some time to vent. If gas is trapped behind the piston, the VVCP can be adjusted when the cylinder is pressurized, but difficult to turn when the cylinder is vented. This problem is corrected by disassembling the VVCP and cleaning.

To adjust the volume, loosen the stem locking handle, so that stem is free to turn. Turn the stem by use of the adjusting handle on the outboard end of the shaft. Turn adjusting handle clockwise to load; counterclockwise to unload. See the VVCP instruction plate on the equipment for the dimensional positions for fully closed (load) and fully open (unload). Reference Figure 1-9: on Page 1-14. Re-tighten the stem locking handle to approximately 150 lbs-ft (203 N·m) torque.

Ethylene Glycol Contamination

Ethylene glycol contamination of a compressor can result from water-cooled compressor rod packing or oil cooler.

Ethylene glycol anti-freeze coolant mixture leaking into the compressor crankcase oil can cause crankshaft seizure due to lack of adequate lubrication. Crankcase oil should be changed as recommended in Section 6, while being routinely sampled and analyzed by a qualified laboratory to verify suitability for continued use, including checking for ethylene glycol contamination.

Even small quantities of ethylene glycol in the oil can be detrimental. If contamination is less than 5%, drain oil, replace filters and flush oil system with a 50-50 mixture of butoxyethanol (Dow Chemical Co. Dowanol EB or equal) and 10W oil using a motor driven pump. Flushing should be done on a warm compressor. Bearings should be continuously flushed for 1/2 hour while barring over compressor. All surfaces that come in contact with crankcase oil are to be flushed which includes spraying all interior surfaces in the crankcase. Completely drain cleaning mixture, being sure to drain all components of the oil system. Repeat flushing operating using a 60/40 mixture of 10W oil and kerosene or fuel oil. Completely drain system, install new filters and fill crankcase with proper oil. Coolant leak is to be found and repaired.

If sampling indicates that glycol contamination is greater than 5% or compressor has seized due to contamination, the unit is to be torn down, cleaned with 100% butoxyethanol, flushed with kerosene or fuel oil and repaired as required. All surfaces that come in contact with crankcase oil must be cleaned with butoxyethanol, including all passages and piping, and then flushed with kerosene or fuel oil. Oil and filters must be changed. Coolant leak is to be found and repaired.

Butoxyethanol presents health and safety hazards. Use proper eye and skin protection and adequate ventilation. Do not use near open flame or sparks. See manufacturer's Material Safety Data Sheet for complete details.

Ethylene glycol, butoxyethanol, contaminated oils and solvents must be properly disposed. A chemical disposal service should be used.

Cleaning Components & Thread Lube for Non-Lube Compressor Cylinders

Complete non-lube cylinders ordered and shipped from Ariel are provided cleaned and protected to non-lube service requirements. Internal parts shipped loose, contaminated internal surfaces and all repair parts are to be cleaned prior to installation, thus providing long life of non-lube compressors and extending life of rings.

Clean the cylinder bore thoroughly with denatured alcohol until a clean, alcohol soaked, white "Bounty" paper towel does not remove anymore debris. This includes all surfaces of the bore, counter bore, valve pockets, etc. Do not use "Never-Seez" on steel gaskets. Apply only a very light film of oil to the cylinder seating surfaces to seal O-rings.

Denatured alcohol presents health and safety hazards. Keep alcohol away from heat, sparks, flame and all other ignition sources. Use adequate ventilation, neoprene or butyl gloves, mono-goggles or face-mask and impermeable apron. It contains methyl alcohol and is poisonous if ingested. Avoid eye and skin contact. Materials resulting from clean-up are to be handled and disposed in a proper manner. See manufacturer's Material Safety Data Sheets for more details.

Do not use any lubricants or anti-seize compounds on parts that can come into contact with the gas stream.

Use very small amounts of "Never-Seez" Regular Grade on the nut and collar when assembling the piston assembly.

Thoroughly clean the piston with denatured alcohol until a clean, alcohol soaked towel does not remove anymore debris. This includes cleaning the ring grooves exceptionally well.

Disassemble the packing case. Wipe all surfaces clean with denatured alcohol. Re-assemble. When the packing case is water cooled, re-assemble and test to "Water-Cooled Piston Rod Packing" on Page 5-54. Handle cleaned parts with new or clean "rubber" or new white cotton gloves.

Before installing the piston rod into the unit, wipe the piston rod with denatured alcohol. Be careful not to leave any fingerprints on the rod before it contacts the packing case-rings.

Make sure the piston rod is wiped down with denatured alcohol after the rod is installed.

Clean the head end head or unloader components with denatured alcohol. Use minimal amounts of oil for the bolt-holes to make sure the oil does not run down into the cylinder. Also install the head end steel gasket without "Never-Seez".

The valves are to be disassembled, cleaned with denatured alcohol, re-assembled, wiped down again, and installed. Clean the retainers and high clearance assemblies with denatured alcohol. Use only a thin film of oil for the valve cap O-rings and bolt-holes.

Cleaned parts are to be assembled immediately to avoid contamination and corrosion. If cylinder is not to be put into immediate service, contact Ariel for preservation instructions to ER-34.

NOTES:

SECTION 6 - MAINTENANCE INTERVALS & TROUBLE SHOOTING

Recommended Maintenance Intervals

For latest available Recommended Maintenance Intervals, see ER-8.2 at www.arielcorp.com.

Like all equipment, Ariel compressors do require maintenance. The frequency of maintenance is dictated by the environment in which the compressor is placed, the loads the user imposes on the compressor and the cleanliness of the gas.

First and foremost on the preventative maintenance list is the completion and compliance with the Ariel Corporation Packagers Standard and Compressor Start Up Check List. All items must be adhered to, both before and after start up.

The following is a guide only and, as stated above, may vary due to operating conditions. The time intervals start from the start up date of the unit. If your oil supplier's recommended oil service changes are more frequent than the Ariel recommendations, the supplier's intervals should be followed. Regular oil analysis is recommended. If problems develop the oil should be changed immediately and the cause of the problem determined and corrected.

A log book should be kept with each unit. Every maintenance item can be entered with exacting detail in order that records will be available for tracking maintenance costs per unit and for trouble-shooting.

Operator logs should be reviewed by qualified personnel to determine trends in compressor performance and/or maintenance.

CAUTION: BE SURE THAT THE COMPRESSOR IS COMPLETELY VENTED TO RELIEVE ALL GAS PRESSURE, AND THE DRIVER WILL NOT EXERT TORQUE ON THE COMPRESSOR CRANKSHAFT THAT COULD RESULT IN INJURY, PRIOR TO TAKING COUPLING READINGS, RE-CHECKING BOLTING TORQUES ON PRESSURE CONTAINING COMPONENTS OR REMOVING ACCESS COVERS FOR PERFORMING INTERNAL INSPECTION OR MAINTENANCE ON THE COMPRESSOR. IN THE CASE OF A DIRECT DRIVE MOTOR, THE BREAKER IS LOCKED OUT. FAILURE TO FOLLOW THESE STEPS CAN RESULT IN SERIOUS PERSONAL INJURY OR DEATH.

Daily¹

1. Check frame oil pressure. It should be 50 to 60 psig (3.5 to 4.2 bar_g) when at

operating temperature. Compressor inlet oil temperature is 190°F (88°C) maximum.

2. Check frame oil level. It should be visible in the sight glass and approximately mid-level when running, if not, determine and correct cause. Do not overfill. Check oil makeup tank for sufficient oil supply.
3. Check lubricator block cycle movement indicator. Refer to information plate on top of lubricator box for correct cycle time. Very dirty or wet gas may require a more frequent cycle time than normal.
4. Check primary and secondary packing vents for blowing. If blowing, determine cause and, if necessary, replace packing internal parts.
5. Check and correct any gas leaks.
6. Check and correct any oil leaks.
7. Check operating pressure and temperatures. If not normal, determine cause of abnormality and correct. It is recommended that a daily log of operating temperatures and pressure be kept for reference.
8. Check shutdown set points.
9. Low oil pressure shutdown 35 psig (2.4 bar_g) minimum.
10. High temperature shutdown to be set within 25°F (14°C) of actual operating temperature.
11. High and low pressure shutdowns set as close as practical. Consideration should be given to rod load capacity of machine.
12. Check lubricator box oil level.
13. Check for unusual noises or vibrations.

Monthly¹ (in addition to Daily Requirements)

1. Check and confirm safety shutdown functions.

Every 6 Months or 4,000 Hours (plus Daily/Monthly)

1. Drain and replace lubricator box oil.
2. Change oil filter or when oil filter differential pressure exceeds the filter change value, see filter information plate on the top cover or Technical Manual, Section 4 for value.

1. After running a new compressor (or after a re-location, re-configuring or major overhaul) for the first 24 hours, shutdown, vent gas system and perform a hot alignment check at coupling within 30 minutes, while barring driver shaft to packager's recommendations. Realign if necessary to hold coupling alignment within 0.005 inch (0.13 mm) TIR. Also check fastener torque on gas nozzle flanges, valve caps, cylinder heads and compressor rod packing flanges. Reference Technical Manual, Section 1, Fastener Torque Tightening Values or Toolbox Torque Chart, ER-63. After the first week or 150 hours, repeat this fastener torque check. Repeat after the first month or 650 hours. Fasteners that turn at the first month check, should be re-checked after the second month or 1300 hours. If loosening persists, consult your packager or Ariel to help determine the cause and recommend the correction.

3. Change oil. A more frequent oil change interval may be required if operating in an extremely dirty environment or if the oil supplier recommends it or if an oil analysis dictates it. A less frequent oil change interval may be allowed if the oil is replenished on a regular basis due to force feed lubricator usage.
4. Clean sintered element in the small oil filter supplied on the force feed lubrication system or every time main oil filter is changed.
5. Clean strainer when oil is changed.
6. Open frame when oil is changed and visually inspect for foreign material. Disassembly is not recommended unless a reason for it found.
7. Check fluid level in torsional vibration damper (if applicable). Take fluid sample for viscosity testing.
8. Re-tighten hold down stud-nuts to proper torque values and perform a soft foot check. More than 0.002 inch (0.05 mm) pull down requires re-shimming. If re-shimming is required, realign if necessary to hold hot coupling alignment within 0.005 inch (0.13 mm) TIR.
9. Check cylinders for the proper lubrication rates. Reference Technical Manual, Section 4 for a practical indication using the paper test method.

Yearly or 8,000 Hours (plus Daily/Monthly/6 Months)

1. Check main bearing clearance, connecting rod bearing clearance, and crankshaft thrust clearance with a pry bar and dial indicator¹. Any time bearing clearances are outside the limits listed in the Technical Manual, Section 1, Clearances Table, replace the affected bearings. Disassembly to check clearances is not recommended. Disassembly should be performed if the pry bar check indicates excessive clearance.
2. Check crosshead guide clearance with feelers and if outside the limits listed in the Technical Manual, Section 1, Clearances Table, replace the affected parts.
3. Inspect valves for broken plates and loose center bolts, replace broken parts and tighten center bolts. Reference Technical Manual, Section 1, Fastener Torque Tightening Values or Toolbox Torque Chart, ER-63.
4. Inspect cylinder bores for damage or wear. If the cylinder bore surface is blemished or gouged, affecting efficiency or causing rapid ring wear, or is more than 0.001 inch per inch of cylinder bore diameter (0.001 mm/mm) out of round or tapered, the cylinder body should be replaced or the bore restored. Contact Ariel for re-boring and bore restoration guidelines.
5. Inspect piston ring end gap. Replace rings that are outside the maximum limit listed in the Technical Manual, Section 1.
6. Inspect piston rods for damage and excessive wear. If gouged or scratched, replace the rod. If the rod is more than 0.005 inch (0.13 mm) under size, out of round more than 0.001 inch (0.03 mm), or tapered more than 0.002 inch (0.05 mm) replace the rod.
7. Rebuild cylinder packing cases.

1. Check main, connecting rod and crankshaft thrust bearing clearances anytime if a periodic oil analysis indicates lead, tin or copper particles in oil, if bearing temperature increases or if visual inspection of crankcase indicates bearing wear.

FOR MODELS: JGE, JGH, JGK AND JGT SECTION 6 - MAINTENANCE INTERVALS & TROUBLE SHOOTING

8. Inspect for frame twist or bending by checking shimming of compressor feet.
9. Realign if necessary to hold coupling hot alignment within 0.005 inch (0.13 mm) TIR.
10. Check and re-calibrate all temperature and pressure gauges.
11. Check and record compressor rod run out.
12. Grease VVCP stem threads at grease fitting, with 2 to 3 pumps of multi-purpose grease using a standard hand pump grease gun.
13. Clean crankcase breather filter.
14. Adjust drive chains.
15. Pressure test distribution blocks.
16. Check gas nozzle flange, valve cap, compressor rod packing, crosshead pin through bolt, crosshead guide to frame, crosshead guide to cylinder, cylinder mounting flange to forged steel cylinder, distance piece to cylinder, distance piece to crosshead guide and tandem cylinder to cylinder fastener torque.
17. If the compressor is equipped with crankcase over-pressure relief valves, inspect and exercise valves to the manufacturer's recommendations.

Every 2 Years or 16,000 Hours (plus Daily/Monthly/6 Months/ Yearly)

1. Check auxiliary end chain drive for sprocket teeth undercutting and chain for excessive stretching.
2. Rebuild oil wiper cases.

Every 4 Years or 32,000 Hours (plus Daily/Monthly/6 Months/1 & 2 Years)

1. Check crosshead pin to crosshead pin bore and connecting rod bushing bore by removing crosshead pins.
2. Check for excessive wear in the auxiliary end drive chain tightener.
3. Check for excessive ring groove wear in pistons.

Every 6 Years or 48,000 hours (plus Daily/Monthly/6 Months/1, 2 & 4 Years)

1. Replace lubricator distribution blocks.
2. Replace crosshead bushings.

Trouble Shooting

Minor problems can be expected during the routine operation of an Ariel compressor. These troubles are most often traced to liquid, dirt, improper adjustment or to operating personnel being unfamiliar with Ariel compressors. Difficulties of this type can usually be corrected by

FOR MODELS: JGE, JGH, JGK AND JGT SECTION 6 - MAINTENANCE INTERVALS & TROUBLE SHOOTING

cleaning, proper adjustment, elimination of an adverse condition, replacement of a relatively minor part or proper training of the operating personnel.

Major problems can usually be traced to long periods of operation with unsuitable lubrication, careless operation, lack of routine maintenance or the use of the compressor for purposes for which it was not intended.

Recording of the interstage pressures and temperatures on multistage units is valuable because any variation, when operating at a given load point, indicates trouble in one of the stages. Normally, if the interstage pressure drops the trouble is in the lower pressure cylinder. If it rises, the problem is normally in the higher pressure cylinder.

While it would be impossible to compile a complete list of every possible problem, listed below are some of the more common ones with their possible causes.

Problem	Possible Causes
Low Oil Pressure	Oil Pump pressure regulating valve set too low or sticking. Oil pump or oil pump drive failure. Oil foaming from counterweights striking oil surface (oil level too high). Cold oil. Dirty oil filter. Interior frame oil leaks. Excessive leakage at bearings. Improper low oil pressure switch setting. Oil pump relief valve set too low. Defective pressure gauge. Plugged oil sump strainer. Improper end clearance in oil pump.
Noise in Cylinder	Loose piston. Piston hitting cylinder head end head or crank end head. Loose crosshead balance nut. Broken or leaking valve(s). Worn or broken piston rings or wear bands. Valve improperly seated or damaged seat gasket. Liquids in cylinder.
Excessive Packing Leakage	Worn packing rings. Improper lube oil and or insufficient lube rate. Dirt in packing. Packing rings assembled incorrectly. Improper ring side or end gap clearance. Plugged packing vent system. Scored, tapered or out of round piston rod. Excessive piston rod run-out. Packing not seated or properly run in.
Packing Over Heating	Lubrication failure. Improper lube oil and/or insufficient lube rate. Worn packing rings. Dirt in packing. Improper ring side or end gap clearance. Scored, tapered or out of round piston rod. Excessive piston rod runout.

Problem	Possible Causes
Excessive Carbon on Valves	Excessive lube oil. Improper lube oil. Oil carry-over from inlet system or previous stage. Broken or leaking valves causing high temperature. Excessive temperature due to high pressure ratio across cylinders.
Relief Valve Popping	Faulty relief valve. Leaking suction valves or rings on next higher stage. Obstruction, closed or faulty valve in discharge line.
High Discharge Temperature	Excessive ratio across cylinder due to leaking inlet valves or rings on next higher stage. Fouled intercooler piping. Leaking discharge valves or piston rings. High inlet temperature. Improper lube oil and or lube rate.
Frame Knocks	Loose crosshead pin or pin caps. Loose or worn main, crankpin or crosshead bearings. Low oil pressure. Cold oil. Incorrect oil. Knock is actually from cylinder end. Low fluid level in damper.
Drive End of Crankshaft Oil Leak	Clogged vent or vent piping. Excessive cylinder packing leakage.
Piston Rod Oil Wiper Leaks	Worn wiper rings. Wipers incorrectly assembled. Worn/scored rod. Improper fit of rings to rod/side clearance.
Force Feed Lubrication Shut-down	Force feed pump or lubricator block failure. Loss of oil supply to F.F. pump. Lubricator box drive failure. Proflo not programmed correctly. Proflo battery failure or power lose. Loose or grounded control wiring. Pin assembly not completely pushed into the Proflo housing for reliable operation.
Oil Leaks at Pipe Threaded Connections	Joint not tight. Pipe sealant was omitted. Defective or damaged pipe threads. NPTF Dryseal threads not being used. Pressure too high to be using pipe threaded connection. Type of pipe thread sealant used is not compatible with the type of synthetic oil being used. Cracked pipe or fittings.

SECTION 7 - APPENDICES

Ariel Tools

Ariel Furnished Tools

Ariel provides the following tools with each compressor (see Figure 7-1: on Page 7-2).

- Tool Kit (G-8631), containing the following:
 - Tool Box (A-0798). Not illustrated).
 - 1/4" x 3/8" UNF Valve Tool for Installing or Removing Valves (A-0409).
 - 5/16" x 1/2" UNF Valve Tool for Installing or Removing Valves (A-0135).
 - 5/8" x 3/4" UNF Valve Tool for Installing or Removing Valves (A-0626).
 - Peg Wrench for Round Crosshead Balance Nuts (A-4996).
 - Ratchet Wrench Extension Support for Turning Piston and Rod Assembly (B-1240).
 - 3/4" x 1" UNC Valve Tool for Installing or Removing 'CT' Type Valves (A-2289).
 - Connecting Rod Bolt 90° Turn Indicator Tool (B-1495).
 - Piston Nut Spanner for 1" Square Drive Ratchet (B-1410).
 - Cylinder Bolt Torque Adapter (A-6393).
 - Crosshead Installation Tool (A-1858).
 - Fastener Tightening Torque Chart (ER-63).
 - Connecting Rod Cap Removal Tool (C-2106) (See Figure 7-2:).
 - Crosshead Pin Alignment Tool (B-1989).
 - Piston Rod Entering Sleeve (A-11341) (See Figure 7-3:).

Ariel provides the following tools with each compressor when applicable, as required:

- Piston Turning Tool for 9/16" Socket (A-1678) provided with small cylinders only (not illustrated).
- 4-Inch Open End Wrench for Hex Crosshead Balance Nuts (C-0618)¹.
- Valve Removal Tool for forged steel cylinders ². (See Figure 7-4: on Page 7-3).
- Piston Ring Entering Sleeves for forged-steel, tail-rod compressor cylinders with step to bore, not illustrated.

Ariel provides these tools with every compressor. Please contact your Distributor if you do not have these tools.

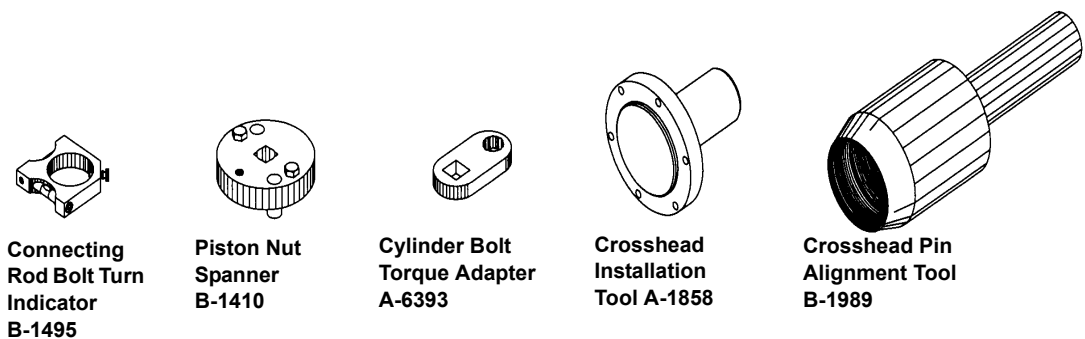
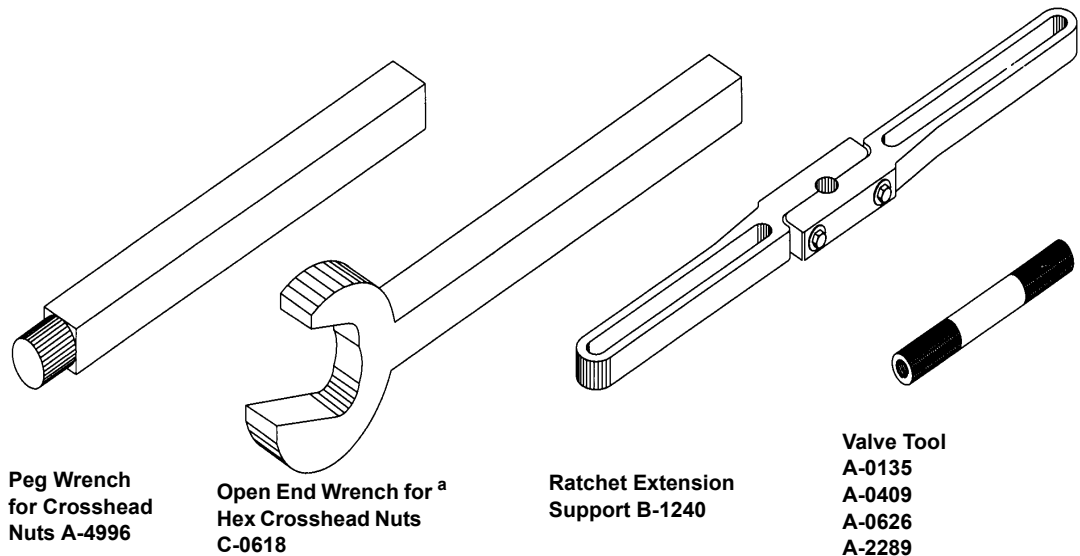
1. Provided only when original equipment compressor is provided with any hex crosshead balance nuts.

2. Provided only when original equipment compressor is provided with forged steel cylinders. Used to remove the metallic wire gasket in high pressure applications.

These tools are specifically designed for use on Ariel units. Clean all tools before use. Be sure that the tool and the part being removed or installed are fully engaged during the process. If a tool is missing, worn or broken, please call your distributor for a replacement. Do not use worn or broken tools, or substitutes for Ariel furnished tools.

Also included in the tool box are standard commercial tools as follows:

- Forged Eyebolts: 3/8" - 16, UNC and 1/2" - 13 UNC
- Allen Wrenches: 5/32", 3/16", 3/8", 1/2" & 3/4"
- (6) Hex Capscrews, Grade 5, 1/4 - 20 UNC x 1 (A-1858 to crosshead guide diaphragm)



a.) Provided only when original equipment compressor is provided with any hex crosshead balance nuts.

FIGURE 7-1: ARIEL TOOLS

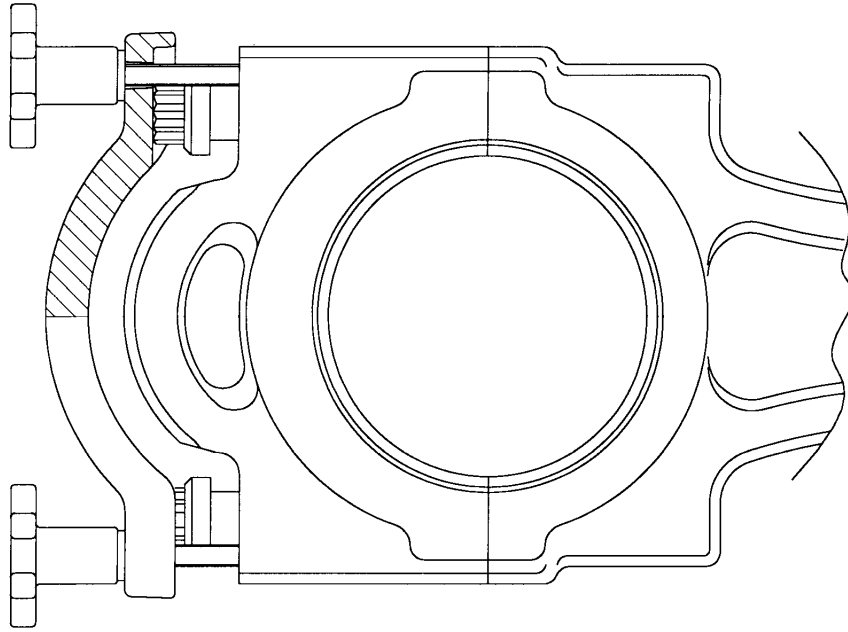


FIGURE 7-2: CONNECTING ROD CAP REMOVAL TOOL - TYPICAL (C-2106)

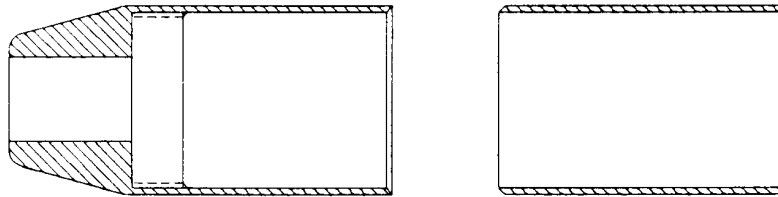
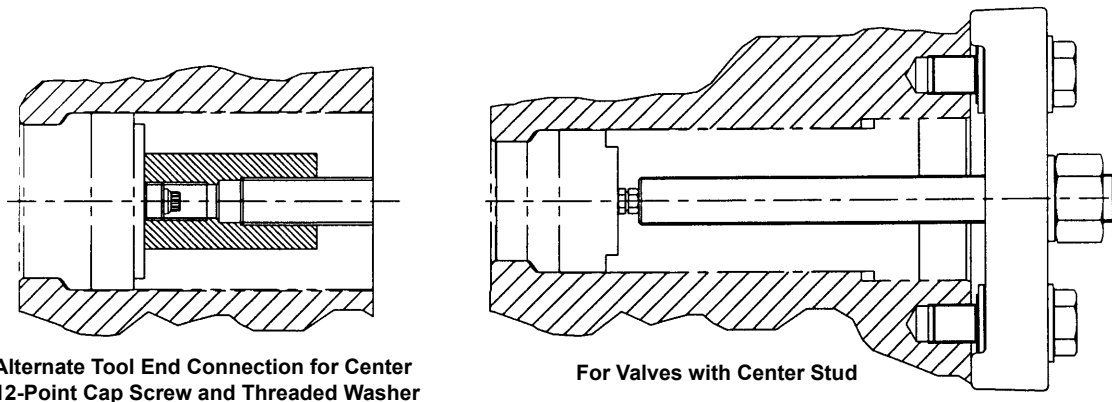


FIGURE 7-3: PISTON ROD ENTERING SLEEVE (A-11341)



Alternate Tool End Connection for Center
12-Point Cap Screw and Threaded Washer

For Valves with Center Stud

This tool is used to remove the metallic wire gasket in high pressure applications. See the Ariel Parts Book for G- part number for ordering this tool. Provided only when original equipment compressor is provided with forged steel cylinder

FIGURE 7-4: VALVE REMOVAL TOOL - TYPICAL

Ariel Tools - Purchased Separately

- Hydraulic Piston Nut Torquing Tool (G-12643). See Figure 5-25: on Page 5-39).
- Piston Rod Clamping Fixture for Wrench Torquing Piston Nut (D-0961). See Figure 5-24: on Page 5-37.
- Piston Rod Support for Installing Piston and Rod Assembly (G-8325). See Figure 7-5: on Page 7-4.
- Hydraulic Crosshead Balance Nut Torquing Tool (G-7583), includes tool and ram. See Figure 5-8: on Page 5-13.
- Hand Pump Kit for Hydraulic Piston Nut and Crosshead Balance Nut Torquing Tools, includes hand pump, hose, coupler and gauge (G-12639). Not illustrated.
- Force Feed Lubrication Hand Purge Pump (G-7162). See Figure 7-6: on Page 7-4
- Plastic Main Bearing Plastic Removal Tool (B-3340). Used to push (rotate) out bottom half of bearing shell with crankshaft in place. See Figure 7-7: on Page 7-5.
- Force Feed Lubricator Bearing Housing Spanner Wrench (A-8158). See Figure 7-8: on Page 7-5.

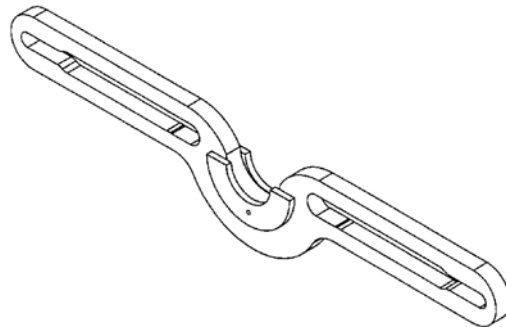


FIGURE 7-5: PISTON ROD SUPPORT (G-8325)

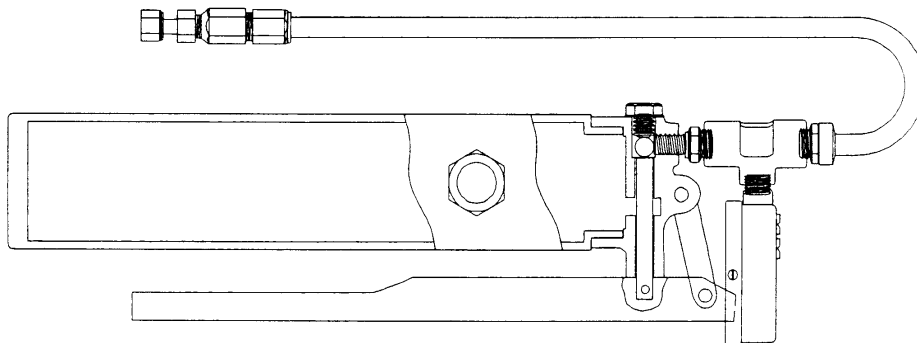


FIGURE 7-6: FORCE FEED LUBRICATION HAND PURGE PUMP (G-7162)

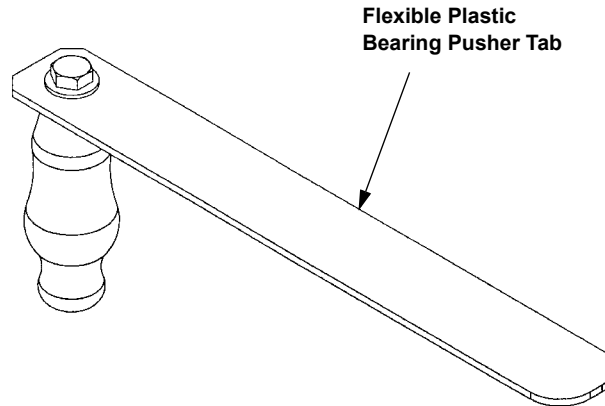


FIGURE 7-7: PLASTIC MAIN BEARING REMOVAL TOOL (B-3340)

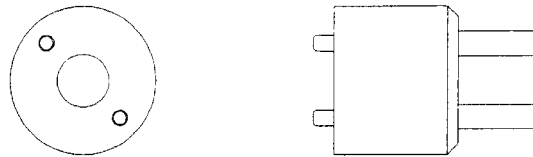


FIGURE 7-8: FORCE FEED LUBRICATOR BEARING HOUSING SPANNER WRENCH (A-8158)

Minimum Hand & Commercial Tools Required

The following standard tools are normally all that is required to work on Ariel reciprocating compressors. These tools are in addition to the Ariel furnished and optional tools listed above. Acquiring high-quality tools and user-friendly, secure tool storage facilities are cost effective. Please contact Ariel if you have questions about tools on Ariel units.

- Tool box for hand tools
- 15 - 18" Adjustable Wrench (Crescent Type)
- Combination Open/Boxed End Wrench Set - including sizes up through 1-1/8".
- Screw Driver Set, Flat and Phillips - including 2 - Medium; 1 - Extra Large; 1 - Extra Long Sizes.
- 3/8" Square Drive Wrench Set, including:
 1. 12 Point Socket Set w/ Breaker Bar, Ratchet, Speed Wrench, Extensions.
 2. Universal Joint, Impact Type (Ball).
 3. Adapter to 1/2" Drive.
 4. 12 Point Box-End "Torque Adapter" Extension Wrench Set, including 1/2" & 5/8" sizes, for tandem forged steel cylinder mounting bolts on smaller frame sizes.
 5. Calibrated Torque Wrench, 10 LB-IN to 250 LB-IN (1 to 30 N·m) range.
- 1/2" Square Drive Wrench Set, including:
 1. 12 Point Socket Set w/ Breaker Bar, Ratchet, Speed Wrench, Extensions.

2. Universal Joint, Impact Style (Ball).
 3. Adapters to 3/8" and 3/4" Drive.
 4. 1-1/4" Open End Crows Foot.
 5. 1/4", 1/2", 5/8" Hex Key (Allen) Socket.
 6. Calibrated Torque Wrench, 50 LB-FT to 250 LB-FT (65 to 350 N·m) range.
- 3/4" Square Drive Wrench Set, including:
 1. 12 Point Socket Set w/ Breaker Bar, Ratchet, Extensions.
 2. Adapters to 1/2" and 1" Drive.
 3. Calibrated Torque Wrench to 600 LB-FT (800 N·m) range.
 - 1" Square Drive Wrench set, including:
 1. 12 Point Socket Set (w/ Sockets up through 2-5/8").
 2. Calibrated Torque Wrench to 1000 LB-FT (1400 N·m) range.
 - Two (2) Dead Blow Semi-Soft Faced Hammers, Primarily for Slugging the Cross-head-Balance Nut Wrench, approximately 100 ounce or 6 lb (3 kg) for JGC:D frames and 56 ounce or 3.5 lb (1.5 kg) for smaller frames.
 - Long Blade Feeler Gage Pack in Assorted Thickness'.
 - Pry Bar - 3' (1 m) Long.
 - Hexagon Allen-Type Key-Wrenches (to ANSI/ASTM B18.3) for Piston-Nut Set-Screws. 2 Hex Wrenches are Consumed (Destroyed) with each Tightening of a Piston Nut. A quantity of hex wrenches needs to be kept on hand, considering the consumption during maintenance. Hex Allen-type-wrench sizes for piston-nut screws - nominal inch sizes:
 1. JG:A:M:N:P:Q:I 3/32
 2. JGR:J:W:B:V 1/8
 3. JGH:E:K:T 5/32
 4. JGC:D;Z;U 3/16
 - Tape Measure.
 - Machinist scale with 0.01 inch or 0.5 mm increments.
 - Calibrated Button and Needle type Dial Indicators with 0.0005 inches (0.005 mm) increments, magnetic stands and mounting hardware.
 - Torque Multiplier and/or Hydraulic Torque Wrench for larger frame sizes.

Terms, Abbreviations¹ and Conversion to SI Metric²

Area

in² or square inch x 0.00064516 = meter², or m²

in² or square inch x 6.4516 = centimeter², or cm²

-
1. US units of measure can appear abbreviated in upper or lower case.
 2. Maintain upper and lower case letters in SI Metric as shown.

Flow - Gas

MMSCFD or million standard cubic feet per day (at 14.696 psia & 60°F) x 0.310 = normal meter³/second (at 1.01325 bar & 0°C), or m³/s_n

SCFM or standard cubic feet per minute (at 14.696 psia & 60°F) x 1.607 = normal meter³/hour (at 1.01325 bar & 0°C), or m³/h_n

Flow - Liquid

GPM or US gallons per minute x 0.0630902 = liter/second, or L/s = dm³/s

GPM or US gallons per minute x 0.227125 = meter³/hour, or m³/h

Force

lbf or pound (force) x 4.44822 = Newton, or N

Heat

BTU or British Thermal Units x 1.05506 = kilojoule, or kJ

Length

in. or " or inches x 25.4000 = millimeters, or mm

ft or feet x 0.304800 = meter, or m

Mass

lb_m or pound (mass) x 0.453592 = kilogram, or kg

Moment or Torque

LB x FT or pound-foot (force) x 1.35583 = Newton-meter, or N·m

LB x IN or pound-inch (force) x 0.112985 = Newton-meter, or N·m

Power¹

HP or Horsepower x 0.745700 = kilowatt, or kW

1. Horsepower based on 550 ft-lb/sec.

Pressure¹ or Stress

psi x 6894.757 = Pascal, or Pa

Pa x 0.000145 = psi

psi x 6.894757 = kiloPascal, or kPa

kPa x 0.145 = psi

bar x 100 000 = Pascal, or Pa

Pa x 0.00001 = bar

bar x 100 = kPa

kPa x 0.01 = bar

psi x 68.94757 = mbar or millibar

mbar x 0.0145 = psi

psi x 0.06894757 = bar

bar x 14.5 = psi

Speed

FPM or feet per minute x 0.005080 = meter per second, or m/s

RPM or r/min or revolutions per minute x 60 = revolutions per second, or rev/s

Temperature

°F or degrees Fahrenheit. $(°F - 32)/1.8 = \text{degrees Celsius, or } °C$

Time

sec = second, or s

min or minute x 60 = second, or s

hr or h or hour x 3600 = second, or s

Viscosity

SSU, SUS or Saybolt Universal seconds x 0.22 - $(180/\text{SSU}) = \text{mm}^2/\text{s} = \text{centistoke, or cSt}$
(for a range of 33 through 200,000 SUS)

1. "G" or "g" suffix indicates gauge pressure; "A", "a" indicates absolute; "D", "d" indicates differential.

Volume

gal or gallons (US liquid) x 3.78541 = liter, or L

Other Abbreviations

AC = Alternating Current (Electrical)

ACT = Actuator

ADI = Austempered Ductile Iron

ADPTR = Adapter

AFC = Added Fixed Clearance

AISI = American Iron and Steel Institute

AL = Aluminum

ANSI = American National Standards Institution

API = American Petroleum Institute

ASME = American Society of Mechanical Engineers

ASSY = Assembly

ASTM = American Society of Testing and Materials

ATEX = ATmosphère EXplosible

AUX = Auxiliary

AVG = Average

AWS = American Welding Society

BAL = Balance

BHN = Brinell Hardness Number

BLK = Block

BPS = Bypass

BR = Brass

BRKT = Bracket

BRST = Burst Test

BS = Bottom Suction

BW = Butt-Welded

BZ = Bronze

C/CERT = Chemical Certification

CCT = CC Technology

CE = European Conformance Marking to European Union Directives

CE = Crank End

CERT = Certification

CGA = Compressed Gas Association

CHR = Chrome

CI = Cast Iron

CIP = Cycle Indicator Pin

CIU = Compressor Interface Unit

CL = Centerline

CL = Clearance or Class

CL PKT = Clearance Pocket

CNTR = Center

COMP or COMPR = Compressor

CONC = Concentric

CONN or CON = Connecting or Connection

CRK or C'SHAFT = Crankshaft

CSA = Canadian Standards Association

CSTG = Casting

CT = Calcium Treated

CTB = Ariel Customer Technical Bulletin

CU = Cubic

CVR = Cover

CYL = Cylinder

DAQ = Data Acquisition System

DC = Direct Current (Electrical)

D/D = Double Deck

D/S = Drilled-Seat Valves

DI = Ductile Iron

DIA or D = Diameter

DIS = Discharge

DNFT = Digital No-Flow Timer Switch

DPI = Dye Penetrant Inspection

DUPLX = Duplex

DS = Dry Sump

EEPROM = Electrical Erasable Programmable Read Only Memory

ELEC or ELECT = Electric

ELEM = Element

ESNA = Registered Trade Mark of Elastic Stop Nut Division, Harvard Industries

EN = European Union

EX = Explosion Protection

EXT = External

EXTB = External Thrust Bearing

EXTN = Extension or Extended

FAB = Fabricated

FEM = Female

FFT = Fluid Flow Trending (software)

FIN = Finished

FLG = Flange

FPT = Female Pipe Tap

FS = Forged Steel

FTG = Fitting(s)

FVCP = Fixed Volume Clearance Pocket

FW = Fillet-Welded

GI = Gray Iron

GPSA = Gas Producers Suppliers Association

GRHT = Gerhardt

GR = Grooved Nozzle or Grade

H/S = Half Shell

H-COM = Hydro-Com

HCL = High Clearance

HE = Head End

HES = Head End Support(s)

HEX = Hexagonal

HL = High Lift or High Level

HP = High Pressure or Horsepower, see Power above

HRC = Hardness Measurement on Rockwell C Scale

HTP = Hydrostatic Test Pressure

IEC = International Electric Congress

ID = Inside Diameter

IDP = Integral Distance Piece

IFI = International Fasteners Institute

IH = Integral Head

IN = Ion-Nitrided or Inches, see Length above

ISO = International Standards Organization

IT = Indicator Tap(s)

J BOX = Junction Box

JIC = Joint Industry Conference

KEMA = NV tot Keuring van Elektrotechnische Materialen (Electrical Engineering Equipment Testing Company)

LCD = Liquid Crystal Display

LED = Light Emitting Diode

LG = Long

LHP = Low Horsepower

LL = Low Lift or Low Level

LO = Lubricating Oil

LOSD = Lube Oil Shutdown

LXD = Higher Temperature Liquid Crystal Display

LS = Long Single Compartment Distance Piece

LUBE = Lubricating or Lubricated

L2 = Long Two Compartment Distance Piece

M/CERT = Mechanical Material Certification

M/S = Milled-Seat Valve(s)

MAWP = Maximum Allowable Working Pressure

MAX = Maximum

MC = Medium Temperature Carbon Filled Nylon

MIL = Military

MIN = Minimum

MPI = Magnetic Particle Inspection

MPPT = Mini-Poppet Valve

MPT = Male Pipe Thread

MT = Medium Temperature Glass Filled Nylon

MTD = Mounted

MTG = Mounting

N/A = Not Applicable

N/H = Not Hydrostatically Tested

NAC or NACE = (National Association of Corrosion Engineers), now NACE International Corrosion Society

NAS = National Aerospace Standard

NC or N/C = Normally Closed

NEC = National Electric Code

NFPA = National Fire Protection Association

NL = Non-Lubricated

NMC = Nimonic (Valve Spring)

NO. or # = Number

NO or N/O = Normally Open

NOZ = Nozzle

NP = No Pumps (Force Feed Lubrication)

NPT = National Pipe Thread

OD = Outside Diameter

OVRFLO = Overflow

P/N = Part Number

PC = Piece or Personal Computer

PCT or PCNT or % = Percent

PEEK or PK = Poly-Ether-Ether-Ketone (plastic material)

PIST = Piston

PL = Plastic

PLC = Programmable Logic Controller

PLT = Plate

PPA = Proprietary Polymer Alloy

PPT = Poppet

PR/PKG = Propane Package

PRC = Process

PRS = Pressure

PT = Point

PU = Purge

R/R = Reverse Rotation

RD NOZZ = Round Nozzle

RED = Reducing

RET = Retainer

RFO = Radial Force Only

RNG = Ring

RTD = Resistance Temperature Detector

RTRN = Return

S&D = Suction and Discharge

S/F = Semi-Finished

S/R = Seal Ring

SAE = Society of Automotive Engineers

SBB = Steel Backed Bronze

SD or S/D = Shutdown

SF = Stainless Steel Tubing and Fittings

SG = Specific Gravity

SI = International System, as applied to the modern metric system

SJ = Seal Joint Piston Rings

SM = Small

S. N. or S/N = Serial Number

SOC = Socket (Head)

SPCL = Special

SPCR = Spacer

SPEC = Specifications

SPR = Spring

SS = Stainless Steel

STD = Standard

STL = Steel

STR = Straight

SUC = Suction

SVU = Suction Valve Unloader

SW = Switch

T&B = Top and Bottom (Cylinder Lubrication)

T'CPL = Thermocouple

TFE = Teflon

THD or THRD = Thread

THK = Thick

THRM = Thermostatic Valve

TIR = Total Indicator Reading

TMC = Thomas Coupling

TPI = Threads Per Inch

TR = Tail Rod

TRAV = Travel

TS = Tapered Seat

TVA = Torsional Vibration Analysis

TW = Thermowell Connection

UL = Underwriters Laboratory

UNC = Unified (Inch) National Coarse Screw Threads

UNF = Unified (Inch) National Fine Screw Threads

UNL = Unloader

UNMTD = Unmounted

UNT = Unit

UPS = United Parcel Service

UT = Ultrasonic Inspection

VIB = Vibration

VLV = Valve

VOL = Volume

VRN = Vernier

VS2 = VS2 Type Shutdown

VS = Vertical forged Steel (Cylinder)

VSPCR = Valve Spacer

VTR = Vertical Tail Rod (Cylinder)

W/ = With

W/P = With Clearance Plug

WB = Wear Band

WD = Wideland Valve Seat

WELDMENT = Welded Assembly

WN = Welded Nozzle

WR² or WR² = Weight times Radius Squared (Inertia)

WTRPMP = Water Pump

WT(S) = Weight(s)

XHD = Crosshead

Z/PL = Zinc Plated

2/L = Two Lube Points

2ND = Second (Two)

2SHT = Two Sheet Drawing

Gas Analysis Common Abbreviations

TABLE 7-1: GAS ANALYSIS COMMON ABBREVIATIONS

COMMON ABBREVIATION	COMPONENT NAME (SYNONYM)	CHEMICAL FORMULA
C1	Methane	CH ₄
C2	Ethane	C ₂ H ₆
C3	Propane	C ₃ H ₈
IC4	Iso-Butane (2-Methyl Propane)	C ₄ H ₁₀
NC4	N-Butane	C ₄ H ₁₀
IC5	Iso-Pentane (2-Methyl Butane)	C ₅ H ₁₂
NC5	N-Pentane	C ₅ H ₁₂
NEOC5	Neopentane	C ₅ H ₁₂
NC6	Hexane	C ₆ H ₁₄
NC7	Heptane	C ₇ H ₁₆
NC8	Octane	C ₈ H ₁₈
NC9	Nonane	C ₉ H ₂₀
NC10	N-Decane	C ₁₀ H ₂₂
NC11	N-Undecane (Hendecane)	C ₁₁ H ₂₄
NC12	N-Dodecane	C ₁₂ H ₂₆
C2-	Ethylene (Ethene)	C ₂ H ₄
C3-	Propene (Propylene)	C ₃ H ₆
BENZ	Benzene	C ₆ H ₆
TOL	Toluene	C ₇ H ₈
EBNZ	Ethylbenzene	C ₈ H ₁₀
CO	Carbon Monoxide	CO
CO ₂	Carbon Dioxide	CO ₂
H ₂ S	Hydrogen Sulfide	H ₂ S
H ₂	Hydrogen	H ₂
O ₂	Oxygen	O ₂
N ₂	Nitrogen	N ₂
H ₂ O	Water	H ₂ O
He	Helium	He
Ar	Argon	Ar
---	Air	---

TABLE 7-2: USEFUL SI METRIC MULTIPLE AND SUBMULTIPLE FACTORS

MULTIPLICATION FACTOR	PREFIX	SI SYMBOL ^A
1 000 000 = 10 ⁶	mega	M
1 000 = 10 ³	kilo	k
100 = 10 ²	hecto ^b	h
10 = 10 ¹	deka ^B	da
0.1 = 10 ⁻¹	deci ^B	d
0.01 = 10 ⁻²	centi ^B	c
0.001 = 10 ⁻³	milli	m
0.000 001 = 10 ⁻⁶	micro	μ

a. Maintain upper and lower case letters as shown.

b. Not Recommended, but occasionally used.

Technical and Service Schools on Ariel Compressors

Ariel schedules several in plant schools each year, which include classroom and hands on training. Ariel can also arrange to send a representative to provide a customized training school at your location. Contact Ariel for details.

Ariel Customer Technical Bulletins

Ariel Customer Technical Bulletins provide important technical information, including changes, corrections and /or additions to the Technical Manual, for Packagers and End Users. Be sure to refer to this material before operating or servicing the equipment.

For a listing of the latest available editions of Ariel Customer Technical Bulletins, see the Ariel Website (www.arielcorp.com), or copies may be obtained from the Packager or from Ariel.

To view the Ariel Customer Technical Bulletins from the Ariel Website, “Acrobat Reader” software must be installed on your computer. If your computer does not have “Acrobat Reader”, or to get a current version, go to “Downloads” at the Ariel Home Page (www.arielcorp.com) and follow the links via “Computer Tools” to obtain the free software. To view and print Ariel CTB’s (with “Acrobat Reader” installed), go to the Ariel Home Page, and follow the links to get to the CTB’s. To download a CTB electronic pdf file to your computer, hold cursor over the desired CTB number in the listing and right mouse click, then right click on “Save Target As...” in the pop up window. After using printed or downloaded copies of CTB’s to satisfy the purpose at hand, destroy all prints and files. Seek the latest CTB information from the Ariel Website.

Vendor Literature

When available, vendor literature on purchased parts used in Ariel Compressors is provided on the Ariel Website (www.arielcorp.com), or copies may be obtained from the Packager or from Ariel.

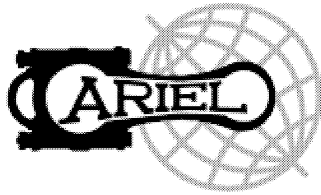
Ariel Telephone, Fax, E-Mail and Web Site Numbers

CONTACT	TELEPHONE	FAX	EMAIL
Ariel Response Center	888-397-7766	740-397-1060	arc@arielcorp.com
Spare Parts	(toll free USA & Canada) or 740-397-3602 (International)	740-393-5054	spareparts@arielcorp.com
Order Entry		740-397-6450	---
Ariel World Headquarters	740-397-0311	740-397-3856	info@arielcorp.com
Technical Field Service			fieldservice@arielcorp.com
Web Site: www.arielcorp.com			

- Ariel Response Center Technicians or Switchboard Operators will answer telephones during Ariel business hours, Eastern Time - USA or after hours by voice mail.
- The after Hours Telephone Emergency System works as follows:
 1. Follow automated instructions to Field Service Emergency Technical Assistance or Spare Parts Emergency Service.
 2. Calls are answered by voice mail.
 3. Leave Message: caller's name, telephone number, serial number of equipment in question (frame, cylinder, unloader) and brief description of emergency.
 4. Your voice message is routed to an on-call representative, who will respond as soon as possible.
- Users are to contact an Authorized Distributor for purchase of Ariel parts.

NOTES:

Wed Jul 19 15:03:20 EDT 2006



ARIEL CORPORATION
Recommended Spares Start-Up



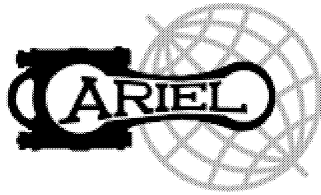
F23790
C82051, C82052, C82053, C82054
U51912, U51913, U51914, U51915

Project:

QTY	Part Number	Description	Your Price	Net Amount
JGH-JGE-JGK-JGT FRAME CLASS				
1	C-4367	GSKT,RET,77-5/8 X20-3/8X1/32	\$0.0000	\$0.00
4	B-0832	GSKT,RET,15-5/16X10-13/16X1/32	\$0.0000	\$0.00
8	B-1805	GSKT,RET,10.813X7.5/8X1/32	\$0.0000	\$0.00
3	A-0661	LO FILTER ELEMENT,SPIN-ON	\$0.0000	\$0.00
8	A-0124	BLOW-OUT DISC,3250 PSIG,PURPLE	\$0.0000	\$0.00
4	A-3689	CHECK VALVE,1/8M X 1/8F,PPT,SS	\$0.0000	\$0.00
			Sub Total	\$0.00
CYL ASSY, 5-7/8K:T,HES,SF 2050				
2	A-2331	STL GASKET, 6.813 X 6.375 X 60	\$0.0000	\$0.00
1	A-0145	THUMB SCREW,NYLON,1/4-20 X 3/4	\$0.0000	\$0.00
4	A-2126	STL GASKET, 4.861 X 4.543 X 30	\$0.0000	\$0.00
4	A-2336	O-RING,VT, 4.887 O.D. X .139	\$0.0000	\$0.00
1	B-3325-CC	DIS VLV,102CT ,SS,MT,M/S	\$0.0000	\$0.00
1	B-1945-T	SUC VLV,102CT ,NY,SS,M/S	\$0.0000	\$0.00
			Sub Total	\$0.00
VVCP, 5-7/8K:C:K-HP:T				
1	A-2331	STL GASKET, 6.813 X 6.375 X 60	\$0.0000	\$0.00
			Sub Total	\$0.00
CYL ASSY, 9-1/8K:T,SF,HES 1270				
2	A-2125	STL GASKET,10.063 X 9.750 X 60	\$0.0000	\$0.00
4	A-0145	THUMB SCREW,NYLON,1/4-20 X 3/4	\$0.0000	\$0.00
6	A-2126	STL GASKET, 4.861 X 4.543 X 30	\$0.0000	\$0.00
4	A-2124	O-RING,VT, 4.895 O.D. X .210	\$0.0000	\$0.00
1	B-3325-BB	DIS VLV,102CT ,SS,MT,M/S	\$0.0000	\$0.00
1	B-1945-S	SUC VLV,102CT ,NY,SS,M/S	\$0.0000	\$0.00
			Sub Total	\$0.00
VVCP, 9-1/8KC				
1	A-2125	STL GASKET,10.063 X 9.750 X 60	\$0.0000	\$0.00

			Sub Total	\$0.00
CYL ASSY, 5-7/8K:T,HES,SF 2050				
2	A-2331	STL GASKET, 6.813 X 6.375 X 60	\$0.0000	\$0.00
1	A-0145	THUMB SCREW,NYLON,1/4-20 X 3/4	\$0.0000	\$0.00
4	A-2126	STL GASKET, 4.861 X 4.543 X 30	\$0.0000	\$0.00
4	A-2336	O-RING,VT, 4.887 O.D. X .139	\$0.0000	\$0.00
1	B-3325-CC	DIS VLV,102CT ,SS,MT,M/S	\$0.0000	\$0.00
1	B-1945-T	SUC VLV,102CT ,NY,SS,M/S	\$0.0000	\$0.00
			Sub Total	\$0.00
VVCP, 5-7/8K:C:K-HP:T				
1	A-2331	STL GASKET, 6.813 X 6.375 X 60	\$0.0000	\$0.00
			Sub Total	\$0.00
CYL ASSY, 9-1/8K:T,SF,HES 1270				
2	A-2125	STL GASKET,10.063 X 9.750 X 60	\$0.0000	\$0.00
2	A-0145	THUMB SCREW,NYLON,1/4-20 X 3/4	\$0.0000	\$0.00
3	A-2126	STL GASKET, 4.861 X 4.543 X 30	\$0.0000	\$0.00
3	A-2124	O-RING,VT, 4.895 O.D. X .210	\$0.0000	\$0.00
1	B-3325-BB	DIS VLV,102CT ,SS,MT,M/S	\$0.0000	\$0.00
1	B-1945-S	SUC VLV,102CT ,NY,SS,M/S	\$0.0000	\$0.00
			Sub Total	\$0.00
VVCP, 9-1/8KC				
1	A-2125	STL GASKET,10.063 X 9.750 X 60	\$0.0000	\$0.00
			Sub Total	\$0.00
			Start-Up Grand Total	\$0.00

Wed Jul 19 15:03:20 EDT 2006



ARIEL CORPORATION
Recommended Spares Consumables



F23790

C82051, C82052, C82053, C82054

U51912, U51913, U51914, U51915

Project:

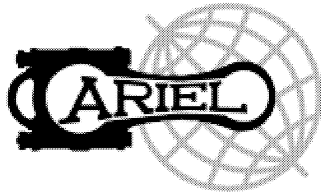
QTY	Part Number	Description	Your Price	Net Amount
JGH-JGE-JGK-JGT FRAME CLASS				
1	C-4367	GSKT,RET,77-5/8 X20-3/8X1/32	\$0.0000	\$0.00
8	B-0832	GSKT,RET,15-5/16X10-13/16X1/32	\$0.0000	\$0.00
16	B-1805	GSKT,RET,10.813X7.5/8X1/32	\$0.0000	\$0.00
4	A-3780	CHK.VLV,DOU.BALL SOFT SEAT SS	\$0.0000	\$0.00
1	A-8723-K	FILTER KIT, LUBRICATOR 150 MIC	\$0.0000	\$0.00
2	A-9478	FF LUBR PUMP 3/8 PREMIER	\$0.0000	\$0.00
6	A-0661	LO FILTER ELEMENT,SPIN-ON	\$0.0000	\$0.00
8	A-0124	BLOW-OUT DISC,3250 PSIG,PURPLE	\$0.0000	\$0.00
2	A-0080	BLOW-OUT ASSY,SPECIFY DISC.	\$0.0000	\$0.00
10	A-3689	CHECK VALVE,1/8M X 1/8F,PPT,SS	\$0.0000	\$0.00
			Sub Total	\$0.00
CYL ASSY, 5-7/8K:T,HES,SF 2050				
2	A-2331	STL GASKET, 6.813 X 6.375 X 60	\$0.0000	\$0.00
1	A-3780	CHK.VLV,DOU.BALL SOFT SEAT SS	\$0.0000	\$0.00
5	A-2332	PISTON RING, 5-7/8K:T:C:D-HP	\$0.0000	\$0.00
1	B-1589-K	RBLD KIT,PIST ROD PKG,2.000	\$0.0000	\$0.00
1	B-1806-K	RBLD KIT,WIPER PKG,2.000,L2	\$0.0000	\$0.00
1	A-2334	WEAR BAND, 5-7/8K:K-HP:C:C-HP	\$0.0000	\$0.00
2	A-4376	GUIDE RING,90CT,.370 THK,SS	\$0.0000	\$0.00
2	A-4682	CNTR.BLT,12PT,3/8-24X2-1/8,SS	\$0.0000	\$0.00
1	A-5992	DIS VLV SEAT,102CT ,SS,M/S	\$0.0000	\$0.00
2	KB-3325-CC	KIT,VLV,102CT ,SS,MT,M/S	\$0.0000	\$0.00
2	A-4500	GUIDE RING,102CT,378 THK,SS	\$0.0000	\$0.00
2	A-4585	CNTR.BLT,12PT,3/8-24X2-1/2,SS	\$0.0000	\$0.00
1	A-5991	SUC VLV SEAT,102CT ,SS,M/S	\$0.0000	\$0.00
2	KB-1945-T	KIT,VLV,102CT ,NY,SS,M/S	\$0.0000	\$0.00
4	A-5994	WAFER SPR,102CT,NAC	\$0.0000	\$0.00
			Sub Total	\$0.00

VVCP, 5-7/8K:C:K-HP:T

1	A-2331	STL GASKET, 6.813 X 6.375 X 60	\$0.0000	\$0.00
			Sub Total	\$0.00
CYL ASSY, 9-1/8K:T,SF,HES 1270				
2	A-2125	STL GASKET,10.063 X 9.750 X 60	\$0.0000	\$0.00
1	A-3780	CHK.VLV,DOU.BALL SOFT SEAT SS	\$0.0000	\$0.00
4	A-2127	PISTON RING, 9-1/8KTCD&HP:ZU	\$0.0000	\$0.00
1	B-1589-K	RBLD KIT,PIST ROD PKG,2.000	\$0.0000	\$0.00
1	B-1806-K	RBLD KIT,WIPER PKG,2.000,L2	\$0.0000	\$0.00
1	A-2129	WEAR BAND, 9-1/8K&CE:C:Z 2.0W	\$0.0000	\$0.00
4	A-4376	GUIDE RING,90CT, .370 THK,SS	\$0.0000	\$0.00
4	A-4682	CNTR.BLT,12PT,3/8-24X2-1/8,SS	\$0.0000	\$0.00
1	A-5992	DIS VLV SEAT,102CT ,SS,M/S	\$0.0000	\$0.00
4	KB-3325-BB	KIT,VLV,102CT ,SS,MT,M/S	\$0.0000	\$0.00
4	A-4500	GUIDE RING,102CT,378 THK,SS	\$0.0000	\$0.00
4	A-4585	CNTR.BLT,12PT,3/8-24X2-1/2,SS	\$0.0000	\$0.00
1	A-5991	SUC VLV SEAT,102CT ,SS,M/S	\$0.0000	\$0.00
4	KB-1945-S	KIT,VLV,102CT ,NY,SS,M/S	\$0.0000	\$0.00
8	A-5994	WAFER SPR,102CT,NAC	\$0.0000	\$0.00
			Sub Total	\$0.00
VVCP, 9-1/8KC				
1	A-2125	STL GASKET,10.063 X 9.750 X 60	\$0.0000	\$0.00
			Sub Total	\$0.00
CYL ASSY, 5-7/8K:T,HES,SF 2050				
2	A-2331	STL GASKET, 6.813 X 6.375 X 60	\$0.0000	\$0.00
1	A-3780	CHK.VLV,DOU.BALL SOFT SEAT SS	\$0.0000	\$0.00
5	A-2332	PISTON RING, 5-7/8K:T:C:D-HP	\$0.0000	\$0.00
1	B-1589-K	RBLD KIT,PIST ROD PKG,2.000	\$0.0000	\$0.00
1	B-1806-K	RBLD KIT,WIPER PKG,2.000,L2	\$0.0000	\$0.00
1	A-2334	WEAR BAND, 5-7/8K:K-HP:C:C-HP	\$0.0000	\$0.00
2	A-4376	GUIDE RING,90CT, .370 THK,SS	\$0.0000	\$0.00
2	A-4682	CNTR.BLT,12PT,3/8-24X2-1/8,SS	\$0.0000	\$0.00
1	A-5992	DIS VLV SEAT,102CT ,SS,M/S	\$0.0000	\$0.00
2	KB-3325-CC	KIT,VLV,102CT ,SS,MT,M/S	\$0.0000	\$0.00
2	A-4500	GUIDE RING,102CT,378 THK,SS	\$0.0000	\$0.00
2	A-4585	CNTR.BLT,12PT,3/8-24X2-1/2,SS	\$0.0000	\$0.00
1	A-5991	SUC VLV SEAT,102CT ,SS,M/S	\$0.0000	\$0.00
2	KB-1945-T	KIT,VLV,102CT ,NY,SS,M/S	\$0.0000	\$0.00
4	A-5994	WAFER SPR,102CT,NAC	\$0.0000	\$0.00
			Sub Total	\$0.00
VVCP, 5-7/8K:C:K-HP:T				
1	A-2331	STL GASKET, 6.813 X 6.375 X 60	\$0.0000	\$0.00

			Sub Total	\$0.00
CYL ASSY, 9-1/8K:T,SF,HES 1270				
2	A-2125	STL GASKET,10.063 X 9.750 X 60	\$0.0000	\$0.00
1	A-3780	CHK.VLV,DOU.BALL SOFT SEAT SS	\$0.0000	\$0.00
4	A-2127	PISTON RING, 9-1/8KTCD&HP:ZU	\$0.0000	\$0.00
1	B-1589-K	RBLD KIT,PIST ROD PKG,2.000	\$0.0000	\$0.00
1	B-1806-K	RBLD KIT,WIPER PKG,2.000,L2	\$0.0000	\$0.00
1	A-2129	WEAR BAND, 9-1/8K&CE:C:Z 2.0W	\$0.0000	\$0.00
4	A-4376	GUIDE RING,90CT,.370 THK,SS	\$0.0000	\$0.00
4	A-4682	CNTR.BLT,12PT,3/8-24X2-1/8,SS	\$0.0000	\$0.00
1	A-5992	DIS VLV SEAT,102CT ,SS,M/S	\$0.0000	\$0.00
4	KB-3325-BB	KIT,VLV,102CT ,SS,MT,M/S	\$0.0000	\$0.00
4	A-4500	GUIDE RING,102CT,378 THK,SS	\$0.0000	\$0.00
4	A-4585	CNTR.BLT,12PT,3/8-24X2-1/2,SS	\$0.0000	\$0.00
1	A-5991	SUC VLV SEAT,102CT ,SS,M/S	\$0.0000	\$0.00
4	KB-1945-S	KIT,VLV,102CT ,NY,SS,M/S	\$0.0000	\$0.00
8	A-5994	WAFER SPR,102CT,NAC	\$0.0000	\$0.00
			Sub Total	\$0.00
VVCP, 9-1/8KC				
1	A-2125	STL GASKET,10.063 X 9.750 X 60	\$0.0000	\$0.00
			Sub Total	\$0.00
			Consumables Grand Total	\$0.00

Wed Jul 19 15:03:20 EDT 2006



ARIEL CORPORATION
Recommended Spares Insurance



F23790

C82051, C82052, C82053, C82054

U51912, U51913, U51914, U51915

Project:

QTY	Part Number	Description	Your Price	Net Amount
JGH-JGE-JGK-JGT FRAME CLASS				
12	B-0787	SLEEVE BEARING,BZ,X-HD,JGE:K:T	\$0.0000	\$0.00
4	FP0500FE	DOWEL PIN, 1/4 X 3/4 +.0002	\$0.0000	\$0.00
1	A-3884	ROLLER CHAIN,40-1 X114,JGH:E:K	\$0.0000	\$0.00
4	B-0772	SLEEVE BEARING,BZ,ROD,H:E:K:T	\$0.0000	\$0.00
8	B-2082	SLEEVE BRG,H/S,ROD,H:E:K:T	\$0.0000	\$0.00
1	A-3875	GSKT,RND,12-13/16, X 1/32	\$0.0000	\$0.00
2	B-0844	GSKT,RET,23-1/2X20-5/16X1/32	\$0.0000	\$0.00
1	C-4367	GSKT,RET,77-5/8 X20-3/8X1/32	\$0.0000	\$0.00
2	FP0512EF	THD.TAPER PIN,#4 X 1"LG	\$0.0000	\$0.00
2	FP0512FH	THD.TAPER PIN,#5 X 1-1/2LG	\$0.0000	\$0.00
2	FP0512FJ	THD.TAPER PIN,#5 X 2"LG	\$0.0000	\$0.00
1	A-0245-B	DUST SEAL,TFE,JGH:E:K:T,J/6	\$0.0000	\$0.00
2	B-0776	THRUST PLATE,BZ,JGH:E:K:T	\$0.0000	\$0.00
8	B-0770	SLEEVE BRG,H/S,MAIN,H:E:K:T	\$0.0000	\$0.00
1	A-3869	12 PT, 1/2-20 X 10 G8	\$0.0000	\$0.00
4	FN0461GA	SELF-LOCK NUT,ESNA,1/2-20	\$0.0000	\$0.00
1	B-0773	CROSSHEAD PIN,JGH:E:K:T	\$0.0000	\$0.00
2	A-3507	O-RING,VT, 2.012 O.D. X .139	\$0.0000	\$0.00
3	A-3508	O-RING,VT, 2.762 O.D. X .139	\$0.0000	\$0.00
12	A-3512	O-RING,VT, 1.318 O.D. X .103	\$0.0000	\$0.00
1	A-3763	CHK VLV,1/8MX1/8F,SS,PPT/14PSI	\$0.0000	\$0.00
1	A-5375	GSKT,RND,2-1/4,X 1/32,INNER	\$0.0000	\$0.00
1	A-5376	GSKT,RND,2-1/4 X 1/8,OUTER	\$0.0000	\$0.00
1	A-5374	SIGHT GLASS,2-1/4"LENS	\$0.0000	\$0.00
1	A-0745	O-RING,VT, 2.756 O.D. X .103	\$0.0000	\$0.00
1	A-9870	O-RING,VT, 2.250 O.D. X .063	\$0.0000	\$0.00
4	A-2688	O-RING,VT,10.145 O.D. X .210	\$0.0000	\$0.00
8	A-4905	O-RING,VT, 3.637 O.D. X .139	\$0.0000	\$0.00
1	A-5641	SIGHT GLASS,3/4" NPT	\$0.0000	\$0.00
2	A-9478	FF LUBR PUMP 3/8 PREMIER	\$0.0000	\$0.00

1	A-0261	L.O.PSI GAUGE,ASHCROFT,1/4 NPT	\$0.0000	\$0.00
1	A-8727	GAUGE, 3000 PSI, BACK MOUNT	\$0.0000	\$0.00
2	A-10754	FF.S/D, DNFT, PS, TRAB, DC PRG	\$0.0000	\$0.00
1	A-10585-SS	9T-9T-9T-9T-6T SF	Call Ariel	Call Ariel
1	A-10955-SS	9T-9T-6T-6T-6T SF	\$0.0000	\$0.00
			Sub Total	\$0.00

CYL ASSY, 5-7/8K:T,HES,SF 2050

1	B-3549	GSKT,RND,22-1/2 X 1/64,18 HOLE	\$0.0000	\$0.00
1	B-2186	PISTON COLLAR,SS,K:K-HP&22.5H	\$0.0000	\$0.00
1	B-1221	PISTON NUT, JGK:T, 3.5"OD	\$0.0000	\$0.00
1	C-1473	P ROD,SS,5.50STK/51.440LG	\$0.0000	\$0.00
2	A-0145	THUMB SCREW,NYLON,1/4-20 X 3/4	\$0.0000	\$0.00
8	A-2126	STL GASKET, 4.861 X 4.543 X 30	\$0.0000	\$0.00
6	A-2336	O-RING,VT, 4.887 O.D. X .139	\$0.0000	\$0.00
2	B-3325-CC	DIS VLV,102CT ,SS,MT,M/S	\$0.0000	\$0.00
2	B-1945-T	SUC VLV,102CT ,NY,SS,M/S	\$0.0000	\$0.00
			Sub Total	\$0.00

VVCP, 5-7/8K:C:K-HP:T

1	A-2387	BELLOWS, UNL.THREAD PROTECTOR	\$0.0000	\$0.00
1	A-0028	O-RING,VT, 5.645 O.D. X .210	\$0.0000	\$0.00
1	A-0639	V PACKING, UNL	\$0.0000	\$0.00
1	A-2357	UNL.PISTON RING, 4-1/4 O.D.	\$0.0000	\$0.00
			Sub Total	\$0.00

CYL ASSY, 9-1/8K:T,SF,HES 1270

1	B-3549	GSKT,RND,22-1/2 X 1/64,18 HOLE	\$0.0000	\$0.00
1	FW0550ID	STAT-O-SEAL,VT,75DUR. 3/4 DIA	\$0.0000	\$0.00
1	B-2185	PISTON COLLAR,SS,K,4"OD	\$0.0000	\$0.00
1	B-1249	PISTON NUT, JGK:T, 4"OD	\$0.0000	\$0.00
1	C-1473	P ROD,SS,5.50STK/51.440LG	\$0.0000	\$0.00
16	A-0145	THUMB SCREW,NYLON,1/4-20 X 3/4	\$0.0000	\$0.00
24	A-2126	STL GASKET, 4.861 X 4.543 X 30	\$0.0000	\$0.00
16	A-2124	O-RING,VT, 4.895 O.D. X .210	\$0.0000	\$0.00
4	B-3325-BB	DIS VLV,102CT ,SS,MT,M/S	\$0.0000	\$0.00
4	B-1945-S	SUC VLV,102CT ,NY,SS,M/S	\$0.0000	\$0.00
			Sub Total	\$0.00

VVCP, 9-1/8KC

1	A-2394	BELLOWS, UNL.THREAD PROTECTOR	\$0.0000	\$0.00
1	A-0473	O-RING,VT, 9.145 O.D. X .210	\$0.0000	\$0.00
1	A-2399	V PACKING, UNL. 2-3/4 X 3-1/2	\$0.0000	\$0.00
1	A-0477	UNL.PISTON RING, 7-1/2 O.D.	\$0.0000	\$0.00
			Sub Total	\$0.00

CYL ASSY, 5-7/8K:T,HES,SF 2050

1	B-3549	GSKT,RND,22-1/2 X 1/64,18 HOLE	\$0.0000	\$0.00
1	B-2186	PISTON COLLAR,SS,K:K-HP&22.5H	\$0.0000	\$0.00
1	B-1221	PISTON NUT, JGK:T, 3.5"OD	\$0.0000	\$0.00
1	C-1473	P ROD,SS,5.50STK/51.440LG	\$0.0000	\$0.00
2	A-0145	THUMB SCREW,NYLON,1/4-20 X 3/4	\$0.0000	\$0.00
8	A-2126	STL GASKET, 4.861 X 4.543 X 30	\$0.0000	\$0.00
6	A-2336	O-RING,VT, 4.887 O.D. X .139	\$0.0000	\$0.00
2	B-3325-CC	DIS VLV,102CT ,SS,MT,M/S	\$0.0000	\$0.00
2	B-1945-T	SUC VLV,102CT ,NY,SS,M/S	\$0.0000	\$0.00

Sub Total	\$0.00
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VVCP, 5-7/8K:C:K-HP:T

1	A-2387	BELLOWS, UNL.THREAD PROTECTOR	\$0.0000	\$0.00
1	A-0028	O-RING,VT, 5.645 O.D. X .210	\$0.0000	\$0.00
1	A-0639	V PACKING, UNL	\$0.0000	\$0.00
1	A-2357	UNL.PISTON RING, 4-1/4 O.D.	\$0.0000	\$0.00

Sub Total	\$0.00
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CYL ASSY, 9-1/8K:T,SF,HES 1270

1	B-3549	GSKT,RND,22-1/2 X 1/64,18 HOLE	\$0.0000	\$0.00
1	FW0550ID	STAT-O-SEAL,VT,75DUR. 3/4 DIA	\$0.0000	\$0.00
1	B-2185	PISTON COLLAR,SS,K,4"OD	\$0.0000	\$0.00
1	B-1249	PISTON NUT, JGK:T, 4"OD	\$0.0000	\$0.00
1	C-1473	P ROD,SS,5.50STK/51.440LG	\$0.0000	\$0.00
8	A-0145	THUMB SCREW,NYLON,1/4-20 X 3/4	\$0.0000	\$0.00
12	A-2126	STL GASKET, 4.861 X 4.543 X 30	\$0.0000	\$0.00
10	A-2124	O-RING,VT, 4.895 O.D. X .210	\$0.0000	\$0.00
4	B-3325-BB	DIS VLV,102CT ,SS,MT,M/S	\$0.0000	\$0.00
4	B-1945-S	SUC VLV,102CT ,NY,SS,M/S	\$0.0000	\$0.00

Sub Total	\$0.00
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VVCP, 9-1/8KC

1	A-2394	BELLOWS, UNL.THREAD PROTECTOR	\$0.0000	\$0.00
1	A-0473	O-RING,VT, 9.145 O.D. X .210	\$0.0000	\$0.00
1	A-2399	V PACKING, UNL. 2-3/4 X 3-1/2	\$0.0000	\$0.00
1	A-0477	UNL.PISTON RING, 7-1/2 O.D.	\$0.0000	\$0.00

Sub Total	\$0.00
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Insurance Grand Total	\$0.00
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All amounts are in US dollars and price is subject to change at any time.



COMPRESSOR BALANCING RECORD

BALANCE BY: JIM FROST

DATE COMPLETED: 07/19/2006

FRAME: JGK/4

FRAME SERIAL NO. F23790

STROKE: 05.500

	THROW # 1		THROW # 2		THROW # 3		THROW # 4		THROW # 5		THROW # 6	
	P/N	LB	P/N	LB	P/N	LB	P/N	LB	P/N	LB	P/N	LB
PARTS GROUP 3	SN: C82051		SN: C82052		SN: C82053		SN: C82054		SN:		SN:	
	BORE: 05.875 K		BORE: 09.125 K		BORE: 05.875 K		BORE: 09.125 K		BORE:		BORE:	
	SN:		SN:		SN:		SN:		SN:		SN:	
	BORE:		BORE:		BORE:		BORE:		BORE:		BORE:	
Connecting Rod with bushing, bolts and bearing shells	D-0973	90.50	D-0973	89.78	D-0973	90.72	D-0973	90.82		0.00		0.00
	C-1010	99.84	C-3176	165.60	C-1010	99.78	C-3176	165.78		0.00		0.00
	C-1473		C-1473		C-1473		C-1473					
	D-0870	134.02	D-0868	77.24	D-0870	133.86	D-0868	77.10		0.00		0.00
Crosshead with bushings 3	B-0783	18.06	B-0781	9.94	B-0783	18.12	B-0781	9.94		0.00		0.00
	342.42		342.56		342.48		343.64		0.00		0.00	
Total Weight LB mass	342.42		342.56		342.48		343.64		0.00		0.00	
Opposing Throws Difference LB mass	0.14						1.16				0.00	

4

* THESE FIELDS ONLY NEEDED WHEN CYLINDERS ARE TANDEM.
IF CYLINDERS ARE TANDEM, THEN THE "SN" AND "BORE" FIELDS ARE TO BE USED FOR C.E.

3 REV: 3 ECN:8015 ER-4.2
4 REV: 4 ECN:010288



Ariel Lubrication Sheet



Company: Enerflex Compression
 Order: 37099 Rev:3
 7.5.1.1 Case 42: 125 - 800 psig

Customer: EnCana Corporation
 P.O. #: 0520377
 Project: EnCana A1478, Big Horn Stock Unit

Frame: JGK/4 Stroke, in: 5.50 Rod Dia, in: 2.000 Frame S/N: F23790
 Gas Stream: Natural Gas (Water Saturated and H2S > 2% to 30%)
 Underlube limit: 90%
 Overlube limit: 125%

See Special Oil Recommendation Notice

Throw	Cylinder Model	MAWP psig	Service	Stage #	Suction psig	Discharge psig
1	5.875K	2050.0	Gathering	2	355.65	810.00
3	5.875K	2050.0	Gathering	2	355.65	810.00

Break-in operation cycle time, sec: **6** for period of 200 hours
 Normal operation cycle time, sec: **10** at max rated rpm
 Total delivered per day, pints: **21.5**
 Recommended mineral oil lubricant for application and pressures:
SAE 40 wt (ISO 150) w/ Compounding
 Best Premier pump(s): **One 3/8"** Recomm. base feed rate: 0.50 US pints/inch diameter/day
 Rupture Disc: 3250 psi Purple 0.250 in. hole diameter

Lube block
 Part No.: A-10955-SS

Lube Block Schematic - Page 1

Throw 1: Cylinder (5.875)	6T	Throw 1: Cylinder (5.875)
Throw 3: Cylinder (5.875)	6T	Throw 3: Cylinder (5.875)
Throw 3: Packing	9T	Throw 1: Packing
Throw 3: Lg 2 comp	6T	Throw 1: Lg 2 comp
Throw 3: Flushing	9T	Throw 1: Flushing

(Note: # indicates crossport.
 Block layout is recommendation only, however crossported divider valve must discharge to divider valve below)

Throw	Location	Base rate multiplier	Recomm. U.S. Pints per day	Deliv. U.S. Pints per day	Deliv./Recomm.	Cycle Time vs. RPM	
						RPM	seconds
1	Lg 2 comp	1.00	1.00	1.79	179%	1200	10.0
1	Flushing	1.00	2.00	2.69	135%	1100	10.9
1	Packing	1.25	2.50	2.69	108%	1000	12.0
1	Cylinder	1.25	1.84	1.79	98%	900	13.3
1	Cylinder	1.25	1.84	1.79	98%	800	15.0
3	Lg 2 comp	1.00	1.00	1.79	179%	700	17.1
3	Flushing	1.00	2.00	2.69	135%	600	20.0
3	Packing	1.25	2.50	2.69	108%		
3	Cylinder	1.25	1.84	1.79	98%		
3	Cylinder	1.25	1.84	1.79	98%		

****NOTE:** Ariel suggests that delivered/recommended amount for cylinders and packings be within 90 - 125%. These recommendations are general guidelines. If the lubricants or flow rates do not appear to work adequately, flow rates and/or lubricant types may need to be changed. Please contact the lubricant supplier for specific lubricant recommendations. See Section 6.0 of the Ariel Packager Standards for more information.



Ariel Lubrication Sheet

Company: Enerflex Compression
 Order: 37099 Rev:3
 Case 42: 125 - 800 psig

Customer: EnCana Corporation
 P.O. #: 0520377
 Project: EnCana A1478, Big Horn Stock Unit



Frame: JGK/4 **Stroke, in:** 5.50 **Rod Dia, in:** 2.000 **Frame S/N:** F23790
Gas Stream: Natural Gas (Water Saturated and H2S > 2% to 30%)
Underlube limit: 90%
Overlube limit: 125%

See Special Oil Recommendation Notice

Throw	Cylinder Model	MAWP psig	Service	Stage #	Suction psig	Discharge psig
2	9.125K	1270.0	Gathering	1	125.00	362.36
4	9.125K	1270.0	Gathering	1	125.00	362.36

Break-in operation cycle time, sec: **6** for period of 200 hours
 Normal operation cycle time, sec: **10** at max rated rpm
 Total delivered per day, pints: **25.1**
 Recommended mineral oil lubricant for application and pressures:
SAE 40 wt (ISO 150) w/ Compounding
 Best Premier pump(s): **One 3/8"** Recomm. base feed rate: 0.50 US pints/inch diameter/day
 Rupture Disc: 3250 psi Purple 0.250 in. hole diameter

Lube block
 Part No.: A-10585-SS

Lube Block Schematic - Page 2

Throw 4: Cylinder (9.125)	9T	Throw 4: Cylinder (9.125)
Throw 2: Cylinder (9.125)	9T	Throw 2: Cylinder (9.125)
Throw 2: Packing	9T	Throw 4: Packing
Throw 2: Lg 2 comp	6T	Throw 4: Lg 2 comp
Throw 2: Flushing	9T	Throw 4: Flushing

(Note: # indicates crossport.
 Block layout is recommendation only, however crossported divider valve must discharge to divider valve below)

Throw	Location	Base rate multiplier	Recomm. U.S. Pints per day	Deliv. U.S. Pints per day	Deliv./Recomm.	Cycle Time vs. RPM	
						RPM	seconds
4	Lg 2 comp	1.00	1.00	1.79	179%	1200	10.0
4	Flushing	1.00	2.00	2.69	135%	1100	10.9
4	Packing	1.25	2.50	2.69	108%	1000	12.0
4	Cylinder	1.25	2.85	2.69	94%	900	13.3
4	Cylinder	1.25	2.85	2.69	94%	800	15.0
2	Lg 2 comp	1.00	1.00	1.79	179%	700	17.1
2	Flushing	1.00	2.00	2.69	135%	600	20.0
2	Packing	1.25	2.50	2.69	108%		
2	Cylinder	1.25	2.85	2.69	94%		
2	Cylinder	1.25	2.85	2.69	94%		

****NOTE:** Ariel suggests that delivered/recommended amount for cylinders and packings be within 90 - 125%. These recommendations are general guidelines. If the lubricants or flow rates do not appear to work adequately, flow rates and/or lubricant types may need to be changed. Please contact the lubricant supplier for specific lubricant recommendations. See Section 6.0 of the Ariel Packager Standards for more information.

6/29/06

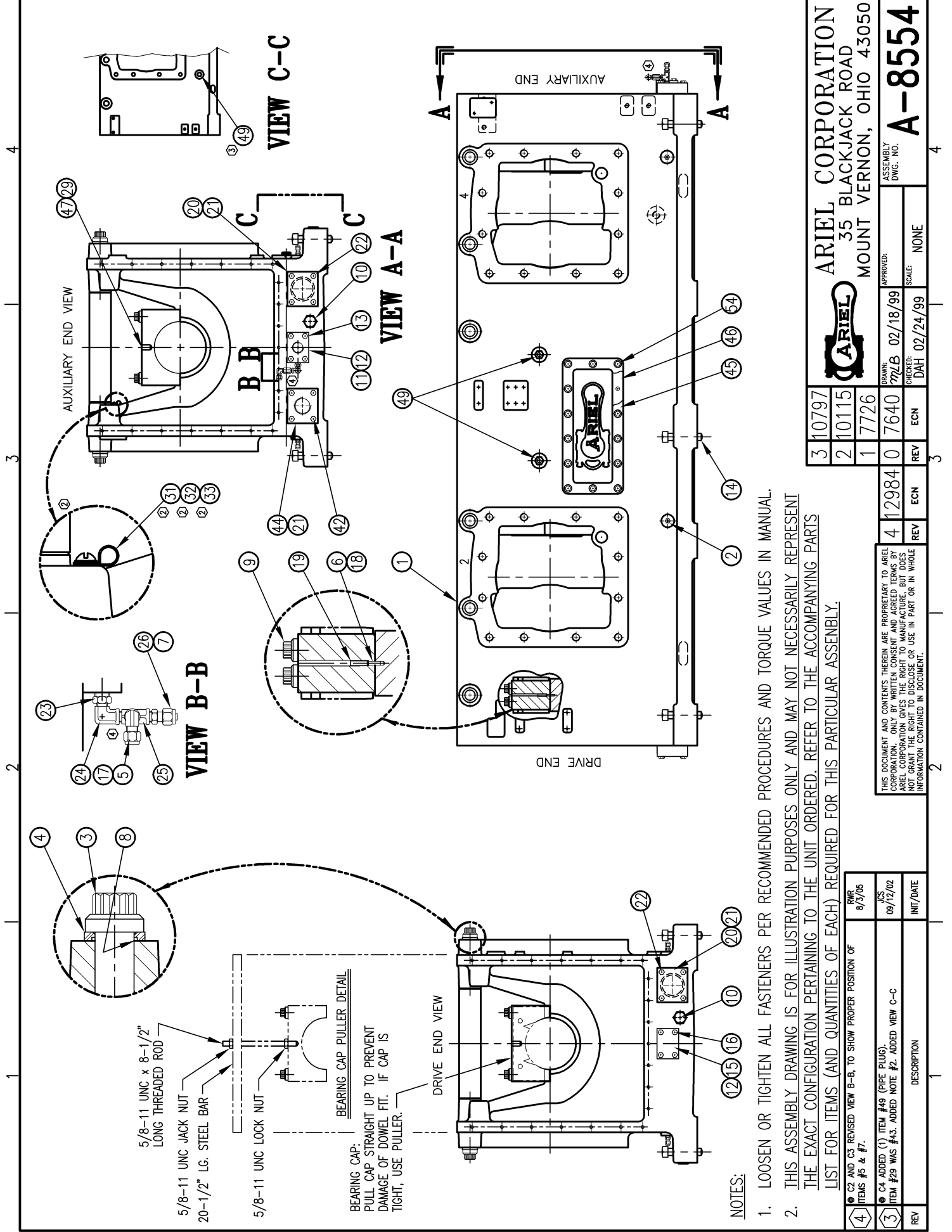
ARIEL CORP. - BLACKJACK DIV. C/N: 001
SALES ORDER COVER SHEET

RHCOVP02

SERIAL NUMBER: F-23790

PART: JGH:E:K CLASS DESCRIPTION: JGH-JGE-JGK-JGT FRAME CLASS

PART NUMBER	QUANTITY	DESCRIPTION	DRAWING NO.
A-10585-SS	1	9T-9T-9T-9T-6T SF	N.A.
A-10955-SS	1	9T-9T-6T-6T-6T SF	N.A.
B-0781	2	CROSSHEAD NUT,10.0#,RND, H:E:K	B-0781
D-0868	2	CROSSHEAD,LGT,DI, 74.9#,E:K:T	D-0868
D-0870	2	CROSSHEAD,MED,DI,131.8#,E:K:T	D-0870
G-14167	1	FRAME ASSY,JGH:E:K:T/4,SF	A-8554
G-1522	1	CRANKSHAFT ASSY,JGK/4,STD	A-11864
G-7661	4	GUIDE ASSY,K:T,L2,PU,SF	A-6847
G-2658	4	SUPPORT,GUIDE,CROSSHEAD,JGK:T	A-3621
G-5118	4	CONN ROD ASSY,FS,E:K:T,NEW BRG	A-3093
G-1322	4	X-HEAD ASSY,JGK:E:T,STD	A-6871
G-0978	1	DRIVE END COVER,JGH:E:K:T/2:4	A-6330
G-2360	1	AUX.END COVER ASSY,HEKT/4 SF	A-6328
G-0986	1	LO LEVEL GLASS,J6>,STD	A-4068
G-1721	1	LO PUMP ASSY,JGH:E:K:T/4,SF	A-8599
G-3589	1	FF LUBR,3/8,3/8,HEKT2/4,SF	D-1107
G-5299	1	DST.BLK.MTG.SINGL,JKCBR/4:6	N.A.
G-2708	2	RUPTURE DISC ASSY, 3250 PSI	N.A.
G-2205	4	FLUSHING OIL HDWR,ANY CYL.,SF	N.A.
G-2860	1	FF TUBING,JGK:T:C:D/4,SF	N.A.
G-7982	1	CHAIN ASSY,HEKT/2:4 STD OR R/R	A-9639
G-1073	1	TOP COVER ASSY,JGH:E:K:T/4	A-7072
G-7626	2	FF GAGE,3000PSI/BLK,SF	A-9020
G-4830	2	FF S/D,DIGITAL NO FLOW,DC,PRG	A-6423
G-8631	1	TOOL KIT ASSY, JGH:E:K:T	N.A.



NOTES:

1. LOOSEN OR TIGHTEN ALL FASTENERS PER RECOMMENDED PROCEDURES AND TORQUE VALUES IN MANUAL.
2. THIS ASSEMBLY DRAWING IS FOR ILLUSTRATION PURPOSES ONLY AND MAY NOT NECESSARILY REPRESENT THE EXACT CONFIGURATION PERTAINING TO THE UNIT ORDERED. REFER TO THE ACCOMPANYING PARTS LIST FOR ITEMS (AND QUANTITIES OF EACH) REQUIRED FOR THIS PARTICULAR ASSEMBLY.

4	C2 AND C3 REVISED VIEW B-B, TO SHOW PROPER POSITION OF ITEMS #5 & #7.	RWR 8/3/05
3	C4 ADDED (1) ITEM #49 (PIPE PLUG). ITEM #29 WAS #43. ADDED NOTE #2. ADDED VIEW C-C	JCS 09/12/02
REV	DESCRIPTION	INIT/DATE

3	10797	REV	ECN	3
2	10115	REV	ECN	4
1	7726	REV	ECN	12984
0	7640	REV	ECN	4

3	10797	REV	ECN	3
2	10115	REV	ECN	4
1	7726	REV	ECN	12984
0	7640	REV	ECN	4

ARIEL CORPORATION
 35 BLACKJACK ROAD
 MOUNT VERNON, OHIO 43050

ARIEL

DRAWN: 7726 02/18/99
 APPROVED:
 CHECKED: DAH 02/24/99
 SCALE: NONE

ASSEMBLY DWG. NO. **A-8554**

6/29/06

PARTS LIST

FRAME, SPACER BARS AND MAIN BEARING CAPS PART NO. G-14167
STAINLESS STEEL TUBING AND FITTINGS. REF DRAWING A-8554
JGH/4, JGE/4, JGK/4 AND JGT/4

ITEM NUMBER	PART NUMBER	QUANTITY	DESCRIPTION
1	D-4447	1	FRAME,JGH:E:K/4
2	A-0938	4	MALE CONN,SS, 1/4T X 1/4P
3	FC0125LY	12	12 PT,1-1/8-12 X 7 G8
4	A-3887	12	WASHER,SPACER BAR,FRAME/GUIDE
5	A-3763	1	CHK VLV,1/8MX1/8F,SS,PPT/14PSI
6	FP0500FE	0	DOWEL PIN, 1/4 X 3/4 +.0002
7	A-0948	1	PLUG-TUBE FIT,FEMALE,SS, 1/4T
8	A-3512	12	O-RING,VT, 1.318 O.D. X .103
9	FC0120JY	16	12 PT,7/8-9 X 7 G8
10	PP0810KE	2	PIPE PLUG,1 NPT,HEX HD,SS
11	A-3871	1	END PLT,OIL GALLERY,HEK/2/4/6
12	A-3507	2	O-RING,VT, 2.012 O.D. X .139
13	FC0102EL	4	HEX HD CAP,3/8-16 X 2-1/4 G5
14	FS0420JS	6	SQ.HD.SETSCREW,7/8-9X4 OVAL PT
15	A-3877	1	END PLT,H:E:K/2/4
16	FC0102EI	4	HEX HD CAP,3/8-16 X 1-1/2 G5
17	A-0812	1	MALE ELBOW,SS, 1/4T X 1/8P
18	FP0500GE	0	DOWEL PIN,5/16 X 3/4 +.0002
19	FS0400EG	0	CUP PT.SET-SCREW, 3/8-16 X 1
20	A-3876	2	END PLT,HTR MTG,H:E:K/2/4
21	A-3508	3	O-RING,VT, 2.762 O.D. X .139
22	FC0102EH	8	HEX HD CAP,3/8-16 X 1-1/4 G5
23	A-0824	1	HEX RED BUSH,SS, 1/4M X 1/8F

WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT
DOES NOT REPRESENT THE QUANTITY REQUIRED.

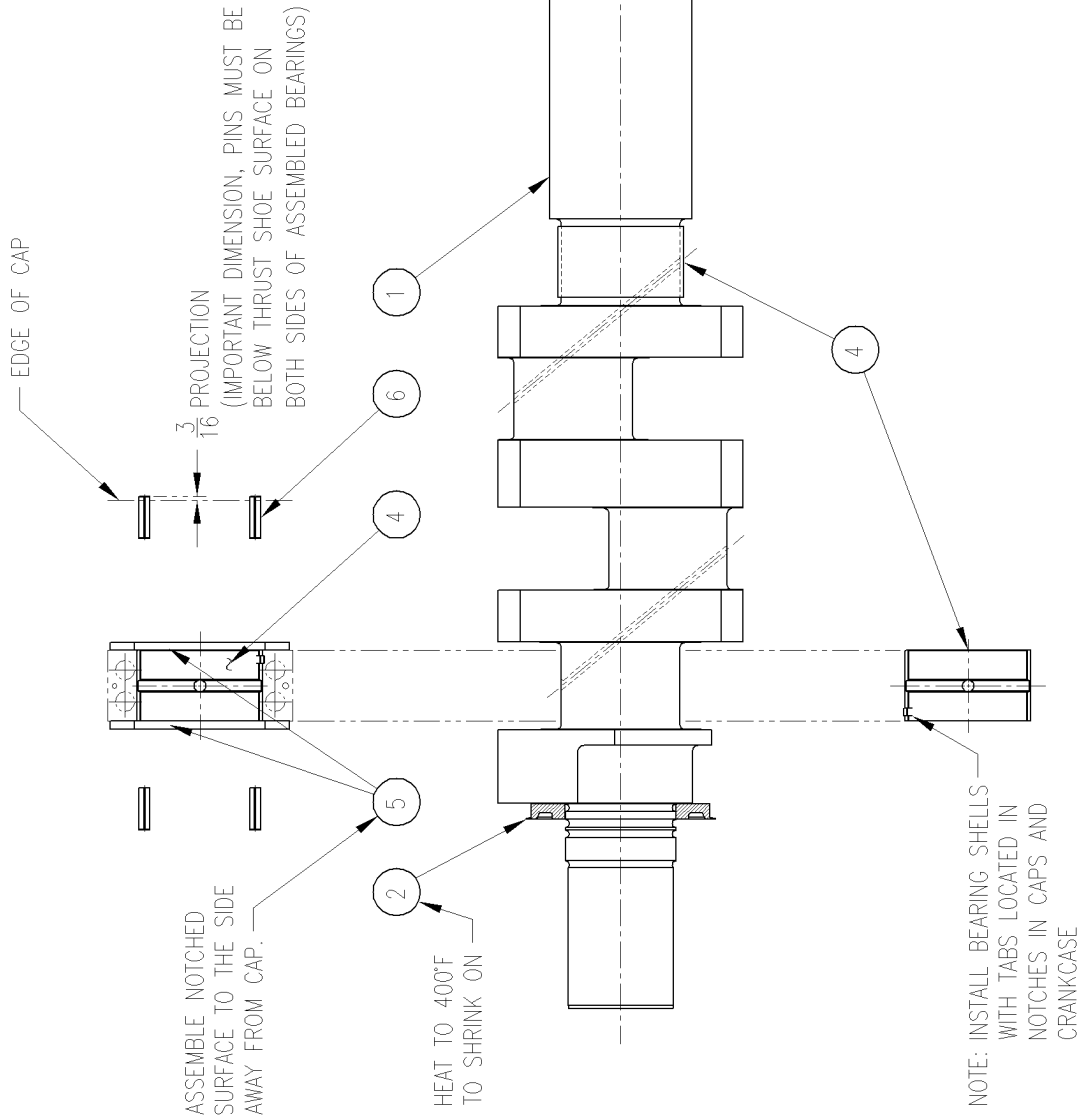
6/29/06

PARTS LIST

24	A-2193	1	STREET ELBOW,SS, 1/8P, 90
25	A-2245	1	STREET TEE,SS, 1/8P
26	A-0813	1	MALE CONN,SS, 1/4T X 1/8P
29	PP0810CE	4	PIPE PLUG,1/4NPT,HEX HD,SS
42	FC0102EJ	4	HEX HD CAP,3/8-16 X 1-3/4 G5
44	A-3929	1	THREADED FLG,RECT.H:E:K:T:C:D
45	C-0641	2	FRAME SIDE COVER,JGH:E:K
46	C-0642	2	GSKT,RET,15-5/8 X 7 X 1/32
47	FS0450HC	4	CUP PT.S-SCRW,NY, 5/8-11 X 1/2
49	PP0810GE	5	PIPE PLUG,1/2NPT,HEX HD,SS
54	A-10201	28	SEMS BOLT, 3/8-16 X 1-1/2

WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT
DOES NOT REPRESENT THE QUANTITY REQUIRED.

THIS ASSEMBLY DRAWING IS FOR ILLUSTRATION PURPOSES ONLY AND MAY NOT NECESSARILY REPRESENT THE EXACT ITEMS PERTAINING TO THE UNIT ORDERED. REFER TO PARTS LIST FOR ITEMS AND QUANTITIES OF EACH REQUIRED FOR YOUR PARTICULAR ASSEMBLY.



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REV	DESCRIPTION	INIT./DATE

REV	ECN	FCN
0	10200	

APPROVED:	DRAWN:	CHECKED:
	NEE 01/13/03	NEH 01/14/03

ASSEMBLY DWG. NO.	SCALE:
A-11864	NONE



ARIEL CORPORATION
 35 BLACKJACK ROAD
 MOUNT VERNON, OHIO 43050

REV	DESCRIPTION

6/29/06

PARTS LIST

CRANKSHAFT AND MAIN BEARINGS
JGK/4, 5-1/2" STROKE

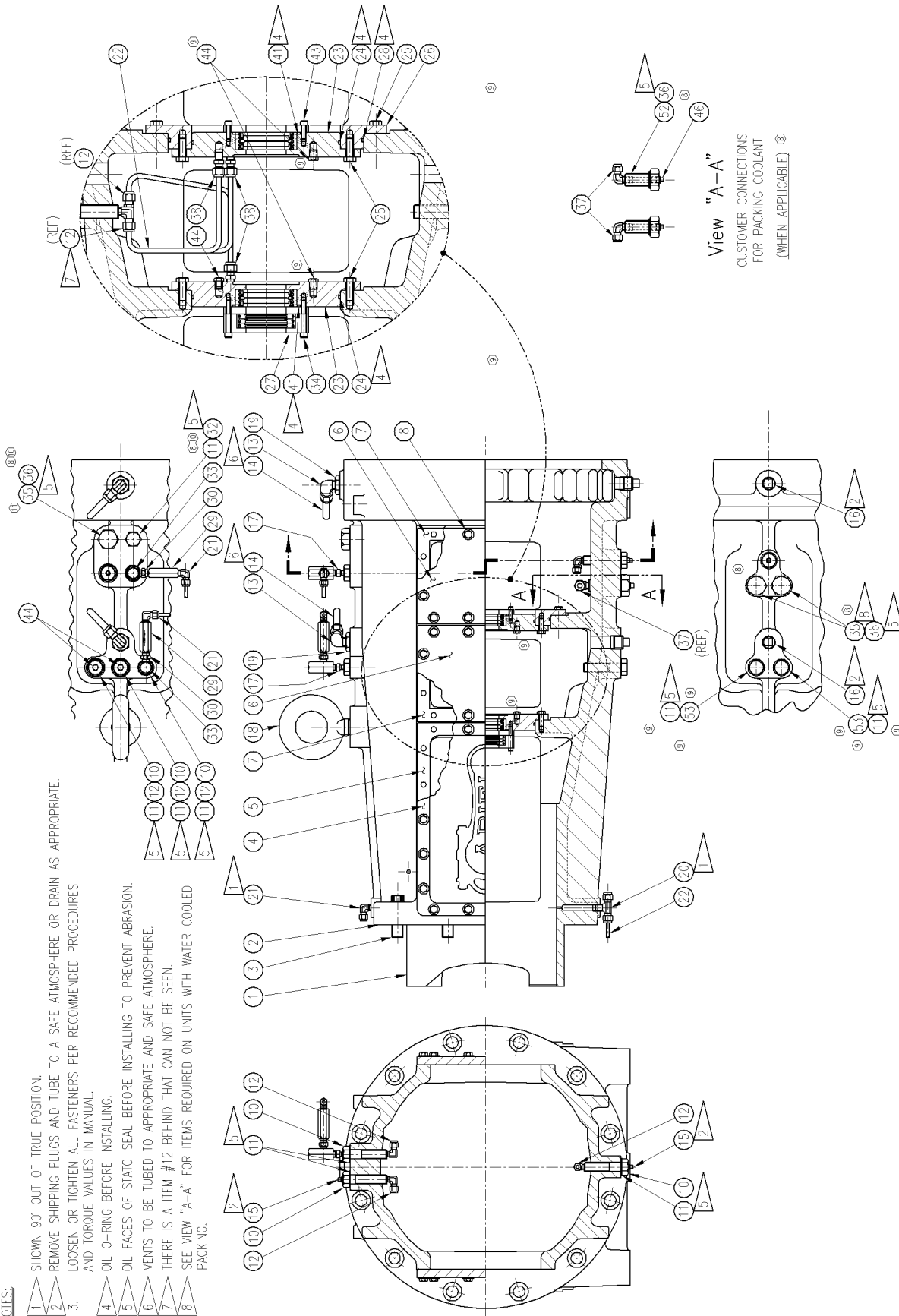
PART NO. G-1522
REF DRAWING A-11864

ITEM NUMBER	PART NUMBER	QUANTITY	DESCRIPTION
1	AD-0991	1	CRANK ASSY,FS,JGK/4
2	B-0778	0	OIL SLINGER,JGH:E:K & JGJ/6
3	A-3872	0	SPKT,RLR.CHAIN,CSHAFT,#40-24T
4	B-0770	8	SLEEVE BRG,H/S,MAIN,H:E:K:T
5	B-0776	2	THRUST PLATE,BZ,JGH:E:K:T
6	FP0505JK	4	ROLL PIN, 1/2 X 2

WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT
DOES NOT REPRESENT THE QUANTITY REQUIRED.

NOTES:

- 1 SHOWN 90° OUT OF TRUE POSITION.
- 2 REMOVE SHIPPING PLUGS AND TUBE TO A SAFE ATMOSPHERE OR DRAIN AS APPROPRIATE.
- 3 LOOSEN OR TIGHTEN ALL FASTENERS PER RECOMMENDED PROCEDURES AND TORQUE VALUES IN MANUAL.
- 4 OIL O-RING BEFORE INSTALLING.
- 5 OIL FACES OF STATO-SEAL BEFORE INSTALLING TO PREVENT ABRASION.
- 6 VENTS TO BE TUBED TO APPROPRIATE AND SAFE ATMOSPHERE.
- 7 THERE IS A ITEM #12 BEHIND THAT CAN NOT BE SEEN.
- 8 SEE VIEW "A-A" FOR ITEMS REQUIRED ON UNITS WITH WATER COOLED PACKING.



ARIEL CORPORATION
 35 BLACKJACK ROAD
 MOUNT VERNON, OHIO 43050



APPROVED: _____
 DRAWN: JJZ 04-11-97
 CHECKED: _____
 SCALE: NONE
 ASSEMBLY DWG. NO. **A-6847**

REV	DESCRIPTION	REV	ECN	REV	ECN	REV	ECN
11	ITEM #35 WAS ITEM #32 @C3.	7	8159	3	7704		
10	REVISED DRAWING. @ C3 VIEW SHOWING ITEMS 11, 32, 35, 36 WAS SHOWN IN REVERSE LOCATIONS.	6	8031	2	7261		
		5	8001	1	6933		
		4	7839	0	6818		

REV	DESCRIPTION	INIT/DATE
		NEE 04/21/2004
		MLB 12/19/03

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6/29/06

PARTS LIST

JGK:T CROSSHEAD GUIDE, STAINLESS STEEL
TUBING AND FITTINGS, LONG TWO
COMPARTMENT DISTANCE PIECE, PURGE
CONNECTION.

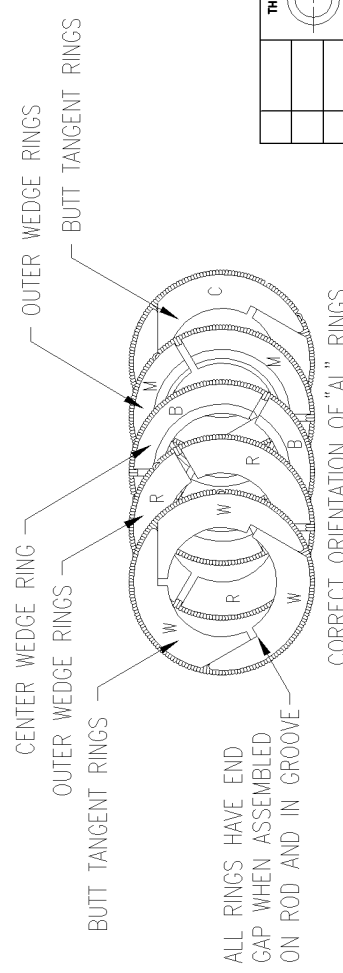
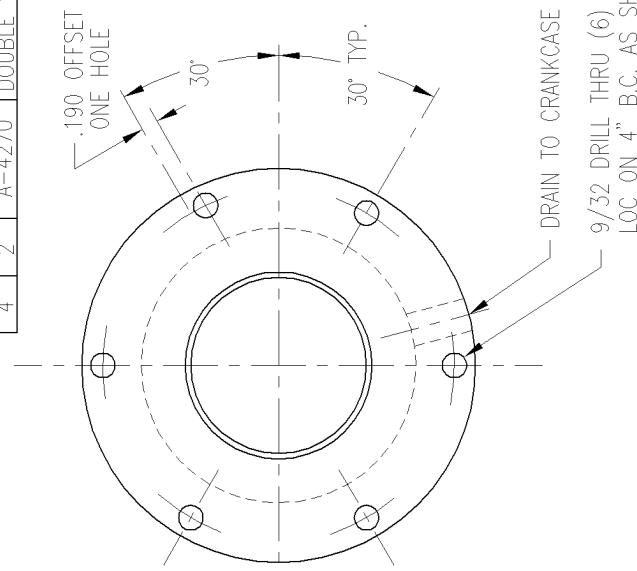
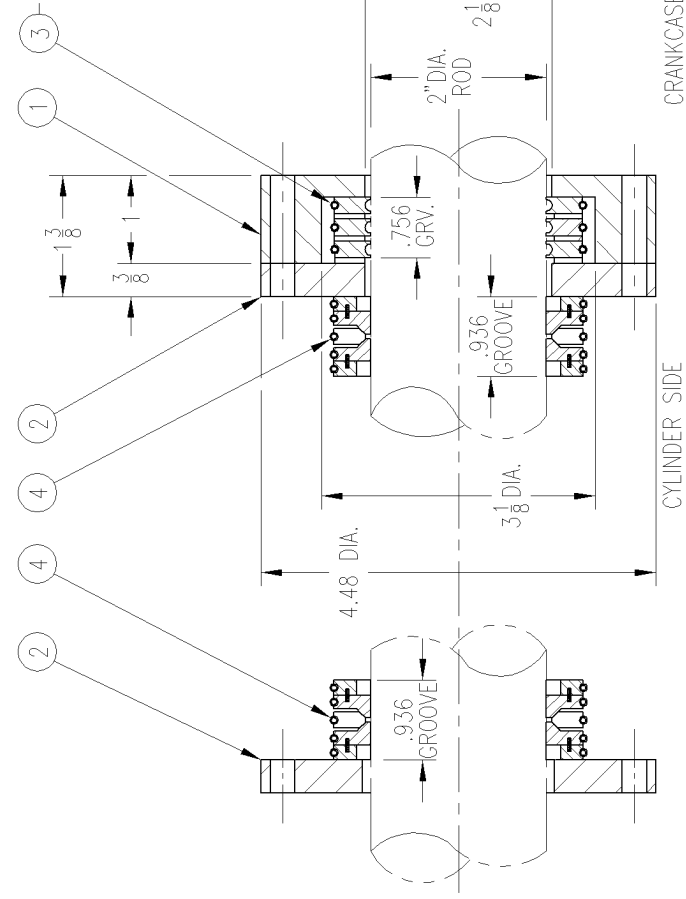
PART NO. G-7661
REF DRAWING A-6847

ITEM NUMBER	PART NUMBER	QUANTITY	DESCRIPTION
1	D-2926	1	X-HD GUIDE,L2,JGK
2	B-0835	1	GSKT,NST,17-3/4 X15-7/8X1/64
3	FC0120JO	12	12 PT, 7/8-9 X 3 G8
4	B-1834	2	GUIDE COVER,CAST,JGH:E:ET:K:T
5	B-0832	2	GSKT,RET,15-5/16X10-13/16X1/32
6	B-1858	4	GUIDE COVER,L2,CSTG,JGK
7	B-1805	4	GSKT,RET,10.813X7.5/8X1/32
8	A-6830	84	SEMS BOLT, 3/8-16 X 1-1/4
10	A-0158	6	LUBE FITTING, 3/4-10 X 3
11	FW0550IA	9	STAT-O-SEAL, 3/4 DIA., NITRILE
12	A-0812	6	MALE ELBOW,SS, 1/4T X 1/8P
13	A-6484	2	MALE ELBOW,SS, 3/4T X 3/4P
14	PT0201HD	12.	" TUBING,316 SS 3/4 OD X .065
15	PP0802RD	2	PIPE PLUG,1/8NPT,SQ HD,PLASTIC
16	PP0802ID	2	PIPE PLUG,3/4NPT,SQ HD,PLASTIC
17	A-8725	2	OMNI OIL TRAP,STEM,SS,1/8NPT
18	A-2206	1	EYEBOLT,1-1/2-6 UNC, SHORT
19	A-2188	2	HEX RED BUSH,SS,1M X 3/4F
20	A-0943	1	MALE BRANCH T,SS, 1/4T X 1/4P
21	A-0941	3	MALE ELBOW,SS, 1/4T X 1/4P
22	PT0201CD	90.	" TUBING,316 SS 1/4 OD X .065
23	B-1793	2	X-HD GUIDE,GLAND,JGH:E:K,PU

WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT
DOES NOT REPRESENT THE QUANTITY REQUIRED.

COMPONENT PART LIST				
ITEM	QUAN	PART NUMBER	DESCRIPTION	MAT'L
1	1	A-2525	WIPER CUP, 2"	C.I.
2	2	A-2540	PACKING PLATE, 2"	C.I.
3	1	A-2532	WIPER RINGS "3RWS"	C.I.
4	2	A-4270	DOUBLE SEAL RING "AL"	TFE

3- INSTALL WITH GROOVES FACING THE CYLINDER (FLAT SIDE TO CRANKCASE).



REV	DESCRIPTION
0	5433
REV	ECN

ARIEL CORPORATION
35 BLACKJACK ROAD
MOUNT VERNON, OHIO 43050

TITLE: ROD PACKING 2" LONG (2) COMPARTMENT OIL WIPER

DATE: 02/11/95
DRAWN: CJH
CHECKED: DB
APPROVED:

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******* DO NOT SCALE DRAWING *******

DIMENSIONS ARE IN INCHES UNLESS OTHERWISE SPECIFIED.

DIMENSIONING AND TOLERANCING PER ARIEL SPECIFICATION ER-17.0.1 UNLESS OTHERWISE SPECIFIED.

SEE COMPONENT PART LIST

SCALE: NONE

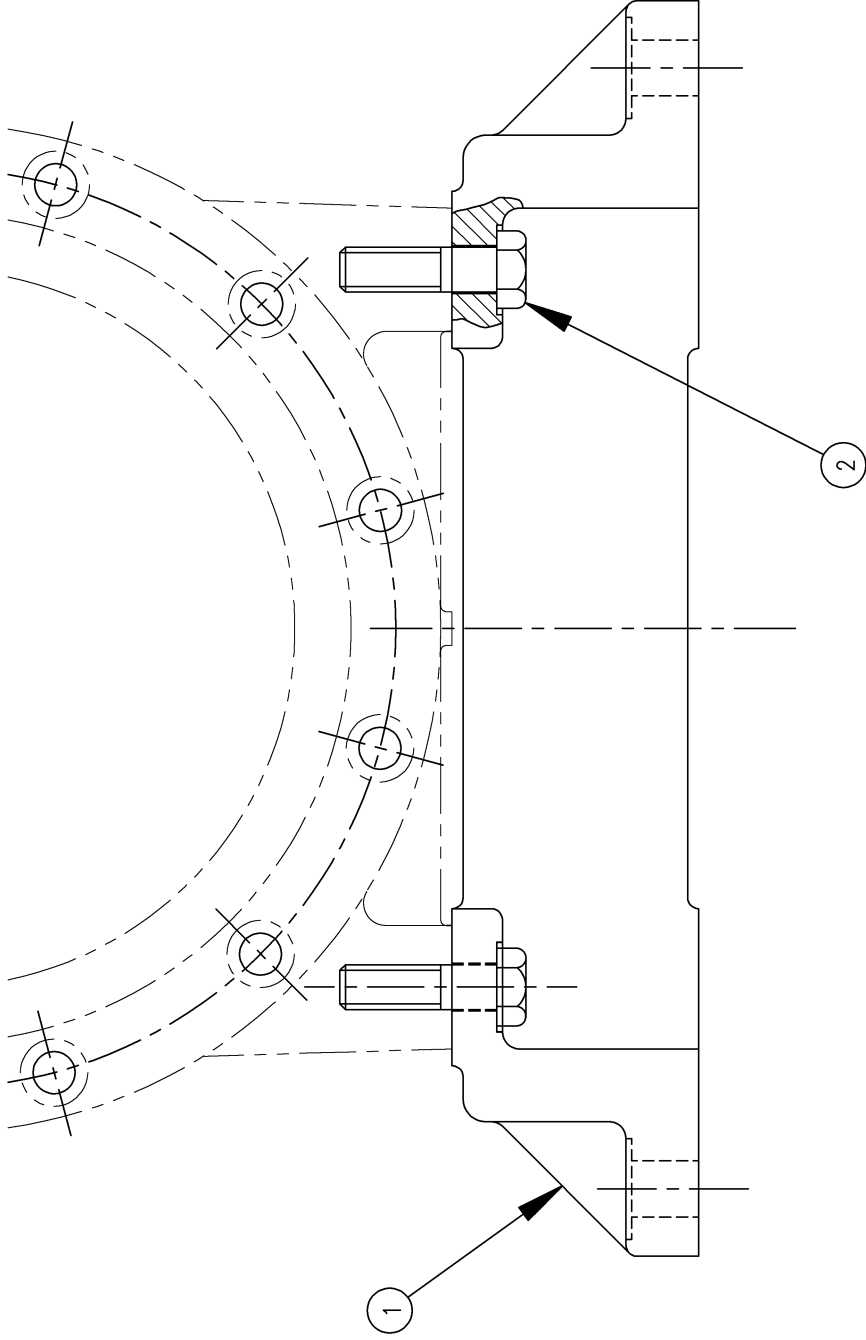
B-1806	COMPLETE PACKING REBUILD KIT	REV	ECN
B-1806-K	REBUILD KIT	0	5433
PART NUMBER	DESCRIPTION	REV	ECN

6/29/06

PARTS LIST

24	A-3509	2	O-RING,VT, 7.762 O.D. X .139	
25	FC0102EG	12	HEX HD CAP,3/8-16 X 1	G5
26	B-1807	1	X-HD GUIDE,GLND,ADPTR,L2,HEKT	
27	B-1806	1	PKG,2.0, OIL WIPER,AL,L2	
28	A-2688	1	O-RING,VT,10.145 O.D. X .210	
29	A-3780	2	CHK.VLV,DOU.BALL SOFT SEAT SS	
30	A-6058	2	HEX PIPE NIPPLE,SS,1/4 X 1/4	
32	FC0103IM	1	HEX HD CAP,3/4-10 X 2-1/2	G2
33	A-8724	2	OMNI OIL TRAP,BODY,SS,1/4NPTF	
34	FC0160CJ	6	SOC HD CAP,1/4-20 X 1-3/4	NY
35	FC0103KO	3	HEX HD CAP,1-8 X 3	G2
36	FW0550KA	3	STAT-O-SEAL, 1"DIA., BLACK	
38	A-0813	3	MALE CONN,SS, 1/4T X 1/8P	
41	A-4905	2	O-RING,VT, 3.637 O.D. X .139	
43	FC0160CE	6	SOC HD CAP,1/4-20 X 3/4	NY
44	PP0810RE	5	PIPE PLUG,1/8NPT,HEX HD,SS	
53	FC0103IO	2	HEX HD CAP,3/4-10 X 3	G2

WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT
DOES NOT REPRESENT THE QUANTITY REQUIRED.



014614

ARIEL CORPORATION
35 BLACKJACK ROAD
MOUNT VERNON, OHIO 43050

ASSEMBLY
DWG. No. **A-3621**

6/29/06

PARTS LIST

CROSSHEAD GUIDE SUPPORT
JGK AND JGT

PART NO. G-2658
REF DRAWING A-3621

ITEM NUMBER	PART NUMBER	QUANTITY	DESCRIPTION
1	D-1523	1	X-HD GUIDE,SUPPORT,JGK:T
2	FC0100KQ	2	HEX HD CAP,1-8 X 3-1/2 G9

WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT
DOES NOT REPRESENT THE QUANTITY REQUIRED.

NOTES:

- 1.- LOOSEN OR TIGHTEN ALL FASTENERS PER RECOMMENDED PROCEDURES AND TORQUE VALUES IN MANUAL.
- 2.- PRESS BRONZE BUSHING IN WHILE MAINTAINING ALIGNMENT OF OIL HOLE TO OIL PASSAGE IN ROD.
- 3.- INSTALL BEARING SHELLS WITH TABS LOCATED IN NOTCHES IN ROD AND ROD CAP.
- ④ 4.- PRE-TORQUE ROD BOLTS PER ER-63 (TOOL BOX TORQUE CHART) USING CRISSCROSS PATTERN. THEN TURN EACH BOLT PER ER-63 USING TURN INDICATOR TOOL ITEM 6 AS SHOWN BELOW.
- ⑤ 5.- THIS ASSEMBLY DRAWING IS FOR ILLUSTRATION PURPOSES ONLY, AND MAY NOT NECESSARILY REPRESENT THE EXACT CONFIGURATION PERTAINING TO THE UNIT ORDERED. REFER TO ACCOMPANYING PARTS LIST FOR ITEMS (AND QUANTITIES OF EACH) REQUIRED FOR THIS PARTICULAR ASSEMBLY.

START WITH FIRST LEVEL VIAL FACING UP WITH THE BUBBLE CENTERED. TIGHTEN THUMB
 ② SCREW/SETScrew ONTO SOCKET AND TURN BOLT WITH SOCKET AS SPECIFIED IN ER-63
 UNTIL SECOND VIAL IS VERTICAL AND BUBBLE IS CENTERED.

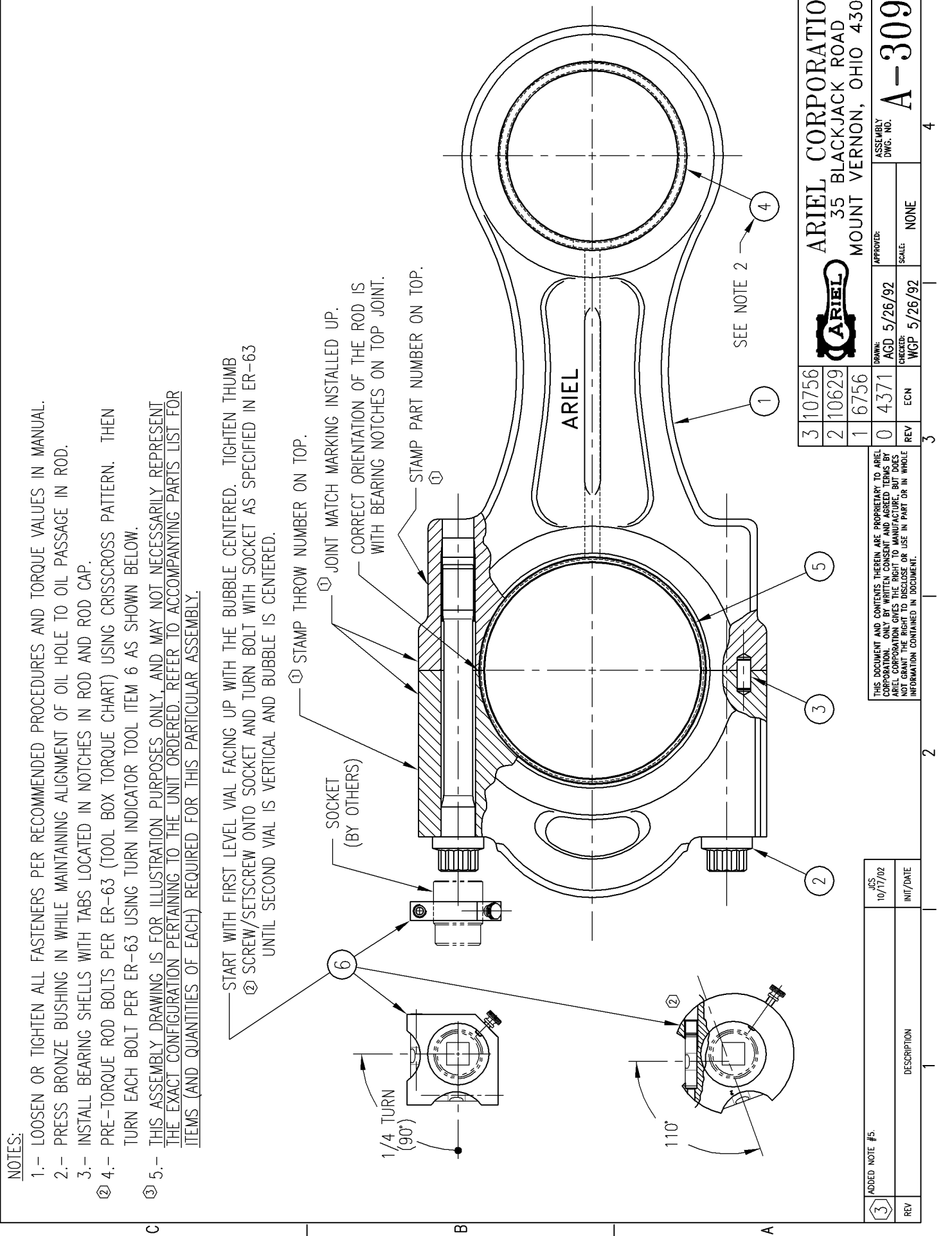
① STAMP THROW NUMBER ON TOP.

SOCKET
 (BY OTHERS)

① JOINT MATCH MARKING INSTALLED UP.

CORRECT ORIENTATION OF THE ROD IS
 WITH BEARING NOTCHES ON TOP JOINT.

① STAMP PART NUMBER ON TOP.



3	10756									 ARIEL CORPORATION 35 BLACKJACK ROAD MOUNT VERNON, OHIO 43050	APPROVED: DRAWN: AGD 5/26/92 CHECKED: WGP 5/26/92 SCALE: NONE	ASSEMBLY DWG. NO. A-3093
2	10629											
1	6756											
0	4371											
REV	ECN											

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3	ADDED NOTE #5.	10/17/02
REV	DESCRIPTION	INIT/DATE

6/29/06

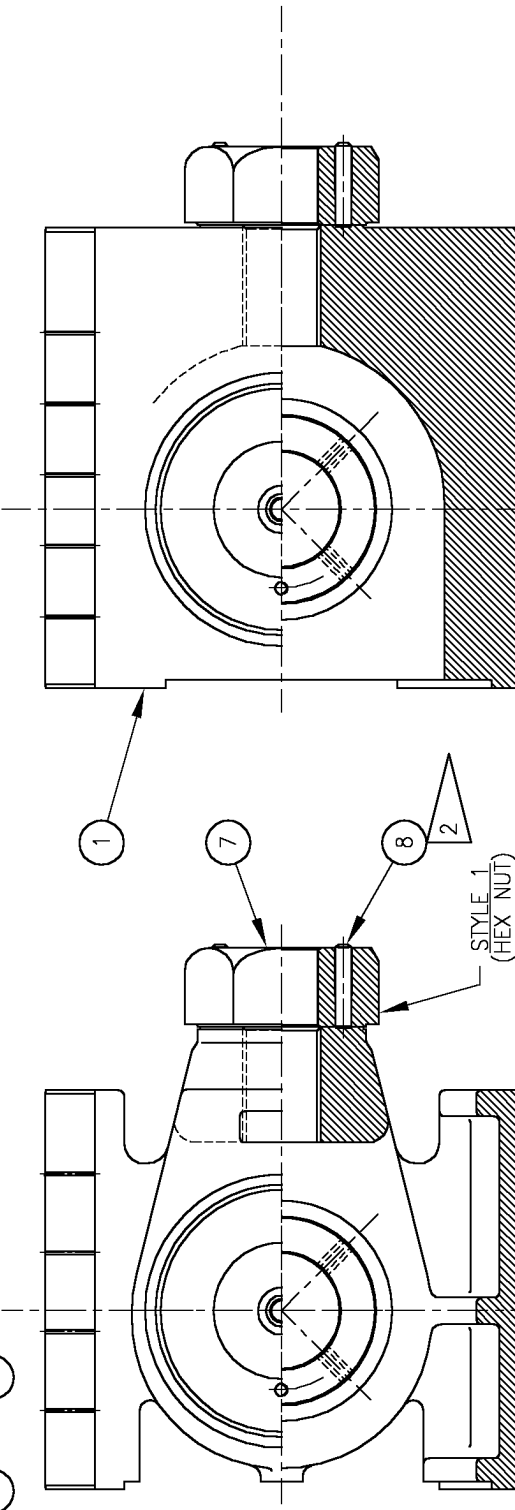
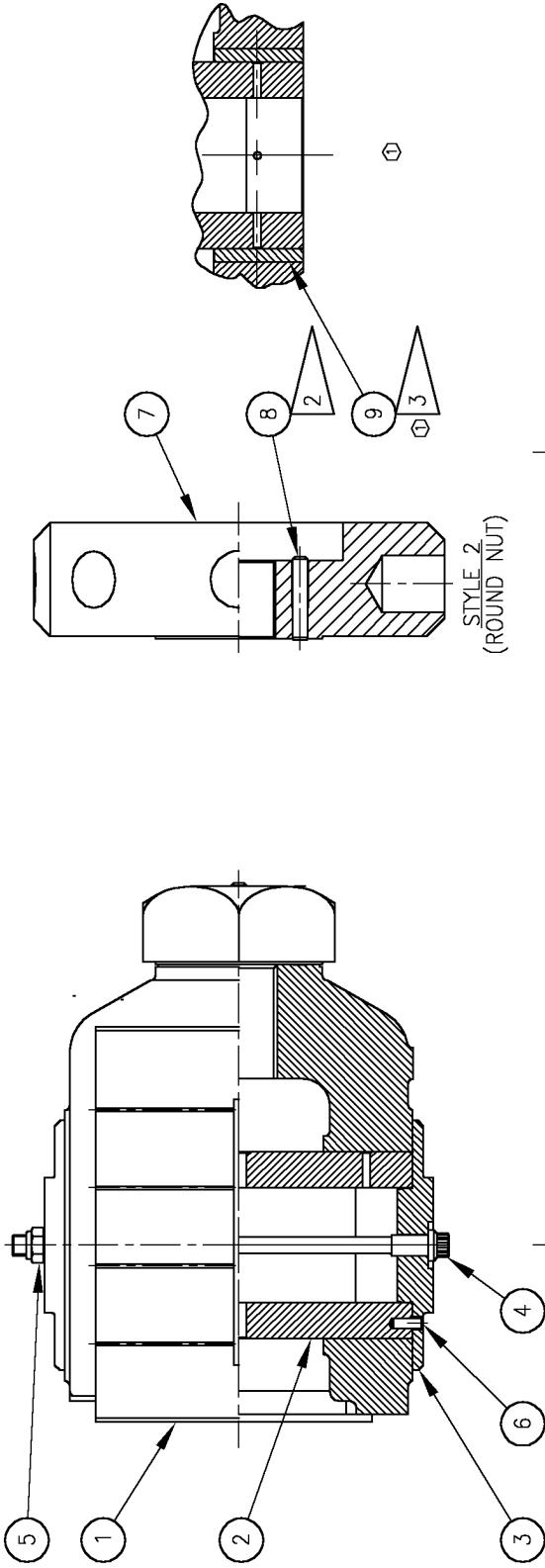
PARTS LIST

CONNECTING ROD, FORGED STEEL
JGE, JGK & JGT, NEW STYLE BEARING H/S.

PART NO. G-5118
REF DRAWING A-3093

ITEM NUMBER	PART NUMBER	QUANTITY	DESCRIPTION
1	AD-0973	1	CONN ROD ASSY,FS,JGE:K:T
2	A-3941	0	12 PT, 1-14 X 7-1/4 G8
3	FP0500GG	0	DOWEL PIN,5/16 X 1" +.0002
4	B-0772	0	SLEEVE BEARING,BZ,ROD,H:E:K:T
5	B-2082	2	SLEEVE BRG,H/S,ROD,H:E:K:T
6	B-1495	0	TURN INDICATOR,JGH:E:K:T

WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT
DOES NOT REPRESENT THE QUANTITY REQUIRED.



STYLE 2 CROSSHEAD

STYLE 1 CROSSHEAD

NOTES:

1. LOOSEN OR TIGHTEN ALL FASTENERS PER RECOMMENDED PROCEDURES AND TORQUE VALUES IN MANUAL.
2. LOOSEN TWO SET SCREWS (ITEM #8) BEFORE REMOVING CROSSHEAD NUT (ITEM #7). SET SCREWS ARE TO BE SCREWED IN AND TIGHTENED (TO LOCK) ONLY AFTER CROSSHEAD NUT (ITEM #7) HAS BEEN TORQUED TO SPECIFICATIONS
3. MAY NOT APPLY TO ALL CROSSHEADS

REMOVED NOTE VIEW TYP. OF JGE AND JGK. ADDED NOTE #3 MAY NOT APPLY TO ALL CROSSHEADS.

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ARIEL CORPORATION
 35 BLACKJACK ROAD
 MOUNT VERNON, OHIO 43050



REV	ECN	SCALE	APPROVED:	ASSEMBLY DWG. NO.
0	6859	04/18/97	DJB	A-6871
1	8001	04/24/97		

REV	DESCRIPTION

6/29/06

PARTS LIST

CROSSHEAD, PIN AND BALANCE NUT
JGE, JGK & JGT

PART NO. G-1322
REF DRAWING A-6871

ITEM NUMBER	PART NUMBER	QUANTITY	DESCRIPTION
1	CROSSHEAD	0	FOR PART NO. SEE COVER SHEET
1	D-0868	0	CROSSHEAD,LGT,DI, 74.9#,E:K:T
1	D-0869	0	CROSSHEAD,MED,DI,105.2#,E:K:T
1	D-0870	0	CROSSHEAD,MED,DI,131.8#,E:K:T
1	D-0871	0	CROSSHEAD,HVY,DI,153.3#,E:K:T
1	D-0949	0	CROSSHEAD,XHV,BZ,189.4#,H:E:K
1	D-0995	0	CROSSHEAD,BAL,CI,198.0#JGH:E:K
1	D-0996	0	CROSSHEAD,BAL,CI,237.0#JGH:E:K
1	D-0997	0	CROSSHEAD,BAL,CI,276.0#JGH:E:K
1	D-0998	0	CROSSHEAD,BAL,CI,336.0#JGH:E:K
1	D-2299	0	CROSSHEAD,BAL,CI,426.0#,HEK
1	D-3277	0	CROSSHEAD,XLT,ADI,59#,E:K:T
2	B-0773	1	CROSSHEAD PIN,JGH:E:K:T
3	A-3870	2	END PLATE,CROSSHEAD PIN, H:E:K
4	A-3869	1	12 PT, 1/2-20 X 10 G8
5	FN0461GA	1	SELF-LOCK NUT,ESNA,1/2-20
6	FP0505FE	2	ROLL PIN, 1/4 X 3/4
7	B-0781	0	CROSSHEAD NUT,10.0#,RND, H:E:K
7	B-0782	0	CROSSHEAD NUT,14.0#,RND, H:E:K
7	B-0783	0	CROSSHEAD NUT,18.0#,RND, H:E:K
7	B-0784	0	CROSSHEAD NUT,22.0#,RND, H:E:K
7	B-0785	0	CROSSHEAD NUT,26.0#,RND, H:E:K
7	B-0786	0	CROSSHEAD NUT,30.0#,RND, H:E:K

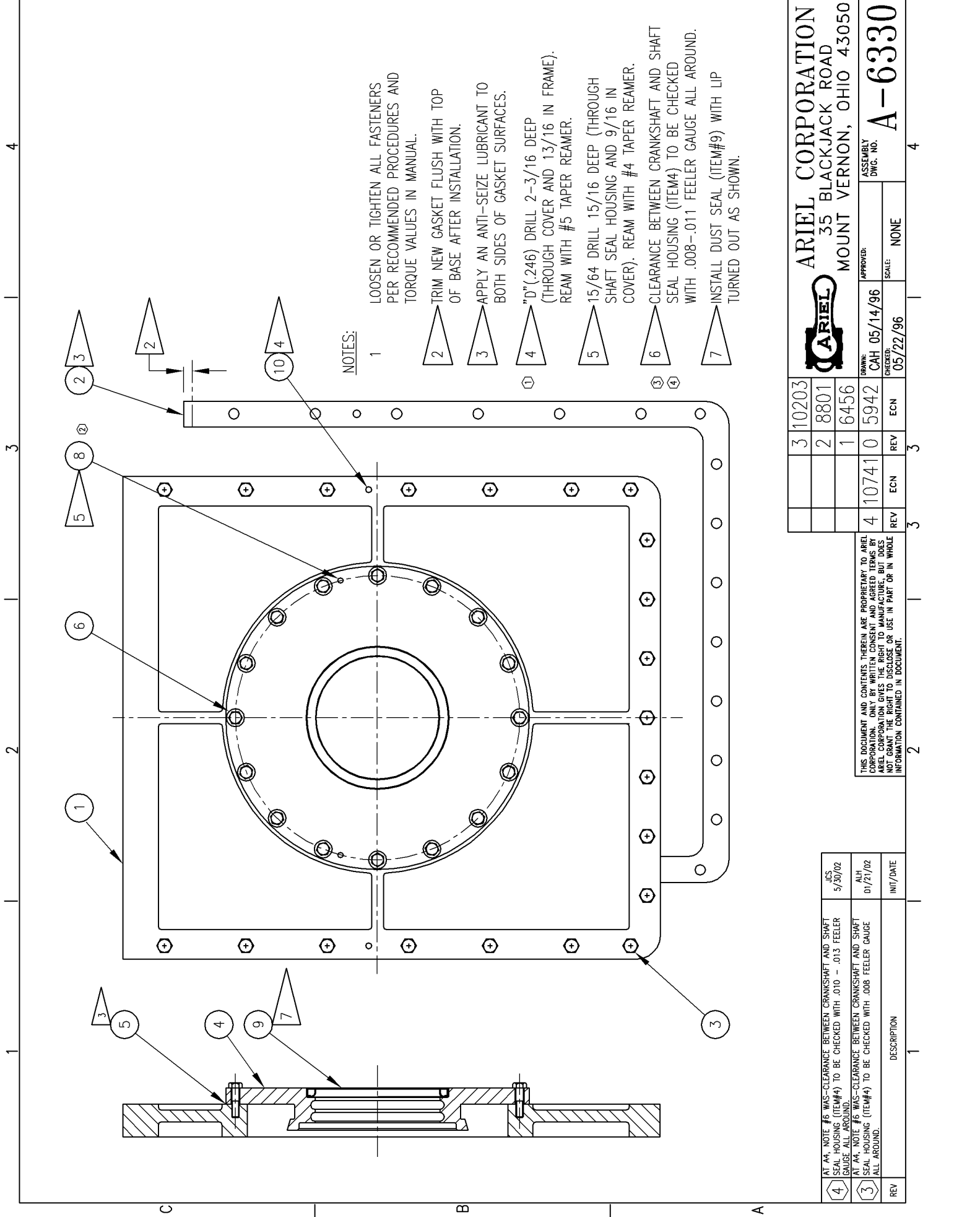
WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT
DOES NOT REPRESENT THE QUANTITY REQUIRED.

6/29/06

PARTS LIST

7	B-1325	0	CROSSHEAD NUT,34.0#,RND, H:E:K
7	B-1573	0	CROSSHEAD NUT,38.0#,RND, H:E:K
7	B-1574	0	CROSSHEAD NUT,42.0#,RND, H:E:K
7	B-1575	0	CROSSHEAD NUT,46.0#,RND, H:E:K
7	B-1576	0	CROSSHEAD NUT,50.0#,RND, H:E:K
7	B-1577	0	CROSSHEAD NUT,54.0#,RND, H:E:K
7	CROSSHEAD NUT	0	FOR PART NO. SEE COVER SHEET
8	FS0455EK	2	CUP PT.S-SCRW,NY, 3/8-24 X 2
9	B-0787	0	SLEEVE BEARING,BZ,X-HD,JGE:K:T

WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT
DOES NOT REPRESENT THE QUANTITY REQUIRED.



NOTES:

- 1 LOOSEN OR TIGHTEN ALL FASTENERS PER RECOMMENDED PROCEDURES AND TORQUE VALUES IN MANUAL.
- 2 TRIM NEW GASKET FLUSH WITH TOP OF BASE AFTER INSTALLATION.
- 3 APPLY AN ANTI-SEIZE LUBRICANT TO BOTH SIDES OF GASKET SURFACES.
- 4 "D"(.246) DRILL 2-3/16 DEEP (THROUGH COVER AND 13/16 IN FRAME). REAM WITH #5 TAPER REAMER.
- 5 15/64 DRILL 15/16 DEEP (THROUGH SHAFT SEAL HOUSING AND 9/16 IN COVER). REAM WITH #4 TAPER REAMER.
- 6 CLEARANCE BETWEEN CRANKSHAFT AND SHAFT SEAL HOUSING (ITEM4) TO BE CHECKED WITH .008-.011 FEELER GAUGE ALL AROUND.
- 7 INSTALL DUST SEAL (ITEM#9) WITH LIP TURNED OUT AS SHOWN.

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ARIEL CORPORATION
 35 BLACKJACK ROAD
 MOUNT VERNON, OHIO 43050



ASSEMBLY DWG. NO. **A-6330**

APPROVED:
 DRAWN: CAH 05/14/96
 CHECKED: 05/22/96
 SCALE: NONE

REV	DESCRIPTION	INIT/DATE
4	AT A4, NOTE #6 WAS CLEARANCE BETWEEN CRANKSHAFT AND SHAFT SEAL HOUSING (ITEM#4) TO BE CHECKED WITH .010 - .013 FEELER GAUGE ALL AROUND.	JCS 5/30/02
3	AT A4, NOTE #6 WAS CLEARANCE BETWEEN CRANKSHAFT AND SHAFT SEAL HOUSING (ITEM#4) TO BE CHECKED WITH .008 FEELER GAUGE ALL AROUND.	ALH 01/21/02

REV	ECN	REV	ECN
3	10203	4	10741
2	8801	REV	ECN
1	6456	REV	ECN

REV	ECN	REV	ECN
3	5942	3	5942
2	5942	2	5942
1	5942	1	5942

6/29/06

PARTS LIST

DRIVE END COVER
JGH, JGE, JGK AND JGT, 2 AND 4 THROWS.

PART NO. G-0978
REF DRAWING A-6330

ITEM NUMBER	PART NUMBER	QUANTITY	DESCRIPTION
1	C-0587	1	DRIVE END COVER, JGH:E:K:T
2	B-0844	1	GSKT,RET,23-1/2X20-5/16X1/32
3	FC0102EK	21	HEX HD CAP,3/8-16 X 2 G5
4	C-0594	1	SHAFT SEAL HOUSING, JGH:E:K
5	A-3875	1	GSKT,RND,12-13/16, X 1/32
6	A-10186	16	SEMS BOLT, 5/16-18 X 1-1/4
8	FP0512EF	2	THD.TAPER PIN,#4 X 1"LG
9	A-0245-B	1	DUST SEAL,TFE,JGH:E:K:T,J/6
10	FP0512FJ	2	THD.TAPER PIN,#5 X 2"LG

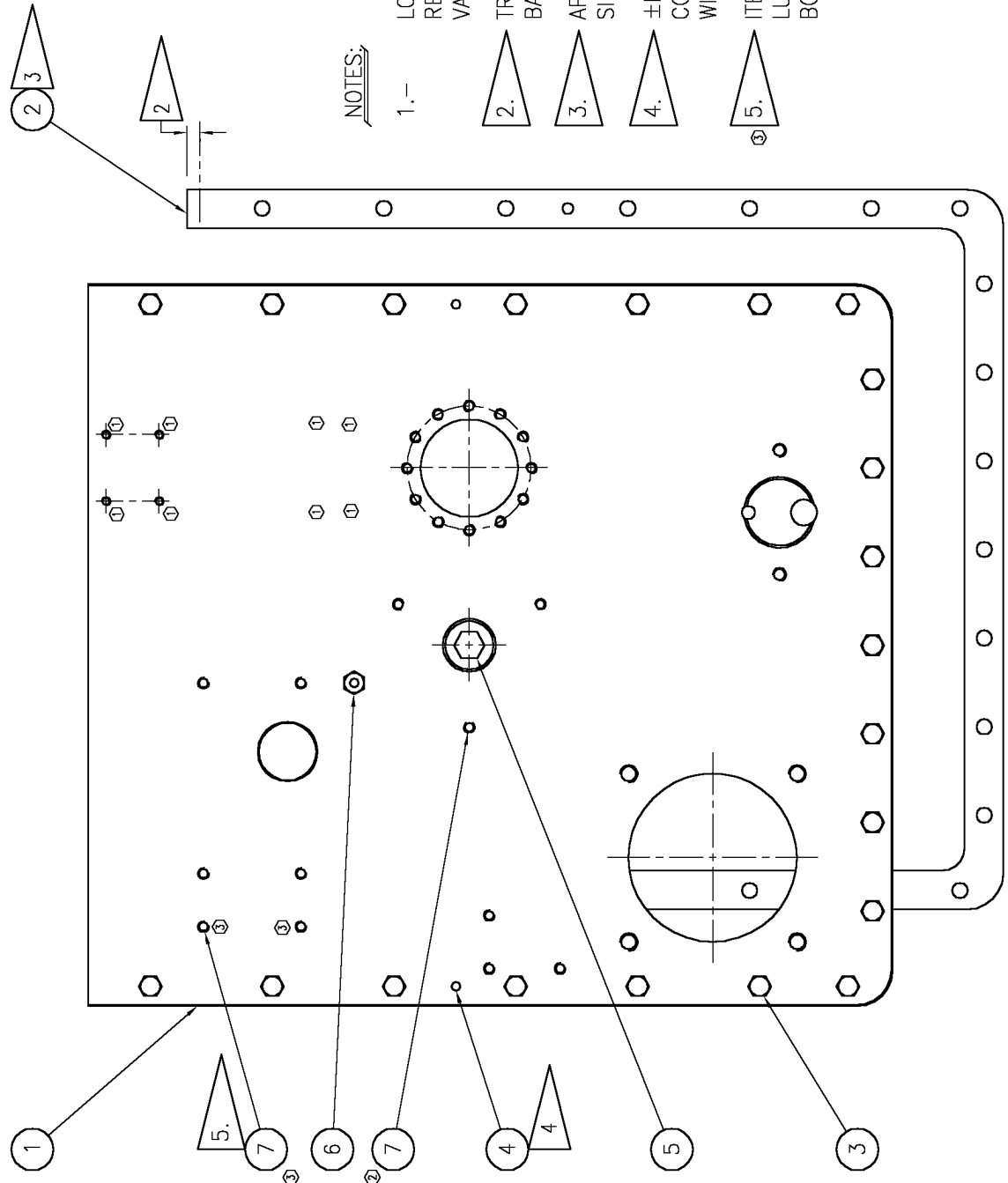
WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT
DOES NOT REPRESENT THE QUANTITY REQUIRED.

4

3

2

1



NOTES:

- 1.- LOOSEN OR TIGHTEN ALL FASTENERS PER RECOMMENDED PROCEDURES AND TORQUE VALUES IN MANUAL.
2. TRIM NEW GASKET FLUSH WITH TOP OF BASE AFTER INSTALLATION.
3. APPLY AN ANTI-SEIZE LUBRICANT TO BOTH SIDES OF GASKET SURFACES.
4. ±F" (.257) DRILL 1-11/16 DEEP (THROUGH COVER AND 11/16 IN FRAME). REAM WITH #5 TAPER REAMER.
5. ITEM #7 WILL NOT BE USED IN THE TWO (2) LUBE BOX MOUNTING HOLE IF A 2 PUMP BOX IS USED. (REF. 2 THROW ONLY)

REV	DESCRIPTION	INIT/DATE	DDP 10/18/00
3	ZONE B3 ADDED NOTE #5. ITEM #7 WILL NOT BE USED IN THE TWO (2) LUBE BOX MOUNTING HOLE. ZONE C1 ADDED TWO MORE ITEMS #7 AND FLAG #5.		

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3	8457			
2	7842			
1	7323			
0	5942	DRAWN: CAH 5/13/96	APPROVED:	
		CHECKED: NH 7/12/96	SCALE: NONE	
		REV	ECN	



ARIEL CORPORATION
 35 BLACKJACK ROAD
 MOUNT VERNON, OHIO 43050

ASSEMBLY
 DWG. NO. **A-6328**

4

2

1

6/29/06

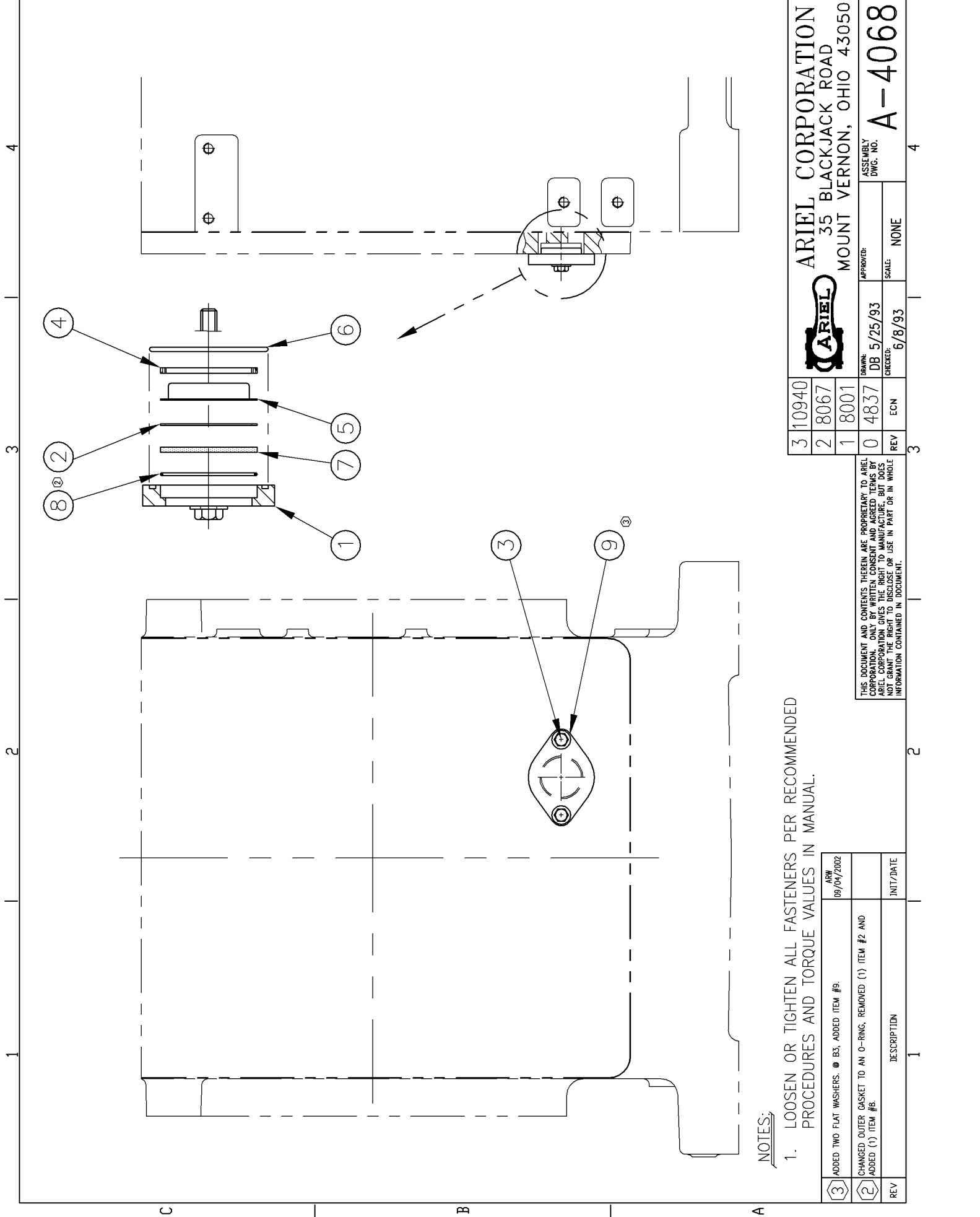
PARTS LIST

AUXILIARY END COVER
WITH STAINLESS STEEL FITTINGS
JGH/4, JGE/4, JGK/4 & JGT/4

PART NO. G-2360
REF DRAWING A-6328

ITEM NUMBER	PART NUMBER	QUANTITY	DESCRIPTION
1	C-2593	1	AUX END COVER,JGH:E:K:T/4
2	B-0844	1	GSKT,RET,23-1/2X20-5/16X1/32
3	FC0102EI	21	HEX HD CAP,3/8-16 X 1-1/2 G5
4	FP0512FH	2	THD.TAPER PIN,#5 X 1-1/2LG
5	PP0810ME	1	PIPE PLUG,1-1/4NPT,HEX HD,SS
6	A-0938	1	MALE CONN,SS, 1/4T X 1/4P
7	A-0490	3	PUSH IN PLUG,PL, 5/16,YELLOW

WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT
DOES NOT REPRESENT THE QUANTITY REQUIRED.



NOTES:

1. LOOSEN OR TIGHTEN ALL FASTENERS PER RECOMMENDED PROCEDURES AND TORQUE VALUES IN MANUAL.

③	ADDED TWO FLAT WASHERS. ● B3, ADDED ITEM #9.	ARW	09/04/2002
②	CHANGED OUTER GASKET TO AN O-RING, REMOVED (1) ITEM #2 AND ADDED (1) ITEM #9.		
REV	DESCRIPTION	INIT/DATE	

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3	10940	ARIEL CORPORATION 35 BLACKJACK ROAD MOUNT VERNON, OHIO 43050	ASSEMBLY DWG. NO. A-4068
2	8067		
1	8001		
0	4837	DRAWN: DB 5/25/93	APPROVED:
REV	ECN	CHECKED: 6/8/93	SCALE: NONE

6/29/06

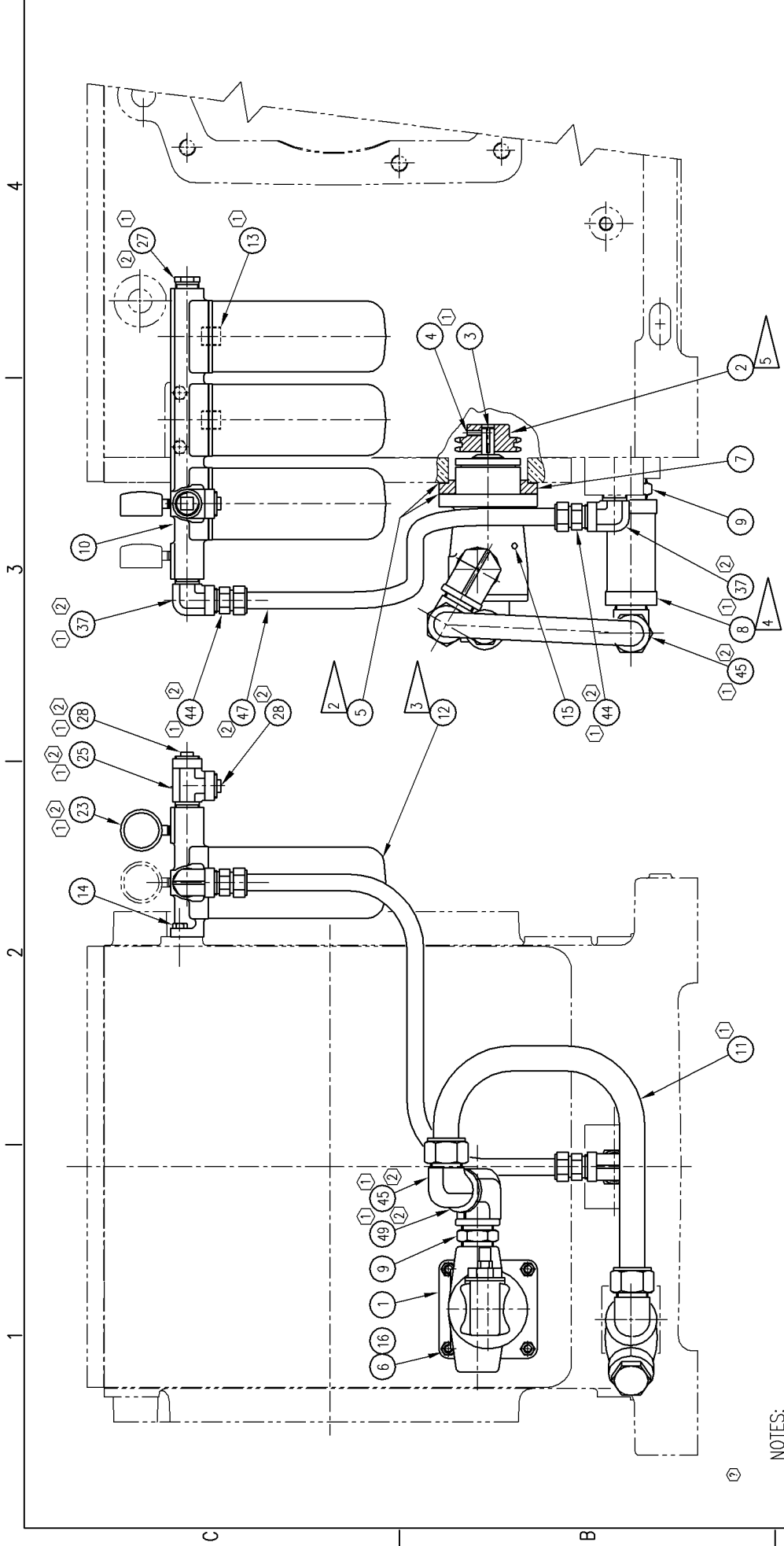
PARTS LIST

SIGHT GLASS ASSEMBLY STD
JGE:K:T, JGC:D, JGB:V, & JGJ/6

PART NO. G-0986
REF DRAWING A-4068

ITEM NUMBER	PART NUMBER	QUANTITY	DESCRIPTION
1	B-3322	1	FLANGE, SIGHT GLASS, HEKT:CD:BV
2	A-5375	1	GSKT, RND, 2-1/4, X 1/32, INNER
3	FC0102EG	2	HEX HD CAP, 3/8-16 X 1 G5
4	A-5376	1	GSKT, RND, 2-1/4 X 1/8, OUTER
5	A-5378	1	SIGHT GLASS, 2" REFLECTOR
6	A-0745	1	O-RING, VT, 2.756 O.D. X .103
7	A-5374	1	SIGHT GLASS, 2-1/4" LENS
8	A-9870	1	O-RING, VT, 2.250 O.D. X .063
9	FW0501DA	2	FLAT WASHER, 3/8 ID PLAIN

WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT
DOES NOT REPRESENT THE QUANTITY REQUIRED.



NOTES:

1. LOOSEN OR TIGHTEN ALL FASTENERS PER RECOMMENDED PROCEDURES AND TORQUE VALUES IN MANUAL.
2. APPLY AN ANTI-SEIZE LUBRICANT TO GASKET SURFACES.
3. CHANGE FILTER ELEMENT EVERY SIX MONTHS.
4. REMOVE AND INSPECT STRAINER SCREEN WHEN CHANGING OIL (CLEAN IN A SUITABLE SOLVENT).
5. ALIGN L.O. PUMP SPROCKET WITH CRANKSHAFT SPROCKET AND TIGHTEN SET SCREWS.

2	UPDATED ITEM NUMBERS TO CURRENT ITEM # ROTATION	JCS 8/9/02
1	RENUMBERED ITEMS MARKED:	
REV	DESCRIPTION	INIT/DATE

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		ARIEL CORPORATION 35 BLACKJACK ROAD MOUNT VERNON, OHIO 43050	
2	10797	0	7576
1	8001	0	7576
REV	ECN	CHANGES	APPROVED:
		WGP 5/20/92	SCALE: NONE
		ASSEMBLY DWG. NO. A-8599	

6/29/06

PARTS LIST

LUBE OIL PUMP, STRAINER, FILTER
STAINLESS STEEL FITTINGS
JGH/4, JGE/4 AND JGK/4 JGT/4

PART NO. G-1721
REF DRAWING A-8599

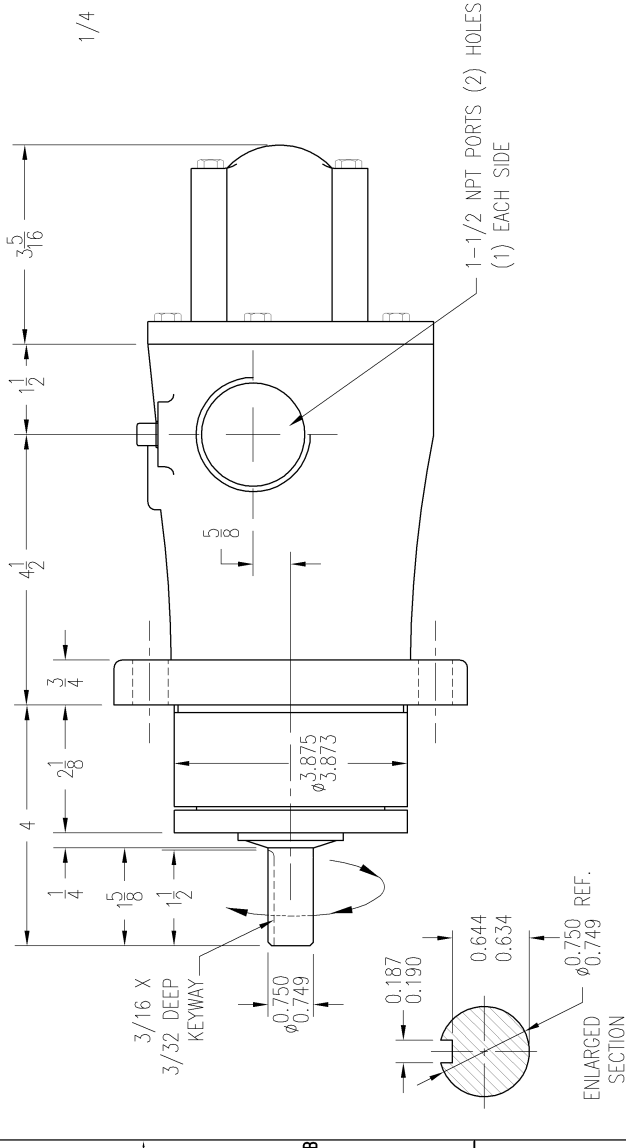
ITEM NUMBER	PART NUMBER	QUANTITY	DESCRIPTION
1	D-0752	1	L O PUMP,VIKING,HEKT/4,JGC:D/2
2	A-3918	1	SPKT,RLR.CHAIN,LO,PUMP,21T
3	FK0361EG	1	SQR KEY,3/16 X 1"LG
4	FS0455DG	2	CUP PT.S-SCRW,NY,5/16-24 X 1
5	B-0779	2	GSKT,SQ,5-15/16X5-15/16X1/32
6	FD0212GDI	4	1/2 DOG PT.STUD,1/2-13 X 3-1/2
7	B-0777	1	L O PUMP ADPTR,VIK,JGH:J/6
8	A-8249	1	L O STRAINER, 1-1/2"NPT
9	A-2319	2	HEX PIPE NIPPLE,SS, 1-1/2P
10	D-0744	1	L O FILTER HEAD,3 ELEMENT
11	A-4230	1	TUBE,PREF,316,LO,SUC,H/4:C/2
12	A-0661	3	LO FILTER ELEMENT,SPIN-ON
13	A-0660	0	STUD,SPIN-ON L O FILTER
14	FC0102GH	2	HEX HD CAP,1/2-13 X 1-1/4 G5
15	A-5257	1	DRIVE PLUG, VIKING WEEPHOLE
16	FN0460GA	4	SELF-LOCK NUT,ESNA,1/2-13
23	A-0261	2	L.O.PSI GAUGE,ASHCROFT,1/4 NPT
25	A-2472	1	STREET TEE,SS, 1"P
27	PP0810KE	1	PIPE PLUG,1 NPT,HEX HD,SS
28	PP0802KD	2	PIPE PLUG,1"NPT,SQ HD,PLASTIC
37	A-2378	2	STREET ELBOW,SS, 1"P-90
44	A-2320	2	MALE CONN,SS, 1T X 1P
45	A-2321	2	MALE ELBOW,SS, 1 1/2T X 1-1/2P

WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT
DOES NOT REPRESENT THE QUANTITY REQUIRED.

ARIEL PART NUMBER	ROTATION	MODEL No.	GPR	PUMP CAPACITY	DESCRIPTION (FOR D-0292 & A-4441)	ITEM NO.	ARIEL P/N	QUAN. REQD.	DESCRIPTION (COMMON PARTS)
⊕ D-0292	STANDARD	HL495	.01328	PUMP CAPACITY IS APPROX. 16.5 GPM (ACTUAL) AT 1286 RPM (PUMP SPEED) AT 100 SSU VISCOSITY (REF VIKING CURVE No. 144-11)		1	A-5203	1	LOCKNUT
⊕ A-4441	REVERSE	HL495	.01328	PUMP CAPACITY IS APPROX. 16.5 GPM (ACTUAL) AT 1286 RPM (PUMP SPEED) AT 100 SSU VISCOSITY (REF VIKING CURVE No. 144-11)		2	A-5204	1	SNAP RING, OUTER
⊕ D-0752	STANDARD	HL495	.01898	PUMP CAPACITY IS APPROX. 21 GPM (ACTUAL) AT 1130 RPM (PUMP SPEED) AT 100 SSU VISCOSITY (REF VIKING CURVE No. 144-19)		3	A-5205	1	SNAP RING, OUTER
⊕ A-2568	REVERSE	HL495	.01898	PUMP CAPACITY IS APPROX. 21 GPM (ACTUAL) AT 1130 RPM (PUMP SPEED) AT 100 SSU VISCOSITY (REF VIKING CURVE No. 144-19)		4	A-5206	1	SNAP RING FOR SHAFT
⊕						5	A-5207	1	BEARING HOUSING WITH SETSCREWS
⊕						6	A-5208	1	SNAP RING, INNER
⊕						7	A-5209	1	BALL BEARING, INNER
⊕						8	A-5210	1	CASING
⊕						9	A-5084	2	PIPE PLUG-1/4 (2 REQD.)
⊕						10	A-5211	1	MECHANICAL SEAL (COMPLETE)
⊕						14	A-4041	1	O'RING GASKET FOR HEAD
⊕						15	A-5216	1	IDLER PIN
⊕						⊕17	FC0102DE	5	CAPSCREW FOR HEAD (5-REQD.)
⊕						18	A-5083	1	GASKET FOR RELIEF VALVE
⊕						19	A-5219	1	INTERNAL RELIEF VALVE (COMPLETE)
⊕						⊕20	FC0102DM	4	CAPSCREW FOR VALVE (4 REQD.)
⊕						2,3,5	A-5221	1	BEARING HOUSING ASSY. (COMPLETE)
⊕						⊕21	A-12707	1	GASKET, RELIEF VALVE CAP
⊕						⊕22	A-10935	1	CAP, RELIEF VALVE
⊕						⊕23	A-4928	1	SPRING RELIEF VALVE 51-80 PSI.

STANDARD ROTATION SHOWN.

TO REVERSE ROTATION, REMOVE AND REMOUNT RELIEF VALVE 180°
NOTE: THE RELIEF VALVE IS ALWAYS POINTED AT THE SUCTION PORT.



REV	DATE	BY	CHK	DESCRIPTION
5	10/31/74			
4	5/31/74			
3	4/9/74			
2	3/28/79			
1	11/19/79			

MANUFACTURER: VIKING PUMP
RELIEF VALVE SET AT 75 PSIG.
C.I. BODY & ROTOR; STL. SHAFT
MAX. OPERATING TEMP. 225°F

NOTES:
⊕ 1.- GALLONS PER REVOLUTION (GPR) IS THEORETICAL DISPLACEMENT. FOR DESIGN PURPOSES, REFER TO MANUFACTURERS PERFORMANCE CHARTS.

ARIEL CORPORATION
35 BLACKJACK ROAD
MOUNT VERNON, OHIO 43050

DATE: APR. 11/19/79
DRAWN BY: JLS
CHECKED BY: JLS

PUMP-LUBE OIL
JCA/6, JGRW-1/4,
JGHE-K/2/4, JGCD/2

PROCURED NONE

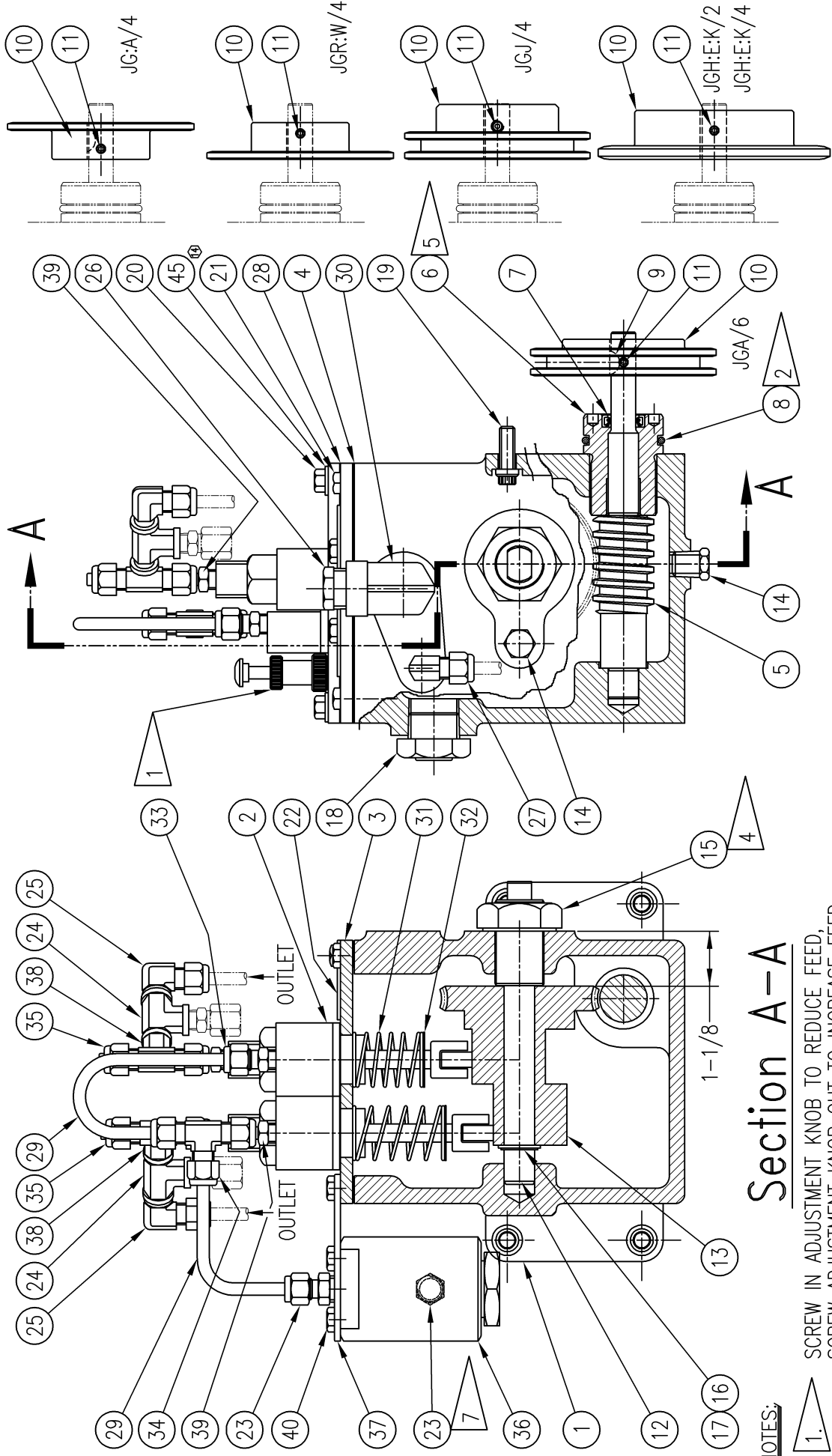
D-0292

6/29/06

PARTS LIST

47	PT0201JC	40.	" TUBING,316 SS 1" OD X .049
49	A-2317	1	FEMALE ELBOW,SS, 1-1/2P

WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT
DOES NOT REPRESENT THE QUANTITY REQUIRED.



Section A-A

- NOTES:
1. SCREW IN ADJUSTMENT KNOB TO REDUCE FEED.
 2. SCREW ADJUSTMENT KNOB OUT TO INCREASE FEED.
 3. OIL O-RING BEFORE INSTALLING.
 4. SEE CYLINDER LUBRICATION SHEET FOR CORRECT PUMP SETTING (DISTRIBUTION BLOCK CYCLE INDICATOR TIMING).
 5. TORQUE TO 75 FT/LB.
 6. TORQUE TO 70 FT/LB.

6. LOOSEN OR TIGHTEN ALL FASTENERS PER RECOMMENDED PROCEDURES AND TORQUE VALUES IN MANUAL.
7. OIL INLET ON BACK SIDE OF FILTER.

14	ADDED ITEM #45.
REV	DESCRIPTION

11	7704	7	5895	3	4297
14	8001	10	6487	6	4159
13	7908	9	6443	5	4752
12	7839	8	6416	4	4428
REV	ECN	REV	ECN	REV	ECN

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ARIEL CORPORATION
 35 BLACKJACK ROAD
 MOUNT VERNON, OHIO 43050

ASSEMBLY DWG. NO. **D-1107**
 APPROVED: _____
 DRAWN: BH 2/20/89
 CHECKED: _____
 SCALE: NONE
 2/20/89

6/29/06

PARTS LIST

FORCE FEED LUBRICATOR, ARIEL
TWIN 3/8" DIA. PUMPS JGH:E:K:T 2/4 WITH
STAINLESS STEEL TUBING AND FITTINGS

PART NO. G-3589
REF DRAWING D-1107

ITEM NUMBER	PART NUMBER	QUANTITY	DESCRIPTION
1	D-2001	1	FF LUBR, 2 PUMP TANK ASSY
2	A-9478	2	FF LUBR PUMP 3/8 PREMIER
3	A-2347	0	TOP CVR DOUBLE FF LUBE BOX
4	A-2349	0	GSKT, ARL DBL LUBE BOX CVR, 1/32
5	A-2360	0	WORM SHAFT, FF LUBR 1/2D E
6	A-5638	0	HSG BRG FF LUBE BOX LH
7	A-3911	0	SHAFT OIL SEAL
8	A-0030	0	O-RING, VT, 1.637 O.D. X .139
9	FK0360AA	1	WOODRUFF KEY, #204, 1/2D X 1/16
10	A-3873	1	SPKT, RLR. CHAIN, FF LUBR, 28T
11	FS0455DH	1	CUP PT. S-SCRW, NY, 5/16-24X1-1/4
12	A-2353	0	ADJ SHAFT-DOUBLE LUBE BOX
13	B-1177	0	CAM/WORM GEAR, 2-PUMP FF LUBR
14	PP0810CE	2	PIPE PLUG, 1/4NPT, HEX HD, SS
15	FN0457KA	0	HEX NUT, JAM, STL, 1"-14
16	A-2359	0	SNAP RING, STL, RADIAL ASSYO. 625
17	A-2358	0	FLAT WASHER, SUPPORT, 518, HARD
18	A-5641	0	SIGHT GLASS, 3/4" NPT
19	FC0120DF	4	12 PT CAP, 5/16-18 X 7/8 G8
20	FC0102CG	0	HEX HD CAP, 1/4-20 X 1 G5
21	FC0102CE	0	HEX HD CAP, 1/4-20 X 3/4 G5
22	A-3928	1	DATA PLATE, 2 PUMP FF LUBR
23	A-0938	2	MALE CONN, SS, 1/4T X 1/4P

WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT
DOES NOT REPRESENT THE QUANTITY REQUIRED.

6/29/06

PARTS LIST

24	A-2245	2	STREET TEE,SS, 1/8P
25	A-0812	2	MALE ELBOW,SS, 1/4T X 1/8P
26	PP0810GE	1	PIPE PLUG,1/2NPT,HEX HD,SS
27	A-0941	1	MALE ELBOW,SS, 1/4T X 1/4P
28	A-9631	0	FF LUB PUMP GASKET
29	PT0201CD	28.	" TUBING,316 SS 1/4 OD X .065
30	A-2952	1	STREET ELBOW,SS, 1/2P 90
31	A-9619	0	SPRING,FF PUMP,PREMIER
32	A-9618	0	SPRING RETAINER,FF PUMP,PREM
33	A-0813	1	MALE CONN,SS, 1/4T X 1/8P
34	A-9181	1	UNION TEE ,SS , 1/4T
35	A-0948	2	PLUG-TUBE FIT,FEMALE,SS, 1/4T
36	A-8723	1	FF LUBR FILTER, 150 MIC
37	A-8729	1	BRKT, FF INLET FILTER
38	A-8826	2	FEMALE BRANCH TEE 1/4TX1/8P SS
39	A-8829	3	MALE ADAPTR,SS, 1/4T X 1/8P
40	FC0102CC	2	HEX HD CAP,1/4-20 X 1/2 G5
45	FW0500CA	0	WASHER, 1/4" I.D., SAE
99	A-8723-K	0	FILTER KIT, LUBRICATOR 150 MIC
99	AD-2894	0	FF LUBR,SF,3/8,3/8 1/2S

WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT
DOES NOT REPRESENT THE QUANTITY REQUIRED.

6/29/06

PARTS LIST

DISTRIBUTION BLOCK, MOUNTING BOLTS
JGA:H:E:K:T:C:D:B:V/4:6, SINGLE BLOCK

PART NO. G-5299
REF DRAWING N.A.

ITEM NUMBER	PART NUMBER	QUANTITY	DESCRIPTION
1	FC0102CI	8	HEX HD CAP,1/4-20 X 1-1/2 G5

WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT
DOES NOT REPRESENT THE QUANTITY REQUIRED.

6/29/06

PARTS LIST

RUPTURE DISC ASSEMBLY
3250 PSI

PART NO. G-2708
REF DRAWING N.A.

ITEM NUMBER	PART NUMBER	QUANTITY	DESCRIPTION
1	A-0080	1	BLOW-OUT ASSY, SPECIFY DISC.
2	A-0124	0	BLOW-OUT DISC, 3250 PSIG, PURPLE
3	A-2570	1	PLUG PLASTIC, 7 X RED

WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT
DOES NOT REPRESENT THE QUANTITY REQUIRED.

6/29/06

PARTS LIST

FLUSHING OIL HARDWARE, ANY CYLINDER
WITH STAINLESS STEEL FITTINGS

PART NO. G-2205
REF DRAWING N.A.

ITEM NUMBER	PART NUMBER	QUANTITY	DESCRIPTION
1	A-0401	1	BRACKET,BULKHEAD UNION
2	A-0949	1	BULK.UNION,SS, 1/4T X 1/4T
3	FC0134CC	1	BUT HD CAP,1/4-20 X 1/2 316SS
4	PT0201CD	70. "	TUBING,316 SS 1/4 OD X .065
5	A-2570	1	PLUG PLASTIC, 7 X RED

WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT
DOES NOT REPRESENT THE QUANTITY REQUIRED.

6/29/06

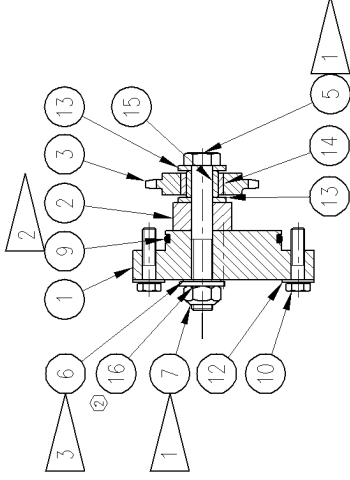
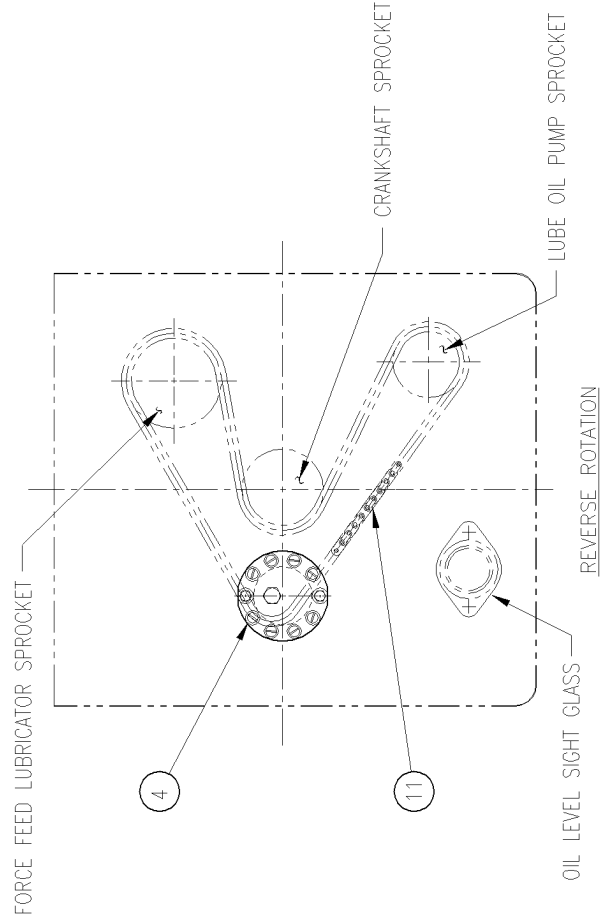
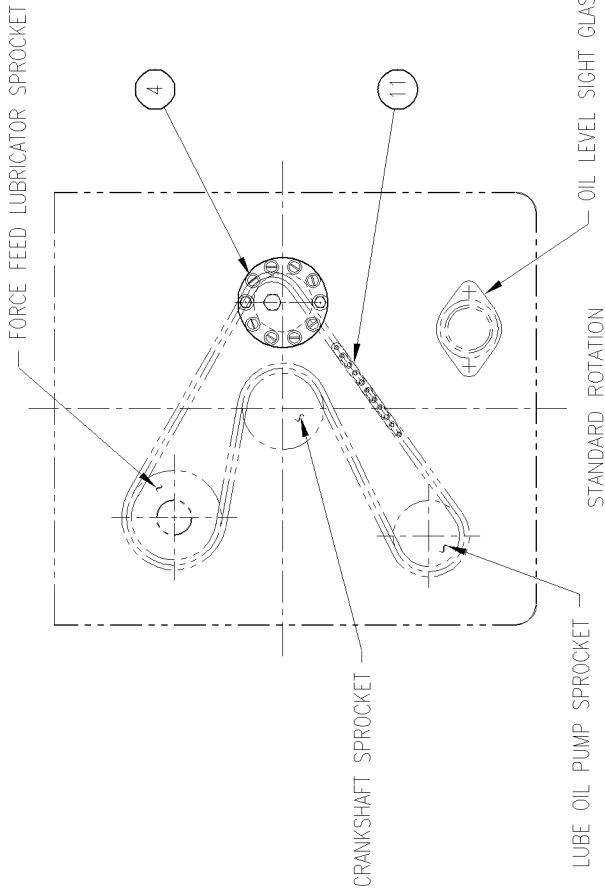
PARTS LIST

FORCE FEED LUBRICATION TUBING,
WITH STAINLESS STEEL FITTINGS
JGK:T:C:D/4

PART NO. G-2860
REF DRAWING N.A.

ITEM NUMBER	PART NUMBER	QUANTITY	DESCRIPTION
1	PT0201CD	900.	" TUBING, 316 SS 1/4 OD X .065
2	A-0949	8	BULK.UNION, SS, 1/4T X 1/4T
3	A-0401	8	BRACKET, BULKHEAD UNION
4	FC0134CC	8	BUT HD CAP, 1/4-20 X 1/2 316SS
5	A-0831	9	TUBING CLAMP, 1/4 TUBE
6	FM0400BC	9	SLTD.MACH.SCREW, #10-24 X 1/2
7	FW0500AA	9	FLAT WASHER, #8 SAE

WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT
DOES NOT REPRESENT THE QUANTITY REQUIRED.



NOTES:

- 1 REPLACE NUT (ITEM 7) AND CAPSCREW (ITEM 5) WITH NEW PARTS WHEN REPLACING IDLER SPROCKET (ITEM 3).
- 2 OIL O-RING (ITEM 9) BEFORE INSTALLING.
- 3 OIL FACES BEFORE INSTALLING TO PREVENT ABRASION TO STATO-SEAL (ITEM 6).
- 4 FOR CHAIN TIGHTENING REFER TO ER-74.

REVISED CHAIN TIGHTENING NOTE:	RWR 8/26/04
DESCRIPTION	INIT/DATE

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3	11872	APPROVED:	ASSEMBLY DWG. NO.
2	8434	DRAWN: MLA 1/20/00	SCALE:
1	8281	CHECKED: DAH 1/24/00	NONE
0	8060	ECN	
REV			

ARIEL CORPORATION
 35 BLACKJACK ROAD
 MOUNT VERNON, OHIO 43050

A-9639

6/29/06

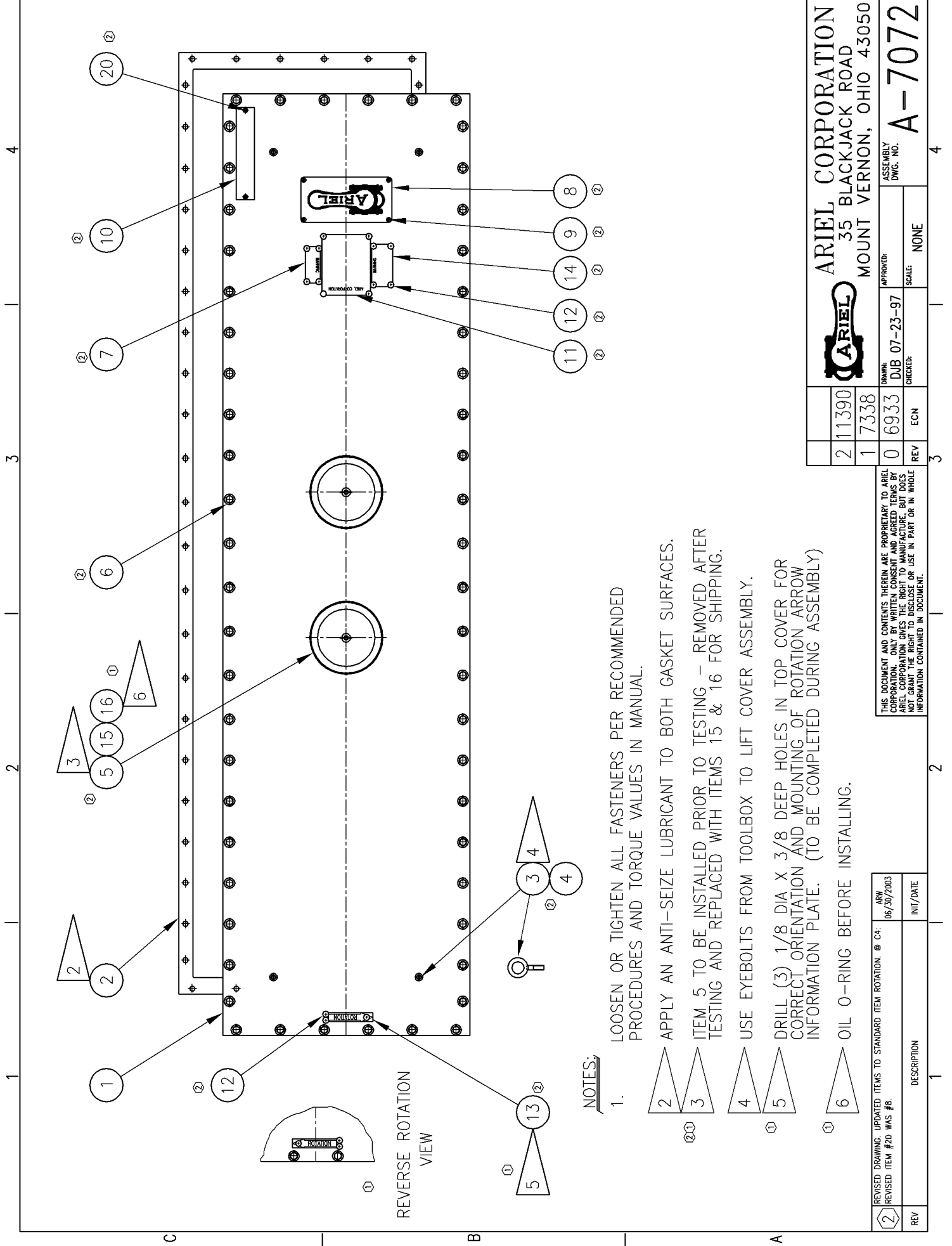
PARTS LIST

CHAIN DRIVE ASSY, STANDARD OR REVERSE
ROTATION. JGH:E:K:T/2:4 THROW UNITS

PART NO. G-7982
REF DRAWING A-9639

ITEM NUMBER	PART NUMBER	QUANTITY	DESCRIPTION
1	B-0030	1	ECC VERNIER CAP
2	A-9598	1	IDLER SPACER, K/2:4
3	A-9599	1	SPKT ASSY, RLR CHAIN #40-15T BZ
4	A-0109	8	MACHINE SCREW PLUG, PL, 7/16-14
5	FC0107GQ	1	HEX HD CAP, 1/2-20 X 3-1/2 G5
6	FW0550GA	1	STAT-O-SEAL, 1/2 DIA., BLACK
7	FN0468GA	1	HEX NUT, STOVER TYPE C, 1/2-20
9	A-0010	1	O-RING, VT, 2.625 O.D. X .139
10	FC0100DH	2	HEX HD CAP, 5/16-18 X 1-1/4 G9
11	A-3884	1	ROLLER CHAIN, 40-1 X114, JGH:E:K
12	FW0501CA	2	FLAT WASHER, 5/16 I.D. PLAIN
13	FW0502HA	2	WASHER, 1/2 STEEL
14	A-9600	0	SLEEVE BUSHING, BZ, 1/2 LG
15	A-9601	1	SLEEVE BEARING, STL, 5/8 LG
16	FW0500GA	1	FLAT WASHER, 1/2 SAE

WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT
DOES NOT REPRESENT THE QUANTITY REQUIRED.



REVERSE ROTATION VIEW

NOTES:

1. LOOSEN OR TIGHTEN ALL FASTENERS PER RECOMMENDED PROCEDURES AND TORQUE VALUES IN MANUAL.
2. APPLY AN ANTI-SEIZE LUBRICANT TO BOTH GASKET SURFACES.
3. ITEM 5 TO BE INSTALLED PRIOR TO TESTING - REMOVED AFTER TESTING AND REPLACED WITH ITEMS 15 & 16 FOR SHIPPING.
4. USE EYEBOLTS FROM TOOLBOX TO LIFT COVER ASSEMBLY.
5. DRILL (3) 1/8 DIA X 3/8 DEEP HOLES IN TOP COVER FOR CORRECT ORIENTATION AND MOUNTING OF ROTATION ARROW INFORMATION PLATE. (TO BE COMPLETED DURING ASSEMBLY)
6. OIL O-RING BEFORE INSTALLING.

REV	DESCRIPTION	INIT/DATE
2	REVISED DRAWING. UPDATED ITEMS TO STANDARD ITEM ROTATION. @ C4. REVISED ITEM #20 WAS #8.	ARW 06/30/2003

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2	11390	ECN	APPROVED:	SCALE:
1	7338	REV	DRAWN:	CHECKED:
0	6933	REV	DJB 07-23-97	NONE
ARIEL CORPORATION 35 BLACKJACK ROAD MOUNT VERNON, OHIO 43050		ASSEMBLY DWG. NO. A-7072		

6/29/06

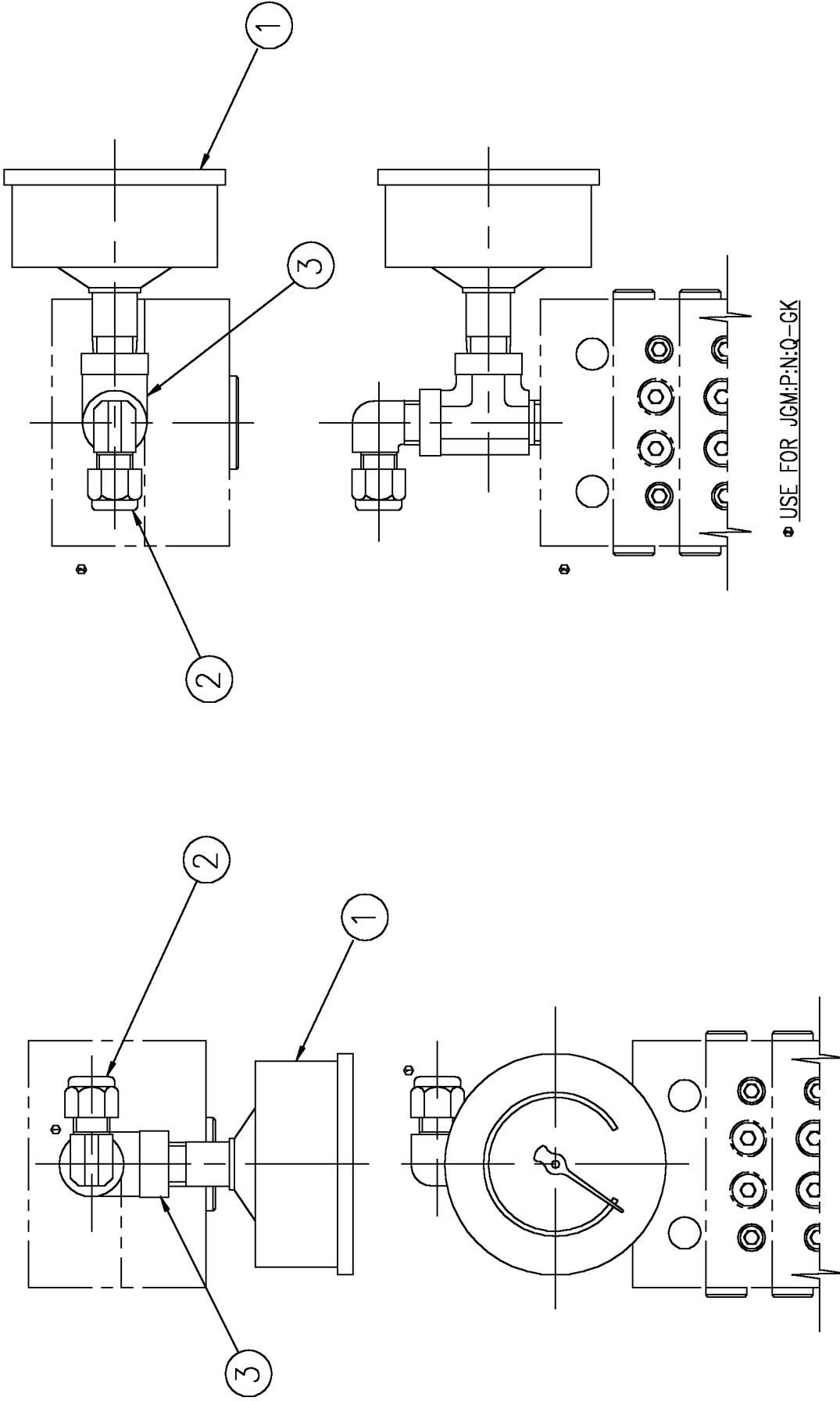
PARTS LIST

TOP COVER, BREATHER
JGH/4, JGE/4, JGK/4 & JGT/4

PART NO. G-1073
REF DRAWING A-7072

ITEM NUMBER	PART NUMBER	QUANTITY	DESCRIPTION
1	C-0644	1	TOP COVER, JGH:E:K:T/4
2	C-4367	1	GSKT,RET,77-5/8 X20-3/8X1/32
3	FE0300EA	0	EYEBOLT,3/8-16 UNC
4	A-0467	4	PUSH IN PLUG,PL, 3/8,YELLOW
5	B-2567	2	BREATHER,1"NPT,FRAME
6	A-6830	56	SEMS BOLT, 3/8-16 X 1-1/4
7	A-0464	1	CAUTION PLT,COMPRESSOR VLV
8	A-0138	1	NAME PLATE,ARIEL LOGO
9	FC0134BC	4	BUT HD CAP,10-24 X 1/2 316SS
10	A-0713	1	INFO PLATE,L O FILTER,SPIN-ON
11	A-0459	1	DATA PLATE,FRAME SPECIFICATION
12	FR0570CC	15	DRIVE SCREW, #6 X 1/4 U-TYPE
13	A-0719	1	INFO PLATE,ROTATION ARROW
14	A-0463	1	CAUTION PLATE,CYLINDER VENTING
15	A-7655	2	PIPE PLUG,1"NPT,SLOTTED HEAD
16	A-0009	2	O-RING,VT, 1.375 O.D. X .139
20	FC0134BB	2	BUT HD CAP,10-24 X 3/8 316SS

WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT
DOES NOT REPRESENT THE QUANTITY REQUIRED.



NOTES:

1. LOOSEN OR TIGHTEN ALL FASTENERS PER RECOMMENDED PROCEDURES AND TORQUE VALUES IN MANUAL.

②	REVISED DWG. ADDED RIGHTSIDE VIEWS: USE FOR JGM:P:N:Q-GK
①	REMOVED 1/4 NPT ELBOW (WAS ITEM 2), RENUMBERED OTHER ITEMS.
REV	DESCRIPTION

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2	8014	ECN	REV
1	7908	ECN	REV
0	7704	ECN	REV

DRAWN:	WSH 7/28/99	APPROVED:	
CREATED:	NEH 07/31/99	SCALE:	NONE

ARIEL CORPORATION
 35 BLACKJACK ROAD
 MOUNT VERNON, OHIO 43050

ARIEL

ASSEMBLY DWG. NO. **A-9020**

6/29/06

PARTS LIST

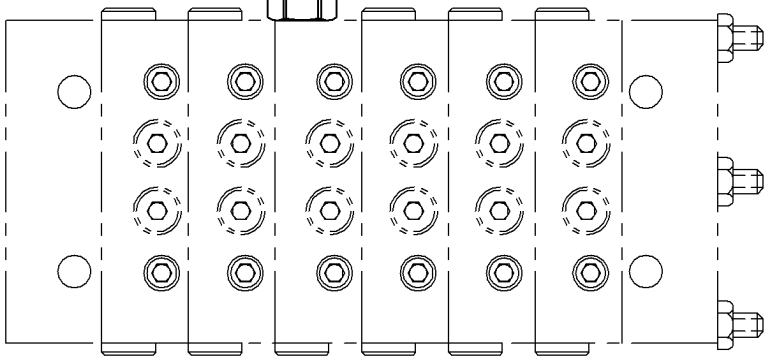
FORCE FEED PRESSURE GAUGE
WITH STAINLESS STEEL FITTINGS
3000 PSI, PER BLK.
JG:I:RJ:H:E:K:T:C:D:B:V

PART NO. G-7626
REF DRAWING A-9020

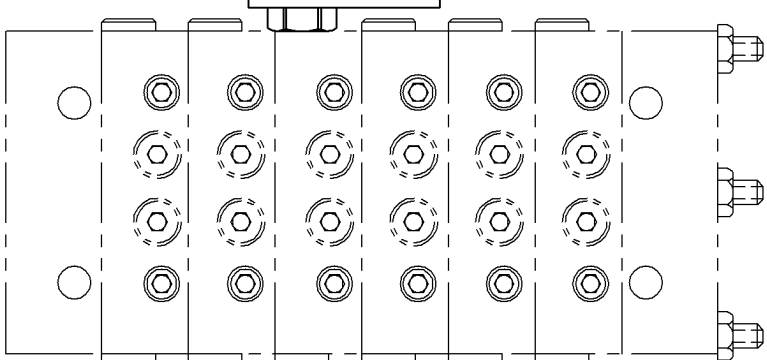
ITEM

NUMBER	PART NUMBER	QUANTITY	DESCRIPTION
1	A-8727	1	GAUGE, 3000 PSI, BACK MOUNT
2	A-0941	1	MALE ELBOW,SS, 1/4T X 1/4P
3	A-7318	1	STREET TEE,SS, 1/4P

WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT
DOES NOT REPRESENT THE QUANTITY REQUIRED.



STANDARD TIMER ASSEMBLY



PROGRAMMABLE TIMER ASSEMBLY

NOTES:

1. IF RESETTING THE SWITCH IS NECESSARY, REFER TO VENDOR LITERATURE IN CUSTOMER BOOK.

1	REVISED DWG - UPDATED DWG TO CURRENT DRAFTING STANDARDS (R2) (R2) REVISED VIEW OF DNFT TO SHOW NEW CURRENT STYLE DNFT BEING USED.	MIB	06/13/01
REV	DESCRIPTION	INIT/DATE	

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1	8747		
0	6410	DRAWN: CJH 07/22/96	APPROVED:
REV	ECN	CHECKED: 08/05/96	SCALE: NONE

ARIEL CORPORATION
35 BLACKJACK ROAD
MOUNT VERNON, OHIO 43050

ARIEL		ASSEMBLY DWG. NO. A-6423	
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6/29/06

PARTS LIST

FORCE FEED LUBRICATOR PROGRAMMABLE
DIGITAL NO FLOW TIMER WITH PROXIMITY
SWITCH FOR TRABON DISTRIBUTION BLOCKS

PART NO. G-4830
REF DRAWING A-6423

ITEM NUMBER	PART NUMBER	QUANTITY	DESCRIPTION
1	A-10754	1	FF.S/D, DNFT, PS, TRAB, DC PRG
99	A-6506	0	DNFT MAGNET ASSY, TRAB, 7/16-20

WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT
DOES NOT REPRESENT THE QUANTITY REQUIRED.

6/29/06

PARTS LIST

SPECIAL TOOLS
JGE, JGK & JGT

PART NO. G-8631
REF DRAWING N.A.

ITEM NUMBER	PART NUMBER	QUANTITY	DESCRIPTION
1	A-0798	1	TOOL BOX
2	A-0135	1	VALVE PULLER, 5/16 X 1/2 UNF
3	A-0409	1	VALVE PULLER, 1/4 X 3/8 UNF
4	A-0626	1	VLV PULLER, 5/8 X 3/4 UNF
5	A-2289	1	VLV PULLER TOOL FOR 'CT' VALVE
6	A-1858	1	CROSSHD INSTALL.TOOL,JGH:E:K
7	ER-63	1	TORQUE CHART, ALL UNITS
8	A-4996	1	PEG WRENCH,1-3/8"
9	B-1240	1	PISTON TURNING TOOL SUPT. ASSY
10	B-1410	1	PISTON NUT SPANNER, JGH:E:K
11	B-1495	1	TURN INDICATOR,JGH:E:K:T
13	FE0300EA	6	EYEBOLT,3/8-16 UNC
14	FE0300GA	2	EYEBOLT,1/2-13 UNC
15	TA0100GA	5	ALLEN WRENCH, 5/32 SHORT ARM
16	TA0100HA	5	ALLEN WRENCH, 3/16 SHORT ARM
17	TA0100LA	1	ALLEN WRENCH, 3/8 SHORT ARM
18	TA0100NB	2	ALLEN WRENCH, 1/2 LONG ARM
19	TA0100QB	1	ALLEN WRENCH, 3/4 LONG ARM
20	A-6393	1	CYL. BOLT TORQUE ADAPTER
21	C-2106	1	CONN.ROD CAP REMOVAL TOOL, HEK
22	B-1989	1	X-HD/PIN ALIGN. TOOL,JGH:E:K
23	FC0102CG	6	HEX HD CAP,1/4-20 X 1 G5
24	A-8158	0	BRG HSG SPANNER WRENCH

WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT
DOES NOT REPRESENT THE QUANTITY REQUIRED.

6/29/06

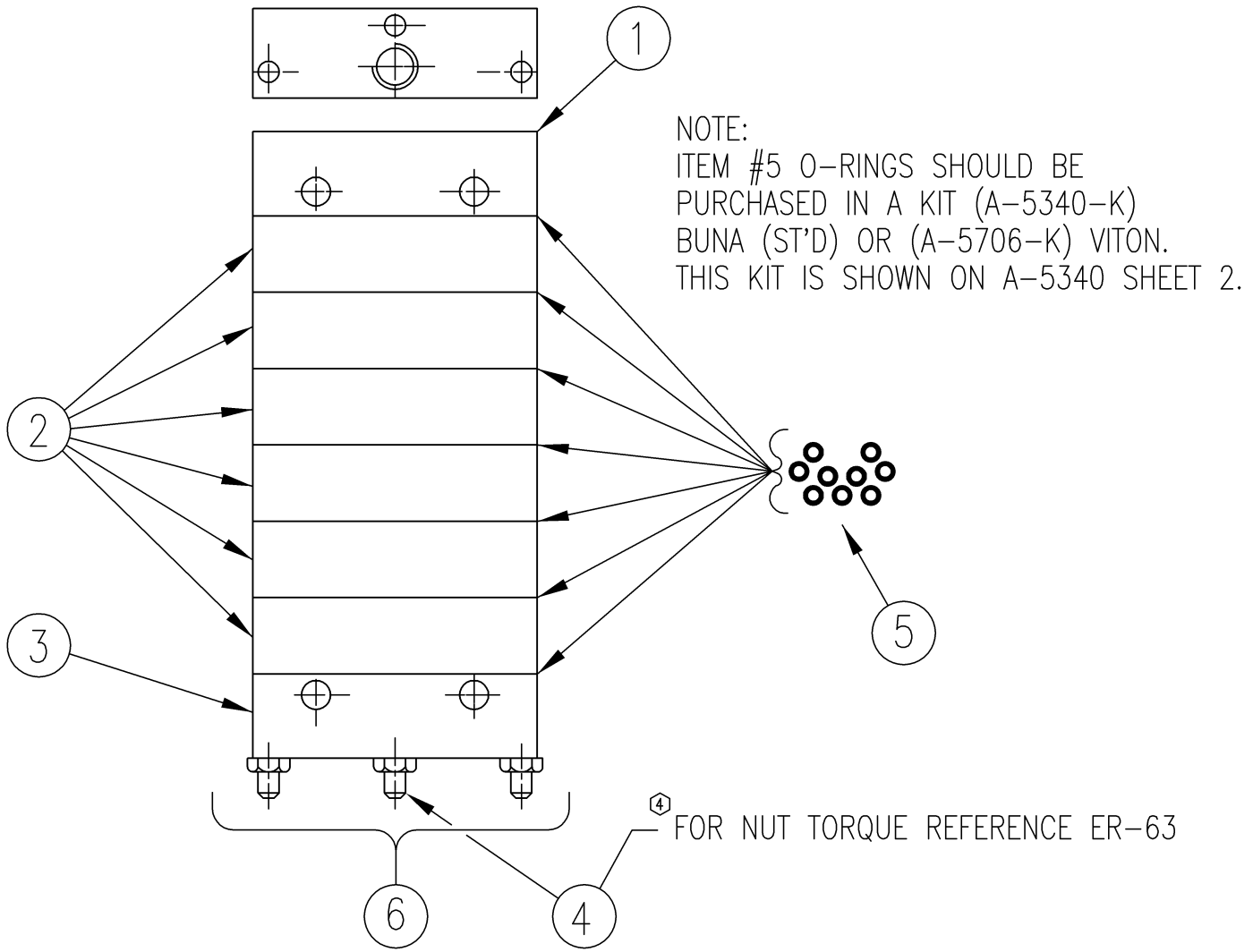
PARTS LIST


25 A-11341

1 ENTER SLEEVE,PIST RD,2PC HEKT

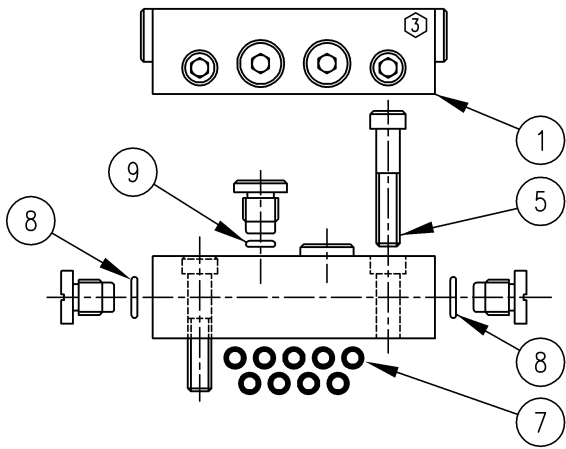
WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT
DOES NOT REPRESENT THE QUANTITY REQUIRED.

NUMBER OF BASE PLATES SECTIONS				DESCRIPTION	ARIEL PART No.	ITEM
3	4	5	6			
1	1	1	1	INLET SECTION	A-5537	1
3	4	5	6	INTERMEDIATE SECTION	A-5531	2
1	1	1	1	END SECTION	A-5538	3
3				TIE ROD W/NUT	A-5539	4
	3			TIE ROD W/NUT	A-5540	
		3		TIE ROD W/NUT	A-5541	
			3	TIE ROD W/NUT	A-5542	
36	45	54	63	O-RING, BUNA STANDARD	A-5570	5
36	45	54	63	O-RING, VITON	A-5703	
A-5533	A-5534	A-5535	A-5536	COMPLETE BASE PLATE ASSEMBLY		6

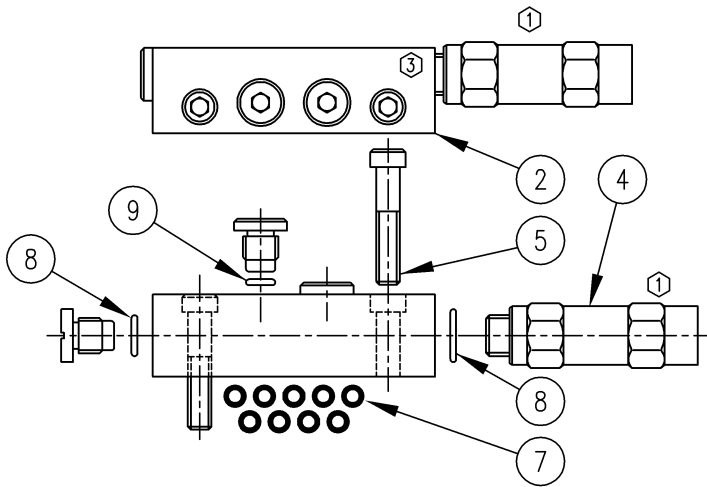


4	© ITEM #4 FOR NUT TORQUE REFERENCE ER-63 WAS TORQUE NUT TO 72 IN/LBS.	3	10737	 ARIEL CORPORATION 35 BLACKJACK ROAD MOUNT VERNON, OHIO 43050	TITLE: DISTRIBUTION BLOCK VALVE (SLOAN BROS.) DRAWING No. A-5340 SHT 1 OF 2
		2	8200		
		1	8175		
		0	5695		
REV	DESCRIPTION	REV	ECN		

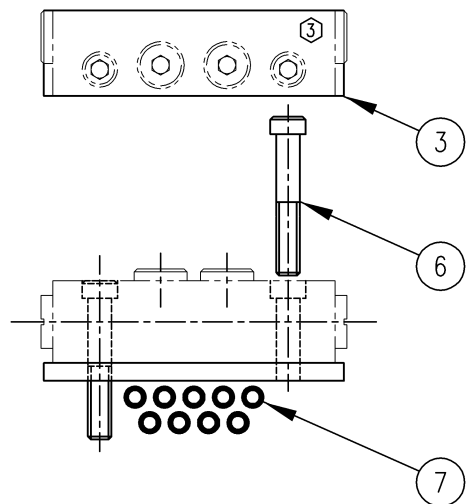
WITHOUT CYCLE PIN



WITH CYCLE PIN



CROSSPORT



ITEM	ARIEL PART	QUAN	DESCRIPTION
1	A-5543	1	DIVIDER VALVE, 6T
1	A-5545	1	DIVIDER VALVE, 6S
1	A-5547	1	DIVIDER VALVE, 9T
1	A-5549	1	DIVIDER VALVE, 9S
1	A-5551	1	DIVIDER VALVE, 12T
1	A-5553	1	DIVIDER VALVE, 12S
1	A-5555	1	DIVIDER VALVE, 18T
1	A-5557	1	DIVIDER VALVE, 18S
1	A-5559	1	DIVIDER VALVE, 24T
1	A-5561	1	DIVIDER VALVE, 24S
1	A-5563	1	DIVIDER VALVE, 30T
1	A-5565	1	DIVIDER VALVE, 30S

2	A-5544	1	DIVIDER VALVE, 6T W/CIP
2	A-5546	1	DIVIDER VALVE, 6S W/CIP
2	A-5548	1	DIVIDER VALVE, 9T W/CIP
2	A-5550	1	DIVIDER VALVE, 9S W/CIP
2	A-5552	1	DIVIDER VALVE, 12T W/CIP
2	A-5554	1	DIVIDER VALVE, 12S W/CIP
2	A-5556	1	DIVIDER VALVE, 18T W/CIP
2	A-5558	1	DIVIDER VALVE, 18S W/CIP
2	A-5560	1	DIVIDER VALVE, 24T W/CIP
2	A-5562	1	DIVIDER VALVE, 24S W/CIP
2	A-5564	1	DIVIDER VALVE, 30T W/CIP
2	A-5566	1	DIVIDER VALVE, 30S W/CIP

3	A-5567	1	CROSSPORT BAR, RIGHT
3	A-5568	1	CROSSPORT BAR, LEFT
3	A-5569	1	CROSSPORT BAR, BOTH

①	4	A-9787	1	CYCLE INDICATOR
②	5	FC0115CH	2	SOC. CAP. 1/4-28 X 1-1/4
②	6	FC0115CI	2	SOC. CAP. 1/4-28 X 1-1/2

NOTE:
O-RINGS SHOULD BE PURCHASED IN A KIT (A-5340-K) BUNA (ST'D) OR (A-5706-K) VITON. THE KITS CONTAIN THE FOLLOWING O-RINGS:

7	A-5570	20	O-RING, INTERFACE, BUNA
7	A-5703	20	O-RING, INTERFACE, VITON
8	A-5696	4	O-RING, ENCLOSURE, BUNA
8	A-5704	4	O-RING, ENCLOSURE, VITON
9	A-5695	4	O-RING, OUTLET, BUNA
9	A-5705	4	O-RING, OUTLET, VITON

④	SEE SHEET #1	4	12506
③	REMOVED LUBRIQUIP DESIGNATION FROM BLOCKS.	3	10737
		2	8200
		1	8175
		0	5695
REV	DESCRIPTION	REV	ECN



ARIEL CORPORATION
35 BLACKJACK ROAD
MOUNT VERNON, OHIO 43050

TITLE: DISTRIBUTION BLOCK VALVE (SLOAN BROS.)	DRAWING No. A-5340 SHT 2 OF 2
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6/29/06

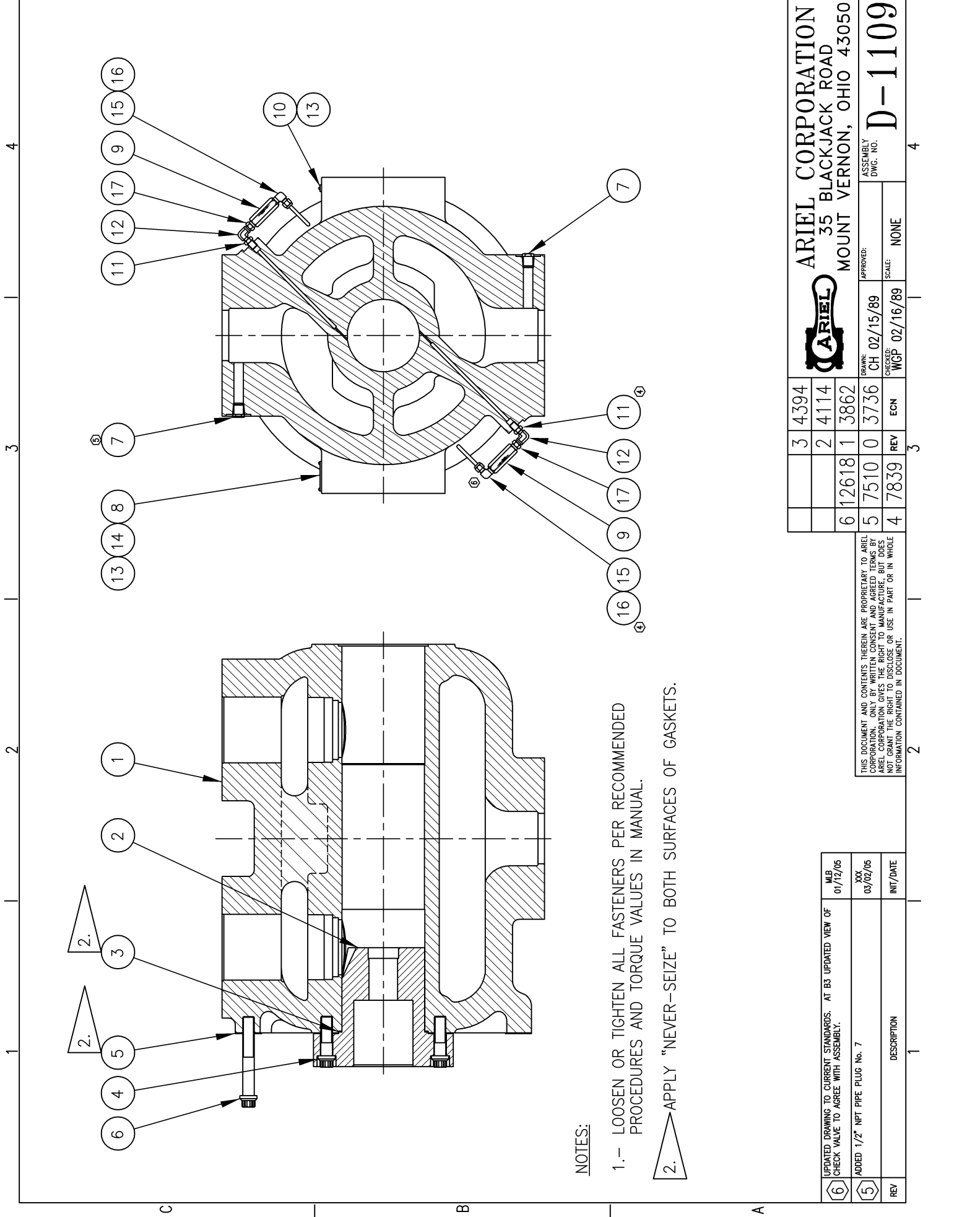
ARIEL CORP. - BLACKJACK DIV. C/N: 001
SALES ORDER COVER SHEET

RHCOVP02

SERIAL NUMBER: C-82051 & 53

PART: 6-1/4K CLASS DESCRIPTION: 6-1/4" JGK CYLINDER CLASS

PART NUMBER	QUANTITY	DESCRIPTION	DRAWING NO.
G-12469	1	CYL ASSY, 5-7/8K:T,HES,SF 2050	D-1109
G-1744	2	SUC VLV ASSY, 6-1/4KT	A-6267
G-1745	2	DIS VLV ASSY, 6-1/4KT	A-6267
G-5544	1	PIST. 5-7/8K,WB,L2,PU,SR/F	A-6230
B-1945-T	2	SUC VLV,102CT ,NY,SS,M/S	A-9265
B-3325-CC	2	DIS VLV,102CT ,SS,MT,M/S	A-9264
G-1775	1	HCL VLV ASSY,SUC, 6-1/4K:T	A-12945
G-1776	1	HCL VLV ASSY,DIS, 6-1/4K:T	A-12945



NOTES:

1.- LOOSEN OR TIGHTEN ALL FASTENERS PER RECOMMENDED PROCEDURES AND TORQUE VALUES IN MANUAL.

2.- APPLY "NEVER-SEIZE" TO BOTH SURFACES OF GASKETS.

6	UPDATED DRAWING TO CURRENT STANDARDS. AT B3 UPDATED VIEW OF CHECK VALVE TO AGREE WITH ASSEMBLY.	MLP	01/12/05
5	ADDED 1/2" NPT PIPE PLUG No. 7	XXY	03/02/05
REV	DESCRIPTION	INIT/DATE	

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3	4394				
2	4114				
6	12618	1	3862		
5	7510	0	3736		
4	7839	REV	ECN		



ARIEL CORPORATION
 35 BLACKJACK ROAD
 MOUNT VERNON, OHIO 43050

ASSEMBLY DWG. NO. **D-1109**
 APPROVED: _____
 DRAWN: CH 02/15/89
 CHECKED: WGP 02/16/89
 SCALE: NONE

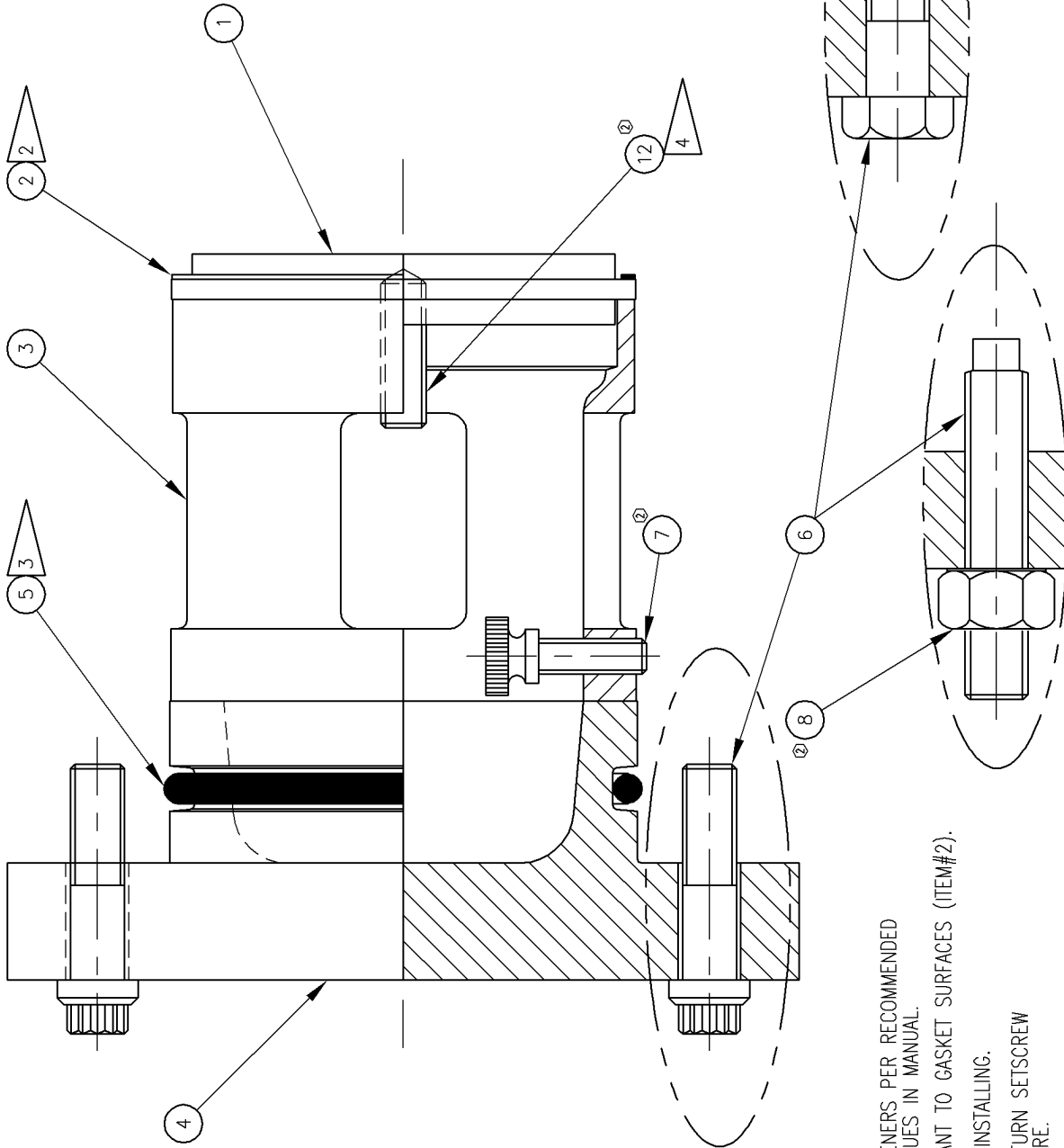
6/29/06

PARTS LIST

5-7/8" JGK:T CYLINDER BODY, HEAD END PART NO. G-12469
SUPPORTS, STAINLESS STEEL TUBING AND REF DRAWING D-1109
FITTINGS. RDP 1864#, MAWP 2050#

ITEM NUMBER	PART NUMBER	QUANTITY	DESCRIPTION
1	D-4176	0	CYL, 5-7/8K,HES 2050
2	C-0944	0	CE HEAD, 5-7/8K:K-HP
3	A-2331	1	STL GASKET, 6.813 X 6.375 X 60
4	FC0120JO	14	12 PT, 7/8-9 X 3 G8
5	B-3549	1	GSKT,RND,22-1/2 X 1/64,18 HOLE
6	FC0120JW	12	12 PT, 7/8-9 X 6 G8
7	PP0810GE	4	PIPE PLUG,1/2NPT,HEX HD,SS
8	A-0640-A	2	INFO PLATE,SUCTION
9	A-3780	2	CHK.VLV,DOU.BALL SOFT SEAT SS
10	A-0640-B	2	INFO PLATE,DISCHARGE
11	A-0824	2	HEX RED BUSH,SS, 1/4M X 1/8F
12	A-2193	2	STREET ELBOW,SS, 1/8P, 90
13	FR0570CC	12	DRIVE SCREW, #6 X 1/4 U-TYPE
14	A-0465	1	DATA PLATE,CYLINDER SPEC STD
15	A-0941	2	MALE ELBOW,SS, 1/4T X 1/4P
16	PT0201CD	96.	" TUBING,316 SS 1/4 OD X .065
17	A-3563	2	HEX PIPE NIPPLE,SS, 1/4 X 1/8
100	HD-4176	1	CYL ASSY, 5-7/8K,HES

WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT
DOES NOT REPRESENT THE QUANTITY REQUIRED.



NOTES:

1. LOOSEN OR TIGHTEN ALL FASTENERS PER RECOMMENDED PROCEDURES AND TORQUE VALUES IN MANUAL.
2. APPLY AN ANTI-SEIZE LUBRICANT TO GASKET SURFACES (ITEM#2).
3. OIL O-RING (ITEM#5) BEFORE INSTALLING.
4. APPLY LOCTITE TO ITEM #12, TURN SETSCREW TO BOTTOM OF HOLE TO SECURE.

THIS ASSEMBLY DRAWING IS FOR ILLUSTRATION PURPOSES ONLY AND MAY NOT NECESSARILY REPRESENT THE EXACT CONFIGURATION PERTAINING TO THE UNIT ORDERED. REFER TO THE ACCOMPANYING PARTS LIST FOR ITEMS (AND QUANTITIES OF EACH) REQUIRED FOR THIS ASSEMBLY.

REV	DESCRIPTION	INIT/DATE
1		
2		
3		

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2	10873	REV	ECN
1	10217	REV	ECN

DRAWN:	CAH 3/28/96	APPROVED:	NONE
CHECKED:	4/11/96	SCALE:	NONE

ARIEL
ARIEL CORPORATION
 35 BLACKJACK ROAD
 MOUNT VERNON, OHIO 43050

ASSEMBLY
 DWG. NO. **A-6267**

6/29/06

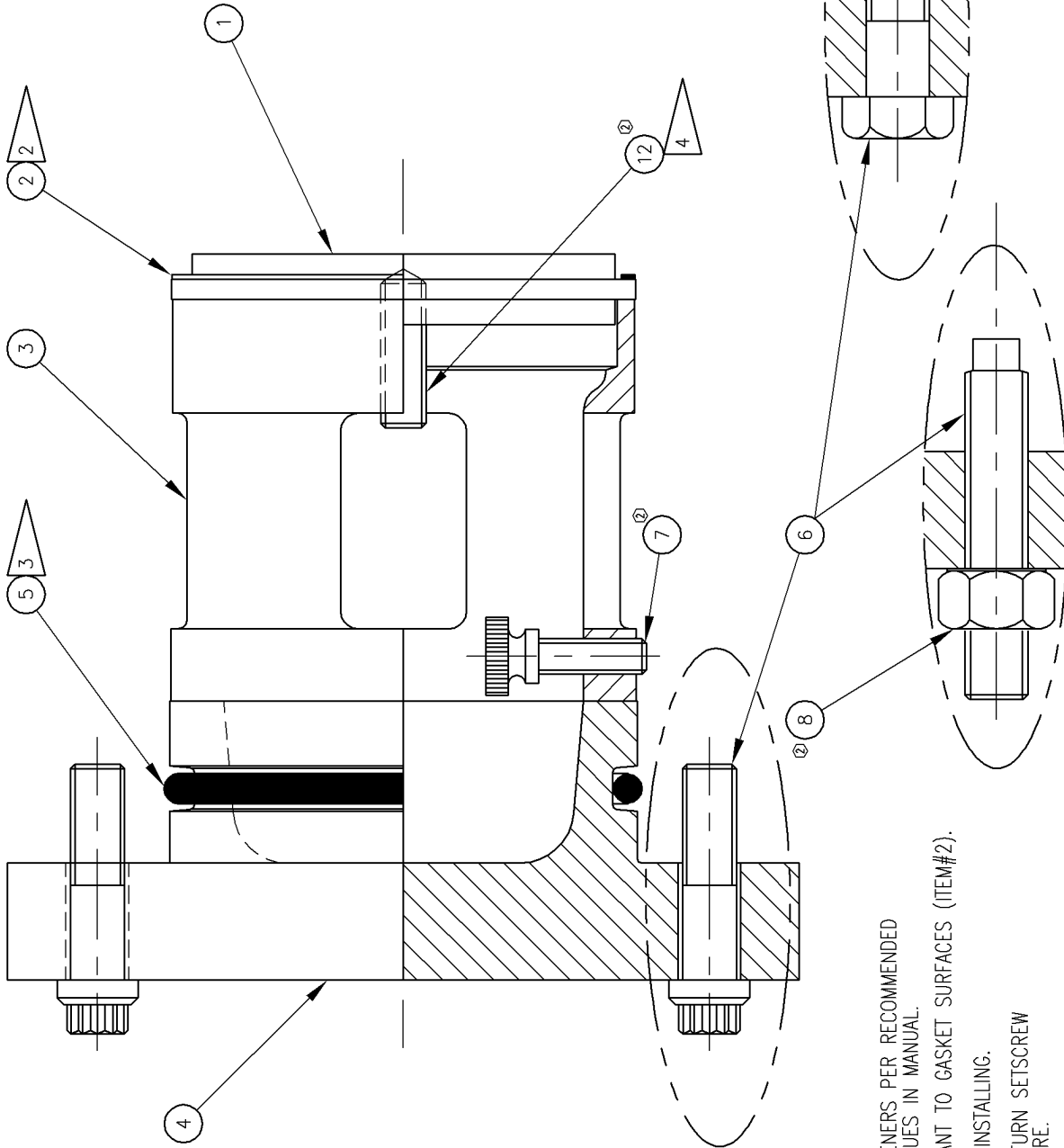
PARTS LIST

SUCTION VALVE, RETAINER AND CAP
6-1/4" JGK:T CLASS

PART NO. G-1744
REF DRAWING A-6267

ITEM NUMBER	PART NUMBER	QUANTITY	DESCRIPTION
1	SUCTION VALVE	0	FOR PART NO. SEE COVER SHEET
2	A-2126	1	STL GASKET, 4.861 X 4.543 X 30
3	B-1078	1	VLV RET,S&D, 6-1/4K,9-5/8K-CE
4	B-1138	0	VLV CAP, 6-1/4K:K-HP:C CL
5	A-2336	1	O-RING,VT, 4.887 O.D. X .139
6	FC0171GKL	6	12 PT,7/8-9 X 3-1/2 X 1-1/16G8

WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT
DOES NOT REPRESENT THE QUANTITY REQUIRED.



NOTES:

1. LOOSEN OR TIGHTEN ALL FASTENERS PER RECOMMENDED PROCEDURES AND TORQUE VALUES IN MANUAL.
2. APPLY AN ANTI-SEIZE LUBRICANT TO GASKET SURFACES (ITEM#2).
3. OIL O-RING (ITEM#5) BEFORE INSTALLING.
4. APPLY LOCTITE TO ITEM #12, TURN SETSCREW TO BOTTOM OF HOLE TO SECURE.

THIS ASSEMBLY DRAWING IS FOR ILLUSTRATION PURPOSES ONLY AND MAY NOT NECESSARILY REPRESENT THE EXACT CONFIGURATION PERTAINING TO THE UNIT ORDERED. REFER TO THE ACCOMPANYING PARTS LIST FOR ITEMS (AND QUANTITIES OF EACH) REQUIRED FOR THIS ASSEMBLY.

REV	DESCRIPTION	INIT/DATE
②	REVISED DRAWING: UPDATED ITEM #S TO CURRENT ITEM # ROTATION. ADDED VIEWS OF CAPSCREW AND STUD AND NUT. REVISED NOTE #5. THIS MAY NOT APPLY TO ALL ASSEMBLIES. ADDED ITEM #8 (NUT).	JCS 9/30/02

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2	10873	APPROVED:	SCALE:	NONE
1	10217	DRAWN:	CHECKED:	
0	6157	CAH 3/28/96	4/11/96	
REV	ECN			

ARIEL
ARIEL CORPORATION
 35 BLACKJACK ROAD
 MOUNT VERNON, OHIO 43050

ASSEMBLY
 DWG. NO. **A-6267**

6/29/06

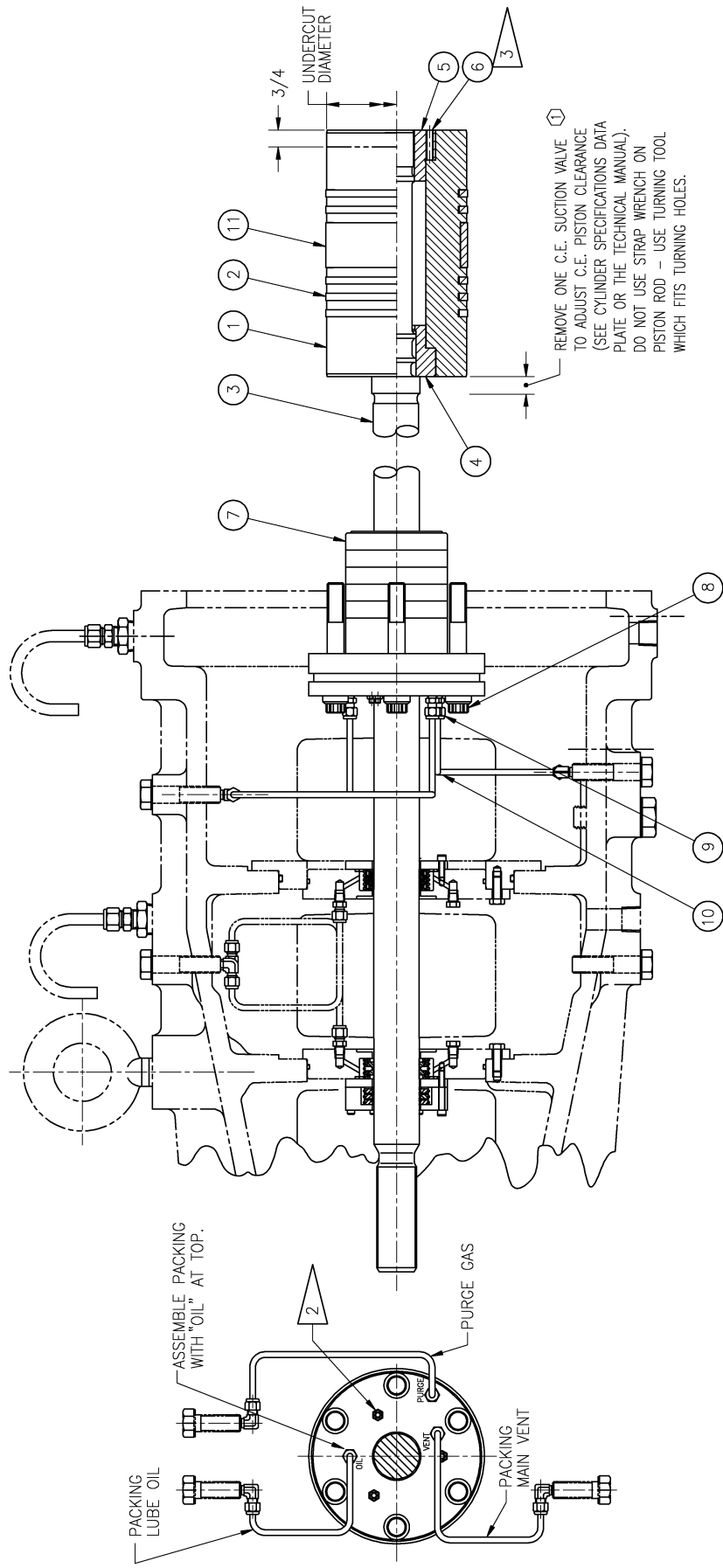
PARTS LIST

DISCHARGE VALVE, RETAINER, CAP
6-1/4" JGK:T CLASS CYLINDER

PART NO. G-1745
REF DRAWING A-6267

ITEM NUMBER	PART NUMBER	QUANTITY	DESCRIPTION
1	DISCHARGE VALV	0	FOR PART NO. SEE COVER SHEET
2	A-2126	1	STL GASKET, 4.861 X 4.543 X 30
3	B-1078	1	VLV RET,S&D, 6-1/4K,9-5/8K-CE
4	B-1138	0	VLV CAP, 6-1/4K:K-HP:C CL
5	A-2336	1	O-RING,VT, 4.887 O.D. X .139
6	FC0171GKL	6	12 PT,7/8-9 X 3-1/2 X 1-1/16G8

WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT
DOES NOT REPRESENT THE QUANTITY REQUIRED.



REMOVE ONE C.E. SUCTION VALVE
 TO ADJUST C.E. PISTON CLEARANCE
 (SEE CYLINDER SPECIFICATIONS DATA
 PLATE OR THE TECHNICAL MANUAL).
 DO NOT USE STRAP WRENCH ON
 PISTON ROD - USE TURNING TOOL
 WHICH FITS TURNING HOLES.

NOTES:

- 1 OIL O-RING BEFORE INSTALLING, (ON OPTIONAL TWO COMP. GUIDE ONLY).
- 2 RETIGHTEN TIE STUD NUTS AFTER CASE (ITEM#7) IS BOLTED INTO CYLINDER.
- 3 PRICK PUNCH TO RETAIN SETSCREW (ITEM#6).
4. LOOSEN OR TIGHTEN ALL FASTENERS PER RECOMMENDED PROCEDURES AND TORQUE VALUES IN MANUAL.

116900
 016123

ARIEL CORPORATION
 35 BLACKJACK ROAD
 MOUNT VERNON, OHIO 43050

ASSEMBLY
 DWG. No. **A-6230**

REV	DESCRIPTION
1	REVISED PISTON END CLEARANCE NOTE TO REFER TO DATA PLATE OR TECHNICAL MANUAL.

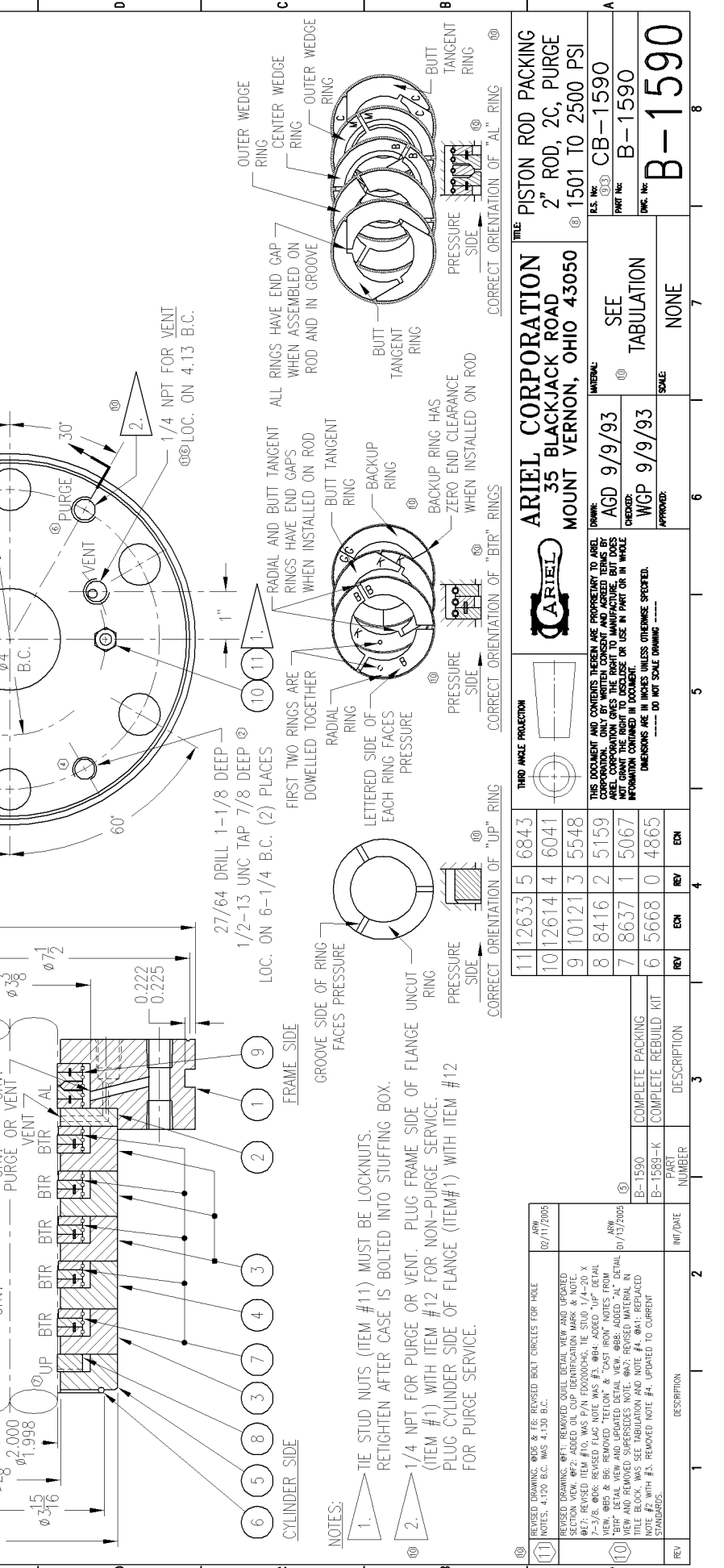
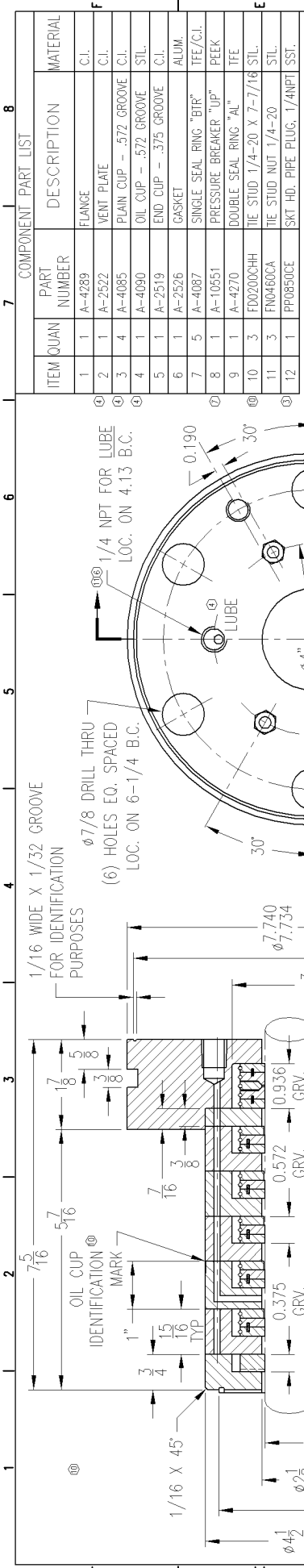
6/29/06

PARTS LIST

5-7/8"JGK PISTON, TFE RINGS, TFE WEAR PART NO. G-5544
BAND, PURGE PACKING, LONG TWO COMPARTMENT REF DRAWING A-6230
DISTANCE PIECE, STAINLESS STEEL PISTON
ROD, TUBING AND FITTINGS. 5-1/2" STROKE

ITEM NUMBER	PART NUMBER	QUANTITY	DESCRIPTION
1	C-1010	1	PISTON, WB, STD, 5-7/8K:K-HP
2	A-2332	5	PISTON RING, 5-7/8K:T:C:D-HP
3	C-1473	1	P ROD, SS, 5.50STK/51.440LG
4	B-2186	1	PISTON COLLAR, SS, K:K-HP&22.5H
5	B-1221	1	PISTON NUT, JGK:T, 3.5"OD
6	FS0405DH	2	CUP PT.SET-SCREW, 5/16-24X1-1/4
7	B-1590	1	PKG, 2.0, 2500, S2:L2, PU, BTR
8	FC0120IO	6	12 PT, 3/4-10 X 3 G8
9	A-0938	3	MALE CONN, SS, 1/4T X 1/4P
10	PT0201CD	45.00	" TUBING, 316 SS 1/4 OD X .065
11	A-2334	1	WEAR BAND, 5-7/8K:K-HP:C:C-HP
99	B-1589-K	0	RBLD KIT, PIST ROD PKG, 2.000
99	B-1806-K	0	RBLD KIT, WIPER PKG, 2.000, L2

WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT
DOES NOT REPRESENT THE QUANTITY REQUIRED.



COMPONENT PART LIST

ITEM QUAN	PART NUMBER	DESCRIPTION	MATERIAL
1	A-4289	FLANGE	C.I.
2	A-2522	VENT PLATE	C.I.
3	A-4085	PLAIN CUP - .572 GROOVE	C.I.
4	A-4090	OIL CUP - .572 GROOVE	SIL.
5	A-2519	END CUP - .375 GROOVE	C.I.
6	A-2526	GASKET	ALUM.
7	A-4087	SINGLE SEAL RING "BTR"	TEE/C.I.
8	A-10551	PRESSURE BREAKER "UP"	PEEK
9	A-4270	DOUBLE SEAL RING "AL"	TEE
10	F002000CH	TIE STUD 1/4-20 X 7-7/16	SIL.
11	FN04600CA	TIE STUD NUT 1/4-20	SIL.
12	PP08500CE	SKT HD. PIPE PLUG, 1/4NPT SST.	

NOTES:

- TIE STUD NUTS (ITEM #11) MUST BE LOCKNUTS. RETIGHTEN AFTER CASE IS BOLTED INTO STUFFING BOX.
- 1/4 NPT FOR PURGE OR VENT. PLUG FRAME SIDE OF FLANGE (ITEM #1) WITH ITEM #12 FOR NON-PURGE SERVICE. PLUG CYLINDER SIDE OF FLANGE (ITEM #1) WITH ITEM #12 FOR PURGE SERVICE.

REV	DESCRIPTION	INT/DATE
1	REVISED DRAWING. @B5 & T65 REVISED BOLT CIRCLES FOR HOLE NOTES. 4-130 B.C. W65 4-130 B.C.	02/17/2005
2	REVISED DRAWING. @P1: REMOVED QUILT DETAIL VIEW AND UPDATED SECTION VIEW. @P2: ADDED OIL CUP IDENTIFICATION MARK & NOTE. 7-1/8. @P6: REVISED FLANGE NOTE WAS P1. @P4: ADDED "UP" DETAIL VIEW. @B5 & B6: REMOVED "TELETON" & "CAST IRON" NOTES FROM "VERY" DETAIL VIEW AND UPDATED DETAIL VIEW. @B8: ADDED "AL" DETAIL VIEW AND REMOVED SUPERSEDES NOTE. @P2: REVISED MATERIAL IN TITLE BLOCK. WAS SEE TABULATION AND NOTE #4. @P4: REPLACED WITH #3. REVISED NOTE #4. UPDATED TO CURRENT STANDARDS.	09/13/2005

REV	DESCRIPTION	INT/DATE
1	COMPLETE PACKING	
2	COMPLETE REBUILD KIT	

THIRD ANGLE PROJECTION

ARIEL CORPORATION
35 BLACKJACK ROAD
MOUNT VERNON, OHIO 43050

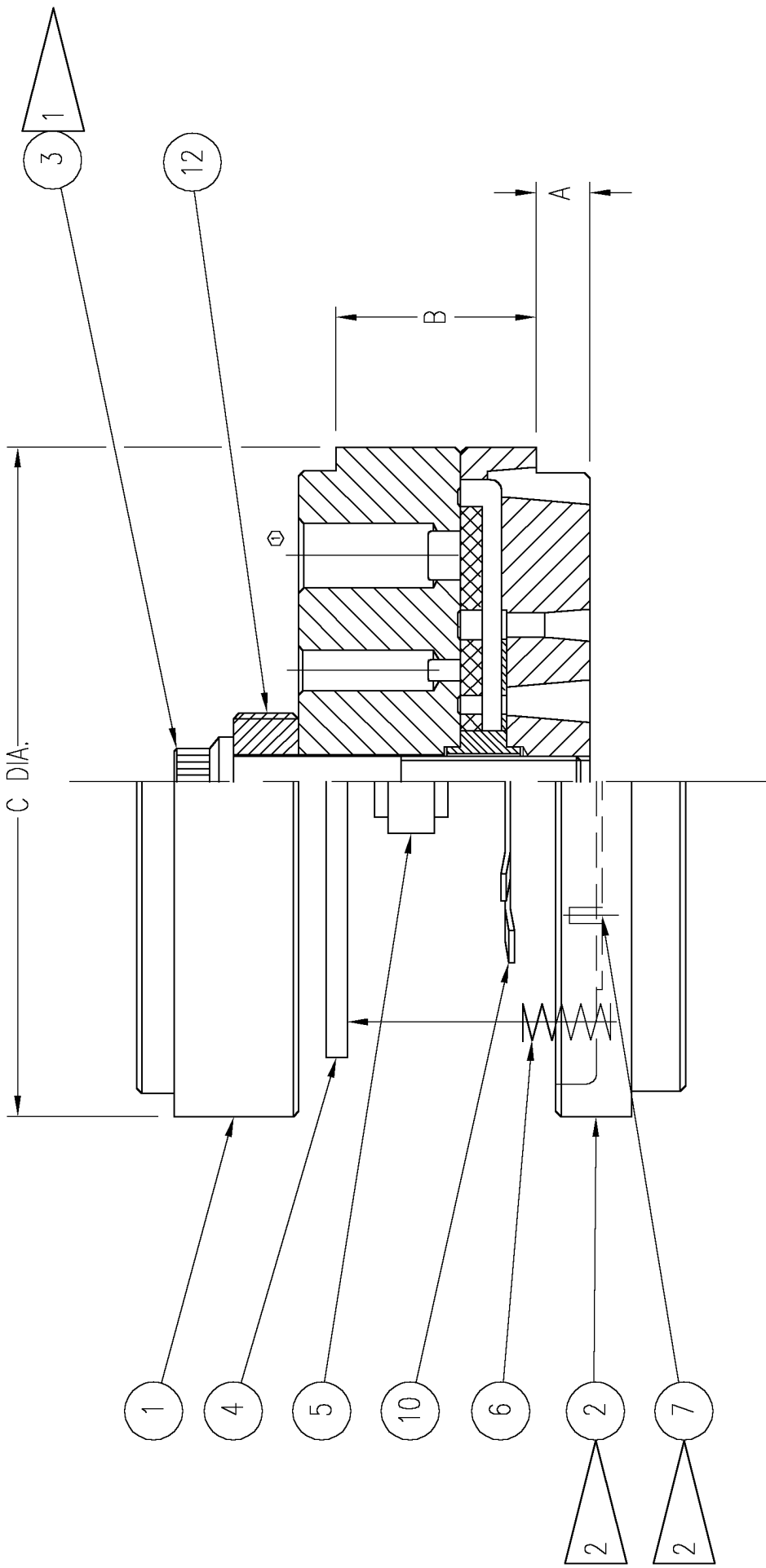
DATE: AGD 9/9/93
CHECKED: WGP 9/9/93
APPROVED:

SEE TABULATION

SCALE: NONE

U.S. INC. (313) CB-1590
PART NO: B-1590
INC. NO: B-1590

TITLE: PISTON ROD PACKING
2" ROD, 2C, PURGE
1501 TO 2500 PSI



NOTES:

- 1. FOR ASSEMBLY OF CENTER BOLT SEE ER-35.
- 2. VALVE GUARD ASSEMBLY (ITEM #2) CONSISTS OF VALVE GUARD, AND SPIROL PIN (ITEM #7).

ARIEL CORPORATION
 35 BLACKJACK ROAD
 MOUNT VERNON, OHIO 43050

TITLE: SUCTION VALVE, CT	
MATERIAL: PROCURED	R.S. No.
DRAWN: IG 9/27/99	PART NO.
CHECKED: ED 10/1/99	DWG. No: A-9265
SCALE: NONE	

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 DIMENSIONS ARE IN INCHES UNLESS OTHERWISE SPECIFIED.
 ---- DO NOT SCALE DRAWING ----
 DIMENSIONING AND TOLERANCING PER ARIEL SPECIFICATION ER-17.0.1 UNLESS OTHERWISE SPECIFIED.

REV	ECN
1	8549
0	7799

REV	DESCRIPTION
1	REMOVED THE OUTER RING FROM THE VALVE SEAT.

6/29/06

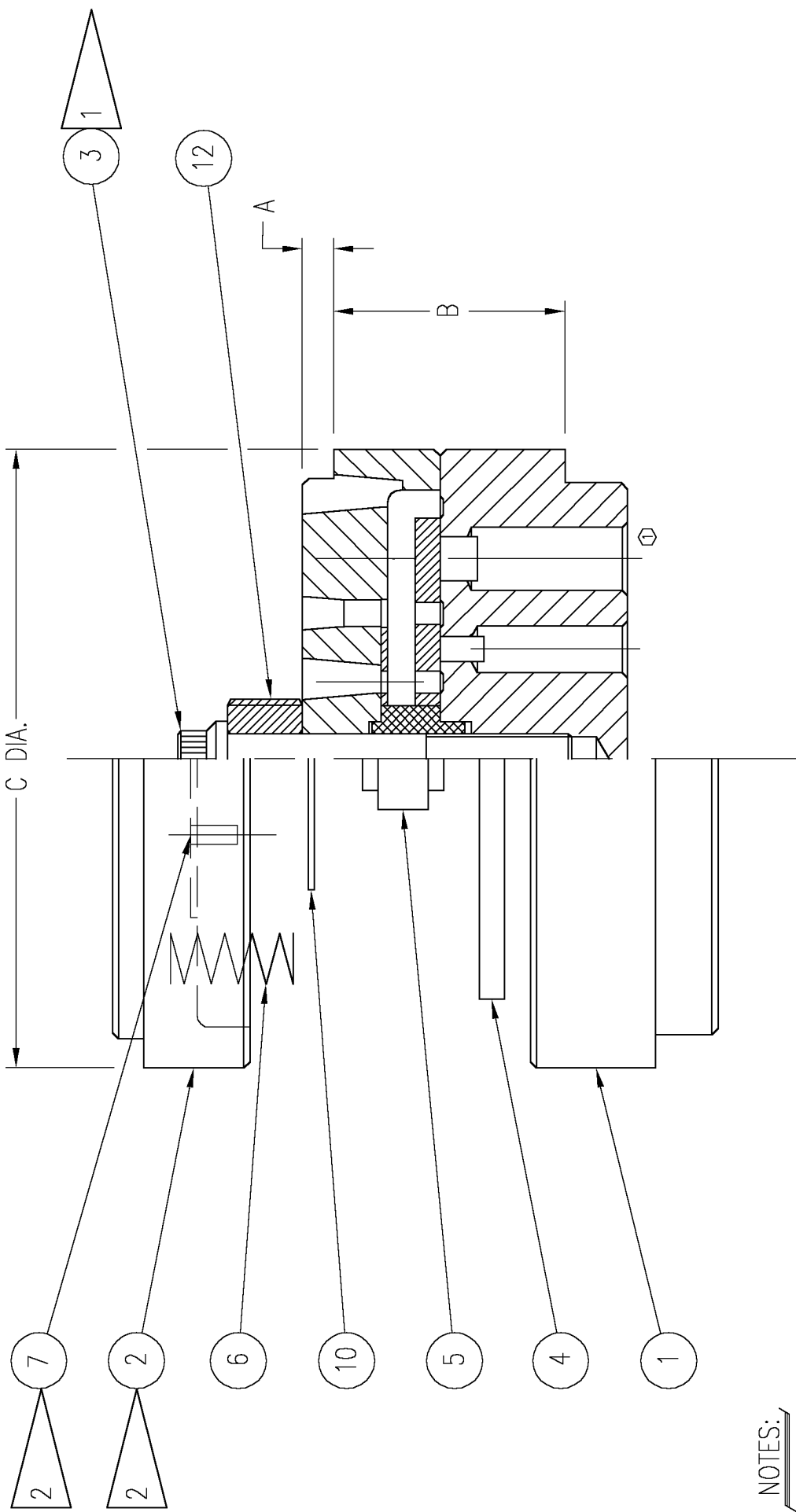
PARTS LIST

0.3940=A
1.4570=B
4.8760=C
0.1020=LFT

PART NO. B-1945-T
REF DRAWING A-9265

ITEM NUMBER	PART NUMBER	QUANTITY	DESCRIPTION
1	A-5991	1	SUC VLV SEAT,102CT ,SS,M/S
2	A-4499-A	1	SUC VLV GUARD ASSY,102CT ,SS
3	A-4585	1	CNTR.BLT,12PT,3/8-24X2-1/2,SS
4	A-4654	1	VLV PLT,102CT.236THK,NY
5	A-4500	1	GUIDE RING,102CT,378 THK,SS
6	A-4430	10	SPRING(.354X.669 BLUE)NMC 90
7	A-2039	2	SPIROL PIN,.118D X .591L
10	A-5994	1	WAFER SPR,102CT,NAC
12	A-2155	1	VLV WASHER,3/8ID X 1"-8 THD
99	KB-1945-T	0	KIT,VLV,102CT ,NY,SS,M/S

WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT
DOES NOT REPRESENT THE QUANTITY REQUIRED.



NOTES:

1. FOR ASSEMBLY OF CENTER BOLT SEE ER-35.
2. VALVE GUARD ASSEMBLY (ITEM #2) CONSISTS OF VALVE GUARD AND SPIRAL PIN (ITEM #7).

ARIEL CORPORATION
 35 BLACKJACK ROAD
 MOUNT VERNON, OHIO 43050



DISCHARGE VALVE, CT

MATERIAL: PROCURED	
DRAWN: IG 9/27/99	R.S. No.
CHECKED: ED 10/1/99	PART NO.
SCALE: NONE	DWG. No: A-9264

1	8549	REV	ECN
0	7799	REV	ECN

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 DIMENSIONS ARE IN INCHES UNLESS OTHERWISE SPECIFIED.
 ---- DO NOT SCALE DRAWING ----
 DIMENSIONING AND TOLERANCING PER ARIEL SPECIFICATION ER-17.0.1 UNLESS OTHERWISE SPECIFIED.

1	REMOVED OUTER RING FROM THE VALVE SEAT.
REV	DESCRIPTION

6/29/06

PARTS LIST

0.2750 =A
1.4570 =B
4.9010 =C
0.0750 =LFT

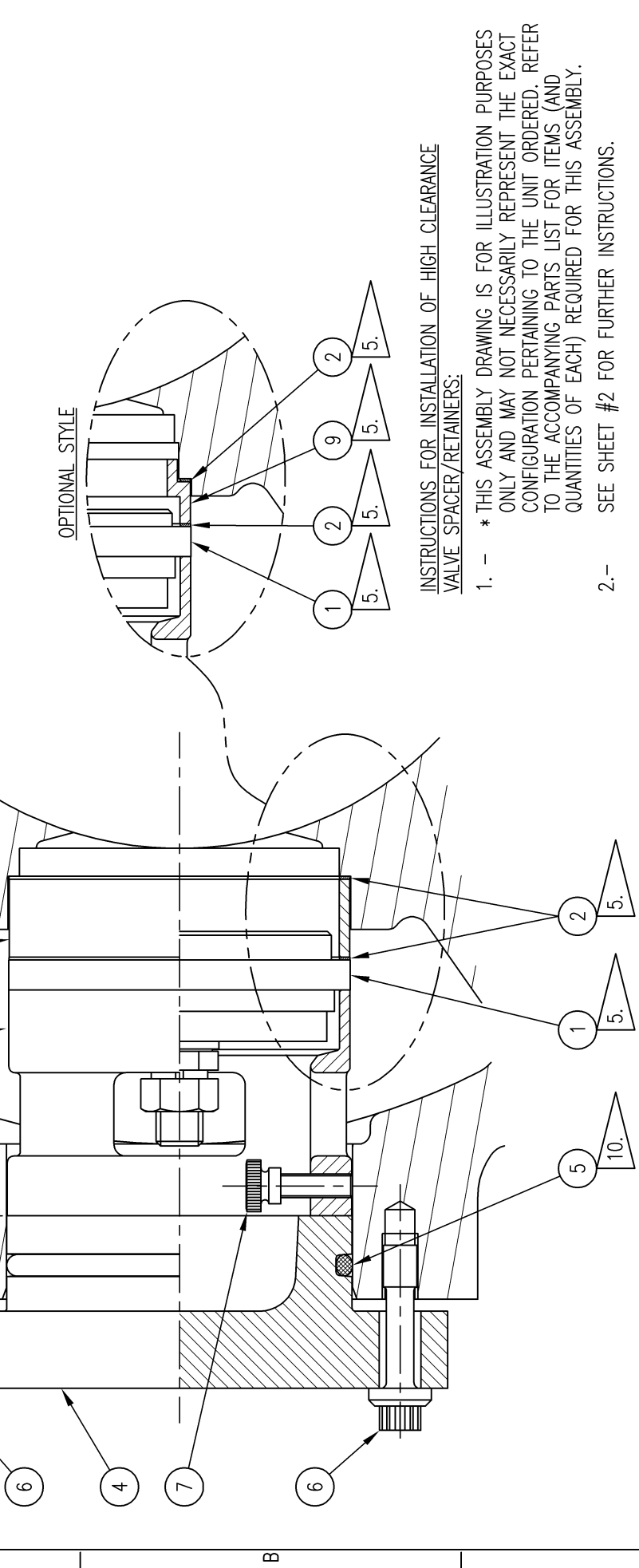
PART NO. B-3325-CC
REF DRAWING A-9264

ITEM NUMBER	PART NUMBER	QUANTITY	DESCRIPTION
1	A-5992	1	DIS VLV SEAT,102CT ,SS,M/S
2	A-4502-A	1	DIS VLV GUARD ASSY,102CT ,SS
3	A-4682	1	CNTR.BLT,12PT,3/8-24X2-1/8,SS
4	A-8186	1	VLV PLT,102CT.256THK,MT
5	A-4376	1	GUIDE RING,90CT,.370 THK,SS
6	A-4434	20	SPRING(.354X.610 WHITE)NMC 90
7	A-2039	2	SPIROL PIN,.118D X .591L
10	A-5994	1	WAFER SPR,102CT,NAC
12	A-2155	1	VLV WASHER,3/8ID X 1"-8 THD
99	KB-3325-CC	0	KIT,VLV,102CT ,SS,MT,M/S

WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT
DOES NOT REPRESENT THE QUANTITY REQUIRED.

1 2 3 4

ITEM	QTY	DESCRIPTION
1	1	VALVE
2	2	GASKET, STEEL
3	1	VALVE RETAINER, HIGH CLEARANCE ASS'Y
4	1	VALVE CAP
5	1	O-RING
6	*	CAPSCREWS OR DOG POINT STUDS
7	*	THUMBSCREW
8	*	HEX NUT
9	1	VALVE SPACER, HIGH CLEARANCE ASS'Y



INSTRUCTIONS FOR INSTALLATION OF HIGH CLEARANCE VALVE SPACER/RETAINERS:

1. -- * THIS ASSEMBLY DRAWING IS FOR ILLUSTRATION PURPOSES ONLY AND MAY NOT NECESSARILY REPRESENT THE EXACT CONFIGURATION PERTAINING TO THE UNIT ORDERED. REFER TO THE ACCOMPANYING PARTS LIST FOR ITEMS (AND QUANTITIES OF EACH) REQUIRED FOR THIS ASSEMBLY.
2. -- SEE SHEET #2 FOR FURTHER INSTRUCTIONS.

REV	DESCRIPTION	INIT/DATE
0	12367	
REV	ECN	DAH 12/15/04
0	12367	DAH 12/15/04
APPROVED:	ASSEMBLY DWG. NO.	SHEET
		1 OF 2
<p>ARIEL CORPORATION 35 BLACKJACK ROAD MOUNT VERNON, OHIO 43050</p>		<p>A-12945</p>

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A B C

6/29/06

PARTS LIST

HIGH CLEARANCE SUCTION VALVE SPACER
AND RETAINER
6-1/4" JGK CYLINDER CLASS

PART NO. G-1775
REF DRAWING A-12945 2 SHT



ITEM NUMBER	PART NUMBER	QUANTITY	DESCRIPTION
1	SUCTION VALVE	0	FOR PART NO. SEE COVER SHEET
2	A-2126	2	STL GASKET, 4.861 X 4.543 X 30
3	B-1171	1	HCL VLV RET,S&D, 6-1/4K CL
4	B-1138	0	VLV CAP, 6-1/4K:K-HP:C CL
5	A-2336	1	O-RING,VT, 4.887 O.D. X .139
6	FC0171GKL	0	12 PT,7/8-9 X 3-1/2 X 1-1/16G8
9	A-2382	1	HCL VLV SPCR,SUC, 6-1/4K:C CL

WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT
DOES NOT REPRESENT THE QUANTITY REQUIRED.

INSTRUCTIONS FOR INSTALLING HIGH CLEARANCE VALVE SPACER/RETAINERS: Cont.

WARNING:

BEFORE ATTEMPTING TO REMOVE ANY VALVE CAP, BE VERY CERTAIN THAT ALL GAS PRESSURE HAS BEEN VENTED FROM THE CYLINDER. PRESSURE MUST BE COMPLETELY VENTED FROM BOTH THE SUCTION AND DISCHARGE PASSAGES OF THE CYLINDER.

- 3.- REMOVE VALVE CAP AND EXTRACT EXISTING VALVE RETAINER, VALVE AND GASKET.
- 4.- AFTER CLEANING AND INSPECTING THE VALVE POCKET BORE, INSTALL A NEW METALLIC GASKET COATED WITH AN ANTI-SEIZE LUBRICANT TO RETAIN IT IN POSITION WHILE THE REMAINDER OF THE ASSEMBLY IS INSERTED.
5.  ASSEMBLE VERTICALLY; THE SPACER, METALLIC GASKET (COATED WITH AN ANTI-SEIZE LUBRICANT), VALVE AND NEW VALVE RETAINER. IF ADDITIONAL CLEARANCE IS NOT REQUIRED REMOVE THE SPACER AND USE THE STANDARD RETAINER. THE SPACER IS NOT DESIGNED TO BE PLACED BETWEEN THE VALVE AND RETAINER
- 6.- THREAD THE VALVE PULLER ONTO VALVE CENTER BOLT AND PICK UP THE ASSEMBLY HOLDING THE SPACER AND NEW VALVE RETAINER IN POSITION.
- 7.- INSERT THE ASSEMBLY INTO THE APPROPRIATE VALVE POCKET. TO CHECK IF THE VALVE ASSEMBLY IS SEATED PROPERLY TWIST THE VALVE PULLER HANDLE CLOCKWISE. IF SEATED PROPERLY THE ASSEMBLY SHOULD SPIN. TO ENSURE THE VALVE ASSEMBLY IS FULLY "HOME", MEASURE DISTANCE #1 FROM THE TOP OF THE VALVE RETAINER TO THE EDGE OF THE VALVE POCKET BORE. MEASURE THE NOSE LENGTH ON THE VALVE CAP, DISTANCE #2 AND SUBTRACT DIMENSION #1 FROM IT. 1/8" WILL BE THE RESULT. IF YOU HAVE A VALUE GREATER THAN 1/8" CALL THE ARIEL RESPONSE CENTER AT 1-888-397-7766 (NORTH AMERICA) OR 1-740-397-3602 (INTERNATIONAL) FOR ASSISTANCE.
- 8.- HOLD THE VALVE ASSEMBLY IN VALVE POCKET USING HAND AND UNTHREAD THE VALVE PULLER.
- 9.- WHILE STILL HOLDING THE VALVE ASSEMBLY IN VALVE POCKET, TIGHTENING THE THUMBSCREWS (PROVIDED ON DISCHARGE RETAINER ONLY).
10.  INSTALL OILED, NEW O-RING ON THE VALVE CAP AND INSERT IN THE VALVE POCKET.
- 11.- INSTALL CAP SCREWS AND TIGHTEN EVENLY, IN SMALL STEPS, TO PROPER TORQUE PER ER-63.

NOTE:

IF ASSEMBLED CORRECTLY, THERE SHOULD BE AN 1/8" GAP BETWEEN THE VALVE CAP AND THE CYLINDER VALVE PAD.

REV	DESCRIPTION	INIT/DATE

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0	12367	DRAWN: ARW 12/15/04	APPROVED:	ASSEMBLY DWG. NO.
REV	ECN	CHECKED: DAH 12/15/04	SCALE:	NONE

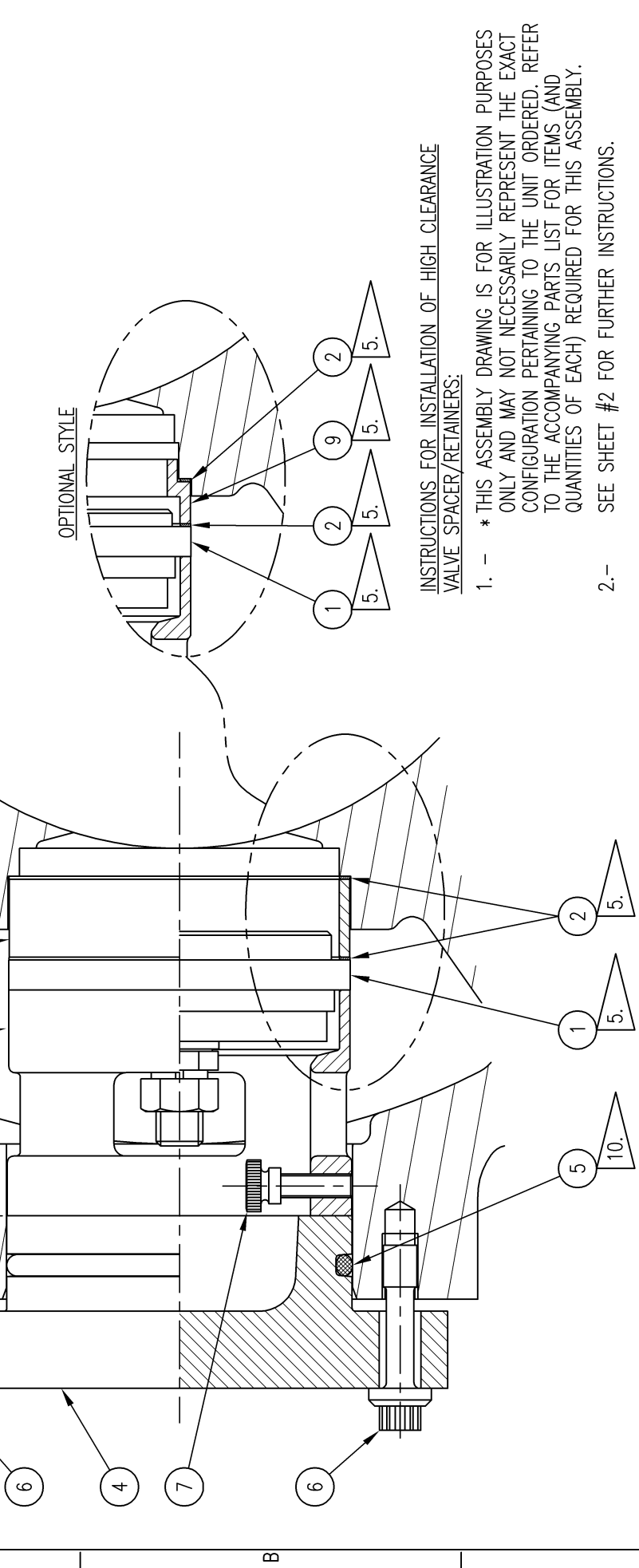


ARIEL CORPORATION
35 BLACKJACK ROAD
MOUNT VERNON, OHIO 43050

ASSEMBLY DWG. NO.
A-12945
SHEET
2 OF 2

1 2 3 4

ITEM	QTY	DESCRIPTION
1	1	VALVE
2	2	GASKET, STEEL
3	1	VALVE RETAINER, HIGH CLEARANCE ASS'Y
4	1	VALVE CAP
5	1	O-RING
6	*	CAPSCREWS OR DOG POINT STUDS
7	*	THUMBSCREW
8	*	HEX NUT
9	1	VALVE SPACER, HIGH CLEARANCE ASS'Y



INSTRUCTIONS FOR INSTALLATION OF HIGH CLEARANCE VALVE SPACER/RETAINERS:

1. -- * THIS ASSEMBLY DRAWING IS FOR ILLUSTRATION PURPOSES ONLY AND MAY NOT NECESSARILY REPRESENT THE EXACT CONFIGURATION PERTAINING TO THE UNIT ORDERED. REFER TO THE ACCOMPANYING PARTS LIST FOR ITEMS (AND QUANTITIES OF EACH) REQUIRED FOR THIS ASSEMBLY.
2. -- SEE SHEET #2 FOR FURTHER INSTRUCTIONS.

<p>ARIEL CORPORATION 35 BLACKJACK ROAD MOUNT VERNON, OHIO 43050</p>		APPROVED: DWG. NO. A-12945
DRAWN: ARW 12/15/04 CHECKED: DAH 12/15/04	REV ECN SCALE: NONE	SHEET 1 OF 2

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6/29/06

PARTS LIST

HIGH CLEARANCE DISCHARGE VALVE SPACER
AND RETAINER
6-1/4" JGK:T CYLINDER CLASS

PART NO. G-1776
REF DRAWING A-12945 2 SHT



ITEM NUMBER	PART NUMBER	QUANTITY	DESCRIPTION
1	DISCHARGE VALV	0	FOR PART NO. SEE COVER SHEET
2	A-2126	2	STL GASKET, 4.861 X 4.543 X 30
3	B-1171	1	HCL VLV RET,S&D, 6-1/4K CL
4	B-1138	0	VLV CAP, 6-1/4K:K-HP:C CL
5	A-2336	1	O-RING,VT, 4.887 O.D. X .139
6	FC0171GKL	0	12 PT,7/8-9 X 3-1/2 X 1-1/16G8
7	A-0145	2	THUMB SCREW,NYLON,1/4-20 X 3/4
9	A-2383	1	HCL VLV SPCR,DIS, 6-1/4K:C CL

WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT
DOES NOT REPRESENT THE QUANTITY REQUIRED.

INSTRUCTIONS FOR INSTALLING HIGH CLEARANCE VALVE SPACER/RETAINERS: Cont.

WARNING:

BEFORE ATTEMPTING TO REMOVE ANY VALVE CAP, BE VERY CERTAIN THAT ALL GAS PRESSURE HAS BEEN VENTED FROM THE CYLINDER. PRESSURE MUST BE COMPLETELY VENTED FROM BOTH THE SUCTION AND DISCHARGE PASSAGES OF THE CYLINDER.

- 3.- REMOVE VALVE CAP AND EXTRACT EXISTING VALVE RETAINER, VALVE AND GASKET.
- 4.- AFTER CLEANING AND INSPECTING THE VALVE POCKET BORE, INSTALL A NEW METALLIC GASKET COATED WITH AN ANTI-SEIZE LUBRICANT TO RETAIN IT IN POSITION WHILE THE REMAINDER OF THE ASSEMBLY IS INSERTED.
5.  ASSEMBLE VERTICALLY; THE SPACER, METALLIC GASKET (COATED WITH AN ANTI-SEIZE LUBRICANT), VALVE AND NEW VALVE RETAINER. IF ADDITIONAL CLEARANCE IS NOT REQUIRED REMOVE THE SPACER AND USE THE STANDARD RETAINER. THE SPACER IS NOT DESIGNED TO BE PLACED BETWEEN THE VALVE AND RETAINER
- 6.- THREAD THE VALVE PULLER ONTO VALVE CENTER BOLT AND PICK UP THE ASSEMBLY HOLDING THE SPACER AND NEW VALVE RETAINER IN POSITION.
- 7.- INSERT THE ASSEMBLY INTO THE APPROPRIATE VALVE POCKET. TO CHECK IF THE VALVE ASSEMBLY IS SEATED PROPERLY TWIST THE VALVE PULLER HANDLE CLOCKWISE. IF SEATED PROPERLY THE ASSEMBLY SHOULD SPIN. TO ENSURE THE VALVE ASSEMBLY IS FULLY "HOME", MEASURE DISTANCE #1 FROM THE TOP OF THE VALVE RETAINER TO THE EDGE OF THE VALVE POCKET BORE. MEASURE THE NOSE LENGTH ON THE VALVE CAP, DISTANCE #2 AND SUBTRACT DIMENSION #1 FROM IT. 1/8" WILL BE THE RESULT. IF YOU HAVE A VALUE GREATER THAN 1/8" CALL THE ARIEL RESPONSE CENTER AT 1-888-397-7766 (NORTH AMERICA) OR 1-740-397-3602 (INTERNATIONAL) FOR ASSISTANCE.
- 8.- HOLD THE VALVE ASSEMBLY IN VALVE POCKET USING HAND AND UNTHREAD THE VALVE PULLER.
- 9.- WHILE STILL HOLDING THE VALVE ASSEMBLY IN VALVE POCKET, TIGHTENING THE THUMBSCREWS (PROVIDED ON DISCHARGE RETAINER ONLY).
10.  INSTALL OILED, NEW O-RING ON THE VALVE CAP AND INSERT IN THE VALVE POCKET.
- 11.- INSTALL CAP SCREWS AND TIGHTEN EVENLY, IN SMALL STEPS, TO PROPER TORQUE PER ER-63.

NOTE:

IF ASSEMBLED CORRECTLY, THERE SHOULD BE AN 1/8" GAP BETWEEN THE VALVE CAP AND THE CYLINDER VALVE PAD.

REV	DESCRIPTION	INIT/DATE

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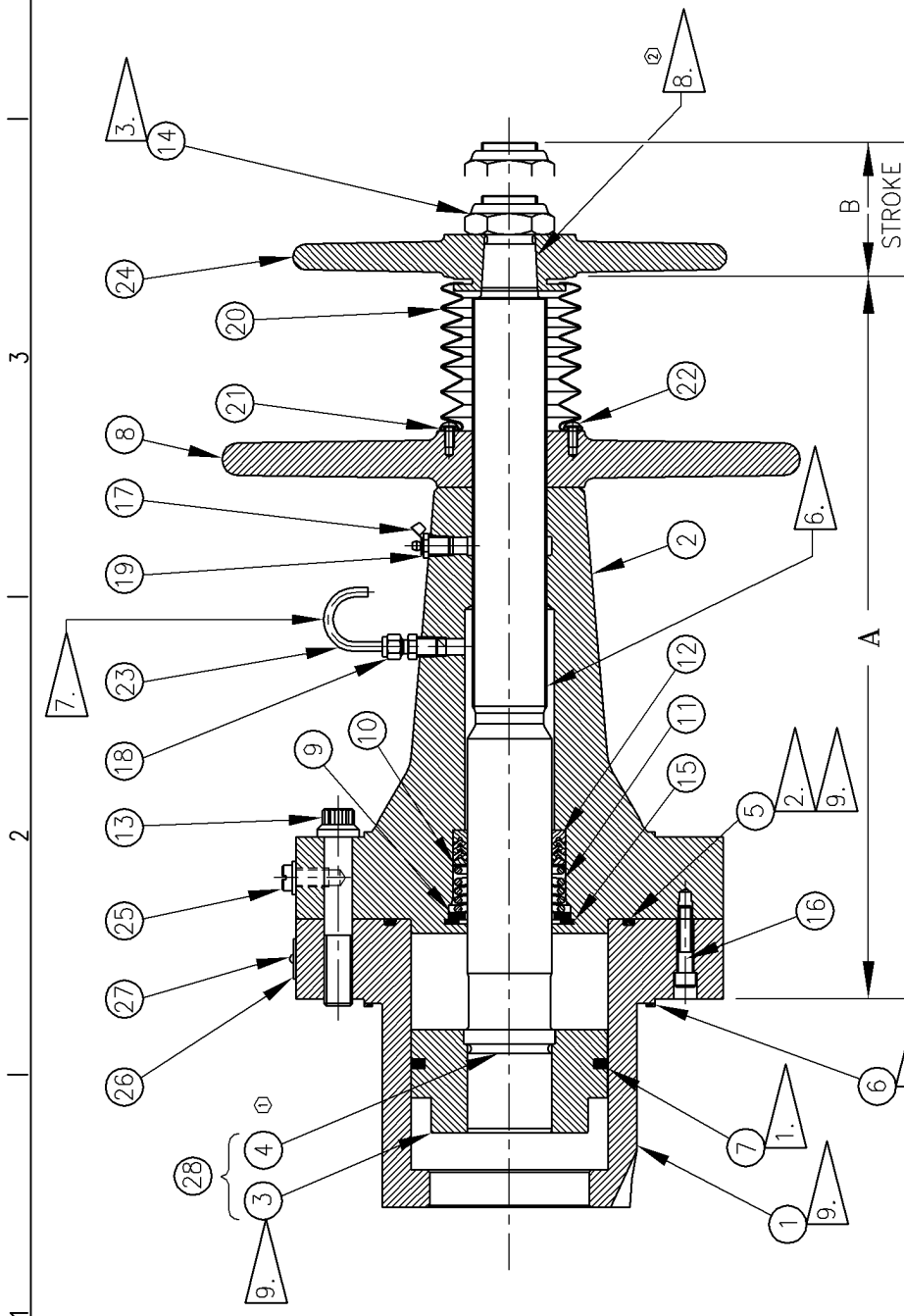
0	12367	DAH	12/15/04	SCALE	NONE
REV	ECN	CHECKED	DRAWN	APPROVED	ASSEMBLY DWG. NO.



ARIEL CORPORATION
 35 BLACKJACK ROAD
 MOUNT VERNON, OHIO 43050

ASSEMBLY DWG. NO. **A-12945**
 SHEET 2 OF 2

"B" DIM.	"A" DIM.	UNLOADER
4-3/4	18-1/2	5-7/8KU
4-3/4	18-1/2	6-1/4KU
4-1/2	19-1/2	6-3/4KU
4-1/2	19-1/2	7-1/4KU



NOTES:

1. LIGHTLY OIL BORE AND RING BEFORE INSTALLING.
 2. OIL O-RING BEFORE INSTALLING.
 3. TORQUE ITEM 14 TO 30 FT-LBS, THEN TORQUE 2-1/2 FLATS OR 300 FT-LBS MAX.
 4. LOOSEN OR TIGHTEN ALL BOLTS PER RECOMMENDED PROCEDURES AND TORQUE VALUES IN MANUAL.
 5. APPLY AN ANTI-SEIZE LUBRICANT TO GASKET (ITEM 6) SURFACES.
 6. APPLY AN ANTI-SEIZE LUBRICANT TO STEM THREADS BEFORE ASSEMBLING.
7. VENT TUBE ALWAYS POINTED DOWN.
8. ACCEPTANCE OF TAPER FIT WILL BE DETERMINED AT THE ASSEMBLY OF COMPONENTS. HANDLE TO STEM FIT MUST BE TIGHT.
9. CAUTION: FOR NON-LUBE APPLICATIONS REFER TO TECHNICAL MANUAL FOR SPECIAL PROCEDURES FOR THESE ITEMS.

3	AT 1 - ADDED FLAG NOTE #9 TO ITEMS 1,3, AND 5.	ALH	02/26/02
REV	DESCRIPTION	INIT/DATE	

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3	10035	3	10035	3	10035
2	10297	2	10297	2	10297
1	7854	1	7854	1	7854
0	3799	0	3799	0	3799
REV	ECN	DRAWN	CH	APPROVED:	
		05/09/89			
		CHECKED:	05/10/89	SCALE:	NONE
ARIEL CORPORATION 35 BLACKJACK ROAD MOUNT VERNON, OHIO 43050					
				ASSEMBLY	D-1134
				DWG. NO.	

6/29/06

ARIEL CORP. - BLACKJACK DIV. C/N: 001
SALES ORDER COVER SHEET

RHCOVP02

SERIAL NUMBER: U-51912 & 14

PART: G-11813 DESCRIPTION: VVCP, 5-7/8K:C:K-HP:T

5-7/8" JGK:T:K-HP:C UNLOADER ASSEMBLY, PART NO. G-11813
STAINLESS STEEL TUBING AND FITTINGS. REF DRAWING D-1134

ITEM

NUMBER	PART NUMBER	QUANTITY	DESCRIPTION
1	C-0979	1	UNL.HEAD, 5-7/8KU:C
2	C-0975	1	HE UNL ADPTR, 6-1/4K:C CL
3	B-3861	0	UNL PIST, 6-1/4 & 5-7/8KCZ
4	C-3983	0	UNL.STEM,7-1/4 & 6-1/4KCZ
5	A-0028	1	O-RING,VT, 5.645 O.D. X .210
6	A-2331	1	STL GASKET, 6.813 X 6.375 X 60
7	A-2357	1	UNL.PISTON RING, 4-1/4 O.D.
8	C-0369	1	LOCKING HANDLE,UNL,2"THD
9	A-2388	1	UNL SPRING RETAINER
10	A-0643	1	BACK-UP RING, PACKING
11	A-0629	1	COMPRESSION SPRING, UNL.
12	A-0639	1	V PACKING, UNL
13	FC0120JV	14	12 PT,7/8-9 X 5-1/2 G8
14	A-2389	1	SELF-LOCK NUT,ESNA,TN,1-3/8-12
15	A-2391	1	SNAP RING,SS,INT,3-1/4 BORE
16	FC0110EK	2	SOC HD CAP,3/8-16 X 2 G8
17	A-0500	1	GREASE FITTING CAP, PLASTIC
18	A-0938	1	MALE CONN,SS, 1/4T X 1/4P
19	PZ0230BA	1	STRAIGHT GREASE FITTING,1/4-18
20	A-2387	1	BELLOWS, UNL.THREAD PROTECTOR
21	A-0642	1	BACK-UP RING, BELLOWS

6/29/06

SALES ORDER COVER SHEET

22	FC0134CC	3	BUT HD CAP,1/4-20 X 1/2 316SS
23	PT0201CD	5.	" TUBING,316 SS 1/4 OD X .065
24	C-0982	1	HANDLE,UNL,3 PRONG
25	A-0467	1	PUSH IN PLUG,PL, 3/8,YELLOW
26	A-0755	1	DATA PLATE,UNLOADER SPEC
26	A-12927	1	DATA PLATE,UNLOADER POSITION
27	FR0570CC	2	DRIVE SCREW, #6 X 1/4 U-TYPE
28	AC-3984	1	UNL PIST ASY,6-1/4 & 5-7/8KCZ

VARIABLE VOLUME CLEARANCE POCKET (Headend Unloader) DATA SHEET

6-1/4K Class Cylinder

Stroke: 5.50 in 140 mm
 Bore: 5.875 in 149 mm
 MAWP: 2050 psi 141.3 barg 14134 kPa(g)

General Data for VVCP (independent of cylinder):

MAWP*:	2435	167.9 barg	16789 kPa(g)	<small>*Note: If VVCP services another cylinder, it may have a higher MAWP than the above cylinder.</small>
VVCP piston diameter:	4.25 in	108 mm		
Stem thread lead (pitch):	0.125 in	3 mm		
Total travel:	4.75 in	12.1 cm		
Number of turns from closed to fully open:		38.0		
Minimum added fixed clearance:	1.0 in3	16 cm3		
Additional added clearance when fully open:	67.4 in3	1104 cm3		
Total added clearance when fully open:	68.3 in3	1120 cm3		
Clearance volume change per turn:	1.8 in3	29.1 cm3		
Clearance volume change per change in travel:	14.2 in3/in	91.5 cm3/cm		

Clearance Data for VVCP alone, in percent of swept volume of above cylinder:

Minimum added fixed clearance:	0.6%
Additional added clearance when fully open:	45.2%
Total added clearance when fully open:	45.8%
Head end clearance change per turn:	1.2%
Head end clearance change per change in travel:	9.5% /in 3.7% /cm

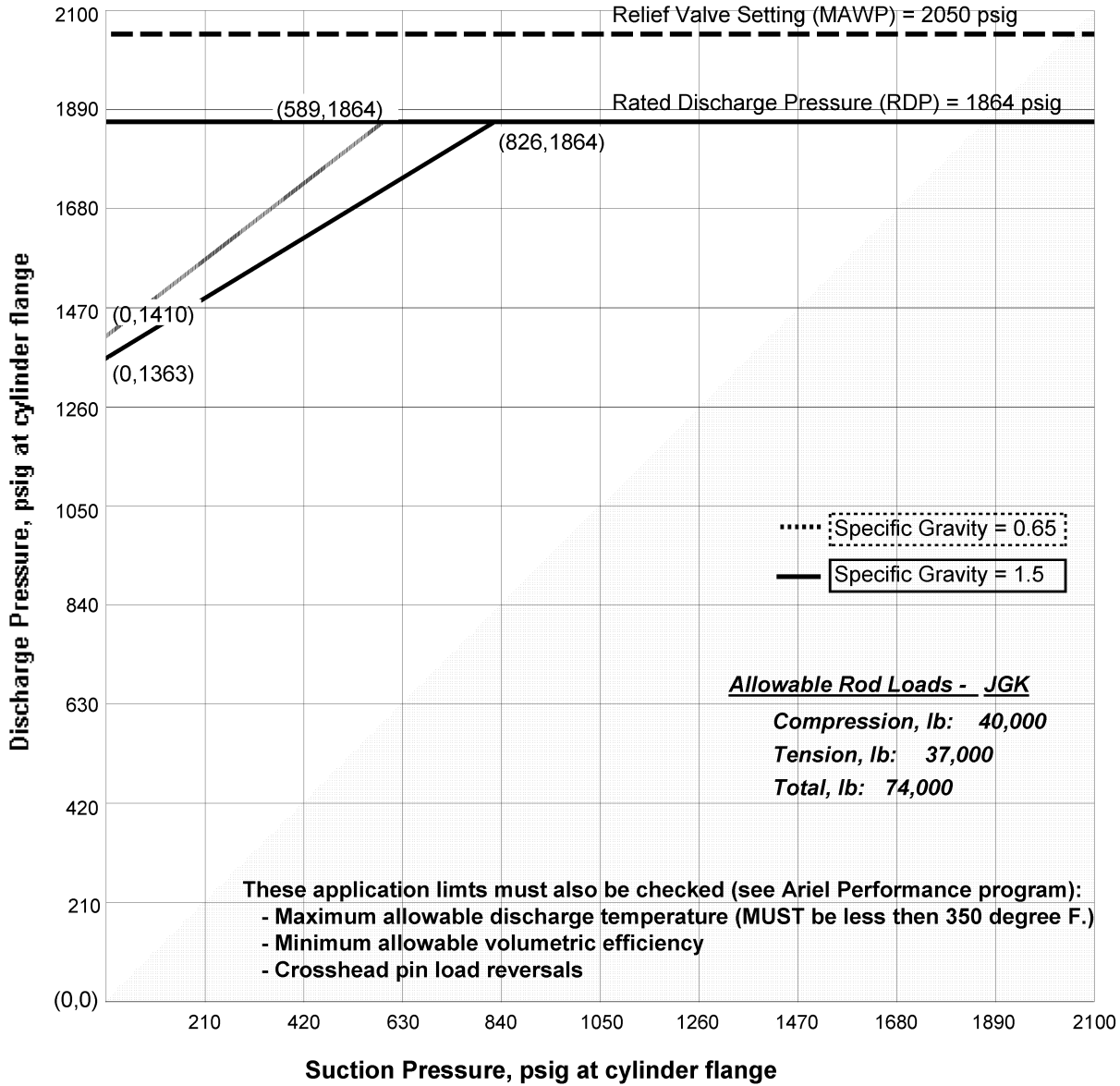
Clearance Data with VVCP installed on above cylinder with standard valves, in percent of swept volume:

Minimum fixed head end clearance:	22.6%
Total head end clearance when fully open:	67.8%

PLEASE NOTE: It is important to understand that the percent clearance figures for the variable volume clearance pocket above include the cylinder headend clearance. However, any valve spacers or other non-standard added clearances on the unit must be accounted for.

Estimated Gas Rod Load and Pressure Limits for 5.5 inch stroke at 1200 RPM

Cylinder Class: 6-1/4K Bore, inches: 5.875
 Cylinder Serial Number: C-82051 & 53



This chart defines allowable operating limits for gas rod loads and standard working pressures. Pressure combinations falling above the line for the applicable Specific Gravity of the gas being compressed will exceed the Rod Load limitations of the equipment.

Calculations are based on 80 degrees Fahrenheit hydrocarbon gas at 1500 ft. elevation.

6/29/06

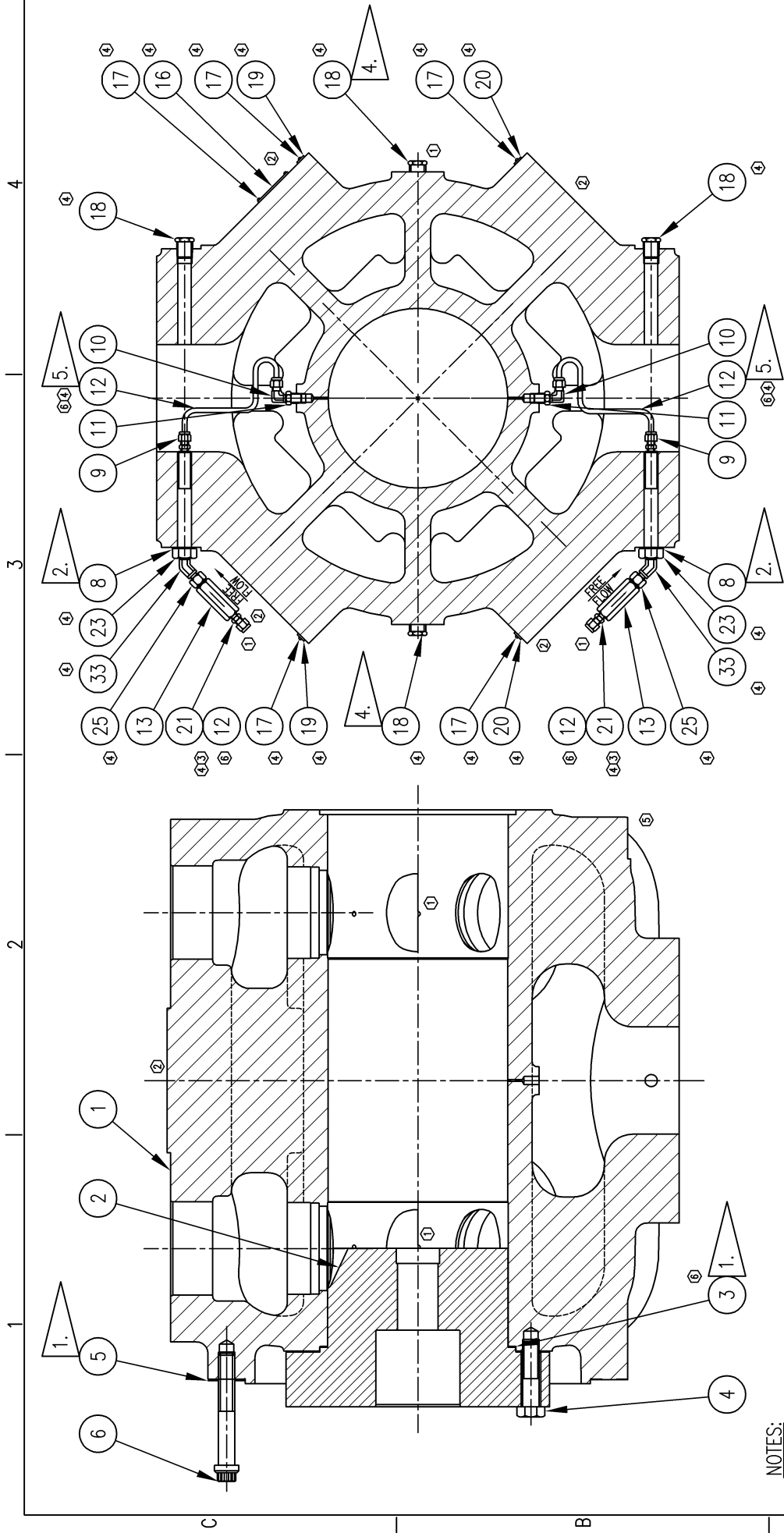
ARIEL CORP. - BLACKJACK DIV. C/N: 001
SALES ORDER COVER SHEET

RHCOVP02

SERIAL NUMBER: C-82052 & 54

PART: 9-5/8K CLASS DESCRIPTION: 9-5/8" JGK:T CYLINDER CLASS

PART NUMBER	QUANTITY	DESCRIPTION	DRAWING NO.
G-12500	1	CYL ASSY, 9-1/8K:T,SF,HES 1270	A-4083
G-1646	4	SUC VLV ASSY,9-5/8KC,K-CE,C-CE	A-6700
G-1647	4	DIS VLV ASSY, 9-5/8K:C,KC-CE	A-6700
G-9033	1	PIST. 9-1/8K,WB,2PC,PU,L2,SR/F	A-10319
B-1945-S	4	SUC VLV,102CT ,NY,SS,M/S	A-9265
B-3325-BB	4	DIS VLV,102CT ,SS,MT,M/S	A-9264
G-1781	4	HCL VLV ASSY,SUC,9-5/8KC:KC-CE	A-12945
G-1782	4	HCL VLV ASSY,DIS,9-5/8KC:KC-CE	A-12945



NOTES:

- ①. APPLY AN ANTI-SEIZE LUBRICANT TO GASKET (ITEM #3 AND #5) SURFACES.
- ②. OIL FACES OF STATO-SEAL (ITEM #8) BEFORE INSTALLING TO PREVENT ABRASION
- 3. LOOSEN OR TIGHTEN ALL FASTENERS PER RECOMMENDED PROCEDURES AND TORQUE VALUES IN MANUAL.
- ④. USED TO PLUG INDICATOR PASSAGES WHERE APPLICABLE.

⑤. ON PIPELINE CYLINDERS USE .065 WALL TUBING ON THE INNER LUBE TUBE.

⑥⑤ 6.- THIS CYLINDER ASSEMBLY DRAWING IS FOR ILLUSTRATION PURPOSES ONLY AND MAY NOT NECESSARILY REPRESENT THE EXACT CONFIGURATION PERTAINING TO THE UNIT ORDERED. REFER TO ACCOMPANYING PARTS LIST FOR ITEMS (AND QUANTITIES OF EACH) REQUIRED FOR THIS PARTICULAR ASSEMBLY.

⑥	⑥B1 ADDED FLAG #1. ⑥NOTE #1 WAS APPLY AN ANTI-SEIZE LUBRICANT BEFORE INSTALLING GASKET (ITEM #5) SURFACES. ⑥C4 & A4 ADDED FLAG #5 TO BALLOON #12 ⑥B3 AND C3 ADDED BALLOON #12 TO BALLOON #21. ⑥ A2 ADDED FLAGNOTE #5. NOTE #6 WAS NOTE #5. REVISED DRAWING. ⑥ B2: ADDED HEAD END SUPPORT TO VIEW. ⑥ A3: ADDED NOTE #5. UPDATED TO CURRENT STANDARDS.	RWR 4/21/06
⑤	DESCRIPTION	HW 10/02/2003
REV	INIT/DATE	

3	7576					
6	12735	2	6966			
5	10823	1	6282			
4	7510	0	4852			
REV	ECN	REV	ECN	CHECKED:	APPROVED:	SCALE:
				WRB 6/02/98		NONE

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ARIEL CORPORATION
 35 BLACKJACK ROAD
 MOUNT VERNON, OHIO 43050

ASSEMBLY DWG. NO. **A-4083**

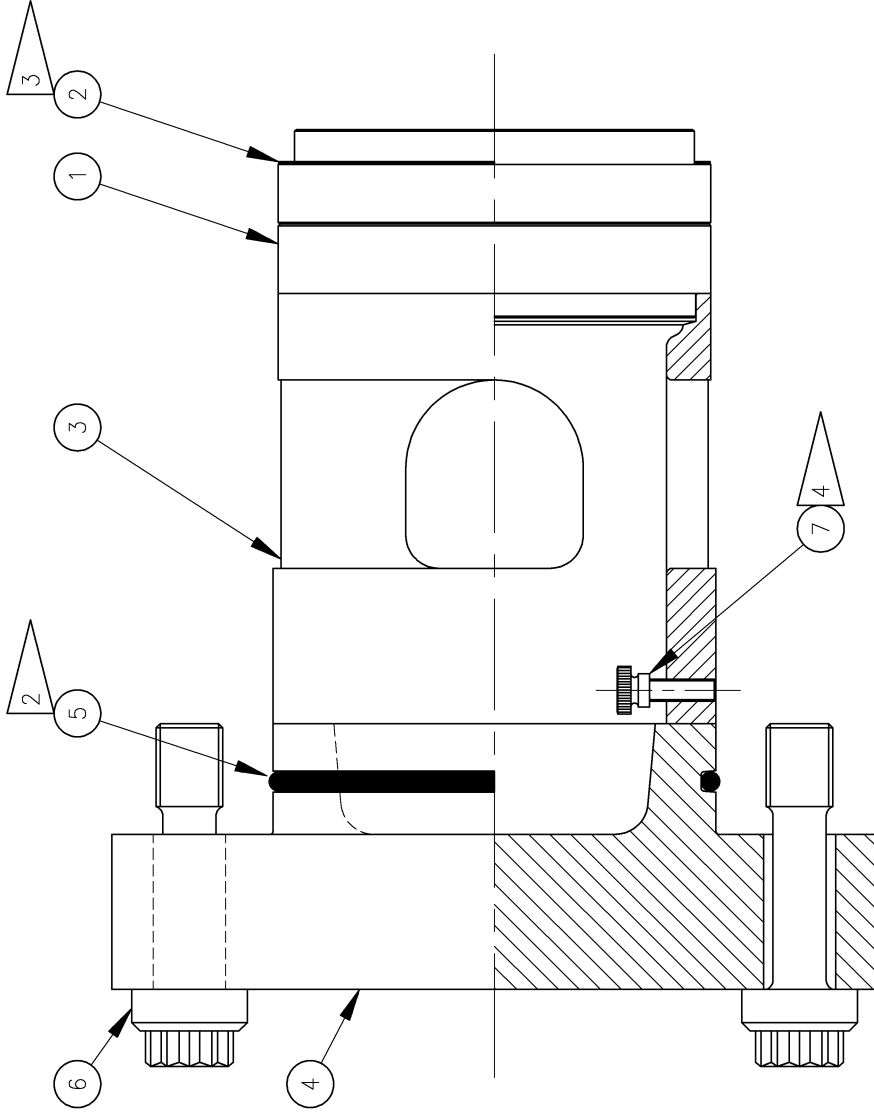
6/29/06

PARTS LIST

9-1/8" JGK:T CYLINDER BODY, W/HEAD END PART NO. G-12500
SUPPORTS,STAINLESS STL TUBING & FITTINGS REF DRAWING A-4083
RDP 1155#, MAWP 1270#

ITEM NUMBER	PART NUMBER	QUANTITY	DESCRIPTION	
1	D-4209	0	CYL, 9-1/8K:C,HES	1270
2	C-0915	0	CE HEAD, 9-1/8K:K-CE	
3	A-2125	1	STL GASKET,10.063 X 9.750 X 60	
4	FC0100IP	16	HEX HD CAP,3/4-10 X 3-1/4	G9
5	B-3549	1	GSKT,RND,22-1/2 X 1/64,18 HOLE	
6	FC0120JW	12	12 PT, 7/8-9 X 6	G8
8	FW0550ID	2	STAT-O-SEAL,VT,75DUR. 3/4 DIA	
9	A-0813	2	MALE CONN,SS, 1/4T X 1/8P	
10	A-0812	2	MALE ELBOW,SS, 1/4T X 1/8P	
11	A-0824	2	HEX RED BUSH,SS, 1/4M X 1/8F	
12	PT0201CD	100.	" TUBING,316 SS 1/4 OD X .065	
13	A-3780	2	CHK.VLV,DOU.BALL SOFT SEAT SS	
16	A-0465	1	DATA PLATE,CYLINDER SPEC	STD
17	FR0570CC	12	DRIVE SCREW, #6 X 1/4 U-TYPE	
18	PP0810GE	6	PIPE PLUG,1/2NPT,HEX HD,SS	
19	A-0640-A	2	INFO PLATE,SUCTION	
20	A-0640-B	2	INFO PLATE,DISCHARGE	
21	A-0938	2	MALE CONN,SS, 1/4T X 1/4P	
23	A-3210	2	LUBE FITTING, 3/4-10 X 5	
25	A-3563	2	HEX PIPE NIPPLE,SS, 1/4 X 1/8	
33	A-3990	2	STREET ELBOW,45,1/8P	SS
100	HD-4209	1	CYL ASSY, 9-1/8K,HES	

WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT
DOES NOT REPRESENT THE QUANTITY REQUIRED.



NOTES:

1. LOOSEN OR TIGHTEN ALL FASTENERS PER RECOMMENDED PROCEDURES AND TORQUE VALUES IN MANUAL.
2. OIL O-RING BEFORE INSTALLING.
3. APPLY AN ANTI-SEIZE LUBRICANT TO GASKET SURFACES.
4. ITEM #7 USED ON DISCHARGE ASSEMBLY ONLY.

016635
ARIEL CORPORATION
 35 BLACKJACK ROAD
 MOUNT VERNON, OHIO 43050

ASSEMBLY
 DWG. No. **A-6700**

REV	DESCRIPTION

6/29/06

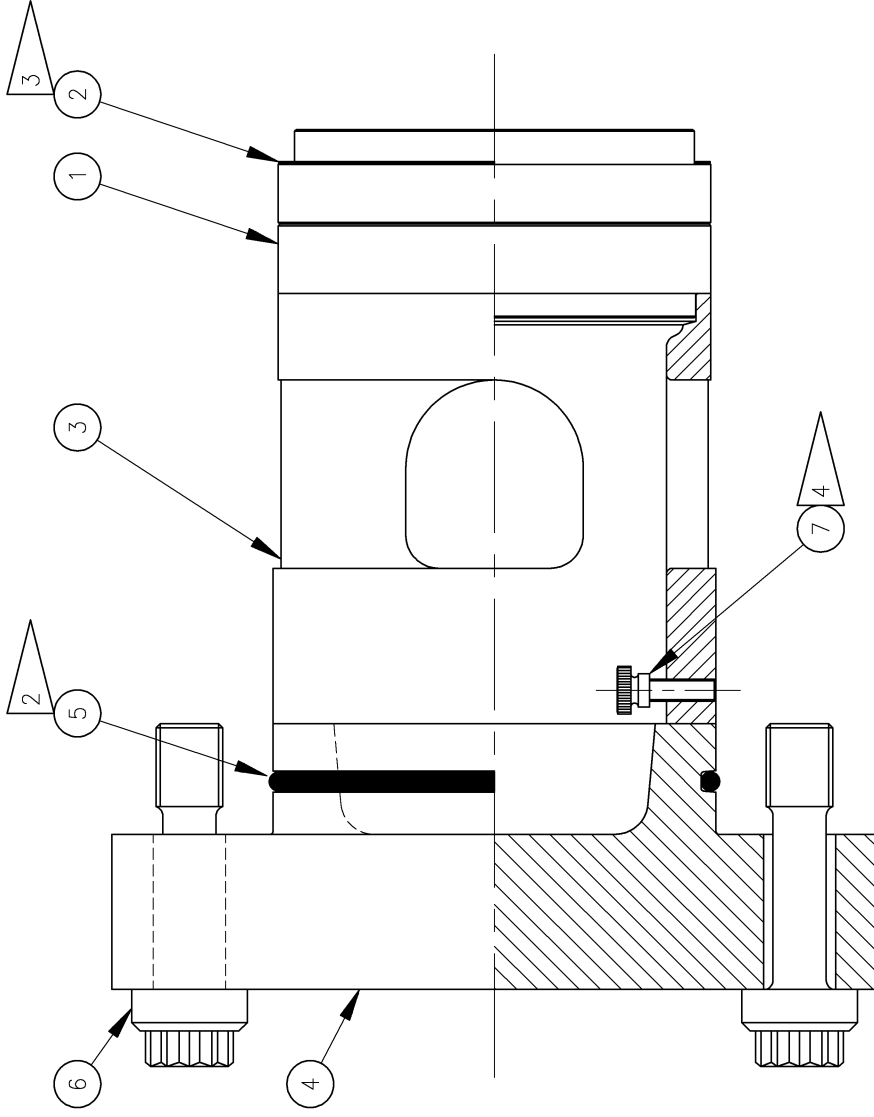
PARTS LIST

SUCTION VALVE, RETAINER AND CAP
9-5/8" JGK:C:D CYLINDER CLASS

PART NO. G-1646
REF DRAWING A-6700

ITEM NUMBER	PART NUMBER	QUANTITY	DESCRIPTION
1	SUCTION VALVE	0	FOR PART NO. SEE COVER SHEET
2	A-2126	1	STL GASKET, 4.861 X 4.543 X 30
3	B-1078	1	VLV RET,S&D, 6-1/4K,9-5/8K-CE
4	B-1104	0	VLV CAP, 9-5/8K:C CL
5	A-2124	1	O-RING,VT, 4.895 O.D. X .210
6	FC0171FIJ	4	12 PT,3/4-10 X 3 X 15/16 G8

WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT
DOES NOT REPRESENT THE QUANTITY REQUIRED.



NOTES:

1. LOOSEN OR TIGHTEN ALL FASTENERS PER RECOMMENDED PROCEDURES AND TORQUE VALUES IN MANUAL.
2. OIL O-RING BEFORE INSTALLING.
3. APPLY AN ANTI-SEIZE LUBRICANT TO GASKET SURFACES.
4. ITEM #7 USED ON DISCHARGE ASSEMBLY ONLY.

016635
ARIEL CORPORATION
 35 BLACKJACK ROAD
 MOUNT VERNON, OHIO 43050

ASSEMBLY
 DWG. No. **A-6700**

REV	DESCRIPTION

6/29/06

PARTS LIST

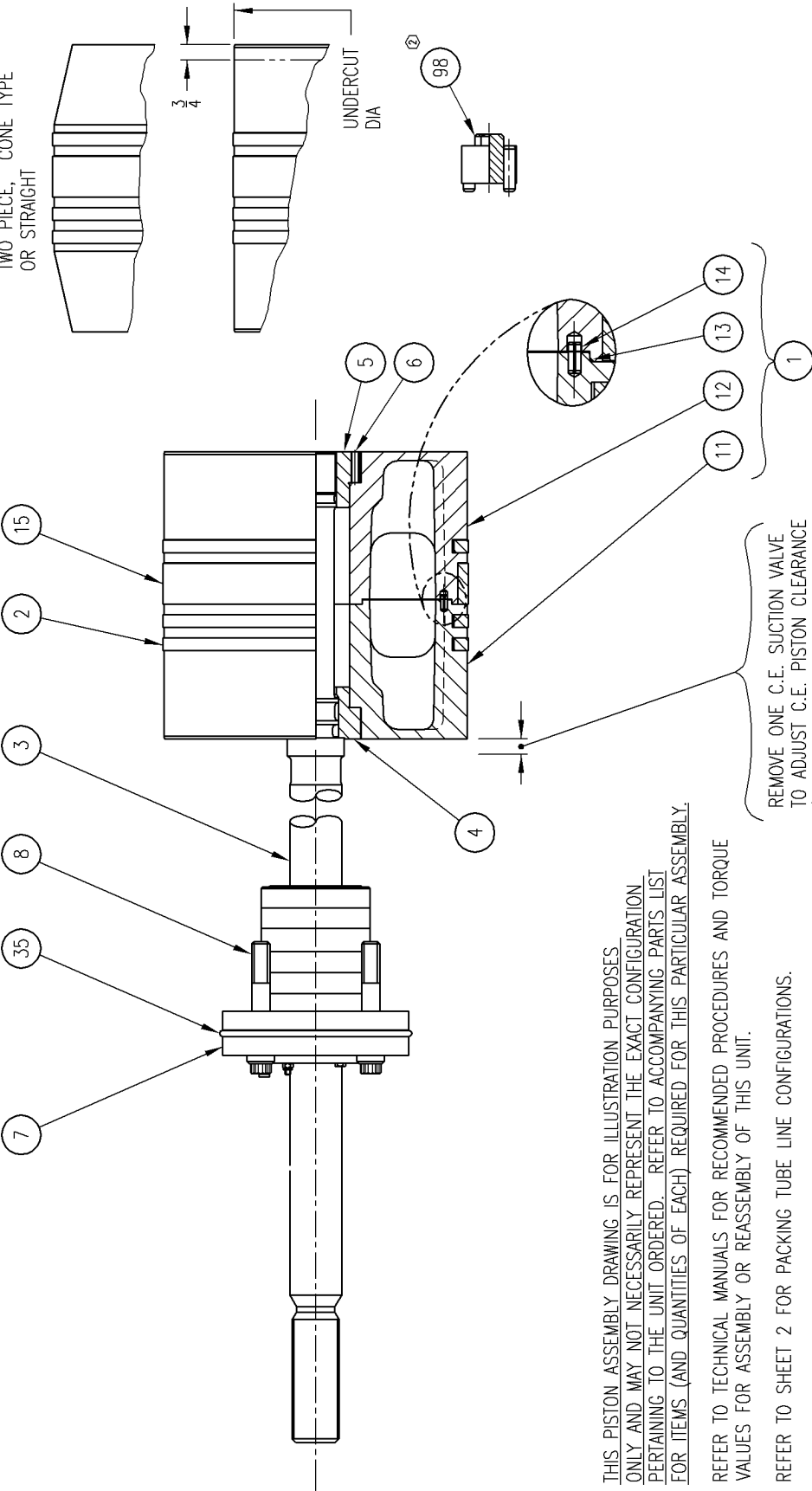
DISCHARGE VALVE, RETAINER, CAP
9-5/8" JGK:C:D:T CYLINDER CLASS

PART NO. G-1647
REF DRAWING A-6700

ITEM NUMBER	PART NUMBER	QUANTITY	DESCRIPTION
1	DISCHARGE VALV	0	FOR PART NO. SEE COVER SHEET
2	A-2126	1	STL GASKET, 4.861 X 4.543 X 30
3	B-1078	1	VLV RET,S&D, 6-1/4K,9-5/8K-CE
4	B-1104	0	VLV CAP, 9-5/8K:C CL
5	A-2124	1	O-RING,VT, 4.895 O.D. X .210
6	FC0171FIJ	4	12 PT,3/4-10 X 3 X 15/16 G8
7	A-0145	2	THUMB SCREW,NYLON,1/4-20 X 3/4

WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT
DOES NOT REPRESENT THE QUANTITY REQUIRED.

PISTON MAY BE ONE OR TWO PIECE, CONE TYPE OR STRAIGHT



NOTES:

1. THIS PISTON ASSEMBLY DRAWING IS FOR ILLUSTRATION PURPOSES ONLY AND MAY NOT NECESSARILY REPRESENT THE EXACT CONFIGURATION PERTAINING TO THE UNIT ORDERED. REFER TO ACCOMPANYING PARTS LIST FOR ITEMS (AND QUANTITIES OF EACH) REQUIRED FOR THIS PARTICULAR ASSEMBLY.
2. REFER TO TECHNICAL MANUALS FOR RECOMMENDED PROCEDURES AND TORQUE VALUES FOR ASSEMBLY OR REASSEMBLY OF THIS UNIT.
3. REFER TO SHEET 2 FOR PACKING TUBE LINE CONFIGURATIONS.
4. PRICK PUNCH TO RETAIN SET SCREWS (ITEM 6).
5. OIL O-RINGS BEFORE INSTALLING.
6. ITEMS 11, 12, 13 AND 14 APPLY TO TWO PIECE PISTONS ONLY.
7. PISTON NUT SPANNER, ITEM 98, IS SHIPPED IN TOOL BOX, WHEN REQUIRED.

REMOVE ONE C.E. SUCTION VALVE TO ADJUST C.E. PISTON CLEARANCE (SEE CYLINDER SPECIFICATIONS DATA PLATE OR THE TECHNICAL MANUAL). DO NOT USE STRAP WRENCH ON PISTON ROD - USE TURNING TOOL WHICH FITS TURNING HOLES IN PISTON NUT.

H:E:K:T

3 10867		DRAWN: RW 10/12/00		APPROVED:	
2 10603		CHECKED: MEH 10/17/00		SCALE: NONE	
1 8132		REV		ECN	
0 8072		THIS DOCUMENT AND CONTENTS THEREIN ARE PROPRIETARY TO ARIEL CORPORATION. ONLY BY WRITTEN CONSENT AND AGREED TERMS BY ARIEL CORPORATION GIVES THE RIGHT TO MANUFACTURE, BUT DOES NOT GRANT THE RIGHT TO DISCLOSE OR USE IN PART OR IN WHOLE INFORMATION CONTAINED IN DOCUMENT.		ASSEMBLY DWG. NO. A-10319	
3		DESCRIPTION		SHEET 1 OF 2	
3		SEE SHEET #2		JCS 8/19/02	
REV		INIT/DATE			

ARIEL CORPORATION
 35 BLACKJACK ROAD
 MOUNT VERNON, OHIO 43050

6/29/06

PARTS LIST

9-1/8" JGK PISTON, 2 PIECE, TFE RINGS & PART NO. G-9033
WEAR BAND, PURGE PACKING, STAINLESS REF DRAWING A-10319 2 SHT
STEEL PISTON ROD, TUBING, & FITTINGS,
LONG TWO COMPARTMENT DISTANCE PIECE.
5-1/2" STROKE.

ITEM

NUMBER	PART NUMBER	QUANTITY	DESCRIPTION
1	C-3176	1	PISTON ASSY, 9-1/8K,2PC
2	A-2127	4	PISTON RING, 9-1/8KTCD&HP:ZU
3	C-1473	1	P ROD,SS,5.50STK/51.440LG
4	B-2185	1	PISTON COLLAR,SS,K,4"OD
5	B-1249	1	PISTON NUT, JGK:T, 4"OD
6	FS0405DH	2	CUP PT.SET-SCREW,5/16-24X1-1/4
7	B-1589	1	PKG,2.0,1500,S2,PU, BTR
8	FC0120IU	4	12 PT,3/4-10 X 5 G8
9	A-0938	3	MALE CONN,SS, 1/4T X 1/4P
10	PT0201CD	45.	" TUBING,316 SS 1/4 OD X .065
11	SC-3174	0	PISTON, ,STD,CE/PC, 9-1/8K
12	SC-3175	0	PISTON, ,STD,HE/PC, 9-1/8K
13	A-7381	0	O-RING,VT, 7.390 O.D. X .070
14	FP0505EE	0	ROLL PIN,3/16 X 3/4
15	A-2129	1	WEAR BAND, 9-1/8K&CE:C:Z 2.0W
99	B-1589-K	0	RBLD KIT,PIST ROD PKG,2.000
99	B-1806-K	0	RBLD KIT,WIPER PKG,2.000,L2

WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT
DOES NOT REPRESENT THE QUANTITY REQUIRED.

4

3

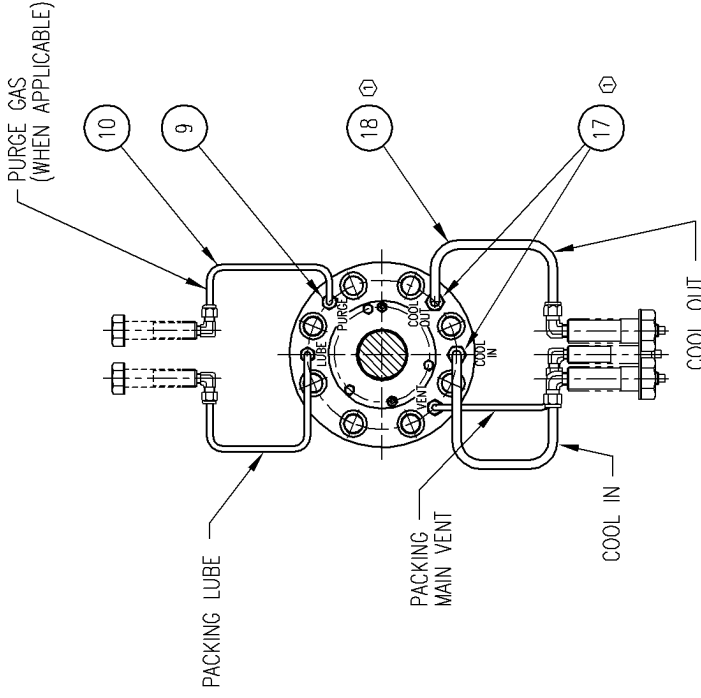
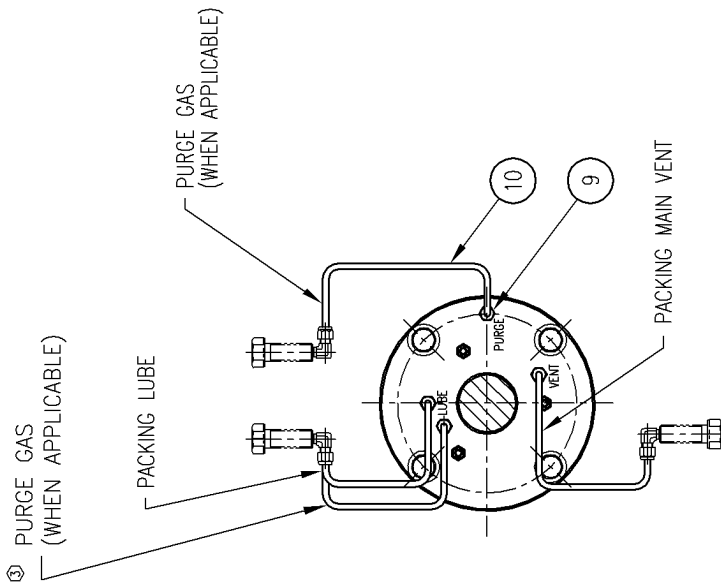
2

1

C

B

A



NOTES:

1. THIS PISTON ASSEMBLY DRAWING IS FOR ILLUSTRATION PURPOSES ONLY AND MAY NOT NECESSARILY REPRESENT THE EXACT CONFIGURATION PERTAINING TO THE UNIT ORDERED. REFER TO ACCOMPANYING PARTS LIST FOR ITEMS (AND QUANTITIES OF EACH) REQUIRED FOR THIS PARTICULAR ASSEMBLY.
2. ASSEMBLE FITTINGS BEFORE INSTALLING PACKING.
3. RETIGHTEN PACKING TIE STUD NUTS AFTER CASE IS BOLTED INTO CYLINDER.
4. REFER TO TECHNICAL MANUALS FOR RECOMMENDED PROCEDURES AND TORQUE VALUES FOR ASSEMBLY OR REASSEMBLY OF THIS UNIT.

3	⊕ B1 ADDED 2ND PURGE CONNECTION	JCS 8/19/02
REV	DESCRIPTION	INIT/DATE

3	10876	DRW	0	8072	APPROVED:	ASSEMBLY DWG. NO.	A-10319
2	10603	ECN	0	8072	CHECKED: NEH	SCALE:	NONE
1	8132	REV	1	8132	DRAWN: RW	SCALE:	NONE

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ARIEL
ARIEL CORPORATION
 35 BLACKJACK ROAD
 MOUNT VERNON, OHIO 43050

H:E:K:T

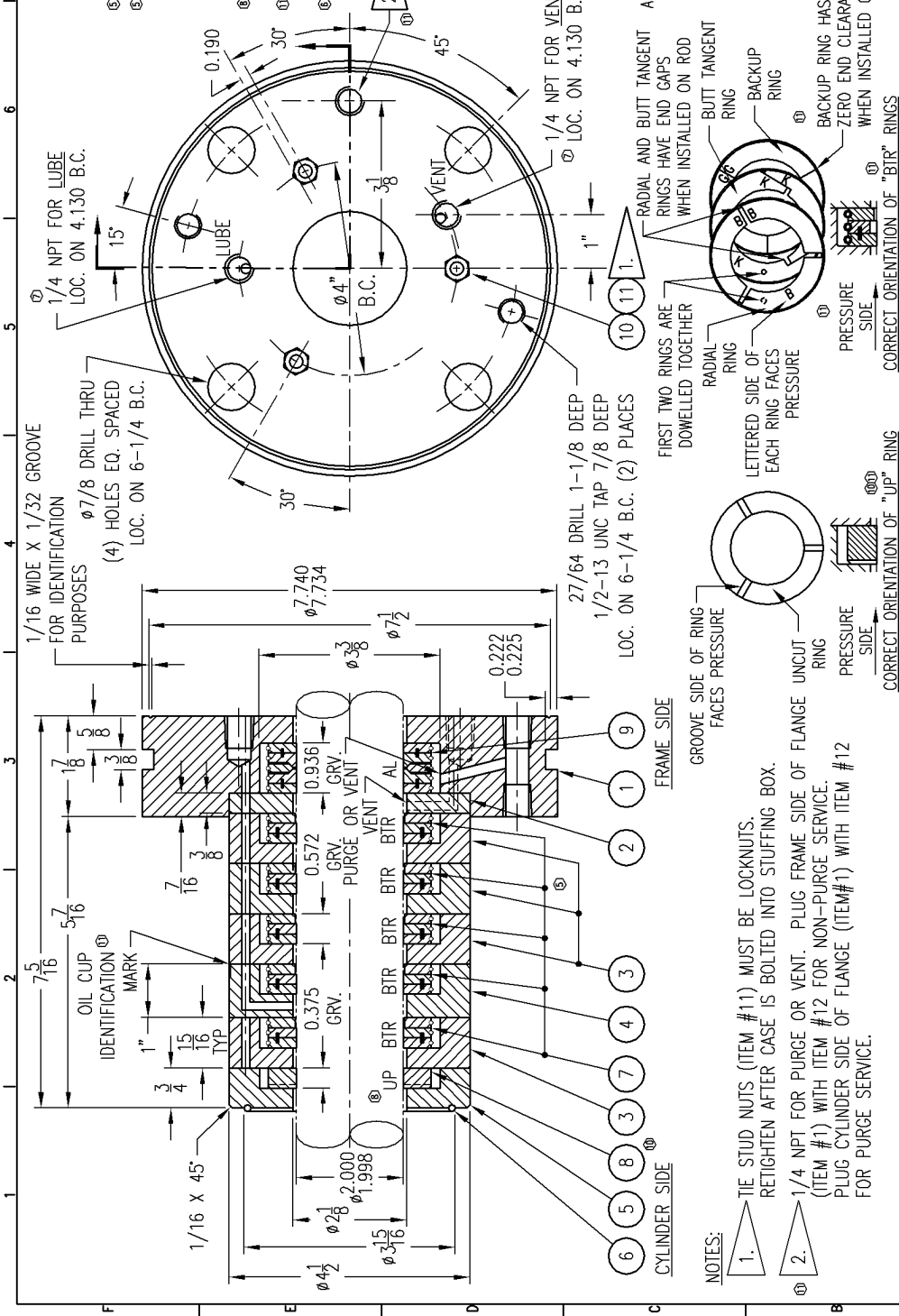
3

2

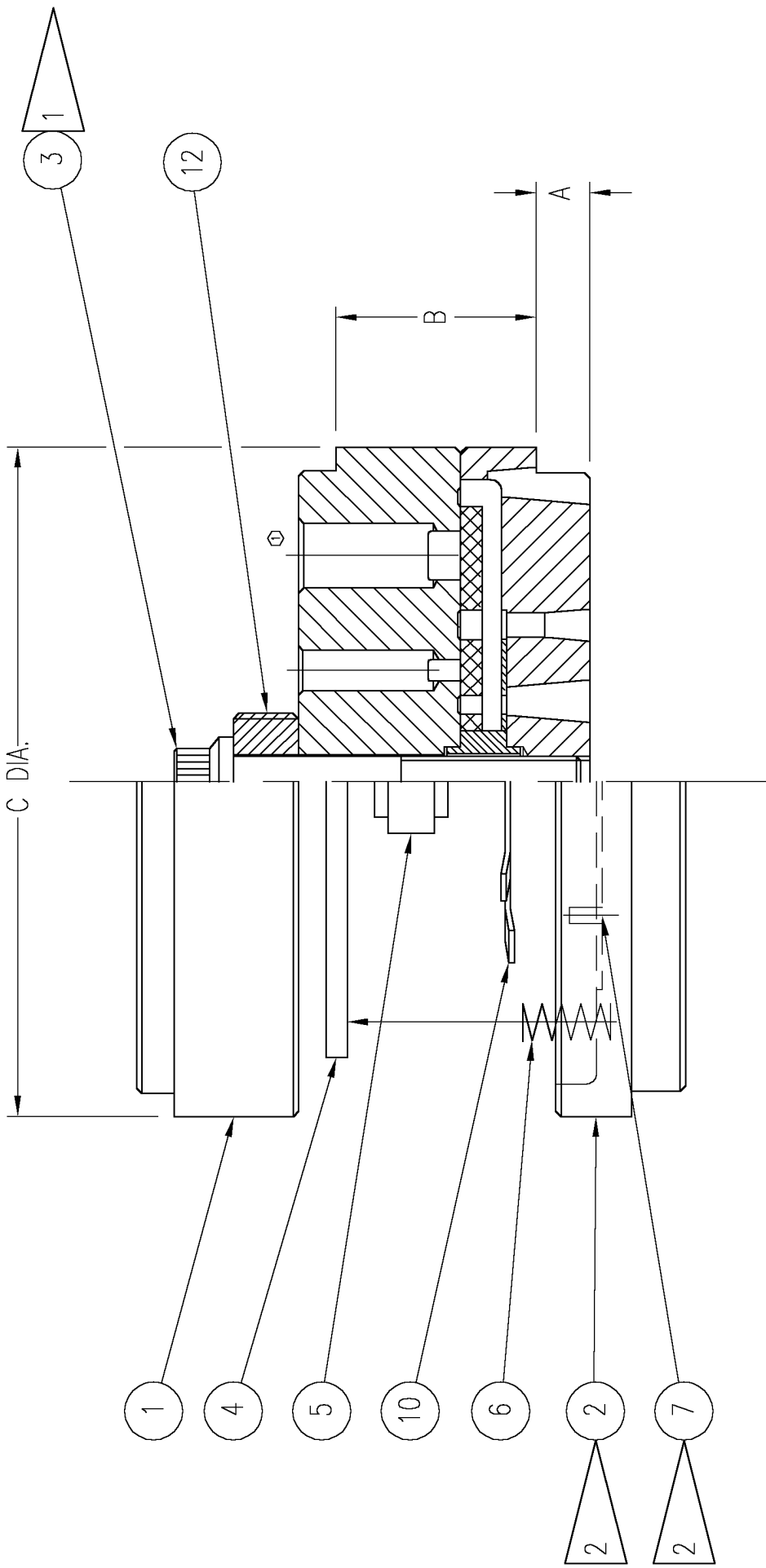
3

4

COMPONENT PART LIST				
ITEM	QUAN	PART NUMBER	DESCRIPTION	MATERIAL
1	1	A-4288	FLANGE	C.I.
2	1	A-2522	VENT PLATE	C.I.
3	4	A-4085	PLAIN CUP - .572 GROOVE	C.I.
4	1	A-4086	OIL CUP - .572 GROOVE	C.I.
5	1	A-2519	END CUP - .375 GROOVE	C.I.
6	1	A-2526	GASKET	ALUM.
7	5	A-4087	SINGLE SEAL RING "BTR"	TEE/C.I.
8	1	A-10551	PRESSURE BREAKER "UP"	PEEK
9	1	A-4270	DOUBLE SEAL RING "AL"	TEE
10	3	F00200CHH	TIE STUD 1/4-20 X 7-7/16	STL
11	3	FND4600A	TIE STUD NUT 1/4-20	STL
12	1	PP0850CE	HEX SOCKET PLUG, 1/4 NPT	SST



		ARIEL CORPORATION 35 BLACKJACK ROAD MOUNT VERNON, OHIO 43050	
TITLE: PISTON ROD PACKING 2" ROD, S2C, PURGE 601 TO 1500 PSI		U.S. No. CB-1589 PART No. B-1589 DWG. No. B-1589	
DRAWN: AGD 9/9/93 CHECKED: WCP 9/9/93 APPROVED:		MATERIAL: SEE TABULATION NONE	
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1112614	5	6420	EDN
1010894	4	5553	REV
910121	3	5425	EDN
88637	2	5159	REV
75668	1	5067	EDN
6783	0	4865	REV
COMPLETE PACKING COMPLETE REBUILD KIT		DESCRIPTION	
B-1589 B-1589-K		PART NUMBER	
06/23/02		INT/DATE	
DESCRIPTION		2	
REV		1	



NOTES:

- 1. FOR ASSEMBLY OF CENTER BOLT SEE ER-35.
- 2. VALVE GUARD ASSEMBLY (ITEM #2) CONSISTS OF VALVE GUARD, AND SPIROL PIN (ITEM #7).

ARIEL CORPORATION
 35 BLACKJACK ROAD
 MOUNT VERNON, OHIO 43050

TITLE: SUCTION VALVE, CT	
MATERIAL: PROCURED	R.S. No.
DRAWN: IG 9/27/99	PART NO.
CHECKED: ED 10/1/99	DWG. No: A-9265
SCALE: NONE	

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DIMENSIONS ARE IN INCHES UNLESS OTHERWISE SPECIFIED.
 ---- DO NOT SCALE DRAWING ----

DIMENSIONING AND TOLERANCING PER ARIEL SPECIFICATION ER-17.0.1 UNLESS OTHERWISE SPECIFIED.

1	8549	REV	ECN
0	7799	REV	ECN

REV	DESCRIPTION
1	REMOVED THE OUTER RING FROM THE VALVE SEAT.

6/29/06

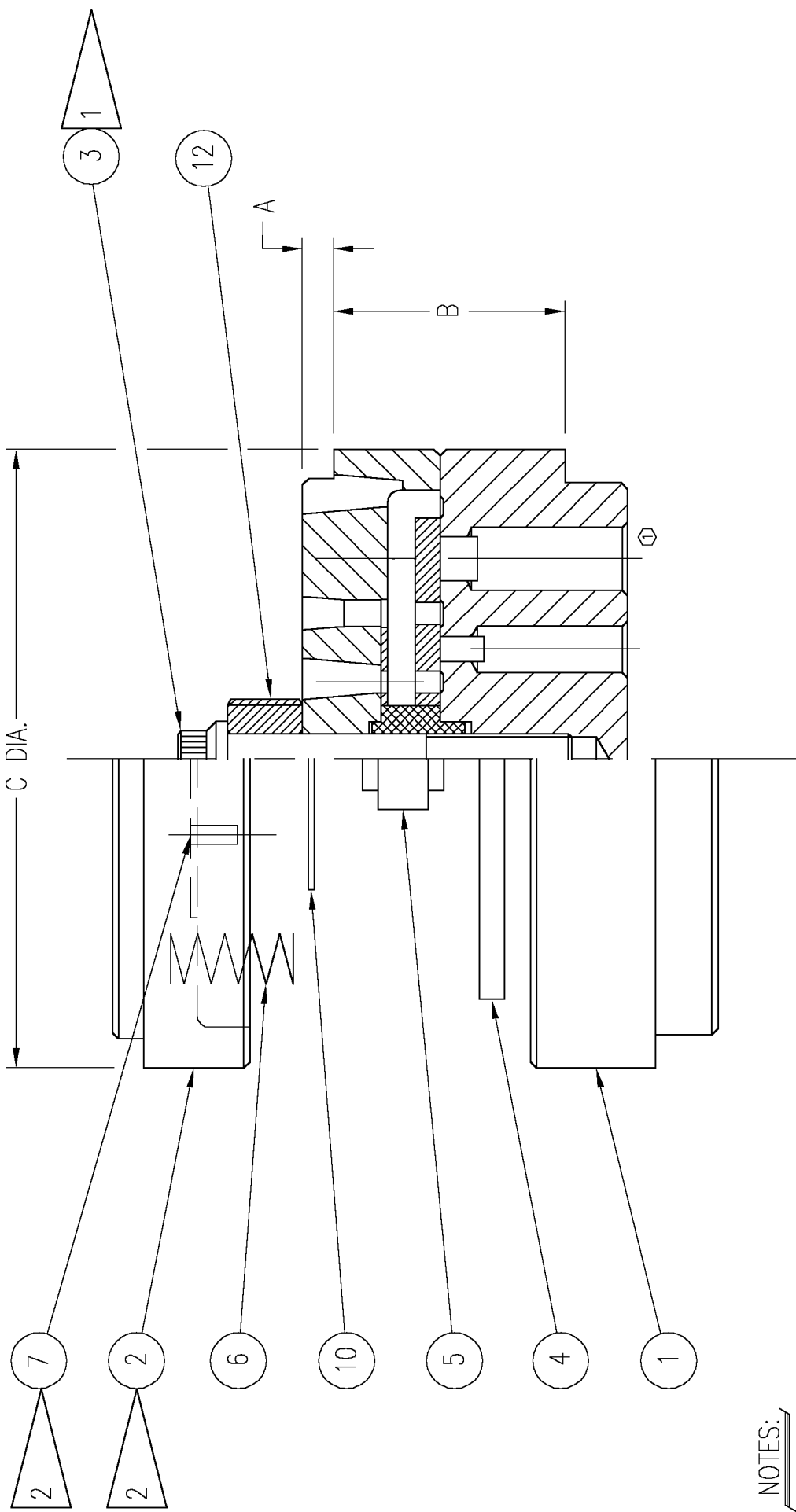
PARTS LIST

0.3940=A
1.4570=B
4.8760=C
0.1020=LFT

PART NO. B-1945-S
REF DRAWING A-9265

ITEM NUMBER	PART NUMBER	QUANTITY	DESCRIPTION
1	A-5991	1	SUC VLV SEAT,102CT ,SS,M/S
2	A-4499-A	1	SUC VLV GUARD ASSY,102CT ,SS
3	A-4585	1	CNTR.BLT,12PT,3/8-24X2-1/2,SS
4	A-4654	1	VLV PLT,102CT.236THK,NY
5	A-4500	1	GUIDE RING,102CT,378 THK,SS
6	A-12176	10	SPRING(.354DX.630 GREEN),NMC
7	A-2039	2	SPIROL PIN,.118D X .591L
10	A-5994	1	WAFER SPR,102CT,NAC
12	A-2155	1	VLV WASHER,3/8ID X 1"-8 THD
99	KB-1945-S	0	KIT,VLV,102CT ,NY,SS,M/S

WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT
DOES NOT REPRESENT THE QUANTITY REQUIRED.



NOTES:

1. FOR ASSEMBLY OF CENTER BOLT SEE ER-35.
2. VALVE GUARD ASSEMBLY (ITEM #2) CONSISTS OF VALVE GUARD AND SPIRAL PIN (ITEM #7).

REV	DESCRIPTION
1	REMOVED OUTER RING FROM THE VALVE SEAT.

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 DIMENSIONS ARE IN INCHES UNLESS OTHERWISE SPECIFIED.
 ---- DO NOT SCALE DRAWING ----
 DIMENSIONING AND TOLERANCING PER ARIEL SPECIFICATION ER-17.0.1 UNLESS OTHERWISE SPECIFIED.

REV	ECN
1	8549
0	7799

ARIEL CORPORATION
 35 BLACKJACK ROAD
 MOUNT VERNON, OHIO 43050



TITLE: DISCHARGE VALVE, CT	
MATERIAL: PROCURED	R.S. No.
DRAWN: IG 9/27/99	PART NO.
CHECKED: ED 10/1/99	DWG. No: A-9264
SCALE: NONE	

6/29/06

PARTS LIST

0.2750 =A
1.4570 =B
4.9010 =C
0.0750 =LFT

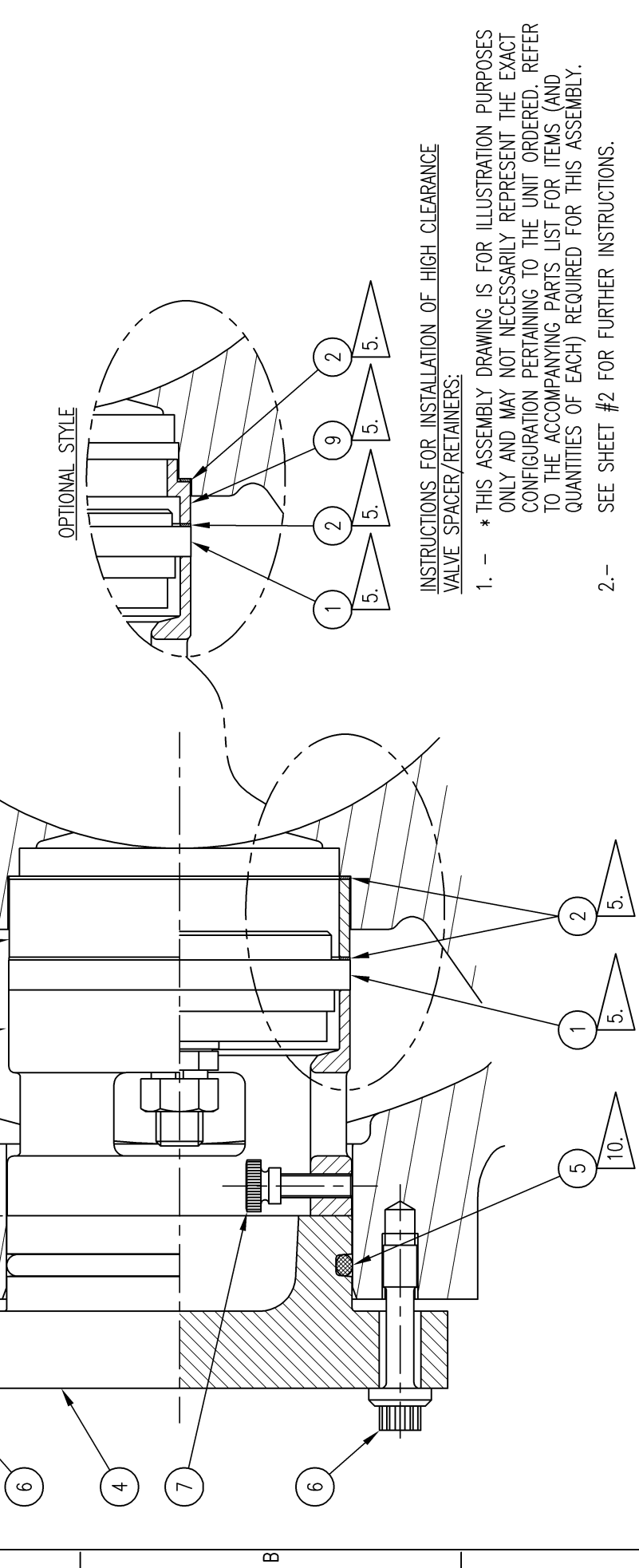
PART NO. B-3325-BB
REF DRAWING A-9264

ITEM NUMBER	PART NUMBER	QUANTITY	DESCRIPTION
1	A-5992	1	DIS VLV SEAT,102CT ,SS,M/S
2	A-4502-A	1	DIS VLV GUARD ASSY,102CT ,SS
3	A-4682	1	CNTR.BLT,12PT,3/8-24X2-1/8,SS
4	A-8186	1	VLV PLT,102CT.256THK,MT
5	A-4376	1	GUIDE RING,90CT,.370 THK,SS
6	A-4430	20	SPRING(.354X.669 BLUE)NMC 90
7	A-2039	2	SPIROL PIN,.118D X .591L
10	A-5994	1	WAFER SPR,102CT,NAC
12	A-2155	1	VLV WASHER,3/8ID X 1"-8 THD
99	KB-3325-BB	0	KIT,VLV,102CT ,SS,MT,M/S

WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT
DOES NOT REPRESENT THE QUANTITY REQUIRED.

1 2 3 4

ITEM	QTY	DESCRIPTION
1	1	VALVE
2	2	GASKET, STEEL
3	1	VALVE RETAINER, HIGH CLEARANCE ASS'Y
4	1	VALVE CAP
5	1	O-RING
6	*	CAPSCREWS OR DOG POINT STUDS
7	*	THUMBSCREW
8	*	HEX NUT
9	1	VALVE SPACER, HIGH CLEARANCE ASS'Y



INSTRUCTIONS FOR INSTALLATION OF HIGH CLEARANCE VALVE SPACER/RETAINERS:

1. -- * THIS ASSEMBLY DRAWING IS FOR ILLUSTRATION PURPOSES ONLY AND MAY NOT NECESSARILY REPRESENT THE EXACT CONFIGURATION PERTAINING TO THE UNIT ORDERED. REFER TO THE ACCOMPANYING PARTS LIST FOR ITEMS (AND QUANTITIES OF EACH) REQUIRED FOR THIS ASSEMBLY.
2. -- SEE SHEET #2 FOR FURTHER INSTRUCTIONS.

<p>ARIEL CORPORATION 35 BLACKJACK ROAD MOUNT VERNON, OHIO 43050</p>		APPROVED: DWG. NO. A-12945
DRAWN: 0 12367	ARW 12/15/04	SHEET 1 OF 2
CHECKED: DAH 12/15/04	ECN	SCALE: NONE
REV	DESCRIPTION	INIT/DATE

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6/29/06

PARTS LIST

HIGH CLEARANCE SUCTION VALVE SPACER &
RETAINER
9-5/8" K:K-CE & C:C-CE CYLINDER CLASS

PART NO. G-1781
REF DRAWING A-12945 2 SHT



ITEM NUMBER	PART NUMBER	QUANTITY	DESCRIPTION
1	SUCTION VALVE	0	FOR PART NO. SEE COVER SHEET
2	A-2126	2	STL GASKET, 4.861 X 4.543 X 30
3	B-1194	1	HCL VLV RET,S&D, 9-5/8K:C CL
4	B-1104	0	VLV CAP, 9-5/8K:C CL
5	A-2124	1	O-RING,VT, 4.895 O.D. X .210
6	FC0171FIJ	0	12 PT,3/4-10 X 3 X 15/16 G8
9	A-2424	1	HCL VLV SPACER,SUC, 9-5/8K:C

WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT
DOES NOT REPRESENT THE QUANTITY REQUIRED.

INSTRUCTIONS FOR INSTALLING HIGH CLEARANCE VALVE SPACER/RETAINERS: Cont.

WARNING:

BEFORE ATTEMPTING TO REMOVE ANY VALVE CAP, BE VERY CERTAIN THAT ALL GAS PRESSURE HAS BEEN VENTED FROM THE CYLINDER. PRESSURE MUST BE COMPLETELY VENTED FROM BOTH THE SUCTION AND DISCHARGE PASSAGES OF THE CYLINDER.

- 3.- REMOVE VALVE CAP AND EXTRACT EXISTING VALVE RETAINER, VALVE AND GASKET.
- 4.- AFTER CLEANING AND INSPECTING THE VALVE POCKET BORE, INSTALL A NEW METALLIC GASKET COATED WITH AN ANTI-SEIZE LUBRICANT TO RETAIN IT IN POSITION WHILE THE REMAINDER OF THE ASSEMBLY IS INSERTED.
- 5.  ASSEMBLE VERTICALLY; THE SPACER, METALLIC GASKET (COATED WITH AN ANTI-SEIZE LUBRICANT), VALVE AND NEW VALVE RETAINER. IF ADDITIONAL CLEARANCE IS NOT REQUIRED REMOVE THE SPACER AND USE THE STANDARD RETAINER. THE SPACER IS NOT DESIGNED TO BE PLACED BETWEEN THE VALVE AND RETAINER
- 6.- THREAD THE VALVE PULLER ONTO VALVE CENTER BOLT AND PICK UP THE ASSEMBLY HOLDING THE SPACER AND NEW VALVE RETAINER IN POSITION.
- 7.- INSERT THE ASSEMBLY INTO THE APPROPRIATE VALVE POCKET. TO CHECK IF THE VALVE ASSEMBLY IS SEATED PROPERLY TWIST THE VALVE PULLER HANDLE CLOCKWISE. IF SEATED PROPERLY THE ASSEMBLY SHOULD SPIN. TO ENSURE THE VALVE ASSEMBLY IS FULLY "HOME", MEASURE DISTANCE #1 FROM THE TOP OF THE VALVE RETAINER TO THE EDGE OF THE VALVE POCKET BORE. MEASURE THE NOSE LENGTH ON THE VALVE CAP, DISTANCE #2 AND SUBTRACT DIMENSION #1 FROM IT. 1/8" WILL BE THE RESULT. IF YOU HAVE A VALUE GREATER THAN 1/8" CALL THE ARIEL RESPONSE CENTER AT 1-888-397-7766 (NORTH AMERICA) OR 1-740-397-3602 (INTERNATIONAL) FOR ASSISTANCE.
- 8.- HOLD THE VALVE ASSEMBLY IN VALVE POCKET USING HAND AND UNTHREAD THE VALVE PULLER.
- 9.- WHILE STILL HOLDING THE VALVE ASSEMBLY IN VALVE POCKET, TIGHTENING THE THUMBSCREWS (PROVIDED ON DISCHARGE RETAINER ONLY).
- 10.  INSTALL OILED, NEW O-RING ON THE VALVE CAP AND INSERT IN THE VALVE POCKET.
- 11.- INSTALL CAP SCREWS AND TIGHTEN EVENLY, IN SMALL STEPS, TO PROPER TORQUE PER ER-63.


NOTE:

IF ASSEMBLED CORRECTLY, THERE SHOULD BE AN 1/8" GAP BETWEEN THE VALVE CAP AND THE CYLINDER VALVE PAD.

DESCRIPTION	INIT/DATE

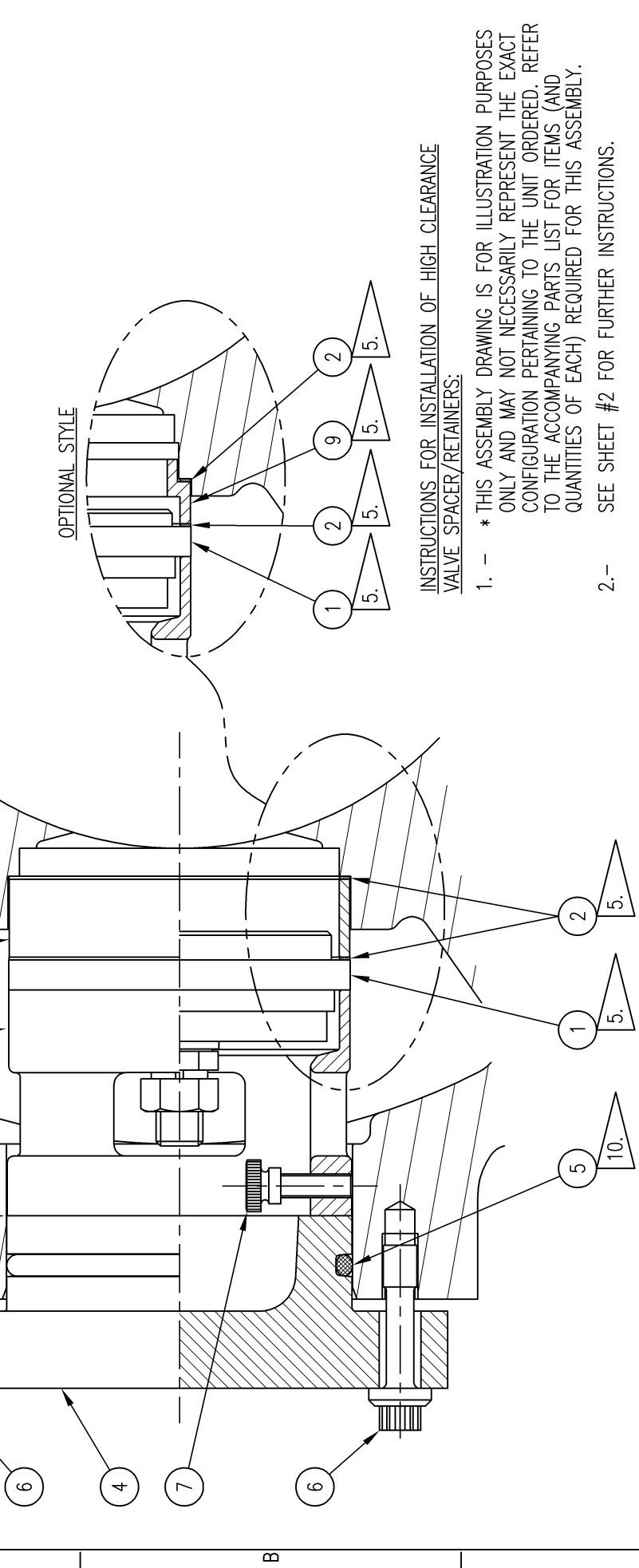
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REV	ECN	REV	DAH	12/15/04
0	12367	0	ARW	12/15/04
DRAWN:		APPROVED:		
CHECKED:		SCALE:		
NONE		NONE		

	ARIEL CORPORATION 35 BLACKJACK ROAD MOUNT VERNON, OHIO 43050		ASSEMBLY DWG. NO.	A-12945 SHEET 2 OF 2
	DRAWN: ARW 12/15/04	APPROVED:	SCALE: NONE	

1 2 3 4

ITEM	QTY	DESCRIPTION
1	1	VALVE
2	2	GASKET, STEEL
3	1	VALVE RETAINER, HIGH CLEARANCE ASS'Y
4	1	VALVE CAP
5	1	O-RING
6	*	CAPSCREWS OR DOG POINT STUDS
7	*	THUMBSCREW
8	*	HEX NUT
9	1	VALVE SPACER, HIGH CLEARANCE ASS'Y



INSTRUCTIONS FOR INSTALLATION OF HIGH CLEARANCE VALVE SPACER/RETAINERS:

1. -- * THIS ASSEMBLY DRAWING IS FOR ILLUSTRATION PURPOSES ONLY AND MAY NOT NECESSARILY REPRESENT THE EXACT CONFIGURATION PERTAINING TO THE UNIT ORDERED. REFER TO THE ACCOMPANYING PARTS LIST FOR ITEMS (AND QUANTITIES OF EACH) REQUIRED FOR THIS ASSEMBLY.
2. -- SEE SHEET #2 FOR FURTHER INSTRUCTIONS.

REV	DESCRIPTION	INIT/DATE
0	12367	
1	0	

ECN	DAH 12/15/04	SCALE	NONE
REV	DAH 12/15/04	APPROVED:	

ASSEMBLY DWG. NO.	A-12945
SHEET	1 OF 2

ARIEL CORPORATION
 35 BLACKJACK ROAD
 MOUNT VERNON, OHIO 43050



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6/29/06

PARTS LIST

HIGH CLEARANCE DISCHARGE VALVE SPACER &
RETAINER
9-5/8" K:K-CE & C:C-CE CYLINDER CLASS

PART NO. G-1782
REF DRAWING A-12945 2 SHT



ITEM NUMBER	PART NUMBER	QUANTITY	DESCRIPTION
1	DISCHARGE VALV	0	FOR PART NO. SEE COVER SHEET
2	A-2126	2	STL GASKET, 4.861 X 4.543 X 30
3	B-1194	1	HCL VLV RET,S&D, 9-5/8K:C CL
4	B-1104	0	VLV CAP, 9-5/8K:C CL
5	A-2124	1	O-RING,VT, 4.895 O.D. X .210
6	FC0171FIJ	0	12 PT,3/4-10 X 3 X 15/16 G8
7	A-0145	2	THUMB SCREW,NYLON,1/4-20 X 3/4
9	A-2425	1	HCL VLV SPACER,DIS, 9-5/8K:C

WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT
DOES NOT REPRESENT THE QUANTITY REQUIRED.

INSTRUCTIONS FOR INSTALLING HIGH CLEARANCE VALVE SPACER/RETAINERS: Cont.

WARNING:

BEFORE ATTEMPTING TO REMOVE ANY VALVE CAP, BE VERY CERTAIN THAT ALL GAS PRESSURE HAS BEEN VENTED FROM THE CYLINDER. PRESSURE MUST BE COMPLETELY VENTED FROM BOTH THE SUCTION AND DISCHARGE PASSAGES OF THE CYLINDER.

- 3.- REMOVE VALVE CAP AND EXTRACT EXISTING VALVE RETAINER, VALVE AND GASKET.
- 4.- AFTER CLEANING AND INSPECTING THE VALVE POCKET BORE, INSTALL A NEW METALLIC GASKET COATED WITH AN ANTI-SEIZE LUBRICANT TO RETAIN IT IN POSITION WHILE THE REMAINDER OF THE ASSEMBLY IS INSERTED.
5.  ASSEMBLE VERTICALLY; THE SPACER, METALLIC GASKET (COATED WITH AN ANTI-SEIZE LUBRICANT), VALVE AND NEW VALVE RETAINER. IF ADDITIONAL CLEARANCE IS NOT REQUIRED REMOVE THE SPACER AND USE THE STANDARD RETAINER. THE SPACER IS NOT DESIGNED TO BE PLACED BETWEEN THE VALVE AND RETAINER
- 6.- THREAD THE VALVE PULLER ONTO VALVE CENTER BOLT AND PICK UP THE ASSEMBLY HOLDING THE SPACER AND NEW VALVE RETAINER IN POSITION.
- 7.- INSERT THE ASSEMBLY INTO THE APPROPRIATE VALVE POCKET. TO CHECK IF THE VALVE ASSEMBLY IS SEATED PROPERLY TWIST THE VALVE PULLER HANDLE CLOCKWISE. IF SEATED PROPERLY THE ASSEMBLY SHOULD SPIN. TO ENSURE THE VALVE ASSEMBLY IS FULLY "HOME", MEASURE DISTANCE #1 FROM THE TOP OF THE VALVE RETAINER TO THE EDGE OF THE VALVE POCKET BORE. MEASURE THE NOSE LENGTH ON THE VALVE CAP, DISTANCE #2 AND SUBTRACT DIMENSION #1 FROM IT. 1/8" WILL BE THE RESULT. IF YOU HAVE A VALUE GREATER THAN 1/8" CALL THE ARIEL RESPONSE CENTER AT 1-888-397-7766 (NORTH AMERICA) OR 1-740-397-3602 (INTERNATIONAL) FOR ASSISTANCE.
- 8.- HOLD THE VALVE ASSEMBLY IN VALVE POCKET USING HAND AND UNTHREAD THE VALVE PULLER.
- 9.- WHILE STILL HOLDING THE VALVE ASSEMBLY IN VALVE POCKET, TIGHTENING THE THUMBSCREWS (PROVIDED ON DISCHARGE RETAINER ONLY).
10.  INSTALL OILED, NEW O-RING ON THE VALVE CAP AND INSERT IN THE VALVE POCKET.
- 11.- INSTALL CAP SCREWS AND TIGHTEN EVENLY, IN SMALL STEPS, TO PROPER TORQUE PER ER-63.


NOTE:

IF ASSEMBLED CORRECTLY, THERE SHOULD BE AN 1/8" GAP BETWEEN THE VALVE CAP AND THE CYLINDER VALVE PAD.

REV	DESCRIPTION	INIT/DATE

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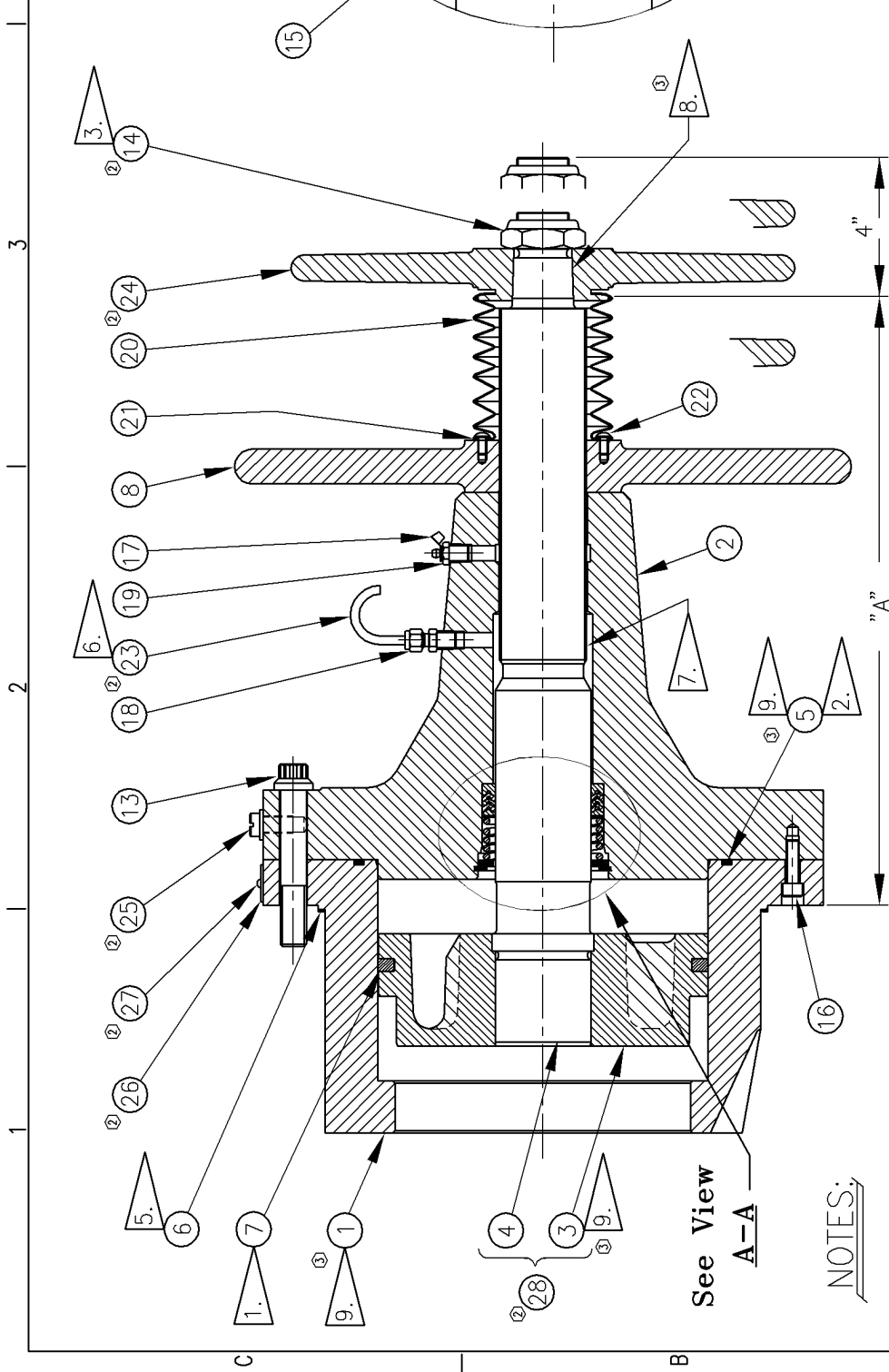
REV	ECN	DATE	APPROVED:	SCALE	NONE
0	12367	ARW 12/15/04	DAH 12/15/04		



ARIEL CORPORATION
 35 BLACKJACK ROAD
 MOUNT VERNON, OHIO 43050

DRAWN:	APPROVED:	ASSEMBLY DWG. NO.	A-12945		
CHECKED:	SCALE:	SHEET	2 OF 2		
DAH 12/15/04	NONE	4			

CLASS	BORES	"A" LENGTH
8-3/8	7-7/8 & 8-3/8	18
9-5/8	9-1/8 & 9-5/8	18-1/2
11	10-1/2 & 11	17-3/4
12-1/2	12 & 12-1/2	17-1/2



- NOTES:**
1. LIGHTLY OIL BORE AND RING (ITEM #7) BEFORE INSTALLING.
 2. OIL O-RING (ITEM #5) BEFORE INSTALLING.
 3. TORQUE (ITEM #14) TO 30 FT-LBS, THEN TORQUE 2-1/2 FLATS OR 350 FT-LBS.
 4. LOOSEN OR TIGHTEN ALL BOLTS PER RECOMMENDED PROCEDURES AND TORQUE VALUES IN MANUAL.
 5. APPLY AN ANTI-SEIZE LUBRICANT TO (ITEM #6) GASKET SURFACES.
 6. VENT TUBE (ITEM #23) ALWAYS POINTED DOWN.
 7. APPLY AN ANTI-SEIZE LUBRICANT TO (ITEM #4) STEM THREADS BEFORE ASSEMBLING.
 8. ACCEPTANCE OF TAPER FIT WILL BE DETERMINED AT THE ASSEMBLY OF COMPONENTS. HANDLE TO STEM FIT MUST BE TIGHT.
 9. CAUTION: FOR NON-LUBE APPLICATIONS REFER TO TECHNICAL MANUAL FOR SPECIAL PROCEDURES FOR THESE ITEMS.

3	10297	APPROVED:	12/05/97	ASSEMBLY DWG. NO.	A-7213
2	8001	DRAWN:	MLB	REV	
1	7854	CHECKED:	CAH	ECN	NONE
0	7094	THIS DOCUMENT AND CONTENTS THEREIN ARE PROPRIETARY TO ARIEL CORPORATION. ONLY BY WRITTEN CONSENT AND AGREED TERMS BY ARIEL CORPORATION GIVES THE RIGHT TO MANUFACTURE, BUT DOES NOT GRANT THE RIGHT TO DISCLOSE OR USE IN PART OR IN WHOLE INFORMATION CONTAINED IN DOCUMENT.			

ARIEL CORPORATION
 35 BLACKJACK ROAD
 MOUNT VERNON, OHIO 43050

ADDED FLAG NOTE #8: ACCEPTANCE OF TAPER FIT WILL BE DETERMINED AT THE ASSEMBLY OF COMPONENTS. HANDLE TO STEM FIT MUST BE TIGHT. UPDATED TO LATEST ARIEL DRAFTING STANDARDS. ADDED FLAG NOTE #9. ADDED FLAG NOTE #9 TO ITEMS 1, 3, AND 5.

ALH
01/25/2002

INIT/DATE

DESCRIPTION

6/29/06

ARIEL CORP. - BLACKJACK DIV. C/N: 001
SALES ORDER COVER SHEET

RHCOVP02

SERIAL NUMBER: U-51913 & 15

PART: G-11012 DESCRIPTION: VVCP, 9-1/8KC

9-1/8" JGK:T:C:D UNLOADER ASSEMBLY, PART NO. G-11012
STAINLESS STEEL TUBING AND FITTINGS. REF DRAWING A-7213

ITEM

NUMBER	PART NUMBER	QUANTITY	DESCRIPTION
1	C-0992	1	UNL.HEAD, 9-1/8KC
2	C-0997	1	HE UNL ADPTR, 9-5/8KCZ CL
3	C-1373	0	UNL PIST, 9-5/8K:C:Z CL
4	C-3719	0	UNL.STEM,KCZ,2-1/2-8 THD.
5	A-0473	1	O-RING,VT, 9.145 O.D. X .210
6	A-2125	1	STL GASKET,10.063 X 9.750 X 60
7	A-0477	1	UNL.PISTON RING, 7-1/2 O.D.
8	C-0983	1	LOCKING HANDLE,UNL,2-1/2-8 THD
9	A-2397	1	UNL PACKING RETAINER, KCZ
10	A-2395	1	BACK-UP RING, PACKING
11	A-2400	1	COMPRESSION SPRING,UNL,3-7/16D
12	A-2399	1	V PACKING, UNL. 2-3/4 X 3-1/2
13	FC0120IV	16	12 PT,3/4-10 X 5-1/2 G8
14	A-2390	1	SELF-LOCK NUT,ESNA,TN,1-1/2-12
15	A-2392	1	SNAP RING,SS,INT,3-3/4 BORE
16	FC0110EK	2	SOC HD CAP,3/8-16 X 2 G8
17	A-0500	1	GREASE FITTING CAP, PLASTIC
18	A-0938	1	MALE CONN,SS, 1/4T X 1/4P
19	PZ0230BA	1	STRAIGHT GREASE FITTING,1/4-18
20	A-2394	1	BELLOWS, UNL.THREAD PROTECTOR
21	A-2398	1	BACK-UP RING, BELLOWS

6/29/06

SALES ORDER COVER SHEET

22	FC0134CC	3	BUT HD CAP,1/4-20 X 1/2 316SS
23	PT0201CD	6.	" TUBING,316 SS 1/4 OD X .065
24	C-0984	1	HANDLE,UNL,3 PRONG
25	A-0467	1	PUSH IN PLUG,PL, 3/8,YELLOW
26	A-0755	1	DATA PLATE,UNLOADER SPEC
26	A-12927	1	DATA PLATE,UNLOADER POSITION
27	FR0570CC	2	DRIVE SCREW, #6 X 1/4 U-TYPE
28	AC-3721	1	UNL PIST ASSY, 9-5/8K:C:Z CL

VARIABLE VOLUME CLEARANCE POCKET (Headend Unloader) DATA SHEET

9-5/8K Class Cylinder

Stroke: 5.50 in 140 mm
 Bore: 9.125 in 232 mm
 MAWP: 1270 psi 87.6 barg 8756 kPa(g)

General Data for VVCP (independent of cylinder):

MAWP*:	1390	95.8 barg	9584 kPa(g)	*Note: If VVCP services another cylinder, it may have a higher MAWP than the above cylinder.
VVCP piston diameter:	7.5 in	191 mm		
Stem thread lead (pitch):	0.125 in	3 mm		
Total travel:	4.00 in	10.2 cm		
Number of turns from closed to fully open:		32.0		
Minimum added fixed clearance:	3.1 in ³	51 cm ³		
Additional added clearance when fully open:	176.7 in ³	2896 cm ³		
Total added clearance when fully open:	179.8 in ³	2946 cm ³		
Clearance volume change per turn:	5.5 in ³	90.5 cm ³		
Clearance volume change per change in travel:	44.2 in ³ /in	285.0 cm ³ /cm		

Clearance Data for VVCP alone, in percent of swept volume of above cylinder:

Minimum added fixed clearance:	0.9%
Additional added clearance when fully open:	49.1%
Total added clearance when fully open:	50.0%
Head end clearance change per turn:	1.5%
Head end clearance change per change in travel:	12.3% /in 4.8% /cm

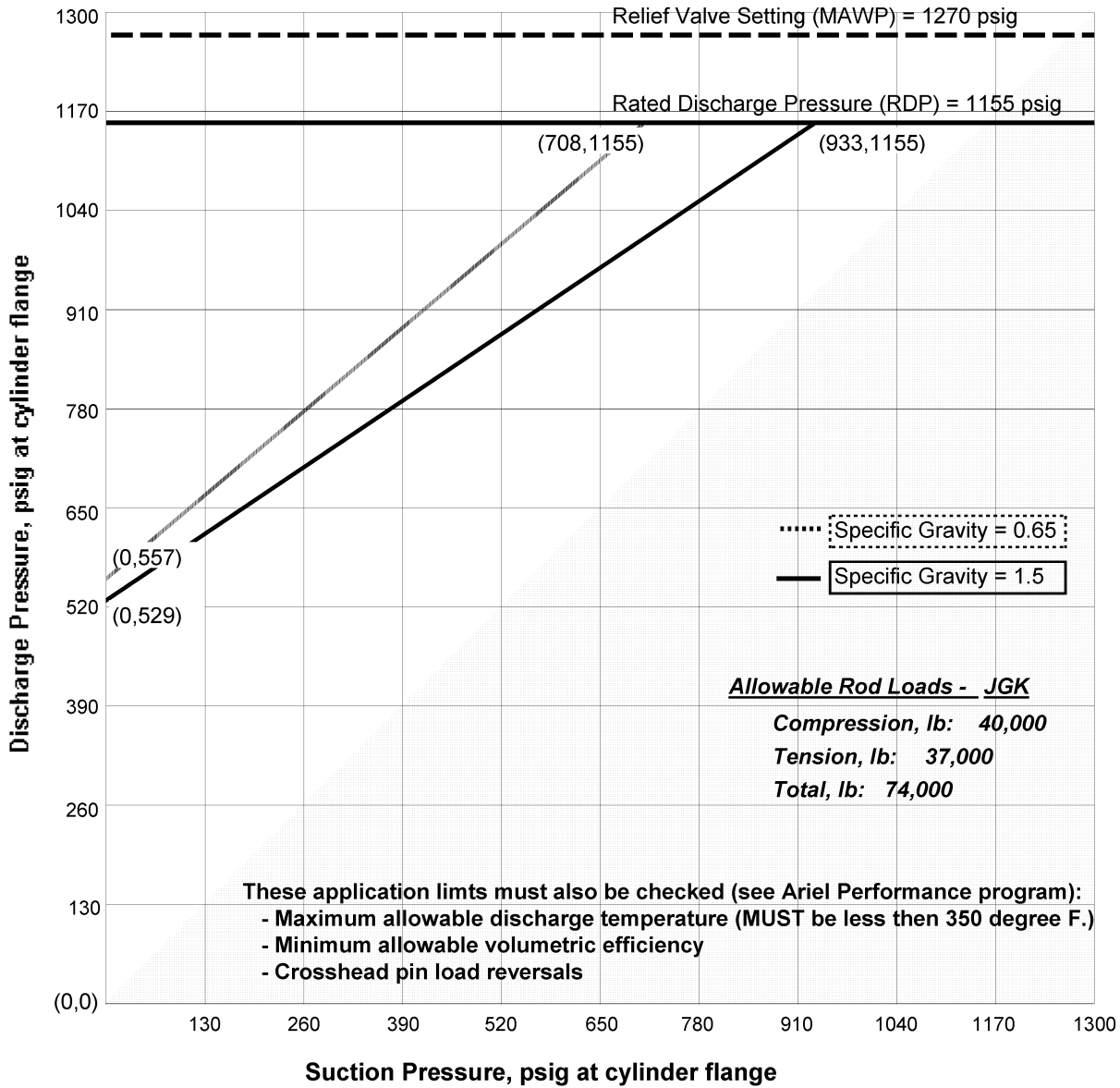
Clearance Data with VVCP installed on above cylinder with standard valves, in percent of swept volume:

Minimum fixed head end clearance:	18.2%
Total head end clearance when fully open:	67.4%

PLEASE NOTE: It is important to understand that the percent clearance figures for the variable volume clearance pocket above include the cylinder headend clearance. However, any valve spacers or other non-standard added clearances on the unit must be accounted for.

Estimated Gas Rod Load and Pressure Limits for 5.5 inch stroke at 1200 RPM

Cylinder Class: 9-5/8K Bore, inches: 9.125
 Cylinder Serial Number: C-82052 & 54



This chart defines allowable operating limits for gas rod loads and standard working pressures. Pressure combinations falling above the line for the applicable Specific Gravity of the gas being compressed will exceed the Rod Load limitations of the equipment.

Calculations are based on 80 degrees Fahrenheit hydrocarbon gas at 1500 ft. elevation.

ENERFLEX

DRIVER

Waukesha
VHP
12 Cylinder
G/GL/GSI Engines
Parts Catalog

Second Edition

Form 6246

See CD

Waukesha

VHP

6, 12, & 16 Cylinder
Operation & Maintenance

Second Edition

Form 6277

See Hard Copy

Waukesha

ESM

Waukesha
Engine System Manager
Operation & Maintenance

Third Edition

Form 6295

See Hard Copy

ENERFLEX

COOLER

TABLE OF CONTENTS

<i>GENERAL-Introduction and Operation</i>	2
<i>EQUIPMENT DELIVERY AND SITING</i>	2
<i>UNLOADING & HANDLING</i>	3
<i>PRIOR TO RUN-IN & START UP</i>	4
<i>HYDROSTATIC TEST</i>	4
<i>BEARINGS</i>	4
<i>LUBRICATION GUIDE</i>	4
<i>FANS</i>	4
<i>LOUVERS/SHUTTERS</i>	5
<i>V-BELTS</i>	5
<i>GEAR BOX</i>	5
<i>VIBRATION SWITCH</i>	5
<i>PROCESS START UP</i>	5
<i>HEADER ACCESS PLUGS</i>	5
<i>LONG TERM MAINTENANCE</i>	6
<i>FIN CLEANING</i>	6
<i>TUBE CLEANING</i>	6
<i>LEAKING TUBES</i>	6
<i>INSTALLATION OF TAPER TUBE SEALING PINS</i>	7
<i>INSPECTION</i>	8
<i>RECOMMENDED SPARE PARTS</i>	8
<i>WARRANTY</i>	9

AXH air-coolers

401 East Lowry Road, Claremore, Oklahoma 74017
(918) 283-9200 Fax (918) 283-9229
www.axh.com

INTRODUCTION

This manual has been prepared for the purpose of providing general information and recommendations for the operation and maintenance of your air-cooled heat exchanger in order to insure that it will continue to provide you maximum performance in future years under a variety of operating conditions.

Normal maintenance items and light repairs as outlined can be achieved with basic mechanics tools. These include adjusting v-belt tension, checking and adjusting fan blade pitch angle, lubrication of bearings, setting of vibration switches and the periodic cleaning of fin tubes, both externally and internally. For more specific and detailed information please refer to the individual manufacturer's maintenance instructions for the specific item or component in questions (i.e. motors, fans, bearings, and controls). The Table of Contents indicates the appropriate section where this information is contained.

Naturally, prudent judgment should always be exercised when repairing, replacing or particularly modifying any original parts to make certain that they are equivalent to the original design. **AXH air-coolers** stocks most standard parts and components and are available within a 24 hour emergency basis if necessary.

RECEIPT OF EQUIPMENT & SITING

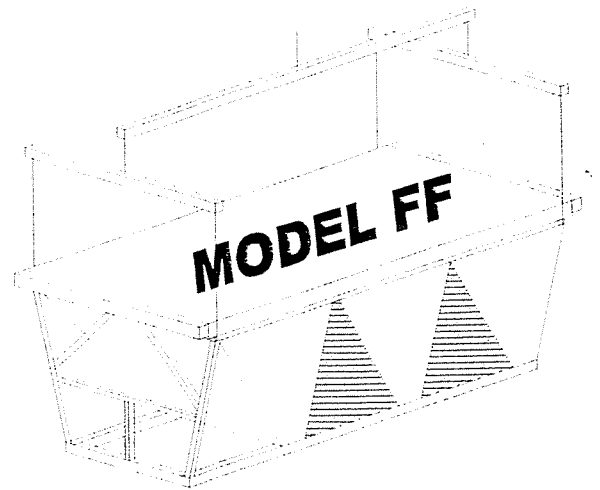
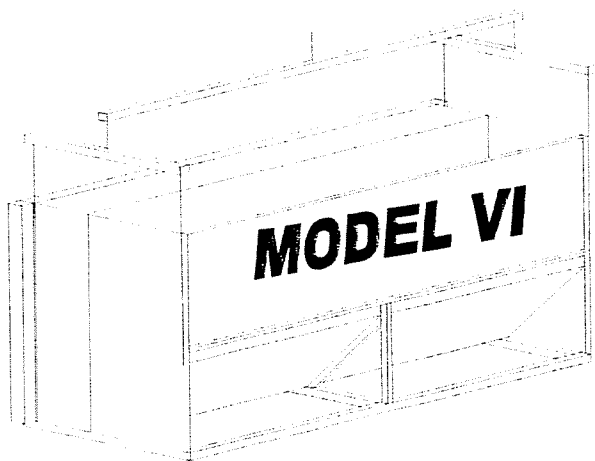
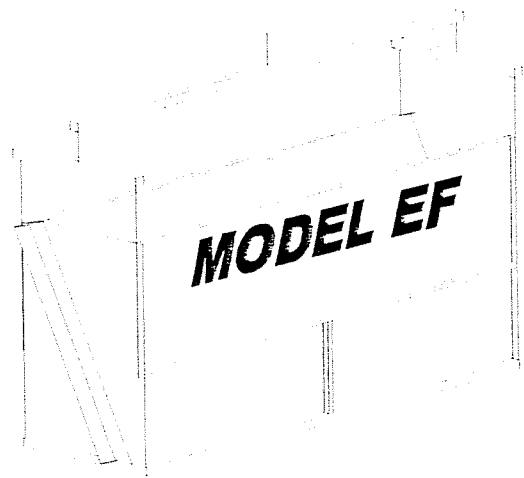
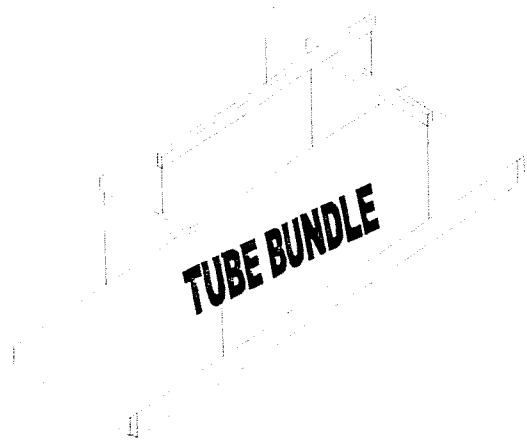
Upon arrival at site, the cooler should be inspected thoroughly by receiving personnel. Damage in transit could be the result of dropping or being struck by heavy objects or equipment. Observe the sub-skid, flanges, plenum side panels and coil sections for any apparent physical damage. Dents, bent flanges, crushed fins, damaged controls are among other items that should be described on the bill of lading document and presented by the carrier. Prompt reporting will expedite filing of claims and will expedite resolution and compensation from the responsible party.

Installation of the cooler(s) is the responsibility of the purchaser or contractor who must insure that the cooler intake areas are free from obstructions and provide adequate airflow. Spacing of air coolers should be adequate to avoid hot air re-circulation (and the affects of other coolers). The impact of grouping coolers closely together may be compensated for by either elevating and/or separating them.

The cooler is normally completely shop assembled and no field assembly at the job-site is required. However, occasionally optional or special accessories may require disassembly to meet transportation height or width limitations. In the event some assembly of the unit is required, the appropriate assembly instructions will accompany the shipment. The packing list should be checked carefully to see that all parts shipped with the cooler are on hand. These parts may be shipped separately, secured to the skid base (if so designed) or inside the plenum area.

UNLOADING & HANDLING COOLERS

Spreader bars should be used for lifting when the cooler width is over eight (8) feet. The cooler is normally supplied with multiple lifting points to be used for off loading from carrier. Lifting by any other point may cause damage to the cooler. Following are some recommended ways of lifting. Please refer to the illustration below that resembles the type of **AXH air-coolers** cooler to be handled and use it as a guide on how to unload and handle the cooler properly. (See unit name plate for unit type i.e. EF, VI, FF, ZF, etc.)



PRIOR TO RUN-IN & START UP

HYDROSTATIC TEST

AXH air-coolers tube bundles (sections) are hydrostatically tested to 1.3 times the design pressure as required by ASME before being released for shipment. To ensure that no damage has been done during shipment and/or installation, it is good practice to hydro test the entire system, including piping, heat exchangers, pumps, etc., prior to start up.

BEARINGS

Check bearings for lubrication. **Caution: DO NOT OVER GREASE.** The manufacturer has greased the bearings and no additional grease is necessary at start up. Remote lubrication lines, when provided, should be loosened at the bearing end, and checked to be sure they are filled with grease from the fitting end. This will ensure that the lube lines are full of grease and free of air and any debris. During high-speed operation too much grease will cause overheating. When dust and water are present bearings should contain as much grease as the operating speed will permit since a full bearing with very slight leakage is the best protection against the entrance of foreign material. Under normal conditions refer to the following table as a general guideline, although certain conditions may require a change of lubrication periods other than those described. Bearing mounting bolts and set screws should be checked for tightness. See bearing manufacturer recommended lubrication chart for recommended maintenance schedule and type of grease.

FANS

Check fan blade bolts and hub bushing set screws for tightness. Rotate fan by hand to insure that shaft, speed reducer, and driver turn freely. The fan blades should be checked for adequate tip clearance and blade pitch angle. To measure this, first move all blades past a fixed point on the inside of the fan ring and observe which blade has the least amount of clearance at that point. Then move the blade selected 360 degrees to the point of minimum clearance. Refer to the section on fans. If the fan is found not to be centered in the fan ring, slight adjustment of the tip clearance can be made by loosening the fan shaft bearing bolts and moving the complete fan and fan shaft assembly until it is centered in the fan ring. To check the fan blade angle, use a level bubble protractor (this can be obtained from *AXH air-coolers*). Loosen the nuts on the bolts and place the protractor on the angle setting mark or the clevis. Refer to fan manufactures information for proper location and air-x-hemphill parts list for design angle. Using a mallet, tap on the shank end of the blade to adjust the angle. Tighten fan blade bolts to the proper torque (refer to manufactures maintenance instructions) making sure to tighten evenly. Recheck blade angle. Occasionally coolers may be equipped with an auto-variable type fan. These fans have blade angles controlled by varying the air supply pressure. Air pressure should be applied to the fan before starting to check for proper operation. **Before starting, any electric motor should be "bumped" to check for proper direction of fan rotation and air flow.** This will also insure that the motor is in proper working order.

LOUVERS/SHUTTERS

Check all mounting brackets and bolts for tightness. To insure that the linkage is adjusted properly on manually operated louvers, operate blades from a fully open to a fully closed position. On automatic louvers with air motors (optional) air should be applied to actuator to check for proper linkage adjustment, free operation, and sufficient air supply. For further information on air motors see attached manufacture maintenance instructions.

CAUTION: DO NOT WALK ON LOUVERS OR USE THEM AS A LADDER

V-BELT DRIVES

Check V-Belt tension in accordance with V-Belt tensioning section of this manual.

GEAR BOX

When supplied, check gearbox for oil. Gears are shipped without oil and must be filled and serviced in accordance with the instructions contained later in this operating manual.

VIBRATION SWITCH (OPTIONAL)

For Murphy switches, after the switch has been installed, adjust it by turning the adjustment screw in a clockwise direction until the starting torque does not trip the vibration switch. For other brands see the specific manufacture's information.

PROCESS START-UP

The process start-up should be conducted in a manner that will minimize thermal shock of the tube bundles. Over cooling of fluids during periods of low ambient temperature and/or low heat load duty should also be avoided, especially during start up.

HEADER ACCESS PLUGS

Header plugs opposite each tube are installed at room temperature. To correct any minor leaking, it may be necessary to tighten the plugs when the bundle is at operating temperature. **WARNING: DO NOT** tighten plugs while bundle is under pressure. If any plugs are removed, the soft iron gasket (shoulder plugs only) should always be replaced. Replacement gaskets are in stock and may be ordered from **AXH air-coolers**. When installing the plugs, a thread lubricant and/or anti-galling compound should be used.

LONG TERM MAINTENANCE

FIN CLEANING

Fins should be kept free of dirt and lint. Bug and lint screens are an available option that will greatly assist in keeping tube bundles clean. Fin tubes can be cleaned by directing compressed air perpendicular to the tubes in a direction OPPOSITE to the normal airflow. Caution should be when using steam or chemicals to clean fins. DO NOT clean or spray water when the section/bundle is hot.

TUBE CLEANING

The internal cleaning of tubes can be done in several different ways:

1. **Mechanical Cleaning** - This consists of using a drill, (or wire brushes), on long rods, and rotating them with air or electric motors. This is normally followed by a treated water or chemical wash or air purge.
2. **Chemical Cleaning** - This consists of circulating chemical solutions through the tubes. The solution should contain inhibitors to avoid corrosion of the tube walls.
3. **High Pressure Water Sprays** - This consists of placing a high-pressure water jet head at the end of hollow rods and pushing through the individual tubes.

NOTE: The last two processes will not work on tubes that have been "plugged" with sealing pins.

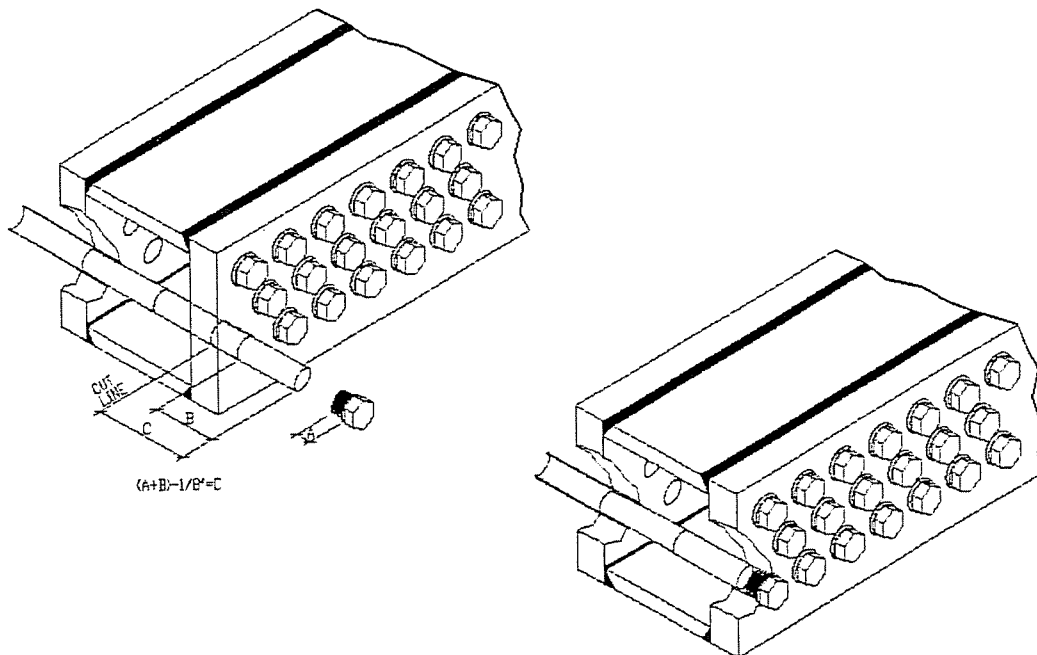
LEAKING TUBES

Tube leaks are generally of two types: 1) leaks through the tube wall itself, and more commonly 2) leaks in the tube end attachment in the header (tube sheet). In the first case it is desirable to plug both ends of the tube. Only a limited number of tubes can be sealed off in this manner before performance is adversely affected and will vary with each specific application. When cooling performance falls below acceptable limits, the tube bundle may be re-tubed. If leaks develop in the tube end attachment at the tube sheet, re-rolling of the tube may be necessary. Care must be taken in selecting the proper tube expander for the tube size (diameter) and gauge of tube to be rolled. When rolling a tube, excess or "over-rolling" must be avoided. Consult the factory for further information on taper sealing pins to plug the tubes and tube roller sizes.

INSTRUCTIONS FOR USING TAPER PINS FOR SEALING TUBES

- 1.) Remove header access plug from one end of leaking tube (do not switch plugs in holes) and replace with new gaskets whenever possible.
- 2.) Insert taper sealing pin through plug hole into tube and tap lightly with hammer until seated firmly, but not too tight to be removed.
- 3.) Measure plug to determine the depth it was originally screwed into header plug sheet. (Dimension A)
- 4.) Measure the distance that the taper pin protrudes from the header plug sheet in "seated" position. (Dimension B)
- 3.) Add the distance measured in Steps 3 and 4 and subtract 1/8". This will be the length which should be cut off the large end of the taper sealing pin. ($A+B-1/8" = \text{Dimension C}$)
- 4.) Remove the taper pin from the end of the tube.
- 5.) Cut the end off the large end of the taper pin to the length calculated in Step 5. CAUTION: Do not cut the pin too short.
- 6.) Re-insert the taper sealing pin in the tube and drive securely into place.
- 7.) Lubricate the access plug and replace it in plug sheet and run in tightly. The plug should now seat tightly and hold taper pin in place.
- 8.) Repeat operation on other end of tube.
- 9.) Hydro-test section to insure proper pressure seal without leaks.

NOTE: If the access plug that was removed does not seal properly, replace it along with the gasket if it is a shoulder type plug.



INSPECTION

TUBES

Tubes should be inspected for internal and external corrosion and/or erosion periodically. This depends on the severity and type of service and atmosphere that the tubes are operating in. Inspection of the tubes should be performed every six months to one year intervals. Tube wall thickness can be checked externally using an ultrasonic technique.

FANS

Fans should be inspected for wear or loose bolts (cracks, pitting and corrosion) on all surfaces. These inspections should be performed every six months. In addition to surface inspections, all bolts and nuts must be checked for proper torque. (See the fan section of the manual).

BEARINGS

In addition to checking bearings as recommended by the manufacture, the mounting bolts should be checked for proper torque and alignment. These checks should be done at least every six months.

STRUCTURE

A general inspection of the structure should be performed every six months to a year. This inspection should include checks for corrosion, damaged members, sheeting guards and for loose bolts.

HEADERS

Headers should be inspected for corrosion periodically. This corrosion should not be allowed to proceed past the stated corrosion allowance as stated on the individual job specification data sheet.

RECOMMENDED SPARE PARTS

We suggest that one each of the parts that are identified as recommended spare parts on the Table of Contents page, be kept in stock or be readily available. The down time caused by waiting for delivery of a replacement part may cost far more in lost production or service than the cost of the item itself.

Spare parts orders should be specified in accordance with the parts list description and always include the corresponding *AXH air-coolers'* model and job number.

WARRANTY

AXH air-coolers warrants that the equipment it *manufactures* is free of defects in material and workmanship, when operated in accordance with conditions stated, for a period of one (1) year after start-up not to exceed fifteen (15) months from shipment. Such warranty shall not apply to any equipment that has been altered or repaired by other than the Company's personnel. The Company's obligation under this warranty is limited, however, to repairing or, if in the Company's judgment it seems more appropriate, to furnishing without charge, F.O.B. the Company's factory, a similar part to replace any part which after examination shall, to its own satisfaction be determined to have been defective at the time it was shipped. This warranty applies only if the Company received an immediate written notice upon discovery of such defect. The Company makes no warranties covering deterioration or failure due to corrosion, erosion or fouling or due to improper installation or operation. EXCEPT AS SPECIFICALLY STATED ABOVE, AXH AIR-COOLERS HEREBY DISCLAIMS ANY AND ALL WARRANTIES, EXPRESS OR IMPLIED, WHETHER OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, OR OTHERWISE.

LIMITATION OF LIABILITY

The remedies set forth herein are exclusive. AXH air-coolers shall not be liable, in excess of the purchase price of the equipment, for any damages, whether in contract, in tort or on any other basis, sustained by the customer or any other person arising from or related to the delivery, use or failure of the equipment or for any delay, special, incidental, consequential, indirect or commercial damages whether due to lost profits or otherwise resulting from the delivery, use or failure of the equipment. If it is ever necessary to contact our plant for service or replacement parts, it is essential that our job number and other identifying data be obtained from the metal nameplate attached to the cooler, or the nameplate attached to the tube bundle header box, which also contains the design pressure, temperature, and serial number.

AXH air-coolers

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AXH air-coolers

401 E. Lowry Road, Claremore, Oklahoma 74105
(918) 283-9200 Fax (918) 283-9237
www.airxhemphill.com

JOB NUMBER(S): **64468**
CUSTOMER: **Enerflex Systems**
QUANTITY: **6**
MODEL: **144EF-102-24**

RECOMMENDED SPARE PARTS

<u>QUANTITY</u>	<u>DESCRIPTION OF PARTS</u>					
<u>6</u>	<u>FAN(S)</u>	MAKE	<u>MOORE</u>	MODEL	<u>CLASS 10000HD, SERIES 48, VT</u>	
	DIAMETER	<u>144"</u>	BLADES	<u>10</u>	ROTATION	<u>LEFT</u>
	ANGLE	<u>16°</u>	@ Mark	BORE	<u>2-15/16"</u>	KEYWAY <u>3/4" X 3/8"</u>

SHAFTS

<u>6</u>	FAN:	<u>2-15/16"</u>	DIA PER DRAWING NO.	<u>64468</u>	<u>SHD</u>
<u>6</u>	IDLER:	<u>2-3/16"</u>	DIA PER DRAWING NO.	<u>64468</u>	<u>SHD</u>

NOTE: All shaft material to be C1045 Turn, Ground and Polished

BEARINGS

<u>12</u>	FAN:	DIA	<u>2-15/16"</u>	MAKE	<u>Dodge</u>	MODEL	<u>TAF PB</u>	<u>PN 037588</u>
<u>12</u>	IDLER:	DIA	<u>2-3/16"</u>	MAKE	<u>Dodge</u>	MODEL	<u>TAF PB</u>	<u>PN 037583</u>



2230 East 49th Street Phone (918) 712-8268
 Tulsa, OK 74105 Fax (918) 712-8269
info@axh.com www.axh.com

Proposal / Job No. 64468
Date 3/24/2006
Page 1 OF 1

1	Purchaser	ENERFLEX/060XXX 7042GL-JGK4	Ultimate User	
2	Inquiry / PO#	0640045, 46, 47, 48, 49	Destination ENCANA-AB,BC	
3	# Units	5	Model	144EF-102-24
4	Assembly	PACKAGED	Draft	FORCED
			Overall Size (WxL), Ft	Est Wt 23500 LBS

THERMAL & MECHANICAL DESIGN

5	Service	EJW	AUX-W	IC-1	IC-2	AC
6	Flow	465GPM	80GPM	16.3MMSCFD	7.42MMSCFD	7.42MMSCFD
7	Fluid	50%GLY	50%GLY	.65SPGR	.65SPGR	.65SPGR
8	Temp. In / Out, °F	180.0 / 165.0	164.7 / 130.0	195.0 / 120.0	237.0 / 120.0	238.0 / 120.0
9	Pressure, PSI			615PSIG	1400PSIG	1400PSIG
10	Pressure Drop, PSI	4.8	13.1	4.2	4.6	4.6
11	Heat Load, BTU/HR	3237250	1241630	1511228	1201805	1211973
12	True LMTD	54.2	38.6	45.5	56.8	57.1
13	Overall Rate, U	166.3	159.0	97.2	105.2	105.2
14	Fouling Factor	.0005	.0005	.0020	.0020	.0020
15	Surface, Tube / Total, Sq Ft	359 / 5350	205 / 3057	350 / 5561	205 / 3057	205 / 3057
16	Sections, #	(1) - COMBINED	(1) - COMBINED	(1)	(1)	(1)
17	Design Temp, °F Max / Min	300 / -20	300 / -20	350 / -20	350 / -20	350 / -20
18	MWP / Test Press, PSIG	* 14 / 75	* 14 / 75	1292 / 1680	1935 / 2516	1935 / 2516
19	Pass Arrangement	CROSSFLOW	CROSSFLOW	CROSSFLOW	CROSSFLOW	CROSSFLOW
20	# Tube Rows	3	3	4	3	3
21	# Tube Passes	1	3	1	2	2
22	Tubes, OD x BWG	3/4X16	3/4X16	5/8X16	3/4X16	3/4X16
23	Material	SA214 STEEL	SA214 STEEL	SA179 STEEL	SA179 STEEL	SA179 STEEL
24	# Per Section / Length, Ft	77 / 24	44 / 24	90 / 24	44 / 24	44 / 24
25	Turbulators					
26	Accelerators					
27	Fins, Type	HI-EFF	HI-EFF	HI-EFF	HI-EFF	HI-EFF
28	Material	AL	AL	AL	AL	AL
29	Nozzles, Rating / Type	STUB	STUB	600RF	900RF	900RF
30	Material			SA105	SA105	SA105
31	# Inlets / Size In	(1) 6	(1) 2	(1) 6	(1) 4	(1) 4
32	# Outlets / Size In	(1) 6	(1) 2	(1) 6	(2) 4	(2) 4
33	Headers, Type	REC TUBE	REC TUBE	BOX	BOX	BOX
34	Material	A500	A500	SA516-70	SA516-70	SA516-70
35	Corrosion Allow, In			.1250	.1250	.1250
36	Grooved Tubesheet	SGL	SGL	DBL	DBL	DBL
37	Plugs, Type	TAPER	TAPER	SHOULDER	SHOULDER	SHOULDER
38	Plugs Material	STEEL	STEEL	A105 STEEL	A105 STEEL	A105 STEEL
39	PWHT			YES	YES	YES
40	ASME Code & Nat'l Board			YES	YES	YES
41	CRN			AB, BC	AB, BC	AB, BC
42	Add'l Specs & Options					
43	API					
44	Louvers / Hail Screen	MAN /	MAN /	AUTO /	AUTO /	AUTO /
45	Inspection / NDT			BX, UT	BX, UT	BX, UT

FX= 100% X-Ray of all header seam, attachment & nozzle butt welds. **SX=** Spot X-Ray of 1 long seam & 1 end closure, per header
BX= 100% X-Ray of all nozzle butt welds. **UT =** 100% UT of all header seam, attachment & nozzle butt welds. **H =** Hardness testing.

AIR-SIDE PERFORMANCE		FAN DATA		DRIVER DATA		STRUCTURAL	
46	Ambient Air Temp, In °F	90	Fan(s) (1) MOORE48-10K/VT	Type		Guards FAN	
47	Elevation, Ft	2500	Blade Material ALUMINUM	V-BELT BY OTHERS		SOFT BUGSCREEN	
48	Air Flow, SCFM	203,580	HP / Fan 54			DISCHARGE GUARD	
49	Outlet Air Temp, °F	127.5	Dia, In / # Blades 144 / 10				
50	Min Air Temp, °F	-20	RPM 275				
51			Tipspeed, FPM 10367				
52	Est. Noise Data:	87dBA @ 1m, 69dBA @ 15m.	Pitch, Deg 16				

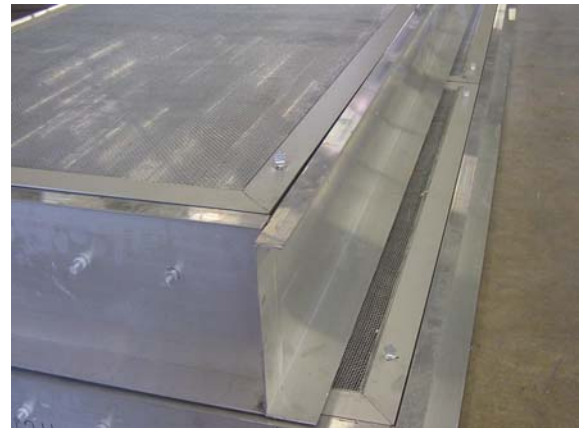
53 **Additional Info.** *-BUILT TO STANDARD 150# DESIGN BUT DESIGNATED 14# TO AVOID THE NEED FOR PROVINCIAL REGISTRATION
 54
 55
 56
 57
 58

Duraflow Industrial Louvers

- Aluminum or Galvanized Steel Construction
- Built to Heavy Duty Airtech Standards
- Optional API 661 Compliance
- Bolted or Welded Construction
- Internal Mechanism / Actuation



- Bug Screens & Hail Guards
 - Wire Cloth
 - Expanded Metal
 - Vinyl
- Fan Guards
- Recirc Doors with Frames



- Short Lead Times
- Built to Customer Specifications
- Competitive Pricing
- Domestic or Export Crating

AIRTECH Products, Inc.

P.O. Box 790

Sand Springs, OK 74063

Phone: 918-241-0264

Fax: 918-241-0270

Email: info@airtechinc.biz

Technical Information / Standard Configurations

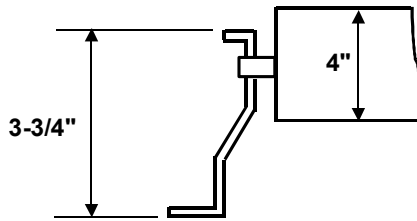
Aluminum Frame (extrusion):	6063-T5
Aluminum Frame (folded sheet):	3003-H14
Galvanized Steel Frame:	A653-G90 Carbon Steel (Mechanical Galvanized Finish)
Blades:	6063-T6 Aluminum
Blade Pins:	
Aluminum:	6061-T6 Aluminum
Stainless Steel:	303 Stainless Steel
Torque Tube:	6063-T6 Aluminum
Actuator Rod:	6063-T6 Aluminum
Actuator Lever Arm:	6061-T6 Aluminum
Clevis:	1018 Carbon Steel
Clevis to Arm Connecting Link:	6061-T6 Aluminum

Assembly Hardware:

Cap Screws:	ANSI/ASME 18.2.1 Grade 5, Zinc Plate
Nuts:	Locking nut, Performance Spec IFI/100, MIL/N/25027, Light Hex, Standard Height, Zinc Plate
Bearings:	Glass Filled Nylon, (Per API Specification 661)

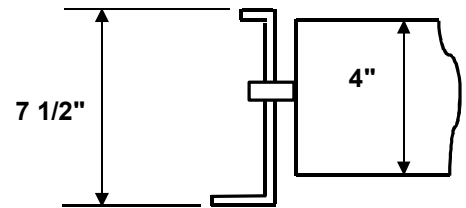
Series 300

- 3 3/4" Frame
- 4" Blade



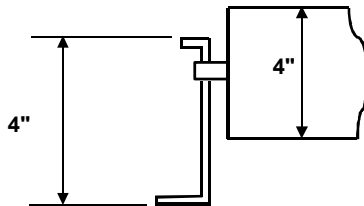
Series 740

- 7 1/2" Frame
- 4" Blade



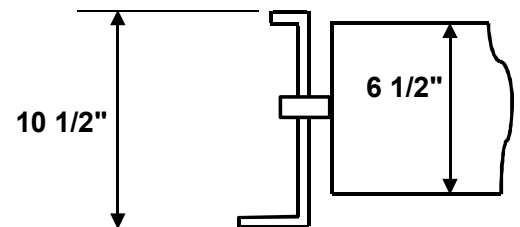
Series 400

- 4" Frame
- 4" Blade



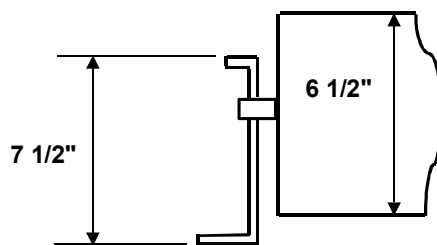
Series 1000

- 10 1/2" Frame
- 6 1/2" Blade



Series 700

- 7 1/2" Frame
- 6 1/2" Blade



Airtech Products, Inc., P.O. Box 790, Sand Springs, OK 74063
Phone: 918-241-0264, Fax: 918-241-0270
Email: info@airtechinc.biz

AIRTECH PRODUCTS, INC.

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918-241-0264 (Phone)

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Duraflow Industrial Louvers

Installation and Maintenance Instructions

PRE-INSTALLATION ACTIVITIES:

1. With the louver crate resting firmly on either saw horses or a smooth and level area at grade, remove packing crate top and sides.
2. Make a visual inspection of the louver frame, blades and all linkages/drive mechanisms to ensure there was no shipping damage.
3. Various small parts needed to connect the drive linkages are shipped in a separate and smaller cardboard box. Keep this box at hand but out of the way and in a safe place.
4. Inspect the mounting surface of the cooler giving particular attention to ensure it provides uniform support of the louver perimeter and that it is structurally adequate to support all static and dynamic loadings.
 - a. If the louver is to be mounted in a horizontal configuration, it is **CRITICALLY IMPORTANT** to ensure the mounting surface is uniform and level to +/- .25" over 20'. Airtech louvers are manufactured to precise tolerances and bolting to an off-level surface will cause binding in the moving parts. This will result in inconsistent operation, shorten product life and can cause permanent damage that voids the manufacturers warranty.
 - b. If the louver is to be mounted in a vertical configuration, the installer must confirm there will be uniform support / attachment to the mounting surface at spacing not greater than 18" centers on the louver perimeter flange. Failure to do so may result in bending of the louver frame and inconsistent operation, a shortened product life and can cause damage that voids the manufacturers warranty.
5. Take a moment to visualize the installation and plan the placement of individual louver sub-assemblies. Although all louver installations involve essentially the same procedure, any given application will have some unique characteristics. Some projects will require louver sections to link together at the side via torque tube connectors while others may link together at the ends via end links on the actuator rod. Small projects may require neither type of connection while large projects will require both.
6. Open the cardboard box of small parts and confirm all the necessary pieces are at hand. Depending on the application, this could be torque tube couplings, actuator rod end links, grade level operator components, clevises, etc. Please note, unless the louvers are to be attached via angle clips, the actual attachment hardware won't be included in the louver shipment.
7. Most of the time, louver installation is easiest done using self-drilling speed screws, 1/4" x 1 1/4" long, fine thread. Ensure a screw is in place on all corners and not greater than 18" centers around the louver perimeter. Simply drill through the louver flange into the host structure making sure the screw is completely pulled down tight. If retaining clips is your preferred method of attachment, please review to "Reference A" for instructions on use and installation.

MOUNTING & ATTACHMENT

1. Hoist the louver (or first louver sub-section) into place making sure the lift is well supported around the perimeter. DO NOT ALLOW THE LOUVER TO RACK or excessively bend during the lifting process.
 - a. **For horizontal applications**, set the louver onto the mounting surface and visually confirm 100% of the perimeter is supported and resting flat upon the top of the cooler. Make sure the operating mechanism travels freely through the entire range of motion and there is no interference from complete shut to complete open. If the louver is supplied in multiple sections, install the section with the operator first and perform the motion/operation test noted above. Square the louver to the cooler as best you can but above all, be sure the louver remains square – do not force to the louver out of square to accommodate the cooler. THE LOUVER MUST BE SQUARE to operate properly. After confirming the louver is properly placed relative to the mounting surface (and to other subsequent sections, if applicable), install a self-drilling screw at each corner and at no greater than 18” centers along all flanges. If applicable, hoist subsequent sections into place and following the above instructions, attach each to the host structure. DO NOT STEP ON LOUVER BLADES AT ANY TIME. If you must step out onto the louver, use dimension lumber or plywood as a walking surface.
 - b. **For vertical applications**, hoist the louver (or first louver section) into place and after checking for clearance on moving parts, attach to the cooler with a self drilling screw at each corner and at no greater than 18” spaces along all flanges. Install all attachment screws before releasing hoist cables or hoisting device to ensure the louver is fully attached and there is no deflection in the louver frame. If applicable, hoist subsequent sections into place and following the above instructions, attach each to the host structure.
2. If the louver is supplied in multiple sections, remove the connecting links / couplers from the shipping box and install them as required at the ends of actuator rods and torque tubes. End link installation instructions are detailed as attached “Reference B” and Torque Tube coupling installation instructions are detailed as attached “Reference C”.
3. When all sections are installed and connected, test the drive mechanism to ensure it moves freely, without binding or interference. On very large louvers with multiple sections, this may require use of a lever. Small to average size louvers should easily operate by hand strength on the torque tube.
4. Complete the installation by attaching any remaining components such as pneumatic actuator or grade level operators. Detailed installation instructions for actuator can be found in its shipping carton. For instructions on grade level operators, see attached “Reference D”.
5. After installing any remaining operators, complete the installation process by cycling the louver several times to ensure it moves freely, without interference and isn’t binding at any location. Some adjustment of end links may be required to ensure all louver blades open and shut consistently down the entire length of the louver.
6. Check all attachment fasteners to ensure all are properly tightened and completely engaged to the louver flange.
7. If applicable, check all end link connections and torque tube couplers to ensure they are properly tightened and fasteners are completely engaged.

MAINTENANCE INSTRUCTIONS (Annual)

1. Visually inspect all blade pins to ensure the pin bearings are in place and do not have unacceptable wear.
2. Visually inspect all connections between blade horns and actuator rod to confirm all connecting bearing, bolts and nuts are in place and not showing unacceptable wear.
3. Visually inspect all attachment screws to ensure none have backed off or are missing.
4. If dirt or grease buildup is excessive, clean louver blades and operating mechanisms with high pressure clear water wash.
5. Operate any manual levers or grade level operators to confirm all are in good working order and move freely without binding or interference.
6. If actuators are installed, visually inspect the mounting bolts to ensure all are tight and in place. Visually inspect the condition of all connecting links, the clevis and clevis pin.
7. Visually inspect all actuator rod end links and torque tube connectors to confirm all are in place and properly engaged.
8. Remove any leaves or other debris that may have collected in corners or between the louver blades and integral hailguards.

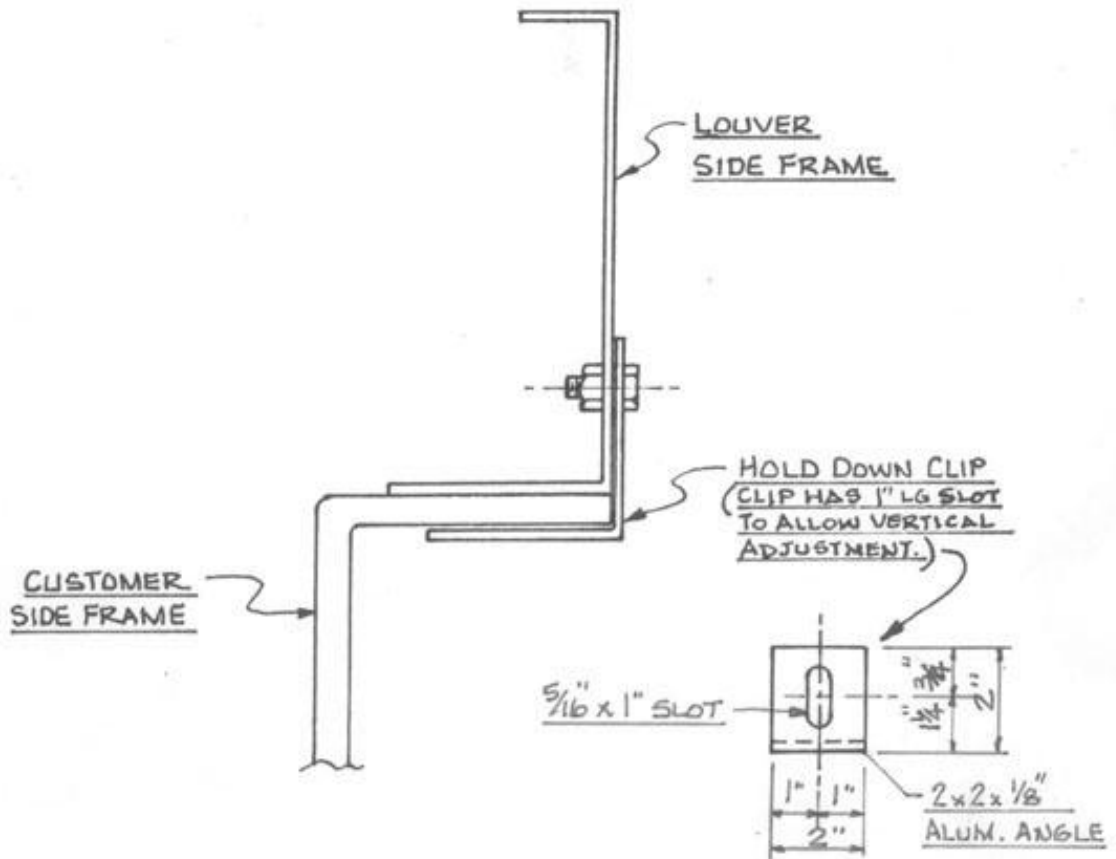
RECOMMENDED SPARE PARTS LIST

Item Description	Suggested Quantity
1. Blade horn bearing, bolt and nut kit	1 per 5 Ft ² louver area
2. Actuator rod end link kit	1 per 2 connections
3. Torque Tube couplings	1 per 2 torque tube connections
4. Blade Pin and Pin Bearing kits	5 per 10 Ft ² louver area
5. Manual handle kits	1

AIRTECH Products Inc.

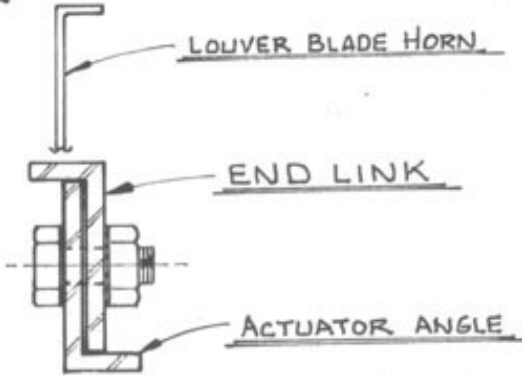
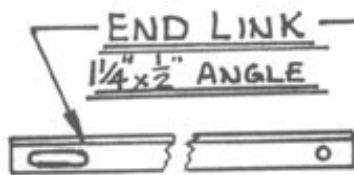
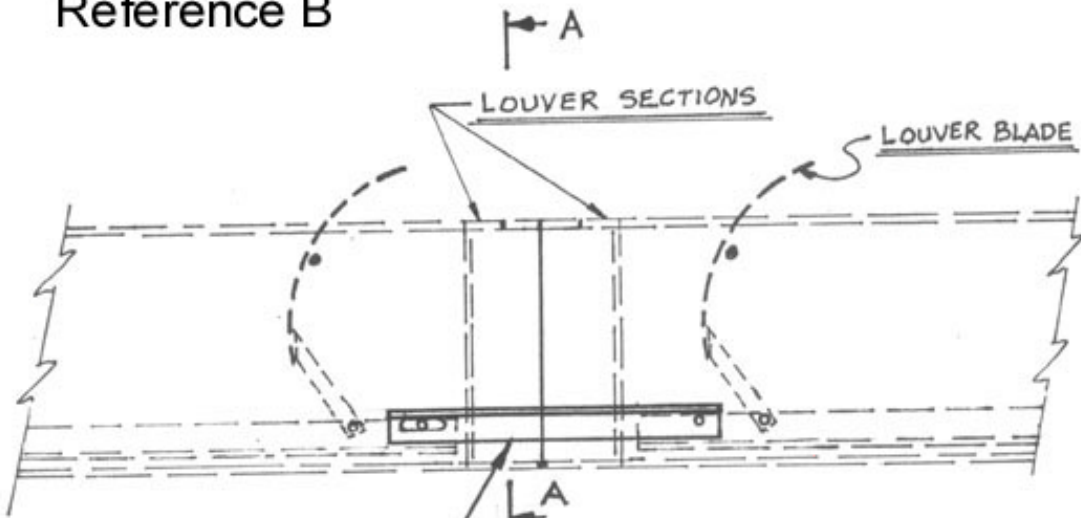
Reference A

MOUNTING CLIP DETAIL



P.O. BOX 790
SAND SPRINGS, OK 74063
(918) 241-0264

Reference B



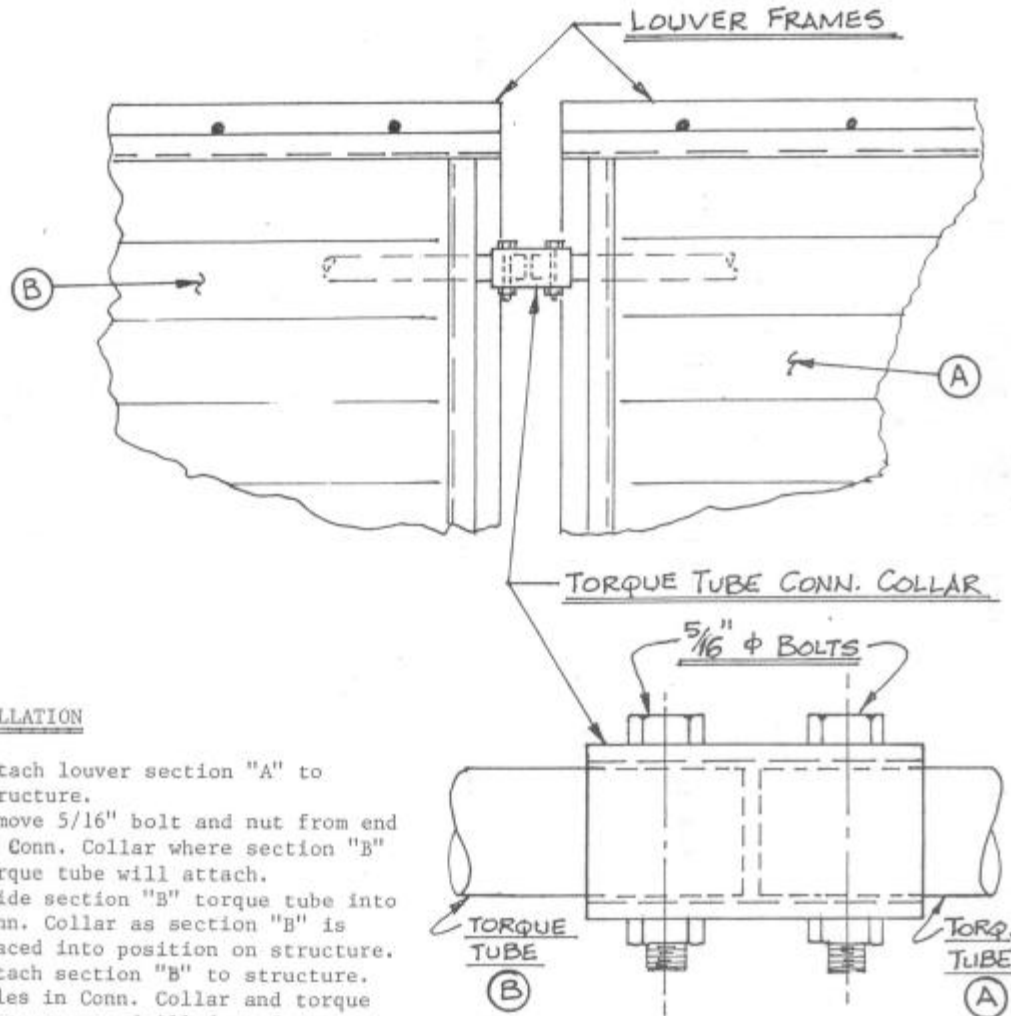
INSTALLATION

1. Position blades in each louver section to same percent of opening.
2. Insert End Link through slots in louver section end frames.
3. Install End Link by attaching to louver actuator rods using the 1/4" bolts and locknuts provided.

END LINKS ARE \$3.25 each including bolts & nuts.

AIRTECH	
INDUSTRIAL SHUTTERS	
END LINK INSTALLATION	
Cust. _____	Dwg. 700-4
Date _____	

Reference C

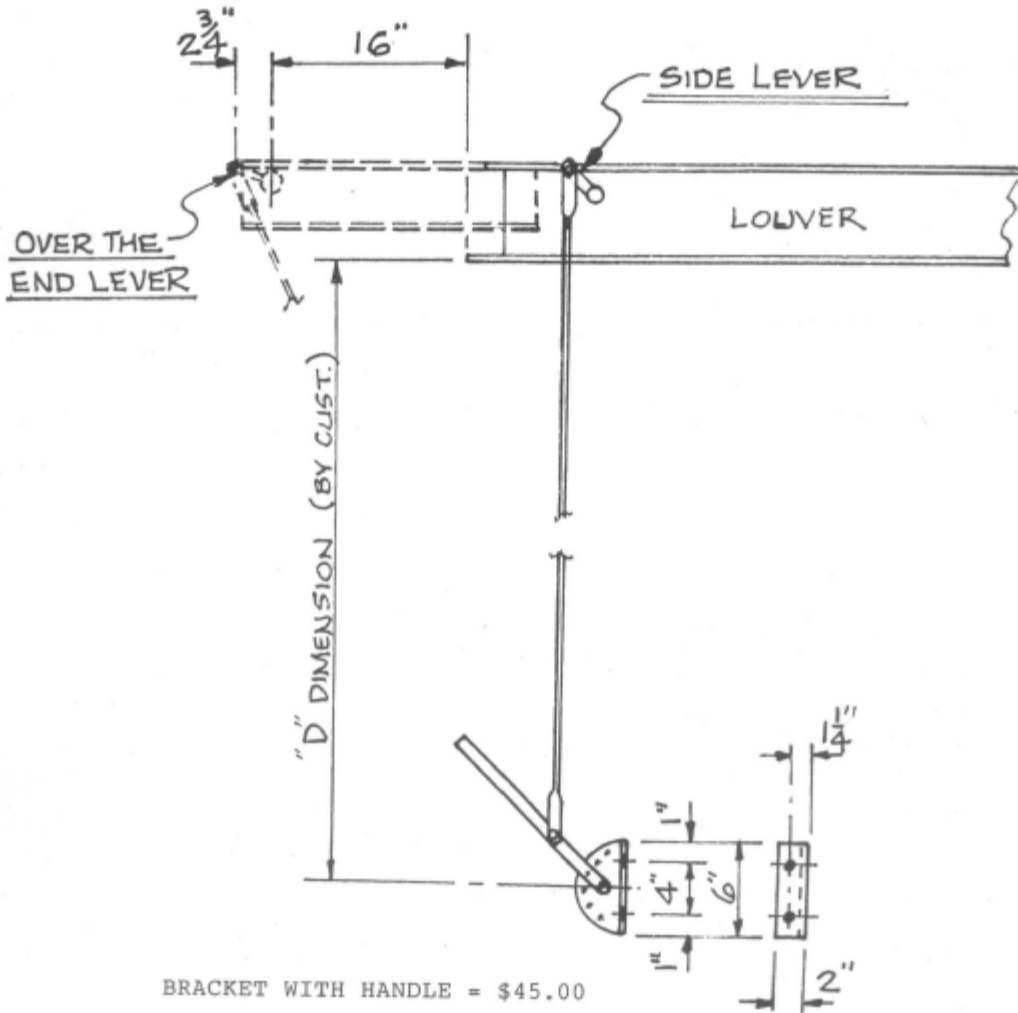


INSTALLATION

1. Attach louver section "A" to structure.
2. Remove 5/16" bolt and nut from end of Conn. Collar where section "B" torque tube will attach.
3. Slide section "B" torque tube into Conn. Collar as section "B" is placed into position on structure.
4. Attach section "B" to structure.
5. Holes in Conn. Collar and torque tube are pre-drilled at factory to assure proper opening and closing of louver blades. Be sure all louver blades are in same percent of opening before replacing 5/16" bolt and nut to Conn. Collar and section "B" torque tube.

AIRTECH	
INDUSTRIAL SHUTTERS	
Connecting Collar Installation	
Cust. _____	Dwg. 700-4
Date _____	

Reference D



AIRTECH

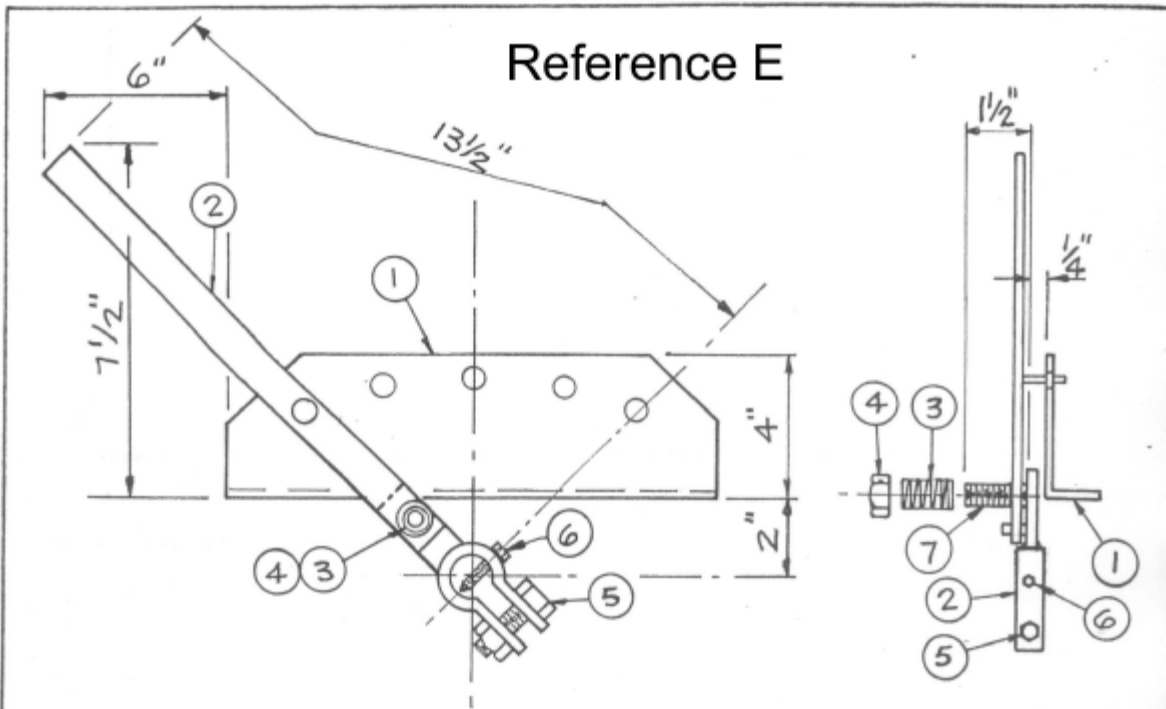
INDUSTRIAL SHUTTERS

MANUAL GRADE LEVEL OPERATOR

Cust.

Date

Dwg. 700-5



Reference E

MANUAL OPERATOR DETAIL

- (1) = Manual Operator Bracket.
- (2) = Manual Operator Handle.
- (3) = Manual Operator Handle Spring.
- (4) = Manual Handle Nut.
- (5) = Manual Handle Clamp Bolt & Nut.
- (6) = Set Screw
- (7) = 3/8" dia. all-thread.

AIRTECH	
INDUSTRIAL SHUTTERS	
MANUAL OPERATOR PARTS	
Cust.	
Date	Dwg. 700 - 3

Reference F

AIRTECH PRODUCTS, INC.

P.O. Box 790
8101 West 16th Street
Sand Springs, OK 74063

918-241-0264 (Phone)
918-241-0270 (Fax)

Louver Materials of Construction

Aluminum Frame (extrusion):	6063 T5
Aluminum Frame (folded sheet):	3003 H14
Galvanized Steel Frame:	A653-G90 10 Ga. Carbon Steel (Mechanical Galvanized Finish)
Blades:	6063-T6 Aluminum
Blade Pins:	
Aluminum:	6061-T6 Aluminum
Stainless Steel:	303 Stainless Steel
Torque Tube:	6063-T6 Aluminum
Actuator Rod:	6063-T6 Aluminum
Actuator Lever Arm:	6061-T6 Aluminum
Clevis:	1018 Carbon Steel
Clevis to Arm Connecting Link:	6061-T6 Aluminum
Assembly Hardware:	
Cap Screws:	ANSI/ASME 18.2.1 ¼-20, Grade 5, Zinc Plate
Nuts:	Nylon Insert lock nut, Performance Spec IFI/100, MIL/N/25027, Light Hex, Standard Height, Zinc Plate
Bearings:	Glass Filled Nylatron, (Per API Specification 661)

Airtech Products, Inc.

P.O. Box 790

8101 West 16th Street

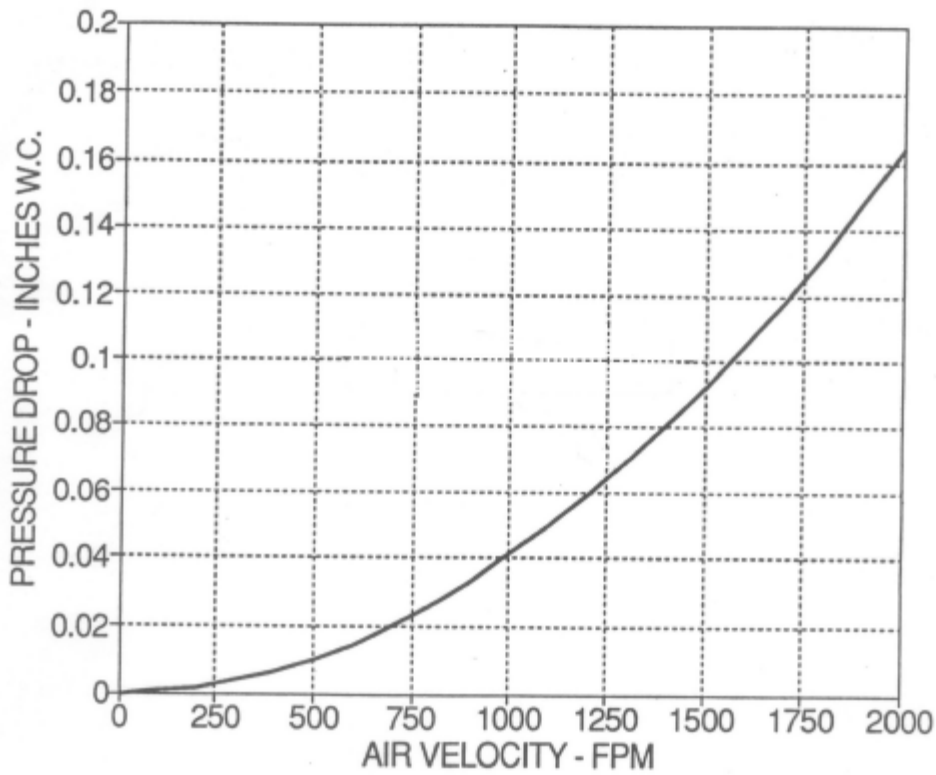
Sand Springs, OK 74063

Reference G

918-241-0264 Phone

918-241-0270 Fax

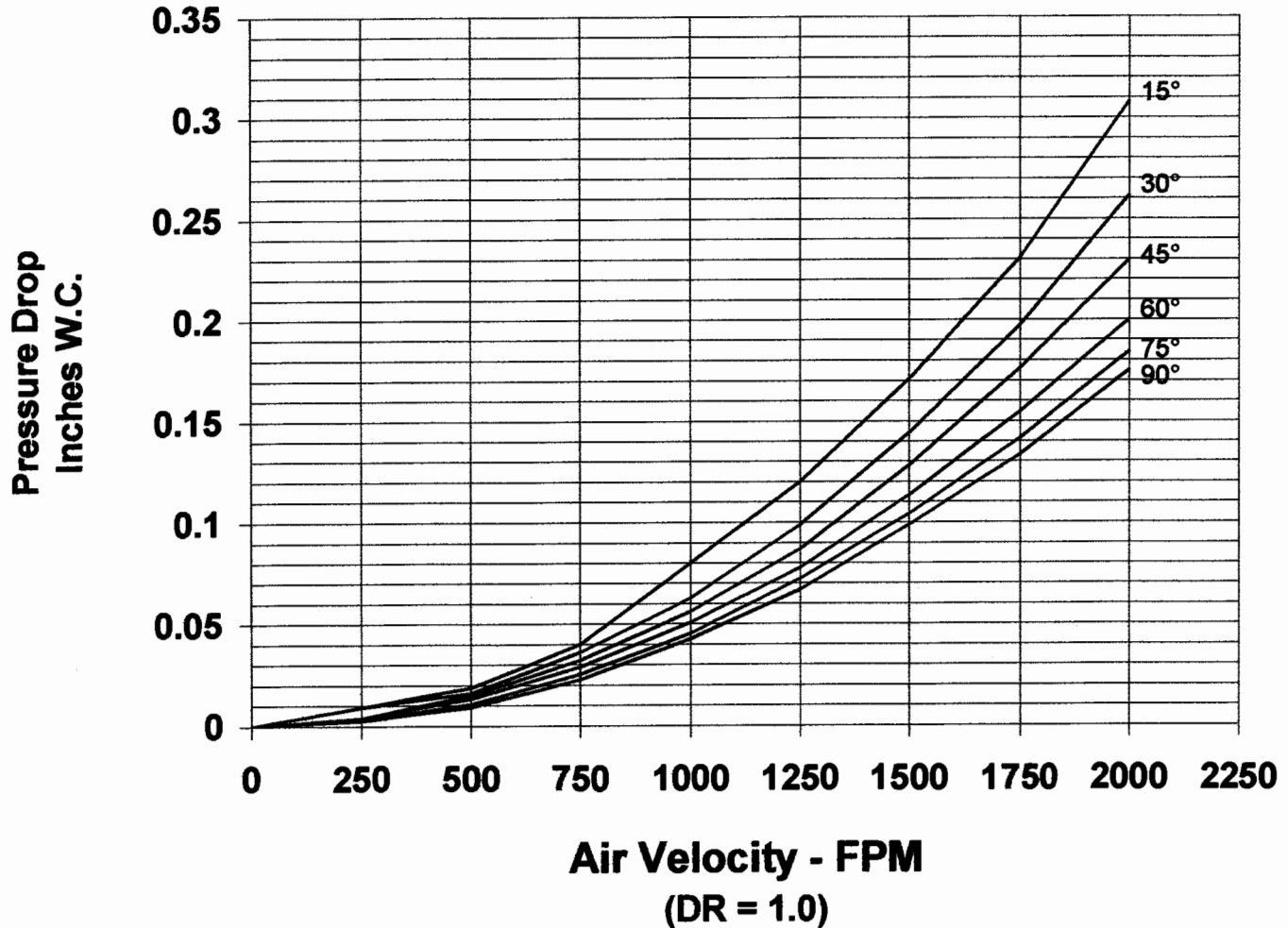
LOUVER PRESSURE DROP CURVE



DENSITY RATIO = 1.0

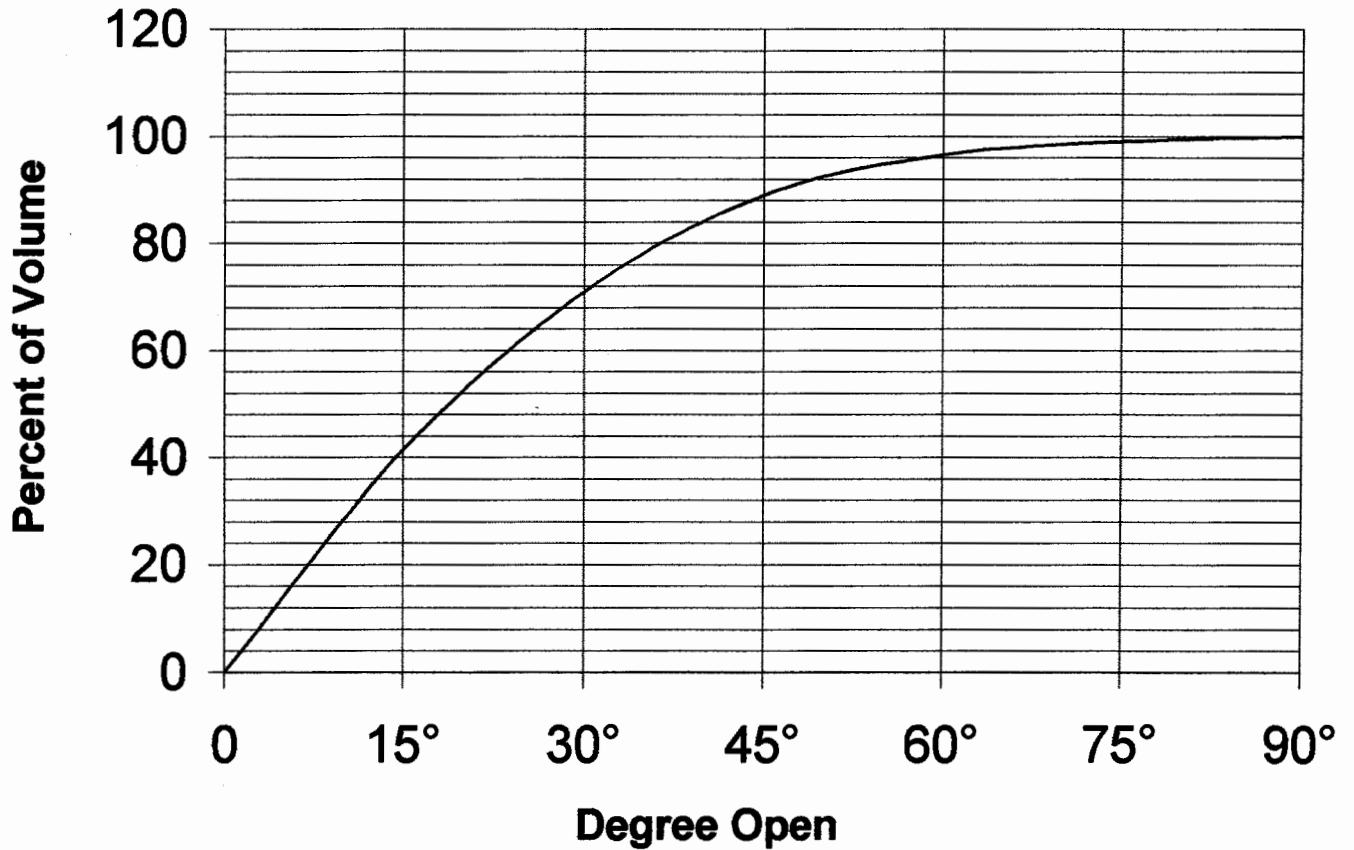
Corrected Pressure Drop Across The Louvers As A
Function of Air Speed Within The Wind Tunnel.

Pressure Drop vs Degree of Opening





Percent of Volume Per Degree Open





CLASS 10000 FANS OWNER'S MANUAL

INSTALLATION

MAINTENANCE

OPERATION

Contents

2.0	INSTALLATION	2
2.2	INSTALL HUB AND AIR SEAL	3
2.3	INSTALL AND ADJUST BLADES	4
2.4	START-UP PROCEDURES	5
3.0	MAINTENANCE	6
3.2	ANNUAL INSPECTION	7
3.4	WARRANTY	8
3.5	PARTS LIST	9
4.0	OPERATION	10
4.2	BLADE OVERLOAD	11
4.3	CAUSES OF IMPROPER BLADE LOADING	12
4.4	CHECKING BLADE LOAD	13
4.4.1	SAMPLE GRAPH of BLADE ANGLE IN DEGREES	14
4.5	DAMAGING OPERATING CONDITIONS	15
4.5.3	OBSTRUCTIONS	16

INSTALLATION

ABOUT THIS MANUAL

Moore is as interested as are its customers that Moore fans operate at top efficiency for many, many years. This manual has been written to achieve that result and is based on more than 50 years of experience as a manufacturer of axial flow fans.

Moore fans represent the highest degree of axial fan development and are in all respects, regardless of price, the finest obtainable for their intended purpose. As for any fine equipment, certain precautions are necessary and certain abuses must be avoided in order to insure the best performance over the longest period of time. If you have any questions regarding the installation or operation of your Moore fan(s), please contact the Company for assistance.

INSPECTION

All Moore units are carefully balanced, inspected and packed at the factory. If any damage is evident

before or after unpacking, the delivering carrier should be promptly notified so that an inspection may be made by the claims adjustor. It is the responsibility of the consignee to file damage claims with the carrier. Although Moore will not be responsible for shipping damage, it is requested that any damage, even of a minor nature, be reported to the factory at once.

IDENTIFY YOUR FAN'S FEATURES

Section 1 consisting of your unit's specifications will be found on the Order Information Sheet attached. Section 2 Getting Started should be read carefully before installation begins. Moore fans have several unique features.

2.0 INSTALLATION

2.1 GETTING STARTED

2.1.1 FAN IDENTIFICATION

Every fan, or group of identical fans, is assigned a Job Number. This number will be found on the Order Information Sheet showing fan specifications. A copy is attached to this manual. If non-identical fans are shipped together, a Job Number is assigned to each fan or group and a set of Information Sheets will be included for each Job Number.

The Job Number is written in semi-permanent ink on each blade, hub and air seal. All fan parts bearing the same Job Number are entirely interchangeable. (Blades of the same Series and Diameter are also interchangeable between Job Numbers.)

Fan components covered by more than one Job Number may be crated together. The Job Number that is written on each part, however, will make sorting simple.

Each individual fan produced by Moore is assigned a Serial Number. This Serial Number is embossed on a permanent metal tag and attached to each fan hub. The Fan Information Sheet provided for each Job Number lists all of the individual Serial Numbers of the identical fans covered by that Job Number so that, in future years, reference to the fan specifications provided will identify the characteristics of each individual fan.

Moore keeps records indexed by serial and job numbers of all fans produced for at least forty years in order to provide proper maintenance advice and information on spare parts and replacements.

2.1.2 PLANNING THE INSTALLATION

The sequence given for the installation may be changed if the conditions warrant. For example, the air seal may be installed on the hub before the hub is installed on the drive shaft. (In fact, for inverted fans, it is necessary to install the air seal first.) The installation should be planned before beginning so that the steps required are taken in the most convenient order. If you need information not found here, please contact Moore.

Class 10000 fans are suitable for horizontal or vertical mounting, for electric motor or engine drive and may be designed for clockwise (right hand) or counterclockwise (left hand) rotation. Some drawings illustrating the installation assume vertical mounting and need to be mentally rotated for horizontal mounting. Be sure to refer to the dimensional drawing(s) provided. These will illustrate the proper orientation of the fan and the rotation direction.

2.2 INSTALL HUB AND AIR SEAL



Hub Only Without Air Seal



Air Seal Installed on Hub

Hub installation instructions

Some Moore Class 10000 hubs are shipped with Moore Hi-Torque (HT) Aluminum Bushings. The following paragraph details the installation procedure for these hubs.

Lubrication:

If the bushing was pre-installed in the hub at the factory, no further lubrication is required prior to installation. If the bushing was not installed in the hub at the factory, it is imperative to apply high quality grease to the following surfaces:

1. The cap screw threads
2. The underside of the cap screw heads
3. The bushing taper / hub bore

DO NOT apply lubricant between the bushing bore and the shaft.

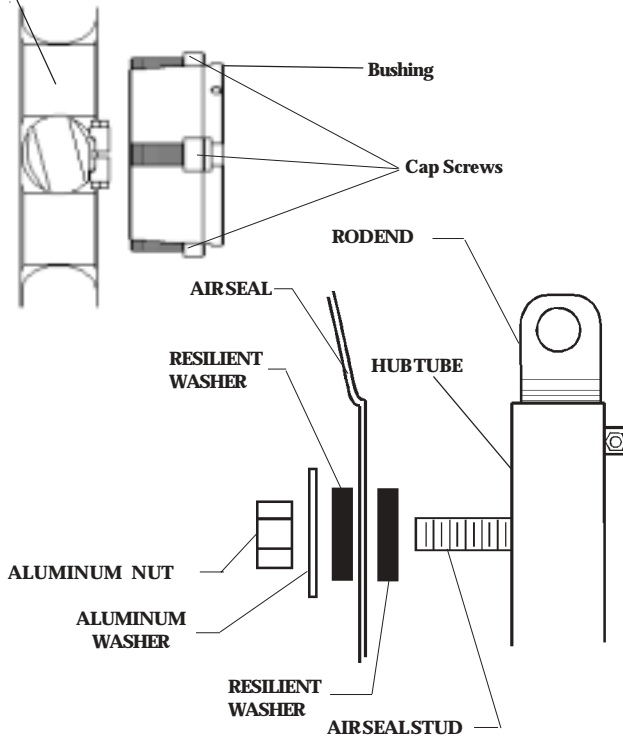
Installation:

Install the bushing in the hub by aligning the threaded holes on the I.D. of the hub with the slots on the OD of the bushing with the cap screws captured between the bushing and the hub. Insert the bushing in the hub. Using a hex key wrench, sequentially tighten the socket head cap screws until the bushing is almost fully engaged in the hub. Leave slight play between the bushing and hub to facilitate installation on the shaft.

Place the hub/bushing on the shaft. (Preferably cap screw heads will be towards free end of shaft.) Insert the key, and tighten the setscrew to secure the hub and key to the shaft. Now begin sequentially tightening the socket head cap screws (approximately 2-3 turns per cap screw initially) to firmly engage the bushing in the hub and seat the bushing on the shaft. Once the bushing/hub is firmly seated on the shaft, continue tightening the cap screws sequentially until the specified torque, shown in the following table, is reached. DO NOT over-tighten cap screws as this could cause damage to the hub.

Bushing TYPE	Bushing OD	Allen Head Bolt	Hex Key Size	Required Torque
T	3"	12 mm	10 mm	50ft-lb (6.9m-kg)
U	4"	12 mm	10 mm	50ft-lb (6.9m-kg)
W	5.5"	16 mm	14 mm	90ft-lb (12.5m-kg)
X	5.5" Long	16 mm	14 mm	135ft-lb (18.7m-kg)
Z	7"	16 mm	14 mm	135ft-lb (18.7m-kg)

FAN HUB



AIR SEAL INSTALLATION ON HUB

Caution:

If bushing is expected to see frequent oscillating loads (Greater than 50% of nominal expected Static Torque), Fan should be operated for approximately 15 minutes and then re-torque bushing cap screws.

To install the airseal:

If the airseal is to be installed on the shaft side of the fan, cut out the center to provide clearance for the bushing.

Locate the air seal installation hardware in the plastic bag taped to one of the hub tubes. Install the air seal studs on the appropriate side of the hub tube. Finger tighten.

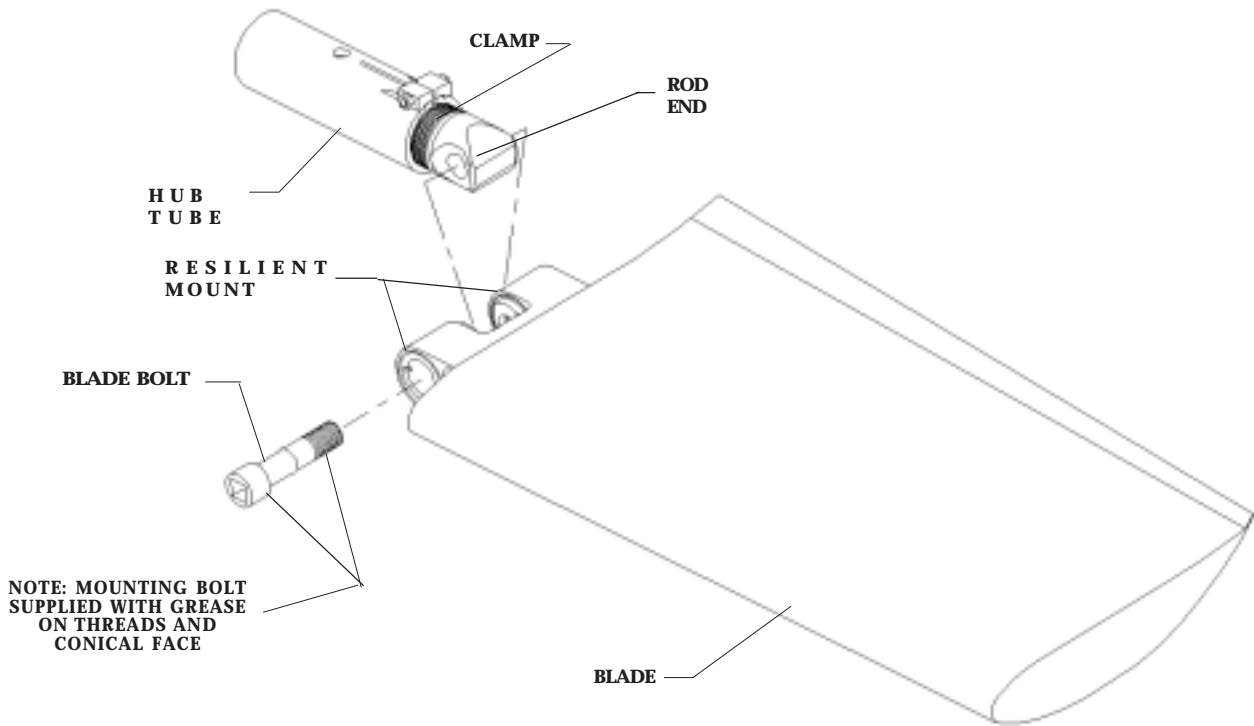
Place one resilient washer on each stud as shown in the drawings at left. Place the air seal onto the studs and install the remaining hardware, following the sequence shown in the drawings. Do not lubricate this end of the studs.

Note that the diameter of the resilient washers, before they are compressed, is slightly less than the diameter of the aluminum washer. Tighten each nut until the resilient washer's diameter is the same as the aluminum washer. Do not overtighten. Overtightness exists when the resilient washer has expanded in diameter larger than the diameter of the aluminum washer.

Note: Some air seals are provided with more mounting holes than may be required. This is done intentionally to make the air seals more interchangeable between units. For example, an air seal with 8 mounting holes can be used with either a 4-blade or an 8-blade unit.

2.3 INSTALL AND ADJUST BLADES

2.3.1 INSTALL BLADES



BEFORE INSTALLING BLADES....

Check to see that the hub is level. If the driveshaft is not truly horizontal (or vertical), causing the hub to be cocked, it will be difficult to adjust blade angles accurately. Eccentric rotation of the fan can also cause serious vibration problems.

If misalignment, vibration or unbalance in the system is present, it will be more easily identified and corrected at this time.

Moore fan blades are carefully balanced to the same moment at the factory. Any Class 10000 blade of the same series and diameter may be installed on any hub furnished on the job. They are completely interchangeable.

Moore Class 10000 Heavy Duty Fans are designed for engine drive and other applications with the more severe requirements of this service. Proper installation, with particular attention to tightening nuts to the specified torque, is essential to maintain the design integrity of these units.

Install one blade: Clean any dirt or grease from the rod end and the surfaces of the resilient mounts. Align the rod end hole with the holes in the resilient mounts and insert the blade mounting bolt first through the resilient mount with the recess to accept the bolt head, then through the rod end hole and screw

the bolt into the second resilient mount lightly. A 3/4" drive torque wrench with a short extension may be used. The blade mounting bolt is supplied from the factory with grease on the threads and conical face. **Do NOT clean the grease from the bolt.**

Complete the installation of one blade by holding the blade so that the blade extends straight out from the hub tube. Holding the blade in this position, **tighten the bolt using a torque wrench set to 200 ft-lb (28 m-kg) making sure the rod end and the resilient mounts seat.**

After installing the first blade, manually rotate the fan while moving the blade tip in and out to be sure the blade clears the ring or throat at all points. When the blade is held in alignment with the blade tube (that is, straight outward from the hub), it should clear the fan ring by a distance adequate to provide for any relative motion between the fan wheel and the ring. Excess clearance between the blade tips and the ring, however, should be avoided to prevent backflow which seriously reduces fan efficiency. If clearance is excessive, the diameter may be adjusted at this time. See Section 2.3.2.

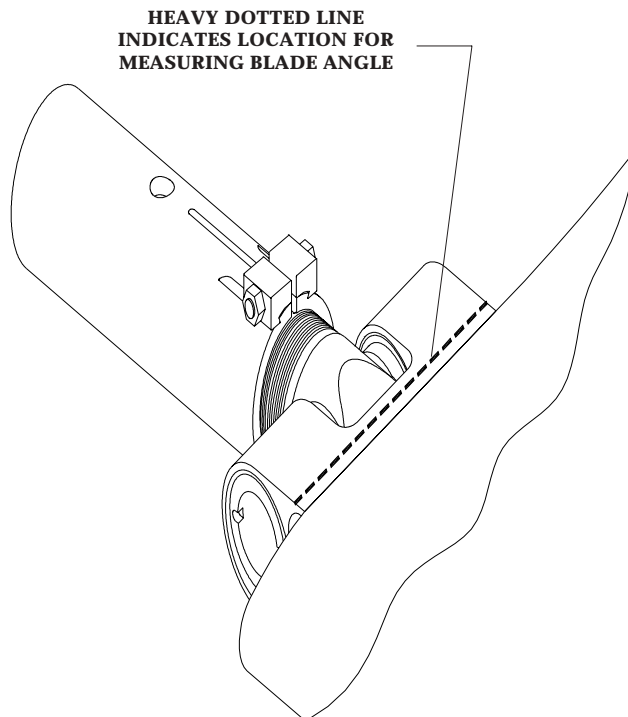
Install the rest of the blades so that they are identical with the first blade. **Torque all bolts to 200 ft-lbs (28 m-kg).** If blades are installed properly, they will return to their undisturbed position if the tips are pressed in the axial direction with moderate force (10 to 20 lb).

2.3.2 ADJUST BLADE ANGLE

Hubs are shipped from the factory with the rod end set for the blade angle indicated by the design performance. A change in blade angle is sometimes necessary, however, to adjust to actual site conditions. Failure to adjust the blade angle when required may result in blade overload. The causes of improper blade loading are explained in Section 4.3 of this manual. Section 4.4 "Checking Blade Load" provides a simple method of determining the maximum blade angle allowable in terms of static pressure vs blade angle. Please refer to these sections before increasing blade angle.

To adjust, loosen the Clamp Nut just enough to allow the blade to be turned. Place an inclinometer on the flat surface of the mounts end as shown in the illustration at right. Turn the blade until the desired angle is achieved. Make a permanent record of the final angle selected and take care that all blades on the fan are set at the same angle. A typical adjustment may be $\pm 3^\circ$. **The maximum recommended blade angle is 30° .**

Retighten the Clamp Nut to 18 ft-lbs (2.5 m-kg). Recheck each blade angle before tightening.



WARNING: The fan is designed to consume the horsepower stated on the Fan Specification Sheet. The engine drive typically produces far more power than the fan can absorb. Too great an increase in blade angle can cause serious blade overload which will stall the blades. In this condition, the fan will actually deliver less air and blade life may be shortened. Blade load considerations are discussed in Section 4.0 Operation in this manual.

2.3.3 ADJUST DIAMETER IF REQUIRED

At times it may be necessary to adjust the fan diameter to suit a particular ring. To do so, loosen the clamp nut so that the rod end can be rotated in the hub tube. One complete revolution will increase or decrease the radius of the fan by .059" (1.5 mm). Take care that the clevis is returned to exactly the factory-set angle unless it is intended that the blade loading be

changed as discussed in the previous section. A match mark may be made at a point on the threads and the tube before turning to assure that exactly one revolution is made. **Tighten the clamp nut to 18 ft-lbs (2.5m-kg).**

Maximum adjustment possible is about ± 0.75 " (19 mm). At least 1.0" (25 mm) of rod end threads must remain in the tube.

2.4 START-UP PROCEDURES

Before starting the fan, manually check all bolts or nuts to see if they are tightened. Take care not to exceed the stated torque limits.

Manually rotate the fan while checking each blade for proper clearance.

Start the fan and watch it in operation. All blades should move to the same operating position, indicating that the blade angles are properly set and that all blades are equally loaded. If vibration or unbalance is evident, see Section 3.3.

After the fan has been operating for several minutes,

stop the fan and observe the blades as the fan comes to rest. All of the blades should return to their original position at the same rate.

Inspect the inner surface of the fan ring and the blade tips for any indication of scoring.

The horsepower given on the Fan Specifications is the calculated horsepower (at the fan shaft) that is required for the specified performance. Consult the factory or the fan curve before increasing the blade angle for the fan to consume more than the specified horsepower.

3.0 MAINTENANCE

3.1 PERIODIC INSPECTION

3.1.1 PURPOSE

Fan failure is most likely the result of destructive repetitive stress acting over a period of time. These stresses may be caused by mechanical abuse, e.g. rough gears or drive shaft imbalance, or by aerodynamic abuse such as blade overload or abnormal flow conditions. Fortunately, these stresses manifest themselves in typical ways that may easily be detected on inspection if one knows what to look for. The purpose of this section of this manual is to describe the symptoms of potentially damaging mechanical problems and how they can be corrected. Aerodynamic abuses are covered in Section 4.0 Operation.

3.1.2 FREQUENCY OF INSPECTION

The frequency of inspection varies widely in accordance with the severity of service and a suitable inspection schedule should be developed with experience over time. During the first week of operation, at least one inspection should be made. At these initial inspections, in addition to the items listed below, check all nuts for tightness to make certain that all were tightened properly at installation. Take care not to exceed the stated torque limits. Following the first week, it is probable that inspections of the fan need be made no more frequently than inspection of the drive.

3.1.3 BLADE ANGLE AND RUNNING POSITION

Turn off the unit and watch the blade tips. A looseness in the clamp bolt will permit a blade to flatten in angle. This usually can be detected by looking at the tips of the blades while the fan is slowing down. At the same time, before the unit comes to a complete stop, watch the track of the blade tips to see that all blades move to the same operating position. If one or more blades is at a substantially different position than the other blades, or if all of the blades are at a different position than at the last inspection, investigate further. This condition may be caused by a damaged resilient mount, requiring blade replacement.

3.1.4 CRACKS, DENTS AND CORROSION

Skin cracking may be caused by the tips dragging on the fan ring, or it may be the result of long-term fatigue due to continued operation under conditions of vibration or unbalance as discussed in Section 3.3 which follows. Skin cracking can also be caused by continued operation under overload conditions as discussed in Section 4.3 Causes of Blade Overload.

Cracking in air seals can occur if the airseal has been improperly installed. See Section 2.2. Check to be sure the resilient washers are present and the nuts properly tightened.

The fatigue strength of materials, whether metal or plastic, may be lowered by long-term exposure to water.

Dents in blades are caused by objects falling into the fan or the fan striking some obstacle. Minor dents may sometimes be repaired by drilling a small hole in the center of the dent and pulling outward on the blade skin. Blades may be ordered from the factory for replacement. If there is any evidence of this type of damage, the hub should be carefully inspected as discussed in Section 3.1.6 which follows.

The Type 5052 aluminum, a marine alloy, used as the blade material on Moore fans works well with either fresh or sea water. Waters that are acid, alkaline, or contain copper salts, however, should be avoided for all aluminum alloys. If you have questions regarding the suitability of the fan materials under certain water conditions, please contact the factory.

3.1.5 HUB INSPECTION

If damage to the fan has occurred, the hub should be carefully inspected since subtle damage may have been caused that is not readily apparent. Check the hub for any sign of bending or twisting of the hub tubes. Hub tubes cannot be replaced in the field on manual fans and a new hub should be ordered.

Bushings are frequently cracked during a fan wreck and should be carefully inspected. Damage may occur to the studs that attach the hub to the bushing. It is a good idea to replace the studs when replacing a damaged fan blade.



*As with any industrial equipment, before entry into fan chamber, strict adherence to **ALL Lock-out/Tag-out procedures** is well advised!*

3.2 ANNUAL INSPECTION

3.2.1 CLEAN BLADES IF INDICATED

A smooth blade surface is essential for efficient fan performance. If an incrustation forms on the blades it should be removed. Use steel wool as an abrasive along with a mild detergent or a very mild form of solvent. Lye must not be used because it attacks aluminum readily.

3.2.2 CHECK SYSTEM PRESSURE

Radiator sections may be effected by the accumulation of dust and dirt in some atmospheres. (Cottonwood seeds are particularly troubling.) These accumulations may significantly increase the static pressure. Adjust the blade angle if necessary as described in Section 4.4 Checking Blade Load.

3.2.3 CLOSE INSPECTION

The yearly inspection should be a very thorough one. All nuts and bolts should be checked and careful scrutiny given to all highly stressed areas.

Inspect the resilient mounts as follows: With the fan turned off, grasp each blade and feel for looseness at the mount. If in doubt, the blade should be removed and the mount assembly visually inspected. Wear is indicated by a fretting effect and the resilient mount material will show signs of extruding from the cavity. If these indications are not apparent, replace the blade and continue normal operations.

Inspect the blade tips for any signs of cracking and the fan ring for any scoring that might indicate that the blades have been striking or rubbing against the fan ring.

3.3 VIBRATION AND UNBALANCE

3.3.1 GENERAL

No piece of rotating equipment is perfectly balanced. It is always possible that the minute unbalances of the various components may combine to provide a noticeable lack of balance. This rarely occurs, since it is unlikely that all unbalanced components will become assembled with their heavy sides in the same direction. Nevertheless, if unbalance is noted, the various components should be rotated into different positions to see if this might cure the unbalanced condition.

If vibration or unbalance occur, either at the time of installation or later during the operation of the unit, its cause may be determined by following the directions below.

3.3.2 FAN UNBALANCE

Vibration is most likely to be caused by the fan if the blades are not set at the same angle. If the blades are properly set, the fan is the least likely cause of vibration. All fan components are balanced to within ± 0.2 ft-lbs.

If the fan is in an unbalanced condition, the frequency of vibration of the structure will be that of the RPM of the fan and is quite low. In the case of large fans, the frequency is often low enough to be mentally counted along with the rotation of the fan. A vibration of 500 RPM or less will be felt as a weave in the structure rather than a vibration. Below 400 RPM, the vibration may be mentally counted and above that point may be read with a frequency meter.

Before assuming fan unbalance, check for loose bearing seats or bearings journaling the shaft on which the fan is mounted. This condition will cause the shaft to rotate eccentrically, throwing the weight of the fan off-center, resulting in unbalance of the frequency of the fan RPM.

After all checks have been made and the fan is still determined to be unbalanced, field balancing may be accomplished as described below in Section 3.3.6.

It should be noted that the loads imposed on the drive shaft and its supporting bearings by fan unbalance

are negligible. A rotating centrifugal load of 100 pounds, due to unbalance, would be extremely objectionable and possibly even damage the structure on which the drive was mounted. By contrast, it would be unlikely that the drive shaft of a fan, of perhaps 25 HP, would be supported on bearings rated less than 2000 or 3000 pounds radial load. For higher horsepowers, the bearing capacity would be correspondingly increased. From this it is evident that speed reducer or drive shaft bearing failure could never be caused by moderate or even objectionable fan unbalance.

3.3.3 BELT DRIVE UNITS

The more common causes of vibration in belt drive units are not the drives themselves but the result of shafts that are too flexible or non-rigid supporting members. Vibration can be caused by misalignment of the sheaves or poorly adjusted belt tension. Consult the manufacturer of the drives for information. The quickest way to identify the cause of vibration in belt drive units is to operate the fan with the blades removed.

3.3.4 ROUGH GEARS

Continued operation on rough gears and bearings is almost certain to develop cracks in the blade skins. Rough gears may be of two types:

1. Rough or failed bearings in the drives or gears will result in a high frequency vibration being transmitted into the fan where some areas of the skin will respond to the frequencies applied. Cracks will appear in the blade skin and eventually, in some areas, the skin may actually fall away.

2. The other type of rough gear occurs when the output shaft accelerates and decelerates with each pinion tooth engagement. With a six tooth pinion and a motor speed of 1800 RPM, or 30 cycles per second, this gear misalignment impresses upon the fan a vibrating frequency of $30 \times 6 = 180$ cycles per second. If the engagement of teeth is also included, the frequency is 360 cycles per second. This type of high frequency vibration is at least as serious as that caused by bad bearings.

3.3.5 THROAT FLUTTER

Any fan that is effectively moving air at the tips of the blades will develop a reduced pressure area (or suction) on the fan throat or ring at the tip of the blade. This suction tends to draw the throat toward the tip of each blade, which means that a four blade fan would tend to draw the throat into something approaching a square while a six blade fan would draw it into something resembling a hexagon, etc. Since the fan is rotating, the effect on the throat is that of continually drawing it into a rotating polygon. The resulting throat flutter is frequently mistaken for fan unbalance.

A substantial throat or ring will be sufficiently rigid that flutter will not exist. A weak or flexible throat, particularly when used with a fan of a low number of blades, will be greatly affected by this type of vibration. Throat flutter is easily detected due to the fact that it is invariably of a frequency of the fan RPM times the number of blades on the fan.

Throat flutter will cause no damage to the fan so long as the throat does not disintegrate and fall into the fan blades. It may be eliminated by stiffening or bracing the throat.

If in doubt that throat flutter is the cause of vibration, reduce the angle of the blades until the fan is doing little or no work. If the vibration ceases under this condition, it is certain that throat flutter is present when the blades are loaded.

3.3.6 FIELD BALANCING

Unbalance in older fans may develop because of some structural change or by installing one new blade on an old fan where the existing blades had changed in weight in the course of operation.

Use wire to attach a small weight in succession to each of the air seal studs until the best location for the weight is found. The weight should then be increased or decreased until the best balance is achieved. The permanent weight may then be secured to the stud or hub tube, whichever is the most convenient for the type and shape of weight to be used. One or more pieces of metal shaped like a washer could be placed over the stud, on the hub tube, behind the stud, or over the threaded portion of the rod end. Aluminum or stainless weights should be used and weights should not be attached to the blade skin.

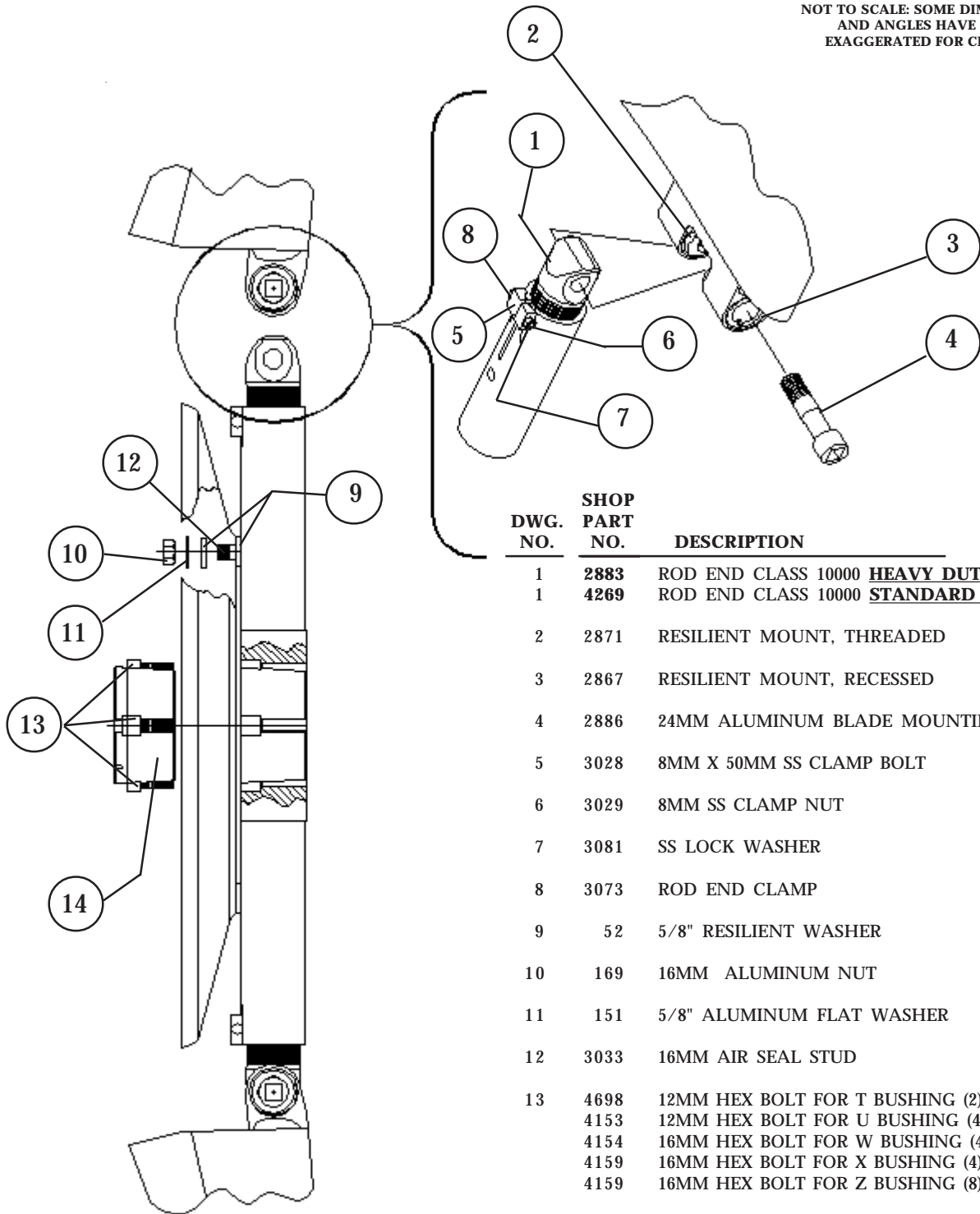
3.4 WARRANTY

MOORE FANS LLC (the Seller) warrants only to Buyer, as its purchaser for resale, that the fans manufactured and sold by Seller to Buyer under this Agreement will be free from all defects in material and workmanship under ordinary use for a period of two (2) years from the date of shipment or one (1) year from the date the fan is installed on a customer's premises, whichever occurs first. This warranty period shall apply only if Seller receives written notice of any defect within the warranty period. Upon receipt of such notice, Seller, at its option, may require Buyer to return the fan at Buyer's cost to Seller for inspection by Seller. If the fan is found to be defective on inspection by Seller, as a sole and exclusive remedy, Seller will, at its option, either repair or replace the fan. This warranty shall not apply to

damage on account of misuse, neglect or accident or shipping damage, or if repairs or part replacements have been made or attempted without Seller's prior written authorization. SELLER SHALL NOT BE LIABLE IN ANY EVENT FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES FOR BREACH OF THIS OR ANY WARRANTY. THIS WARRANTY IS IN LIEU OF ALL OTHER GUARANTEES OR EXPRESSED WARRANTIES AND ALL IMPLIED WARRANTIES, INCLUDING THE IMPLIED WARRANTIES OF MERCHANTABILITY AND OF FITNESS FOR A PARTICULAR PURPOSE. DUE TO THE VARIETY OF CONDITIONS UNDER WHICH THE FANS MAY BE USED, RISKS OF RESULTS OBTAINED FROM USE OF THE FANS, WHETHER USED ALONE OR IN COMBINATION WITH OTHER PRODUCTS, IS ENTIRELY BUYER'S. THE ABOVE LIMITATIONS ON DAMAGE AND EXCLUSION OR LIMITATION OF IMPLIED WARRANTIES ARE NOT APPLICABLE TO THE EXTENT PROHIBITED BY STATE LAW.

3.5 PARTS LIST

NOT TO SCALE: SOME DIMENSIONS
AND ANGLES HAVE BEEN
EXAGGERATED FOR CLARITY



DWG. NO.	SHOP PART NO.	DESCRIPTION
1	2883	ROD END CLASS 10000 <u>HEAVY DUTY</u>
1	4269	ROD END CLASS 10000 <u>STANDARD DUTY</u>
2	2871	RESILIENT MOUNT, THREADED
3	2867	RESILIENT MOUNT, RECESSED
4	2886	24MM ALUMINUM BLADE MOUNTING BOLT
5	3028	8MM X 50MM SS CLAMP BOLT
6	3029	8MM SS CLAMP NUT
7	3081	SS LOCK WASHER
8	3073	ROD END CLAMP
9	52	5/8" RESILIENT WASHER
10	169	16MM ALUMINUM NUT
11	151	5/8" ALUMINUM FLAT WASHER
12	3033	16MM AIR SEAL STUD
13	4698	12MM HEX BOLT FOR T BUSHING (2)
	4153	12MM HEX BOLT FOR U BUSHING (4)
	4154	16MM HEX BOLT FOR W BUSHING (4)
	4159	16MM HEX BOLT FOR X BUSHING (4)
	4159	16MM HEX BOLT FOR Z BUSHING (8)
14		T BUSHING (3") U BUSHING (4") W BUSHING (5.5") X BUSHING LONG (5.5") Z BUSHING (7")

4.0 OPERATION

4.1 AERODYNAMIC ABUSE

4.1.1 ABOUT THIS SECTION . . .

It is widely acknowledged that the kinds of mechanical abuse described on the preceding pages are destructive for all types of operating equipment. It is less well recognized that — for fans — aerodynamic stresses are an even more serious hazard. This section deals with the causes of destructive aerodynamic stresses and how they can be avoided.

Although this information is given primarily for the benefit of operators of Moore equipment, it may be applied to fans of any manufacture.

Unlike smaller fans, which are typically furnished complete with their surroundings, the large fan wheel is supplied as an unprotected component of the system and is installed in innumerable types of surroundings. Not only do the types and conditions of the drives for these fan wheels vary widely, but the entrance and exit conditions and the enclosure for the wheel assume a myriad of possible combinations. In designing his product, the manufacturer of fan wheels must anticipate the operating conditions based upon his knowledge of what is reasonable and customary for the industry. He may over-design for abnormal stresses only until the practical limit is reached to avoid excessive weight, cost and inefficiency.

4.1.2 NORMAL OPERATING CONDITIONS

The fan manufacturer assumes a fairly reasonable atmosphere for the operation of his product, including the following:

- The fan selection will be reasonably in line with the performance the unit is expected to maintain, with an adequate blade area for the pressure required at the given RPM. Blades will not be loaded beyond their capacity to maintain air flow.
- A fan ring will be provided that is round, rigid and of a depth at least sufficient to cover the tips of the blades. Tip clearances will be uniform and controlled.
- The approach air will represent a relatively uniform and axial flow with, of course, some unavoidable turbulence expected. Adequate open area will be provided at the inlet of the fan.
- Major obstructions will not be present at either the inlet or discharge of the fan.
- The RPM of the fan will be within the design limits.
- The relative direction and velocity of approaching air to the blades will be fairly constant and protection will be provided from extreme wind conditions.

Under such conditions, the unit stresses in the blades would not be expected to vary more than plus or minus 50%. Fan design based on such assumptions is entirely reasonable and, with proper drives and installation conditions, has proven highly successful.

4.1.3 ABNORMAL CONDITIONS

Abnormal operating conditions result in destructive repetitive stresses that can seriously shorten fan life. The aerodynamic abuses discussed in this section can cause repeated flexing of the fan blades and hub. Violent displacement of the resiliently mounted Moore fan blades may occur — a greater displacement than would occur in rigidly mounted blades. The resilient mounting, of course, minimizes the structural unit stresses which would be transmitted to the root of the blade and into the hub and drive. Although Moore units may be expected to resist greater stress than units of conventional design, such repetitive stresses may exceed the capability of the resilient mounts to absorb them. If so, fatigue of the mounts and metal may develop, adjusting linkages may wear, and ultimate failure becomes a possibility.

Some of the abuses set out in the following text are far less important than others. All of them may occur in varying degrees.

Specifically, abuse due to serious repetitive stresses can lead to mount failure and, if carried to extremes, can require blade replacement. In units of other manufacture with rigidly mounted blades, repetitive stresses of this type may lead to blade breakage, probably near the root or at the point of attachment to the hub where stresses are highest, or may lead to failure of the hub itself. The resilient mount design, unique with Moore fans, dampens these vibrational forces and results in a fan that is far less vulnerable to failure from these conditions than other units with rigidly mounted blades. Even so, extreme conditions can cause damage.

A well-designed fan can be expected to operate for many years without trouble under normal operation as described above. The extreme repetitive stresses described below, however, will certainly reduce the life of the fan, causing failure many years sooner than would occur if the fan were operated as intended. Fortunately, these destructive conditions are readily observable to someone who is knowledgeable about them, and they can be corrected with reasonable effort and expense once they are observed.

4.2 BLADE OVERLOAD

Of all the aerodynamic abuses to be avoided in the operation of a fan, the most important is that of overloading the fan blades. Blade overload occurs because of insufficient blade area: In other words, when there is an inadequacy in the number of blades on the fan selected.

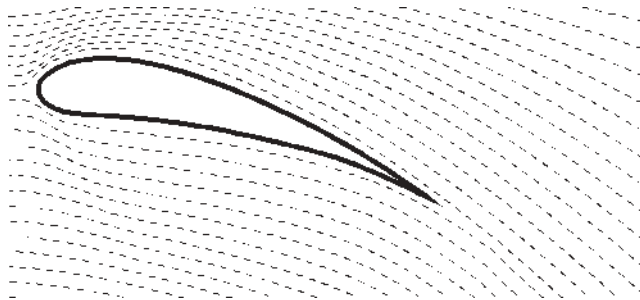
The Moore system of rating is based upon the pressure that each blade will produce at a given RPM with good efficiency. This pressure is called 100% blade load. When blade load exceeds 110%, the fan will not only operate at lower efficiency, it may be subject to structural damage as well.

In selecting a fan, the total pressure divided by the pressure to be produced by one blade determines the number of blades required for the anticipated performance. Whenever information is available, The Moore Company checks the selection. Even so, underestimation of the pressure requirements by the system designer, or changes in the operating conditions over time, may result in overload conditions.

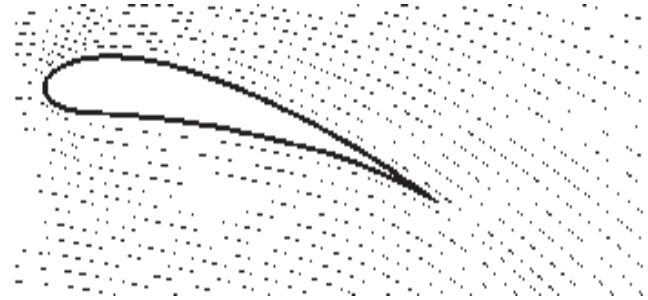
Why is a blade overload condition of such concern? We are all aware of the fact that an airplane traveling at a given speed can carry only a certain load. If the speed of the airplane is decreased or the load increased, stalling flow over the wing will occur. In the case of an airplane, approximately two-thirds of the lift provided by the wing is the result of the air flow over the top or convex portion of the wing. Lift is provided as a reaction to the flow of air being accelerated and deflected downward as it passes over the wing. A negative pressure area is thus formed on the top surface of the wing which tends to lift it upward.

So long as air flow over the wing is smooth and clings to the surface of the wing, little turbulence is present. When the load is increased, or the speed decreased, the angle of the wing to the air stream must be increased to a point where the air flow breaks away from the upper surface of the wing. This is known as stalling or burbling flow, since the air, instead of clinging to the wing, breaks away near the leading edge and leaves what might be called a turbulent void above the upper wing surface, nullifying the accelerated flow which was responsible for the greater part of the lift of the wing.

When this occurs, the wing loses a large portion of its lift. Flow, however, will re-establish briefly and break again, the cycle being repeated continuously, resulting in a severe vibration throughout the aircraft as the flow alternately makes and breaks. Anyone who has experienced a stall in an airplane will be familiar with this violent phenomenon.



AIRFLOW IN NORMAL FLOW
Downward flow provides lift to the wing



AIRFLOW IN STALLING FLOW
Note lack of air deflection downward.

A fan blade is no different than an airplane wing except that the air usually is being deflected upward rather than downward, the convex side of the blade being the lower surface rather than the upper surface as in the case of an airplane. The result of blade overload is identical: When blade load exceeds that allowable, a violent vibration will take place in the blade as the laminar, or uniform, flow makes and breaks perhaps many times a second.

Another way of looking at this problem is to consider that the available number of blades are set at too steep an angle to be able to move air at the axial velocity which is necessary to maintain a smooth flow over the convex surface. In other words, to move air at the velocity necessary for this blade angle, plus overcoming the static resistance of the system, the total pressure which would have to be maintained for an air flow corresponding to this angle is greater than the total pressure capability of the given number of blades at this RPM. Such a condition can only be corrected by decreasing the blade angle until smooth flow is obtained or by increasing the number of blades and the total pressure potential of the fan until the fan's pressure potential equals the pressure necessary to move the specified quantity of air through the system.

Continued operation under conditions of stalling flow, or blade overload, will significantly shorten the life of the fan. Operation under these conditions will also reduce efficiency to a ridiculously low figure. See the chart under Section 4.4 Checking Blade Load which follows. Note that although air flow remains constant or decreases, horsepower continues to increase with increased blade angle.

In conclusion, if a given fan, in a given installation, can only absorb forty horsepower, for example, the blades may be pitched up to consume fifty horsepower without any increase in air delivery, and possibly with a decrease. As a result, the extra ten horsepower is totally wasted -- perhaps worse than wasted. It is good practice to select a sufficient number of blades so that blade load will amount to slightly less than 100% of full blade load when consuming 100% of the rated fan horsepower. There are a number of reasons for allowing this safety factor which are set out in detail below.

4.3 CAUSES OF IMPROPER BLADE LOADING

4.3.1 VARIATION FROM PREDICTED CONDITIONS

Although those who design air coolers and cooling towers undoubtedly do their best to accurately state the calculated static resistance of the system, a number of factors may cause the actual conditions to vary from the design conditions. When a variation occurs, it may be found, upon testing, that the static pressure for a given volume through the system is higher than anticipated. In this case, the number of blades provided may be inadequate to meet the performance. On the other hand, the static pressure may have been overestimated and excess blade area provided, resulting in a fan with unutilized capacity operating at low efficiency.

Inadequate Blade Area: The blade angle is selected to move the anticipated volume of air and the number of blades is selected to maintain the total anticipated pressure required to move this volume at a given RPM. If the static pressure turns out to be higher than predicted, the fan may then be operating in an overload condition. If the RPM cannot be increased, the only solution to this condition is to reduce the blade angle until the fan can carry the then reduced volume at the originally anticipated pressure. Since reducing the volume, while holding the total pressure as originally anticipated, can only reduce the horsepower, it is then impossible to consume the horsepower originally intended without overloading the fan. This is one of a number of reasons for providing some safety factor in blade loading at the time of original fan selection.

Excessive Blade Area: Occasionally, an excessive number of blades may be specified in the interest of making a conservative selection. If the static pressure has been overstated, the theoretical number of blades will be greater than needed. This theoretical number of blades is usually a fractional number and the actual number of blades used must, of course, be the next larger integer, resulting in some "safety factor" in the selection. If, in addition, a blade or two is added as a "safety factor" or in anticipation of increased future requirements, it may be impossible to meet the original performance requirement efficiently. The only way to provide the original performance and draw no more than the original horsepower is to flatten the blade angle. There is a limit, however, in how far the blade angle may be reduced before further reduction will decrease airflow without a further reduction in horsepower. For belt drive units, the most practical solution to this problem is to reduce the RPM of the fan.

4.3.2 EXCESSIVE TIP CLEARANCE

Unless the fan ring is very close to the tip of the blade, air from the high pressure surface of the

blade will flow around the tip and nullify the negative pressure on the underside of the blade for some distance in from the tip. For a fan of, say, 12-ft diameter, the last 12 to 18 inches of the blade could be producing no pressure whatever and performing no useful function. The balance of the fan blade toward the hub then must produce a higher pressure to compensate for the portion near the tip.

Excessive tip clearance also leaves an unswept area between the tip of the blade and the fan ring. Air that has been pumped by the fan will return downward through this unswept area at a velocity greater than that at which it passed through the fan in the desired direction. This condition adds even further to the requirements of the portion of the blade which is doing the work and efficiency will be greatly reduced.

With the loss of a foot at the tips of the blades, plus the back flow between the tips and the ring, the 12-ft fan in this example might be considered an effective 10-ft fan. It would have to deliver sufficient air to satisfy the performance requirements of the installation, plus the amount of air which is returning in the void between the tips and the throat. Under such circumstances, excessive blade loading could occur even though the required system pressure is not achieved.

4.3.3 POOR ENTRANCE CONDITIONS

Air will approach the fan from all possible directions, increasing in velocity as it nears the opening, then accelerating rapidly as it enters. The air approaching from the side must be turned through 90° to enter a ring whose entrance terminates in a flat plate. If the inlet end of the ring projects some distance out, with approach possible from all directions, a portion of the air must be turned through 180°. The inertia of the approaching air prevents it from turning sharply and advancing parallel to the desired flow. It consequently swoops toward the center, leaving the outer area of the fan with reduced flow or even reverse flow near the ring.

The effect of poor entrance conditions is similar to that previously described for excessive tip clearance in that the effective diameter has been reduced and excessive blade loading could occur even though the required system pressure is not achieved. Efficiency will be greatly reduced.

4.3.4 EXCESSIVE DEFLECTION

The pressure which the fan can achieve is dependent upon the square of the velocity of the blades relative to the air. If the air could be moved into the fan in an axial direction and passed through the fan into the discharge without changing direction, the relative velocity of the blades to the air stream would be the true velocity of the blades at any point. This, of course, is not the case. For the blades to accomplish work upon the air, they must also deflect the air in the direction of rotation of the fan. The air when rotated with the fan is moving with a certain

velocity in the same direction as the rotation of the fan, which reduces the relative velocity between the fan blades and the air by some portion of this rotational velocity.

Moore fans are designed in contemplation of a maximum deflection of 50° at the hub, decreasing to a very small value at the tip. This deflection is considered in the determination of the pressure which may be provided by each blade over its full length. If fans are selected, or if conditions exist, which cause the deflection to exceed 50° at the hub, the velocity of the blades relative to the air is less than anticipated and the blades will not provide the rated pressure. The test below, however, will show the full allowable pressure capability of

the fan, even though it does not reach the full rated pressure.

4.3.5 CONCLUSION

As can be seen by the various points discussed in this section, there are a number of complex factors which tend to cause fans to be operated in a condition of improper blade loading which can shorten fan life or lower efficiency. When blade angles are set to consume the specified horsepower (at the fan shaft), the resulting performance should be very close to the specified performance. If this is not the case and the problem cannot be identified or corrected, please contact Moore for assistance.

4.4 CHECKING BLADE LOAD

One method of checking blade load is to run a complete field test on the fan. Although laborious, this method will provide ample proof so long as neither excessive tip clearance nor poor entrance conditions are present. If either are present, however, the conditions set out above under Section 4.3.3 would apply and the fan could be overloaded even though the total pressure indicated by the test was within the allowable blade loading.

A better, more convenient and simpler method of detecting blade overload, or determining maximum allowable blade angle, is set out below. The equipment needed is a wrench, a torque wrench, a protractor and a draft gauge (or manometer).

All fans are shipped with the blade angle set for the anticipated performance requirements furnished to The Moore Company by the purchaser. This blade angle is called out on the Fan Specification Sheet. This angle refers to the angle measured at the location shown in Section 2.3.3. Hubs are shipped with the clevises set at this angle.

To start the test, adjust the blades to an angle of approximately half that called out on the specifications or measured on the units. Connect the draft gauge to as quiescent a spot in the plenum as possible, preferably in the corner of the plenum and either ahead of or following the fan, depending upon whether the application is induced or forced draft. Since the figures obtained are purely relative, it is not necessary that accurate static pressure readings be obtained, but rather that the readings taken represent a consistent series of pressures at the point of reading chosen.

Start the fan and record on the chart provided the blade angle and the static pressure indicated. Advance the blade angle by one or two degrees and repeat the performance, recording again these read-

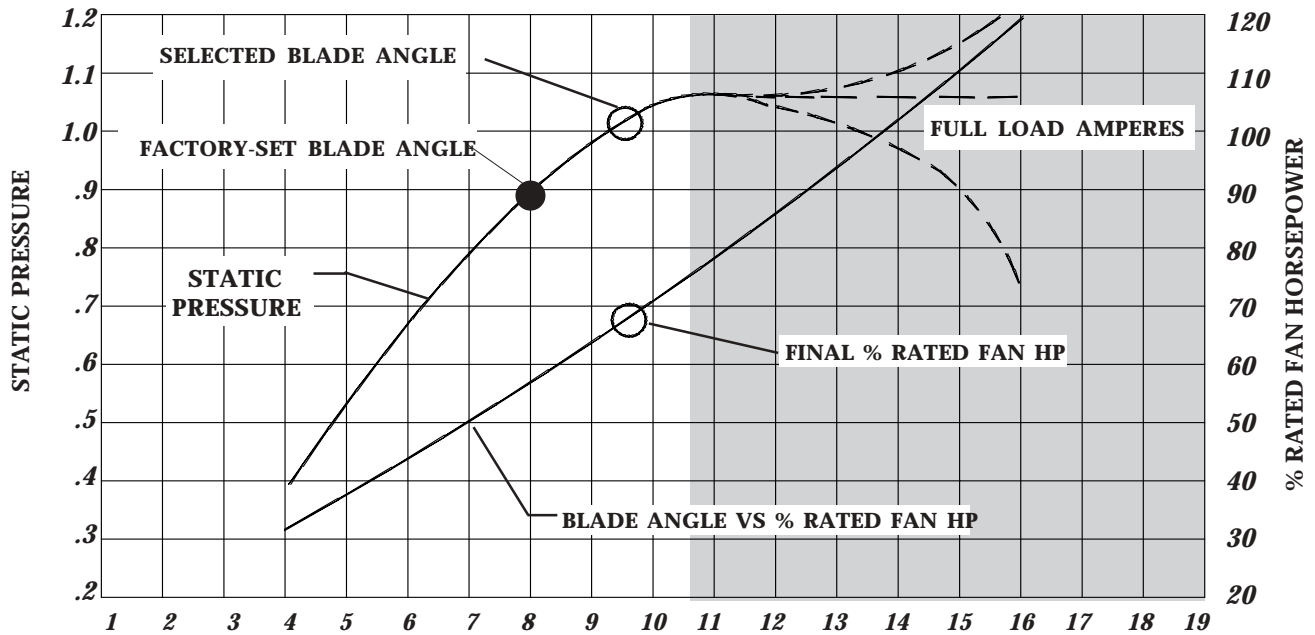
ings. Keep increasing the angle and following this procedure until the motor is fully loaded, in which case the fan is able to consume full rated fan horsepower without overload OR until the curve which will have started on a definite slope begins to approach the horizontal. It will be noted that the static pressure will be consistently increasing with increased blade angle until the blade loading reaches maximum, at which point it will level off.

Subsequent increases in blade angle may have quite different effects, depending on the individual installation. The static pressure curve may merely stay level or may drop off sharply. In rare cases, it may level off and again start rising as the fan begins operating as a centrifugal blower.

Typical examples are shown in dotted lines on the chart opposite. Operation beyond the first point of levelling, or in the area of the dotted lines, is indicative of blade overload. Note that power consumption load will continue to increase even though the fan has passed into overload condition. The maximum blade angle allowable is that which produces a static pressure about 5% below the point where the curve becomes level. This represents a safe loading, and the blades may be set and left at this angle regardless of the location on the chart, assuming the motor is not overloaded.

The point so selected will also approximate the point of the most efficient operation of the fan. Due to possible error in static pressure predictions, or in readings which are intended only to be relative, as well as other variables, the final blade setting chosen may fall below or above the specified static pressure.

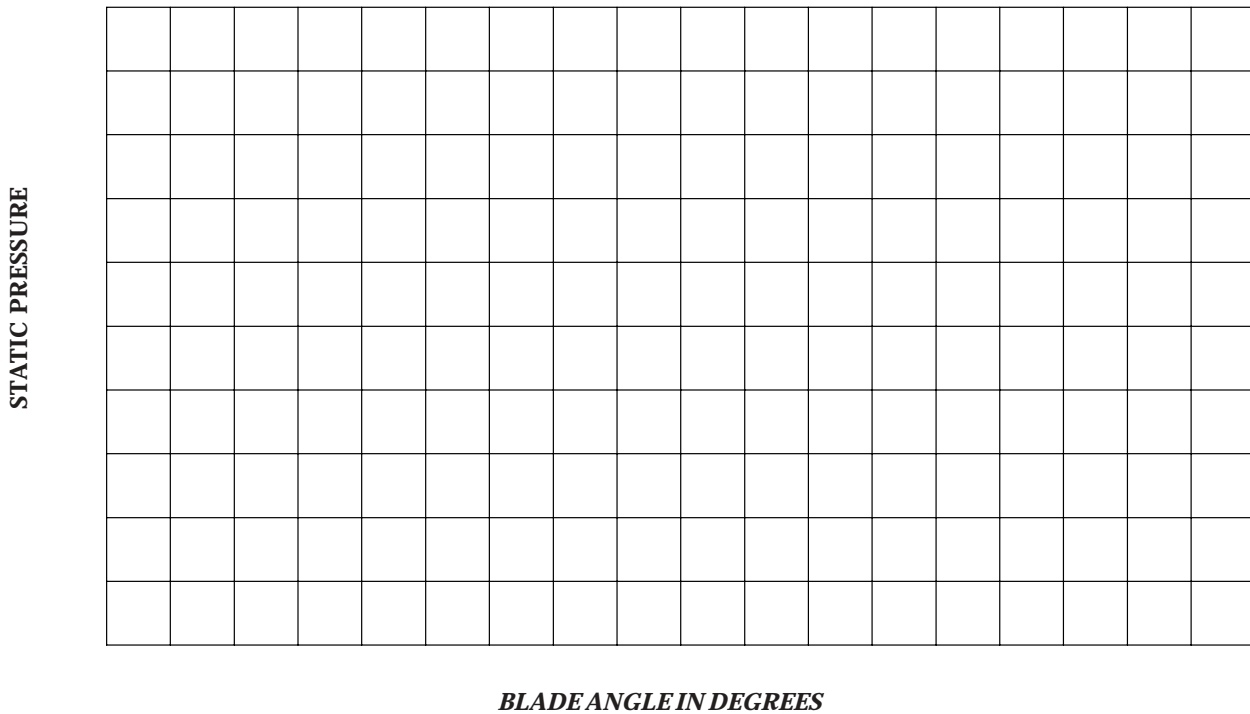
A typical performance chart is shown opposite for a fan capable of a higher blade loading than originally specified. A blank chart is also provided for your use.



4.4.1 SAMPLE GRAPH of BLADE ANGLE IN DEGREES

Note in the chart above that static pressure (and air flow) has reached its maximum at an 11 degree blade setting and blade overload is beginning. With further increase in blade angle, anything may happen, as indicated by the dotted extensions into the shaded overload area. Note that the final selected blade

angle is 5% below the point where the static pressure curve becomes level. The horsepower curve has been added to illustrate the point that in an overload condition, horsepower will increase without increased performance.



BLANK CHART FOR CUSTOMER USE

4.5 DAMAGING OPERATING CONDITIONS

4.5.1 GENERAL

Any condition which causes repeated blade loading and unloading is detrimental to fan performance, both in terms of efficiency and structural durability. Normal obstructions, of course, must be expected in the air stream. There are certain conditions, however, which may be avoided by reasonable attention to the points briefly discussed in this section. Additional information on the importance of inlet and discharge conditions can be found in Moore's General Catalog.

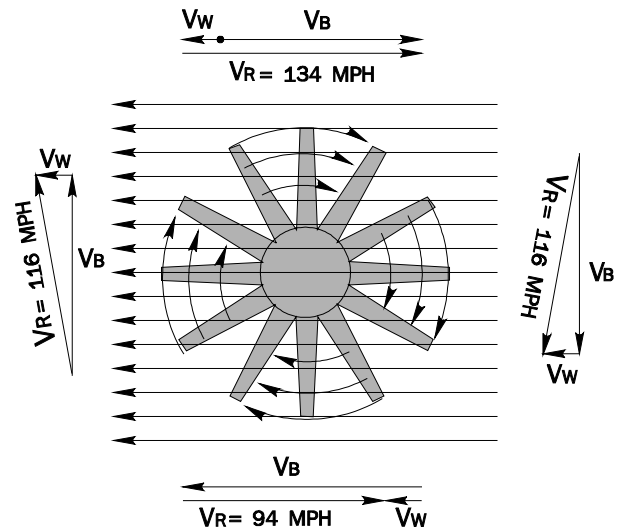
Ideally, air should approach a fan in an axial direction and at a uniform velocity over the area of the fan. Air approaching a fan at an angle tends to increase the relative velocity of the blades to the air on one side of the fan and decrease the relative velocity on the other side. This means that the fan blade during one-half of its revolution is picking up a heavier air load due to the higher relative velocity and, through the other half of its revolution, a lower air load as it goes "down wind". The net result is a repetitive loading and unloading of the blades at each revolution of the fan. This condition can be quite serious if the velocities are high and the angle of approach deviates considerably from axial.

4.5.2 WIND

With a vertically mounted fan blowing outward into the wind and surrounded by a short fan ring or stack, high winds may cause some concern. The farther the ring extends beyond the fan, the less effect would be expected from wind. It is a fact, however, that wind across the face of the ring will affect the direction of air flow well down into the ring. In the case of a fan installed near the outlet of the ring, the direction from axial of the fan discharge may be increased by as much as 45° under high wind conditions.

In the case of a fan blowing inward in a short ring, the condition is even more critical. In such an installation, the air on the inlet side of the fan has a horizontal velocity which may be quite high. It is necessary for the fan to pick up this air and direct it inward. In a strong wind, the angle of air moving through the fan may be increased more than 45°.

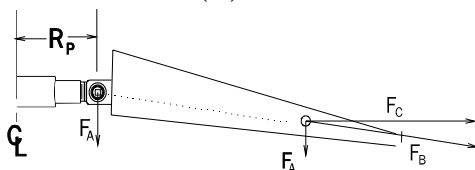
The illustration above assumes a fan operating with a tip speed (V_B) of 10,000 feet per minute (114 miles per



hour) with a horizontal component of wind velocity (V_w) of 20 miles per hour. Note that the velocity (V_R) of the fan blade relative to the air varies by a factor of 1.43. The blade load varies as the square of this velocity, or 2.05.

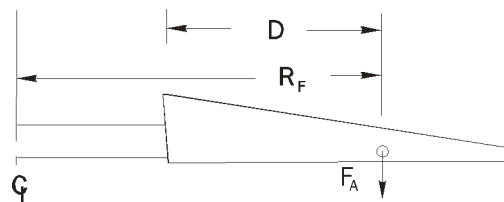
THE EFFECT OF AIR LOAD ON HUB AND DRIVE

Moore fan blades are attached to the hub by a pivot. As the fan rotates, centrifugal force causes the blades to rise (as do the blades of a helicopter). The air load (F_A) is uniform over the blade, but there is a point (shown on the blade in the drawing below) where, if the total load were applied at that point, the effect would be the same. The resultant of the air load (F_A), assumed in this example to be downward, and the horizontal centrifugal force (F_C) is the force on the blade (F_B). The blade automatically posi-



tions itself in the direction of this force with the result that the force is translated inward to the pivot point, as illustrated by the dotted line. The effect of this arrangement is exactly as if the total air load (F_A) were applied at the pivot point rather than at the point outward on the blade. The maximum bending moment applied to the shaft by the air load is equal to the load (F_A) multiplied by the distance from the fan centerline to the pivot point (R_p).

In conventional fans with rigidly attached blades, the bending moment at the shaft due to the air load is equal to the load (F_A) multiplied by the distance from the fan centerline to the point of application of the force on the blade (R_F). This moment will be from 2 to 4 times as great as that produced by the Moore fan under the same condi-



tions.

Also of concern with the conventional fan is the bending moment due to the air load at the point of attachment of the blades to the hub since this is usually the structurally weakest area of the fan. The moment due to the air load at this point is the load (F_A) times the distance (D). For the Moore fan, this moment is zero since the blades are attached at the pivot point.

A more complete discussion of the Moore fan design can be found in The Moore Company's General Catalog.

OPERATION

In this rather common wind condition, then, it can be seen that the blade load on the side where the blade is going against the wind will be double the load on the side where the blade is going with the wind. In a 40 mile per hour wind, the blade load would vary by a factor greater than 4. In a 60 mile per hour wind, the load would vary by a factor of more than 10! It is obvious that operation under such conditions will impose tremendous repetitive loadings on the fan blades.

In areas of unusually high wind velocities, it may be advisable to shield the fan in some manner.

4.5.3 OBSTRUCTIONS

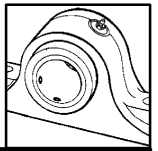
Obstructions of one type or another in the air stream, ahead of or behind the fan, are to be expected. In fact, it would be virtually impossible to eliminate all obstructions. Structural supporting members, foundations and the like, need not be of serious concern although all obstructions, even small ones, will increase the static pressure and must be taken into consideration by the system designer in specifying the fan performance.

The total free area from which the fan can draw air should be twice the net area of the fan (fan area minus hub area). In other words, the air approaching the inlet of the fan should have no more than half the velocity of the air passing

through the fan. This area should be distributed reasonably uniformly. It would be unwise to attempt to operate a fan with one-half or one-third of the fan area completely blanked off. Such a condition would cause stalling of the fan blade through one-half the revolution but create a condition of overload in the half which was not blocked off. Excessive vibration would result. Any condition which forces the air to approach the fan in a non-axial direction should be avoided.

4.5.4 UNEVEN TIP CLEARANCE

Where fan rings are out of round or not centered with the fan, the tip clearance of each blade will vary as it makes a revolution. If tip clearance is tight at one point and excessive at another, proper flow will establish itself at the tight point, loading the blade to the very tip, while at the loose point the air will flow from the high pressure side of the blade through the opening between the blade tip and the ring and nullify the negative pressure on the under side of the blade. This will unload the blade near the tip within the area of excessive tip clearance. Under this condition, the blade will load and unload near the tip one or more times per revolution, resulting in an undesirable repetitive vibration. Every effort should be made to keep the tip clearance to a minimum and to have this clearance as constant as possible around the entire ring.



FEATURES/BENEFITS

Type E/DOUBLE-INTERLOCK/Type K/TAF

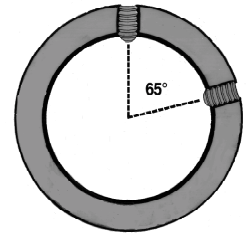
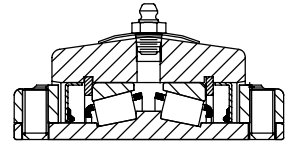
These four product lines have many common features and benefits that are shown on this page. Unique features for each product are shown on the following pages.

The common components used by all four lines include:

- Bearings
- Seals
- Locking collars
- Bore range

General Features:

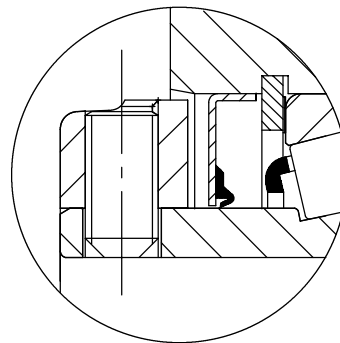
- Factory assembled, adjusted and pre-lubricated
- Case hardened rollers and races
- Easy installation and maintenance
- 65 degree set screw angle
Springlok collar/flingers—
More holding power than 90 or 120 degree
- Single rubber lip contacting seals



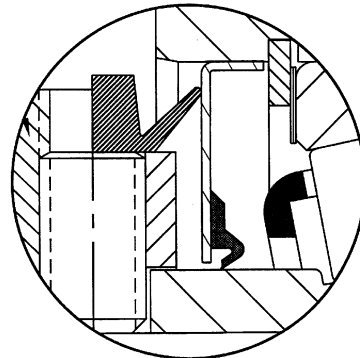
EXCLUSIVE SEALING DESIGNS AND FEATURES

Rolling Elements Never Exposed to Contaminants

- Exclusive “R” Seal features a combination metal shield and positive land riding contacting lip seal. Keeps contaminants out, lubricants in.
- E-TECT Seal option gives extra protection with a combination face rubbing seal in addition to the “R” Seal System. (See page B5-58)
- TIMKEN™ tapered roller bearing inserts allow for combination radial and thrust loads.
- Lip design conforms to cones. Permits grease to purge.
- Close fit oversized collars act as flingers for added protection in dusty or damp environments.

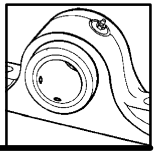


Standard “R” Seal System



E-TECT Seal System

FEATURES/BENEFITS

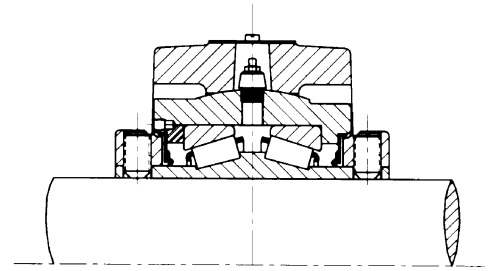


TAF

TAF Is A Cost Saving ALTERNATIVE To SAF SPHERICAL BEARINGS

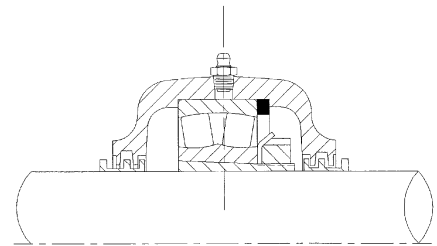
Mounts Fast, Stays Cleaner And Extends Service Life

- **Shaft ready** - mounts six times faster than SAF
- Interchangeable with SAF style pillow blocks
- Self-aligning, factory assembled, adjusted and lubricated
- Available in 1-7/16" up to 7" shaft diameters
- Equipped with expansion or non-expansion housing
- E-TECT seal option available up to 7"
- Optional Smart Housings accommodate speed, vibration and temperature sensor kits



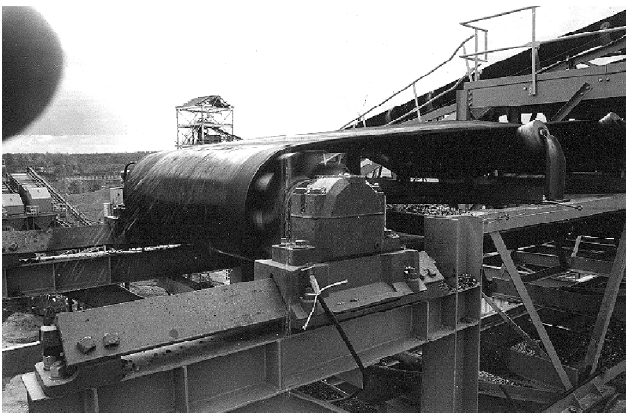
TAF

Self-alignment provided by spherically machined housing.

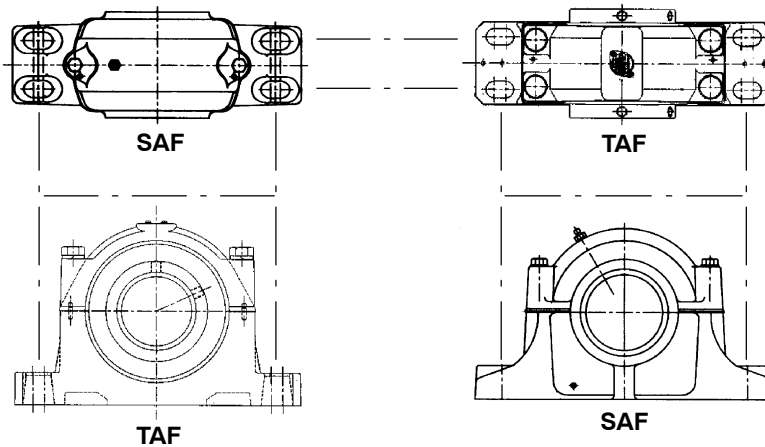


SAF

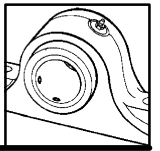
Self-alignment provided by insert, limited by seal interference.



TAF Is Interchangeable With SAF Mounting Dimensions



FEATURES/BENEFITS



Type K/DOUBLE-INTERLOCK/TAF

DODGE BEARINGS SAVE YOU TIME AND MONEY

Compare These DODGE TAF, Type K & DOUBLE-INTERLOCK Bearing Advantages Against Standard SAF Pillow Blocks

Standard SAF

- Four prices
- Up to six packages
- Open bearing
- Feeler gauge required
- Grease required



DODGE TAF, Type K and DOUBLE-INTERLOCK

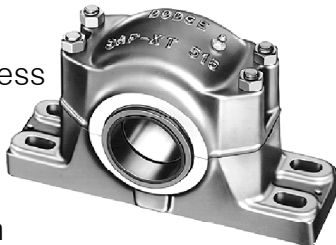
- One price
- Sealed bearing
- Factory adjusted
- Factory lubricated
- **Shaft ready**



Compare Standard SAF and DODGE Sealing Designs

STANDARD SAF

- Seals ride independently of bearing
- Less than 1° static misalignment
- Sealing effectiveness decreases as misalignment increases
- Seals distort when misalignment occurs

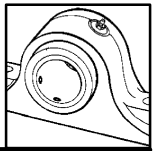


DODGE TAF, TYPE K, DOUBLE-INTERLOCK

- Inner unit carries seal
- Up to 5° static misalignment
- Seal and bearing ride together in inner unit
- Seals maintain contact on cones even with misalignment



SPECIFICATION



Type E, Type K, DOUBLE-INTERLOCK and TAF

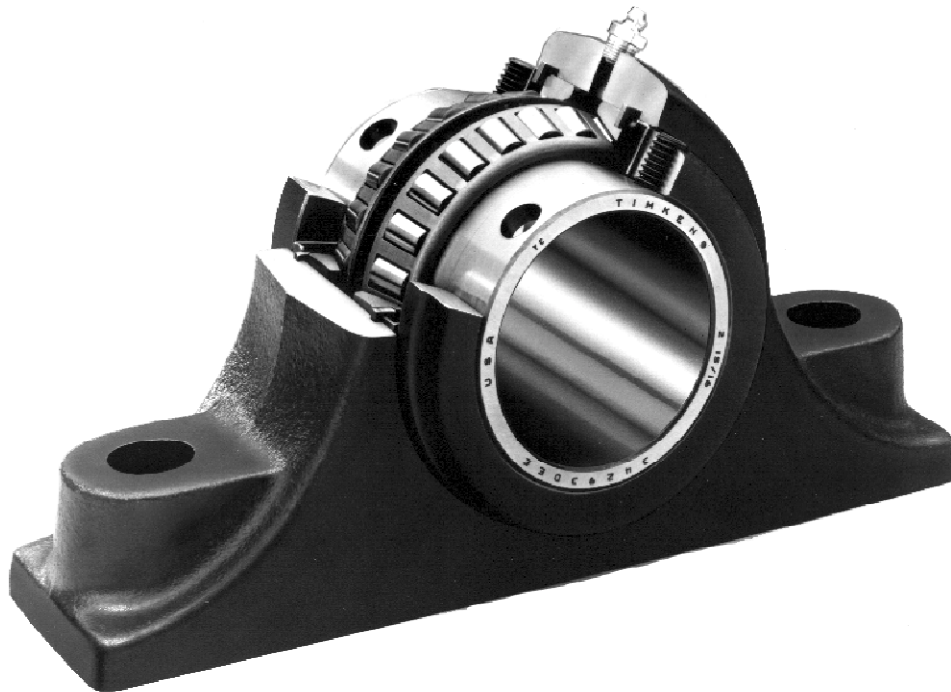
Type E, Type K, DOUBLE-INTERLOCK and TAF mounted bearings are all general purpose high capacity tapered roller bearings capable of handling any combination of radial and thrust load within the capacity of the bearing.

All of these bearings are mounted to the shaft by means of set screw collars having 65 degree set screw spacing for optimum clamping force. The Type E, DOUBLE-INTERLOCK, and TAF mounted bearings have a locking collar at each end of their extended inner races. Type K has a single locking collar. The tapered roller bearings for these mounted bearings all have case carburized inner races (cones), outer races (cups), and rollers.

Bearings are preassembled, prelubricated and factory adjusted. They are normally equipped with land riding contact type seals with a metal deflector guard.

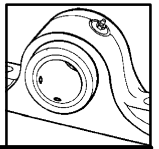
The standard housing material for most of these mounted bearings is ASTM A48 Class 30 Iron having a minimum tensile strength of 30,000 psi. The outer housing for the Type K and DOUBLE-INTERLOCK flange bearings thru 4" bore size utilize housings made of ductile iron (ASTM A536 Grade 65-45-12) with 65,000 psi tensile strength. Type E pillow blocks are also available with cast steel housing having a tensile strength of 70,000 psi for 2 bolt base thru 3-1/2" bore size and 4 bolt base from 3-15/16" thru 5" bore size on an assembled or order basis.

The Type K, DOUBLE-INTERLOCK pillow blocks and flange bearings plus the TAF pillow blocks all have split outer housings used with completely assembled, lubricated and adjusted inner units simplifying replacement of the bearing in the pillow block or flange bearing. All Type E mounted bearings, Type K take up units and all D units, S-1 units, and B-1 units have solid one piece housings.



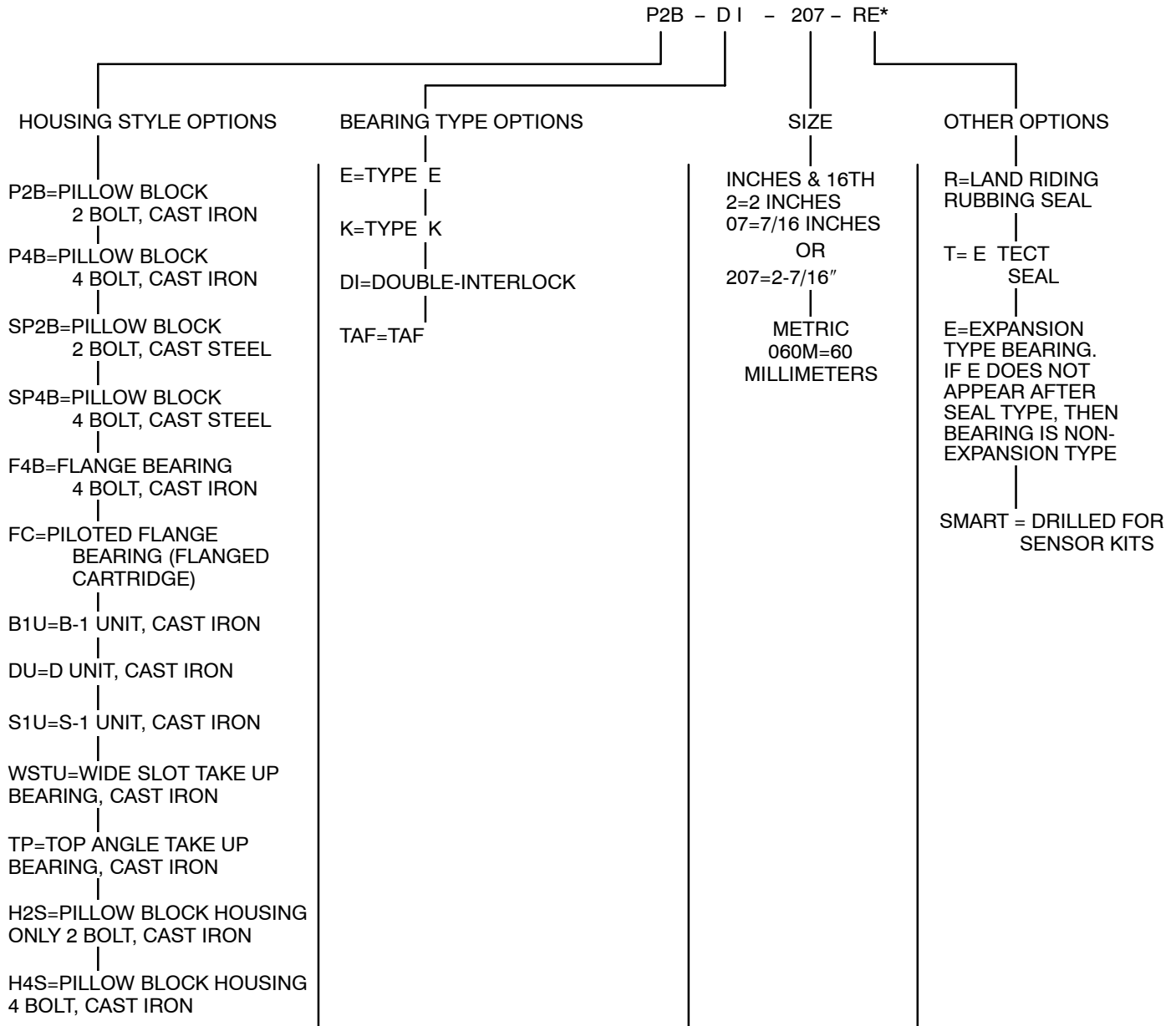
SELECTION/DIMENSIONS TYPE E PAGE B5-11/B5-22	SELECTION/DIMENSIONS TYPE K PAGE B5-11/B5-34	SELECTION/DIMENSIONS DOUBLE-INTERLOCK PAGE B5-11/B5-44	SELECTION/DIMENSIONS TAF PAGE B5-11/B5-52
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NOMENCLATURE



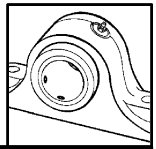
Type E, Type K, DOUBLE-INTERLOCK and TAF

NOMENCLATURE



SELECTION/DIMENSIONS TYPE E PAGE B5-11/B5-22	SELECTION/DIMENSIONS TYPE K PAGE B5-11/B5-34	SELECTION/DIMENSIONS DOUBLE-INTERLOCK PAGE B5-11/B5-44	SELECTION/DIMENSIONS TAF PAGE B5-11/B5-52
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SELECTION



Type E, Type K, DOUBLE-INTERLOCK And TAF Tapered Roller Bearings

DODGE Type E, K, DI and TAF Double Row Tapered Roller Bearings have the capacity to carry heavy radial loads and combined radial and thrust loads. The maximum recommended load which can be applied is limited by various components in the system such as bearing, housing, shaft, shaft attachment, speed and life requirements as listed in this catalog. DODGE tapered roller bearings have been applied successfully even when these limits have been exceeded under controlled operating conditions. Contact DODGE Application Engineering (864) 297-4800 for applications which exceed the recommendations of this catalog.

L₁₀ Hours Life --- The life which may be expected from at least 90% of a given group of bearings operating under identical conditions.

$$L_{10} = \left(\frac{C_{90}}{P} \right)^{10/3} \times \left(\frac{1,500,000}{\text{RPM}} \right)$$

Where: C₉₀ = Dynamic Capacity (Table 1, pg.B5-14), lbs.
P = Equivalent Radial Load, lbs.

GENERAL

Heavy Service --- For heavy shock loads, frequent shock loads, or severe vibrations, add up to 50% (according to severity of conditions) to the Equivalent Radial Load. Consult DODGE Application Engineering for additional selection assistance.

Thrust load values shown in the table below are recommended as a guide for general applications that will give adequate L₁₀ life for pillow blocks. The maximum thrust load should not exceed values shown on Table 3. Where substantial radial load is also present, it is advisable to calculate actual L₁₀ life to assure that it meets the requirements. The effectiveness of the shaft attachment to carry thrust load depends on proper tightening of the setscrews, shaft tolerance and shaft deflections. Therefore, it is advisable to use auxiliary thrust carrying devices such as shaft shoulder, snap ring

or a thrust collar to locate the bearing under thrust loads heavier than shown below, or where extreme reliability is desired.

RPM RANGE		20-200	201-2000	over 2000
RECOMMENDED	E, DI, TAF	C ₉₀ /4	C ₉₀ /8	C ₉₀ /12
THRUST LOAD	K	C ₉₀ /5	C ₉₀ /8	C ₉₀ /12

The shaft tolerances recommended below are adequate for normal radial and radial/thrust load applications. The radial load is limited by the attachment to the shaft (see Table 1). Where the applied radial load (F_R) exceeds this limit (maximum allowable slip fit radial load), a snug-to-light press fit of the shaft is required. Since the allowable load, especially at a low speed, is very large, the shaft should be checked to assure adequate shaft strength.

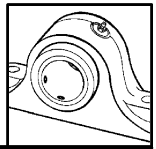
The magnitude and direction of both the thrust and radial load must be taken into account when selecting a housing. **When pillow blocks are utilized, heavy loads should be directed through the base. Where uplift loads are involved, see Tables 6, 7, and, pg.B5-19 for maximum values.** Where a load pulls the housing away from the mounting base, both the hold-down bolts and housing must be of adequate strength. Auxiliary load carrying devices such as shear bars are advisable for side or end loading of pillow blocks and radial load for flange units.

SHAFT SIZE	TOLERANCE, INCHES
UP TO 1-1/2"	+.0000-.0005"
1-5/8 TO 4	+.000 -.001"
4-7/6 TO 6	+.000-.0015"
6-7/16-8"	+.000-.002"

NOTE: The L₁₀ life calculated using the above formula is subject to life adjustment factors in accordance with ABMA standards described on page B14-45.

HOW TO ORDER PAGE B5-8	EASY SELECTION PAGE B5-15	ENGINEERING/TECHNICAL PAGE B5-17	SELECTION/DIMENSIONS TYPE E, METRIC PAGE B5-61/B5-68
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SELECTION



Type E, Type K, DOUBLE-INTERLOCK And TAF Tapered Roller Bearings

SELECTING BEARINGS SUPPORTING RADIAL LOADS ONLY

1. Define L_{10} Life Hours desired.
2. Establish bearing radial load, F_R
($F_R = P$ for Pure Radial Load Conditions).
The DODGE program BEST™* can be used to find application loads.
3. Establish RPM.

Using the easy selection Table 2, pg. B5-15 find, under the RPM column, the equivalent radial load that equals or is higher than the application radial load for the desired life. The shaft size on the far left will be the minimum shaft size that you can use for your application. If the desired life is different than the values shown on the chart, use alternate Method A shown below.

- Example: 1. L_{10} Life = 30,000 Hours
2. Radial load = 3800 lbs.
3. RPM = 1,000

At the intersection of the 1,000 RPM column and the 30,000 hours L_{10} life row, the equivalent radial load of 3910 lbs. exceeds the 3800 lbs. radial load for shaft sizes 2-11/16"-3". A bearing with bore ranging from 2-11/16" to 3" may be used for this application.

ALTERNATE METHOD A --- SELECTING A BEARING FOR AN L10 LIFE VALUE NOT SHOWN IN THE EASY SELECTION CHART.

The L_{10} life equation can be rearranged so that the bearing dynamic capacity C_{90} is identified in terms of L_{10} , RPM and P.

$$C_{90} = \left(\frac{L_{10} \times \text{RPM}}{1,500,000} \right)^{0.3} \times P$$

($P = F_R$ for Pure Radial Load Conditions)

Since the L_{10} , RPM, and P are known, solve for C_{90} . Select from the dynamic capacity column on Table 1, pg. B5-14 the C_{90} value equal to or greater than the C_{90} value just calculated. The bore size on the far left represents the bore size selection. Check that the application RPM does not exceed the MAX. RPM on Table 1. Also check that the radial load does not exceed the Maximum Allowable Slip Fit Radial Load shown on Table 1. If it does, a line to line to light press fit of shaft is required. When selecting an L_{10} life of less than 30,000 hours, particular attention must be paid to shaft deflection and proper lubricant selection.

SELECTING BEARINGS SUPPORTING COMBINATION RADIAL AND THRUST LOADS

When a bearing supports both a radial load and a thrust load, the loading on the two rows is shared unequally depending on the ratio of thrust to radial load. The use of the X (radial factor) and Y (thrust factor) from Table 1 converts the applied thrust load and radial loads to an equivalent radial load having the same effect on the life of the bearing as a radial load of this magnitude.

$$P = XF_R + YF_A$$

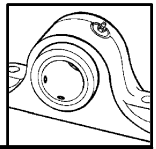
- Where: P = Equivalent radial load, lbs.
 F_R = Radial load, lbs. (see Table 1 for allowable slip fit maximum)
 F_A = Thrust (axial) load, lbs.
 e = Thrust load to radial load factor (Table 1)
 X = Radial load factor (Table 1)
 Y = Thrust load factor (Table 1)

To find X and Y, calculate F_A/F_R and compare to e for the selected bore size. Determine X and Y from Table 1, pg. B5-14 depending on whether F_A/F_R is equal to or less than e , or F_A/F_R is greater than e . Substitute all known values into the equivalent radial load equation. P (equivalent radial load) can be used in the life formula to determine L_{10} , or it can be compared to the allowable equivalent radial load ratings for the speed and hours life desired in the easy selection Table 2, pg. B5-15.

*The DODGE Bearing Evaluation and Selection Technique (BEST) is a menu driven computer program that calculates bearing loads, fatigue life and operating temperature for a two bearing shaft system based on user supplied input parameters. To order, call (864) 287-4800.

SELECTION/DIMENSIONS TYPE E PAGE B5-11/B5-22	SELECTION/DIMENSIONS TYPE K PAGE B5-11/B5-34	SELECTION/DIMENSIONS DOUBLE-INTERLOCK PAGE B5-11/B5-44	SELECTION/DIMENSIONS TAF PAGE B5-11/B5-52
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SELECTION



Type E, Type K, DOUBLE-INTERLOCK and TAF

SELECTING BEARINGS SUPPORTING ONLY THRUST LOADS

Tapered Roller Bearings perform extremely well under pure thrust load applications. Use $P = YF_A$ for the equivalent radial load. The value of Y is obtained from Table 1, pg. B5-14 for $F_A/F_R > e$. Substitute Y and F_A into the equivalent load equation. P (equivalent radial load) can be used in the life formula to determine L_{10} or it can be compared to the allowable equivalent radial load ratings for the speed and hours life desired in the easy selection Table 2, pg. B5-15.

LUBRICATION

DODGE E, K, DI, and TAF tapered roller bearings up to 5" bore are lubricated at the factory with Shell Alvania #2 grease. Above 5" bore they are lubricated with Mobil Mobilux #2EP.

Shell Alvania #2 and Mobil Mobilux #2EP greases are superior industrial greases using a lithium hydroxystearate thickener and highly refined base oil. These greases will adequately handle low and medium speeds with low and medium loads at normal temperatures as defined on Table 5, pg. B5-18. For very low and high speeds, for heavy loads and for low and high temperatures, special greases must be used. Contact DODGE Application Engineering (864) 297-4800. DODGE engineers will recommend bearings and lubricants for the above unusual conditions. DODGE also has the expertise to custom design and build special bearings for your needs. The only maintenance requirement for DODGE Tapered Roller Bearings is periodic relubrication at regular intervals as outlined in the appropriate instruction manuals.

RELUBRICATION SCHEDULE

Hours Run per Day	SUGGESTED LUBRICATION PERIOD IN WEEKS							
	1 to 250 RPM	251 to 500 RPM	501 to 750 RPM	751 to 1000 RPM	1001 to 1500 RPM	1501 to 2000 RPM	2001 to 2500 RPM	2501 to 3000 RPM
8	12	12	10	7	5	4	3	2
16	12	7	5	4	2	2	2	1
24	10	5	3	2	1	1	1	1

High Speed Operation --- In the higher speed ranges too much grease will cause overheating. The amount of grease that the bearing will take for particular high speed application can only be determined by experience --- see "Operating Temperature" below. If excess grease in the bearing caused overheating, it will be necessary to remove grease fitting (also drain plug when furnished) to permit excess grease to escape. When establishing a relubrication schedule, note that a small amount of grease at frequent intervals is preferable to a large amount at infrequent intervals.

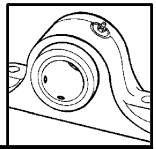
Operation in Presence of Dust, Water or Corrosive Vapors --- Under these conditions the bearing should contain as much grease as speed will permit, since a full bearing with consequent slight leakage is the best protection against entrance of foreign material. In the higher speed ranges too much grease will cause overheating --- see "High Speed Operation". In the lower speed ranges, it is advisable to add extra grease to a new bearing before putting into operation. Bearings should be greased as often as necessary (daily if required) to maintain a slight leakage at the seals.

INSTALLATION AND MAINTENANCE

In nearly all applications good design practice requires two bearings supporting the shaft. In cases where three or more bearings are installed, unless precautions are taken to line the bearings up, both vertically and horizontally, it is possible to induce heavy loads. In the case of two bearings, alignment is not as critical, especially with DODGE K, DI, and TAF Tapered Roller Bearings. K, DI, and TAF bearings are designed to allow as much as 2° to 7° of static misalignment depending on bore size. To ensure good alignment, mounting surfaces must be checked for flatness and must lie in the same plane. When tightening base bolts and cap bolts, each bolt should be alternately tightened in incremental torque values until full torque is achieved to prevent the angular shifting of the pillow block that occurs when one bolt is tightened to its full torque. Shimming may be required to minimize misalignment.

FEATURES/BENEFITS PAGE B5-2	SPECIFICATIONS PAGE B5-7	HOW TO ORDER PAGE B5-8	SELECTION/DIMENSIONS TYPE E, METRIC PAGE B5-61/B5-68
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SELECTION



Type E, Type K, DOUBLE-INTERLOCK and TAF

TABLE 1 – E, K, DI, AND TAF TAPERED ROLLER BEARINGS RADIAL AND THRUST FACTORS

SHAFT SIZE	e	F _A /F _R ≤e		F _A /F _R >e		DYNAMIC CAPACITY C ₉₀ *		MAXIMUM RPM	MAXIMUM RPM	MAXIMUM ALLOWABLE SLIP FIT RADIAL LOAD, F _R ** , LBS	
		X	Y	X	Y	LBS.	NEWTONS	R-SEAL	E-TECT	E,DI,&TAF	K
1-3/16 1-1/4	.49	.87	1.77	.70	2.14	2,980	13,260	4,490	3,100	3,100	2,100
1-3/8 1-7/16	.46	.87	1.89	.70	2.28	4,760	21,180	3,820	2,675	5,000	3,300
1-1/2 1 5/8 1-11/16	.44	.87	1.96	.70	2.37	6,140	27,320	3,320	2,325	6,400	4,300
1-3/4 1-7/8 1-15/16 2	.33	.87	2.64	.70	3.18	8,070	35,908	3,050	2,135	8,400	5,600
2-3/16	.36	.87	2.38	.70	2.87	8,550	38,044	2,730	1,900	8,900	5,900
2-1/4 2-7/16 2-1/2	.40	.87	2.17	.70	2.63	9,090	40,447	2,420	1,700	9,500	6,300
2-11/16 2-3/4 2-15/16 3	.46	.87	1.87	.70	2.26	9,600	42,716	2,060	1,440	10,000	6,700
3-3/16 3-1/4 3-7/16 3-1/2	.50	.87	1.71	.70	2.07	15,300	68,078	1,640	1,145	16,000	10,500
3-15/16 4	.49	.87	1.77	.70	2.14	21,000	93,440	1,530	1,070	22,000	14,600
4-7/16 4-1/2	.53	.87	1.63	.70	1.97	25,800	114,799	1,360	950	27,000	----
4-15/16 5	.47	.87	1.83	.70	2.21	35,500	157,959	1,200	840	35,000	----
5-7/16 5-15/16 6	.49	.87	1.76	.70	2.12	40,700	181,097	915	640	42,400	----
6-7/16 6-1/2 6-15/16 7	.54	.87	1.61	.70	1.95	69,200	307,910	790	550	72,000	----

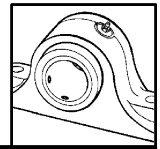
Comparing Spherical To Taper Roller Bearings: The dynamic capacity C (spherical) and C90 (taper) are not to the same base. To compare basic dynamic capacities, multiply C x .259 and compare to C90.

* C₉₀ – Dynamic capacity based on a rated life of 90 million revolutions or 3000 hours at 500 RPM.

** If load exceeds maximum allowable slip fit radial load, (F_R), line-to-line, to light press fit of shaft required. Application up to maximum slip fit radial load may be applied if recommended shaft tolerances are used.

SELECTION/DIMENSIONS TYPE E PAGE B5-11/B5-22	SELECTION/DIMENSIONS TYPE K PAGE B5-11/B5-34	SELECTION/DIMENSIONS DOUBLE-INTERLOCK PAGE B5-11/B5-44	SELECTION/DIMENSIONS TAF PAGE B5-11/B5-52
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SELECTION



Type E, Type K, DOUBLE-INTERLOCK and TAF

TABLE 2 – EASY SELECTION TABLE TYPE E, K, DI, AND TAF

Shaft Size	L10 Hours Life	Allowable Equivalent Radial Load Rating (Lbs.) at Various Revolutions Per Minute														
		50	100	150	250	500	750	1000	1250	1500	1750	2000	2500	2700	3000	3500
1-3/16 1-1/4	10,000	4145	3365	2980	2555	2075	1840	1685	1575	1495	1425	1370	1280	1250	1215	1160
	30,000	2980	2420	2145	1840	1495	1320	1215	1135	1075	1025	985	920	900	870	835
	40,000	2735	2220	1965	1685	1370	1215	1110	1010	985	940	905	845	825	800	765
	60,000	2420	1965	1740	1495	1215	1075	985	920	870	835	800	750	730	710	675
	100,000	2075	1685	1495	1280	1040	920	845	790	750	715	685	640	625	610	580
1-3/8 1-7/16	10,000	6620	5375	4760	4085	3315	2935	2695	2520	2385	2275	2190	2045	2000	1935	1850
	30,000	4760	3865	3425	2935	2385	2110	1935	1810	1715	1640	1575	1470	1440	1395	1330
	40,000	4365	3545	3140	2695	2190	1935	1775	1660	1575	1500	1445	1350	1320	1280	1220
	60,000	3865	3140	2780	2385	1935	1715	1575	1470	1395	1330	1280	1195	1170	1130	1080
	100,000	3315	2695	2385	2045	1660	1470	1350	1260	1195	1140	1095	1025	1000	970	925
1-1/2 1-5/8 1-11/16	10,000	8535	6935	6140	5265	4280	3790	3475	3250	3075	2940	2820	2640	2580	2500	
	30,000	6140	4985	4415	3790	3075	2725	2500	2335	2215	2115	2030	1900	1855	1795	
	40,000	5630	4575	4050	3475	2820	2500	2290	2145	2030	1940	1860	1740	1700	1650	
	60,000	4985	4050	3585	3075	2500	2215	2030	1900	1795	1715	1650	1540	1505	1460	
	100,000	4280	3475	3075	2640	2145	1900	1740	1630	1540	1470	1415	1325	1290	1250	
1-3/4 1-7/8 1-15/16 2	10,000	11220	9115	8070	6925	5625	4980	4565	4270	4045	3860	3710	3470	3390	3285	
	30,000	8070	6555	5805	4980	4045	3580	3285	3070	2910	2775	2670	2495	2440	2360	
	40,000	7400	6010	5325	4565	3710	3285	3015	2820	2670	2545	2445	2290	2235	2165	
	60,000	6555	5325	4715	4045	3285	2910	2670	2495	2360	2255	2165	2025	1980	1920	
	100,000	5625	4565	4045	3470	2820	2495	2290	2140	2025	1935	1860	1740	1700	1645	
2-3/16	10,000	11885	9655	8550	7335	5960	5275	4840	4525	4285	4090	3930	3675	2590		
	30,000	8550	6945	6150	5275	4285	3795	3480	3255	3080	2940	2825	2645	2585		
	40,000	7845	6370	5640	4840	3930	3480	3190	2985	2825	2700	2595	2425	2370		
	60,000	6945	5640	4995	4285	3480	3080	2825	2645	2505	2390	2295	2145	2100		
	100,000	5960	4840	4285	3675	2985	2645	2425	2270	2145	2050	1970	1840	1800		
2-1/4 2-7/16 2-1/2	10,000	12640	10265	9090	7800	6335	5610	5145	4810	4555	4350	4180	3910			
	30,000	9090	7385	6535	5610	4555	4035	3700	3460	3275	3130	3005	2810			
	40,000	8340	6770	5995	5145	4180	3700	3395	3175	3005	2870	2755	2580			
	60,000	7385	5995	5310	4555	3700	3275	3005	2810	2660	2540	2440	2285			
	100,000	6335	5145	4555	3910	3175	2810	2580	2410	2285	2180	2095	1960			

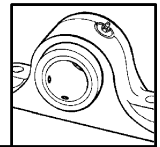
For maximum RPM see Table 1 on page B5-14.

In the shaded area, E, DI, and TAF mounted units require a line-to-line to light press fit of shaft.

In the boxed area, Type K mounted units require a line-to-line to light press fit of shaft.

NOMENCLATURE PAGE B5-10	EASY SELECTION TYPE E, METRIC PAGE B5-64	SELECTION/DIMENSIONS TYPE E, METRIC PAGE B5-61/B5-68	ENGINEERING/TECHNICAL PAGE B5-17
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SELECTION



Type E, Type K, DOUBLE-INTERLOCK and TAF

TABLE 2 (continued) – EASY SELECTION TABLE TYPE E, K, DI, AND TAF

Shaft Size	L10 Hours Life	Allowable Equivalent Radial Load Rating (Lbs.) at Various Revolutions Per Minute														
		50	100	150	250	500	750	1000	1250	1500	1750	2000	2500	2700	3000	3500
2-11/16 2-3/4 2-15/16 3	10,000	13345	10840	9600	8235	6690	5925	5435	5080	4810	4595	4415				
	30,000	9600	7795	6905	5925	4810	4260	3910	3655	3460	3305	3175				
	40,000	8805	7150	6335	5435	4415	3910	3585	3350	3175	3030	2910				
	60,000	7795	6335	5610	4810	3910	3460	3175	2970	2810	2685	2580				
100,000	6690	5435	4810	4125	3350	2970	2725	2545	2410	2300	2210					
3-3/16 3-1/4 3-7/16 3-1/2	10,000	21370	17280	15300	13125	10665	9440	8660	8100	7670	7320					
	30,000	15300	12425	11005	9440	7670	6790	7230	5825	5515	5625					
	40,000	14035	11400	10095	8660	7035	5230	5715	5345	5060	4830					
	60,000	12425	10095	8940	7670	6230	5515	5060	4730	4480	4275					
100,000	10660	8660	7670	6580	5345	4730	4340	4060	3845	3670						
3-15/16 4	10,000	29200	23715	21000	18015	14635	12955	11885	11115	10525						
	30,000	21000	17055	15105	12955	10525	9320	8550	7995	7570						
	40,000	19265	15645	13855	11885	9655	8550	7840	7335	6945						
	60,000	17055	13855	12270	10525	8550	7570	6945	6495	6150						
100,000	14635	11885	10525	9030	7335	6495	5955	5570	5275							
4-7/16 4-1/2	10,000	35870	29135	25800	22135	17980	15920	14605	13655							
	30,000	25800	20955	18555	15920	12930	11450	10500	9820							
	40,000	23665	19225	17020	14605	11860	10500	9635	9010							
	60,000	20955	17020	15070	12930	10500	9300	8530	7980							
100,000	17980	14605	12930	11095	9010	7980	7320	6845								
4-15/16 5	10,000	49360	40090	35500	30455	24740	21905	20095	18790							
	30,000	35500	28835	25530	21905	17790	15755	14450	13515							
	40,000	32565	26450	23420	20095	16320	14550	13255	12400							
	60,000	28835	23420	20740	17790	14450	12795	11740	10980							
100,000	24740	20095	17790	15265	12400	10980	10070	9420								
5-7/16 5-15/16 6	10,000	56590	45965	40700	34915	28360	25115	23035								
	30,000	40700	33060	29270	25115	20400	18060	16570								
	40,000	37335	30325	26850	23035	18710	16570	15200								
	60,000	33060	26850	23775	20400	16570	14670	13455								
100,000	28360	23035	20400	17500	14215	12585	11545									
6-7/16 6-1/2 6-15/16 7	10,000	96215	78150	69200	59365	48220	42700									
	30,000	69200	56205	49770	42700	34680	30710									
	40,000	63480	51560	45655	39170	31815	28170									
	60,000	56205	45655	40425	34680	28170	24945									
100,000	48220	39170	34680	29755	24170	21400										

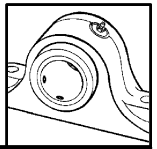
For maximum RPM see Table 1 on page B5-14.

In the shaded area, E, DI, and TAF mounted units require a line-to-line to light press fit of shaft.

In the boxed area, Type K mounted units require a line-to-line to light press fit of shaft.

FEATURES/BENEFITS PAGE B5-2	SPECIFICATIONS PAGE B5-7	HOW TO ORDER PAGE B5-8	
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SELECTION



Type E, Type K, DOUBLE-INTERLOCK and TAF

TABLE 3 – PERMISSIBLE THRUST LOAD, LBS. *

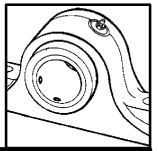
SHAFT SIZE INCHES	*E		K/DI		TAF	
	2-Bolt	4-Bolt	2-Bolt	4-Bolt	2-Bolt	4-Bolt
1-3/16	2000		2000			
1-1/4	2000		2000			
1-3/8	2590		2100			
1-7/16	2590		2100		2100	
1-1/2	2590		2100			
1-5/8	2590		2100			
1-11/16	2590		2100		2100	
1-3/4	3454		2900			
1-7/8	3454		2900			
1-15/16	3454		2900		2900	
2	3454		2900			
2-3/16	3454		2900		2900	
2-1/4	3454	3454	3454	3454		
2-7/16	3454	3454	3454	3454	3454	3454
2-1/2	3454	3454	3454	3454	3454	3454
2-11/16	5181	5181	5181	5181	5181	
2-3/4	5181	5181	5181	5181	5181	
2-15/16	5181	5181	5181	5181	5181	5181
3	5181	5181	5181	5181	5181	5181
3-3/16	5181	5181	5181	5181		
3-1/4	5181	5181	5181	5181		
3-7/16	5181	5181	5181	5181	5181	5181
3-1/2	5181	5181	5181	5181	5181	5181
3-15/16		6908		6908		6908
4		6908		6908		6908
4-7/16		6908		6908		6908
4-1/2		6908		6908		6908
4-15/16		6908		6908		6908
5		6908		6908		6908
5-7/16		8635		8635		8635
5-15/16		8635		8635		8635
6		8635		8635		8635
6-7/16		8635		12282		12282
6-1/2		8635		12282		12282
6-15/16		8635		12282		12282
7		8635		12282		12282

Note: The limits above apply to set screw shaft mounting or pillow block over turning force. Under heavy thrust loads it is always wise to use shear bars. At all times the L10 life of the bearing should be checked for proper selection and life requirements. For thrust loads larger than listed or heavy thrust loading on other style housing, contact DODGE Engineering for recommendation.

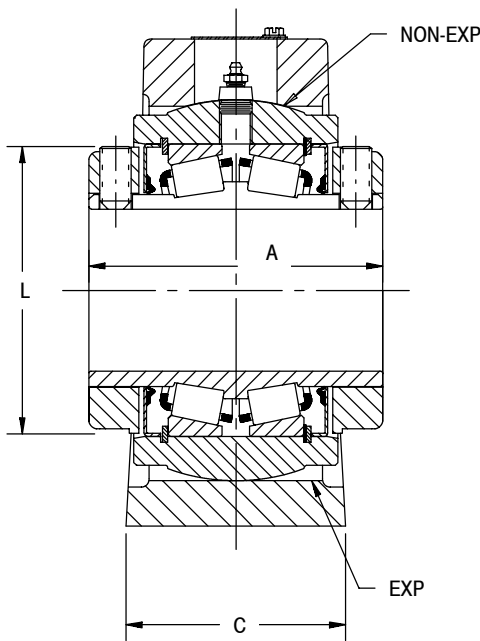
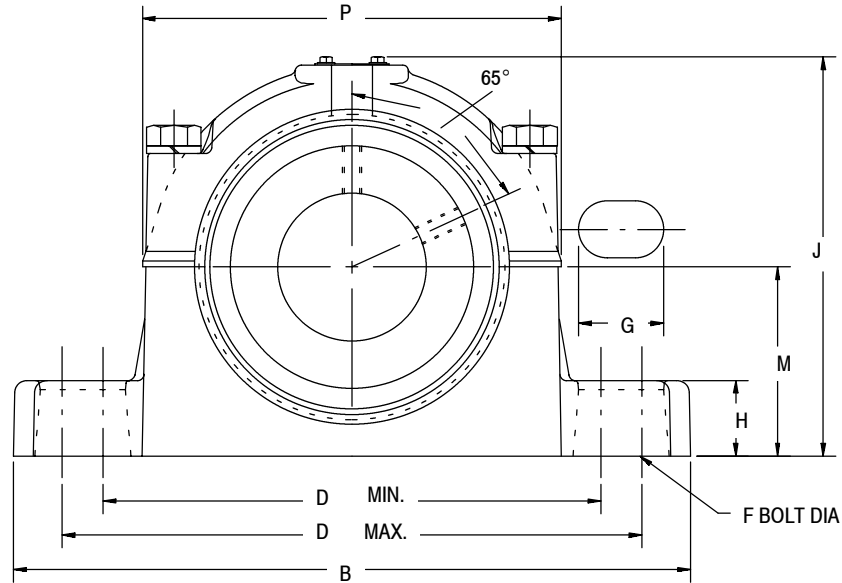
* Does not include Piloted Flange.

SELECTION/DIMENSIONS TYPE E PAGE B5-11/B5-22	SELECTION/DIMENSIONS TYPE K PAGE B5-11/B5-34	SELECTION/DIMENSIONS DOUBLE-INTERLOCK PAGE B5-11/B5-44	SELECTION/DIMENSIONS TAF PAGE B5-11/B5-52
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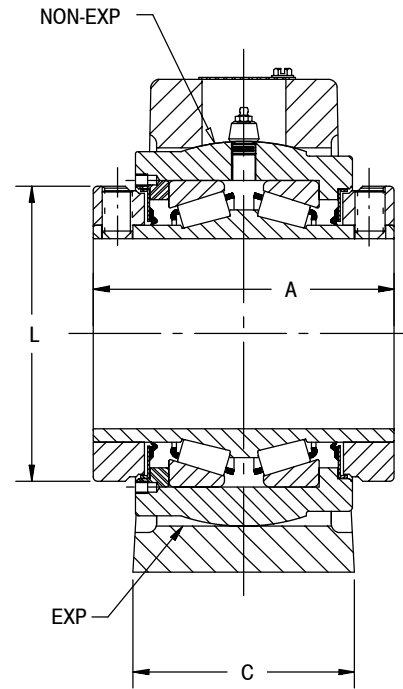
SELECTION/DIMENSIONS



TAF Pillow Block – Inch 2-BOLT BASE



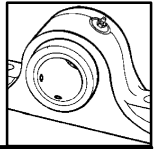
1-7/16" THRU 3" CONSTRUCTION



3-7/16" THRU 3-1/2" CONSTRUCTION

FEATURES/BENEFITS PAGE B5-2	SPECIFICATIONS PAGE B5-7	HOW TO ORDER PAGE B5-8	NOMENCLATURE PAGE B5-10
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SELECTION/DIMENSIONS



TAF Pillow Block – Inch 2-BOLT BASE

GRAY IRON NON-EXPANSION +						
SHAFT SIZE INCHES #	SHAFT SIZE SYMBOL	SAF HOUSING NUMBER	PILLOW BLOCK P/N	HSG ASSEM. P/N	UNIT P/N	PIL. BLK. WT. APRX LBS
1-7/16	107	509	037580	037540	037632	12
1-11/16	111	510	037581	037541	037633	15
1-15/16	115	511	037582	037542	037634	17
2-3/16	203	513	037583	037543	037635	25
2-7/16	207	515	037584	037544	037636	30
2-1/2	208	515	037585	037544	037637	30
2-11/16	211	516	037586	037545	037638	38
2-3/4	212	516	037587	037545	037639	38
2-15/16	215	517	037588	037546	037640	45
3	300	517	037589	037546	037641	44
3-7/16	307	520	037590	037547	037642	71
3-1/2	308	520	037591	037547	037643	70

GRAY IRON EXPANSION						
SHAFT SIZE INCHES #	SHAFT SIZE SYMBOL	SAF HOUSING NUMBER	PILLOW BLOCK P/N	HSG ASSEM. P/N	UNIT P/N	PIL. BLK. WT. APRX LBS
1-7/16	107	509	037592	037555	037632	12
1-11/16	111	510	037593	037556	037633	15
1-15/16	115	511	037594	037557	037634	17
2-3/16	203	513	037595	037558	037635	25
2-7/16	207	515	037596	037559	037636	30
2-1/2	208	515	037597	037559	037637	30
2-11/16	211	516	037598	037560	037638	38
2-3/4	212	516	037599	037560	037639	38
2-15/16	215	517	037600	037561	037640	45
3	300	517	037601	037561	037641	44
3-7/16	307	520	037602	037562	037642	71
3-1/2	308	520	037603	037562	037643	70

+ Furnished Unless Otherwise Specified.
Description = P2b-taf-207re For 2-7/16" Size
Consult DODGE For Sizes Not Shown

Description = P2b-taf-207re For 2-7/16" Size
Consult DODGE For Sizes Not Shown

SHAFT SIZE INCHES	SAF SERIES	A	B	C	D		F BOLT DIA	G	H	J	L	M	P	EXP*
					MIN.	MAX.								
1-7/16	509	3	8-1/4	2-3/16	6-1/4	7	1/2	15/16	7/8	5-7/64	2-3/4	2-1/4	5-33/64	3/32
1-11/16	510	3-3/8	8-1/4	2-3/8	6-1/2	7	1/2	7/8	1-1/32	5-5/8	3-3/16	2-1/2	5-13/16	3/32
1-15/16	511	3-1/2	9-5/8	2-3/4	7-3/8	8-1/4	5/8	1-13/64	1-1/32	6-9/64	3-7/16	2-3/4	6-23/64	9/32
2-3/16	513	3-3/4	11	3-1/4	8-21/32	9-1/2	5/8	1-7/16	1-1/32	6-33/64	3-3/4	3	6-61/64	9/32
2-7/16	515	4	11-1/8	3-1/8	8-5/8	9-5/8	5/8	1-17/64	1-1/4	7-1/32	4-1/16	3-1/4	7-3/8	9/32
2-1/2														
2-11/16	516	4-1/2	12-19/32	3-1/2	9-7/8	11	3/4	1-7/16	1-1/4	7-43/64	4-23/32	3-1/2	8-5/16	9/32
2-3/4														
2-15/16	517	4-1/2	12-19/32	3-1/2	9-7/8	11	3/4	1-7/16	1-1/4	7-59/64	4-23/32	3-3/4	8-5/16	9/32
3														
3-7/16	520	5	14-1/4	4-11/32	11-13/16	13-1/8	7/8	1-21/32	1-21/32	9-27/64	5-5/16	4-1/2	10-3/32	9/32
3-1/2														

*EXP Total Expansion Divided Equally On Both Sides Of Bearing (Expansion Bearing Only).

Dowel Hole Locations For Precision Positioning – See Page B9-30 – B9-31

EASY SELECTION PAGE B5-15	SELECTION/DIMENSIONS TYPE E PAGE B5-11/B5-22	SELECTION/DIMENSIONS TYPE K PAGE B5-11/B5-34	SELECTION/DIMENSIONS DOUBLE-INTERLOCK PAGE B5-11/B5-44
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linear diaphragm operators*



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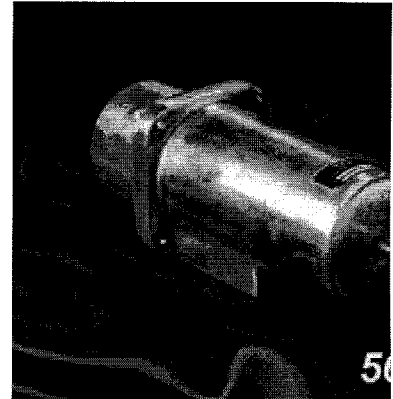


HOME OIL LEVEL REGULATORS LINEAR DIAPHRAGM OPERATORS LOW FLOW METERS PRODUCT REGISTRATION

MODELS 501-4 501-6 501-12 501-25

MODEL 501-12 LINEAR DIAPHRAGM OPERATOR

GARZO Linear Diaphragm Operators are small diameter spring opposed rolling diaphragm operators suitable for gas compressor applications. The series 501 operators are designed specifically to be used in various industrial applications. The rolling diaphragm creates the perfect seal for friction free cylinders. It is a durable, flexible membrane shaped like a top hat with the peak of the hat resting against the end of the piston and the brim clamped between the forward and rear cylinders. Inside the cylinder this forms a long-lasting frictionless sealed cushion of air between the piston head and the cylinder wall. The fabric reinforced elastomer rolling diaphragms are produced exclusively for GARZO to our exacting standards. Standard diaphragm material design allows for operation of the cylinders in temperatures from -31°F to 248°F. Custom diaphragm material design allows for operation of the cylinders in temperatures from -121°F to 500°F.



The operators are designed to withstand many corrosive elements. The piston and body of the operators are made from 100% aluminum castings which resist galvanic corrosion and eliminate the need for painting. The diaphragm is a Dacron fabric, Buna-n impregnated, molded rolling diaphragm. The diaphragms are designed and manufactured to withstand repeated use in industrial applications, and the fabric prevents the elastomer from stretching in over pressure conditions. The spring has been electro zinc plated. The piston rod is a large diameter 300 series stainless steel. All other parts are either plated or stainless steel, making the operator suitable for offshore salt water, natural gas, and sour gas service.

GARZO linear diaphragm operators are designed using INSTRUMENT SOCIETY of AMERICA recognized spring rates. The GARZO operators have strokes that follow a true linear progression. A properly sized GARZO spring opposed diaphragm operator has as much force on the forward stroke as it does on the return stroke.

FEATURES

- Super Sensitivity
- Absolutely No Lubrication Required
- Low Hysteresis
- No Blow-By Leakage - 100% Leak Testing
- Solid Aluminum Construction
- Ease of Maintenance
- Wide Temperature Variations
- Designed For Use With Air or Sour Gas

SPECIFICATIONS

- Cylinders 100% Cast Aluminum
- Piston 100% Cast Aluminum
- Rod 303 Stainless Steel
- Diaphragm Buna-N with Dacron Fabric
- Spring Zink Plated

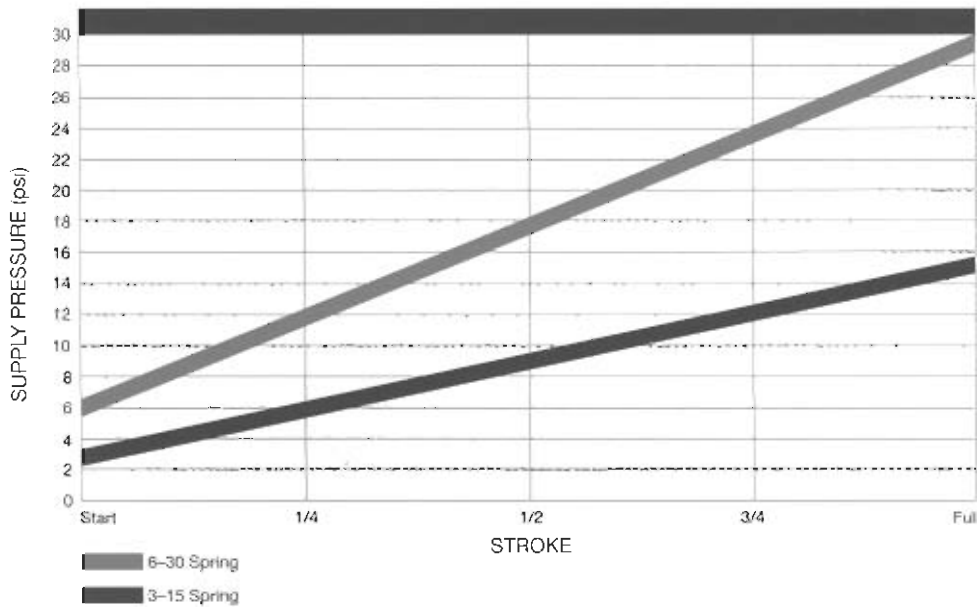
Features

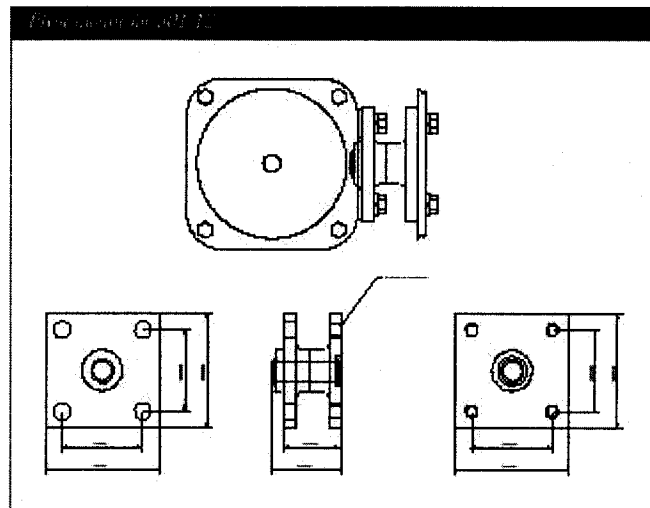
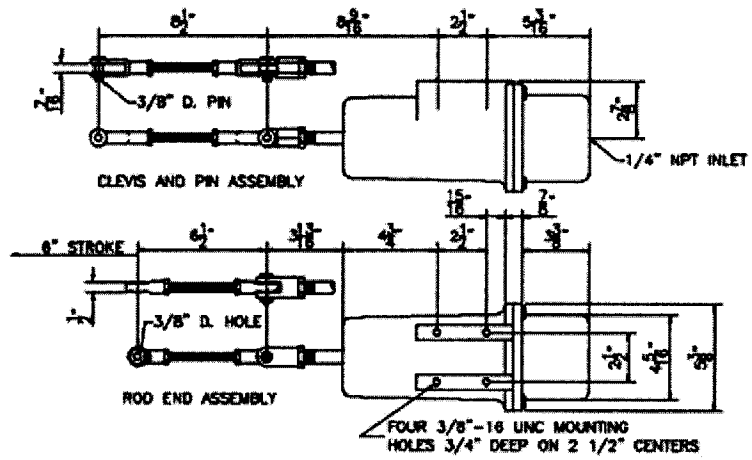
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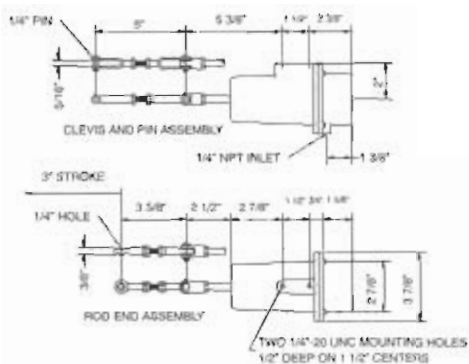
MODEL NUMBER	EFFECTIVE AREA (IN ²)	STROKE (IN)	FORCE AVAILABLE (LB)	NOMINAL SUPPLY PRESSURE	MAXIMUM SUPPLY PRESSURE
501-4-315	4	3	12	20	100
501-4-630	4	3	24	40	100
501-6-315	6	4	18	20	100
501-6-630	6	4	36	40	100
501-12-315	12	6	36	20	100
501-12-630	12	6	72	40	100
501-25-315	25	10	75	20	100
501-25-630	25	10	150	40	



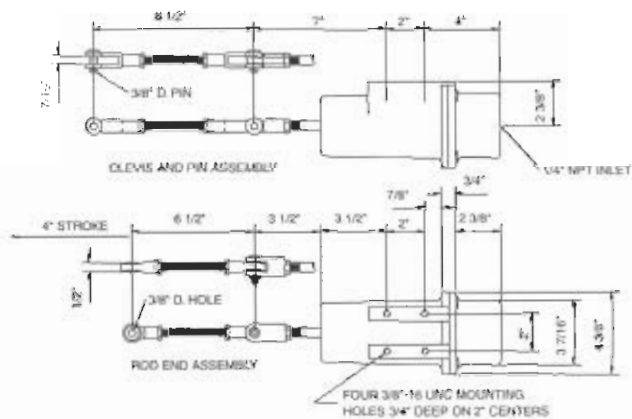


MODEL NUMBER	EFFECTIVE AREA (IN ²)	STROKE (IN)	FORCE AVAILABLE (LBS)	NOMINAL SUPPLY PRESSURE	MAXIMUM SUPPLY PRESSURE
501-12-315	12	6	36	20	100
501-12-630	12	6	72	40	100

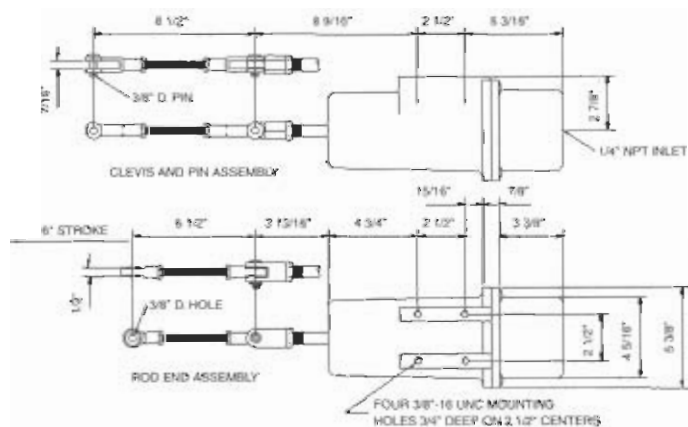
501-4



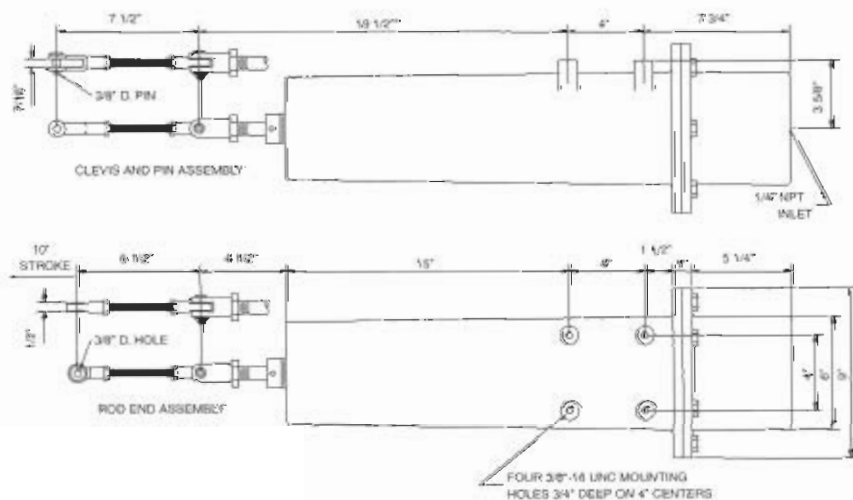
501-6



501-12



501-25

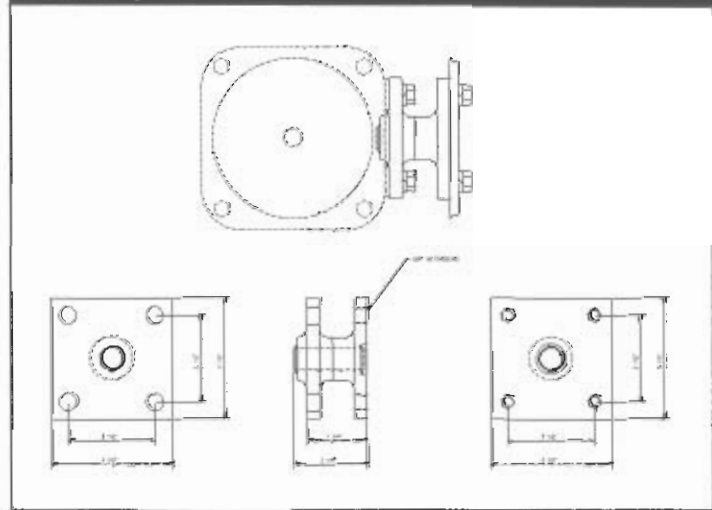




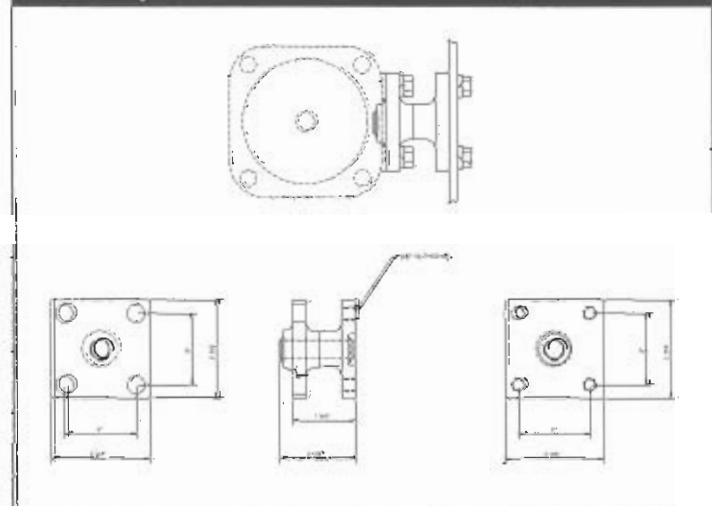
How to order:

Series _____ **501-4-315-SUR-P-SIL**
Model _____
Spring Range _____
 315-3 to 15 psig
 630-6 to 30 psig
Mounting _____
 SUR-Surface Mounting Bracket
 PVT-Pivot Mounting Bracket
Positioner _____
 O-Without Positioner
 P-With Top Mounted Positioner
Diaphragm Temperature Range _____
 Buna-N Diaphragm (Standard) -35°C to 120°C (-31°F to 248°F)
 Silicone Diaphragm -85°C to 260°C (-121°F to 500°F)
Connector Assembly
 Clevis & Pin Assembly (Standard)
 Rod End Assembly

Pivot mount for 501-12



Pivot Mount for 501-6



ENERFLEX

CONTROL PANEL

RC2000

COMPUTER CONTROL SYSTEM

INSTALLATION AND MAINTENANCE MANUAL

Revision 1

This manual applies to the manufacturer's operating system release **12.01A#** and earlier for the **RC2000** and **RC2000L** Control Systems. A one -digit number, representing the software version may follow the descriptor; however, different software versions do not impact this manual's validity.

This manual is based on engine-driven reciprocating compressors; however, it applies to **reciprocating and screw-type compressors** with either **engine or electric drivers**.

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WARNING! The information contained in this Document is the most current at the time of publication. It is provided as a guideline to assist Owners, Operators and Service Personnel with their installation and maintenance procedures on Enerflex Systems Ltd. units. Enerflex Systems Ltd. does not take responsibility for the use of its contents.



CAUTION! Compressing combustible or toxic gas can be very hazardous.

Take all reasonable precautions to protect personnel and property.

The owner and operator are responsible for site and compressor-unit safety systems, and must ensure safety procedures are in place and followed. Only trained personnel should enter, operate, or maintain the compressor unit and its associated equipment.

ABOUT THE RC2000

This modern microprocessor (computer) control system provides safe, accurate and reliable control of Enerflex compressor units.

Featuring an easy-to-use operator's panel (or remote actuation), the system includes automatic startup sequencing and three levels of stop sequencing.

Using built-in PID control, it provides automatic control of unit variables.

It has built-in historical and trend recording, and is capable of remote communication by land line, cellular telephone, or satellite, including auto-paging on alarm and/or shutdown.

ABOUT THIS MANUAL

Intent

This manual assists personnel installing and maintaining the RC2000 Control System. It should be used in conjunction with the *Unit Operating Manual* supplied with each unit and with its companion *RC2000 Operating Manual*. Other important information the operator needs includes:

- Unit Order*
- Unit Component Data*
- Instrument Data*
- Performance Curve(s)*
- Compressor Data Sheet(s)*
- Compressor Operator's Manual*
- Engine Operation and Maintenance Manual*

This manual is written for compressor units with all available options. It is likely that some features are not available on a particular unit, depending on installed options.

Where this manual refers to the "RC2000" Control System, it also applies to the "RC2000L" Control System. The RC2000L is effectively a physical and functional subset of the RC2000 Control System.

Writing Customs

Control panel key selections are shown inside marks like this:

press <START>.

Operator panel action or commands to the panel, and operating modes, are shown in small capital letters in a type style similar to the menu displayed:

choose PROGRAM.

If another document or a form is mentioned in the text, it is in *Italics* (slanted type):

Unit Operating Manual.

Updates

This manual contains the most updated information available at the time of publication.

If you require updated information, or wish to suggest changes or improvements, please contact Customer Support at (403) 236-6800.

Figures and Tables

Figures		
No.	Title	Sect. & Pg.
1-1	RC2000 Control System	1, 2
2-1	Typical Mounted Computer Module	2, 2
2-2	Computer Module Dimensions	2, 3
2-3	Typical Mounted Input Module	2, 4
2-4	Input Module Dimensions	2, 5
2-5	Typical Output Module Cabling	2, 6
2-7	Typical Output Module Mounting	2, 7
3-1	Input Module Connections	3, 1
3-2	Output Module Connections	3, 1
3-3	Computer Module Connections	3, 2
3-4	Computer Cable Termination Schedule	3, 3
3-5	Comm. Cable Termination Schedule	3, 4
3-6	Output Board Connections	3, 5
5-1	Power-Up Screen	5, 2
5-2	Opening Screen	5, 2
5-3	Input Module Initialization Screen	5, 2
5-4	Main Run Mode Screen	5, 2
6-1	Menu Screen	6, 1
6-2	Password Screen	6, 1
6-3	Program Menu Screen	6, 1
6-4	Typical Compressor Configuration Screen	6, 1
6-5	Typical EFX/BTB Options Screen	6, 2
6-6	System Configuration Screen	6, 4
6-7	Time Entry Screen	6, 4
6-8	Daylight Savings Screen	6, 4
6-9	Data Capture Screen	6, 5
6-10	Timers and Settings Screen	6, 5
6-11	Password Screen	6, 5
6-12	Typical Shutdowns and Alarms Screen	6, 6
6-13	Typical. Shutdowns and Alarms Entry Screen	6, 6
6-14	Status Menu Screen	6, 7
6-15	Typical Analog Inputs Screen	6, 7
6-16	Password Screen	6, 7
6-17	Discharge Stage 2 Pressure Calibration Screen	6, 7
6-18	Thermocouple Calibration Screen	6, 10
6-19	Temperature Entry Screen	6, 10

7-1	Status Menu Screen	7, 1
7-1	Shutdown List Screen	7, 1
7-1	Shutdown Screen	7, 1
9-1	Input Modules	9, 4
9-2	Output Module	9, 5
9-3	Control Panel	9, 5
Appendix A	Auxiliary Panel Wiring Diagrams	
Appendix B	Wiring Harness Hook-Up	
Appendix C	Block diagrams with Parts	

Tables		
No.	Title	Sect. & Pg.
5-1	Initialization Diagnostic Numbers	5, 1
6-1	Compressor Configuration Choices	6, 2
6-2	EFX/BTB Options	6, 3
9-1	RC2000 Troubleshooting Tips	9, 1 to 3

1. SYSTEM DESCRIPTION

1.1 Introduction

The RC2000 Control System (Figure 1–1) consists of a computer control panel, a number of input modules, and an output module (located in the auxiliary panel). The RC2000L Control System is a scaled-down version of the RC2000 Control System, and has the same layout, except the RC2000L has only one input module.

Control and instrument inputs and outputs (control devices) connect to standard input and output modules. These in turn are connected to the control panel by communication cables.

Maintenance personnel can set up, configure, calibrate and monitor the compressor unit (called “unit”) using the control panel’s keypad and display.

Data storage is provided, allowing for trending of operating variables and logging of events.

The control panel includes an on-board modem and communication ports to support auto-paging on alarm/shutdown, direct display and monitoring of the Altronic CP-95 ignition system (where applicable), and EFX PanelManager remote monitoring, trending, reporting, and control, as needed. Remote communications by land line and cellular telephone systems, satellite systems, and supervisory control and data acquisition (SCADA) systems are all supported.

The installation of the system consists of mounting each component in a suitable location, and then connecting the cables, wire harnesses (input devices), and output devices.

Power and signal to the ignition module, or electric drives, and to gas and fire detectors will also need to be connected (as applicable). Likewise, connection to the optional remote communications interface system may be required.

The system is then powered up and configured for site-specific operation. The installer performs a system check to ensure all end devices are calibrated and functioning correctly.

For more information on the RC2000 Control System, see the *RC2000 Operating Manual*.

1.2 Functions

The RC2000 is pre-programmed with configured options and I/O sets to provide site-specific monitoring, control, safety, and data capture functions, and to support remote communications functions. These are described in detail in the *RC2000 Operating Manual*.

1.3 Navigation and Password Access

System access to specific functions and menu selections is password protected, with three levels of protection implemented. Password access and Rc2000 Control Panel screen navigation are described in detail in the *RC2000 Operating Manual*.

Many of the maintenance functions require Level 2 password access (Level 1 being the highest). Password access for specific functions is identified in subsequent sections of this manual, with the description of each function.

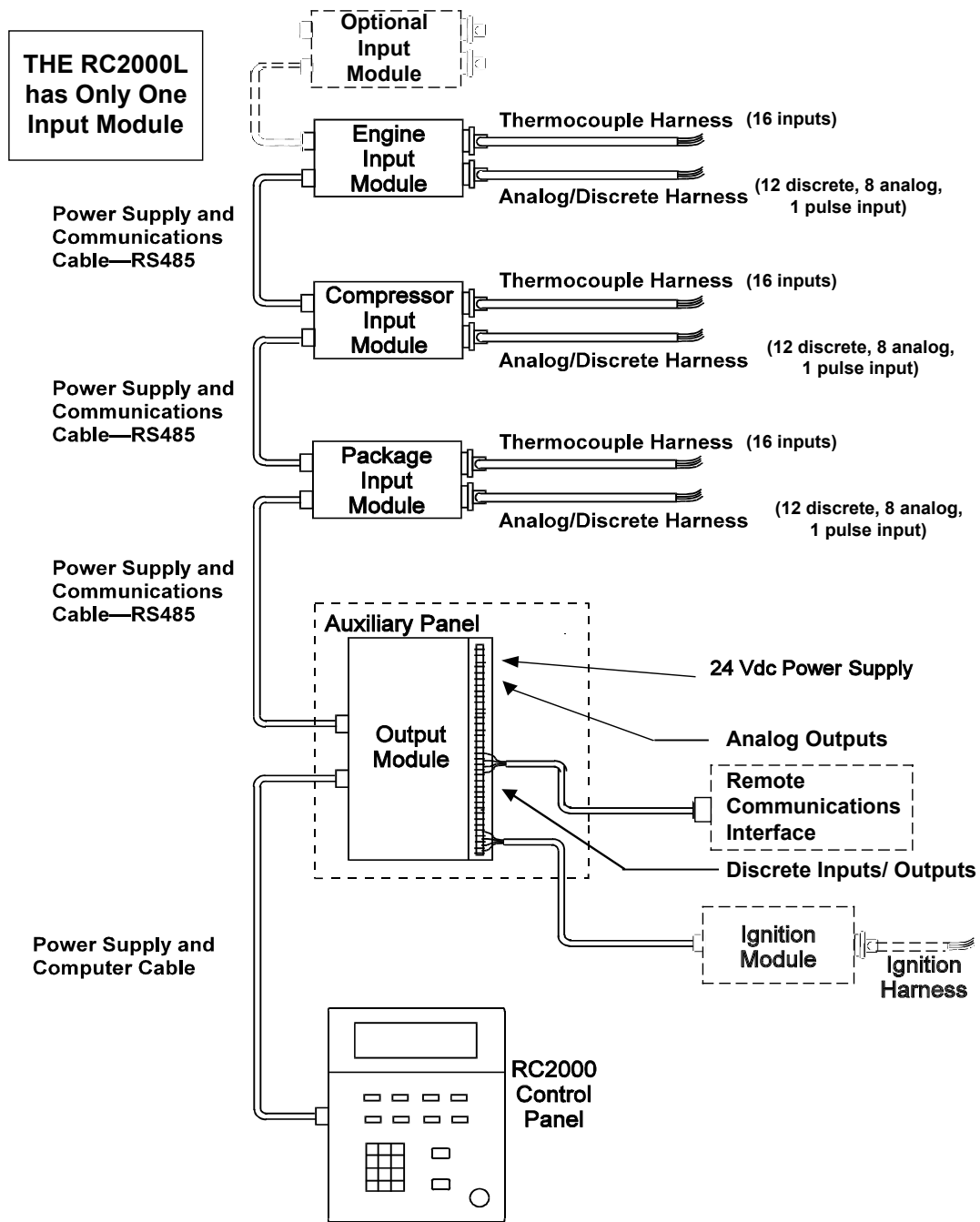


Figure 1-1
RC2000 Control System

Mounting System Components

2. MOUNTING SYSTEM COMPONENTS

The actual mounting locations are application specific. However, each module should be mounted in a strategic location that minimizes the length of end device harness runs. The locations chosen should be away from direct heat and not susceptible to direct fluid leakage. Placement requires that the modules are normally out of the way but are easily accessed if repair is required.

Ensure the wire harness lengths fit the mounting locations chosen.

The units should be mounted to a rigid structure, relatively free of excess vibration. The mounting bolts should be rubber isolated and fitted with shakeproof lockwashers.

Cables and cable harnesses should be run down at the point of connection as far as possible to minimize any chance of moisture ingress.

2.1 Control Panel

Figure 2–1 shows a typical panel mounting situation. Figure 2–2 shows the mounting dimensions of the control panel.

2.2 Input Modules

Figure 2–3 shows a typical module mounting situation. Figure 2–4 shows the mounting dimensions of the input module.

2.3 Output Module

The output module is delivered as a circuit board for mounting in the standard supplied auxiliary cabinet. The board is mounted in the cabinet, and ribbon connectors are plugged in. Terminations and cable connections are then completed (see Section 3).

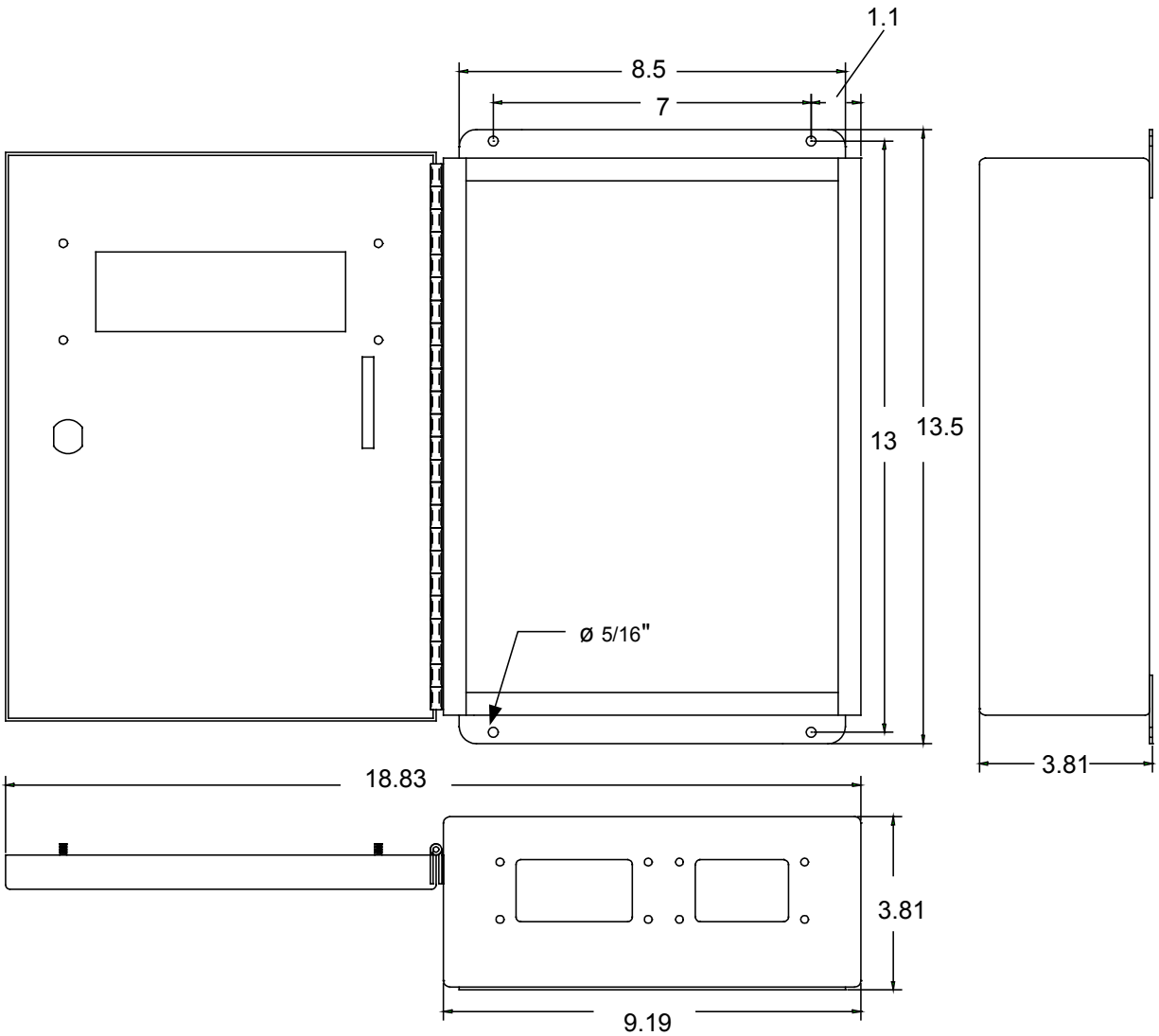
Figure 2–5 shows a typical mounted board and the cabling connection locations.

The output board is mounted on $\frac{3}{4}$ " standoffs using shakeproof star washers under the screw heads. It is located in the auxiliary panel as shown in Figure 2–6.



Note Rubber Vibration
Mounts and Rigid
Mounting Points

Figure 2-1
Typical Mounted Computer Module



All Dimensions in Inches

Figure 2-2
Computer Module Dimensions

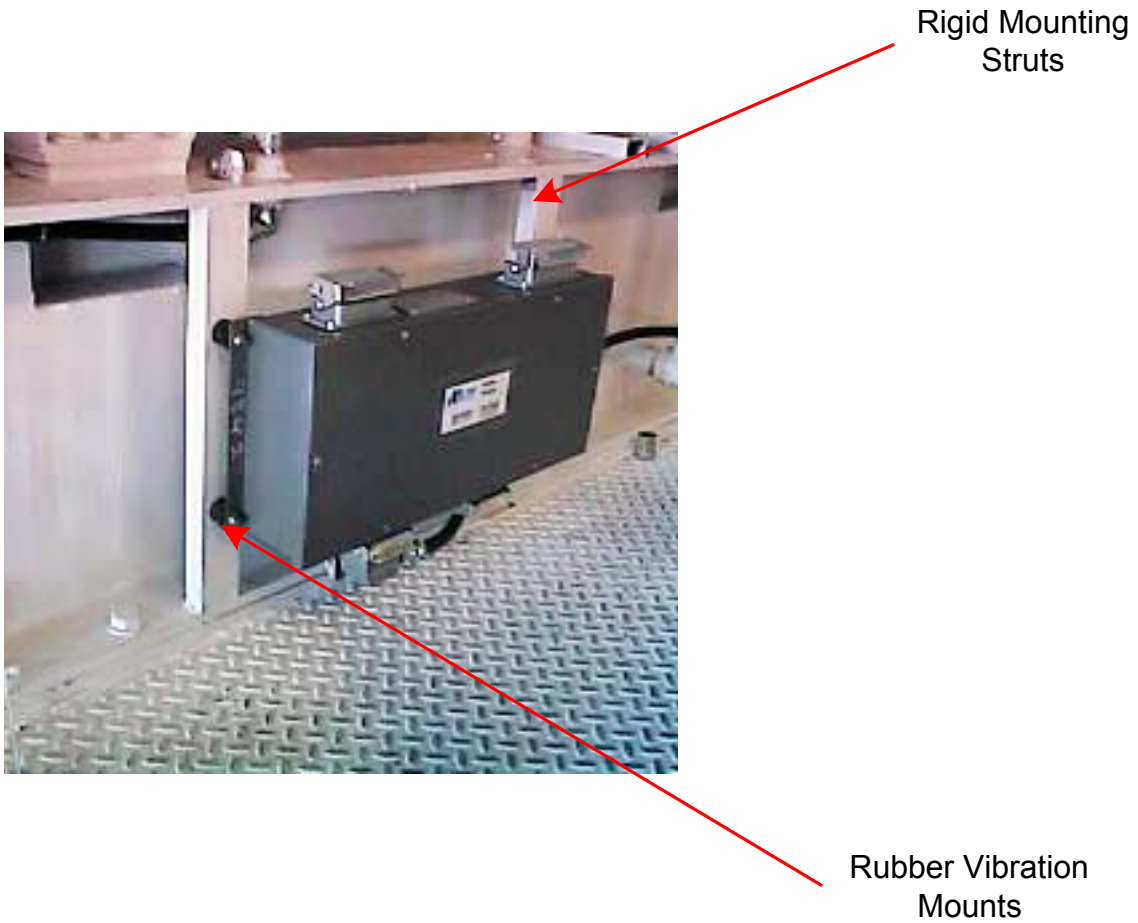


Figure 2-3
Typical Mounted Input Module

Mounting System Components

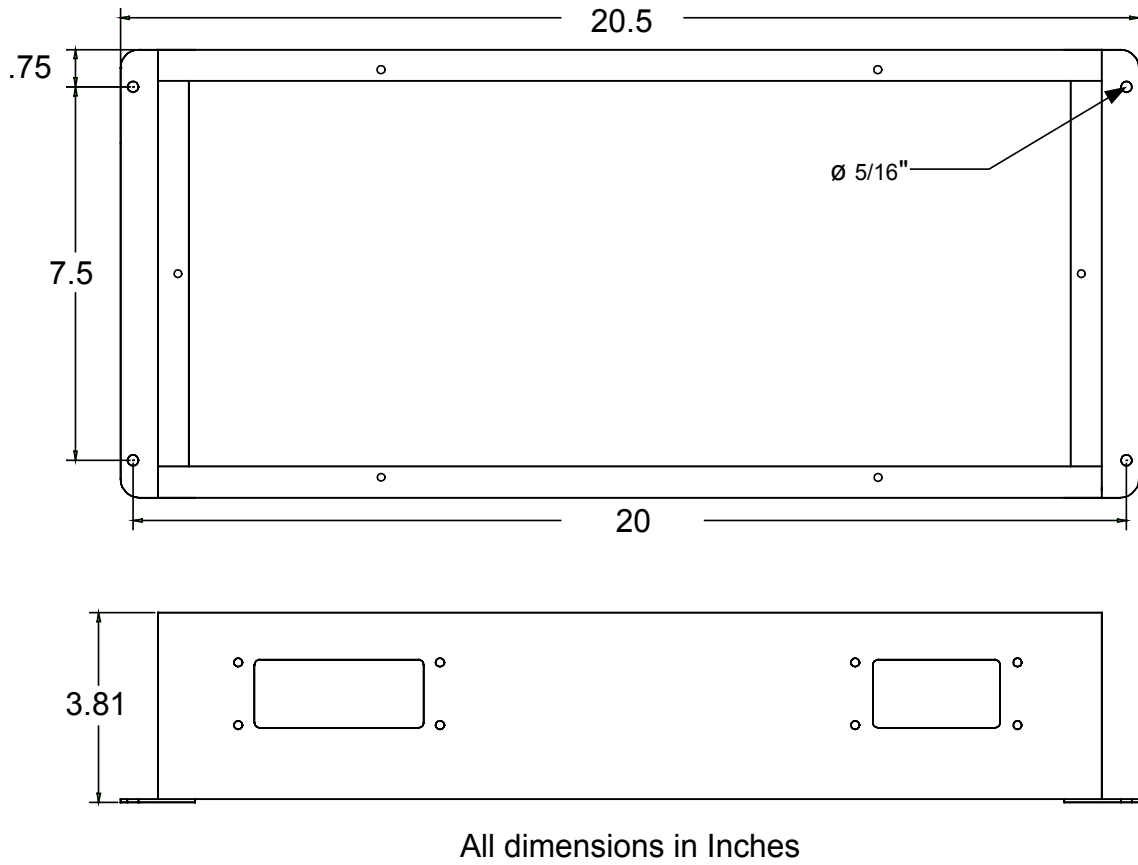
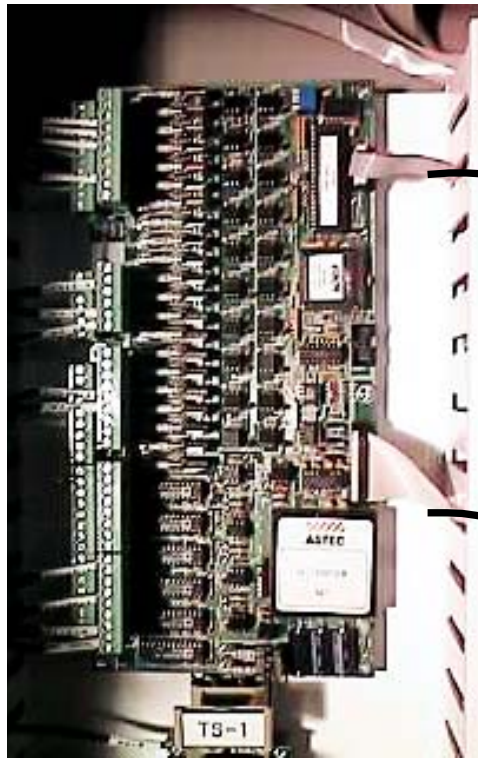
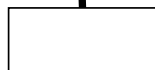


Figure 2-4
Input Module Dimensions

For Connections
See Section 3.



Cable to First Input Board
Ribbon Connection to
DB9 Connector (on Side
Wall of Auxiliary Panel)



Cable to Computer
Ribbon Connection to
DB25 Connector (on Side
Wall of Auxiliary Panel)



Figure 2-5
Typical Output Module Cabling

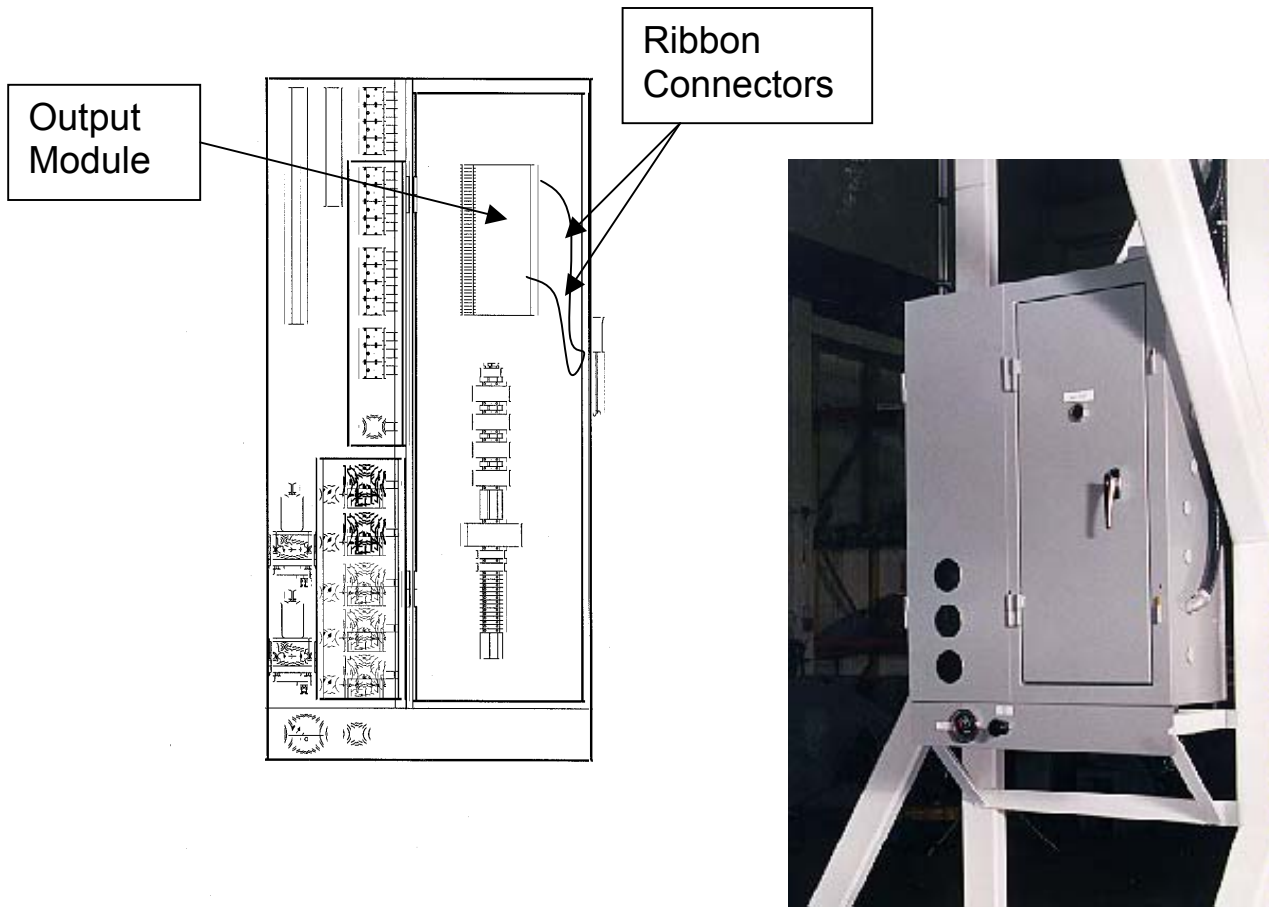


Figure 2-6
Typical Output Module Mounting

**3. POWER SUPPLY/
COMMUNICATIONS HOOK-UP**

3.1 Overview

Figure 1-1 shows the overall system connection layout. Serial communications cables interconnect input modules with the output module and with the control panel itself.

Standard thermocouple and analog/discrete input wire harnesses also plug into each input module and are pre-terminated according to harness type. Plug the harness connector into the receptacle with the matching DB connector type.

Figures 3-1 to 3-3 show which sockets the communications and computer cables are plugged into, and Sections 3.2 to 3.3 explain their termination schedules.

Separate ignition interface cable, remote communication wiring, customer output wiring, and power supply wiring connect into the output module as well. Section 3.4 lists these connections.

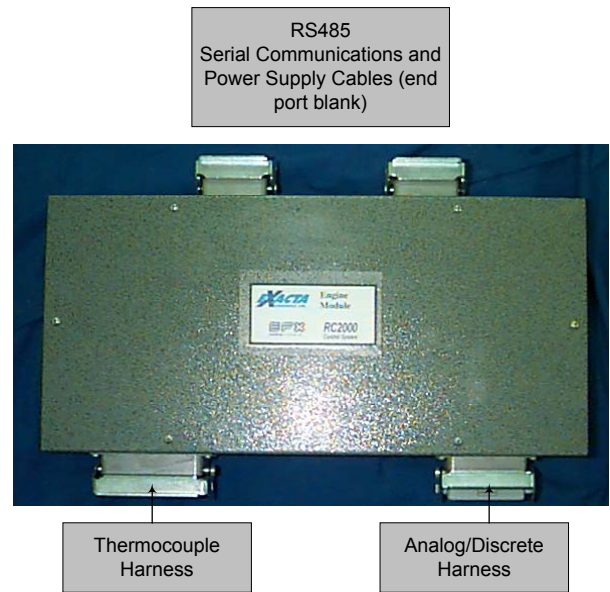


Figure 3-1
Input Module Connections

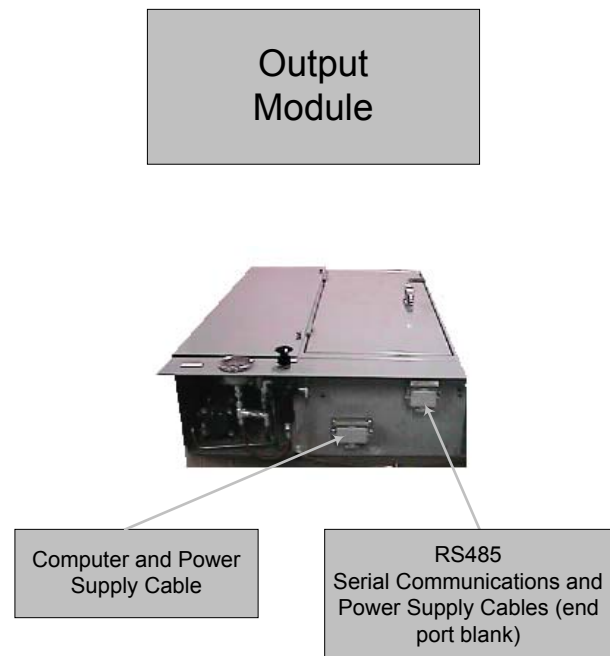


Figure 3-2
Output Module Connections

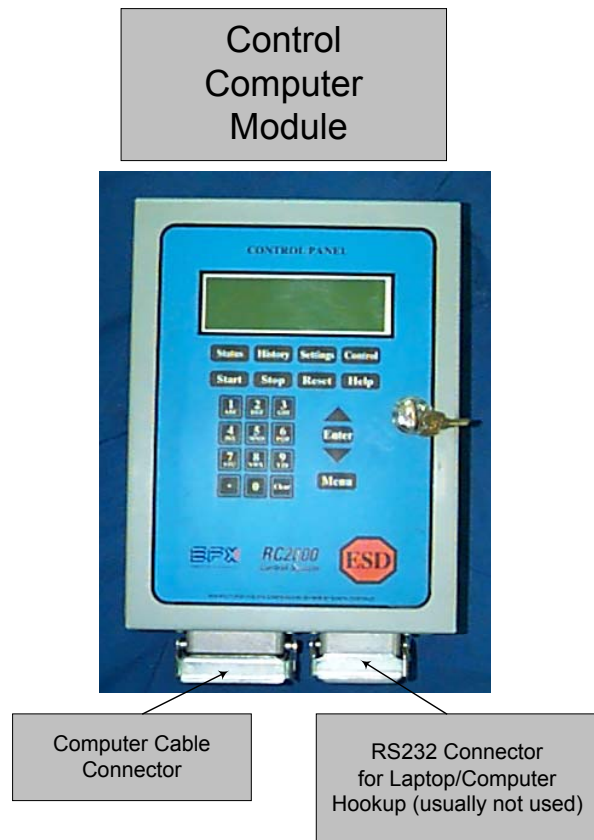


Figure 3-3
Computer Module Connections

3.2 Computer Cable

This pre-built RS485 serial cable connects the computer module and the output module. It plugs into the sockets shown in Figures 3-2 and 3-3.

The cable carries power and communications between the computer and the output module. It should be routed under the grating, and must be supported by cable clamps or ties, with a maximum spacing of 1 m.

Figure 3-4 provides a termination schedule for this cable.

3.3 Communications Cables

These pre-built RS485 serial cables interconnect each input module and the output module. They plug into the sockets shown in Figures 3-1 and 3-2.

The cables carry power and communications between the modules. They should be routed under the grating, and must be supported by cable clamps or ties, with a maximum spacing of 1 m.

These cables can plug into either of the RS485 ports on the input module.

Figure 3-5 provides a termination schedule for these cables.

PAIR NUMBER	DESCRIPTION	+/-	PIN #	COLOR
01	RS-485 COMMUNICATIONS	+	1	
		-	2	
		SH	6*	
02	24 VDC POWER SUPPLY	+	3	
		-	4	
		SH	7*	
03	24 VDC POWER SUPPLY	+	14	
		-	5	
		SH	7*	
04	RS-422 COMMUNICATIONS	+	8	
		-	9	
		SH	6*	
05	RS-422 COMMUNICATIONS	+	10	
		-	11	
		SH	25*	
06	TELEPHONE LINE	TIP	12	
		RING	13	
		SH	25*	
07	24VDC POWER SUPPLY	+	15	
		-	16	
		SH	7*	
08	RS-232 COMMUNICATIONS	TXD	17	
		RXD	18	
		SH	6*	
09	RS-232 COMMUNICATIONS	RTS	19	
		CTS	20	
		SH	6*	
10	RS-232 COMMUNICATIONS	DSR	21	
		GND	22	
		SH	25*	
11	RS-232 COMMUNICATIONS	DCD	23	
		DTR	24	
		SH	25*	

* SHIELD DRAIN WIRES TO BE CONNECTED AT ONE END OF CABLE ONLY.

Figure 3-4
Computer Cable Termination Schedule

PAIR NUMBER	DESCRIPTION	+/-	PIN #	COLOR
01	RS-485 COMMUNICATIONS	+	1	RED
		-	2	CLR
		SH	6*	
02	24 VDC POWER SUPPLY	+	3	WHITE
		-	4	BLACK
		SH	7*	
03	24 VDC POWER SUPPLY	+	8	GREEN
		-	5	BLACK
		SH	9*	

* SHIELD DRAIN WIRES TO BE CONNECTED AT ONE END OF CABLE ONLY.

Figure 3-5
Communications Cable Termination Schedule

3.4 Output Board Connections

Figure 3-6 lists all the connection points to the output board at the unit end.

Appendix A contains typical auxiliary panel wiring diagrams.

Output Board		
#	Output Number/Description	
1	-24V Input	Supply
2	Earth	
3	+24 Input	
4	Earth	
5	A Out 6+	Analog Outputs
6	A Out 6-	
7	A Out 5+	
8	A Out 5-	
9	A Out 4+	
10	A Out 4-	
11	A Out 3+	
12	A Out 3-	
13	A Out 2+	
14	A Out 2-	
15	A Out 1+	
16	A Out 1-	
41	Power Down +	Power Down
42	Power Down -	
31	485+	Modbus
32	485-	
17	Tip	Modem
18	Ring	
25	RXD	Communi- cations
26	GND	
23	DTR	
24	DCD	
21	RTS	
22	DRS	
19	TXD	
20	CTS	
29	422 RX+	
30	422 RX -	
27	422 TX+	
28	422 TX-	
33	IN 4+	Discrete Inputs
34	IN 4-	
35	IN 3+	
36	IN 3-	
37	IN 2+	
38	IN 2-	
39	IN 1+	
40	IN 1-	

Output Board		
#	Output Number/Description	
43	OUT 20+	Discrete Outputs
44	OUT 20-	
45	OUT 19+	
46	OUT 19-	
47	OUT 18+	
48	OUT 18-	
49	OUT 17+	
50	OUT 17-	
51	OUT 16+	
52	OUT 16-	
53	OUT 15+	
54	OUT 15-	
55	OUT 14+	
56	OUT 14-	
57	OUT 13+	
58	OUT 13-	
59	OUT 12+	
60	OUT 12-	
61	OUT 11+	
62	OUT 11-	
63	OUT 10+	
64	OUT 10-	
65	OUT 9+	
66	OUT 9-	
67	OUT 8+	
68	OUT 8-	
69	OUT 7+	
70	OUT 7-	
71	OUT 6+	
72	OUT 6-	
73	OUT 5+	
74	OUT 5-	
75	OUT 4+	
76	OUT 4-	
77	OUT 3+	
78	OUT 3-	
79	OUT 2+	
80	OUT 2-	
81	IGN OUT+ (Note 1)	Ignition
82	IGN OUT- (Note 1)	
83	IGN IN+ (Ground Lead)	
84	IGN IN- Ignition (Note 1)	

Note 1 Terminals 81, 82, 84 are fused together. The ignition ground lead is connected into terminal 83 and then wired out to ground through 81, 82, and 84.

Note 2 Communication to the CPU-95 ignition system (where applicable) is provided at the RS485 terminals.

Note 3 Terminals 17 and 18 provide a link for paging and remote communications (phone line, cellular phone, satellite). Terminals 19 to 26 are available for RS232 links or alternate satellite hookup if otherwise unused.

Figure 3-6
Output Board Connections

4. WIRING HARNESS HOOK-UP

4.1 Overview

A standardized analog/discrete input wire harness and a thermocouple input wire harness has been defined for each input module. These harnesses are pre-built using Phoenix connectors to allow easy installation.

The wire harnesses should be routed, connected and wired on the compressor, engine and package following standard EFX/BTB installation practices, and in agreement with the input device connection instructions.

4.2 Analog/Discrete Harness

These pre-built wire harnesses connect each input module to various end devices for the compressor, engine or package (depending

on the module). The end devices terminate in a Phoenix connector that plugs into the input module sockets shown in Figure 3–1.

For this dual connector, the upper set of pins (closest to the module cover) is for the analog inputs. The lower set is for the discrete inputs.

See Appendix B for details about these wire harnesses and their connections.

4.3 Thermocouple Harness

These pre-built wire harnesses connect each input module to various thermocouples for the compressor, engine, or package (depending on the module). The end devices terminate in a Phoenix connector that plugs into the input module sockets shown in Figure 3–1.

See Appendix B for details about these wire harnesses and their connections.

System Power-Up and Initialization

5. SYSTEM POWER-UP AND INITIALIZATION

CAUTION
<p>Most of the components contain complex electronic equipment.</p> <p>Due care and attention must be given to handling and connection to avoid potential damage.</p>

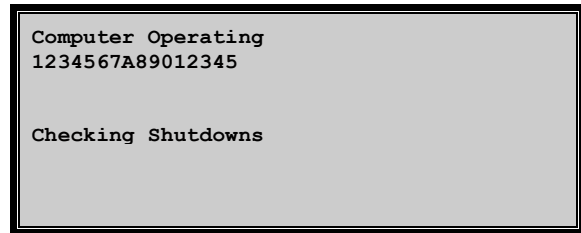


Figure 5-1
Power-Up Screen

There is a sequence of numbers and letters below the “Computer Operating” message on this screen, which indicate that a specific operation has been completed. If a fault occurs, the item following the last one shown is faulty, and the control panel will require internal repair. The meanings of these numbers are shown in Table 5-1.

**Table 5-1
Initialization Diagnostic Numbers**

Number	Meaning
1	Initialize clock
2	Initialize outputs
3	Power-up keyboard detection
4	Memory check
5	Initialize modules
6	Initialize counters
7	Initialize RS232 ports
A	Initialize messages and compressor variables
8	Initialize input control
9	Initialize analog inputs
0	Initialize state engine
1	Initialize modbus communications
2	Initialize BTB options and analog setpoints
3	Update compressor setpoints
4	Check and initialize shutdowns
5	Initialize interrupts

5.1 System Power-Up

The RC2000 computer control system **should not be powered up unless all connections to the output module are complete, and the main cable between the output module and the control panel is properly plugged in.**

The input modules do not need to be connected with any of their harnesses or cables to test the computer and output module.

Under no circumstances should any of the connecting harnesses be removed or connected with the power on. **Always power down the system before connecting/disconnecting any of the harnesses.**

5.2 System Initialization

When the system is first powered up, a sequence of four screens is presented.

First, the POWER-UP screen (Figure 5-1) will be displayed, for what should be about 1 second. If there is an internal diagnostic fault, the computer will stop on this screen.

System Power-Up and Initialization

If everything is OK, and no faults occur, this will be followed for a few seconds by the OPENING screen (Figure 5–2).

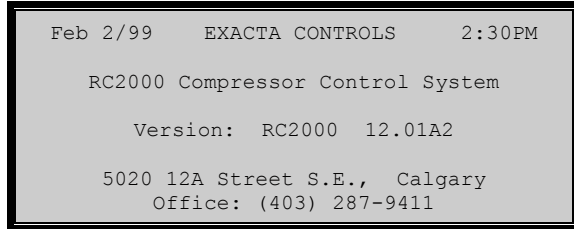


Figure 5–2
Opening Screen

This screen displays the name of the system, the software version, along with the control system manufacturer address, and the current date and time (these may need to be reset).

Next, the INPUT MODULE INITIALIZATION screen (Figure 5–3) will be displayed.

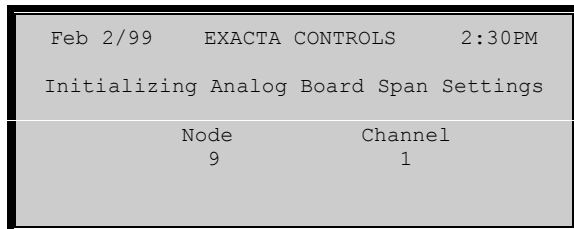


Figure 5–3
Input Module Initialization Screen

This screen may show for up to 30 seconds while the span settings are sent to each input module. The nodes and channels will cycle rapidly through their identification numbers.

Finally, the MAIN RUN MODE screen (Figure 5–4) will be displayed. For an explanation of this screen, see the *RC2000 Operating Manual*.

Feb 2/99	Run Mode	9:40 PM	
Remote Stop			
Suction	Dischl(1)	Dischl(2)	RPM
0kpa	-1kpa	0kpa	0
Shutdowns:	2		
Alarms:	0	Volts	Manifold Hour
Faults:	0	23.5v	-0.1inHg 0

Figure 5–4
Main Run Mode Screen

6. SYSTEM CONFIGURATION AND CALIBRATION

Before checking or changing configurations and settings, it would be advisable to read the *RC2000 Operating Manual* to become familiar with the system and understand screen navigation, passwords, and the functions of the various keys. This information is not included in this manual.

Before the RC2000 can be used to actually control a compressor, there are many settings, options and setpoints that have to be configured. Use the procedures in Sections 6.1 to 6.5 to do this.

Some screens may appear different than illustrated if a screw compressor or electric drive is involved.

6.1 Setting Options and Parameters

- (a) Once the system is displaying any RUN MODE screen (See Section 5), press the <MENU> key.
- (b) The MENU screen (Figure 6–1) will be displayed.

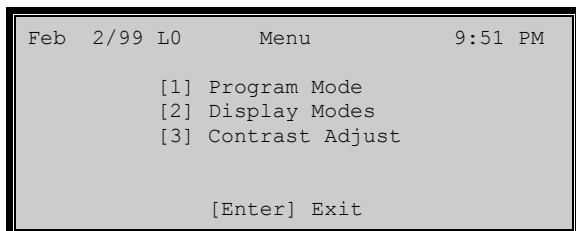


Figure 6–1
Menu Screen

- (c) Choose [1], PROGRAM MODE.
(The other two choices are explained in the *RC2000 Operating Manual*, Section 4.10.)

- (d) The PASSWORD screen (Figure 6–2) will be displayed.

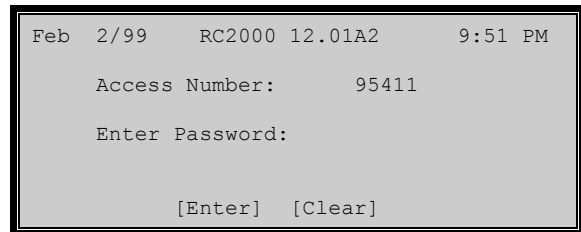


Figure 6–2
Password Screen

- (e) Enter your password (this requires Level 2) to access the PROGRAM MENU.
- (f) The PROGRAM MENU screen (Figure 6–3) will be displayed.

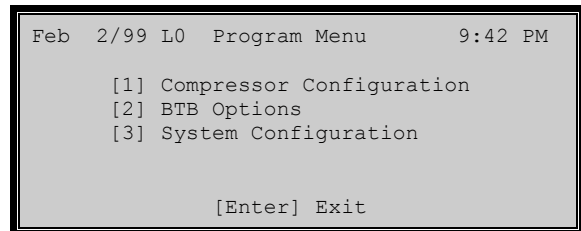


Figure 6–3
Program Menu Screen

6.1.1 Compressor Configuration

- (a) Choose [1] from the PROGRAM MENU.
- (b) The first of two COMPRESSOR CONFIGURATION screen (Figure 6–4) will be displayed.

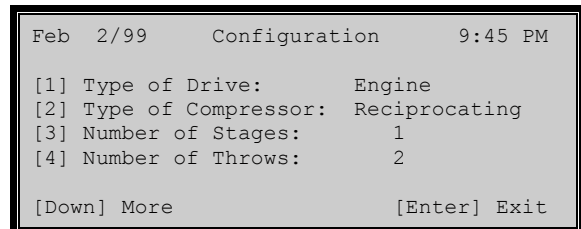


Figure 6–4
Typical Compressor Configuration Screen

Use the ▼ and ▲ panel marks to move between the configuration screens.

The settings and choices on these screens must be set up according to the *Unit Order* for the particular unit.

They require picking the appropriate number, toggling to the correct choice by pushing the number, or keying in a number and pushing <ENTER>. Table 6-1 shows the choices available.

**Table 6-1
Compressor Configuration Choices**

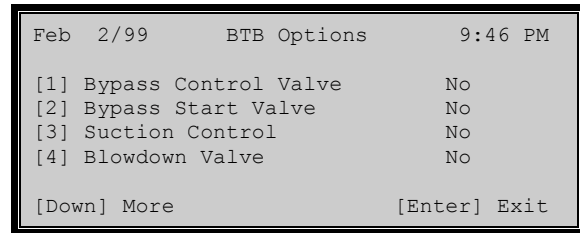
Item	Option Description	Choices	Application Description
[1]	Type of Drive	[1] [2]	Engine Electric*
[2]	Type of Compressor	[1] [2] [3]	Recip Low (RC2000L) Screw Recip Full (RC2000)
[3]	Number of Stages	[1] [2] [3]	Recip 1 Stage Recip 2 Stage Recip 3 Stage
[4]	Number of Throws	[1] [2]	Recip 2 Throw Recip 4 Throw
[1]	Engine Pyrometer	Yes/No	Engine
[2]	Number of Cylinders	Enter #	Engine
[3]	RPM Pulses per Rev.	Enter #	Engine (typ.)

* Engine related choices N/A with electric drives.

- (c) Press <ENTER> to lock in any changes and return to the PROGRAM MENU.

6.1.2 EFX/BTB Options

- (a) Choose [2] from the PROGRAM MENU.
- (b) The first of several EFX/BTB OPTIONS screens (Figure 6-5) will be displayed.



**Figure 6-5
Typical EFX/BTB Options Screen**

Use the ▼ and ▲ panel marks to move between the Options screens.

The choices on these screens must be set up according to the *Unit Order* for the particular unit.

Select the option number as shown on the screen to change the option setting.

Table 6-2 shows the choices available.

- (c) Press <ENTER> to lock in any changes and return to the PROGRAM MENU.

**Table 6–2
EFX/BTB Options**

Option Description	Choices	Application (See note 1)
Bypass Control Valve	Yes/No	a, b, c, d, e, f
Slide Valve Control	Yes/No	e, f
Comp Oil Circ Valve	Yes/No	e, f
Bypass Start Valve	Yes/No	a, b, c, d, e
Suction Control	Yes/No	a, b, c, d, e, f
Motor Current	Yes/No	N/A
Motor Speed Control	Yes/No	c, d, f
Speed Control	Yes/No	b, e
Blowdown Valve	Yes/No	a, b, c, d, e, f
Louvre #1 Control	Yes/No	b, d, e, f
Louver #2 Control	Yes/No	a, b, c, d, e, f
Engine Det. & AFM	Yes/No	a,
Engine Detonation	Discrete/Analog	a,
Engine Detonation	Yes/No	b, e
2nd Stage Dump	Yes/No	b, d,
Sep Fuel Level	Yes/No	a, b, e
Inlet ESD Valve	Yes/No	a, b, c, d, e, f
Suct Valve closed	Yes/No	a, c,
Disch ESD Valve	Yes/No	a, b, c, d, e, f
Utility ESD Valve	Yes/No	a, b, c, d, e, f
Gas Detection	Yes/No	a, b, c, d, e, f
Gas Detection	Discrete/Analog	b, d, e, f
H2S Detection	Yes/No	a, b, c, d, e, f
H2S Detection	Discrete/Analog	b, d
UV Flame Detection	Yes/No	a, c,
Blowcase	Yes/No	a, b, c, d, e, f
Vibration Reset	Yes/No	b, d, e, f
Sep Oil Level High	Yes/No	e, f
BTB Model	B Series/C Series	N/A
Suct Filter Diff Press	Yes/No	a, c,
Enclosure Temp	Yes/No	N/A
Sour Unit	Yes/No	a, b, c, d
Comp Vibrations	Discrete/Analog	d, e, f
Mot & Comp Vibrations	Discrete/Analog	c,
Eng & Comp Vibrations	Discrete/Analog	a,
Engine Vibrations	Discrete/Analog	b,
Speed Increaser	Yes/No	e, f
Eng Exhaust Temp	Yes/No	a,
Fuel/Inst Gas Press	Yes/No	a, c, e, f
Engine Oil Pressure	Discrete/Analog	a, b, e
Eng Manif Air Pressure	Discrete/Analog	a, b, e
Back Pressure Valve	Yes, No	N/A
Comp Oil Pressure	Discrete/Analog	a, c
Slugcatcher	Yes/No	a, c

Note 1

a = Engine Drive Recip. Compressor, RC2000
b = Engine Drive Recip. Compressor, RC2000L
c = Electric Drive Recip. Compressor, RC2000
d = Electric Drive Recip. Compressor, RC2000L
e = Engine Drive Screw Compressor, RC2000L
f = Electric Drive Screw Compressor, RC2000L

6.1.3 System Configuration

This is normally factory preset. If settings are lost, or changes must be made, only a factory representative of EFX/BTB should do them. The exceptions to this are Set Clock and Data Capture.

To set Clock:

- (a) Choose [1] from the PROGRAM MENU.
- (b) The SYSTEM CONFIGURATION screen (Figure 6–6) will be displayed.

```
Feb 11/99      System Config      7:52 PM
[1] Set Clock      [5] Site Information
[2] Set Up RS232   [6] Change Password
[3] Set Up RS485   [7] Communications
[4] Set Up Modem   [8] Data Capture
[Enter] Exit
```

Figure 6–6
System Configuration Screen

- (c) Choose [1], SET CLOCK.
- (d) The TIME ENTRY screen (Figure 6–7) will be displayed.

```
Feb 11/99      Set Clock      7:52 PM
Enter Date [MMDDYY]: 0      Feb 11/99
Enter Time [HHMMSS]:      7:52 PM
[Enter] [Clear] [Dn]Left [Up]Right
```

Figure 6–7
Time Entry Screen

This screen will automatically show the currently set time and date.

- (e) **If the date is correct**, press <ENTER>, and the system will advance to Step (g).

If the date is wrong, re-enter it in MMDDYY format (use zeros where needed), by typing over the numbers shown.

- (f) When the date is entered correctly, press <ENTER>, and the cursor will move to the time line.
- (g) **If the time is correct**, press <ENTER>, and the system will advance to Step (h).

If the time is wrong, re-enter it in HHMMSS format (use zeros where needed), by typing over the numbers shown.

- (h) When the time is entered correctly, press <ENTER>, and the DAYLIGHT SAVINGS screen (Figure 6–8) will be displayed.

```
Feb 11/99      Set Clock      7:52 PM
Enter Date [MMDDYY]: 0      Feb 11/99
Enter Time [HHMMSS]: 0      7:52 PM
Use Day Light Savings Time: [1] Yes
                             [2] No
```

Figure 6–8
Daylight Savings Screen

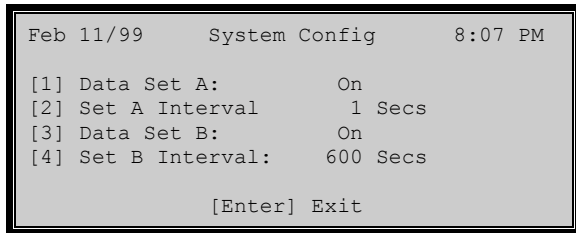
- (i) **If daylight savings time is wanted**, choose [1], YES, and the system will enable daylight savings and revert to the SYSTEM SETUP MENU.

If the daylight savings time is not wanted, choose [2], NO, and the system will revert to the SYSTEM CONFIGURATION MENU.

The spring/fall switch over is automated once daylight savings time is set. The clock will **not have to be reset** on the appropriate dates. This is set up for the Northern Hemisphere only. In the Southern Hemisphere, leave daylight savings off and change the times manually every spring and fall.

To Reset Data Capture:

- (j) Choose [8], DATA CAPTURE.
The DATA CAPTURE screen (Figure 6–9) will be displayed.



**Figure 6–9
Data Capture Screen**

Data set A is the data captured before each shutdown. Its default is at 1-second intervals. Data is captured for 40 intervals before shutdown for each data point.

Data Set B is the general data capture. Its default is normally 10 minutes (600 seconds). 1400 records are captured for each data point.

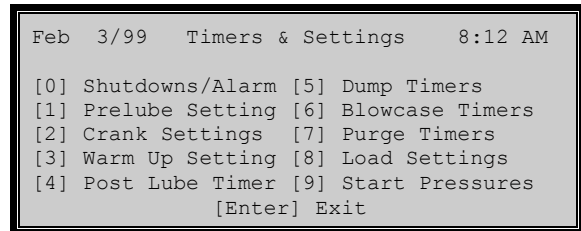
- (k) Options [1] and [3] are toggles that turn the data ON/OFF each time the number is chosen.
- (l) Options [2] and [4] allow you to type in the value desired (up to 99999).
- (m) Press <ENTER> twice to lock in any changes and return to the PROGRAM MENU.

6.2 Adjusting Setpoints

The choices on these screens must be set up according to the *Controls List Worksheet* or *Instrument Data Sheet* supplied for the particular unit.

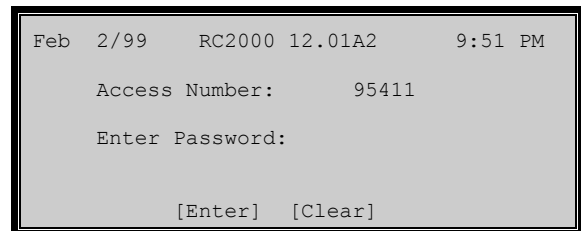
The system is preconfigured with default settings. The user will need to check and change these settings as needed.

- (a) Once the system is displaying any Run Mode screen (See Section 6), press the <SETTINGS> key.
- (b) The TIMERS AND SETTINGS screen (Figure 6–10) will be displayed.



**Figure 6–10
Timers and Settings Screen**

- (c) Choose [0] (or another desired TIMERS AND SETTINGS option by pressing the corresponding number).
- (d) The PASSWORD screen (Figure 6–11) will be displayed (unless a password was entered previously and is still resident for this level of access).



**Figure 6–11
Password Screen**

- (e) Enter your password (this requires Level 2) to access the TIMERS AND SETTINGS.
- (f) If you pushed [0], the first of a series of SHUTDOWN & ALARMS screens (Figure 6–12) will be displayed. This screen shows four settings. (If you entered another choice the first screen for that choice will appear.)

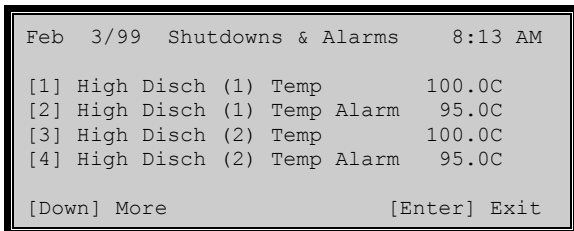


Figure 6–12
Typical Shutdown and Alarms Screen

Use the ▼ and ▲ panel marks to move through these screens, each displaying four settings (some choices only have one screen and no scrolling prompts will appear at the bottom).

- (g) Chose the setting you want to adjust/check by pushing its number key.
- (h) The screen will highlight the choice you make (Figure 6–13), and you can now enter the value for the one item. (Note that some of the choices are simple toggles and will not show a number entry screen.)

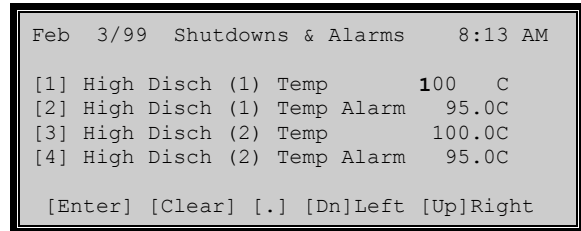


Figure 6–13
Typical Shutdown and Alarms Entry Screen

- (i) Push <ENTER> once to set the value.
- (j) Continue the process by choosing another setting, or moving to another screen using the ▼ or ▲ keys, and choosing.
- (k) When the last value for the group is set, push <ENTER> twice to set the value and return to the TIMERS AND SETTINGS screen (where you can make the next choice).

6.3 Setting End Device Spans

The choices on these screens must be set up according to the *Controls List Worksheet* or *Instrument Data Sheet* supplied for the particular unit.

The system is preconfigured with default settings. The user will need to check and change these settings as needed.

- (a) Once the system is displaying any RUN MODE screen (See Section 6), press the <STATUS> key.
- (b) The STATUS screen (Figure 6–14) will be displayed.

```

Feb  3/99      Status Menu      10:15 AM
[1] Shutdowns: 2   [5] Analog Inputs
[2] Alarms:      0   [6] Discrete Inputs
[3] Faults:      0   [7] Analog Outputs
[4] Shutdown List [8] Discrete Outputs

                [Enter] Exit

```

**Figure 6–14
Status Screen**

```

Feb  2/99      RC2000 12.01A2      9:51 PM
Access Number:      95411
Enter Password:

                [Enter] [Clear]

```

**Figure 6–16
Password Screen**

- (c) Choose [5] ANALOG INPUTS by pressing the corresponding number.
- (d) The first of several ANALOG INPUTS screens (Figure 6–15) will be displayed.

- (g) Enter your password (this requires Level 2) to access.
- (h) If you pushed [3] on the second screen, the DISCHARGE STAGE 2 PRESSURE screen (Figure 6–17) will be displayed.

```

Feb  3/99      Analog Inputs      10:16 AM
[1] Disch (1) Temp      23.3C
[2] Disch (2) Temp      18.3C
[3] Disch (3) Temp      3276C
[4] Disch (4) Temp      3276C

[Down] More                [Enter] Exit

```

**Figure 6–15
Typical Analog Inputs Screen**

```

Disch Stg 2 Press

Current Value:          0 kpa
[1] High Span:         10000 kpa
[2] Low Span:          0 kpa
[3] Calibrate 4 ma Point
[4] Calibrate 20 ma Point
[5] Force Input

```

**Figure 6–17
Discharge Stage 2 Pressure
Calibration Screen**

Use the ▼ and ▲ panel marks to move through these screens, each displaying four settings (some choices only have one screen and no scrolling prompts will appear at the bottom).

- (e) Choose the setting you want to adjust/check by pushing its number key.
- (f) The system will display the PASSWORD screen (Figure 6–16).

This screen allows you to set up the particular input, choosing [1] and [2] to set the high low and high spans. (It is also used for calibration, see Sections 6.4 and 6.5)

The control panel may prompt THE VALUE IS [1] POSITIVE, [2] NEGATIVE. Make the appropriate choice with the numeric keypad.

- (i) Push <ENTER> once to set the values.
- (j) Continue the process by choosing another setting, or moving to another screen using the ▼ or ▲ keys, and choosing.

- (k) When the last value for the group is set, push <ENTER> twice to set the value and return to the STATUS screen (where you can make the next choice).

NOTE: These screens allow the user to force input values. Exercise due caution as inputs are effectively disabled for shutdown and alarm when in a forced state.

DO NOT LEAVE AN INPUT IN A FORCED STATE ON AN UNATTENDED UNIT.

If an input is forced, it is identified by “unfreeze” when selected again.

6.4 Transmitter Calibration

The following procedures are used to calibrate 4 to 20 mA transmitters at the system end. There are two methods of calibration. The first method calibrates the RC2000 and end device as separate items. The second method calibrates the end device and input board simultaneously. The disadvantage of the second method is that a bench-calibrated 4 to 20 mA transmitter would have to be recalibrated when it is put on the unit.

6.4.1 Separate End-Device Calibration Technique

RC2000 Calibration:

- (a) Complete Steps (a) to (g) of Section 6.3 above, until the CALIBRATION screen (Figure 6–24) for the selected 4 to 20 mA analog input is displayed.
- (b) Ensure span settings are correct. If not, complete Section 6.3.

- (c) Connect a calibrator to the appropriate analog input channel, and set the calibrator for 4 mA.

The screen should show the low span setting as the current value in engineering units.

- (d) If not choose [3] to perform a calibration.
- (e) The control panel will prompt CALIBRATE 4 MA POINT [1] YES, [2] NO.
- (f) Choose [2] to exit and return to the CALIBRATION screen.
- (g) If not choose [1] to proceed with the 4 mA point calibration.
- (h) When the reading has stabilized, press <ENTER> to accept the calibration.
- (i) Set the calibrator to 20 mA.
The screen should show the high span setting as the current value.
- (j) If not, choose [4] to perform the calibration of the 20 mA point.
- (k) The control panel will prompt CALIBRATE 20 MA POINT [1] YES, [2] NO.
- (l) Choose [2] to exit and return to the CALIBRATION screen.
- (m) Choose [1] to proceed with the 20 mA point calibration.
- (n) When the reading has stabilized, press <ENTER> to accept the calibration.
- (o) The calibration of the input board is now complete. **Steps (p) to (t) following can be done if the device was not bench tested. If it was, it would be wise to check the settings.**

End Device Calibration:

- (p) Re-attach the end device to the channel and set the input on the device (gas, H₂S, pressure, etc.) to be equal to the low span setting.
- (q) Use the zero span screw on the end device to make the device read as close as possible to the low span.
- (r) Now set the input on the device to be equal to the high span setting. (On a pressure transmitter this means using a hand pump to pressurize the transmitter. On a gas detector this may mean applying test gas to get the desired LEL.)
- (s) Use the range screw adjust on the end device to make the current reading as close as possible to the high span setting.
- (t) Re-test both the low, high and midrange of the end device to ensure proper operation, and repeat (p) to (t) if required.
- (e) If not choose [3] to perform a calibration.
- (f) The control panel will prompt CALIBRATE 4 MA POINT [1] YES, [2] NO.
- (g) Choose [2] to exit and return to the CALIBRATION screen, if you decide you do not want to calibrate.
- (h) Choose [1] to proceed with the 4 mA point calibration.
- (i) When the reading has stabilized at 4 mA, press <ENTER> to accept the calibration.
- (j) Now apply the high span input (hand pump/test gas, etc.) and use the range screw to set the current to 20 mA. The screen should show the high span setting as the current value.
- (k) If not, choose [4] to perform the calibration of the 20 mA point.
- (l) The control panel will prompt CALIBRATE 20 MA POINT [1] YES, [2] NO.

6.4.2 Simultaneous End-Device Calibration Technique

- (a) Complete Steps (a) to (g) of Section 6.3 above, until the CALIBRATION screen (Figure 6–17) for the selected 4 to 20 mA analog input is displayed.
 - (b) Ensure span settings are correct. If not, complete Section 6.3.
 - (c) Connect a current meter in line with the appropriate analog input channel.
 - (d) Apply the low span input and then use the zero screw to make the current equal to 4 mA.
The screen should show the low span setting as the current value. Note that the reading on the screen is in engineering units, not mA.
 - (m) Choose [2] to exit and return to the CALIBRATION screen, if you decide you do not want to calibrate.
 - (n) Choose [1] to proceed with the 20 mA point calibration.
 - (o) When the reading has stabilized, press <ENTER> to accept the calibration.
 - (p) The calibration of the input is now complete.
- Forcing the slide valve output is different than a regular PID.** The [2] key does not work and the ▼ and ▲ panel marks are used instead. Pressing the ▲ key causes the load solenoid to come on, and pressing the ▼ key forces the unload solenoid to come on. The solenoids remain energized for as long as its key is held down.

The slide valve is calibrated at 0% and 100% points, like a normal 4 to 20 mA device. The end-device motion is forced by using prelube pump pressure and using the ▼ and ▲ panel marks, or by applying reduced air pressure to the hydraulic loop. The output should be 0% at the 4 mA open position and 100% at the 20 mA closed position.

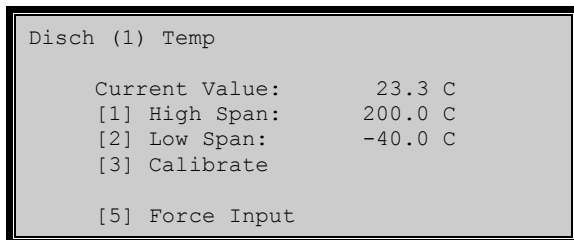
6.5 Thermocouple Calibration (Type J or K)

DO NOT CALIBRATE unless an accurate calibrator is available, or the actual reading can be determined very accurately (perhaps by setting the thermocouple in ice water). The input board is likely more accurate than any manual gauge or temperature gun.

- (a) Complete Steps (a) to (g) of Section 6.3 above, until the CALIBRATION screen (Figure 6–18) for the thermocouple is displayed.

Please note that span settings are used for range testing only on thermocouples.

- (b) Ensure span settings are correct. If not, complete Section 6.3.



**Figure 6–18
Thermocouple Calibration Screen**

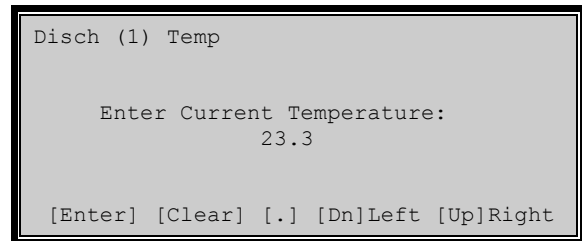
- (c) Connect a calibrator to the appropriate thermocouple input channel and set the calibrator for any temperature within

the span range of the thermocouple input.

Alternatively determine the temperature being read (as accurately as possible).

- (d) Choose [3] to perform the calibration.
- (e) The control panel will prompt DO TEMPERATURE CALIBRATION [1] YES, [2] NO.
- (f) Choose [2] to exit and return to the CALIBRATION screen.
- (g) Choose [1] to proceed with the calibration.

The Temperature Entry Screen (Figure 6–19) will be displayed.



**Figure 6–19
Temperature Entry Screen**

- (h) Enter the current calibrator temperature, or the accurately read temperature, into the control system, using the numeric keypad and the menu choices at the bottom of the screen.
- (i) The control panel will prompt THE VALUE IS [1] POSITIVE, [2] NEGATIVE.
- (j) Make the appropriate choice with the numeric keypad.
- (k) The input is now correctly calibrated for the entire span of the thermocouple input.

7. SYSTEM CHECK

From the control system perspective, a large part of performing a system check is reviewing all settings and parameters, as described in Section 6, and double checking that they are set correctly. The other part is verifying that the actuation of end devices will indeed trip the control system. **Go through each of the following topics in order.**

7.1 Accessing Test Mode

- (a) Press the <STATUS> button.
- (b) The STATUS MENU Figure 7-1 will be displayed.

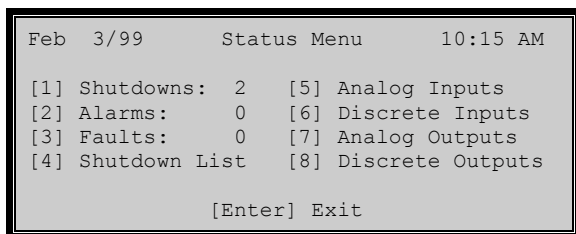


Figure 7-1
Status Menu Screen

- (c) Choose [4], SHUTDOWN LIST, by pressing the <4> key.
- (d) The first of several Shutdown List screens (Figure 7-2) will displayed.

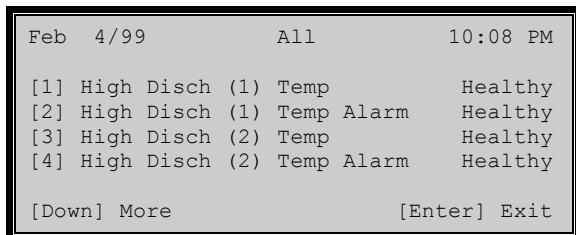


Figure 7-2
Typical Shutdown List Screen

The status of each shutdown and alarm is displayed on the screen.

Use the ▼ and ▲ panel marks to move through these screens, each displaying four settings.

- (e) Chose the shutdown/alarm you want to test by pushing its number key.
- (f) The appropriate Shutdown Screen (Figure 7-3) will be displayed.

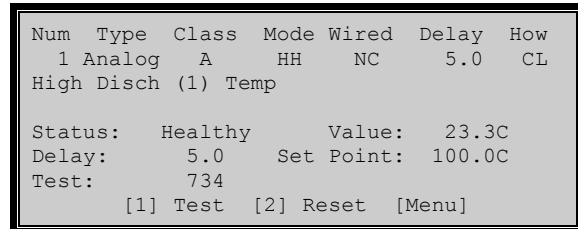


Figure 7-3
Shutdown Screen

- (g) Choose [1], TEST, to put the shutdown into TEST mode.

Test is used to check shutdowns and alarms while the compressor unit is operating, without causing an actual shutdown or alarm to register.

- (h) The control panel will prompt GO INTO TEST MODE? [1] YES, [2] NO.

Choose [1] to enter the Test mode or [2] to exit and return to the Status screen.

When the Test mode is entered, the time remaining (seconds) before expiry appears on line 7.

Test mode will stay active for 20 Min. (1200 Sec.). To exit the mode before the time expires, choose [1] TEST again. The system will prompt CANCEL TEST MODE? [1] YES, [2] NO. Choose [1] to cancel and return to the Status screen, or [2] to allow the mode to continue for its remaining time.

- (i) If TEST mode is selected, for analog, differential, or calculated shutdowns and alarms, the control panel will prompt FREEZE ANALOG INPUT? [1] YES, [2] NO.
- Choose [1] to freeze the input. This will use the value of the input at the time the Test mode was entered for all shutdown, alarm, and control functions in the control logic.
- Choose [2] to simply prevent the specific shutdown or alarm from occurring, but use the current value of the input for all other control logic functions, shutdowns or alarms.

NOTE: Exercise due caution as inputs are effectively disabled for shutdown and alarm while in Test mode.

DO NOT LEAVE AN INPUT IN TEST MODE ON AN UNATTENDED UNIT.

The input will remain in Test mode for preset test duration of 1200 seconds (20 minutes). **This timer will reset whenever a new input is put into Test mode.**

- (j) From the Shutdown screen (Figure 7-3), choose [2] RESET to reset the time (to 1200 seconds) for all inputs in the Test mode.
- (k) Press <MENU> to access CONFIGURATION mode, which allows you to change the shutdown or alarm configuration.

7.1.1 Shutdown Check

- (a) Push <STATUS>.
- (b) Note if there are any shutdowns, alarms or faults.

- (c) Push [1], SHUTDOWN, [2], ALARM, or [3], FAULT, to get details about a listed occurrence.
- (d) Clear the item by removing its cause, where possible.
- (e) Push [4], SHUTDOWN LIST.
- (f) Use the ▼ and ▲ panel marks to scroll through each shutdown on the list, one at a time, and trip each end device by undoing wires on temperature devices, tripping HLSD switches and vibration switches, etc., to simulate a fault condition.

As you go through each device, press the key number for that device, which will bring up another screen where you may view the setup of that device. Make sure the sensed setup matches the setup entered in Section 6. (To change any parameters, follow the appropriate instructions in Section 6.)

- (g) Push <ENTER> once if no setting was changed, twice if it was, and move to the next shutdown.
- (h) After all shutdowns have been done, push <ENTER> once.

7.1.2 Analog Inputs Check

- (a) Push <STATUS> and choose [5], ANALOG INPUTS.
- (b) Use the ▼ and ▲ panel marks to scroll through each input on the list, one at a time.

These devices were calibrated in Section 6. All that should be done at this point is to set a calibrator at some midpoint value and ensure that the reading shown on the system is correct.

It would be possible to force a value on any analog input through the software to check its shutdown, but this is not recommended as normal practice.

As you go through each device, press the key number for that device, which will bring up another screen where you may view the setup of that device. Make sure the sensed setup matches the setup entered in Section 6. (To change any parameters, follow the appropriate instructions in Section 6.)

- (c) Push <ENTER> once after checking each item, since no setting should have been changed. This will bring up the menu analog inputs menu again.
- (d) After all inputs have been checked, push <ENTER> once.

7.1.3 Discrete Inputs Check

- (a) Push <STATUS> and choose [6], DISCRETE INPUTS.
- (b) Use the ▼ and ▲ panel marks to scroll through each input on the list, one at a time.

Trip each associate end devices in turn to check their operation (some end devices may have been previously checked).

- (c) Push <ENTER> once after checking each input, since no setting should have been changed. This will bring up the discrete inputs menu again.
- (d) After all inputs have been checked, push <ENTER> once.

7.1.4 Outputs Check

- (e) Push <STATUS> and choose [7], ANALOG OUTPUTS.

- (f) Use the ▼ and ▲ panel marks to scroll through each output on the list, one at a time.

Check that the readings of each output appear normal. For example, check that the I/P output gauge reading is close to the control system's reading.

- (g) Push <ENTER> once after checking each output, since no setting should have been changed. This will bring up the discrete inputs menu again.
- (h) After all outputs have been checked, push <ENTER> once.
- (i) Push <STATUS> and choose [8], DISCRETE OUTPUTS.

In similar fashion to the preceding, visually check each discrete output. These will be tested under the *PID Control Check and Discrete Outputs Test* following.

7.1.5 PID Control Check and Discrete Outputs Test

Refer to the *RC2000 Operating Manual* for details of PID operation.

- (a) Push the <CONTROL> key.
This key gives access to the PID control functions and settings for speed, slide valve, bypass, suction, and louver controls (as applicable). It also allows access to the Master PID control and the discrete outputs. Each item can be set to AUTO or MANUAL by toggling with the <3> key.
- (b) Set each of these control loops to MANUAL for the test run, but return to AUTO when checking the auto start, later in the procedures.
(For each item you can choose [2] to set the desired output.)

- (c) Set the setpoints for the louvers and Suction control (as applicable) by choosing [1] for each item, and entering the desired setpoint.
- (d) After each item is set, push <ENTER> once.
- (e) Choose [6], MASTER PID.
- (f) The setpoints for the Bypass, Slide Valve and Speed control (as applicable) are determined from the chosen setpoints for suction, discharge, manifold pressure, motor current, etc., done by choosing [8] for each item and entering its setpoint.
- (g) After each item is set and turned to MANUAL, push <ENTER> once.
- (h) Push <ENTER> twice to get back to the CONTROL MENU.

NOTE: There are numerous other settings available for all PID items by choosing <Menu> when the item is selected. These are factory preset and should not normally need changing.

- (i) Choose [4], DISCRETE OUTPUTS.
- (j) Choose each output in turn (an arrow appears beside the one selected).
- (k) Toggle each output device, except where potentially harmful; for example, active electric motor starts or active engine start gas (unless engine valve is hand closed), and check to see that the correct solenoids are being energized.
- (l) The [.] will toggle the output momentarily until released, then it resets. The [0] toggles it without resetting when released (however the computer control will turn it back as required).

Use the ▼ and ▲ panel marks to scroll through the groups of eight outputs.

- (m) When finished, press <ENTER> twice to return to RUN MODE.

7.1.6 Starting and Testing

The following is typical for an engine-driven reciprocating compressor. Refer to the *RC2000 Operating Manual* for details on compressor starting and operation.

- (a) Close all bypass valves and open the blowdown valve to purge system as required.
- (b) Open all bypass valves and close the blowdown valve at the end of the purge cycle.
- (c) Pressurize the unit to a safe level for starting.
- (d) Press <RESET>.
- (e) If all shutdowns, alarms, and faults are cleared the control panel will say OK TO START.
- (f) Ensure speed, bypass and suction are in Manual (see *PID Control Check* above).
- (g) Press <ENTER> then press <START>.
- (h) Choose [2], Manual Crank.
- (i) Screen should say PRELUBING.
- (j) When screen says PUSH START BUTTON TO CRANK, push/hold <START> (it now works like a starter button).
- (k) When engine starts, check all oil pressures. If normal continue, if not press <STOP>.
- (l) Warm up the engine and load the compressor.
- (m) After run test, cool down the unit and shut it down.
- (n) Turn all PID controls to AUTO.

- (o) Refer to *the RC2000 Operating Manual* and do an Auto Start, making sure sequencing is correct.
- (p) Do an Auto Stop, checking for proper sequencing.
- (q) Check that the History Menu is updating.
- (r) Reset all start pressures for the field.

8. SYSTEM SPECIFICATIONS**8.1 Computer Module Hardware Specification****Summary**

- 20 MHz, 68000 CPU
- 512 Kb ROM
- 1 Mb RAM with lithium battery backup (smart socket with clock)
- two RS232 serial ports (connection to laptops, modems, satellites, etc.)
- one 485 serial port (I/O board communication and CPU 95 ignition) optically isolated
- one 485/422 serial port (SCADA connection) optically isolated
- 14.4 K or 33.6 K modem
- power supply – 24 Vdc input (internally converted using a DC/DC convertor)
- 8-line by 40 character screen
- multiple-button keyboard (see Page 2)
- wall-mount NEMA4 cabinet with hinged door (approximately 8.5 in wide by 11.5 in high by 3.0 in. deep)
- two cable connectors at the bottom of the cabinet
 - (a) main connector (19 Pins – see below)
 - (b) RS232 connector (9 Pin – see below)

Main Connector

(25 pin “D” Connector)

- Pin usage:

24 Vdc	2
RS485	2
RS422/485	4
RS232	8
Phone line	2
<u>Earth ground</u>	<u>1</u>
Total Pins	19

RS232 Connector

(Standard 9 Pin “D” Connector)

9 pins using original Exacta specification

Notes

- 15 W (whole) system
- stable to 70°C
- no power switch or reset button.
- Area Classification to meet Class I, Div II, Group D
- solenoids will not work properly below 22 Vdc

8.2 Input Module Hardware Specification**Summary**

- 20 MHz, 68000 CPU
- 512 Kb ROM
- 256 Kb/1 Mb RAM
- lithium battery backup (clock not required)
- two analog to digital (ADC) converters, one for 4 to 20 mA inputs and one for thermocouple inputs

- eight, 4 to 20 ma inputs (transmitter)
 - (a) 100 ohm, 0.05% resistors to convert to voltage (wire wound)
 - (b) each channel separately current limited to 40 mA
 - (c) short circuit detection
 - (d) desired accuracy 0.1%
 - (e) this ADC includes the 24 Vdc power detection
- 16 thermocouple inputs (type J or K)
 - (a) cold junction compensation
 - (b) pull up and pull down resistors on each channel
 - (c) differential switches on each channel
- 12 discrete inputs
 - (a) standard optically isolated inputs
 - (b) zener diode with two resistors (no LED) (wire wound resistors)
- one rpm input
- one, RS485 serial port (optically isolated)
- four quick connects (thermocouples, other inputs, power and communications)
- power supply, 24 Vdc only using DC/DC convertor for other voltages
- sheet metal NEMA4 mounting cabinet

Thermocouple Connector
(DB37 Connector)

- 33 pin connector, 32 for thermocouples and one for earth ground

General Inputs Connector
(Analog/Discrete)

(Two DB25 Connectors)

- Pin usage:

4 to 20 mA inputs	16 pins
Discrete inputs	24 pins
RPM input	2 pins
Earth ground	1 pin

Communications and Power Connectors
(Two DB9 connectors)

- Both connectors are the same with the pins tied together.
- Pin usage:

Power	2 pins
RS485	2 pins
Earth ground	1 pin

Notes

See Section 8.1

8.3 Output Module Hardware Specification**Summary**

- AVR™ CPU
- six analog outputs, 4 to 20 mA
- 20 discrete outputs
 - (a) 19 wet outputs (one side tied to 24 Vdc)
 - (b) fused
 - (c) diode for spike protect when turning off an inductive load
 - (d) one output set up to pull to zero volts
 - (e) LEDs

- four discrete inputs
 - (a) standard optically isolated inputs
 - (b) zener diode with two resistors (no LED) (wire wound resistors)
- one, RS485 serial port (optically isolated)
- two quick connects for communications and power to the computer and other boards
- terminals for I/O connection, see below
- no cabinet provided (will be mounted in standard auxiliary cabinet)

RS485 and 24 Vdc Power Connector
(Standard 9 pin “D” Connector)

This is the standard interconnect for connecting to the other multi-drop boards.

Notes

See Section 8.2.

Main Connector

(Dual row Phoenix Connectors)

Outputs	40
Inputs	8
Analog outputs	12
Phone line	2
24 Vdc power	2
24 Vdc for Ign	4
RS485 for Ign	2
RS422/485	4
RS232	8
Power down	2
<u>Earth ground</u>	<u>1</u>
Total	85

Computer Module Connector

(25 pin “D” Connector)

This is the other end of the main connector shown for computer module.

9. TROUBLESHOOTING

See Table 9–1 for a list of troubleshooting tips for the control system.

9.1 Troubleshooting Tips

Table 9–1

RC2000 Troubleshooting Tips

These tips are for commonly experienced control-related faults. It should help to quickly isolate common occurrences. It does not include compressor unit malfunctions, nor should it be construed as a complete guide to troubleshooting. (Please contact BTB Compressors if you discover something which should be added to this list.)

Problem	Possible Cause	Possible Solutions
RPM not reading	Magnetic pickup broken	Set meter to Vac and check voltage while cranking. Should see around 6 Vac. Check pickup for damage or metal filings.
	Broken cable or loose termination	Check cable for continuity. Check cable terminations.
	RPM setup not correct	Ensure pulses per revolution are set up correctly.
Gas detection reading negative 24% or out of range	Signal from transmitter less than 4 mA	Ensure there is 24 Vdc at transmitter.
		Ensure transmitter is connected correctly to input channel.
Gas detection reads over range	Signal from transmitter reversed	Check conductor terminations at both ends.
Gas detection reads incorrectly	Transmitter needs calibration	Calibrate gas detector.
Temperature reads over range	Open thermocouple or conductors (open circuit)	Check thermocouple with calibrator. Check conductor terminations, both ends.
Temperature decreases as heat is applied (reversed)	Wiring reversed	Correct connections.
Temperature readings are erratic	Loose connections or bad ground	Check and tighten all terminals. Check all cables for proper grounding (shield at one end only).
	Thermocouple wire not used throughout the connection, or wrong type	Replace improper wire with correct type of thermocouple wire.
	Bad thermocouple	Replace thermocouple.
	Segment of thermocouple wire reversed	Replace wiring.
Pressure reading negative	Open connection	Check connections and conductors for open circuit.
	Needs calibrating	Check calibration. Calibrate using hand pumps. See Section 6 of this manual.

Table 12–1 Continued
RC2000 Troubleshooting Tips

Problem	Possible Cause	Possible Solutions
Pressure reading too high	Wires shorted (causes pegged-high reading)	Check wiring.
	Needs calibrating	Check calibration. Calibrate using hand pumps. See Section 6 of this manual.
Discrete input(s) read fault all the time	Open connection or defective device	Check device, wiring and terminations.
Discrete input(s) read healthy all the time	Conductor grounded or defective device	Check device, wiring and terminations.
Computer screen is blank	Computer displaying blank screen	Push <Enter/Exit> button.
	No power, blown fuse, loose connection	Check 24 Vdc supply, fuses and wiring.
	Gas or fire-detection shut down	These shutdowns cut power to panel. Check detectors for gas and fire.
	Screen contrast	Check and adjust.
Date and time are wrong	Wrong settings	Set date and time using <Menu> button, choosing [1] Program Mode (password required), choosing [1] Set Up Menu, then choosing [1] Set Clock.
Single output not working	Fuse blown, open wire, or loose connection	Check the fuse on the 12 x 12 I/O board. Check wiring.
Multiple outputs not working	Fuse blown, open wire, or loose connection	Check 24 Vdc main fuse in panel. Check wiring from fuse to 12 x 12 I/O board. Check the 0 Vdc common that runs to each output end device.
Fuel gas solenoid not coming on	Engine speed did not reach 20 rpm	Check rpm reading while cranking. See "RPM Not Reading" in these tips if no rpm is present.
	Output not working	See "Single Output Not Working" in these tips.
No crank signal	Manual crank selected on start	Push <Stop>, then <Start> and choose [1] Auto Crank.
	Output not working	See "Single Output Not Working" in these tips.
Ignition not turning on	Engine speed did not reach 20 rpm	Check rpm reading while cranking. See "RPM Not Reading" in these tips if no rpm is present.
	Output not working	See "Single Output Not Working" in these tips.

Table 12–1 Continued
RC2000 Troubleshooting Tips

Problem	Possible Cause	Possible Solutions
Solenoid valve not responding	Output in manual, fuse or wiring faulty	See "Single Output Not Working" in these tips.
Unit cranks but does not start	No rpm detection	See "RPM Not Reading" in these tips if no rpm is present.
Cannot clear Class shutdowns	Shutdowns not cleared	Push <Status> button to determine causes and check out one at a time.
	Shutdown not correctly set up	See System Configuration and Calibration, Section 7, in this manual.
	Defective discrete input	See "Discrete Input(s) Reads..." in these tips.
Bypass valve not opening on high discharge or low suction	Bypass valve in manual	Push <Control> and select [2] Bypass Control then [3] Auto/Manual to toggle to Auto.
	Master PID control in manual	Push <Control> and select [6] Master PID Control then [3] Auto/Manual to toggle to Auto.
Speed not slowing on high discharge or low suction	Speed control is in manual	Push <Control> and select [1] Speed Control then [3] Auto/Manual to toggle to Auto.
	Master PID control in manual	Push <Control> and select [6] Master PID Control then [3] Auto/Manual to toggle to Auto.
Electric drive won't start	Motor start output on pulse when should be continuous	Push <Control> and select appropriate setting.

9.2 Diagnostic Messages

There are only six diagnostic (error) messages/shutdowns associated with the control system itself.

One set of four shutdowns is associated with a communications fault between the control computer module and any of the input modules, or with the output module.

These indicate a fault in the connecting cables or in the modules themselves. Power down the system and power it back up again and check for proper operation. If the fault repeats itself, replace the module with the fault.

If this does not fix the problem, then either the cabling is faulty, or the computer module itself is faulty. Call Pamco for service.

The other two control system diagnostics are, an alarm if the supply voltage drops to 23 Vdc, usually indicating a charging fault to the battery supply or weak batteries, and a shutdown if the supply voltage drops below 22 Vdc, indicating a severe loss of charging or a failed power connection.

The remaining alarms and shutdowns are all associated with the compressor unit's normal alarm and shutdown messages. These are not described here, as they are unit-related rather than control-related.

However, a note about range faults is in order:

“Range faults usually will indicate wiring connection problems (open or short) or a problem with the end device. Transmitters should be checked using the calibration techniques shown in Section 6. Thermocouples should be checked by replacing the thermocouple and then checking the operation. Thermocouples that shut the unit down on a range check should

be replaced, even if they read OK while the unit is shut down.”

9.3 Fuses and LED Indications

See Figures 9–1 to 9–3 for annotated digital pictures of the system boards. These figures show all internal fuses and give descriptions of the LED indications on the boards.

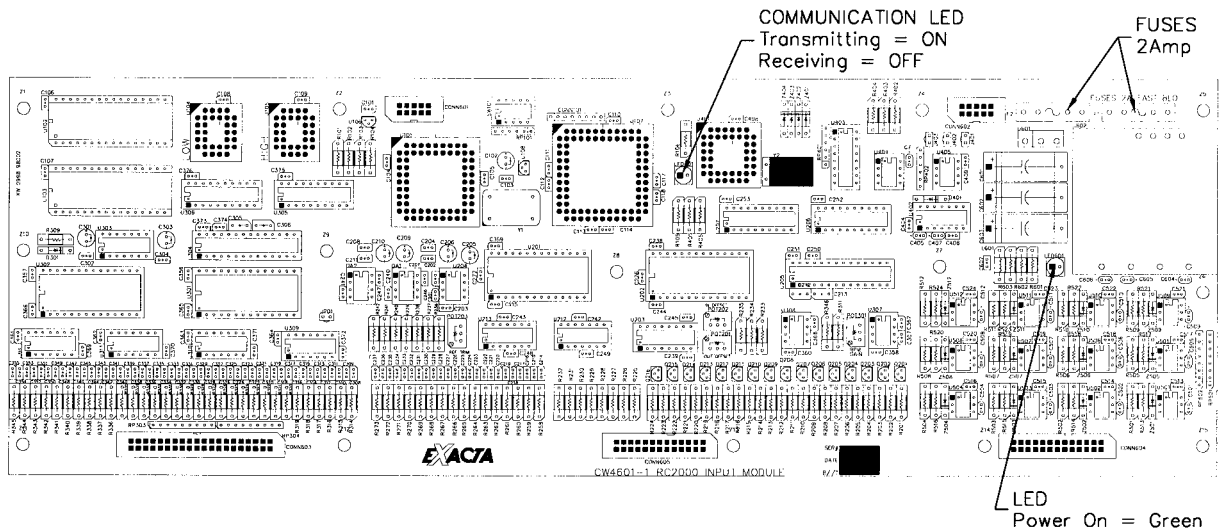
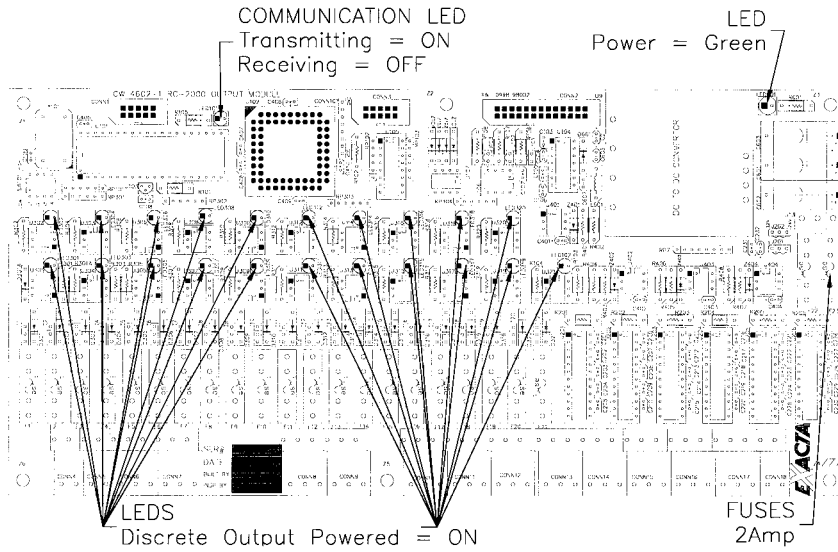
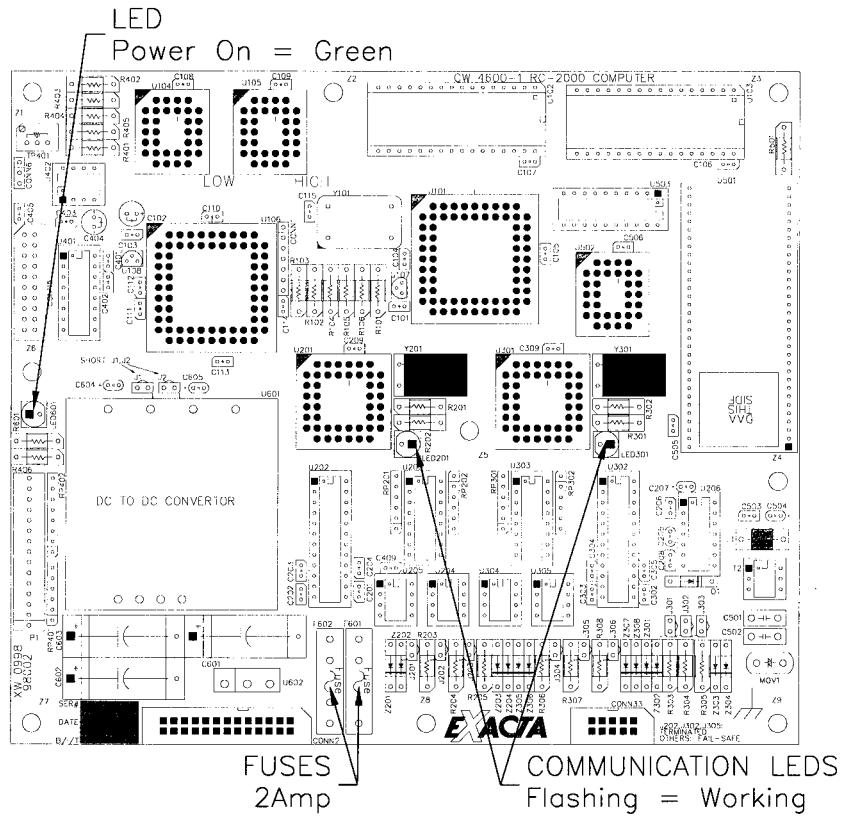


Figure 9–1
Input Modules



**Figure 9-2
Output Module**



**Figure 9-3
Control Panel**

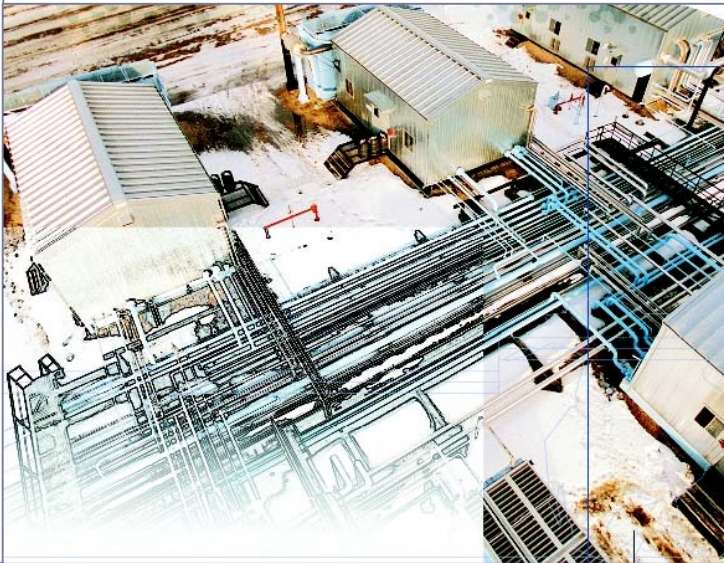
RC2000

COMPUTER CONTROL SYSTEM

Operating Manual

ENGINE DRIVEN
RECIPROCATING COMPRESSORS

ENERFLEX



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WARNING! The information contained in this Document is the most current at the time of publication. It is provided as a guideline to assist Owners, Operators and Service Personnel with operating Enerflex units. Enerflex does not take responsibility for the use of its contents.



CAUTION! Compressing combustible or toxic gas can be very hazardous.

Take all reasonable precautions to protect personnel and property.

The owner and operator are responsible for site and compressor-unit safety systems, and must ensure safety procedures are in place and followed. Only trained personnel should enter, operate, or maintain the compressor unit and its associated equipment.

ABOUT THE RC2000

This modern microprocessor (computer) control system provides safe, accurate and reliable control of Enerflex compressor units.

Featuring an easy-to-use operator's panel (or remote actuation), the RC2000 control system includes automatic startup sequencing and three levels of stop sequencing.

Using built-in PID control, it provides automatic control of unit variables.

It has built-in historical and trend recording, and is capable of remote communication by land line, cellular telephone, or satellite.

ABOUT THIS MANUAL

Intent

This manual assists personnel operating Enerflex compressor units equipped with the RC2000 control system. It should be used in conjunction with the *Unit Operating Manual* supplied with each unit and with its companion *RC2000 Installation and Maintenance Manual*. Other important information the operator needs includes:

- Unit Order*
- Unit Component Data*
- Instrument Index*
- Performance Curve(s)*
- compressor Data Sheet(s)*
- Compressor Operator's Manual*
- Engine Operation and Maintenance Manual*

This manual is written for compressor units with all available options. It is likely that some features are not available on a particular unit, depending on installed options.

This manual is specific to engine-driven reciprocating compressors and applies to units with either the RC2000 and RC2000L control systems

Writing Customs

At the front of the manual, you will find a table of contents and a list of the figures. They make it easy for you to locate information quickly.

Control panel key selections are shown inside marks like this:

press <START>.

Operator panel action or commands to the panel, and operating modes, are shown in small capital letters in a type style similar to the menu displayed:

choose PROGRAM.

If another document or a form is mentioned in the text, it is in Italics (slanted type):

Unit Operating Manual.

Updates

This manual contains the most updated information available at the time of publication.

If you require updated information, or wish to suggest changes or improvements, please contact Customer Support at (403) 236-6800.

IMPORTANT NOTES**FOREWORD****CONTENTS****FIGURES LIST****1. SYSTEM DESCRIPTION**

- 1.1 Overview
- 1.2 Functions
- 1.3 Basic Operation
 - 1.3.1 Keypad
 - 1.3.2 Alphanumeric Display
 - 1.3.3 Control Logic
- 1.4 Safeguards
 - 1.4.1 Shutting Down the unit
 - 1.4.2 Power Disconnect
 - 1.4.3 Password Protection
- 1.5 System Inputs and Outputs
 - 1.5.1 Inputs
 - 1.5.2 Outputs
 - 1.5.3 Remote Tie-Ins
- 1.6 Alarm and Shutdown Conditions
- 1.7 Data Capture
- 1.8 Communications Interfaces
 - 1.8.1 Auto Paging
 - 1.8.2 Remote monitoring and Control
 - 1.8.3 CPU-95 Ignition
 - 1.8.4 Communications Ports

2. CONTROL PANEL OPERATION

- 2.1 Overview
- 2.2 Initial Screen
- 2.3 Navigating Between Screens
- 2.4 Password Access
- 2.5 Run Mode Screens
- 2.6 Status Key
 - 2.6.1 Shutdowns
 - 2.6.2 Alarms
 - 2.6.3 Diagnostic Faults
 - 2.6.4 Shutdown List
 - 2.6.5 Analog Inputs
 - 2.6.6 Discrete Inputs
 - 2.6.7 Analog Outputs
 - 2.6.8 Discrete Outputs
 - 2.6.9 Faults, Shutdown and Alarm Configuration Screens

- 2.7 History Key
 - 2.7.1 History Menu
 - 2.7.2 First-In Shutdowns
 - 2.7.3 Event History
 - 2.7.4 Captured Data
- 2.8 Settings Key
 - 2.8.1 Shutdowns and Alarms
 - 2.8.2 Prelube Settings
 - 2.8.3 Crank Settings
 - 2.8.4 Warmup Setpoints
 - 2.8.5 Post Lube Timer
 - 2.8.6 Dump Timers
 - 2.8.7 Blowcase Timers
 - 2.8.8 Purge Timers
 - 2.8.9 Load Settings
 - 2.8.10 Start Pressures
- 2.9 Control Key
 - 2.9.1 Individual Loop Controls
 - 2.9.2 Master PID
 - 2.9.3 Discrete Outputs
- 2.10 Stop Key
- 2.11 Start Key
- 2.12 Reset Key
- 2.13 Help Key
- 2.14 Menu Key
 - 2.14.1 Program Mode
 - 2.14.2 Display Mode
 - 2.14.3 Contrast Adjust
- 2.15 ESD Key

3. CONTROL SEQUENCES

- 3.1 Introduction
- 3.2 Emergency Shutdown (ESD)
 - 3.2.1 Initiating an ESD Sequence
 - 3.2.2 ESD Sequence
- 3.3 Unit Start
 - 3.3.1 Initiating a Start
 - 3.3.2 Start Sequence Overview
 - 3.3.3 Start Sequence
- 3.4 Normal Cooldown Stop (CL)
 - 3.4.1 Initiating a CL
 - 3.4.2 CL Sequence Overview
 - 3.4.3 CL Sequence
- 3.5 Shutdown/Sudden Stop (SD)
 - 3.5.1 Initiating a SD
 - 3.5.2 SD Sequence Overview
 - 3.5.3 SD (Fast Stop) Sequence

- 3.6 Blowcase Cycle Control
 - 3.6.1 Overview
 - 3.6.2 Fill Mode
 - 3.6.3 Pressurization Mode
 - 3.6.4 Drain Mode
 - 3.6.5 Balance Mode
- 3.7 Separator Boot Dump Valve Control
 - 3.7.1 Overview
 - 3.7.2 Sequence
- 3.8 Power Down

4. CONTROLLING UNIT VARIABLES

- 4.1 Introduction
 - 4.1.1 Process Control Theory
 - 4.1.2 PID Control Theory
 - 4.1.3 Tuning PID Control
- 4.2 Unit Variable Control
- 4.3 Engine Speed Control
 - 4.3.1 Engine Speed PID Controller
 - 4.3.2 Speed Ramp Up & Slowdown PID Controller
- 4.4 Bypass Control Valve
 - 4.4.1 Bypass Control Valve PID Controller
 - 4.4.2 Bypass Auto Slowdown PID Controller
- 4.5 Master PID Control
 - 4.5.1 Example
- 4.6 Inlet Control Valve
 - 4.6.1 Inlet Control Valve PID Controller
 - 4.6.2 Suction Startup PID Controller
 - 4.6.3 Suction Slowdown PID Controller
- 4.7 Gas Cooler Louver Control

APPENDIX A TYPICAL INSTRUMENT INDEX

Figures List

Figures		
No.	Title	Sect. & Pg.
1-1	RC2000 Control System	1, 2
1-2	Control Panel	1, 3
2-1	Control Panel	2, 1
2-2	Typical Main Run Mode Screen	2, 2
2-3	Typical Auxiliary Run Mode Screen (Process and Compressor Temperatures)	2, 2
2-4	Typical Auxiliary Run Mode Screen (Auxiliary Pressures and Miscellaneous)	2, 2
2-5	Typical Auxiliary Run Mode Screen (Auxiliary Temperatures)	2, 2
2-6	Typical Auxiliary Run Mode Screen (Differential Pressures)	2, 2
2-7	Status Menu Screen	2, 3
2-8	Typical Shutdowns Screen	2, 3
2-9	Typical Configuration Screen	2, 3&7
2-10	Typical Alarms Screen	2, 4
2-11	Typical Diagnostic Faults Screen	2, 4
2-12	Typical Shutdown List Screen	2, 4
2-13	Typical Analog Inputs Screen	2, 5
2-14	Typical Thermocouple Calibration Screen	2, 5
2-15	Typical 4 to 20 mA Calibration Screen	2, 5
2-16	Typical Discrete Inputs Screen	2, 6
2-17	Typical Analog Outputs Screen	2, 6
2-18	Typical Discrete Outputs Screen	2, 7
2-19	Typical Configuration Setup Screen	2, 10
2-20	History Menu Screen	2, 10
2-21	Typical First-In Shutdowns Screen	2, 11
2-22	Typical Shutdown Run-mode Screen	2, 11
2-23	Typical Event History Screen	2, 11
2-24	Typical Captured Data Screen	2, 12
2-25	Timers & Settings Menu Screen	2, 13
2-26	Typical Shutdowns and Alarms Screen	2, 13
2-27	Typical Prelube Settings Screen	2, 13
2-28	Typical Crank Settings Screen	2, 14
2-29	Typical Warmup Settings Screen	2, 14
2-30	Typical Post Lube Timer Screen	2, 14
2-31	Typical Dump Timers Screen	2, 15
2-32	Typical Blowcase Timers Screen	2, 15
2-33	Typical Purge Timers Screen	2, 15
2-34	Typical Load Settings Screen	2, 16
2-35	Typical Start Pressures Screen	2, 16
2-36	Typical Control Menu Screen	2, 17
2-37	Typical Speed Control Screen	2, 17
2-38	Typical Bypass Control Screen	2, 17
2-39	Typical Suction Control Screen	2, 17
2-40	Typical Louver Control Screen	2, 18
2-41	Deadband	2, 20
2-42	Typical Master PID Screen	2, 21
2-43	Master PID Loops Screen	2, 22
2-44	Typical Discrete Outputs Screen	2, 22
2-45	Compressor Stop Screen	2, 23
2-46	Engine Starting Screen	2, 23
2-47	Display Modes Screen	2, 24
2-48	Contrast Adjust Screen	2, 25
3-1	Fill Mode	3, 8
3-2	Pressurization mode	3, 8
3-3	Drain Mode	3, 9
3-4	Balance Mode	3, 9
3-5	Separator Boot Dump Valve	3, 10

1. SYSTEM DESCRIPTION

1.1 Overview

The RC2000 Control System (Figure 1-1) consists of a computer control panel, a number of input modules, and an output module (located in an auxiliary panel). The RC2000L control system is a scaled-down version of the RC2000 Control system, and has the same layout, except the RC2000L typically has only one input module.

Instrument inputs and outputs (end devices) connect to standard input and output modules. These in turn are connected to the control panel by communication cables.

Control panel software monitors input end devices (switches, transmitters, etc.) and controls output end devices (solenoids, current-to-pressure I/P transducers, etc.).

Operators can monitor and control the compressor unit (called "unit") using the control panel's keypad and display.

Data storage is provided, allowing for trending of operating variables and logging of events.

The control panel includes an on-board modem and communication ports to support auto-paging on alarm/shutdown, direct monitoring and control of the Altronic CPU-95 ignition system (where applicable), and EFX Panel Manager remote monitoring, trending, reporting and control, as needed. Remote communications via land line and cellular telephone systems, satellite systems, and supervisory control and data acquisition (SCADA) systems are all supported.

System access to specific functions and menu selections is password-protected, with three (3) levels of protection implemented, described in Section 2.

1.2 Functions

The RC2000 is pre-programmed with configured options and I/O sets to provide the following functions:

- (a) Discrete input monitoring, alarm and shutdown activation (pressure switches, level switches, etc.).
- (b) Analog input monitoring, alarm and shutdown activation (pressure transmitters, thermocouples, etc.).
- (c) Discrete output control (solenoids, etc.), including program logic control.
- (d) Analog output control (speed, suction and bypass control valve I/Ps, etc.), including PID and program logic control.
- (e) Start/Auto-Start sequencing control.
- (f) Stop/Shutdown/ESD sequencing control, including Cooldown Stop, Fast Shutdown, and ESD (fast shutdown with blowdown).
- (g) Power-down/power disconnect (to conserve batteries) on low voltage, on ESD signal activation (including high gas LEL, H₂S, fire detection, loss of fire/ESD loop pressure, and loss of purge differential pressure on sour units), and at a predetermined time after a shutdown.
- (h) Periodic data capture (1400 records per analog point/parameter).
- (i) Pre-shutdown data capture (40 records per analog point, up to 40 shutdowns).
- (j) Event log (300 events).

System Description

- (k) Auto-paging on alarm/shutdown and communications interface to EFX Panel Manager remote monitoring and control system (optional).
- (l) Operating interface to the Altronic CPU-95 digital ignition system (under development).
- (m) User-specific remote control and communications tie-ins.

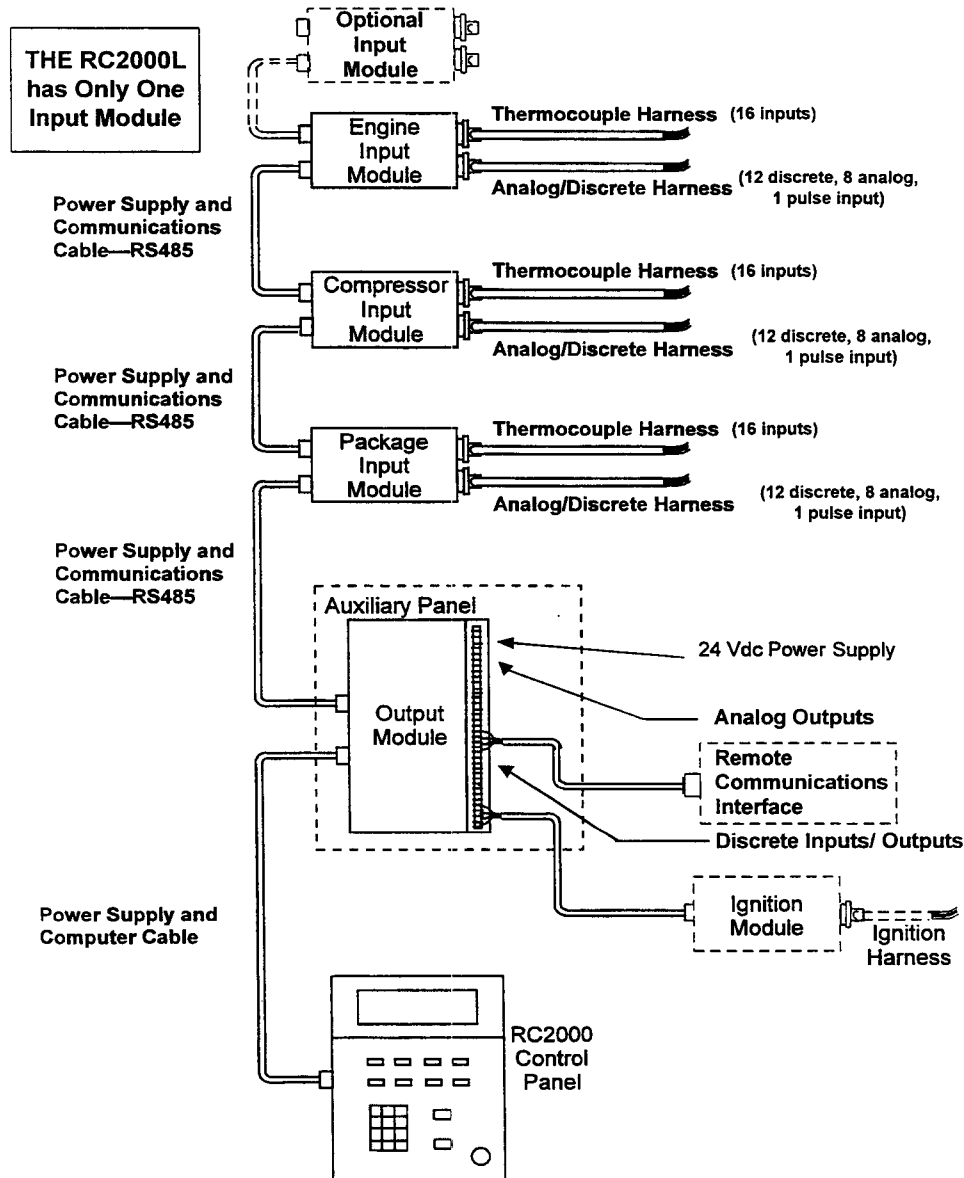


Figure 1-1
RC2000 Control System

1.3 Basic Operation

1.3.1 Keypad

The keypad (Figure 1–2) is set up in a logical manner to provide operators with easy-to-use controls for unit functions, including:

- start
- stop
- emergency shutdown (ESD)
- unit variable control setpoint adjust
- alarm and shutdown setpoint adjust
- timer settings
- alarm reset.

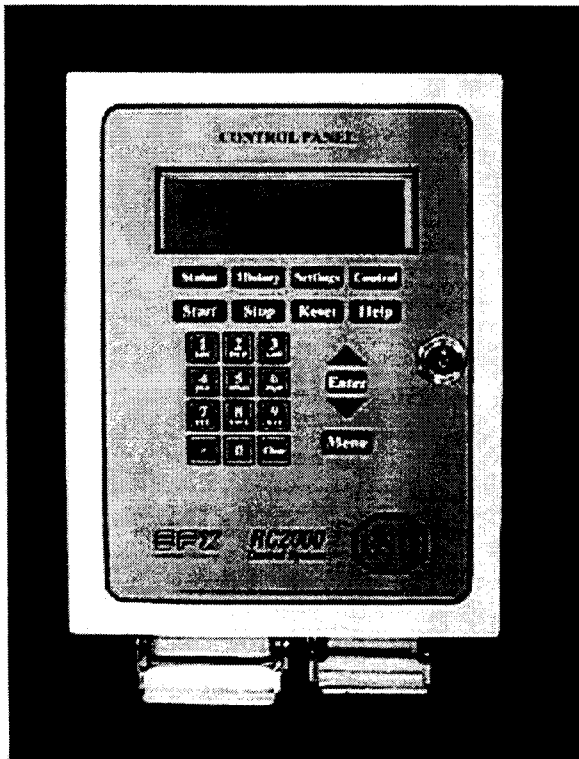


Figure 1–2
Control Panel

1.3.2 Alphanumeric Display

The alphanumeric screen display (Figure 1–2) shows the operator all relevant operating information:

- discrete input status
- discrete output status
- analog input values
- analog output values
- all present alarms
- all present shutdowns
- first-out alarm and shutdown
- present step in start, stop, or shutdown sequence
- control loop parameters
- historical data and event logging.

1.3.3 Control Logic

The control panel performs all monitoring and control for the unit. The unit will be brought to a safe state after any upset condition.

The control logic performs these major functions:

- start sequencing
- stop sequencing
- shutdown sequencing
- engine speed control (as applicable)
- suction and discharge pressure control
- auxiliary systems control
- alarm annunciation
- shutdown annunciation.

1.4 Safeguards

1.4.1 Shutting Down the Unit

The RC2000 control system provides safeguards to automatically stop the unit, protecting equipment from damage if upset conditions occur. The stop sequence can be operator-initiated (locally or remotely), or else initiated automatically on an upset condition. The stop sequence is either:

- a normal cooldown stop (CL), which is a non-critical stop that ramps engine speed down slowly
- a shutdown (SD), which is a critical or sudden stop
- an emergency shutdown (ESD, which is an emergency stop (and blowdown, where applicable).

These are described in detail in subsequent sections of this document.

1.4.2 Power Disconnect

The control panel will energize a relay to disconnect power to the unit (at the auxiliary panel circuit) whenever any of the following occur:

- low voltage
- ESD signal activation, including high gas, high H₂S, fire detection, loss of fire/ESD loop pressure, and loss of purge differential pressure on sour units.
- unit was shut down and has not started within an owner-settable timed period.

NOTE: Loss of electrical power to the outputs will effectively trigger an ESD to the device fail state.

1.4.3 Password Protection

System access to specific functions and menu selections is password-protected, with three levels of protection, as described in Section 2.

1.5 System Inputs and Outputs

1.5.1 Inputs

The control panel continuously monitors inputs to provide information, to control output devices, and to automatically stop the unit if upset conditions occur.

Inputs include these types:

- discrete
- analog
- thermocouple.

Discrete inputs (switches) are either OPEN or CLOSED, and change state (OPEN-to-CLOSED; or CLOSED-to-OPEN) in response to some measured variable; for example, the engine jacket water level falls below some level and a level switch opens.

When the device changes from its normal state (NC = normally closed, NO = normally open), the control panel can respond by controlling an output end device according to a predefined sequence, or it can indicate an alarm or shutdown condition.

Analog inputs (transmitters) provide a continuous reading for the operating variables (called “variables”) being measured; for example, unit suction pressure.

System Description

Thermocouple inputs are a special type of analog input, providing a continuous temperature reading for the variable being measured; for example, engine jacket water temperature.

Both **Analog** and **Thermocouple** inputs are monitored by the control system to:

- control a unit variable at a specific setpoint
- indicate an alarm or shutdown condition if the measured variable rises above or falls below its predetermined alarm or shutdown setpoint
- simply provide information about the operation of the unit.

For a list of inputs to the control system refer to your *Instrument Index* (ensure it's updated if changes are made). A sample of a typical *Instrument Index* is included as Appendix A.

1.5.2 Outputs

The control panel controls output end devices (called "outputs") which are used to control the unit.

Outputs can be either:

- discrete
- analog.

Discrete outputs are either ON or OFF; for example, the fuel gas valve solenoid.

Analog outputs respond to a continuous output signal from the control system, which can be 0% to 100% of the device's range; for example, the bypass control valve position current-to-pressure transducer.

For a list of outputs from the control system refer to your *Instrument Index* (ensure it's updated if changes are made). A sample of a typical *Instrument Index* is included as Appendix A.

1.5.3 Remote Tie-ins

Hardwired connections are available to allow the operator limited monitoring and control functions from a remote control panel.

Operators can initiate stop sequences from a remote control panel through these hardwired inputs:

- REMOTE STOP (initiates CL)
- REMOTE ESD (initiates ESD).

Operators can monitor the status of the unit from a remote control panel through these hardwired outputs:

- RUN STATUS
- ESD STATUS.

1.6 Alarm and Shutdown Conditions

The inputs have been configured to indicate alarm and/or shutdown conditions.

Discrete inputs can be configured to indicate either an alarm or a shutdown.

Analog inputs can be configured for any or all of the following:

- low alarm
- low-low shutdown
- high alarm
- high-high shutdown

- error alarm (signal out of range, or unexpected signal level)
- error shutdown.

An alarm is used to warn operators when a variable is outside its normal (expected) operating range, but no action is taken by the control system. This allows operators time to initiate corrective action in an attempt to prevent the variable from reaching a shutdown condition.

A shutdown is used to automatically shut down the unit if upset conditions occur.

When an alarm or a shutdown condition is detected, the control system latches (traps) the alarm or shutdown in the logic. Even if the measured variable returns to its normal state or value, operators are still able to view the cause of the alarm or shutdown.

To reset an alarm or shutdown once it latches into the control system logic, the condition which caused it must be cleared first (device must return to pre-alarm or pre-shutdown state). Then the <RESET> key on the control panel's keypad must be pressed.

1.7 Data Capture

The RC2000 control panel captures data for monitoring and trouble-shooting purposes, as follows:

- periodic data capture (1400 records per analog point/parameter)
- pre-shutdown data capture (40 records per analog point, up to 40 shutdowns)
- event log (300 events).

These are available for display at the control panel, or for remote download, including by EFX Panel Manager software (see Section 1.8.2).

1.8 Communications Interfaces

1.8.1 Auto-paging

The control panel includes an on-board modem. Connections for tie-in to a land line or cellular telephone system, or to a satellite communications system, are provided at the output board. The control panel will automatically call out/page the operator as needed, either on shutdown only or else on alarm and shutdown.

1.8.2 Remote Monitoring and Control

The control panel includes an on-board modem. Connections for tie-in to a land line or cellular telephone system, or to a satellite communications system are provided at the output board. Optional EFX Panel Manager software installed on a remote computer utilizes this communications link to provide complete remote monitoring, trending, reporting and control, as needed. This software package is described in a separate document, *EFX Panel Manager User's Guide*.

1.8.3 CPU-95 Ignition System

An RS-485 serial communications link at the output board is included to provide an interface to operate the Altronic CPU-95 Ignition System, where applicable. **This is under development and not available yet.**

1.8.4 Communications Ports

Three serial communication ports are provided with the RC2000, to support the following communications standards:

- RS 232
- RS 485
- RS 422.

Through these ports, operators can have full access to the control panel from a remote location, can download stored data to a remote location, and can monitor the unit from a SCADA system.

The remote communication interface is compatible with the Modbus RTU protocol for SCADA systems.

Control Panel Functions

2. CONTROL PANEL OPERATION

2.1 Overview

Figure 2–1 shows the control panel layout. It has a display screen at the top, with various pushbuttons beneath it, which are used to perform many different functions.

The actions of the various buttons, the screen displays available, and the operating adjustments that can be made from the panel are explained in this section.



Figure 2–1
Control Panel

The display screen at the top of the panel is an alphanumeric liquid crystal module. It can display 40 characters on a line and up to 8 lines at a time. It provides an interface for the computer and operator to communicate with each other. It is internally lit, and controls are available to vary its contrast (described in Section 2.14.3).

2.2 Initial Screen

During normal operation when the computer is first turned on, the main RUN-MODE screen will be displayed. Refer to Section 2.5 below.

2.3 Navigating Between Screens

Since it is often not possible to display all the information on one screen, several screens are needed for each control function

Use the ▼ and ▲ panel marks, and the <ENTER> button to navigate between the screens. ▼ cycles to the next screen; ▲ to the previous screen. Pushing <ENTER> brings you up a level or back to the main screen.

Numbers in [] are choices which can be made by entering the number with the keypad (see Figure 2–7).

Numbers followed by a : (not in brackets), are just for reference and cannot be chosen.

2.4 Password Access

System access to specific functions and menu selections is password protected.

Three levels of password are available:

- Level 3 permits viewing only.
- Level 2 permits changing basic setpoints commonly adjusted in the field.
- Level 1 allows full access to setpoints, calibrations, programming, etc.

The Level 1 password allows access to set up Level 2 and Level 3 passwords.

Control Panel Functions

Passwords are set under the PROGRAM mode. When the PROGRAM mode is entered, a screen will come up asking for a password and serial number to proceed. Enter your password (must be Level 1) to access PROGRAM mode. If you want to change/setup passwords, follow the screen prompts.

With a new system, the serial number can be transmitted to EFX/BTB Compressors to obtain a 1-time only main password (if not already received). This allows initial Level 1 access to be established.

2.5 Run-Mode Screens

There is a single main RUN-MODE screen and several auxiliary RUN-MODE screens available (Figures 2-2 to 2-6). These screens permit monitoring the condition of the compressor unit.

The first line shows the current date, the screen's title, and the current time. The second line shows any important messages. The remaining lines display the most often viewed operating variables for the compressor unit.

Oct 7/98	Run Mode	11:00 AM	
Suction	Disch(1)	Disch(2)	RPM
0kpa	0kpa	0kpa	0
Shutdowns:	0		
Alarms:	0	Volts	Manifold
Faults:	1	23.5v	-0.1inHg
			Hour
			0

Figure 2-2
Typical Main Run-Mode Screen

May 12/96	Run Mode	11:00 AM
Process Temps	Cylinder Temps	Packing
Suct 1: 80C	Disch (1): 200C	(1): 200C
Suct 2: 80C	Disch (2): 200C	(2): 200C
Suct 3: 80C	Disch (3): 200C	(3): 200C
Final: 60C	Disch (4): 200C	(4): 200C

Figure 2-3
Typical Auxiliary Run-Mode Screen
(Process and Compressor Temperatures)

May 12/96	Run Mode	11:00 AM
Pressures	Miscellaneous	
Eng Oil: 0.0kpa	Eng Vibr: 0.00mm/s	
Comp Oil: 0.0kpa	Comp Vibr: 0.00mm/s	
Fuel/In Gas: 0.0kpa	Gas LEL: 0.0%	
S Filt Diff: 0.0kpa	H2S: 0.0ppm	

Figure 2-4
Typical Auxiliary Run-Mode Screen
(Auxiliary Pressures and Miscellaneous)

May 12/96	Run Mode	11:00 AM
Temperatures		
Eng Oil: 200C	Comp Oil: 200C	
Eng JW In: 200C	Outside Air: 60C	
Eng JW Out: 200C	Enclosure Air: 60C	
Eng Manif Air: 200C		
Eng Exhaust: 200C		

Figure 2-5
Typical Auxiliary Run-Mode Screen
(Auxiliary Temperatures)

May 12/96	Run Mode	11:00 AM
Differentials		
Diff Stg 1 Press:	0kpa	
Diff Stg 2 Press:	0kpa	
Diff Stg 3 Press:	0kpa	

Figure 2-6
Typical Auxiliary Run-Mode Screen
(Differential Pressures)

NOTE The remainder of this section is arranged by keypad function.

The screens and functions for each key are explained in detail.

2.6 Status Key

The <STATUS> key is used to permit the operator to view the status (condition) of shutdowns, alarms, faults, inputs, and outputs. It allows viewing and making changes to certain parameters.

- Press the <STATUS> key.
- The STATUS MENU screen (Figure 2-7) will be displayed.

Jul 29/98	Status Menu	11:00 AM
[1] Shutdowns: 1	[5] Analog Inputs	
[2] Alarms: 1	[6] Discrete Inputs	
[3] Faults: 0	[7] Analog Outputs	
[4] Shutdown List	[8] Discrete Outputs	
[Enter] Exit		

Figure 2-7
Status Menu Screen

- Press a number on the keypad, to choose a menu item (see 2.6.1 to 2.6.8).
- Press <ENTER> to return to the MAIN RUN-MODE screen.

2.6.1 Shutdowns

- From the STATUS MENU screen (Figure 2-7) choose [1].
- The SHUTDOWNS screen (Figure 2-8) will be displayed.

Up to four active shutdowns will show on the screen, in order of most recent occurrence first, sorted by module and channel number.

Shutdowns will show on the screen until they are reset.

Jul 29/98	Shutdowns	11:00 AM
[1] High Disch Stg 3 Press	Fault	
[2] Low Comp Oil Press	Fault	
[3] High Comp Vibration	Fault	
[4] Low Comp Oil Level	Fault	
[Down] More [Up] Previous [Enter] Exit		

Figure 2-8
Typical Shutdowns Screen

- View the next four shutdowns by scrolling to the next screen with the ▼ or going back with the ▲.
- Press <ENTER> to exit and return to the STATUS MENU screen.
- To view details of a particular shutdown or change its settings, choose a shutdown by entering its number with the keypad.
- The CONFIGURATION screen (Figure 2-9) will be displayed.

Refer to Section 2.6.9 for information on configuring shutdowns.

Num	Type	Class	Mode	Wired	Delay	How
51	Analog	A	HH	NC	2.0	ESD
High Gas LEL (40%)						
Status:	Healthy		Value:	0.0%		
Delay:	2.0	Set Point:	40.0%			
[1] Test [Menu]						

Figure 2-9
Typical Configuration Screen

2.6.2 Alarms

- From the STATUS MENU screen (Figure 2-7) choose [2].

Control Panel Functions

- (b) The ALARMS screen (Figure 2–10) will be displayed.

Up to four active alarms will show on the screen, in order of most recent occurrence first.

Alarms will show on the screen until they are reset.

Jul 29/98	Alarms	11:00 AM
[1]	High Comp Oil In Temp Alarm	Fault
[2]	High Disch Stg 1 Press Alar	Fault
[3]	High Disch Stg 3 Press Alar	Fault
[4]	Low Comp Oil Press Alarm	Fault
[Down] More [Up] Previous [Enter] Exit		

Figure 2–10
Typical Alarms Screen

- (c) View the next four alarms by scrolling to the next screen with the ▼ or going back with the ▲.
- (d) Press <ENTER> to exit and return to the STATUS MENU screen.
- (e) To view details of a particular alarm or change its settings, choose an alarm by entering its number with the keypad.
- (e) The CONFIGURATION screen (Figure 2–9) will be displayed.
Refer to Section 2.6.9 for information on configuring alarms.

2.6.3 Diagnostic Faults

- (a) From the STATUS MENU screen (Figure 2–7) choose [3].
- (b) The DIAGNOSTIC FAULTS screen (Figure 2–11) will be displayed.
Up to four active faults will show on the screen, in order of most recent occurrence first.
Diagnostic faults will show on the screen until they are reset.

Jul 29/98	Faults	11:00 AM
[1]	Comp Oil Press Out Of Range	Fault
[2]	Comp Vibration Out Of Range	Fault
[3]	Eng JW Inlet Temp Out Of Ra	Fault
[4]	Eng JW Outlet Temp Out Of R	Fault
[Down] More [Up] Previous [Enter] Exit		

Figure 2–11
Typical Diagnostic Faults Screen

- (c) View the next four faults by scrolling to the next screen with the ▼ or going back with the ▲.
- (d) Press <ENTER> to exit and return to the STATUS MENU screen.
- (e) To view details of a particular fault or change its settings, choose a fault by entering its number with the keypad.
- (f) The CONFIGURATION screen (Figure 2–9) will be displayed.
Refer to Section 2.6.9 for information on configuring faults.

2.6.4 Shutdown List

- (a) From the STATUS MENU screen (Figure 2–8) choose [4] to display all configured shutdowns and alarms.
- (b) The SHUTDOWN LIST screen (Figure 2–12) will be displayed.
Up to four available shutdowns and alarms will show on the screen.

Jul 29/98	All	11:00 AM
[1]	High Disch (3) Temp	Fault
[2]	High Disch (3) Temp Alarm	Fault
[3]	High Disch (4) Temp	Fault
[4]	High Disch (4) Temp Alarm	Fault
[Down] More [Up] Previous [Enter] Exit		

Figure 2–12
Typical Shutdown List Screen

Control Panel Functions

- (c) View the next four items by scrolling to the next screen with the ▼ or going back with the ▲.
- (d) Press <ENTER> to exit and return to the STATUS MENU screen.
- (e) To view details of a particular shutdown or change its settings, choose a fault by entering its number with the keypad.
- (g) The CONFIGURATION screen (Figure 2–9) will be displayed.
Refer to Section 2.6.9 for information on configuring shutdowns.

2.6.5 Analog Inputs

- (a) From the STATUS MENU screen (Figure 2–7) choose [5].
- (b) The ANALOG INPUTS screen (Figure 2–13) will be displayed.
Up to four inputs will show on the screen. The current operating value is also displayed.

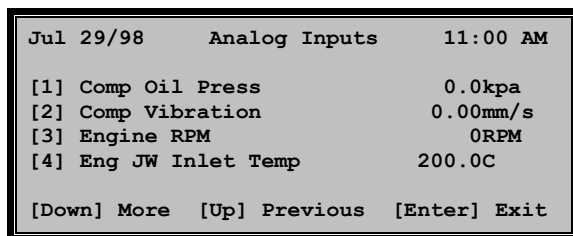


Figure 2–13
Typical Analog Inputs Screen

- (c) View the next four inputs by scrolling to the next screen with the ▼ or going back with the ▲.
- (d) Press <ENTER> to exit and return to the STATUS MENU screen.

- (e) To view calibration information for, or to force or calibrate a particular analog input, choose the appropriate number by entering it with the keypad. One of two calibration screens will appear as shown in Figures 2–14 or 2–15.

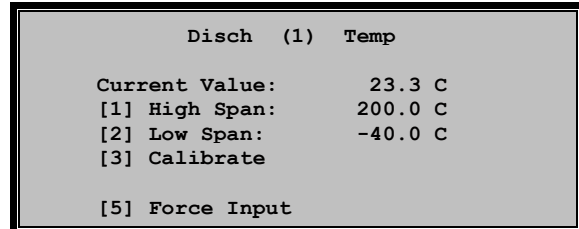


Figure 2–14
Typical Thermocouple Calibration Screen

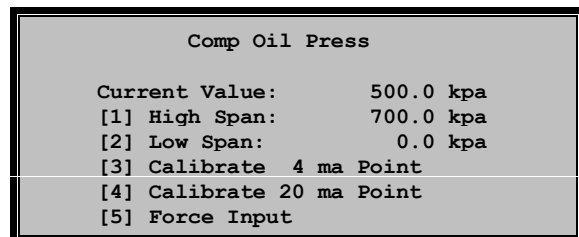


Figure 2–15
Typical 4 to 20 mA Calibration Screen

NOTE: These screens allow the user to force input values. Exercise due caution as inputs are effectively disabled for shutdown and alarm when in a forced state.

DO NOT LEAVE AN INPUT IN A FORCED STATE ON AN UNATTENDED UNIT.

If an input is forced, it is identified by “unfreeze” when selected again.

Control Panel Functions

Thermocouple Inputs

Thermocouple inputs have a high span (highest valid temperature reading) and a low span (lowest valid temperature reading). If the temperature goes outside the span range, a fault will register.

To calibrate a thermocouple input, refer to the *RC2000 Installation and Maintenance Manual*.

To freeze (or unfreeze) an input or to force a fixed value to be read for that input, choose [5] at the screen shown in Figure 2-14.

Upon exiting the CALIBRATION screen, you will be prompted to confirm or remove the force on the input.

4 to 20 mA inputs

4 to 20 mA inputs have a high span (highest valid reading) and a low span (lowest valid reading). If the reading goes outside the span range, a fault will register.

To calibrate a 4 to 20 mA input, refer to the *RC2000 Installation and Maintenance Manual*.

To freeze (or unfreeze) an input or to force a fixed value to be read for that input, choose [5] at the screen shown in Fig. 2-15.

Upon exiting the CALIBRATION screen, you will be prompted to confirm or remove the force on the input.

2.6.6 Discrete Inputs

- (a) From the STATUS MENU screen (Figure 2-7) choose [6].

- (b) The DISCRETE INPUTS screen (Figure 2-16) will be displayed.

Up to four inputs will show on the screen. The status of each discrete input circuit is displayed as CLOSED or OPEN circuit.

Jul 29/98	Discrete Inputs	11:00 AM
Purge Diff Press (3)		Open
Purge Diff Press (4)		Open
Eng JW Level		Open
Eng Oil Level		Open
[Down] More	[Up] Previous	[Enter] Exit

Figure 2-16

Typical Discrete Inputs Screen

- (c) View the next four inputs by scrolling to the next screen with the ▼ or going back with the ▲.
- (d) Press <ENTER> to exit and return to the STATUS MENU screen.

2.6.7 Analog Outputs

- (a) From the STATUS MENU screen (Figure 2-7) choose [7].

- (b) The ANALOG OUTPUTS screen (Figure 2-17) will be displayed.

Up to four outputs will show on the screen. The current output value (%) is also displayed.

Jul 29/98	Analog Outputs	11:00 AM
Governor Control		0%
Bypass Control		0%
Suction Control Valve		0%
IC Louver Control		0%
[Down] More		[Enter] Exit

Figure 2-17

Typical Analog Outputs Screen

- (c) View the next four outputs by scrolling to the next screen with the ▼ or going back with the ▲.

Control Panel Functions

- (d) Press <ENTER> to exit and return to the STATUS MENU screen.

2.6.8 Discrete Outputs

- (a) From the STATUS MENU screen (Figure 2–7) choose [8].
- (b) The DISCRETE OUTPUTS screen (Figure 2–18) will be displayed.

Up to eight outputs will show on the screen. The status of each is displayed as either On or OFF (energized/de-energized)

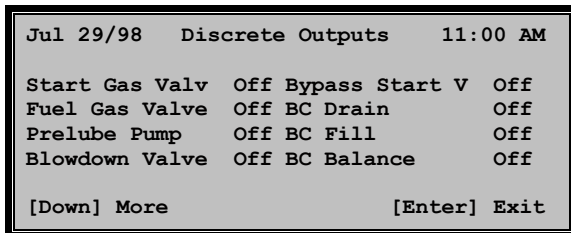


Figure 2–18
Typical Discrete Outputs Screen

- (c) View the next eight outputs by scrolling to the next screen with the ▼ or going back with the ▲.
- (d) Press <ENTER> to exit and return to the STATUS MENU screen.

2.6.9 Fault, Shutdown and Alarm Configuration Screens

- (a) From the SHUTDOWN, ALARM, DIAGNOSTIC FAULTS, or SHUTDOWN LIST screens (Figures 2–8, 2–9, 2–10, or 2–13) choose a particular item.
- (b) The CONFIGURATION screen (Figure 2–9) will be displayed.

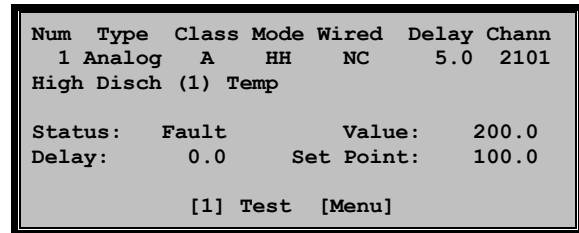


Figure 2–9
Typical Configuration Screen

NOTE: These screens allow the user to force input values. Exercise due caution as inputs are effectively disabled for shutdown and alarm when in a forced or test state.

DO NOT LEAVE AN INPUT IN A FORCED OR TEST STATE ON AN UNATTENDED UNIT.

If an input is forced, it is identified by “unfreeze” when selected again.

The first and second lines of this screen convey the following configuration information about the chosen fault, alarm or shutdown:

Num The reference number of the fault, alarm or shutdown in the list.

Type The type of fault, alarm or shutdown:

Discrete derived from a discrete input device

Analog derived from an analog input device

Differential derived from the difference between two analog input devices

Calculated calculated from one or more analog input devices.

Control Panel Functions

Class The shutdown or alarm class. For Class B, C and E, the class timer value is displayed. For a list of shutdowns, refer to your *Instrument Index* (ensure it's updated if changes are made). A sample of a typical *Instrument Index* is included as Appendix A. There are five shutdown classes:

Class A Enabled at all times; for example, low engine jacket water level.

Class B Enabled after the bypass timer times out following a start sequence; for example, engine oil pressure, which takes a certain amount of time to build up.

Class C Enabled after the input point is initially satisfied following a start sequence. There is only one Class C shutdown, the suction pressure. It must increase above its shutdown setpoint before it is monitored.

Class D Must be healthy to start. Bypassed after start and during normal running.

Class E Must be satisfied to start, but is bypassed for a timed period after start.

Mode The mode of the fault, alarm or shutdown (see your *Instrument Index*):

HH high high shutdown
LL low low shutdown
H high alarm
L low alarm

Wired For discrete inputs only, the wiring of the input end device is programmed into the system:

NO normal operating state is an open circuit; a shutdown or alarm occurs when the circuit closes.
NC normal operating state is a closed circuit; a shutdown or alarm occurs when the circuit opens.

Delay The (filter/debounce) time required for an input device to be in shutdown or alarm condition before the system considers it as an alarm or shutdown. This is used to reduce the frequency of "false" alarms and shutdowns (sometimes called "debounce timer").

SD Method The type of shutdown (ESD, SD, or CL).

The third line of these screens shows the name of the fault, alarm or shutdown.

The fifth and sixth lines (4 is blank) display current information about the fault, alarm or shutdown:

Status The status of the shutdown or alarm. This is either HEALTHY or FAULT, and once an alarm or shutdown occurs, it will remain in FAULT until it is reset.

Control Panel Functions

Value For analog, differential and calculated shutdowns and alarms only, the current value of the monitored shutdown or alarm variable (not shown for discretes).

Delay The current delay time remaining before a shutdown or alarm occurs after the shutdown or alarm condition is first detected (counts down to 0.0 before the shutdown or alarm occurs).

Setpoint For analog, differential and calculated alarms and shutdowns only, the setpoint at which an alarm or shutdown occurs (not shown for discretes).

Configuring Faults, Shutdowns, Alarms

Use the menu choices at the bottom of the screens to adjust the fault, alarm or shutdown. The following procedure should be used for this process. Note that changes to pre-configured alarms/shutdowns must be made with due consideration to safety and equipment protection.

- (a) Choose [1] TEST to place the selected shutdown or alarm in the TEST mode. TEST is used to check shutdowns and alarms while the compressor unit is operating, without causing the unit to shut down.

The control panel will prompt GO INTO TEST MODE? [1] YES, [2] NO.

Choose [1] to enter the TEST mode or [2] to exit and return to the appropriate CONFIGURATION screen.

When the TEST mode is entered, the time remaining (seconds) before expiry appears on line 7.

Test mode will stay active for 20 Min. (1200 Sec.). To exit the mode before

the time expires, choose [2] TEST. The system will prompt CANCEL TEST MODE? [1] YES, [2] NO. Choose [1] to cancel and return to the CONFIGURATION screen, or [2] to allow the mode to continue for its remaining time.

Choose [3] RESET to reset the time for the Test mode.

Assuming YES is selected, for analog, differential or calculated shutdowns and alarms, the control panel will prompt FREEZE ANALOG INPUT [1] YES, [2] NO.

Choose [1] to freeze the input. This will use the value of the input at the time the TEST mode was entered for all shutdown, alarm, and control functions in the control logic. This feature is useful for calibration purposes.

Choose [2] to simply prevent the specific shutdown or alarm from occurring, but use the current value of the input for all other control logic functions, shutdowns or alarms.

- (b) Press <Menu> to change the shutdown or alarm configuration. The CONFIGURATION SETUP screen (Figure 2-19) will be displayed. (An appropriate password is required to access this screen.)

Control Panel Functions

Num	Type	Class	Mode	Wired	Delay	How
1	Analog	A	HH	NC	5.0	CL
High Disch (1) Temp						
Set Point:		100.0				
[1]	Mode	[2]	Class	[5]	Set Point	
[3]	Class Timer		[6]	Delay Timer		
[4]	Shutdown Method		[7]	Wired N/O N/C		

Figure 2–19

Typical Configuration Setup Screen

When any of the following selections are made, a blinking cursor prompts the user to change the setting. Use the menu items at the bottom of the screen (from the keypad) and the keypad numbers, to enter the appropriate changes. The available menu choices are:

- [ENTER] accept the displayed setpoint
- [CLEAR] erase the displayed setpoint
- [.] decimal point
- [DOWN] move left
- [UP] move right

- (c) Choose [1] MODE to change the mode of the shutdown or alarm.
Select one of four modes by pressing the appropriate number on the keypad.
- (d) Choose [2] CLASS to change the shutdown or alarm class.
Select one of five classes by pressing the appropriate number on the keypad. Choosing NOT IN USE from the list displayed will disable the shutdown or alarm.
- (e) Choose [3] CLASS TIMER to change the bypass timer (for Class B, C and E shutdowns and alarms).
- (f) Choose [4] SHUTDOWN METHOD to change the method (CL, SD or ESD).

- (g) Choose [5] SET POINT to change the setpoint for the shutdown or alarm.
- (h) Choose [6] DELAY TIMER to change the delay time for the shutdown or alarm.
- (i) Choose [7] WIRED N/O N/C to toggle the wiring configuration for discrete end devices.

2.7 History Key

The <HISTORY> key permits the operator to view the history of unit operation. This includes past events such as compressor unit starts and stops, alarms, shutdowns and stored data.

2.7.1 History Menu

- (a) Press the <HISTORY> key.
- (b) The HISTORY MENU screen (Figure 2–20) will be displayed.
- (c) Press a number on the keypad to choose a menu item.
- (d) Press <ENTER> to return to the Main RUN-MODE screen.

Jul 29/98	History Menu	11:00 AM
[1]	First In Shutdowns	
[2]	Event History	
[3]	Captured Data	
[Enter] Exit		

Figure 2–20
History Menu Screen

2.7.2 First-in Shutdowns

- (a) From the HISTORY MENU screen choose [1].
- (b) The FIRST-IN SHUTDOWNS screen (Figure 2-21) will be displayed.

Control Panel Functions

Jul 31/98	Select Shutdown	11:00 AM
[1]	High Disch (1) Temp	10:46:05AM
[2]	High Disch (1) Temp	Jul 30/98
[3]	High Disch (1) Temp	Jul 29/98
[4]	High Disch (1) Temp	Jul 28/98
[Down]	More	[Up] Previous [Enter] Exit

Figure 4–21
Typical First-In Shutdowns Screen

- (c) Up to four first-in shutdowns will show on the screen, in order of last occurrence first.
A first-in shutdown is the one that first caused the compressor unit to shut down. Others may occur after the initial shutdown, but since they were not the initial cause, they are not considered first-in shutdowns.
- (d) To view the MAIN RUN-MODE screen at the time a particular first-in shutdown occurred, choose the corresponding number of the first-in shutdown.
- (e) The Run-mode screen for the particular shutdown (Figure 2–22) will be displayed.

Date: Jul 31/98	11:00:77	0		
High Disch (1) Temp				
Suction	Disch1	Disch2	Disch3	RPM
0kpa	0kpa	0kpa	0kpa	0
Shutdowns	Alarms	Volts	Manifold	Hour
0	0	0.00v	0.0inHg	0

Figure 2–22
Typical Shutdown Run-mode Screen

The control panel stores the previous 40 seconds of data (at one-second intervals) for every first-in shutdown. This permits the operator to view the events leading up to a shutdown.

On the RUN-MODE screens, an index number (0 through 39) is displayed in

the upper right-hand corner of the screen. When 0 is displayed, this is the data at the exact time of the first-in shutdown. When 39 is displayed, this is the data 39 seconds before the first-in shutdown occurred.

- (f) To view the various RUN-MODE screens, use the ▼ and ▲ keys.
- (g) Press the [1] and [2] keys to view the data for the 40 seconds leading up to a shutdown.
The index number will increment or decrement accordingly.

2.7.3 Event History

- (a) From the HISTORY MENU screen choose [2].
- (b) The EVENT HISTORY screen (Figure 2-23) will be displayed.

Device	Start Time	Stop Time
High Comp Oil Temp Alarm	Jul 31/98 10:49:46	
Low Comp Oil Press	Jul 31/98 10:49:46	
High JW Outlet Temp Alarm	Jul 31/98 10:49:46	
[Down]	More	[Up] Previous [Enter] Exit

Figure 2–23
Typical Event History Screen

Control Panel Functions

- (c) Up to three events will show on the screen, in order of last occurrence first. The control panel will store up to 335 events.

The name of the event will appear, followed by the date and time of occurrence of the event (START TIME).

For shutdowns and alarms, the date and time that the shutdown or alarm was reset will be displayed (STOP TIME).

- (d) View the next three events by scrolling with the ▼ or going back with the ▲.

2.7.4 Captured Data

- (a) From the HISTORY MENU screen choose [3].
- (b) The MAIN RUN-MODE screen for the most recent data capture (Figure 2–24) will be displayed.

Date: Oct 7/98 11:00:01 0			
Captured Data: [1,4] Backup [2,5] Forward			
Suction	Dischl (1)	Dischl (2)	RPM
500kpa	1500kpa	1500kpa	1675
Shutdowns: 0			
Alarms:	0	Volts	Manifold
Faults:	0	23.5v	4.9inHg
			Hour
			400

Figure 2–24
Typical Captured Data Screen

The control panel stores up to 1400 data captures, set typically to 10-minute intervals. On the RUN-MODE screens, an index number (0 through 1399) will be displayed in the upper right-hand corner of the screen.

When 0 is displayed, this is the data from the most recent data capture.

When 1399 is displayed, this is the data from the oldest stored data capture.

- (c) To view the various sets RUN-MODE screens, use the ▼ and ▲ keys.
- (d) Press the [1] and [2] keys to view the various sets of captured data, one at a time, or the [4] and [5] keys to view 10 sets at a time.

The index number will increment or decrement accordingly.

2.8 Settings Key

The settings key permits the operator to view settings, and change them, for timers (control sequences only) and setpoints controlling shutdowns, alarms, and various control sequences. The following ten choices are included:

- [0] Shutdowns and Alarms
- [1] Prelube Settings
- [2] Crank Settings
- [3] Warmup Settings
- [4] Post-lube Timer
- [5] Dump Timers
- [6] Blowcase Timers
- [7] Purge Timers
- [8] Load Settings
- [9] Start Pressures.

Use the following procedure to navigate in the SETTINGS function:

Control Panel Functions

- (a) Press the <SETTINGS> key.
- (b) The TIMERS & SETTINGS MENU screen (Figure 2–25) will be displayed.

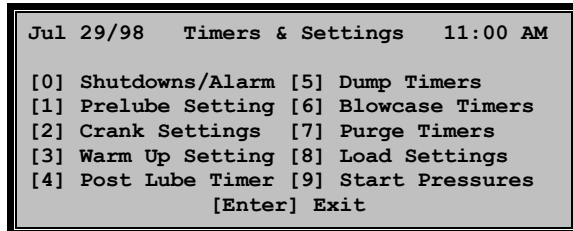


Figure 2–25
Timers & Settings Menu Screen

- (c) Choose an item by entering its corresponding number on the keypad.
- (d) Press <ENTER> to exit and return to the MAIN RUN-MODE screen.

When making any of the following selections, a blinking cursor prompts the user to change the setting. Use the menu items at the bottom of the screen (from the keypad) and the keypad numbers, to enter the appropriate changes. The available menu choices are:

- [ENTER] accept the displayed setpoint
- [CLEAR] erase the displayed setpoint
- [.] decimal point
- [DOWN] move left
- [UP] move right.

Section 3 explains the various control sequences that use the settings in their logic.

2.8.1 Shutdowns and Alarms

- (a) From the SETTINGS MENU screen, choose [0].
- (b) The SHUTDOWNS AND ALARMS screen (Figure 2–26) will be displayed.

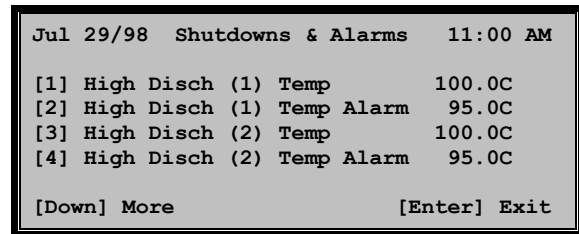


Figure 2–26
Typical Shutdowns and Alarms

- (c) Up to four available shutdowns and/or alarms will show on the screen, together with their current setpoints.
- (d) View the next SHUTDOWNS AND ALARMS screen by scrolling with the ▼ or going back with the ▲.
- (e) To change a setpoint, choose a shutdown or alarm by entering its corresponding number on the keypad.
- (f) A blinking cursor will appear on top of the current setpoint.
Enter the new setpoint using the menu items at the bottom of the screen, and the keypad.

2.8.2 Prelube Settings

- (a) From the SETTINGS MENU screen, choose [1].
- (b) The PRELUBE SETTINGS screen (Figure 2–27) will be displayed.

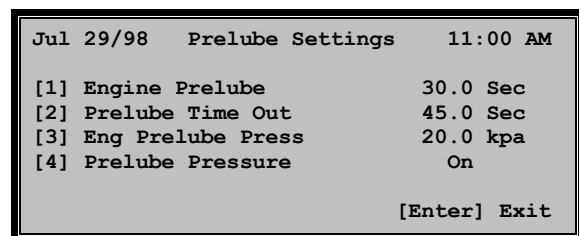


Figure 2–27
Typical Prelube Settings Screen

- (c) Up to four pre-lube parameters will show on the screen, together with their current setpoints.

Control Panel Functions

- (d) To change a setpoint, choose a setting by entering its corresponding number on the keypad.
- (e) A blinking cursor will appear on top of the current setpoint.
Enter the new setpoint using the menu items at the bottom of the screen, and the keypad.

2.8.3 Crank Settings

- (a) From the SETTINGS MENU screen, choose [2].
- (b) The CRANK SETTINGS screen (Figure 2-28) will be displayed.

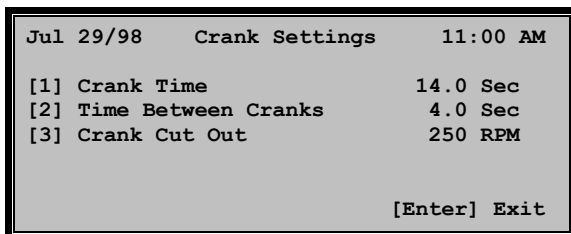


Figure 2-28
Typical Crank Settings Screen

- (c) Three crank parameters will show on the screen, together with their current setpoints.
- (d) To change a setpoint, choose a setting by entering its corresponding number on the keypad.
- (e) A blinking cursor will appear on top of the current setpoint.
Enter the new setpoint using the menu items at the bottom of the screen, and the keypad.

2.8.4 Warmup Setpoints

- (a) From the SETTINGS MENU screen, choose [3].
- (b) The WARMUP SETTINGS screen (Figure 2-29) will be displayed.

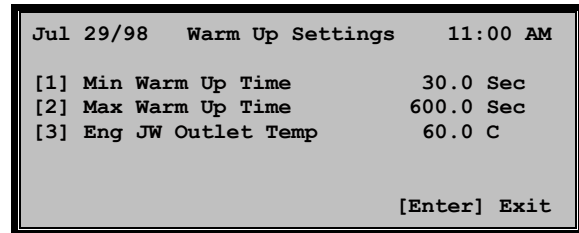


Figure 2-29
Typical Warmup Settings Screen

- (c) Up to three warmup parameters will show on the screen, together with their current setpoints.
- (d) To change a setpoint, choose a setting by entering its corresponding number on the keypad.
- (e) A blinking cursor will appear on top of the current setpoint.
Enter the new setpoint using the menu items at the bottom of the screen, and the keypad.

2.8.5 Post Lube Timer

- (a) From the SETTINGS MENU screen, choose [4].
- (b) The POST LUBE TIMER screen (Figure 2-30) will be displayed.

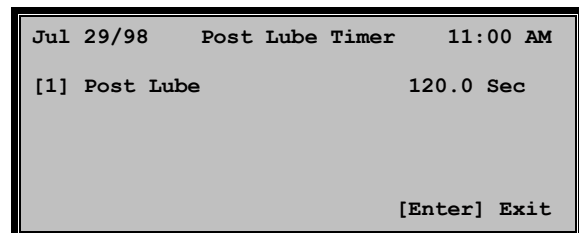


Figure 2-30
Typical Post Lube Timer Screen

- (c) One post-lube parameter will show on the screen, together with its current setpoint.
- (d) To change the setpoint, choose it by entering the corresponding number on the keypad.

Control Panel Functions

- (e) A blinking cursor will appear on top of the current setpoint.

Enter the new setpoint using the menu items at the bottom of the screen, and the keypad.

2.8.6 Dump Timers

- (a) From the SETTINGS MENU screen, choose [5].
- (b) The DUMP TIMERS screen (Figure 2–31) will be displayed.

Jul 29/98	Dump Timers	11:00 AM
[1]	Sep Stg 1 Dump	10.0 Sec
[2]	Sep Stg 2 Dump	10.0 Sec
[3]	Sep Stg 3 Dump	10.0 Sec
		[Enter] Exit

Figure 2–31
Typical Dump Timers Screen

- (c) Up to three dump timer parameters will show on the screen, together with their current setpoints.
- (d) To change a setpoint, choose a setting by entering its corresponding number on the keypad.
- (e) A blinking cursor will appear on top of the current setpoint.

Enter the new setpoint using the menu items at the bottom of the screen, and the keypad.

2.8.7 Blowcase Timers (Option)

- (a) From the SETTINGS MENU screen, choose [6].
- (b) The BLOWCASE TIMERS screen (Figure 2–32) will be displayed.

Jul 29/98	Blowcase Timers	11:00 AM
[1]	BC Drain Delay	5.0 Sec
[2]	Blow Time	120.0 Sec
[3]	BC Fill Delay	3.0 Sec
		[Enter] Exit

Figure 2–32
Typical Blowcase Timers Screen

- (c) Three blowcase timer parameters will show on the screen, together with their current setpoints.
- (d) To change a setpoint, choose a setting by entering its corresponding number on the keypad.
- (e) A blinking cursor will appear on top of the current setpoint.

Enter the new setpoint using the menu items at the bottom of the screen, and the keypad.

2.8.8 Purge Timers

- (a) From the SETTINGS MENU screen, choose [7].
- (b) The PURGE TIMERS screen (Figure 2–33) will be displayed.

Jul 29/98	Purge Timers	11:00 AM
[1]	Start Purge	0.0 Sec
[2]	Stop Purge	0.0 Sec
		[Enter] Exit

Figure 2–33
Typical Purge Timers Screen

- (c) Two purge timer parameters will show on the screen, together with their current setpoints.
- (d) To change a setpoint, choose a setting by entering its corresponding number on the keypad.

Control Panel Functions

- (e) A blinking cursor will appear on top of the current setpoint.
Enter the new setpoint using the menu items at the bottom of the screen, and the keypad.

2.8.9 Load Settings

- (a) From the SETTINGS MENU screen, choose [8].
- (b) The LOAD SETTINGS screen (Figure 2-34) will be displayed.

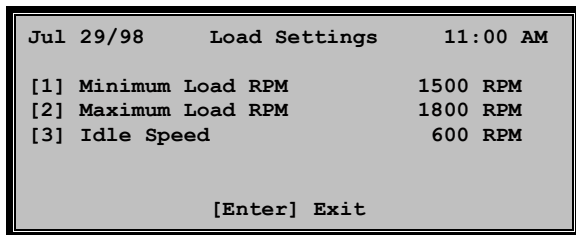


Figure 2-34
Typical Load Settings Screen

- (c) Up to four load parameters will show on the screen, together with their current setpoints.
- (d) To change a setpoint, choose a setting by entering its corresponding number on the keypad.
- (e) A blinking cursor will appear on top of the current setpoint.
Enter the new setpoint using the menu items at the bottom of the screen, and the keypad.

2.8.10 Start Pressures

- (a) From the SETTINGS MENU screen, choose [9].
- (b) The START PRESSURES screen (Figure 2-35) will be displayed.

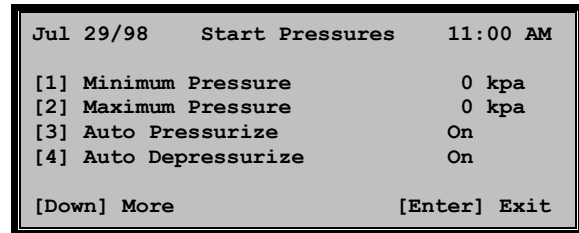


Figure 2-35
Typical Start Pressures Screen

- (c) Up to four start parameters will show on the screen, together with their current setpoints. View a second START PRESSURES screen by scrolling with the ▼ or going back with the ▲.
- (d) To change a setpoint, choose a pressure by entering its corresponding number on the keypad.
- (e) A blinking cursor will appear on top of the current setpoint.
Enter the new setpoint using the menu items at the bottom of the screen, and the keypad.

2.9 Control Key

The <CONTROL> key permits the operator to view, and make changes to, unit variable control setpoints. It also allows the operator to manually control various system outputs. The following choices are typically included:

Control Panel Functions

- [1] Speed Control
- [2] Bypass Control
- [3] Suction Control
- [4] Louver 1 Control
- [5] Louver 2 Control
- [6] Master PID
- [7] Discrete Outputs.

Use the following procedure to navigate in the CONTROL function:

- (a) Press the <CONTROL> key.
- (b) The CONTROL MENU screen (Figure 2-36) will be displayed.

```

Jul 29/98      Control Menu      11:00 AM

[1] Speed Control  [6] Master PID
[2] Bypass Control [7] Discrete Outputs
[3] Suction Control
[4] Louvre 1 Contr
[5] Louvre 2 Contr
                [Enter] Exit
    
```

Figure 2-36
Typical Control Menu Screen

- (c) Choose an item by entering its corresponding number on the keypad.
- (d) Press <ENTER> to exit and return to the MAIN RUN-MODE screen.

When making any of the following selections, a blinking cursor prompts the user to change the setting. Use the menu items at the bottom of the screen (from the keypad) and the keypad numbers, to enter the appropriate changes. The available menu choices are:

- [ENTER] accept the displayed setpoint
- [CLEAR] erase the displayed setpoint
- [.] decimal point
- [DOWN] move left
- [UP] move right.

2.9.1 Individual Loop Controls (Including Speed, Bypass, Suction, Louver Controls, etc., as options)

Individual loop control functions are operated in the same fashion and have been grouped together.

- (a) From the CONTROL MENU screen, choose the appropriate number.
- (b) The corresponding CONTROL screen (ex: Figures 2-37 to 2-40) will be displayed.

```

Speed Control                               Suction
                                           0kpa
Input: Master Control                       Discharge
Output: Governor Control                    -1kpa
Input   SetPoint   Output   PID   RPM
0kpa   0kpa       0RPM   Auto   0

[1]Set [2]Out [3]Man [Menu] [Enter]Exit
    
```

Figure 2-37
Typical Speed Control Screen

```

Bypass Control                               Suction
                                           0kpa
Input: Master Control                       Discharge
Output: Bypass Control                      0kpa
Input   SetPoint   Output   PID   RPM
0kpa   0kpa       0%   Auto   0

[1]Set [2]Out [3]Man [Menu] [Enter]Exit
    
```

Figure 2-38
Typical Bypass Control Screen

```

Suction Control                               Suction
                                           0kpa
Input: Suct Stg 1 Press                     Discharge
Output: Suction Control Valv                0kpa
Input   SetPoint   Output   PID   RPM
0kpa   0kpa       0%   Auto   0

[1]Set [2]Out [3]Man [Menu] [Enter]Exit
    
```

Figure 2-39
Typical Suction Control Screen

Control Panel Functions

```
AC Louvre Control          Suction
                           0kpa
Input:  Disch Final Temp   Discharge
Output: AC Louver Control  0kpa
Input   SetPoint  Output  PID   RPM
60.0C   0.0C     0%     Auto  0
[1]Set [2]Out [3]Man [Menu] [Enter]Exit
```

Figure 2–40
Typical Louver Control Screen

The first line shows the name of the unit-variable control loop.

To assist the operator in proper unit-variable control setup, the suction pressure, discharge pressure, and speed (rpm) are typically displayed on the right-hand side of all the above CONTROL screens.

Section 4 explains the theory behind process control, and the PID control on EFX/BTB compressor units.

The third line shows the name of the input (process variable) to the control loop. For the SPEED CONTROL and BYPASS CONTROL, the input is typically derived from the MASTER PID CONTROL, as explained in Section 4.

The fourth line shows the name of the output (control variable) from the control loop.

The fifth and sixth lines display the current value of the input, control setpoint, and output, and show the current mode of the control loop (AUTO or MANUAL).

- (c) Choose [1] to change the control setpoint.

For the SPEED CONTROL and BYPASS CONTROL, the setpoint is normally changed from the MASTER PID CONTROL screen, as explained in Section 4.

A blinking cursor will appear on top of the current setpoint.

Use the keypad and menu choices at the bottom of the screen to enter the new setpoint.

- (d) Choose [3] to toggle the control loop from MANUAL to AUTO mode.

The control panel will prompt SWITCH TO (AUTO OR MANUAL)? [1] YES, [2] NO.

Choose [1] to change the mode or [2] to leave the mode unchanged and return to the respective CONTROL screen.

- (e) Choose [2] to change the output from the control loop.

The control loop must be in MANUAL to change the output.

A blinking cursor will appear on top of the current setpoint.

Use the keypad and menu choices at the bottom of the screen to enter the new setpoint.

Control Panel Functions

- (f) Press <MENU> to view or change the PID control loop settings for the control loop.

The following PID control configurations can be viewed or changed.

Use the ▼ and menu number to make a choice, or go back with the ▲.

WARNING
<p>Improper Tuning can result in unstable control and could damage the compressor unit.</p> <p>A thorough understanding of process control and tuning techniques is required to properly tune a control loop.</p>

Proportional Band

This feature adjusts the proportional gain of the control loop ($\text{Gain} = 100/\text{proportional band}$). The larger the PROPORTIONAL BAND, the slower the response time of the control loop.

Conversely, a smaller PROPORTIONAL BAND means faster response time. Response time is the time required to return the input to its setpoint. Note that too fast a response time may cause an unstable response.

Choose [1] to change the PROPORTIONAL BAND setting.

Reset

This feature adjusts the integral gain of the control loop (in minutes per repeat). The larger the RESET, the slower the response time of the control loop. Conversely, a smaller RESET means faster response time.

Choose [2] to change the RESET setting.

Rate

This feature adjusts the derivative gain of the control loop (in minutes). The larger the RATE, the faster the response time of the control loop. Conversely, a smaller RATE means slower response time.

Choose [3] to change the RATE setting.

Action

This feature toggles the control loop between DIRECT ACTING and. For a DIRECT ACTING controller, the output will be increased for a positive error and decreased for a negative error. ($\text{Error} = \text{PV} - \text{SP}$; measured/process variable – setpoint) For a REVERSE ACTING controller, the output will be decreased for a positive error and increased for a negative error.

Note that an increasing output to a Fail Open valve will cause the valve to close. The reverse is true on a Fail Close valve.

Choose [4] to toggle between DIRECT ACTING and REVERSE ACTING.

Control Panel Functions

Deadband

This feature adjusts the DEADBAND on either side of the control setpoint. Once the input (process variable) has reached its setpoint, the output (control variable) will remain unchanged until the input strays outside of the DEADBAND; that is., no action will be taken within the \pm DEADBAND (Figure 2–41).

Choose [1] to adjust the DEADBAND setting.

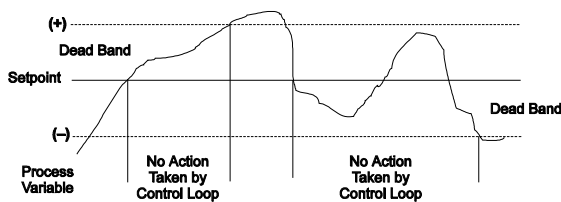


Figure 2–41
Deadband

Manual Output Limits

This feature toggles the MANUAL OUTPUT LIMITS between OUTPUT and PID LIMIT. This is used to determine the range of the output when the control loop is in the MANUAL mode.

When OUTPUT is selected, the operator can set the output anywhere from 0 to 100%.

When PID LIMIT is selected, the operator is limited to setting the output between the OUTPUT LOW and OUTPUT HIGH LIMITS (following).

Choose [2] to toggle the MANUAL OUTPUT LIMITS.

Input Low Limit

This feature adjusts the low limit for the input to the control loop. When the actual input is below the INPUT LOW LIMIT, the INPUT LOW LIMIT value will override as the input to the control loop.

Choose [1] to change the INPUT LOW LIMIT.

Input High Limit

This feature adjusts the high limit for the input to the control loop. When the actual input is above the INPUT HIGH LIMIT, the INPUT HIGH LIMIT value will override as the input to the control loop.

Choose [2] to change the INPUT HIGH LIMIT.

Output Low Limit

This feature adjusts the low limit for the output from the control loop. The actual output is not allowed to decrease below the OUTPUT LOW LIMIT. (Except in MANUAL mode with the MANUAL OUTPUT LIMIT set to OUTPUT.)

Choose [3] to change the OUTPUT LOW LIMIT.

Output High Limit

This feature adjusts the high limit for the output from the control loop. The actual output is not allowed to increase above the OUTPUT HIGH LIMIT. (Except in MANUAL mode with the MANUAL OUTPUT LIMIT set to OUTPUT.)

Choose [4] to change the OUTPUT HIGH LIMIT.

Control Panel Functions**Setpoint Low Clamp**

This feature adjusts the low clamp for the control setpoint of the control loop. If the operator enters a setpoint that is below the low clamp, the SETPOINT LOW CLAMP value will override as the control setpoint for the control loop.

Choose [1] to change the SETPOINT LOW CLAMP value.

Setpoint High Clamp

This feature adjusts the high clamp for the control setpoint of the control loop. If the operator enters a setpoint that is above the high clamp, the SETPOINT HIGH CLAMP value will override as the control setpoint for the control loop.

Choose [2] to change the SETPOINT HIGH CLAMP value.

Setpoint Ramp Rate

This feature adjusts the increment or decrement amount that is used when adjusting the control setpoint using the ▼ and ▲ keys on the keypad to change the setpoint.

Choose [3] to change the SETPOINT RAMP RATE.

Mode

This feature toggles the mode for the control loop when the unit is first powered up between AUTO and MANUAL.

Choose [4] to toggle MODE.

2.9.2 Master PID

Section 4 explains the master PID control system on BTB compressor units.

- (a) From the CONTROL MENU screen, choose [6] (# varies depending on system).
- (b) The MASTER PID screen (Figure 2-42) will be displayed.

Jul 29/98	Master PID	11:00 AM
Mode: Manual		Off
PV Name	Setpoint	PV
[1] Suct Stg 1 Press	100	0
[2] Disch Stg 3 Pres	1000	0
[3] Eng Manifold Air	95.0	0.0
[Enter]Exit	[7]Auto	[8]Setpoint [Menu]

Figure 2-42
Typical Master PID Screen

The second line shows the current mode (AUTO or MANUAL) setting of the MASTER PID CONTROL on the left side and the current status (ON or OFF on the right side).

The MASTER PID CONTROL is turned ON and OFF by the control logic, depending on the current step in the start or stop sequence.

The fourth, fifth and sixth lines display the various inputs (process variables) to the MASTER PID CONTROL. Each input name is shown, along with its control variable and the current value of the input (process variable).

Control Panel Functions

- (c) Choose [7] to toggle the MASTER PID CONTROL between AUTO and MANUAL. The control panel will prompt SWITCH TO AUTO (OR MANUAL)? [1] YES, [2] NO.

Choose [1] to toggle the mode, or choose [2] to exit and return to the MASTER PID screen without making a change.

- (d) To change any of the control setpoints, choose the corresponding number to any of the inputs (process variables). An arrow "<" will appear to the right of the corresponding setpoint. Choose [8] to change the setpoint. A blinking cursor will appear on top of the current setpoint.

Use the keypad and menu choices at the bottom of the screen to enter the new setpoint.

- (e) Press <MENU> to view the control loops that are controlled by the MASTER PID CONTROL. The MASTER PID LOOPS screen (Figure 2-43) will appear.

PID Name	Setpoint	Output
*Bypass Control	0	0
Speed Control	0	0

[Enter] Exit

Figure 2-43
Master PID Loops Screen

The value of the current input (process variable) that is being controlled is shown on the second line.

The fourth and fifth lines display the two (in this case) control loops that are controlled by the MASTER PID CONTROL, along with the control setpoint (for the current variable being controlled) and the current output value (control variable) for the control loop.

An asterisk "*" will appear beside the control loop which is currently being used to control the input (process variable) at its control setpoint.

2.9.3 Discrete Outputs

- (a) From the CONTROL MENU screen, choose [7].
- (b) The DISCRETE OUTPUTS screen (Figure 2-44) will be displayed.

Output Name	Status	Control Option
[1] Start Gas	Off	[5] Bypass Sta
[2] Fuel Gas V	Off	[6] BC Drain
[3] Prelube Pu	Off	[7] BC Fill
[4] Blowdown V	Off	[8] BC Balance

[.]Momentary [0]Toggle [Down] More

Figure 2-44
Typical Discrete Outputs Screen

- (c) Up to eight discrete outputs will be displayed on the screen. The current status (ON or OFF) is displayed beside each discrete output.

View the various screens by scrolling with the ▼ or going back with the ▲.

Control Panel Functions

- (d) To manually force a discrete output ON or OFF, choose the corresponding number beside the particular discrete output.

An arrow '<' will appear to the right of the corresponding discrete output.

- (e) Press and hold <•> to momentarily force the discrete output ON or OFF. When the <•> is released, the output will return to its original state.
- (f) Choose [0] to toggle the discrete output between ON and OFF.

2.10 Stop Key

The <STOP> key permits the operator to stop the compressor unit from a running condition, or to abort a start sequence in progress.

The compressor unit may be stopped using either the normal cooldown stop sequence (CL) described in Section 3, or the fast shutdown sequence (SD) described in Section 3.

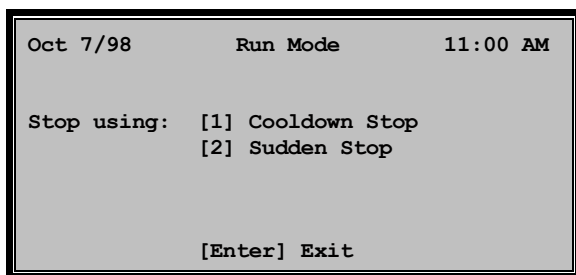


Figure 2-45
Compressor Stop Screen

- (a) From any screen, press the <STOP> key.
- (b) The control panel will prompt STOP USING? [1] COOLDOWN STOP, [2] SUDDEN STOP (Figure 2-45).

Choose [1] to initiate the CL sequence.
Choose [2] to initiate the SD sequence.

- (c) Press <ENTER> to exit and go back to the screen that was displayed before the <STOP> key was pressed, without initiating a stop sequence.

2.11 Start Key

The <START> key permits the operator to initiate a compressor start sequence.

Before a start sequence may be initiated, all shutdowns must be reset, and the message display line on the RUN-MODE screens must read "OK TO START COMPRESSOR".

- (a) From any screen, press the <START> key.
- (b) For an engine-drive unit, the control panel will prompt START USING? [1] AUTO CRANK, [2] MANUAL CRANK.

Choose [1] to initiate the startup sequence using AUTO CRANK (see Section 3).

Choose [2] to initiate the start sequence using MANUAL CRANK. The start sequence will stop at the ENGINE STARTING step (Figure 2-46) and prompt the operator to manually crank the engine.

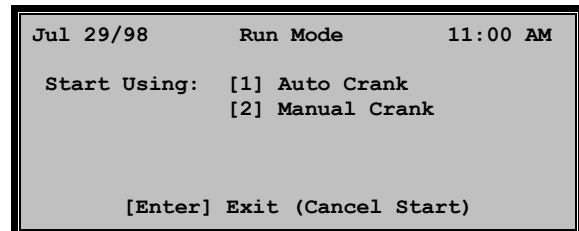


Figure 2-46
Engine Starting Screen

Control Panel Functions

- (c) Press and hold the <START> key (as with a starter button).

If the button is released, the engine must be below 75 rpm before this starter button will work again.

Once the CRANK CUTOUT RPM is reached, the manual button will be disabled and the automatic sequence will continue.

- (d) Press <ENTER> to exit and go back to the screen that was displayed before the <START> key was pressed, without initiating the start sequence.

2.12 Reset Key

The <RESET> key permits the operator to reset shutdowns, alarms and faults that are no longer active.

Before pressing the <RESET> key, all current shutdowns, alarms and faults should be viewed (using <STATUS >).

Pressing <RESET> will reset these items if they have cleared. They can still be viewed by using the <HISTORY> or <STATUS> keys.

- (a) The condition which caused the shutdown, alarm or fault must first be cleared (condition must return to its pre-shutdown, pre-alarm, or pre-fault state).
- (b) Press the <RESET> key to reset any shutdowns, alarms or faults that are registered in the control panel.

2.13 Help Key

This feature is not available at this time.

2.14 Menu Key

The <MENU> key permits access to PROGRAM mode for system setup, DISPLAY

mode to change display between Imperial and SI units, and CONTRAST ADJUST to alter the display's contrast level.

2.14.1 Program Mode

PROGRAM mode enables configuring the control system, and setting it up for various compressor unit configurations and BTB options.

The *RC2000 Installation and Maintenance* manual covers the PROGRAM mode in detail.

2.14.2 Display Mode

- (a) Choose [2] from the MENU screen.
- (b) The DISPLAY screen (Figure 2-47) will be displayed.

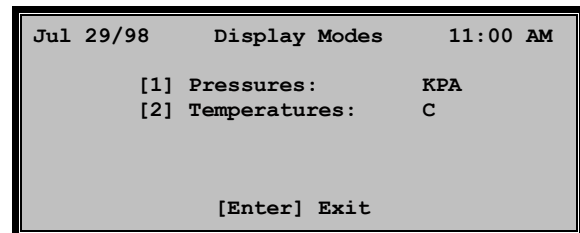


Figure 2-47
Display Modes Screen

- (c) Choose [1] to toggle the pressure unit display between Imperial (psi) and SI (kPa).
- (d) Choose [2] to toggle the temperature unit display between Imperial (°F) and SI (°C).

Control Panel Functions

2.14.3 Contrast Adjust

- (a) Choose [3] from the MENU screen.
- (b) The CONTRAST ADJUST screen (Figure 2-48) will be displayed.

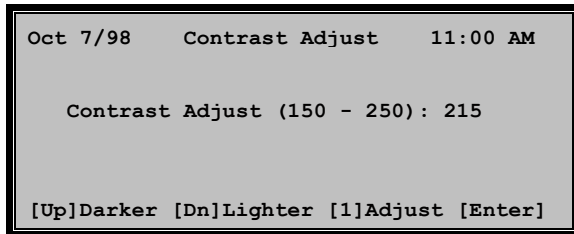


Figure 2-48
Contrast Adjust Screen

The display contrast can be adjusted between 150 (lightest setting) and 250 (darkest setting). The current display contrast setting is displayed on the right-hand side of the screen.

- (c) Press either the ▼ or ▲ until a suitable contrast level is displayed; or choose [1] to enter a number from 150 to 250 using the keypad and the menu choices at the bottom of the screen.
- (d) Press <ENTER> to save the change and return to the MENU screen.

2.15 ESD Key

The <ESD> key permits the operator to initiate an emergency shutdown sequence (see Section 3) from the RC2000 control panel.

- (a) From any screen, press the <ESD> key.

3. CONTROL SEQUENCES

3.1 Introduction

The RC2000 Control System includes pre-configured control sequence logic for specific functions. This Section details the typical control sequence functions available. For variations, refer to the *Program Listing* for your unit.

Note that certain functions may be unavailable, depending on options implemented on your unit.

It is common practice to refer major parts of a control sequence as “steps”.

Step 0 is the initial step of any control sequence. The next major steps are indicated as Step 10, Step 20, etc. Before doing the next major step in a sequence, the previous sequence step must be completed.

This same convention is followed below.

3.2 Emergency Shutdown (ESD)

3.2.1 Initiating an ESD

An ESD is triggered by:

- pressing the <ESD> key on the control panel keypad
- pressing any <ESD> pushbutton
- actuation of an ESD signal, including:
 - loss of fire/ESD loop pressure
 - 40% LEL gas detection
 - fire detection
 - loss of purge differential pressure on sour-gas units
 - 20 ppm H₂S detection.

NOTE: Loss of electrical power to the outputs will effectively trigger an ESD to the device fail state. This does not trigger an ESD Sequence in the RC2000.

3.2.2 ESD Sequence

An ESD initiates a SD Sequence and additionally isolates and blows down the unit. After an ESD is initiated, the unit sequences through the steps described below. Following an ESD, the control system must be reset before a start sequence can be initiated.

- (a) Initiate SD Sequence (see Section 3.5).
- (b) Close these valves simultaneously (where applicable):
 - Inlet ESD valve
 - Discharge ESD valve
 - Utility ESD valve.
- (c) Close the Inlet/Suction Control valve (where applicable).
- (d) Open the Auto Blowdown valve (where applicable).
- (e) Provide an ESD Status indication for user-defined (remote) connection.

3.3 Unit Start

3.3.1 Initiating a Start

The start sequence is initiated by either of the following actions:

- pressing the <START> key on the control panel keypad
- receiving a REMOTE START command (where applicable).

3.3.2 Start Sequence Overview

The start sequence is performed automatically by the control panel. An engine may also be cranked manually (described in Section 2.10).

Before the next start sequence step is initiated, the previous sequence step must be completed.

A Start Sequence Failure timer begins timing as each step of the start sequence is initiated. If a specific sequence step cannot be completed:

- (a) The Start Sequence Failure timer times out.
- (b) A Start Sequence Abort alarm occurs.
- (c) The unit stops using the SD sequence.

NOTE A **START SEQUENCE ABORT** will also happen at any time during the start sequence if the **<STOP>** key on the control panel keypad is pressed, or if a **REMOTE STOP** command is received. The unit will stop by the SD sequence; however, it is not necessary to reset the control system before another start sequence can be initiated.

3.3.3 Start Sequence

The timers and setpoints indicated in this section are specified by the standard control program.

The timers and setpoints can be changed from their initial values using the **<SETTINGS>** key on the control panel keypad (see Section 2.8).

Step 0 — PERMISSIVE TO START

The start sequence may be initiated once the unit is OK TO START. The unit is OK TO START when all shutdown conditions are reset.

Step 10 — Purge and Partial Pressurization

Start sequence Step 10 and Step 20 are performed concurrently. Progression to start sequence Step 30 depends on successful completion of both Step 10 and Step 20.

- (a) Initial valve position (as available):
 - Inlet Control valve Closed
 - Bypass Start valve Open
 - Bypass Control valve Open
 - Auto Blowdown valve Open or Closed.

If the unit is blown down (the Auto Blowdown valve is open) before initiation of the start sequence, Steps (b) through (e) are performed, otherwise the start sequence goes to step (f).

- (b) Close the Bypass Start valve and the Bypass Control valve.
- (c) Open the Inlet Control valve to 15% open position.
- (d) Start the Compressor Purge timer (typically 10 seconds).
- (e) When the Compressor Purge timer times out, close the Auto Blowdown valve.

Control Sequences

- (f) Check unit suction pressure:
- If below the Minimum Partial Pressurization Setpoint (typically 100 kPa) perform Steps (g) and (h).
 - If above the MAXIMUM PARTIAL PRESSURIZATION SETPOINT (typically 600 kPa) perform Steps (i) and (j).

- (g) See (f), open the Inlet Control valve to the 15% open position.

The compressor will begin to pressurize.

- (h) When the unit suction pressure meets the MINIMUM PARTIAL PRESSURIZATION SETPOINT (100 kPa), enable the Suction Startup PID controller (in logic, not accessible the operator).

See Section 4 for details of PID control.

Go to start sequence Step 30 (provided start sequence Step 20 is successfully completed).

- (i) See (f), open the Auto Blowdown valve.

The compressor will begin to de-pressurize.

- (j) When the unit suction pressure has reduced to the MAXIMUM PARTIAL PRESSURIZATION SETPOINT (600 kPa), close the Auto Blowdown valve and enable the Suction Startup PID controller (in logic, not accessible the operator).

See Section 4 for details of PID control.

Go to start sequence Step 30 (provided start sequence Step 20 is successfully completed).

Step 20 — Engine and Compressor Prelube

Start sequence Steps 10 and 20 are performed concurrently. Progression to start sequence Step 30 depends on successful completion of both Step 10 and Step 20.

- (a) Energize the Prelube Pump solenoid/output.
- (b) Start the Prelube Failure timer (90 seconds).

If the start sequence has not progressed to Step 30 before this timer times out, a START SEQUENCE ABORT occurs.

- (c) **If** the engine oil pressure is greater than the ENGINE PRELUBE PRESSURE SETPOINT (typically 70 kPa if engine oil temperature <60°C, 35 kPa if engine oil temperature >60°C), **AND if** the compressor oil pressure is greater than the COMPRESSOR PRELUBE PRESSURE SETPOINT (typically 70 kPa), start the Prelube timer (typically 30 seconds).
- (e) When the Prelube timer has timed out, de-energize the Prelube Pump solenoid/output.
- (f) Go to start sequence Step 30 (provided start sequence Step 10 is successfully completed).

Control Sequences

Step 30 — Engine Starting

- (a) Start the Crank Timeout timer (typically 120 seconds).

If the start sequence has not progressed to Step 40 before this timer times out, a START SEQUENCE ABORT occurs.
- (b) Start the Crank On timer (typically 14 seconds).
- (c) Energize the Start Gas solenoid. The engine shaft should start turning.
- (d) When the engine speed reaches the ENGINE PURGE RPM (typically 20 rpm), start the Engine Purge timer (2 seconds).
- (e) When the Engine Purge timer times out, disconnect the Ignition Shutdown lead from ground. The ignition will fire in sync with the engine rotation.
- (f) Start the Fuel Gas Delay timer (typically 2 seconds).
- (g) When the Fuel Gas Delay timer times out, energize the Fuel Gas solenoid. The engine should fire.
- (h) When the engine speed reaches the CRANK CUT OUT RPM (typically 250 rpm), de-energize the Start Gas solenoid.
 - ❑ If the engine speed does not reach the CRANK CUT OUT RPM before the Crank On timer times out, de-energize the Fuel Gas and Start Gas solenoids and start the Crank Off timer (typically 2 seconds).
 - ❑ When the Crank Off timer times out, repeat Steps (c) through (g).

This will occur three times (typically) in the AUTO mode. The system then gives a Crank Failure alarm and a START SEQUENCE ABORT occurs.

- (i) When the engine speed reaches the IDLE RPM (typically 700 to 900 rpm, 0% governor setpoint), go to start sequence Step 40.

Step 40 — Engine Warmup

- (a) Start the Class B Shutdown timer (individually set for Class B alarms and shutdowns).

When this timer times out for a given alarm/shutdown, enable the alarm/shutdown.
- (b) Start the Engine Warmup (Minimum) timer (typically 30 seconds).
- (c) Start the Engine Warmup (Maximum) timer (typically 600 seconds).
- (d) When the engine jacket water outlet temperature reaches ENGINE JACKET WATER WARMUP SETPOINT (typically 60°C), and the Engine Warmup (Minimum) timer times out, go to start sequence Step 50.

If the Engine Warmup (Maximum) timer times out before the engine jacket water outlet temperature reaches the ENGINE JACKET WATER WARMUP SETPOINT (60°C), a START SEQUENCE ABORT occurs.

Step 50 — Loading

NOTE All PIDs must be in **AUTO** mode for loading to occur.

- (a) Ramp the speed up to the MINIMUM LOAD RPM (typically 1500 rpm) using the Speed Ramp Up & Slowdown PID controller (in logic, not accessible the operator).
- (b) When the speed has reached the MINIMUM LOAD RPM, enable the Inlet Control Valve PID controller (as applicable), and close the Auto Bypass Control valve or Bypass Start valve (as applicable).
- (c) Start the Loading Delay timer (typically 30 seconds).
- (d) When the Loading Delay timer times out, enable the Master PID controller.
This will ramp the Auto Bypass valve closed (as applicable) and control the SPEED SETPOINT (see Section 4 for details).
- (e) The start sequence is now complete and the unit is RUNNING ON-LINE.

3.4 Normal Cooldown Stop (CL)

A CL is the preferred method of stopping the unit, either manually, or from certain less-critical conditions.

3.4.1 Initiating a CL

A CL sequence is initiated by:

- pressing the <STOP> key on the control panel keypad, and selecting normal cooldown

- a REMOTE STOP command (where applicable)
- actuation of a CL (non-critical shutdown) signal: for example, compressor oil temperature HH.

3.4.2 CL Sequence Overview

After a CL is initiated, the unit sequences through the steps described below.

Following a CL, it is **not** necessary to reset the control system before a start sequence can be initiated.

The CL sequence is controlled automatically by the control panel.

Before the next CL sequence step is initiated, the previous sequence step must be successfully completed.

A CL Sequence Failure timer begins timing when the normal cooldown stop sequence is initiated. If a specific sequence step cannot be completed:

- (a) The CL Sequence Failure timer times out.
- (b) A CL Sequence Abort alarm occurs.
- (c) The unit stops using the SD sequence.

3.4.3 CL Sequence

Step 0 — Reduce Speed to MINIMUM LOAD RPM

- (a) Disable the Master PID control.
- (b) Ramp the Bypass Control valve open (where applicable) using the Bypass Auto Slowdown PID controller (in logic, not accessible the operator).

Control Sequences

- (c) Ramp the engine speed down to the MINIMUM LOAD RPM (typically 1500 rpm) using the Speed Ramp Up & Slowdown PID controller (in logic, not accessible the operator).
- (d) Ramp the Inlet Control valve closed (where applicable) using the Suction Slowdown PID controller (in logic, not accessible the operator).
- (e) Disable the Inlet Control Valve PID controller.
- (f) When the engine speed has reduced to the MINIMUM LOAD RPM, disable the Speed Ramp Up & Slowdown PID controller, and open the Bypass Start valve (where applicable).
- (g) Go to CL sequence Step 10.

**Step 10 — Cooldown
(Minimum Load rpm)**

- (a) Start the Cooldown (Minimum Load rpm) timer (typically 60 seconds).
- (b) When the Cooldown (Minimum Load rpm) timer times out, go to CL sequence Step 20.

Step 20 — Reduce Speed (IDLE RPM)

- (a) Ramp the speed down to the IDLE RPM (typically 700 to 900 rpm, 0% governor setpoint) using the Speed Ramp Up & Slowdown PID controller (in logic, not accessible the operator).
- (b) When the speed has reduced to the IDLE RPM, go to CL sequence Step 30.

Step 30 — Cooldown (IDLE RPM)

- (a) Start the Cooldown (Idle rpm) timer (typically 180 seconds).

- (b) When the Cooldown (Idle rpm) timer times out, go to CL sequence Step 40.

Step 40 — Engine Stopping

- (a) De-energize the Fuel Gas solenoid.
- (b) Start the Engine Purge timer (typically 2 seconds).
- (c) When the Engine Purge timer times out, connect the Ignition Shutdown lead to ground, effectively disabling the ignition.
- (d) Energize the Prelube Pump solenoid/output.
- (e) Go to CL sequence Step 50.

**Step 50 — Engine and
Compressor Postlube**

- (a) Start the Postlube timer (typically 120 seconds).
- (b) When the Postlube timer times out, de-energize the Prelube Pump solenoid/output.
- (c) The CL sequence is now complete and the unit is stopped.
- (d) Final valve positions (as available):

<input type="checkbox"/>	Inlet Control valve	Closed
<input type="checkbox"/>	Bypass Start valve	Open
<input type="checkbox"/>	Bypass Control valve	Open
<input type="checkbox"/>	Auto Blowdown valve	Closed.

3.5 Shutdown/Sudden Stop (SD)**3.5.1 Initiating a SD**

A SD Sequence is triggered by:

- pressing the <STOP> key on the control panel keypad, and selecting sudden stop
- actuation of a SD (critical shutdown) signal; for example, Compressor Discharge Press HH.

3.5.2 SD Sequence Overview

After a SD is initiated, the unit sequences through the steps described below. Following a SD, the control system must be reset before a start sequence can be initiated.

The shutdown sequence is performed automatically by the control panel.

Before the next SD sequence step is initiated, the previous sequence step must be successfully completed.

3.5.3 SD (Fast Stop) Sequence

Step 0 — Fast Stop

- (a) Open the Bypass Start valve (as applicable).
- (b) Open the Bypass Control valve (as applicable).
- (c) Close the Inlet Control valve (as applicable).
- (d) Set the SPEED SETPOINT to minimum.
- (e) Disable the Master PID control.
- (f) Disable the Inlet Control valve PID controller (where applicable).
- (g) De-energize the Start Gas solenoid (if currently energized) and the Fuel Gas solenoid.
- (h) Start the Engine Purge timer (2 seconds).
- (i) When the Engine Purge timer times out, connect the Ignition Shutdown

lead to ground, effectively disabling the ignition.

- (j) Energize the Prelube Pump solenoid/output.
- (k) Go to FAST STOP sequence Step 10.

Step 10 —Postlube

- (a) Start the Postlube timer (typically 120 seconds).
- (b) When the Postlube timer times out, de-energize the Prelube Pump solenoid/output.
- (c) The Fast Stop sequence is now complete and the unit is stopped.
- (d) Final valve positions (as available):
 - Inlet Control valve Closed
 - Bypass Start valve Open
 - Bypass Control valve Open
 - Auto Blowdown valve Closed.

3.6 Blowcase Cycle Control

3.6.1 Overview

The control system provides control of the Blow Cycle for the Inlet Separator/Blowcase system.

The Inlet Separator/Blowcase system can be in any one of four modes:

- (a) FILL.
- (b) PRESSURIZATION.
- (c) DRAIN.
- (d) BALANCE.

3.6.2 Fill Mode

The normal mode for the Inlet Separator/Blowcase system is the FILL mode (See Figure 3-1).

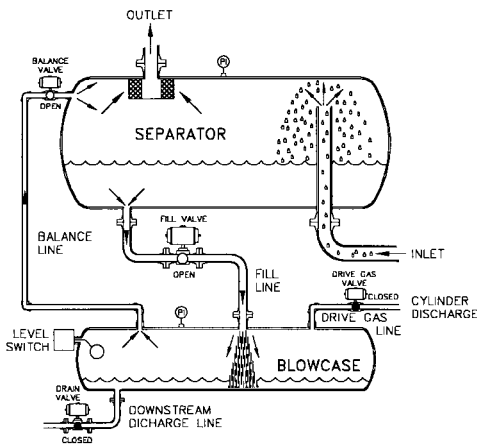


Figure 3-1
Fill Mode

When in the FILL mode, the Inlet Separator/Blowcase valve positions are:

- Fill valve Open
- Balance valve Open
- Drive Gas valve Closed
- Drain valve Closed.

While in the FILL mode, inlet separator liquids drain freely into the Blowcase and the pressures in the Inlet Separator and Blowcase are equalized through the balance line.

- (a) When the liquid level in the Blowcase increases enough to actuate the Blowcase Dump Level Switch, go to the PRESSURIZATION mode sequence.

3.6.3 Pressurization Mode

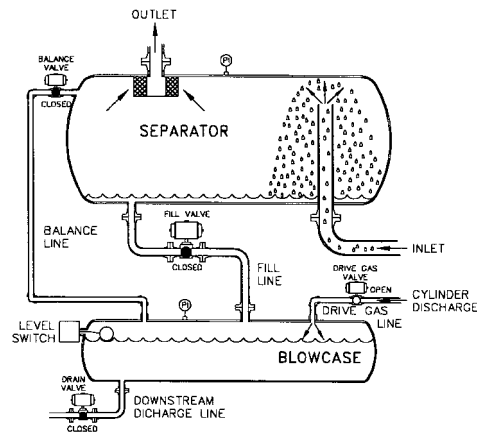


Figure 3-2
Pressurization Mode

- (a) Close the Fill valve and the Balance valve.

This prevents inlet separator liquids from draining into the Blowcase and isolates the Inlet Separator from the Blowcase.

- (b) Start the Blowcase Drive Delay timer (typically 3 seconds).
- (c) When the Blowcase Drive Delay timer times out, open the Drive Gas valve.

This pressurizes the Blowcase in preparation for the DRAIN mode sequence.

- (d) Start the Blowcase Drain Delay timer (typically 5 seconds).
- (e) When the Blowcase Drain Delay timer times out, go to the DRAIN mode sequence.

3.6.4 Drain Mode

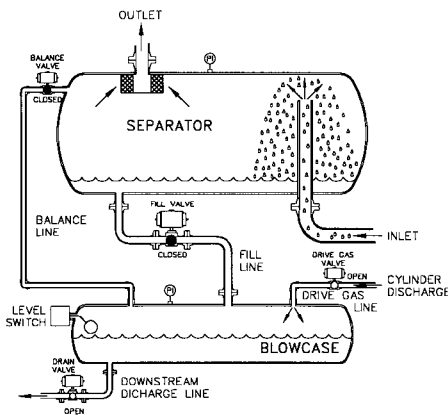


Figure 3-3
Drain mode

- (a) Open the Drain valve.
This forces the liquid in the Blowcase to drain into the discharge line downstream of the unit.
- (b) When the liquid level in the Blowcase decreases enough to return the Blowcase Dump Level switch to its normal position, start the Blowcase Blow timer (typically 120 seconds).

- (c) When the Blowcase Blow timer times out, progress to the BALANCE mode sequence.

3.6.5 Balance Mode

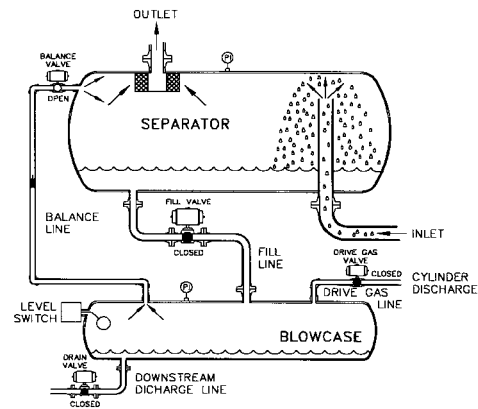


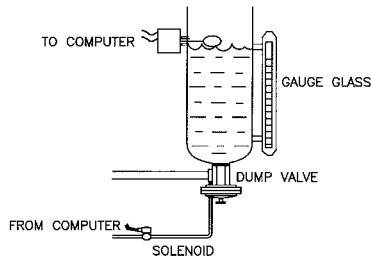
Figure 3-4
Balance Mode

- (a) Close the Drain valve and Drive Gas valve.
- (b) Open the Balance valve.
This allows the pressures in the Inlet Separator and Blowcase to equalize through the balance line.
- (c) Start the Blowcase Fill Delay timer (typically 3 seconds).
- (d) When the Blowcase Fill Delay timer times out, open the Fill valve.
- (e) Return to the FILL mode.

3.7 Separator Boot Dump Valve Control

3.7.1 Overview

The control system provides control of separator boot dump valves (See Figure 3-5).



- | | | |
|--------------------------|----------------------|-------|
| <input type="checkbox"/> | Bypass Start valve | Open |
| <input type="checkbox"/> | Bypass Control valve | Open |
| <input type="checkbox"/> | Auto Blowdown valve | Open. |

NOTE: Loss of electrical power to the outputs will effectively trigger an ESD to the device fail state. This does not trigger an ESD Sequence in the RC2000.

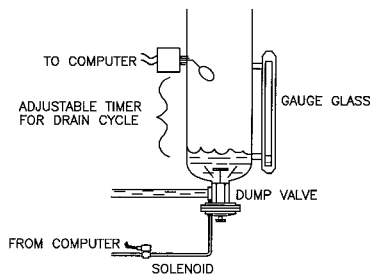


Figure 3-5
Separator Boot Dump valve

3.7.2 Sequence

- (a) When the liquid level in the separator boot increases such that the Separator Boot Dump Level Switch is actuated, open the Separator Boot Dump valve.
- (b) When the liquid level in the separator boot decreases enough to return the Separator Boot Dump Level Switch to its normal position, start the Separator Dump timer (typically 10 seconds).
- (c) When the Separator Dump timer times out, close the Separator Boot Dump valve.

3.8 Power Down

On electric power down, an ESD is initiated and all valves assume the fail-safe positions (as applicable):

- | | | |
|--------------------------|---------------------|--------|
| <input type="checkbox"/> | Inlet Control valve | Closed |
|--------------------------|---------------------|--------|

Controlling Unit Variables

**4. CONTROLLING UNIT
VARIABLES**

This section describes the method used to control unit variables (called “process variables”) at their control setpoint. See Section 2.5 if you want to change settings, display information, etc.

Note that some devices and systems are optional and may not be present on your unit.

4.1 Introduction**4.1.1 Process Control Theory**

There are three basic elements to any process control system (called “control loop”):

- process variable
- control variable
- control setpoint.

The variable that we want to control is called the “process variable”. It is the input to the control loop; for example, the unit suction pressure.

The variable that we use to control the process variable is called the “control variable”. It is the output from the control loop; for example, the Inlet Control valve position.

By changing the control variable (inlet control valve position) we will see a change in the measured process variable (unit suction pressure). Opening the valve further will increase the unit suction pressure; closing it will decrease the unit suction pressure.

The actual value at which the control loop attempts to control the process variable is called the “control setpoint”.

The control setpoint is entered into the control panel and remains at the entered value until it is changed manually by an operator.

For example, if we want the unit suction pressure to be controlled at a value of 1400 kPa, the control setpoint is 1400 kPa.

When the process variable is not at the control setpoint, the control loop will change the control variable until the process variable is at the control setpoint.

If the process variable is at the control setpoint, the control variable remains constant at its last value.

The control loop uses proportional-integral-derivative (PID) control logic to change the control variable in response to changes in the process variable or control setpoint.

4.1.2 PID Control Theory

PID control continuously compares the process variable to the control setpoint and calculates an “error” value:

$$\text{Error} = \text{Process Variable} - \text{Control Setpoint}$$

The error is used to calculate the value of the “control variable”.

The control variable is made up of three components:

$$\text{Control variable} = \text{Proportional Control} + \text{Integral Control} + \text{Derivative Control}$$

Controlling Unit Variables

PID control is developed from complex mathematics. Full explanation is beyond the scope of this manual, but the theory can be simplified, as in the following subsections.

Proportional Control

The proportional component of the control variable is the main output of PID control. It calculates an output amount that is proportional to the error. The larger the error, the larger the proportional component will be, in an attempt to make the process variable equal to the control setpoint. Proportional control alone cannot eliminate all of the error.

Integral Control

The integral control component is proportional to both the error and the length of time the error exists. The larger the error and the longer the error exists, the larger the integral component will be, in an attempt to make the process variable equal to the control setpoint.

The integral control component is used to eliminate all remaining error.

Derivative Control

The derivative control component is proportional to the rate of change of the error. The faster the process variable moves away from the control setpoint, the larger the derivative control component will be, in an attempt to quickly return the process variable to equal the control setpoint.

4.1.3 Tuning PID Control

In PID control, there is a gain setting for each of the three types of control. Determining the appropriate values for each of these gains is referred to as “tuning” a controller.

With a properly tuned PID controller, the process variable will be maintained at the control setpoint during steady-state (normal) conditions. The PID controller will also react quickly to return the process variable to the control setpoint when disturbances occur (such as sudden load changes, etc.).

4.2 Unit Variable Control

The RC2000 control system maintains five different process variables at their control setpoints (as applicable):

1. Unit suction pressure (controlled by the Inlet Control valve, Bypass Control valve, or Engine Speed Setpoint to the Governor).
2. Unit discharge pressure (controlled by the Bypass Control valve or the Engine Speed Setpoint to the Governor).
3. Engine manifold air pressure (controlled by the Bypass Control valve or the Engine Speed Setpoint to the Governor).
4. Compressor interstage gas temperature (controlled by the Intercooler Louvers).
5. Compressor discharge gas temperature (controlled by the Aftercooler Louvers).

Controlling Unit Variables

4.3 Engine Speed Control

The engine speed is controlled by one of two PID controllers, depending on the operating status of the unit (starting, stopping or running):

1. Engine Speed PID controller (Master PID).
2. Speed Ramp Up & Slowdown PID controller.

4.3.1 Engine Speed PID Controller

The Engine Speed PID controller is the main controller used to control the engine speed. It is enabled during start sequence Step 50 “Loading” and is used the entire time the unit is running on line.

For the Engine Speed Control PID, the variables are assigned:

- Process Variable Determined by the Master PID controller (see Section 4.5)
- Control Variable Engine Speed Setpoint to the Governor.

This controller can be set to manual or automatic.

When the controller is in manual, the Engine Speed Setpoint to the Governor will follow the manual output as entered at the control panel keypad, 0% (Idle rpm running) to 100% (1800 rpm) (The display shows % when not running and RPM running.)

When the controller is in automatic, the Engine Speed Setpoint to the Governor will be varied to control any one of the following process variables at its setpoint:

- unit suction pressure
- unit discharge pressure
- engine manifold air pressure.

The Master PID control determines which process variable (and corresponding control setpoint) is used, as described in Section 4.5.

4.3.2 Speed Ramp Up & Slowdown PID Controller

The Speed Ramp Up & Slowdown PID controller is used during the start sequence Step 50 “Loading” to ramp the engine speed up quickly to MINIMUM LOAD RPM.

This controller is also used during the NCS sequence to ramp the engine speed down quickly to MINIMUM LOAD RPM during NCS sequence Step 0 “Reduce Speed to MINIMUM LOAD RPM”. It is used again during Step 20 “Reduce Speed to IDLE RPM” to ramp the speed down quickly to IDLE RPM.

For the Speed Ramp Up & Slowdown PID controller, the variables are assigned:

- Process Variable Engine Speed
- Control Variable Engine Speed Setpoint to the Governor.

This controller is always set to automatic and cannot be used in manual.

4.4 Bypass Control Valve

The Bypass Control valve is controlled by one of two PID controllers, depending on the operating status of the unit (stopping or running):

Controlling Unit Variables

1. Bypass Control Valve PID controller.
2. Bypass Auto Slowdown PID controller.

4.4.1 Bypass Control Valve PID Controller

The Bypass Control Valve PID controller is the main controller used to control the Bypass Control valve. It is enabled during start sequence Step 50 “Loading” and is used the entire time the unit is running on line.

For the Bypass Control Valve PID controller, the variables are assigned:

- Process Variable Determined by the Master PID controller
- Control Variable Bypass Control valve position.

The controller can be set to either manual or automatic.

When the controller is in manual, the Bypass Control valve position will follow the manual output as entered at the control panel keypad (0% to 100% closed).

When the controller is in automatic, the Bypass Control valve position will be varied to control any one of the following process variables at its setpoint:

- unit suction pressure
- unit discharge pressure
- engine manifold air pressure.

The Master PID control determines which process variable (and corresponding control setpoint) is used, as described in Section 4.5.

4.4.2 Bypass Auto Slowdown PID Controller

The Bypass Auto Slowdown PID controller is used during the NCS sequence to ramp the Bypass valve open during NCS sequence Step 0 “Reduce Speed to MINIMUM LOAD RPM”.

For the Bypass Auto Slowdown PID, controller, the variables are assigned:

- Process Variable Unit Discharge pressure
- Control Variable Bypass Control valve position.

This controller is always set to automatic and cannot be used in manual.

4.5 Master PID Control

The Master PID control uses the Engine Speed PID controller and Bypass Control valve to control any one of the following process variables at its control setpoint. (The Master PID control is configured to control the process variable that is closest to its setpoint at any given time):

- unit suction pressure
- unit discharge pressure
- engine manifold air pressure.

The Master PID control is configured to first enable the Bypass Control valve PID controller to control the process variables.

Once the Bypass Control valve reaches the 100% closed position, the Engine Speed PID controller will be enabled and the Bypass Control valve will remain in the 100% closed position.

Controlling Unit Variables

This is accomplished by subtracting an offset from the unit suction pressure control setpoint, and adding offsets to the unit discharge pressure and engine manifold air pressure control setpoints used by the Bypass Control valve PID controller.

The control setpoints used by the Engine Speed PID Controller remain unchanged.

4.5.1 Example

For both the Bypass Control valve and Engine Speed PID controllers, initial control setpoints and offsets are configured:

Process Variable	Control Setpoint (kPa)	Offset (kPa)
Unit suction press.	1400	-100
Unit discharge press.	7000	+150
Engine manifold air air press.	120	+20

During start sequence Step 50 “Loading”, the Master PID control is enabled and the Bypass Control Valve PID controller begins to control to the unit discharge pressure control setpoint.

The Bypass Control valve begins to close, resulting in an increase in unit discharge pressure. Once the Bypass Control valve reaches the 100% closed position, the Master PID control enables the Engine Speed PID controller.

At the same time, the Master PID control subtracts an offset of 100 kPa from the unit suction pressure control setpoint for the Bypass Control Valve PID controller. It also adds offsets of 150 kPa and 20 kPa to the unit discharge pressure and engine manifold air pressure control setpoints, respectively, for the Bypass Control Valve PID Controller.

The Bypass Control Valve PID controller now uses setpoints of:

Process Variable	Control Setpoint (kPa)
Unit suction press.	1300
Unit discharge press.	7150
Engine manifold air air press.	140

The Engine Speed PID controller retains the initial control setpoints. This allows the Engine Speed PID controller to control the process variables, while the Bypass Control valve remains in the 100% closed position, maximizing the unit efficiency.

4.6 Inlet Control Valve

Where an Inlet Control valve is used, the unit suction pressure is controlled by one of three controllers, depending on the operating status of the unit (starting, running or stopping).

1. Inlet Control Valve PID controller.
2. Suction Startup PID controller.
3. Suction Slowdown PID controller.

Controlling Unit Variables

NOTE Where an Inlet Control valve is used, the unit suction pressure control setpoint used by the Master PID control must be set to a lower value than the control setpoint used for the Inlet Control Valve PID controller.

In this case, the Master PID control acts only as an override, should the Inlet Control Valve PID controller fail to maintain the unit suction pressure at its control setpoint.

4.6.1 Inlet Control Valve PID Controller

The Inlet Control Valve PID controller is the main controller used to control the unit suction pressure. It is enabled during start sequence Step 50 “Loading” and is used the entire time the unit is running on line.

For the Inlet Control Valve PID controller, the variables are assigned:

- Process Variable Unit Suction pressure
- Control Variable Inlet Control valve position.

The controller can be set to either manual or automatic.

When the controller is in manual, the Inlet Control valve position will follow the manual output as entered at the control panel (0% to 100% open).

When the controller is in automatic, the Inlet Control valve position will be varied to control the unit suction pressure at its control setpoint.

4.6.2 Suction Startup PID Controller

The Suction Startup PID controller is used to maintain a minimum unit suction pressure during start sequence Step 10 “Purge and Partial Pressurization”, and until the Inlet Control Valve PID controller is enabled during start sequence Step 50 “Loading”.

For the Suction Startup PID controller, the variables are assigned:

- Process Variable Unit Suction pressure
- Control Variable Inlet Control valve position.

This controller is always set to automatic and cannot be used in manual.

4.6.3 Suction Slowdown PID Controller

The Suction Slowdown PID controller is used during the NCS sequence to ramp the Inlet Control valve closed during Step 0 “Reduce Speed to Minimum Load RPM”.

For the Suction Slowdown PID controller, the variables are assigned:

- Process Variable Unit Suction pressure
- Control Variable Inlet Control valve position.

This controller is always set to automatic and cannot be used in manual.

4.7 Gas Cooler Louver Control

Up to two PID controllers can be used to control the gas cooler intercooler and aftercooler louvers.

1. Intercooler PID controller.
2. Aftercooler PID controller.

Controlling Unit Variables

Where two controllers are used, the variables are assigned:

Intercooler

- Process Variable Suction Stage 2 temperature
- Control Variable Intercooler Louver position.

Aftercooler

- Process Variable Discharge Final temperature
- Control Variable Aftercooler Louver position.

Where one controller is used, these variables are assigned:

- Process Variable Discharge Final temperature
- Control Variable Intercooler and Aftercooler Louver position.

The Gas Cooler Louver PID controllers can be set to either manual or automatic.

When they are in manual, the louver positions will follow the manual output as entered at the control panel (0% to 100% open).

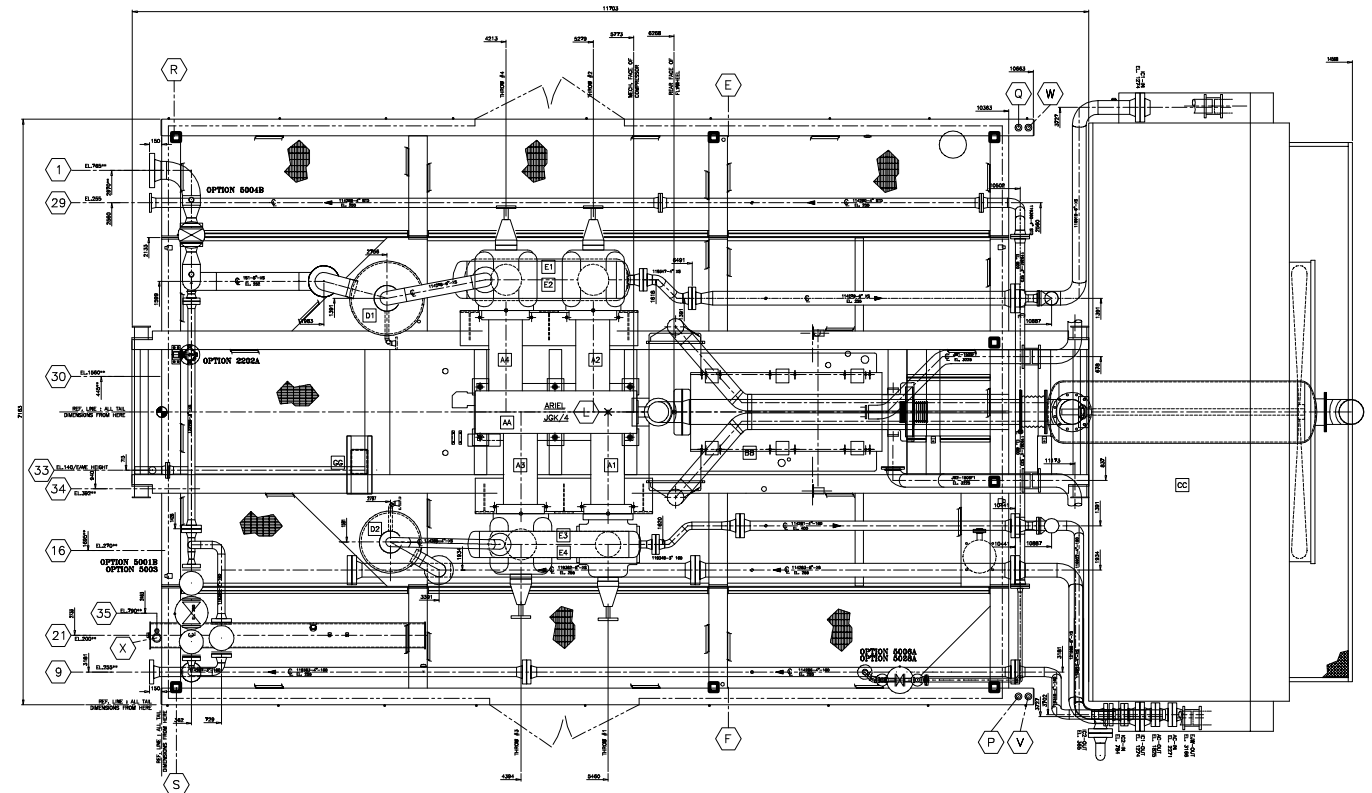
When the Gas Cooler Louver PID controllers are in automatic, the louver positions will be varied to control the Suction Stage 2 gas temperature and/or Discharge Final temperature at their respective control setpoints.

ENERFLEX

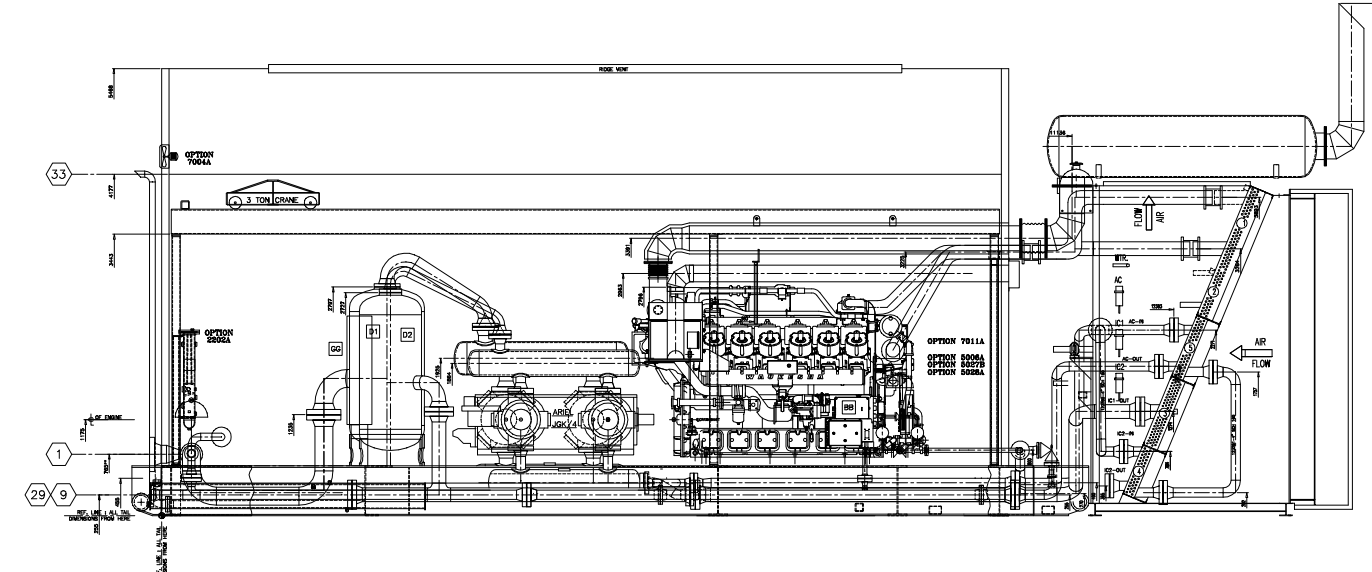
DRAWINGS



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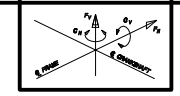
PLAN VIEW



ELEVATION VIEW

COMPRESSOR UNBALANCED FORCES @ _____ RPM _____ RPM

	PRIMARY	SECONDARY
HORIZONTAL FORCE, N	HPF	HSF
VERTICAL FORCE, N	VPF	VSF
HORIZONTAL COUPLE, N.m	HPC	HSC
VERTICAL COUPLE, N.m	VPC	VSC



SHIPPING INFORMATION						
UNIT DIMENSIONS	LENGTH		WIDTH		HEIGHT	
	mm	ft/in	mm	ft/in	mm	ft/in
MAIN SKID w/ ALL EQUIP. MOUNTED	14568	47'-9"	7811	25'-8"	5468	17'-11"
SHIPPING DIMENSIONS	11703	38'-5"	7163	23'-8"	5488	17'-11"
COOLER	2865	9'-5"	7811	25'-8"	4068	13'-5"

GENERAL NOTES

- THIS DRAWING IS NOT TO BE USED FOR CONSTRUCTION UNLESS STAMPED "RELEASED FOR MANUFACTURE".
- DO NOT SCALE THIS DRAWING.
- ALL DIMENSIONS ARE IN MILLIMETERS.
- FOR DESIGN PARAMETERS AND PAINT SPECIFICATION REFER TO PROJECT SCOPE SUMMARY DRAWING NO. SSM01087.
- ALL PIPING MUST BE SELF SUPPORTING BEYOND UNIT CONNECTIONS.
- LOCATIONS OF CUSTOMER CONNECTIONS ARE NOT GUARANTEED AS THESE DIMENSIONS MAY BE SUBJECT TO AN ACCUMULATION OF TOLERANCES ON SEVERAL COMPONENTS. MINOR CHANGES MAY ALSO BE MADE ON SCHEDULED SERVICE PIPING IN ORDER TO FACILITATE INSTALLATION AND MAINTENANCE. ON COMPLETION A FINAL DRAWING WILL BE ISSUED WITH FIELD CONNECTIONS CORRECTED TO 3 mm.
- IT IS SELLER'S RECOMMENDATION THAT ANY PRE-SPRIGGING TO THIS COMPRESSOR PACKAGE CONTAIN FIELD WELDS AT ALL CUSTOMER CONNECTIONS.
- DIMENSIONS INDICATED (*) SHALL BE CONFIRMED AND CERTIFIED CORRECT (**) ON A FINAL REVISION.
- THE FOLLOWING ITEMS WILL BE SHIPPED LOOSE FOR FIELD INSTALLATION BY OTHERS:

CUSTOMER CONNECTIONS			OTHER CONNECTIONS		
NO.	DESCRIPTION	SIZE	NO.	DESCRIPTION	SIZE
E	COMPRESSOR OIL TANK FILL	1" NPT	1	PROCESS INLET	12" SDRFP
F	ENGINE OIL TANK FILL	1" NPT	9	FINAL DISCHARGE	4" SDRFP
L	COMPRESSOR CRANKCASE VENT	1" NPT	16	SCRUBBER DRAIN	1 1/2" COUPLING
M	WASTE OIL TANK VENT	1" NPT	21	PACKING VENT AND DRAIN TANK DRAIN	2" NPT
O	GLYCOL TANK VENT	1" NPT	29	PGV HEADER	4" 150#RF
P	ENGINE OIL TANK VENT	3/4" NPT	30	FUEL GAS SUPPLY	2" 150#RF
Q	COMPRESSOR OIL TANK VENT	3/4" NPT	33	START GAS EXHAUST	3" 150#RF
V	WASTE OIL TANK PUMP OUT	2" NPT	34	START GAS SUPPLY	2" COUPLING
W	GLYCOL TANK PUMP OUT	2" NPT	35	PACKING VENT AND DRAIN TANK LP VENT	1" NPT
X	PACKING VENT AND DRAIN TANK PUMP OUT	2" NPT			

MAJOR COMPONENTS & SHIPPING WEIGHTS		
NO.	DESCRIPTION	ESTIMATED UNIT WEIGHTS, TWO STAGE
BB	ENGINE WAIKESHA L704ZGL 5882	21300
BA	COMPRESSOR	17900
CA	(1) ARIEL JGR/4	8045
CB	(2) 8.5/8" X CLASS	50455
CC	(2) 4.1/4" X CLASS	110000
LESS BUILDINGS & WINGS		
	BUILDING	3864 8500
	SKID WINGS WITH CRANE	8864 19500
	COMPLETE UNIT (WITH WINGS & BUILDING)	62727 138000
DD	SCRUBBERS	12045 26500
EE	(1) 18" STAGE 1 SUCTION BOTTLE	
ES	(1) 18" STAGE 1 DISCH. BOTTLE	
ET	(1) 12" STAGE 2 SUCTION BOTTLE	
EU	(1) 12" STAGE 2 DISCH. BOTTLE	
FF	FUEL GAS FILTER	
GG	CONTROL PANEL	
HH	ESL STD	
II	ESL RC2000	
SKID CENTER SECTION	25000	55000
MISC. SKIDS & LIQUIDS	2500	5500

OPTION NUMBER	DESCRIPTION
8004A	UTILITY GAS FILTER SEPARATOR
8001B	AUTO/PGV CAPACITY CONTROL
8005	AUTO/PGV BLOCK VALVES
8004B	AUTO SUCTION CONTROL
8006A	AUTO/LOWDOWN
8007B	GLASS VALVE OR BLOWDOWN
8009A	AUTO BLOWDOWN BLOCK VALVES
7011A	ERGONOMIC PACKAGE
7004A	BUILDING EXHAUST FAN

CUSTOMER: _____ CONSULTANT: _____ PROJECT LOCATION: _____
 JOB NO: 060158 PO#: _____ LNO: _____

BTB Compressors
4789 47 ST. SE. CALDWIN AL. CANADA T9B 0H1
 TEL: 781-338-6800 FAX: 1 800 376-3347
 WWW.BTB-COMPRESSORS.COM

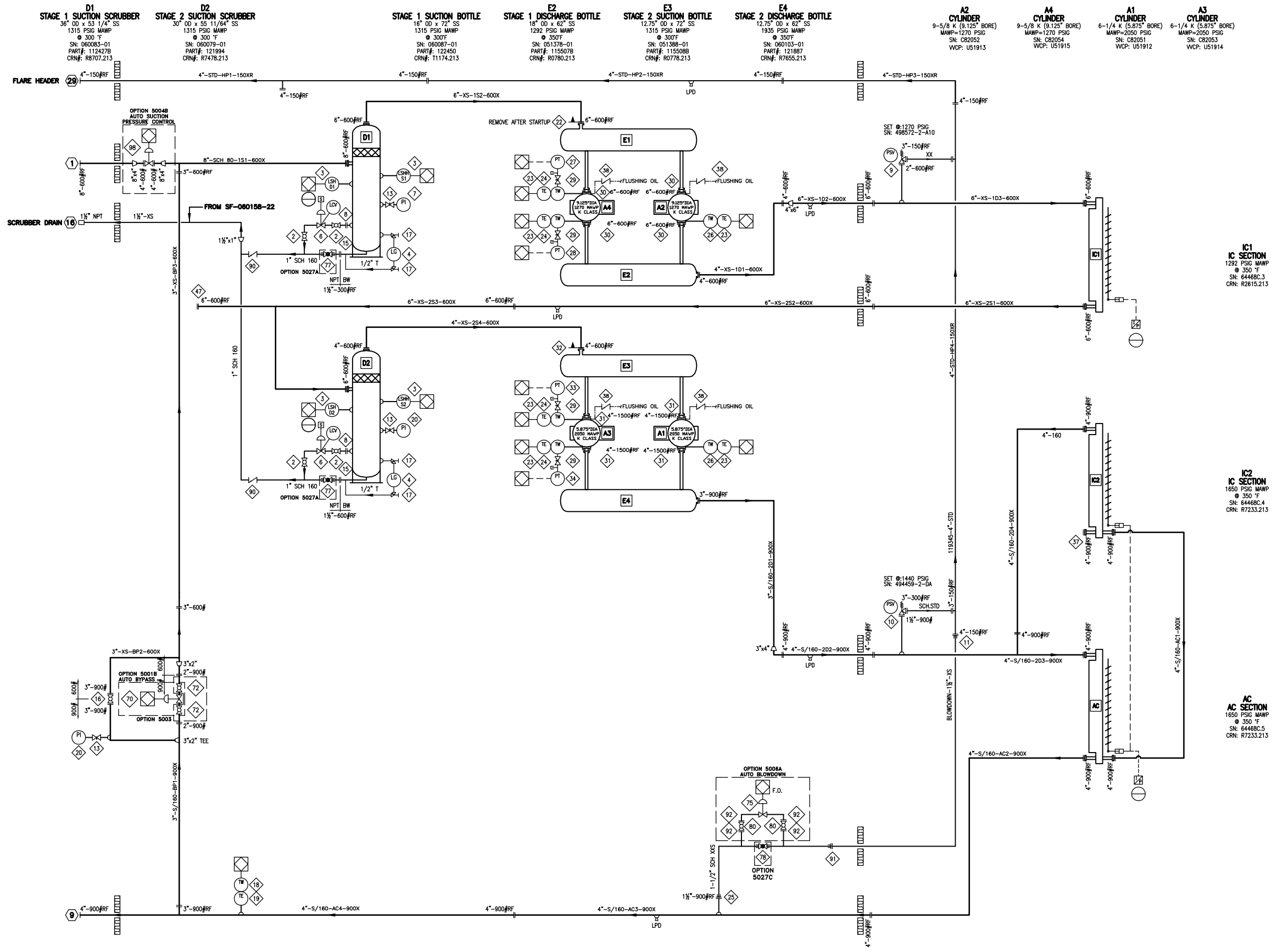
GENERAL ARRANGEMENT
 ARIEL JGR/4, WAUKESHA L704ZGL, AIR-X 144EF
 A1478
 2/3 STAGE COMPRESSOR PACKAGE

DESIGNED BY: WAT	DATE: 08/09/13	CHK: SS
APPROVED BY: RC	DATE: 08/09/17	CHK: SS
DRAWN BY:	DATE:	CHK: SS
CHECKED BY:	DATE:	CHK: SS

REV 1 AS BUILT 08/09/13 LMC SS
 0 ISSUED FOR CONSTRUCTION 08/09/17 LMC SS
 0 DESCRIPTION DATE DRAWN BY CHECKED BY

PROJ. UNIT: METRIC DWG. NO.: GA-060158 OF 10
 SCALE: NTS

P:\Projects\BTB\060158-Built\PF-060158-50(R2).dwg Jul 04, 2007 - 1:24pm



BILL OF MATERIAL			
ITEM	QTY	EXF CODE	DESCRIPTION
FRAME			
2	4	109995	VALVE, BALL, 1" NPT, 3000# WOG, RP, CS, NACE C/W LOCKING (NUTRON, T3-R10S30S)
3	4	108128	SWITCH, LEVEL, 2" NPT, CSA, SOUR MANUAL OVERRIDE, C/W 316SS FLOAT FLNG, L471-41
4	2	1038660	GAUGE, LEVEL, CS WITH REFLEX FLAT GLASS, NACE, 1/2" NPT, 150# (DANIEL, 71RL-N)
6	2	104854	VALVE, CONTROL, 1" NPT, LCC, FLOW ADJ, FC, NACE, 0-35# (FISHER/FLOPRO, D2-X1)
7	1	107884	GAUGE, PRESSURE, BM, 4" LF, 0-1000 PSI DUAL, 1/2" NPT (WIKA, 233.54)
8	2	106476	FLANGE, RF SCRD, 1" 600# SA105N
13	3	108017	VALVE, GAUGE, 3/4" NPTM X 1/2" NPTF, CS, A105, NACE, (CENTURY, CM11-2-M64T-CN-T)
15	2	106359	FLANGE, RF RED HUB, 1-1/2" 600# X 1" SW SA105N
16	1	102969	VALVE, BALL, 3" 900# RF, RP, CS, NACE C/W HANDLE (NUTRON, T3-R30R09S)
17	2	103698	VALVE, SET GAUGE, NACE, 1/2" NPT X 3/4" MNPT, CS, 3470# (DANIEL, 15-N)
18	1	123380	THERMOCOUPLE, K TYPE, 316SS, 1/4" THERMOKINETICS, K250-316-S-010.0-B-82X-YM-72
19	1	105166	THERMOWELL, 316SS, BTB STYLE 5, 1/2" X 3/4" NPTM, U=2.5", 260" BORE
20	2	107897	GAUGE, PRESSURE, BM, 4" LF, 0-2000 PSI DUAL, 1/2" NPT (WIKA, 233.54)
25	1	107884	FLANGE, RED HUB 1-1/2" 9/1500# X 1-1/2" SW, SA105N
38	4	116621	VALVE, CHECK, DOUBLE BALL, 1/4" NPT, 316SS, 8000 MAMP (LINCOLN, 880518-9)
BILL OF MATERIAL: M BTB A1478 FRAME-SOUR/SWEET-63 : PROCESS VALVING			
2 STAGE SOUR			
9	1	113153	VALVE, PSV, 2" 600# RF X 3" 150# RF, .785 OR, NACE L (FARRIS, 26HA13-120/00)
10	1	122871	VALVE, PSV, PILOT, 1-1/2" 900# RF X 3" 300# RF (FARRIS, 38GC14-120/00)
11	1	122898	FLANGE, RF RED HUB, 4" 150# X 1-1/2" SW SA105N
22	1	104264	STRAINER, CONE, 6" 600# SS, 40 MESH, 100% FLOW AREA
23	6	117910B	THERMOCOUPLE, K TYPE, 316SS, 7.5" THERMOKINETICS, K125-316S007.5882X000-0048-99
24	4	114198D	TWELL, 316SS, 1/8" X 1/2" MNPT, 1/4" FNPT PRESSURE PORT, U=2.625", 1650 MAMP
26	2	115505	THERMOWELL, 316SS, BTB STYLE 6B, 1/2" X 1/2" NPTM, U=2.5", 203" BORE
27	1	107995	TRANSMITTER, PRESSURE, 0-1000 PSIG, NACE, 1/4" NPT (WIKA, 892.23.520)
28	1	112184	TRANSMITTER, PRESSURE, 0-1500 PSIG, NACE, 1/4" NPT (WIKA, 892.23.520)
29	4	102802	VALVE, PLUG, 1/4" TUBE, 316SS (NUPRO, SS-4P4)
32	1	104252	STRAINER, CONE, 4" 600# SS, 40 MESH, 100% FLOW AREA
33	1	112184	TRANSMITTER, PRESSURE, 0-1500 PSIG, NACE, 1/4" NPT (WIKA, 892.23.520)
34	1	107698	TRANSMITTER, PRESSURE, 0-2000 PSIG, NACE, 1/4" NPT (WIKA, 892.23.520)
37	1	106298	FLANGE, RF BLND, 4" 900# SA105N
30	4	105504	**ORIFICE PLATE, TYPE 520, 316SS, 1/8" THK, 6" 600#, FULL BORE
31	4	105383	**ORIFICE PLATE, TYPE 520, 316SS, 1/8" THK, 4" 1500# RF, FULL BORE
47	1	106304	FLANGE, RF BLND, 6" 600# SA105N
BILL OF MATERIAL: M BTB A1478 2 STG-SOUR-63 : PROCESS VALVING			
ITEM 30,31,47 NOT IN VISUAL			

OPTIONS			
ITEM	QTY	EXF CODE	DESCRIPTION
OPTION 5001B, AUTO BYPASS CAPACITY CONTROL			
70	1	121628	VALVE, CONTROL, 2" 9/1500# RF, LCC, 1" OR, FO, NACE, 0-33 PSI (FISHER, D4)
BOM: M 113632 : OPTION 5001B, AUTO BYPASS CAPACITY CONTROL, A1478			
OPTION 5003, AUTO BY-PASS BLOCK VALVES			
72	2	113079	VALVE, BALL, 2" 9/1500# RF, RP, CS, NACE C/W LOCKING HANDLE (NUTRON, T3-F20R15SL)
BOM: M 123243 : OPTION 5003, AUTO BY-PASS BLOCK VALVES, A1478			
OPTION 5004B, AUTO SUCTION PRESSURE CONTROLLER			
98	1	127124	VALVE, CONTROL, 4" 3/600# RF, WCC, NACE C/W DVC6020, LH (FISHER, 1051-Y200-40)
99	6	117235	STUD, 7/8" X 14" LONG SA193-B7M (100% TESTED)
100	2	126064	STUD, 7/8" X 17-1/2" LONG SA193-B7M (100% TESTED)
BOM: M 113633 : OPTION 5004B, AUTO SUCTION PRESSURE CONTROLLER, A1478			
OPTION 5006A, AUTO BLOWDOWN VALVE			
75	1	118070	VALVE, CONTROL, 1" NPT, LCC, FLOW ADJ, FO, NACE, 0-35# (FISHER/FLOPRO, D2-X2)
OPTION 5027A, GLOBE VALVE ON SCRUBBER DRAIN 1-2 STG			
77	2	124459	VALVE, GLOBE, 1" SW, 1500# WOG, CS, NACE (NAVCO, GL-R10W15A12)
OPTION 5027C, GLOBE VALVE ON MANUAL BLOWDOWN			
78	1	114714	VALVE, GLOBE, 1-1/2" SW, 1500# WOG, A105, NACE (NAVCO, GL-R15W15A12)
OPTION 5028A, BLOWDOWN BLOCK VALVE, FLANGED			
80	2	117034	VALVE, BALL, 1" 9/1500# RF, RP, CS, NACE, FIRESAFE DESIGN (NUTRON, T3-R10R15S2)
BOM: M 123244 : OPTION 5028A, BLOWDOWN BLOCK VALVE, FLANGED, A1478			
90	2	109950	VALVE, CHECK, PISTON, 1" NPT, 800# WOG, LOW TEMP, NACE (NAVCO, CP-R10S0B12)
91	2	119723	FLANGE, RF RED HUB, 1-1/2" 150# X 1" SW SA105N
92	4	124369	FLANGE, RF RED HUB, 1" 9/1500# X 1" SW SA105N

AC SECTION					
ITEM	QTY	EXF CODE	DESCRIPTION		
2	AS BUILT	(CHANGE STAGE 2 PSV SET @ 1440 PSIG)	07/06/25	ZQS	LB
1	AS BUILT		06/09/13	LHC	SS
0	FOR CONSTRUCTION		06/08/04	LGK	SS

REV	DESCRIPTION	DATE	DRAWN BY	CHECKED BY
2	AS BUILT (CHANGE STAGE 2 PSV SET @ 1440 PSIG)	07/06/25	ZQS	LB
1	AS BUILT	06/09/13	LHC	SS
0	FOR CONSTRUCTION	06/08/04	LGK	SS

BTB Compressors

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 www.enerflex.com

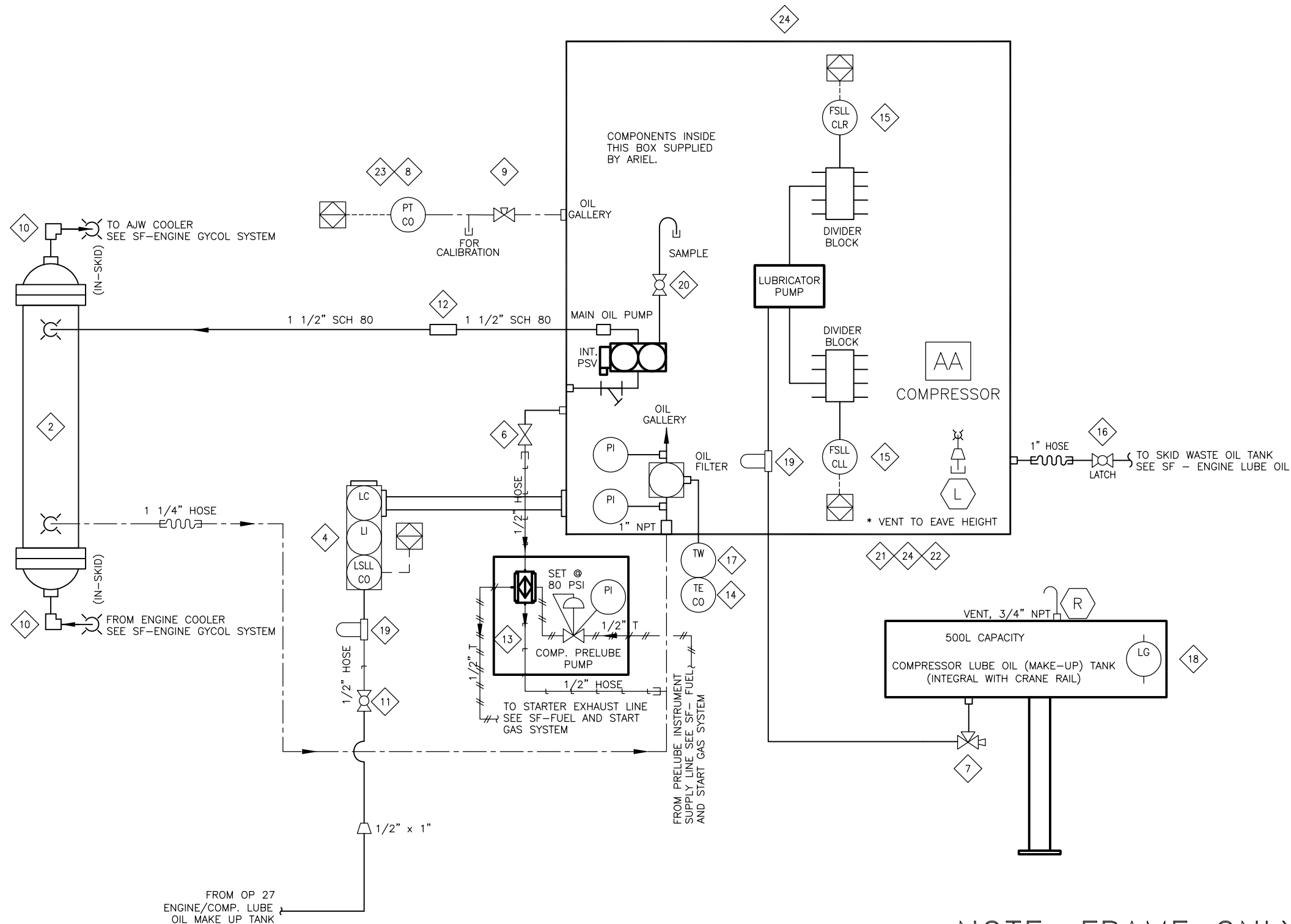
TITLE: **PROCESS & INSTRUMENTATION DIAGRAM**
2/3 STAGE COMPRESSOR PACKAGE
 A1478/A1445 SOUR (OP 50)

FOR: ENCANVA
 ENCANVA STOCK

CONSULTANT: LSD: **nn-nn-nn-nn Xnm**
 JOB No.: **060158**

DRWN BY: **SMH** DATE: **yy/mm/dd** DWG. No. OP#
 DATE: **May 30, '05** CHKD BY: **ABC** DATE: **yy/mm/dd** **PF-060158-50** **50**
 SCALE: **NTS** APPVD BY: **NTS** DATE: **yy/mm/dd**

OPTION No.	OPTION DESCRIPTION	OPTION No.	OPTION DESCRIPTION
<input checked="" type="checkbox"/> 5001B	AUTO BYPASS CAPACITY CONTROL	<input checked="" type="checkbox"/> 5006A	AUTO BLOWDOWN
<input checked="" type="checkbox"/> 5003	AUTO BY-PASS BLOCK VALVES	<input checked="" type="checkbox"/> 5027A	GLOBE VALVE ON SCRUBBER DRAIN 1-2 STG
<input checked="" type="checkbox"/> 5004B	AUTO SUCTION PRESSURE CONTROLLER	<input checked="" type="checkbox"/> 5027B	GLOBE VALVE ON SCRUBBER DRAIN ONLY 3STG
<input type="checkbox"/> 5005B	SUCTION RELIEF VALVE (THERMAL)	<input checked="" type="checkbox"/> 5027C	GLOBE VALVE ON MANUAL BLOWDOWN
<input type="checkbox"/> 5036A	FLUSHING OIL, STD FOR ≥ 2% SOUR, 1/2 STG	<input checked="" type="checkbox"/> 5028A	BLOWDOWN BLOCK VALVE
<input checked="" type="checkbox"/> 5029A	GAUGE VALVES ON SCRUBBER DRAIN	<input type="checkbox"/> 5036B	FLUSHING OIL, STD FOR ≥ 2% SOUR, 3 STG



NOTE: FRAME ONLY

OPTION SELECTION	OPTION NUMBER	OPTION DESCRIPTION
<input type="checkbox"/>	2007	SEP. COMP. LUBRICATOR LUBE OIL SUPPLY (OP 2010 & 2011 UNAVAILABLE)
<input type="checkbox"/>	2008	MUFFLER, COMPRESSOR PRE-LUBE PUMP
<input type="checkbox"/>	2009	SINGLE PIECE SKID (NO SKID BREAK)
<input type="checkbox"/>	2010	COMPRESSOR LUBRICATOR LUBE OIL SUPPLY FROM ENGINE OIL GALLERY
<input type="checkbox"/>	2011	COMBINED COMPRESSOR AND ENGINE LUBE OIL MAKE-UP TANK
<input type="checkbox"/>	2012	ROSEMOUNT COMPRESSOR OIL PRESSURE TRANSMITTER

BILL OF MATERIAL

TEM	QTY	EFX CODE	DESCRIPTION
2	1	104966	COOLER, LUBE OIL [THERMAL TRANSFER, EK-1024-0]
4	1	107966	CONTROLLER, OIL LEVEL C/W ELECTRIC SWITCH, XP, CSA & BRACKET [KENCO, LCE-24]
6	1	102973	VALVE, BALL, 3/4" NPT, 2000# WOG, RP, 316SS, NACE C/W [NAVCO, C1-R07S20A]
8	1	107987	TRANSMITTER, PRESSURE, 0-100 PSIG, SWEET, 1/4" NPT [WIKA, 892.13.500]
9	1	102802	VALVE, PLUG, 1/4" TUBE, 316SS [NUPRO, SS-4P4T]
10	2	101244	COUPLING, ELBOW, 90 DEG, 2", STYLE 90 [DRESSER, 0090-0245-082]
11	1	102949	VALVE, BALL, 1/2" NPT, 2000# WOG, RP, 316SS, NACE C/W [NAVCO, C1-R05S20A]
12	1	101240	COUPLING, ELBOW, 90 DEG, 1-1/2", STYLE 90 [DRESSER, 0090-0244-082]
13	1	119928	PUMP, DIAPHRAGM, 1/2" NPT, ALUM, GAS, CSA, REG/PI [WARREN RUPP, G05FB1ATTXNSN00]
14	1	113106	THERMOCOUPLE, K TYPE, 316SS C/W [THERMOKINETICS, K125-316S-0006-B-82S-000-0018S]
15	2	124378	SWITCH, PRO-FLO, FF, S/D, TRAB, SB [ARIEL, A-11295]
16	1	102937	VALVE, BALL, 1" NPT, 2000# WOG, RP, 316SS, NACE C/W LOCKING [NAVCO, C1-R10S20A]
17	1	105165	THERMOWELL, 316SS, BTB STYLE 4, 1/4" X 1/2", U=2", ?" BORE
19	2	121735	FILTER, ASSEMBLY, OIL, 1/2" NPT, 25 MICRON C/W SF-6510 [KINECOR, SAF-05-00-0]
20	1	102950	VALVE, BALL, 1/4" NPT, 2000# WOG, RP, 316SS, NACE C/W [NAVCO, C1-R02S20A]
21	1	117547	WIRE SUPPORT, COMPRESSOR VIBRATION SENSOR [AGS, W13750153492001]
22	1	117546B	WIRE SUPPORT, COMPRESSOR SIDE DOOR [AGS, W11350346452001]
23	1	123306	BRACKET, COMPRESSOR OIL TRANSMITTER MOUNT
24	2	119946	ASSEMBLY, SUPPORT, TRANSMITTER, WAUKESHA SERIES L-VHP, A1445/A1478 & 4 STG

BILL OF MATERIAL:		M 114238 : ASSEMBLY, COMPRESSOR OIL, A1445/A1478	
DATE-TIME EXPORTED:		2004-06-25-11.10	

7	1	120116	VALVE, BALL, 3-WAY, 1" NPT, FULL SS, 800 PSI [APOLLO, 76-605-01]
18	1	126697	INDICATOR, LEVEL, SIGHT GLASS WINDOW, 10" BOLT CENTER [LUBE DEVICES, G605-10-A-1]

BILL OF MATERIAL:		M 114238 : ASSEMBLY, COMPRESSOR OIL, COMPLETION, A1445/A1478	

OPTIONS

TEM	QTY	EFX CODE	DESCRIPTION

REV	DESCRIPTION	DATE	DRAWN BY	CHECKED BY
1	AS BUILT	06/09/13	LHC	SS
0	FOR CONSTRUCTION	06/08/04	LGK	SS

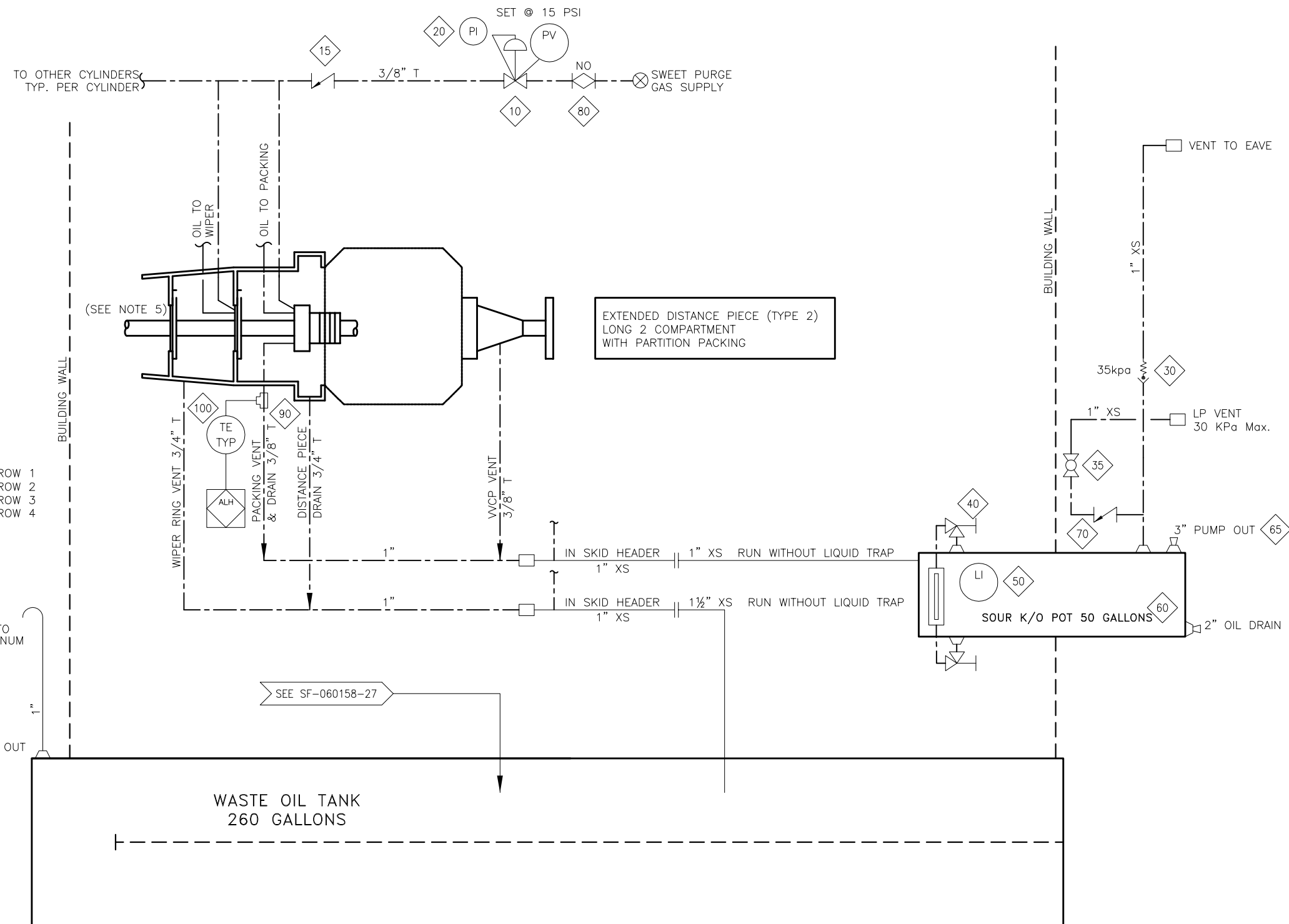
BTB COMPRESSORS

BFX Compression

4700 47 ST. SE. CALGARY AB, CANADA. T2B 3R1 TEL: 1 (403) 236-8800 FAX: 1 (403) 279-0367. www.enerflex.com

TITLE:	SERVICE FLOW COMPRESSOR OIL SYSTEM - JGK/4 A1250, A1445, A1478, A1680 (OP 20)
FOR:	ENCANA STOCK
CONSULTANT:	-
P.O.:	-
DRWN BY:	TTS
DATE:	04/03/19
SCALE:	NTS
DESIGN BY:	-
CHKD BY:	-
APPVD BY:	-
DATE:	-
DATE:	-
DATE:	-
LSD:	-
JOB No.:	060158
DWG. No.:	SF-060158-20
OP	20

P:\Project3\BTB\060158\Fwd\As-Built\SF-060158-20.dwg Jul 06, 2007 - 8:58am



- TE-230 THROW 1
- TE-231 THROW 2
- TE-232 THROW 3
- TE-233 THROW 4

VENT HIGH TO COOLER PLENUM DISCHARGE

2" PUMP OUT

WASTE OIL TANK
260 GALLONS

EXTENDED DISTANCE PIECE (TYPE 2)
LONG 2 COMPARTMENT
WITH PARTITION PACKING

SOUR K/O POT 50 GALLONS

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BILL OF MATERIAL

ITEM	QTY	EFX CODE	DESCRIPTION
10	1	104872	REGULATOR, 1/4" NPT, ALUM., 5-35# SPR RING (W/O PI) [FISHER, 67CFR-362]
15	1	118596	VALVE, CHECK, 3/8" TUBE, 1/3 PSI, 316SS C/W VITON SEALS [NUPRO, SS-CH56-1/3]
20	1	107925	GAUGE, PRESSURE, CBM, 2" DRY, 0-60 PSI DUAL, 1/4" NPT [WKA, 111.10]
30	1	124304	VALVE, IN LINE BALL CHECK, 1" NPT, 3000#, CS BODY, SS TRIM [PLAINSMAN, CB-100]
35	1	102937	VALVE, BALL, 1" NPT, 2000# WOG, RP, 316SS, NACE C/W LOCKING [NAVCO, C1-R10520A]
40	1	103696	VALVE, SET GAUGE, NACE, 1/2" FNPT x 3/4" MNPT, CS, 3470# [DANIEL, 15-N]
50	1	103667	GAUGE, LEVEL, CS WITH REFLEX FLAT GLASS, NACE, 2280# [DANIEL, 71RM-N]
60	1	123417D	PACKING VENT & DRAIN TANK, A SERIES
65	1	105733	PLUG, HEX, SCRD, 3" 3/6000# SA105N
70	1	110000	VALVE, CHECK, SWING, 1" NPT, 800# WOG, LOW TEMP, NACE [NEWCO, 38T-LF24/3]
80	1	102801	VALVE, PLUG, 3/8" TUBE, 316SS [NUPRO, SS-6P4T]
90	4	105165	THERMOWELL, 316SS, BTB STYLE 4, 1/4" x 1/2", U=2", ?" BORE
100	4	114007	THERMOCOUPLE, K TYPE, 316SS, [THERMOKINETICS, K125-3165-004.08-825YT2]
			BILL OF MATERIAL: M 114202-5 : >5% H2S
			DATE-TIME EXPORTED: 2003-02-11-08.27

REV	DESCRIPTION	DATE	DRAWN BY	CHECKED BY
1	AS BUILT	06/09/13	LHC	SS
0	FOR CONSTRUCTION	06/06/04	LJK	SS

BTB Compressors

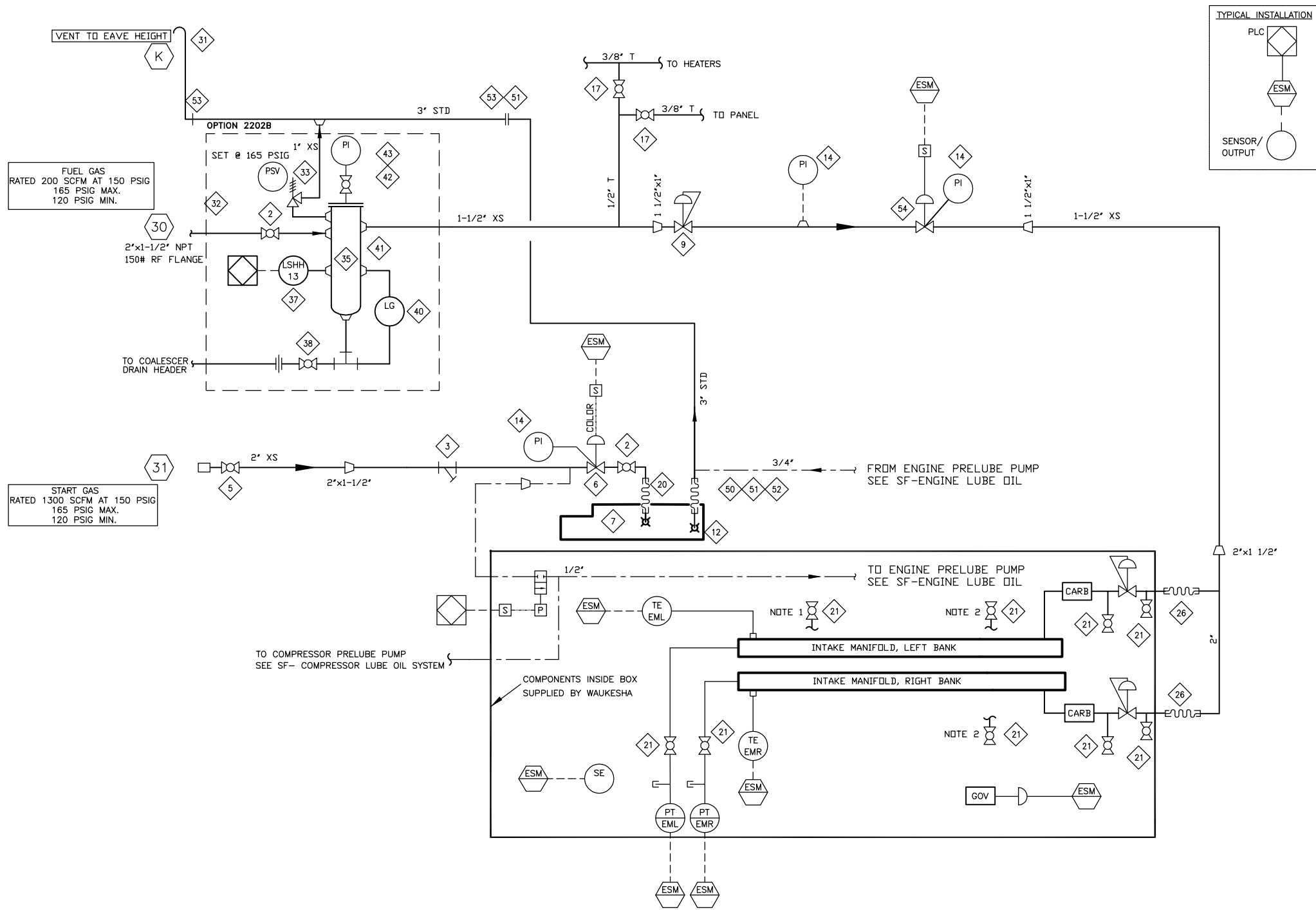
4700 47 ST. SE CALGARY AB, CANADA T2B 3R1
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TITLE: **PACKING VENT & DRAIN SYSTEM - H2S>2%
A1478 (OP21)
COMPRESSOR PACKAGE**

FOR: **ENCANA CORPORATION**

CONSULTANT: _____ LSD: _____
P.O.: _____ JOB No.: **060158**

DRWN BY: ARJ	DESIGN BY: AYH	DATE: 02/11/14	DWG. No.	REV
DATE: 05/02/01	CHKD BY: ABT	DATE: 04/09/20	SF-060158-21	1
SCALE: NIS	APPV BY:	DATE:		



FUEL GAS
RATED 200 SCFM AT 150 PSIG
165 PSIG MAX.
120 PSIG MIN.

START GAS
RATED 1300 SCFM AT 150 PSIG
165 PSIG MAX.
120 PSIG MIN.

OPTION 2202B

SET @ 165 PSIG

2"x1-1/2" NPT
150# RF FLANGE

TO COALESCER
DRAIN HEADER

TO COMPRESSOR PRELUBE PUMP
SEE SF- COMPRESSOR LUBE OIL SYSTEM

3/8" T TO HEATERS

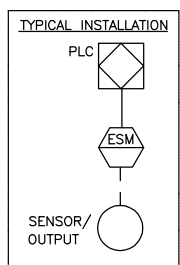
3/8" T TO PANEL

FROM ENGINE PRELUBE PUMP
SEE SF-ENGINE LUBE OIL

TO ENGINE PRELUBE PUMP
SEE SF-ENGINE LUBE OIL

COMPONENTS INSIDE BOX
SUPPLIED BY WAUKESHA

NOTE 1 : CRANK CASE SAMPLE POINT
NOTE 2 : AIR PRESSURE SAMPLE POINT



BILL OF MATERIAL

ITEM	QTY	EFX CODE	DESCRIPTION
9	1	104863	REGULATOR, 1" NPT, DI, 3/8" DR, 35-80# SPR RNG, SET @ 50 PSIG [FISHER, 627-494]
17	2	102974	VALVE, BALL, 3/8" NPT, 2000# WDG, RP, A105 BODY, NACE C/W [NAVCO, HI-R03S20S]
21	9	121054	VALVE, BALL, 1/4" NPT, 2000#, A105 BODY, NO LOCKING HANDLE [NAVCO]
26	2	104683	HOSE, BRAIDED STEEL, 1-1/2" NPTM ENDS X 8' LONG
32	1	106382	FLANGE, RF RED HUB, 2" 150# X 1-1/2" NPT SA105N BILL OF MATERIAL: M 114237-1 : FUEL GAS
3	1	102830	STRAINER, Y, 1-1/2" NPT, 1480 PSIG MAWP, CS, 1/32" SS SCREEN [ALTA, YS-600]
5	1	102952	VALVE, BALL, 2" NPT, 2000# WDG, RP, A105 BODY, NACE C/W [NAVCO, HI-R20S20B]
6	1	103762	VALVE, RELAY, GAS, 1-1/2" NPT, MAWP 450 PSI [TDI, RLVA25683001201]
7	1	103758	STARTER, AIR/GAS, STD 150-60 PSIG, INERTIA DUAL [TDI TURBOSTART, T112-60001-B1R]
12	1	103741	ELBOW, STARTER EXHAUST, 90 DEG, SR, 3" NPTM, CS [TDI, T100-27900]
14	4	107911	GAUGE, PRESSURE, BM, 2-1/2" LF, 0-300 PSI DUAL, 1/4" NPT [WIKA, 233.53]
20	1	104691	HOSE, BRAIDED STEEL, 1-1/2" NPTM ENDS X 12' LONG
31	1	123400	EXHAUST LINE, STARTER TO EAVE, A1478 BILL OF MATERIAL: M 114237-2 : ASSEMBLY, DRIVER, AIR/EXHAUST, A1445/A1478
50	1	120174	HOSE, BRAIDED STEEL, 3" 150# RF X 3' 150# RF X 10' LONG
51	2	106504	FLANGE, RF SLIP-ON, 3" 150# SA105N
52	1	106497	FLANGE, RF SCR'D, 3" 150# SA105N
53	2	106700	FLANGE, RF WN, 3" 150# SCH STD SA105N
54	1	126964	VALVE, SOLENOID, 2-WAY, 1" NPT, 24VDC, 316SS BODY, [BURKERT, CD05358]

OPTIONS

ITEM	QTY	EFX CODE	DESCRIPTION
OPTION 2202B - UTILITY GAS FILTER SEP. & LEVEL GAUGE & SHUTDOWN			
2	1	102933	VALVE, BALL, 1-1/2" NPT, 2000# WDG, RP, 316SS, NACE C/W [NAVCO, CI-R15S20A]
33	1	115779	VALVE, PSV, 1" MNPT X 1" FNPT, .212 OF (E) STD TRIM [MERCER, 81-17151V09G11]
35	1	109467B	VESSEL, FUEL GAS SCRUB. 5-9/16" OD 285 MAWP, 100 DEG F, WAUK VHP/VGF, CAT 33/340
37	1	104493	SWITCH, LEVEL, 1-1/2" NPT, XP, CSA, SPDT (HI) C/W BODYGLAS FLOAT [MURPHY, L1100]
38	1	102936	VALVE, BALL, 1" NPT, 2000# WDG, RP, A105 BODY, NACE C/W [NAVCO, HI-R10S20S]
40	1	103659	GAUGE, LEVEL, CS WITH REFLEX FLAT GLASS, 1820# [DANIEL, 71RL]
41	1	123277	SUPPORT, VERTICAL FUEL GAS SCRUBBER, A1478
42	1	113090	VALVE, BALL, 1/4" NPT, 2000# WDG, FP, SS, 2 PIECE C/W LOCKING HANDLE [MAS, G2]
43	1	107911	GAUGE, PRESSURE, BM, 2-1/2" LF, 0-300 PSI DUAL, 1/4" NPT [WIKA, 233.53]
BILL OF MATERIAL: M 113617-3 : OPTION 2202B, UTILITY GAS FILTER SEPARATOR			

REV	DESCRIPTION	DATE	DRAWN BY	CHECKED BY
3	AS BUILT	06/09/13	LHC	SS
2	REMOVED ITEM #18 & 19, ADDED ITEM #50-54	06/08/04	LGK	SS
1	REVISED INSTRUMENTATION SYMBOLS	06/08/04	LGK	SS
0	FOR CONSTRUCTION	06/05/29	LGK	SS

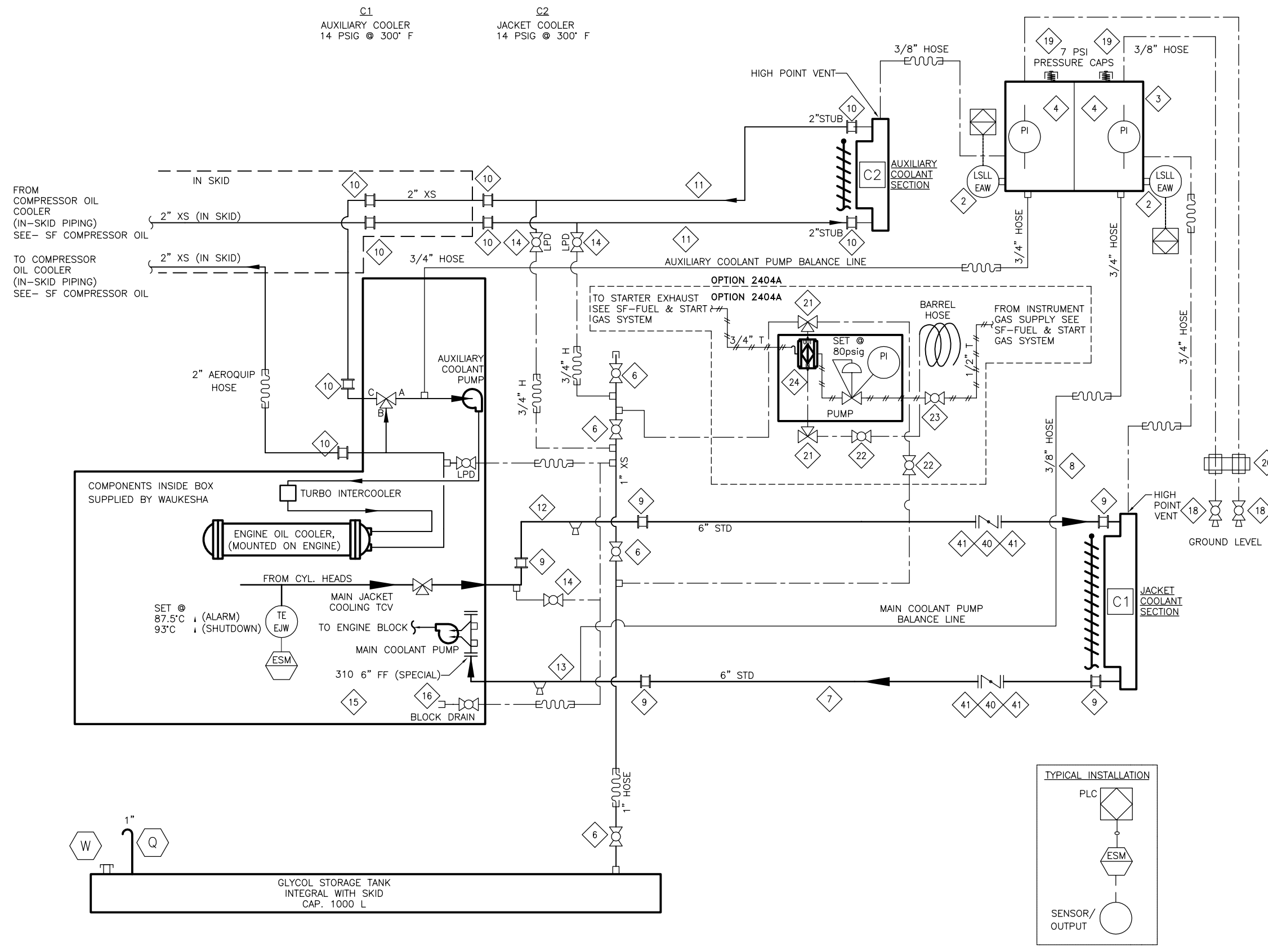
BTB COMPRESSORS
EFX Compression

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TITLE:	SERVICE FLOW FUEL AND START GAS SYSTEM A1478 (OP22)		
FOR: ENCANA	CUSTOMER		
CONSULTANT: -	LSD: -		
P.O.: -	JOB No.: 060158		
DRWN BY: ARJ	DESIGN BY: -	DATE: -	DWG. No. OP
DATE: 05/02/01	CHKD BY: -	DATE: -	SF-060158-22 22
SCALE: NTS	APPVD BY: -	DATE: -	

OPTION SELECTION	OPTION NUMBER	OPTION DESCRIPTION
<input checked="" type="checkbox"/>	2202B	UTILITY GAS FILTER SEP. & LEVEL GAUGE & SHUTDOWN A1478
<input type="checkbox"/>		
<input type="checkbox"/>		
<input type="checkbox"/>		
<input type="checkbox"/>		
<input type="checkbox"/>		

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BILL OF MATERIAL				
ITEM	QTY	EFX CODE	DESCRIPTION	
6	4	102937	VALVE, BALL, 1" NPT, 2000# WOG, RP, 316SS, NACE C/W LOCKING [NAVCO, C1-R10S20A]	
9	1	101238	COUPLING, STRAIGHT, 6", STYLE 38 [DRESSER, 0038-0057-011]	
10	4	101245	COUPLING, STRAIGHT, 2", STYLE 90 [DRESSER, 0090-0005-082]	
12	1	114292C	PIPE, BENT, BASE, JACKET WATER, ENGINE/SKID EDGE, JW1, A1445/A1478	
13	1	114293B	PIPE, BENT, BASE, JACKET WATER, SKID EDGE/ENGINE, JW2, A1445/A1478	
14	3	102973	VALVE, BALL, 3/4" NPT, 2000# WOG, RP, 316SS, NACE C/W [NAVCO, C1-R07S20A]	
15	1	106318	FLANGE, FF SLIP-ON, 6" 150# SA105N	
16	1	105525	ELBOW, 90 DEG, BW SR, 6" NOM SCH STD SA234-WPB	
BILL OF MATERIAL: M 114234 : ASSEMBLY, DRIVER, ENGINE COOLING SYSTEM, A1445/A147				
2	2	104493	SWITCH, LEVEL, 1-1/2" NPT, XP, CSA, SPDT (HI) C/W BUOYGLAS FLOAT [MURPHY, L1100]	
3	1	113683E	TANK, SURGE, 2-COMPARTMENT, 150/59L, A1445/A1478 AS PER DRAWING	
4	2	126697	INDICATOR, LEVEL, SIGHT GLASS WINDOW, 10" BOLT CENTER [LUBE DEVICES, G605-10-A-1]	
7	1	114295	PIPE, BENT, BASE, JACKET WATER, COOLER OUTLET/SKID EDGE, JW4, A1445/A1478	
8	1	114294	PIPE, BENT, BASE, JACKET WATER, SKID EDGE/COOLER INLET, JW3, A1445/A1478	
9	4	101238	COUPLING, STRAIGHT, 6", STYLE 38 [DRESSER, 0038-0057-011]	
10	4	101245	COUPLING, STRAIGHT, 2", STYLE 90 [DRESSER, 0090-0005-082]	
11	1	114291B	PIPE, BENT, AUXILIARY WATER, ENGINE/COOLER, A1445/A1478	
18	2	102904	VALVE, BALL, 3/8" NPT, 2000# WOG, RP, A105 BODY, NACE C/W [NAVCO, H1-R03S20S]	
19	2	112239	RADIATOR CAP & NECK, 2" FNPT, 7 LBS PRESSURE RATING [KENCO, 1794-7]	
20	1	123319	SURGE TANK VENT VALVE SUPPORT, A1478	
BILL OF MATERIAL: M 121974 : ASSEMBLY, DRIVER, ENGINE COOLING, COMPLETION, A1478				
40	2	116800	VALVE, BUTTERFLY, 6" 150#, WAFER STYLE, CAST IRON BODY, [C&C BUTTERFLY]	
41	4	106790	FLANGE, RF WN, 6" 150# SCH STD SA105N	

OPTIONS				
ITEM	QTY	EFX CODE	DESCRIPTION	
24	1	119928	PUMP, DIAPHRAGM, 1/2" NPT, ALUM, GAS, CSA, REG/PI [WARREN RUPP, G05FB1ATTXNSN00]	
21	2	121379	VALVE, BALL, 3-WAY, 3/4" NPT, FULL SS, 800 PSI C/W LOCKING HANDLE [MAS, G4]	
22	2	102937	VALVE, BALL, 1" NPT, 2000# WOG, RP, 316SS, NACE C/W LOCKING [NAVCO, C1-R10S20A]	
23	1	102949	VALVE, BALL, 1/2" NPT, 2000# WOG, RP, 316SS, NACE C/W [NAVCO, C1-R05S20A]	
BILL OF MATERIAL: M 113625 : OPTION 2404A, GLYCOL COOLANT TRANSFER SYSTEM, A1478				

REV	DESCRIPTION	DATE	DRAWN BY	CHECKED BY
2	AS BUILT	06/09/13	LHC	SS
1	REVISED INSTRUMENTATION SYMBOLS	06/08/04	LGK	SS
0	FOR CONSTRUCTION	06/05/29	LGK	SS

BTB COMPRESSORS
EFX Compression

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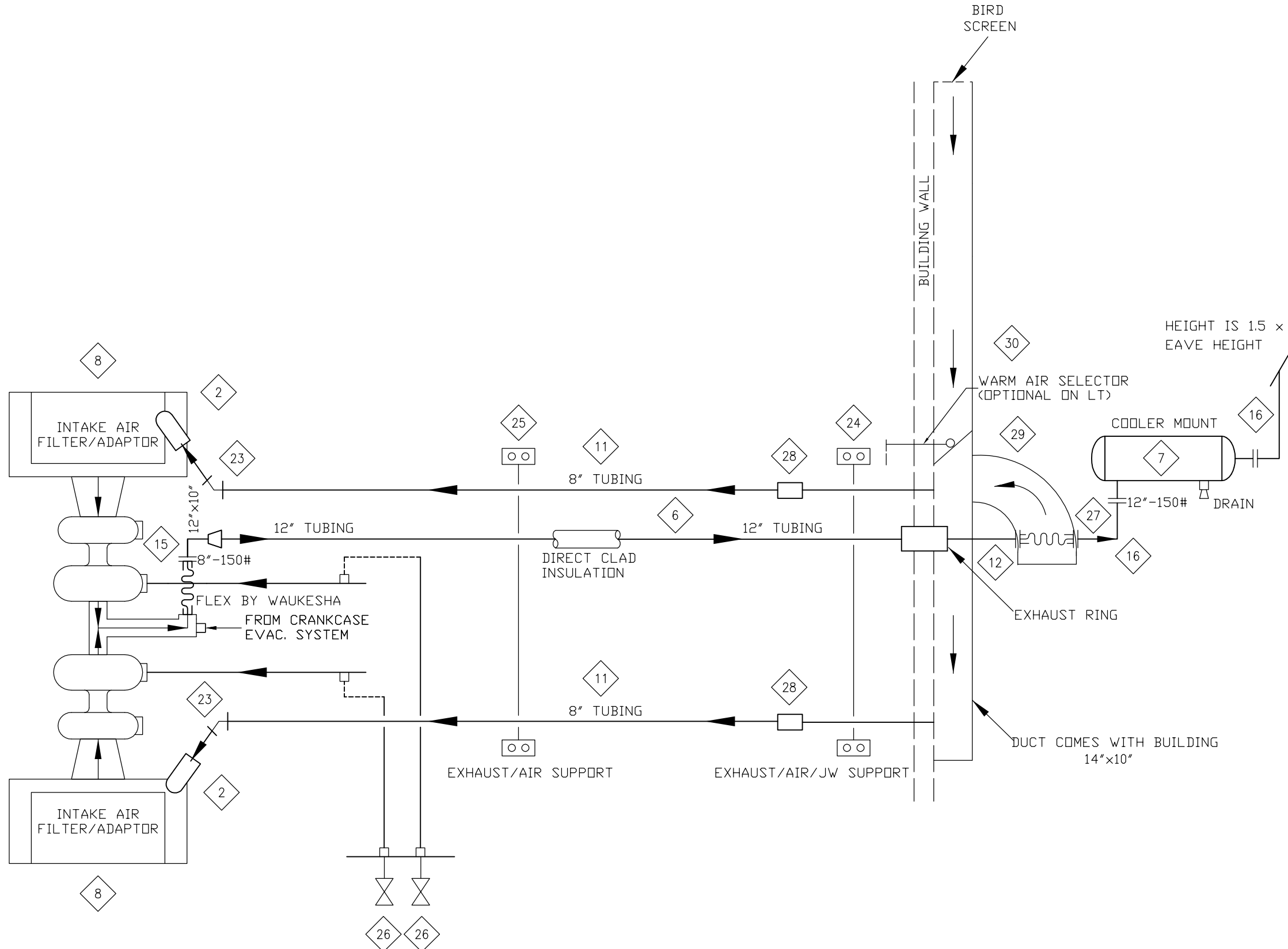
TITLE: **SERVICE FLOW ENGINE GLYCOL SYSTEM A1478 (OP24)**

FOR: ENCANA **ENCANA STOCK**

CONSULTANT: - **ENCANA** LSD: -
P.O.: - **STOCK** JOB No.: 060158

DRWN BY: TTS	DESIGN BY: -	DATE: -	DWG. No. SF-060158-24	OP 24
DATE: 02/10/01	CHKD BY: -	DATE: -		
SCALE: NTS	APPPV BY: -	DATE: -		

OPTION SELECTION	OPTION NUMBER	OPTION DESCRIPTION
<input checked="" type="checkbox"/>	2404A	GLYCOL COOLANT TRANSFER SYSTEM, A1478
<input type="checkbox"/>	2405A	GLYCOL FILTER, A1478
<input type="checkbox"/>		
<input type="checkbox"/>		
<input type="checkbox"/>		



BILL OF MATERIAL				
ITEM	QTY	EFX CODE	DESCRIPTION	
2	2	103614	ELBDW, RUBBER, 90 DEG, 8" [DONALDSON, P11-2605]	
6	1	113884D	EXHAUST LINE, 11 GA 316LSS, 12' 150#, WAUKESHA L-VHP, A1445/A1478	
8	2	113677C	AIR FILTER ADAPTER, DRY TYPE, 8" DD, WAUKESHA L-VHP, A1445/A1478	
11	1set	113676C	INTAKE LINE, AIR, CS, 8" DD, WAUKESHA L-VHP, A1445/A1478	
15	1	121922	GASKET, EXHAUST, THERMICULITE, 1/16" THK, 8" 150# FF EXTERNAL STYLE, 1400 DEG.F	
23	2	113759	ELBDW, RUBBER, 45 DEG, 8" [DONALDSON, P11-2606]	
24	1	114299E	SUPPRT FRAME, AIR, JW & EXHAUST, WAUKESHA SERIES L VHP, A1445/A1478	
25	1	114298B	SUPPRT FRAME, AIR & EXHAUST, WAUKESHA SERIES L VHP, A1445/A1478	
26	2	102950	VALVE, BALL, 1/4" NPT, 2000# WDG, RP, 316SS, NACE C/W [NAVCO, C1-R02S20A]	
28	2	103610	HUMPHOSE, STRAIGHT, RUBBER, 8" [DONALDSON, P11-2608]	
			BILL OF MATERIAL: M 114235 : ASSEMBLY, DRIVER, AIR/EXHAUST, A1445/A1478	
			DATE-TIME EXPORTED: 2004-06-25-15.56	
7	1	114002B	MUFFLER, HOSPITAL GR, 12" 150# SIED [EI WILLIAMS, GER19S-12-SI6-AL-A-AFT-LL]	
12	1	121924	GASKET, EXHAUST, THERMICULITE, 1/16" THK, 12" 150# FF EXTERNAL STYLE, 1400 DEG.F	
16	1	115532	EXHAUST STACK, 12" 150#, 2-PIECES, A1445/A1478	
27	1	104682	EXPANSION BELLOW, 12" 150# INTERNAL FLANGES C/W 2" COLLAR & SS LINER X 12" LONG	
29	1	123481B	WARM AIR SELECTOR, A1478	
30	1	127128	MANUAL POSITIONNER FOR WARM AIR SELECTOR, A1478	
			BILL OF MATERIAL: M 121975 : ASSEMBLY, DRIVER, AIR/EXHAUST, COMPLETION, A1478	
			DATE-TIME EXPORTED: 2004-06-28-11.00	

REV	DESCRIPTION	DATE	DRAWN BY	CHECKED BY
1	AS BUILT	06/09/13	LHC	SS
0	FOR CONSTRUCTION	06/08/04	LGK	SS

BTB COMPRESSORS
ENERFLEX
 BFX Compression

4700 47 ST. SE CALGARY AB, CANADA T2B 3R1 TEL: 1 (403) 236-6800 FAX: 1 (403) 279-0367 www.enerflex.com

TITLE: **SERVICE FLOW AIR AND EXHAUST A1478 (OP26)**

FOR: ENCANA **ENCANA STOCK**

CONSULTANT: - LSD: -
 P.O.: - JOB No.: 060158

DRWN BY: TTS	DESIGN BY: -	DATE: -	DWG. No.	OP
DATE: 2002/07/25	CHKD BY: -	DATE: -	SF-060158-26	26
SCALE: NTS	APPVD BY: -	DATE: -		

OPTION SELECTION	OPTION NUMBER	OPTION DESCRIPTION
<input type="checkbox"/>	2616	AUTO WARM AIR ENGINE INTAKE TEMPERATURE CONTROL
<input type="checkbox"/>		
<input type="checkbox"/>		
<input type="checkbox"/>		
<input type="checkbox"/>		
<input type="checkbox"/>		

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BILL OF MATERIAL

TEM	QTY	EFX CODE	DESCRIPTION
2	1	107968	CONTROLLER, OIL LEVEL C/W ELECTRIC SWITCH, XP, CSA C/W DOOR MT [KENCO, LCE-17]
3	1	126697	INDICATOR, LEVEL, SIGHT GLASS WINDOW, 10" BOLT CENTER [LUBE DEVICES, G605-10-A-1]
5	1	102951	VALVE, BALL, 2" NPT, 2000# WOG, RP, 316SS, NACE C/W LOCKING [NAVCO, C1-R20S20A]
6	1	120116	VALVE, BALL, 3-WAY, 1" NPT, FULL SS, 800 PSI [APOLLO, 76-605-01]
12	2	121054	VALVE, BALL, 1/4" NPT, 2000#, A105 BODY, NO LOCKING HANDLE [NAVCO]
14	1	102949	VALVE, BALL, 1/2" NPT, 2000# WOG, RP, 316SS, NACE C/W [NAVCO, C1-R05S20A]
15	2	102937	VALVE, BALL, 1" NPT, 2000# WOG, RP, 316SS, NACE C/W LOCKING [NAVCO, C1-R10S20A]
16	2	101245	COUPLING, STRAIGHT, 2", STYLE 90 [DRESSER, 0090-0005-082]
17	3	101244	COUPLING, ELBOW, 90 DEG, 2", STYLE 90 [DRESSER, 0090-0245-082]
18	1	121735	FILTER, ASSEMBLY, OIL, 1/2" NPT, 25 MICRON C/W SF-6510 [KINECOR, SAF-05-00-0]
19	1	107895	GAUGE, PRESSURE, BM, 2-1/2" LF, 0-200 PSI DUAL, 1/4" NPT [WIKA, 233.53]
20	1	106931	FLANGE, FF SQ, 2" NPT C/W RECESS FOR WAUK 12VHP OIL FILTER
21	1	106932	FLANGE, FF SQ, 2" NPT FOR WAUKESHA 12VHP OIL FILTER COOLER
22	1	123293C	BRACKET, ENGINE OIL AND MANIFOLD PRESSURE TRANSMITTER
23	1	123318	DRIVER/COMPRESSOR OIL DRAIN, A1478
24	1	123315	MOUNTING BLOCK, ENGINE, WAUKESHA FILTER, A1478
30	1	120133	VALVE, CHECK, SWING, 2" NPT, 800# WOG, CS [NEWCO, 38TFS2]

BILL OF MATERIAL:			M 114236 : ASSEMBLY, DRIVER, ENGINE OIL, A1445/A1478
8	340	104080	OIL, LUBE, BULK (1,600 LITRE CUBE) [PETRO CANADA, SENTINAL 445]

BILL OF MATERIAL:			M 121976 : ASSEMBLY, DRIVER, ENGINE OIL, COMPLETION, A1478

OPTIONS

TEM	QTY	EFX CODE	DESCRIPTION
2			AS BUILT
1			REVISED INSTRUMENTATION SYMBOLS
0			FOR CONSTRUCTION
REV			DESCRIPTION
			DATE
			DRAWN BY
			CHECKED BY

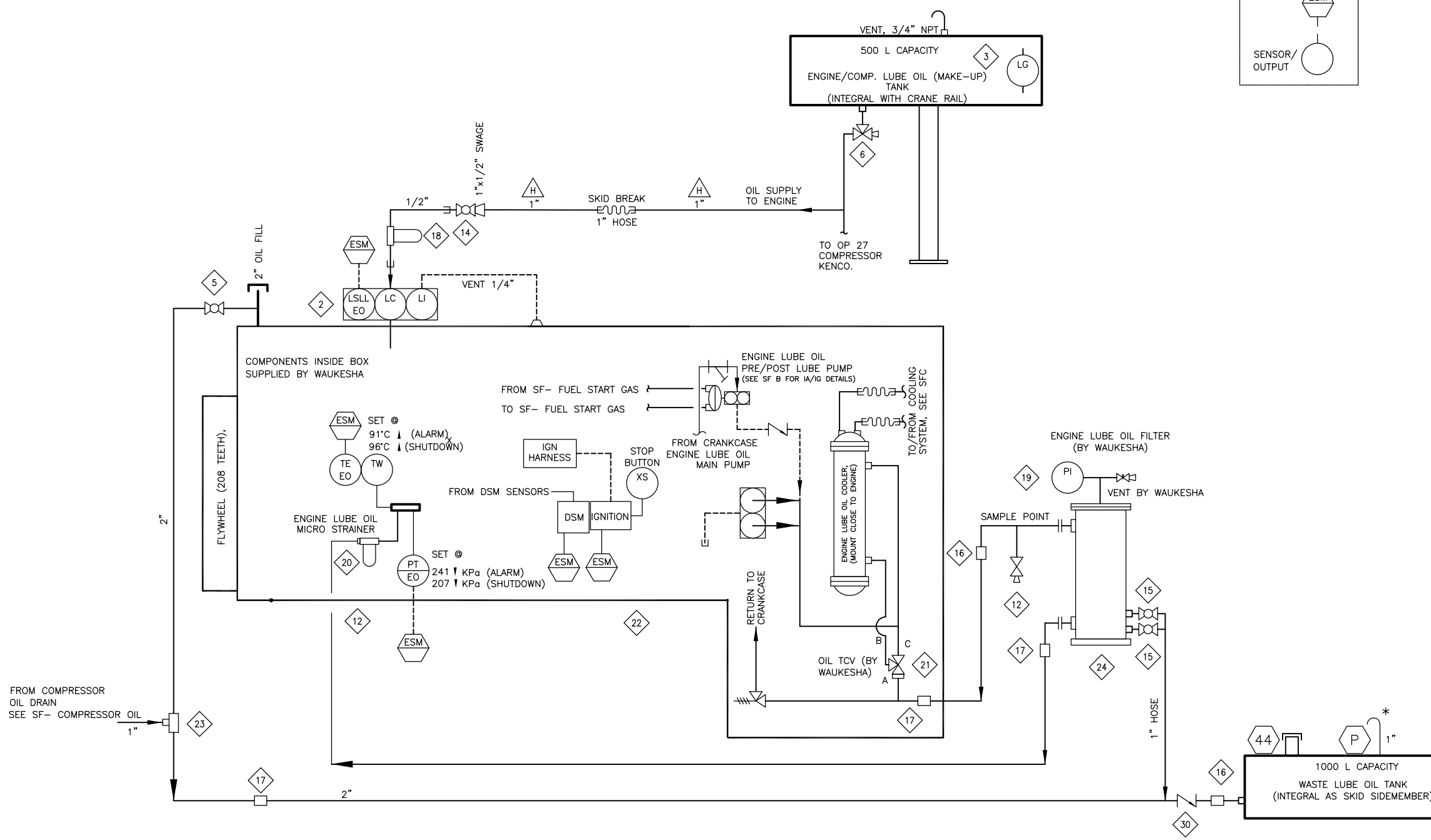
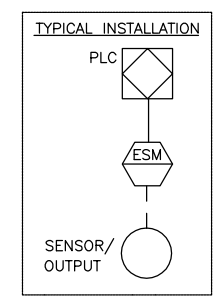
* VENT HEIGHT TO COOLER PLENUM.

BTB COMPRESSORS

BFX Compression

4700 47 ST. SE CALGARY AB, CANADA T2B 3R1 TEL. 1 (403) 236-6800 FAX 1 (403) 279-0367. www.enerflex.com

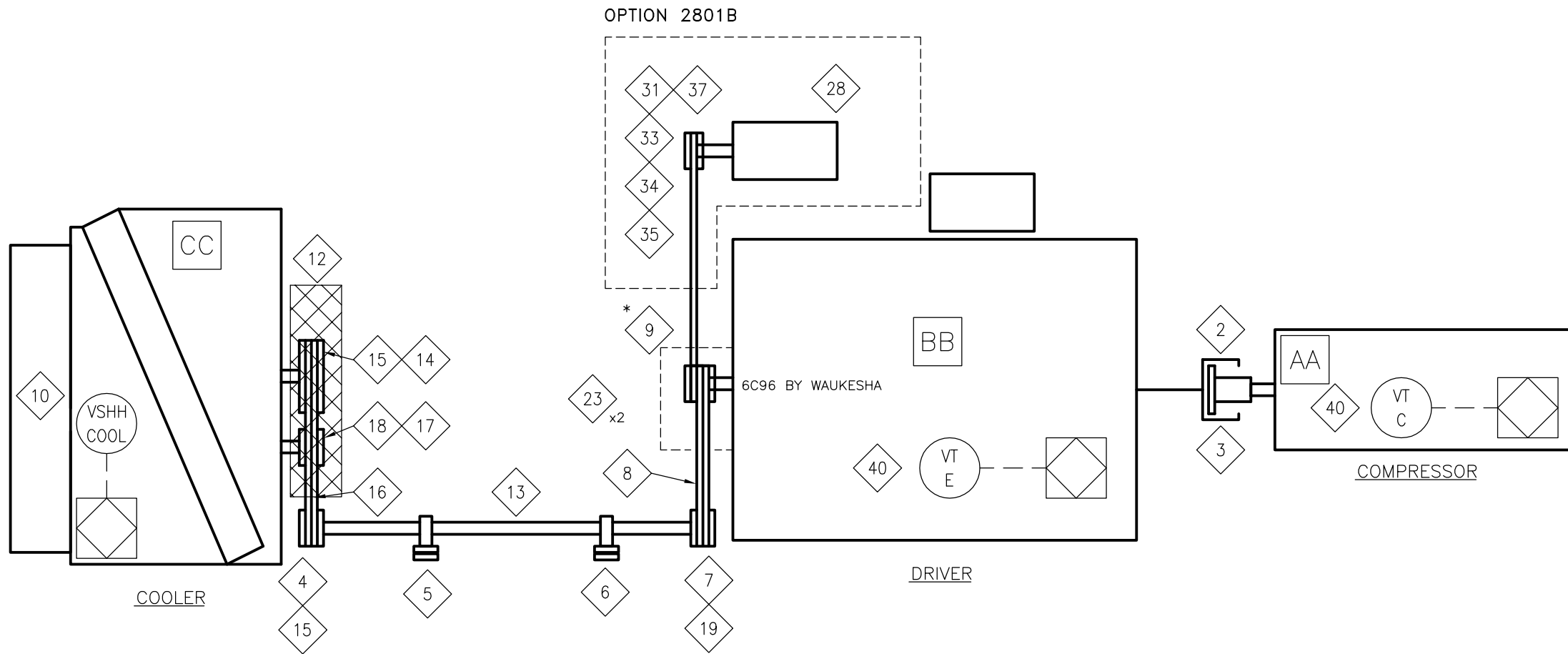
TITLE:	SERVICE FLOW ENGINE LUBE OIL A1478 (OP27)		
FOR: ENCANA	ENCANA STOCK		
CONSULTANT: -	LSD: -		JOB No.: 060158
P.O.: -	DRWN BY: TTS		DATE: -
DATE: 2002/07/23	CHKD BY: -	DATE: -	DWG. No. OP
SCALE: NTS	APPVD BY: -	DATE: -	SF-060158-27 27



OPTION SELECTION	OPTION NUMBER	OPTION DESCRIPTION
<input type="checkbox"/>	2708A	ALFA LAVAL FILTER ASSEMBLY
<input type="checkbox"/>	2709	OIL TRANSFER STATION
<input type="checkbox"/>	SOUR	OIL TANK CHECK VALVE (REQUIRED FOR SOUR SERVICE)
<input checked="" type="checkbox"/>	2711	MICROSPIN FILTER OPTION
<input type="checkbox"/>		
<input type="checkbox"/>		

P:\Projects\BTB\060158\Pid\As-Built\SF-060158-27.dwg Jul 06, 2007 - 9:03am

DESCRIPTION	SHEAVE PICTH ϕ	RPM
ENGINE SHAFT	9.6"	1200
JACK SHAFT		
ENGINE END	20.0"	576
COOLER END	13.0"	
IDLER		
COOLER END	9.6"	N/A
COOLER SHAFT	27.0"	275



BILL OF MATERIAL			
ITEM	QTY	EFX CODE	DESCRIPTION
2	1	105068	COUPLING, ADAPTER PLATE 22.5" OD HD C/W STEEL HUB [FORMFLEX, FSH70-22B-GK-HD]
3	1	115047	GUARD, COUPLING, FIBERGLASS, ENERFLEX RED, PMS 188 AS PER QUOTE #01-143
4	1	112676	SHEAVE, 6-GROOVE, USED WITH R2 BUSHING [BROWNING, 6C130R]
5	1	107128	PILLOW BLOCK, 2-15/16", EXPANSION [BROWNING, PB970EX 2-15/16]
6	1	107132	PILLOW BLOCK, 2-15/16", NON-EXPANSION [BROWNING, PB970NEX 2-15/16]
7	1	113101	SHEAVE, 4-GROOVE, USED WITH R1 BUSHING [BROWNING, 4C200R]
8	4	117007	V-BELT, C-SECTION, GRIPNOTCH [MBL, CX-109]
10	1	116993	SWITCH, VIBRATION, ENTELLA APPROVED C/W MANUAL RESET [MURPHY, VS2-E]
13	1	120309	JACKSHAFT, GEN III, 2-15/16" DIA. C/W 3/4" X 3/8" X 8" KEYWAY @ BOTH ENDS (72")
15	1	107080	BUSHING, R2 2-15/16" [BROWNING, R2]
19	1	107079	BUSHING R1, 2 15/16" (BROWING R1)
21	3	105049	GROUT, 3 PART, COMPLETE UNIT [CARTER-WATERS, 604]
22	8	123314B	PUSH BLOCK, A1478
23	2	123323B	ASSEMBLY, JACK SHAFT ADJUSTING PLATE, A1478
24	1	123324B	ASSEMBLY, MOUNTING KIT, A1478
BILL OF MATERIAL: M 114239 : ASSEMBLY, DRIVE TRAIN, A1445/A1478			
9	1	NPN	ENGINE DRIVE BELT GUARD
12	1	NPN	CUSTOM DRIVE BELT GUARD
14	1	107227	SHEAVE, 6-GROOVE, USED WITH R2 BUSHING [BROWNING, 6C270R]
15	1	107080	BUSHING, R2 2-15/16" [BROWNING, R2]
16	6	107004	V-BELT, C-SECTION [GOODYEAR, C-195]
17	1	107216	SHEAVE, 6-GROOVE, USED WITH R2 BUSHING [BROWNING, 6C96R]
18	1	107085	BUSHING, R2 2-3/16" [BROWNING, R2]
40	2	104787	TRANSMITTER, VIBRATION, 4-20MA, 24VDC CSA, IS [METRIX, ST5484E-767]

OPTIONS			
ITEM	QTY	EFX CODE	DESCRIPTION
OPTION 2801B - 24V UPS, 30 AMP A1478			
28	1	126958	ASSEMBLY, ALTERNATOR, 24VDC, 30 AMP, C/W GUARD & CSA [CE NIEHOFF, A1-101]
31	1	123308	*** DRIVE BELT
32	1	123309	WIRE, FOR OPTION 2801A, 24VDC UPS A-SERIES
33	2	103869	BATTERY, 12V, 100AMP, GEL CELL, MODEL 34DC-48W
34	1	119966	BATTERY BOX, C/W LID, PLASTIC, 14.75" X 10.75" X 12" [NOCO MARINE, HM426]
35	1	120811	PANEL, RC2000, OPTION, 24V UPS
36	1	102822	REGISTRATION, CSA, UPS GENERATOR ASSEMBLY
BILL OF MATERIAL: M 123310-2 : OPTION 2801B, 24V UPS, 30 AMP A1478			
37	1	124462	PULLEY ASSEMBLY FOR NIEHOFF, A1-101 ALTERNATOR [NEIHOFF, A3-303]

NOTE:
1. * SUPPLIED BY VENDOR

REV	DESCRIPTION	DATE	DRAWN BY	CHECKED BY
1	AS BUILT	06/09/13	LHC	SS
0	FOR CONSTRUCTION	06/08/04	LGK	SS

REV	DESCRIPTION	DATE	DRAWN BY	CHECKED BY
1	AS BUILT	06/09/13	LHC	SS
0	FOR CONSTRUCTION	06/08/04	LGK	SS

BTB Compressors
ENERFLEX
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TEL: 1 (403) 236-6800 FAX 1 (403) 279-0367
www.enerflex.com

TITLE: DRIVE TRAIN MODULE WITH JACKSHAFT
ARIEL JGK/4, WAUKESHA SERIES L VHP, AIR X
A1445/A1478

FOR: ENCANA ENCANA STOCK

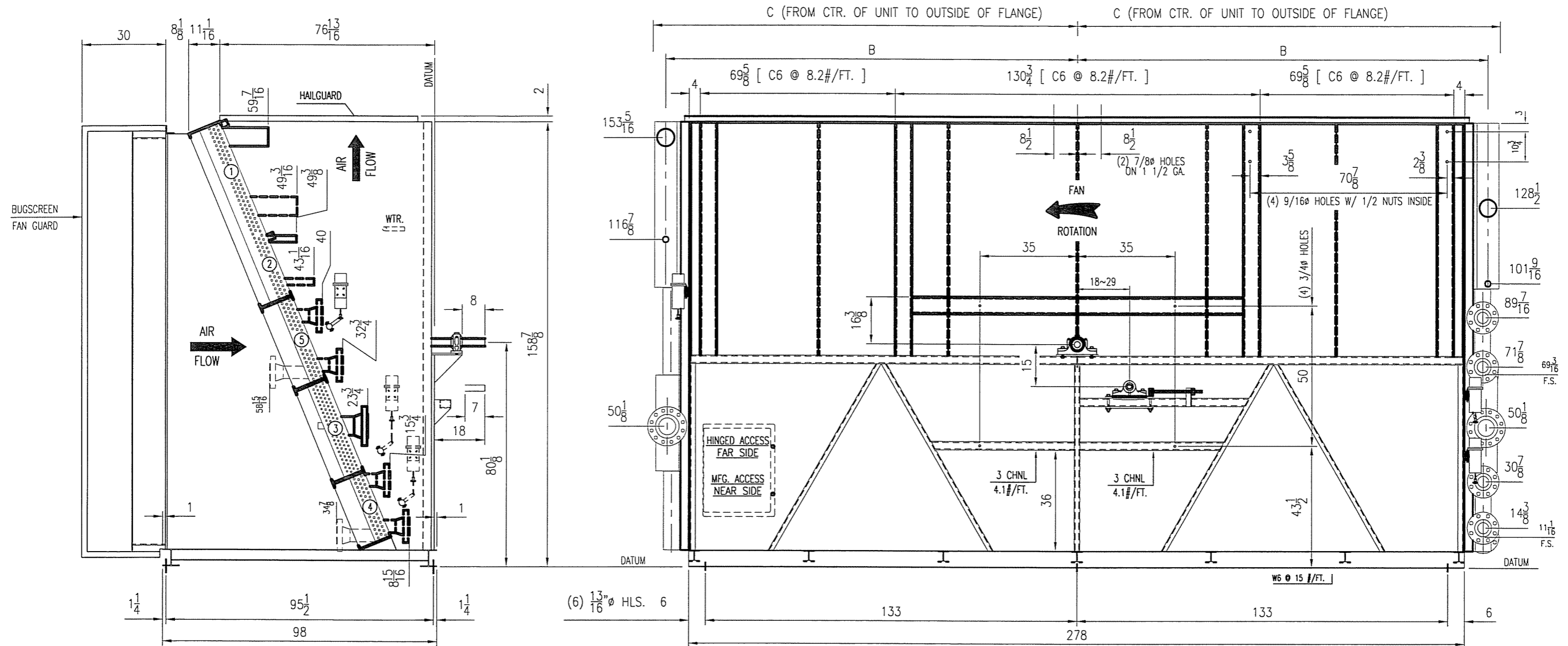
CONSULTANT: - LSD: -
P.O.: - JOB No.: 060158

DRWN BY: TTS DESIGN BY: - DATE: - DWG. No. OP
DATE: 02/07/24 CHKD BY: - DATE: - SF-060158-28 28
SCALE: NTS APPVD BY: - DATE: -

OPTION SELECTION	OPTION NUMBER	OPTION DESCRIPTION
<input type="checkbox"/>	2801A	24V UPS, 60 AMP A1478
<input checked="" type="checkbox"/>	2801B	24V UPS, 30 AMP A1478
<input type="checkbox"/>	2803	ENGINE & COMPRESSOR VIBRATOR TRANSMITTERS
<input type="checkbox"/>		
<input type="checkbox"/>		
<input type="checkbox"/>		

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ITEM	SERVICE	MAWP	CODE	NOZZLES		COUPLINGS VENT&TEMP	REF. DIMENSIONS		LOUVERS	BUG SCREEN	DRIVE	FAN	FINISH
				INLET	OUTLET		B	C					
1	EJW (COMBINED) 42 GALS	14 PSI @ 300/-20°F	NONE	6-PIPE STUB	6-PIPE STUB	1-3000	147.38	-	MANUAL	YES	ENGINE DRIVE SHEAVES, BELTS, AND GUARDS BY OTHERS Ø2.1875 IDLER SHAFT WITH .5 x .25 KWY	144Ø MOORE 10K, 48, VT 10 BLADE, 16 PA LH ROTATION 275 RPM @ 54 HP REQ'D	STRUCTURE STD. PRIMER W/ WARM GRAY ENAMEL TOP COAT
2	AUX-W (COMBINED) 24 GALS	14 PSI @ 300/-20°F	NONE	2-PIPE STUB	2-PIPE STUB	1-3000	147.38	-					
3	IC1	1292 PSI @ 350/-20°F	ASME	6-600 RFWN	6-600 RFWN	1-6000	146.75	153.75	AUTO				
4	IC2	1935 PSI @ 350/-20°F	ASME	4-900 RFWN	(2) 4-900 RFWN	NONE	145.75	151.50	AUTO				
5	AC	1935 PSI @ 350/-20°F	ASME	4-900 RFWN	(2) 4-900 RFWN	NONE	145.75	151.50	AUTO		Ø2.9375 FAN DRIVE SHAFT WITH .75 x .375 KWY	Ø2.9375 BORE WITH .75 x .375 KWY.	HAILGUARD FAN GUARD GALVANIZED



RELEASED
FABRICATION OF THIS
ORDER HAS BEGUN

						FOR: ENERFLEX SYSTEMS LTD.
						P.O. NO: 0640045 THRU 0640049
						CUST. TAG: 060151, 52, 58, 59, 60
						USER: ENCANA (7042GL-JGK4 2/3)
						JOBSITE: CUTBANK MONTANA
						JOB NO: 64468
						WORK ORDER NO.: -
						DR: LES DATE: 03/29/06
						CK: M.B. DATE: 03/29/06
1	CHG'D QUANTITY, ADDED P.O. & TAG #'S	MIKE	L.W.	06/28/06		
REV	REVISION DESCRIPTION	BY	CK	APP	DATE	APPD: DATE:

ESTIMATED DRY WEIGHT 23,500#

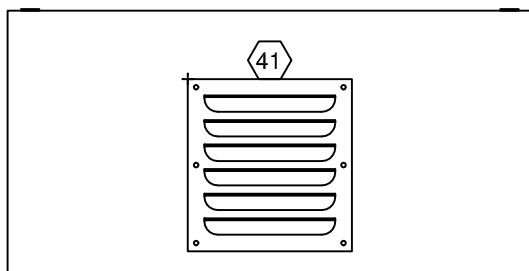
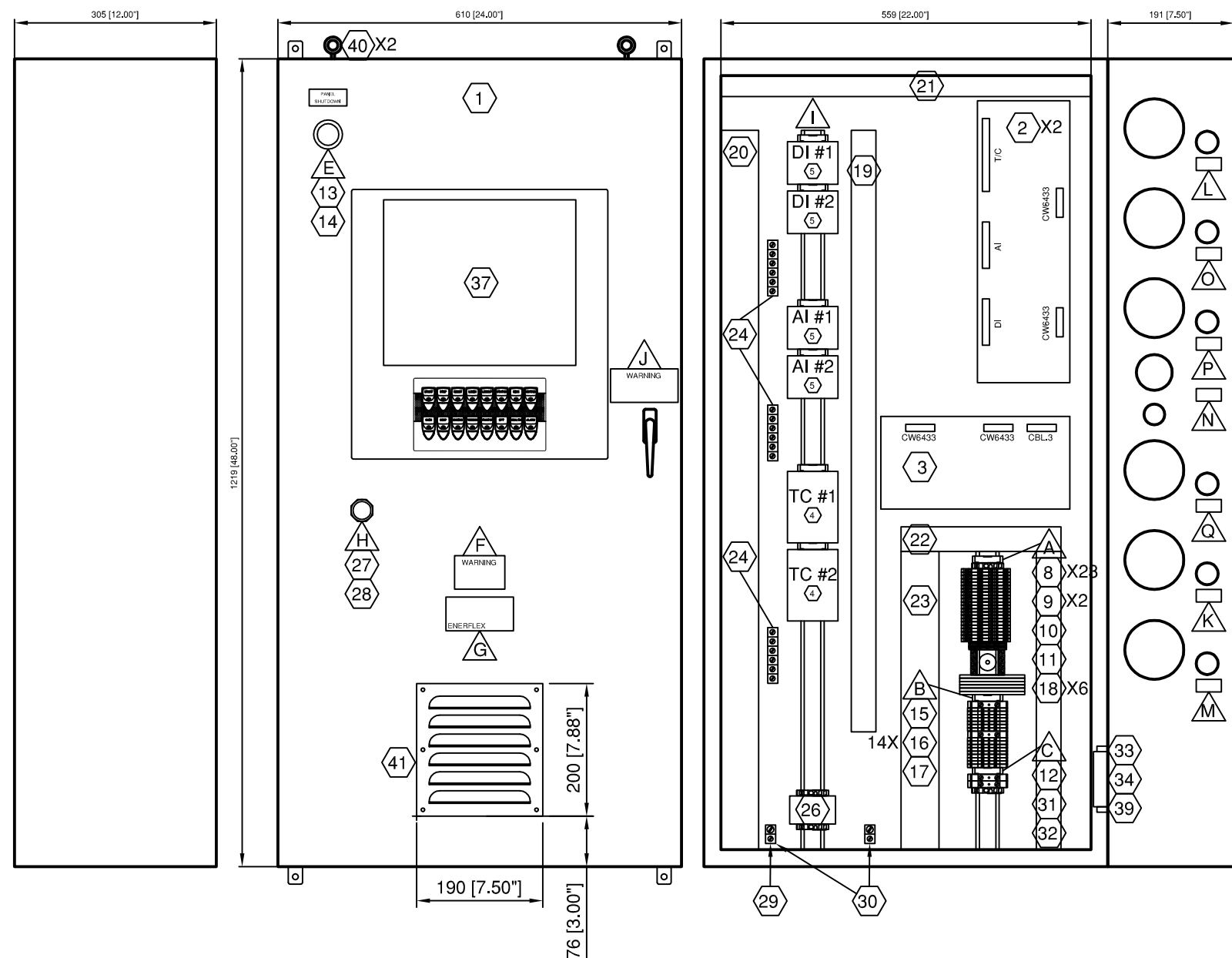


CERTIFIED DRAWING

MODEL 144EF-102-24 QUANTITY: 6

CERTIFIED DRAWING NUMBER 64468-CRT

DATE: 03/29/06 SCALE: FULL REV 1



TOP VIEW

BILL OF MATERIALS

ITEM	QTY	DESCRIPTION	MODEL #
1	1	ACE 48"X24"X12" ENCLOSURE w/ FEET	ACE 482412
2	2	RC 2000 INPUT MODULE	ALTCW4769-3
3	1	RC 2000 OUTPUT MODULE	ALTCW5218-2
4	2	WIELAND. 40 PIN TERMINATION BLOCK	WIE8721022083
5	4	WIELAND. 26 PIN TERMINATION BLOCK	WIE8721022053
6			
7			
8	23	WDK 2.5 STACKED FEED THROUGH TERM.	WET102150
9	2	WEID. WPE 4 GROUND TERMINAL	WET101010
10	1	MAGNECRAFT 24VDC 2 POLE RELAY	MGE750XBXH-24D
11	1	MAGNECRAFT RELAY BASE FOR ABOVE	MGBIE70-464-1
12	1	BUSSMAN FUSE HOLDER USM3J1/ 25A FUSE	BUSGOUUS3J1/BUSGOUA4J25
13	1	AB BUTTON, PUSH/PULL, 2 POS, RED	ALB800TFX6
14	1	BLOCK, CONTACT, N/C SEAL, CL 1, DIV 2	ALB800TXD2P
15	1	WEID SAKS 1/35 FUSED TERMINAL	WET50162
16	14	WEID WDU 2.5 FEED THROUGH TERMINAL	WET102000
17	1	WEID WDU 10 FEED THROUGH TERMINAL	WET102030
18	6	WEIL. RELAY, FLARE, 24DC, 1W, 250V6A	WIE8001040000
19	LOT	DUCT, PLASTIC, GREY 1" X 2" PANDUIT	PANF1X2LG6
20	LOT	DUCT, PLASTIC, GREY 2" X 4" PANDUIT	PANF2X4LG6
21	LOT	DUCT, PLASTIC, WHITE 1" X 2" PANDUIT	PANF1X2WH6
22	LOT	DUCT, PLASTIC, WHITE 1" X 3" PANDUIT	PANF1X3WH6
23	LOT	DUCT, PLASTIC, WHITE 2" X 3" PANDUIT	PANF2X3WH6
24	LOT	WEID BAR, GROUND, 6FT	WET28020
25			
26	1	WEID. SPARE FUSE HOLDER	WET7914760001
27	1	AB BUTTON, PUSH, FLUSH HEAD, BLACK	ALB800TA2
28	1	BLOCK, CONTACT, N/O SEAL, CL 1, DIV 2	ALB800TXD1P
29	1	GLASTIC ISOLATORS RED	MSGGLA21651A
30	2	BURNDY PANEL GROUND LUG	BURKA2U
31	1	WEID WDU-35 FEED-THROUGH TERMINAL	WET 102050
32	1	END PLATE FOR ABOVE	WET 105010
33	LOT	TS-35 MOUNTING RAIL	WET38340
34	LOT	BRACKET, END, EW35 FOR TS35	WET38356
35	LOT	SCHT5s TERMINAL STRIP MARKERS	WET163193
36	-	-	-
37	1	CPU ASSEMBLY c/w 10" HMI & KEYPAD	RC2000-10T
38	-	-	-
39	1	E-CURVE LIGHT MODULE	RMX-EL
40	2	LIFTING EYE HOOKS	ACKGRTBS12
41	2	HOFFMAN LOUVER 6x6 / FILTER	HOFAVK66 / HOFAFLT66

LAMACOIDS SCHEDULE

ITEM	QTY	TEXT	SIZE
A	1	INCENDIVE I/O	SCHT5s
B	1	24 VDC DISTRIBUTION	SCHT5s
C	1	ESM PS	SCHT5s
D			
E	1	PANEL SHUTDOWN	1" X 3"
F	1	WARNING: EXPLOSION HAZARD SUBSTITUTION OF COMPONENTS MAY IMPAIR SUITABILITY FOR CLASS 1 DIV 2 HAZARDOUS LOCATIONS DO NOT DISCONNECT IF CIRCUIT IS LIVE OR UNLESS THAT AREA IS KNOWN TO BE NON HAZARDOUS	2" x 4" WHT/RED
G	1	ENERFLEX CSA LAMACOIDS	2" X 4"
H	1	POWER RESET	1" X 3"
I	1	NON-INCENDIVE I/O	SCHT5s
J	1	WARNING : DISCONNECT CABLE CONNECTION TO INPUT / OUTPUT BOARDS BEFORE WELDING	2" x 4" WHT/RED

LAMACOIDS SCHEDULE

ITEM	QTY	TEXT	SIZE
K			
L	1	BYPASS VALVE	3/4" X 1.5"
M			
N	1	FIRELOOP	3/4" X 1.5"
O	1	IC-1 LOUVER CONTROL	3/4" X 1.5"
P	1	IC-2 LOUVER CONTROL	3/4" X 1.5"
Q	1	AC LOUVER CONTROL	3/4" X 1.5"

Rev.	Soft Rev.	Revision Description	By	Date	Checked	Aprvd
1		PANEL SHOP AS BUILT	AK	29.08.2006	LH	
0		ISSUED FOR CONSTRUCTION	AK	24.08.2006	LH	

Project Title		ENCANA PANEL # 000145
Drawing Title		PANEL LAYOUT DRAWING

Syntech

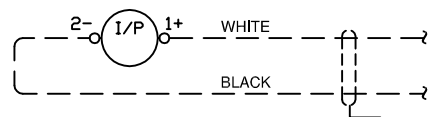
Syntech Drawing Number **SPR000145-01** 1 of 1

Customer Drawing Number **060158** NTS

TYPICAL FIELD I/O WIRING

INCENDIVE

CONTROL VALVE



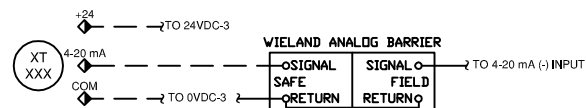
4 TO 20 mA OUTPUT WIRING

SOLENOID



DISCRETE OUTPUT WIRING

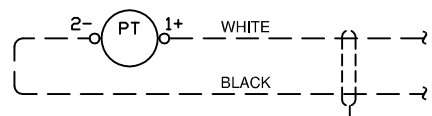
3-WIRE TRANSMITTER



4 TO 20 mA INPUT WIRING

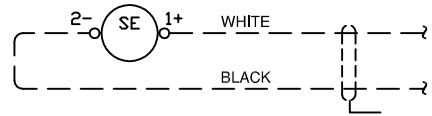
NON-INCENDIVE

2-WIRE PRESSURE TRANSMITTER



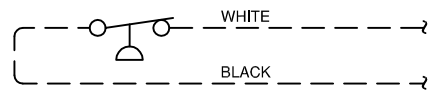
4 TO 20 mA INPUT WIRING

SPEED TRANSMITTER



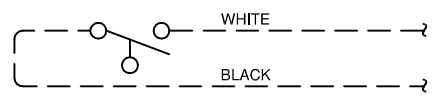
ENGINE SPEED PULSE INPUT WIRING

PRESSURE SWITCH



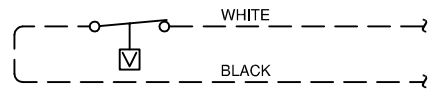
I/S DISCRETE INPUT WIRING

LEVEL SWITCH



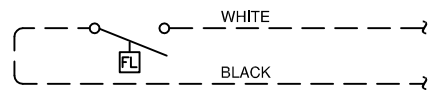
DISCRETE INPUT WIRING

VIBRATION SWITCH



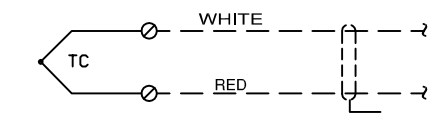
DISCRETE INPUT WIRING

FLOW SWITCH



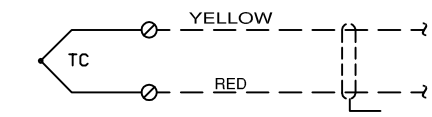
DISCRETE INPUT WIRING

TYPE J THERMOCOUPLE

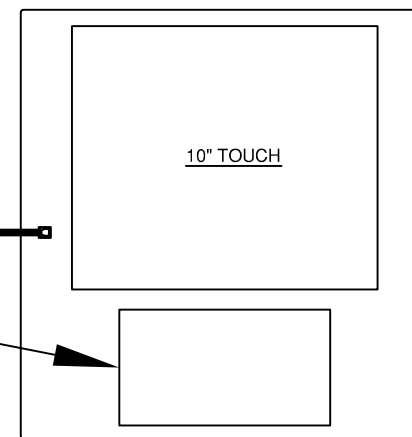
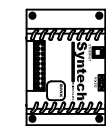
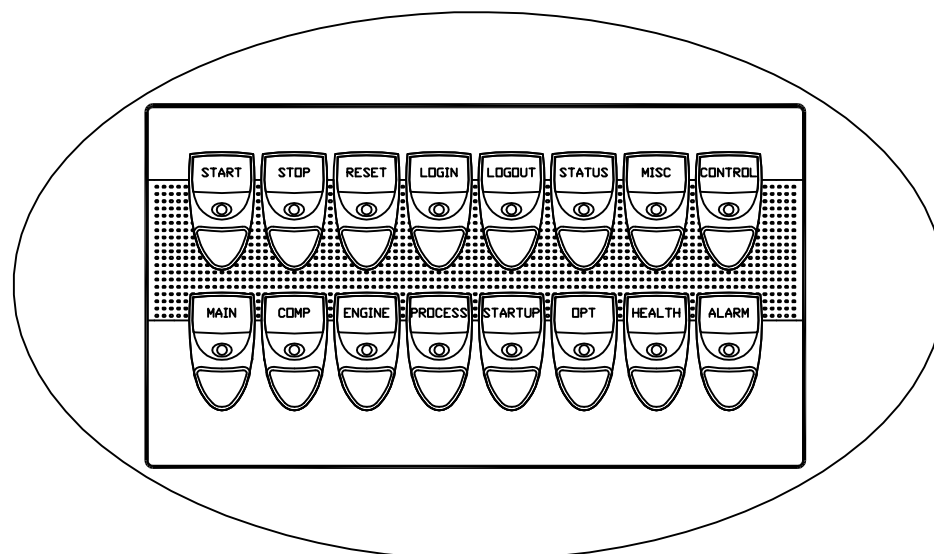


TYPE J THERMOCOUPLE INPUT WIRING

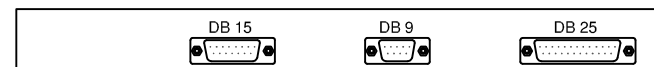
TYPE K THERMOCOUPLE



TYPE K THERMOCOUPLE INPUT WIRING

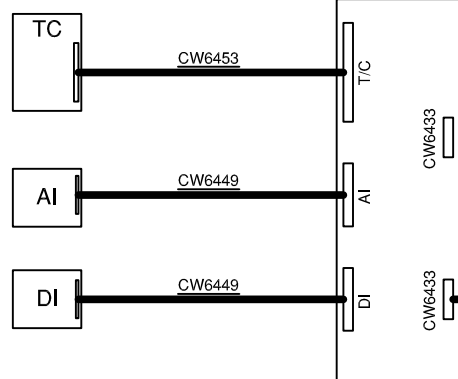


BOTTOM OF CPU MODULE

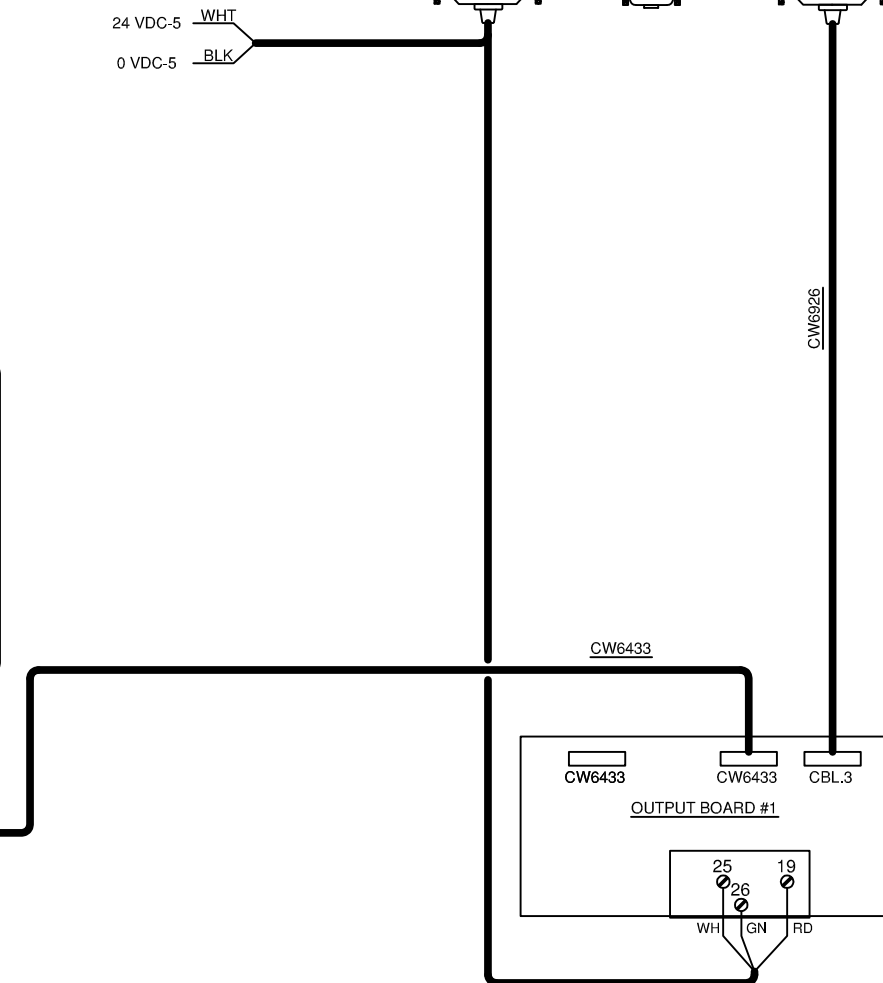
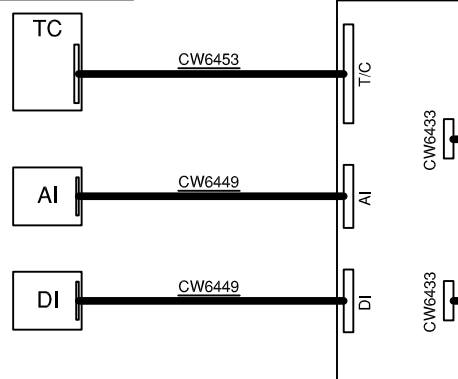


24 VDC-5 WHT
0 VDC-5 BLK

I/O TERMINAL BLOCKS



I/O TERMINAL BLOCKS



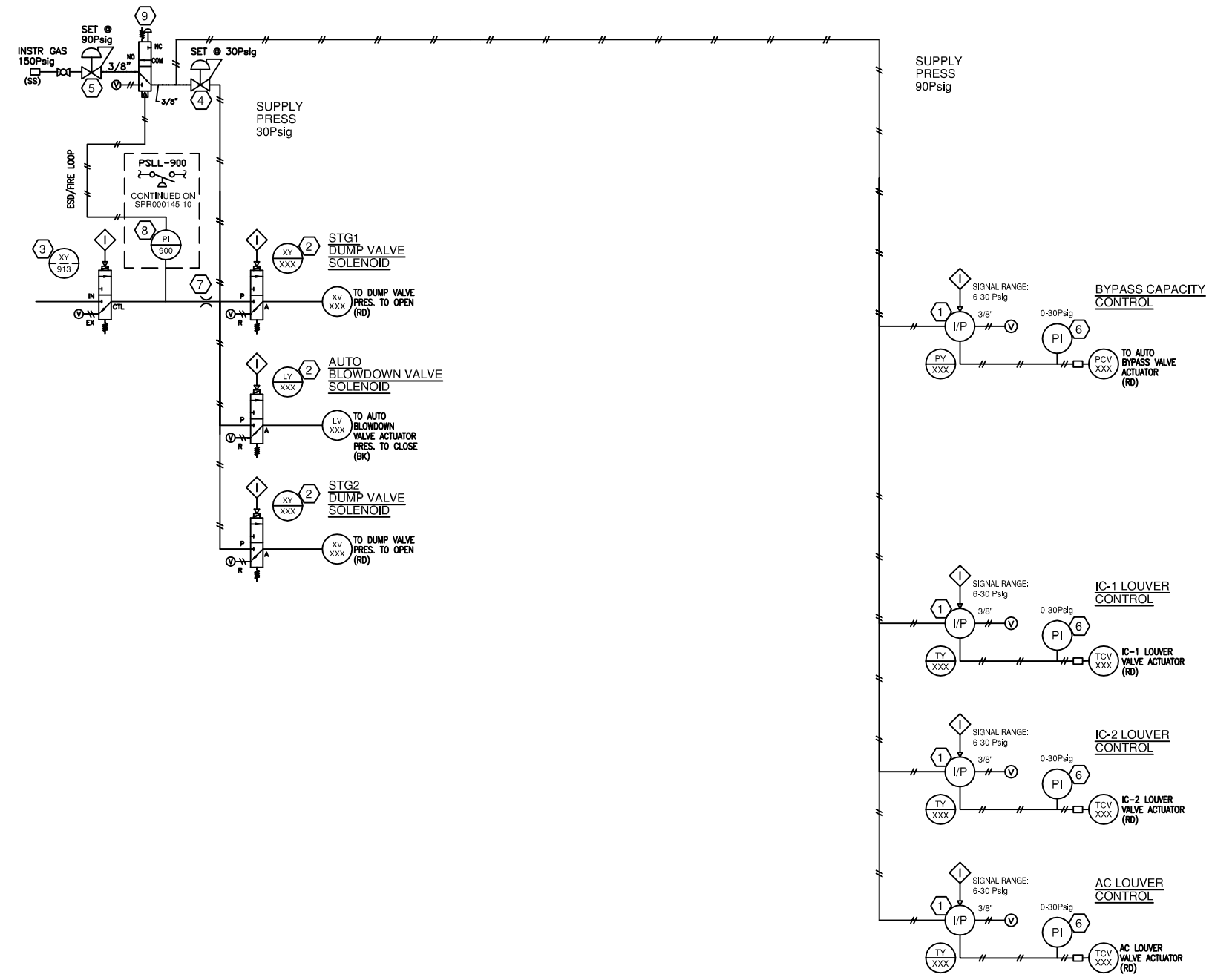
Rev.	Soft Rev.	Revision Description	By	Date	Checked	Aprvd
1		PANEL SHOP AS BUILT	AK	29.08.2006	LH	
0		ISSUED FOR CONSTRUCTION	AK	24.08.2006	LH	

Project Title	ENCANA PANEL # 000145
Drawing Title	I/O BOARD CABLE CONNECTION LAYOUT DRAWING

<h1>Syntech</h1>	
Syntech Drawing Number	SPR000145-02
Customer Drawing Number	060158
1 of 1	NTS

BILL OF MATERIALS

ITEM	QTY	DESCRIPTION	MODEL #
1	4	FAIRCHILD TRANSDUCER, ADJUSTABLE, I/P	TCX17800-401E2
2	3	BURKERT VALVE, SOLENOID, 3/2 WAY, 145PSI, 24VDC	462374F
3	1	SNAPTITE SOLENOID, VENTED BONNET, 90PSI, 24VDC	3013Z-2NT-V6F6C
4	1	FISHER REGULATOR, 1/4" NPT, 0-125PSI	FIS67CFR-601/TB
5	1	FISHER REGULATOR, PRESSURE REDUCING	FIS64-29
6	4	WIKA PRESSURE GAUGE 0-30 PSI	9603021
7	1	AMOT 2185 ORFICE, 1/4" NPT	2185L011
8	1	MURPHY GAUGE, 0-100PSI, MODEL A25PEF-100	MUR45A 25PEF100
9	1	AMOT 3-WAY ESD SWITCH	4057DO23H2
10	-	-	-
11	-	-	-
12	-	-	-
13	-	-	-
14	-	-	-
15	-	-	-
16	-	-	-
17	-	-	-
18	-	-	-



TUBING COLOR CODE

- BK (BLACK) VENTS
- BL (BLUE) ESD, FIRE LOOP SIGNAL
- RD (RED/TAG #) CONTROL VALVE
- OR (ORANGE) INSTR GAS OVER 35Psi
- YL (YELLOW) INSTR GAS BELOW 35Psi
- OR (START) ENGINE START GAS
- YL (FUEL) ENGINE FUEL GAS
- BK (BLACK) ENGINE OIL
- BR (BROWN) COMPRESSOR OIL
- GR/WH (GREEN) MANIFOLD
- SS STAINLESS STEEL TUBING

LEGEND

- PROCESS PIPING
- UTILITY PIPING
- TUBING - STAINLESS STEEL
- TUBING - NYLON
- HOSE (PRE-LUBE OIL, DRAIN)
- ELECTRICAL SIGNAL

Rev.	Soft Rev.	Revision Description	By	Date	Checked	Aprvd
1		PANEL SHOP AS BUILT	AK	29.08.2006	LH	
0		ISSUED FOR CONSTRUCTION	AK	24.08.2006	LH	

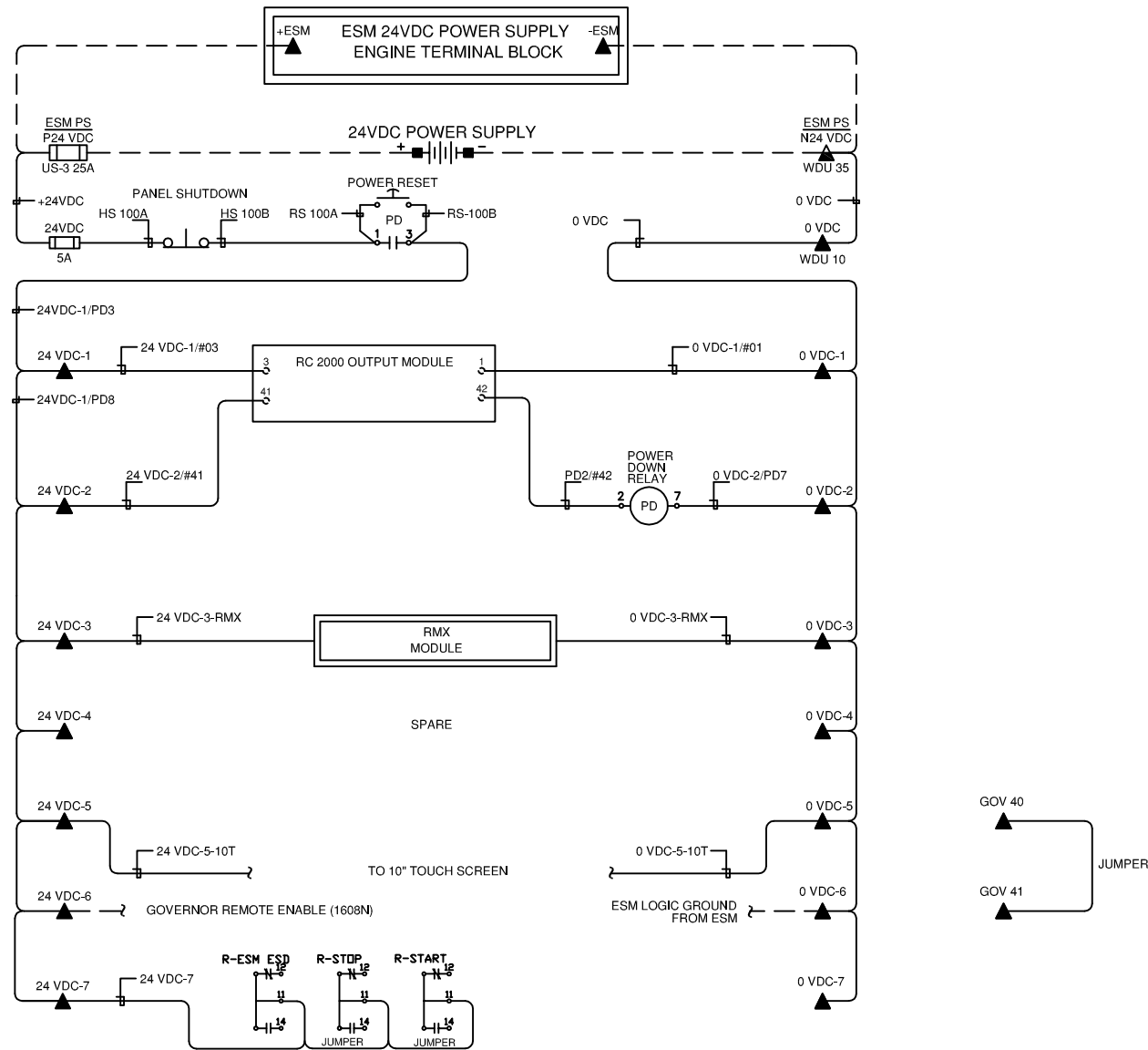
Project Title	ENCANA PANEL # 000145
Drawing Title	PNEUMATIC LAYOUT DRAWING

Syntech

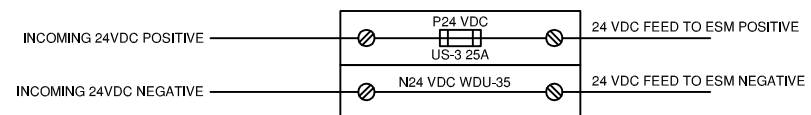
Syntech Drawing Number	SPR000145-04	1 of 1
Customer Drawing Number	060158	NTS

THIS DRAWING IS DESIGNED ENTIRELY FOR USE BY SYNTECH AND IS SOLE PROPERTY OF SYNTECH WHICH ASSUMES NO LIABILITY FOR REPRODUCTION OF THE DRAWING CONTENTS.

24VDC POWER DISTRIBUTION

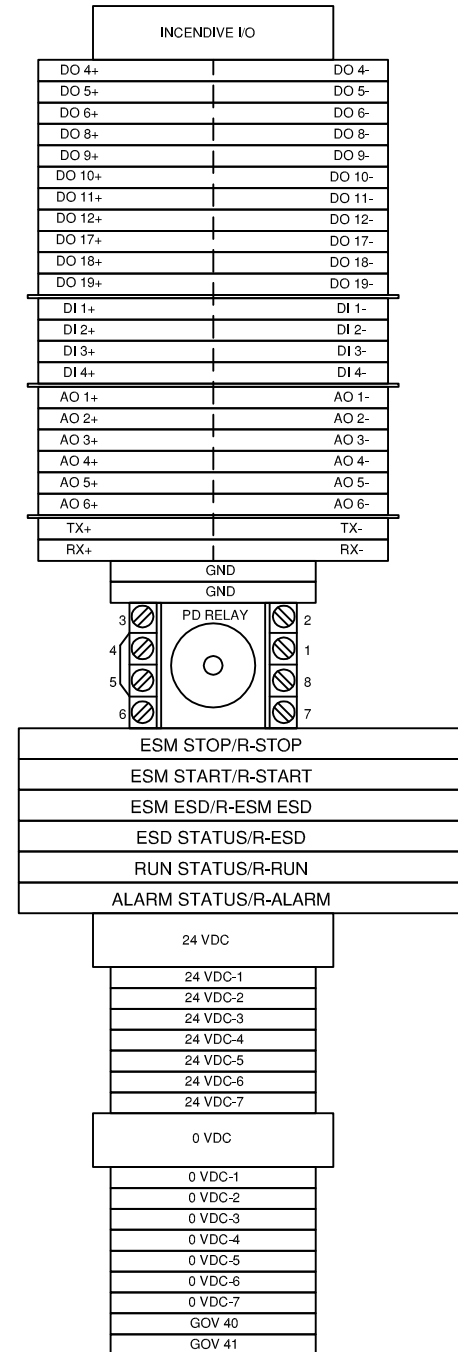


POWER SUPPLY TERMINAL LAYOUT



24VDC TERMINAL LAYOUT

TOP LEVEL BOTTOM LEVEL



LEGEND		WIRE COLOR LEGEND	
1.	PANEL WIRING	1. +24VDC: RED	
2.	FIELD WIRING	2. -24VDC: YELLOW	
3.	UNFUSED TERMINAL	3. SWITCHED: ORANGE	
4.	FUSED TERMINAL	4. ANALOG INPUT/OUTPUT - : BLACK	
5.	FEED THROUGH TERMINAL	5. ANALOG INPUT/OUTPUT + : WHITE	
6.	DISCONNECT TERMINAL	6. ANALOG LOOP: PURPLE	

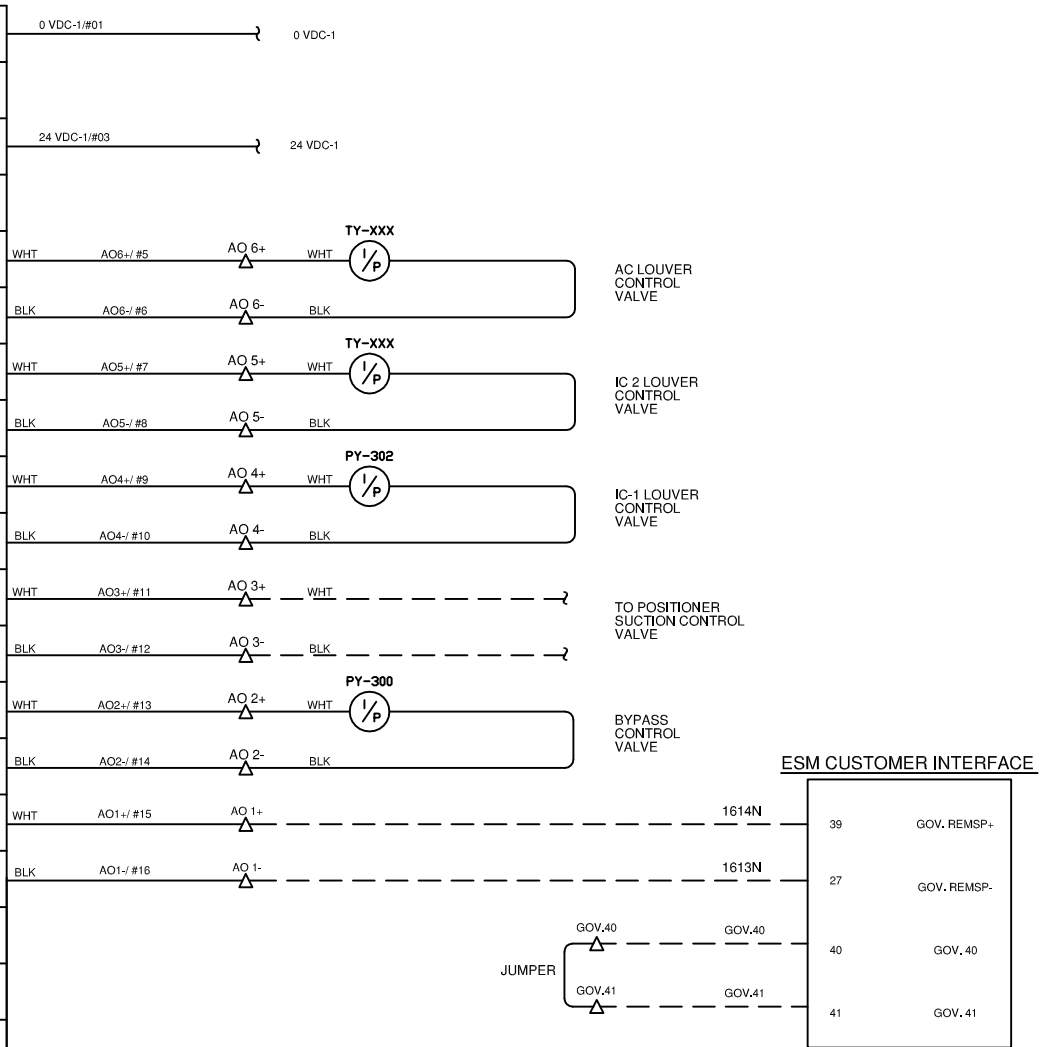
Rev.	Soft Rev.	Revision Description	By	Date	Checked	Aprvd
1		PANEL SHOP AS BUILT	AK	29.08.2006	LH	
0		ISSUED FOR CONSTRUCTION	AK	24.08.2006	LH	

Project Title	ENCANA PANEL # 000145
Drawing Title	24 VDC POWER DISTRIBUTION LAYOUT DRAWING

		Syntech Drawing Number	SPR000145-05	1 of 1
		Customer Drawing Number	060158	NTS

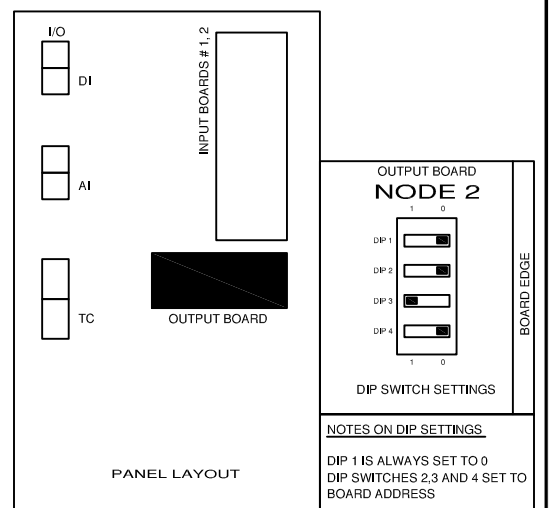
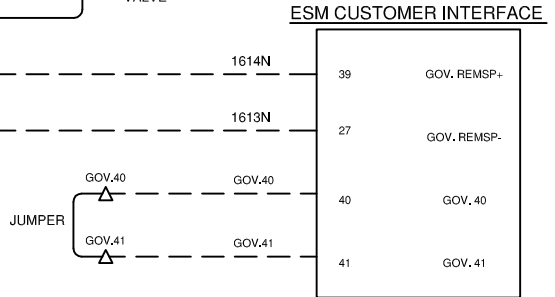
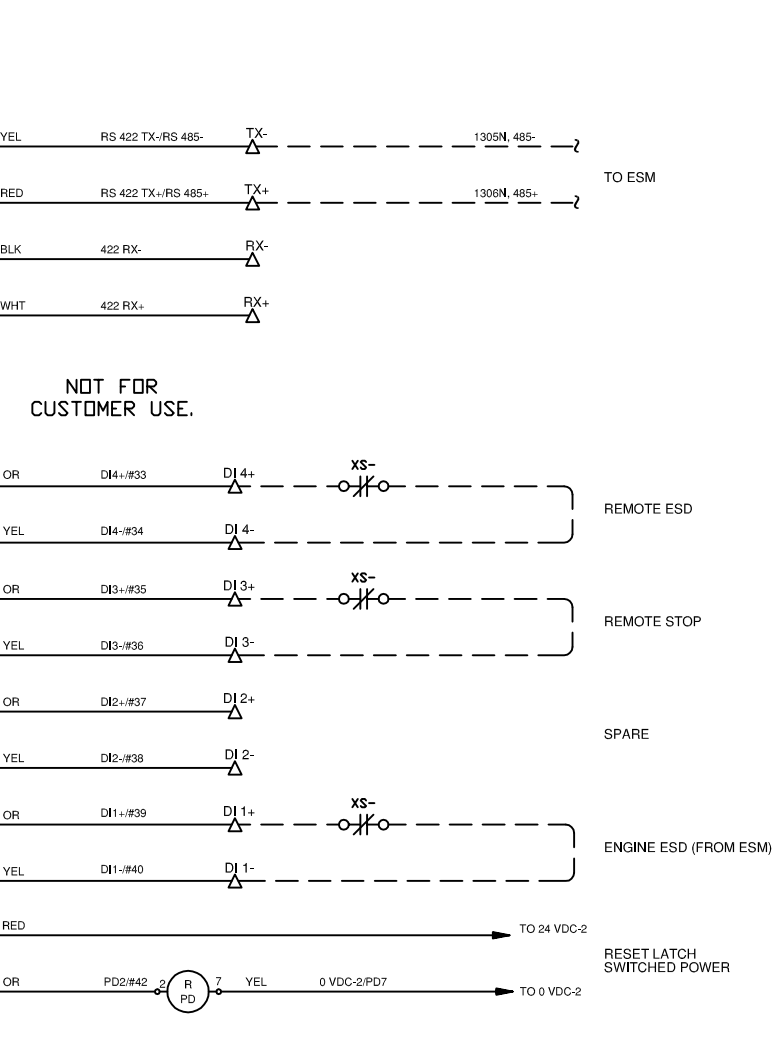
OUTPUT BOARD

DESCRIPTION	FUNC	+/-	COLOR	TERM
24V	-			1
EARTH				2
24V	+			3
EARTH				4
AO6	+	WHT		5
AO6	-	BLK		6
AO5	+	WHT		7
AO5	-	BLK		8
AO4	+	WHT		9
AO4	-	BLK		10
AO3	+	WHT		11
AO3	-	BLK		12
AO2	+	WHT		13
AO2	-	BLK		14
AO1	+	WHT		15
AO1	-	BLK		16
PHONE TIP				17
PHONE RING				18
RS232 TXD				19
RS232 CTS				20
RS232 RTS				21
RS232 DRS				22
RS232 DTR				23
RS232 DCD				24



OUTPUT BOARD (cont.)

DESCRIPTION	FUNC	+/-	COLOR	TERM
RS232 RXD				25
RS232 GND				26
RS422 TX	-	YELLOW		27
RS422 TX	+	RED		28
RS422 RX	-	BLACK		29
RS422 RX	+	WHITE		30
RS485	+			31
RS485	-			32
DI04	+	OR		33
DI04	-	YEL		34
DI03	+	OR		35
DI03	-	YEL		36
DI02	+	OR		37
DI02	-	YEL		38
DI01	+	OR		39
DI01	-	YEL		40
+24VDC				41
POWER DOWN				42



NOTES:
1. NOT FOR CUSTOMER USE

LEGEND		WIRE COLOR LEGEND	
1.	PANEL WIRING	1. +24VDC: RED	
2.	FIELD WIRING	2. -24VDC: YELLOW	
3.	UNFUSED TERMINAL	3. SWITCHED: ORANGE	
4.	FUSED TERMINAL	4. ANALOG INPUT/OUTPUT -: BLACK	
5.	FEED THROUGH TERMINAL	5. ANALOG INPUT/OUTPUT +: WHITE	
6.	DISCONNECT TERMINAL	6. ANALOG LOOP: PURPLE	

Rev.	Soft Rev.	Revision Description	By	Date	Checked	Aprvd
1		PANEL SHOP AS BUILT	AK	29.08.2006	LH	
0		ISSUED FOR CONSTRUCTION	AK	24.08.2006	LH	

Project Title	ENCANA PANEL # 000145
Drawing Title	INCENDIVE OUTPUT BOARD #1 LAYOUT DRAWING

Syntech

Syntech Drawing Number	SPR000145-07	1 of 1
Customer Drawing Number	060158	NTS

DESCRIPTION	FUNC	+/-	COLOR	TERM
OUT 20	+			43 OR DO 20-/#43
	-			44 YEL DO 20-/#44
OUT 19	+	OR		45 OR DO19-/#45 DO 19+
	-	YEL		46 YEL DO19-/#46 DO 19-
OUT 18	+	OR		47 OR DO18-/#47 DO 18+
	-	YEL		48 YEL DO18-/#48 DO 18-
OUT 17	+	OR		49 OR DO17-/#49 DO 17+
	-	YEL		50 YEL DO17-/#50 DO 17-
OUT 16	+	OR		51 OR DO16-/#51
	-	YEL		52 YEL DO16-/#52
OUT 15	+	OR		53 OR DO15-/#53
	-	YEL		54 YEL DO15-/#54
OUT 14	+	OR		55 OR DO14-/#55
	-	YEL		56 YEL DO14-/#56
OUT 13	+	OR		57 OR DO13-/#57
	-	YEL		58 YEL DO13-/#58
OUT 12	+	OR		59 OR DO12-/#59 DO 12+
	-	YEL		60 YEL DO12-/#60 DO 12-
OUT 11	+	OR		61 OR DO11-/#61 DO 11+
	-	YEL		62 YEL DO11-/#62 DO 11-
OUT 10	+	OR		63 OR DO10-/#63 DO 10+
	-	YEL		64 YEL DO10-/#64 DO 10-
OUT 09	+	OR		65 OR DO9-/#65 DO 9+
	-	YEL		66 YEL DO9-/#66 DO 9-

INSTR/UTIL GAS SOLENOID

SPARE

SPARE

SPARE

ESM ESD RELAY

ESD STATUS RELAY

RUN STATUS RELAY

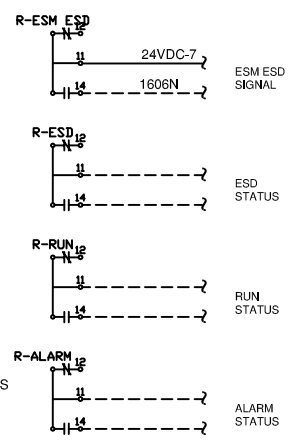
ALARM STATUS RELAY

SPARE

SPARE

SPARE

SPARE



DESCRIPTION	FUNC	+/-	COLOR	TERM
OUT 08	+	OR		67 OR DO8-/#67 DO 8+ OR XY-XXX
	-	YEL		68 YEL DO8-/#68 DO 8- YEL
OUT 07	+	OR		69 OR DO7-/#69 XY-XXX
	-	YEL		70 YEL DO7-/#70
OUT 06	+	OR		71 OR DO6-/#71 DO 6+
	-	YEL		72 YEL DO6-/#72 DO 6-
OUT 05	+	OR		73 OR DO5-/#73 DO 5+ OR LY-XXX
	-	YEL		74 YEL DO5-/#74 DO 5- YEL
OUT 04	+	OR		75 OR DO4-/#75 DO 4+
	-	YEL		76 YEL DO4-/#76 DO 4-
OUT 03	+	OR		77 OR DO3-/#77
	-	YEL		78 YEL DO3-/#78
OUT 02	+	OR		79 OR DO2-/#79
	-	YEL		80 YEL DO2-/#80
OUT 01	+	OR		81
	-	YEL		82
NC				83
				84

STAGE 2 DUMP VALVE SOLENOID

STAGE 1 DUMP VALVE SOLENOID

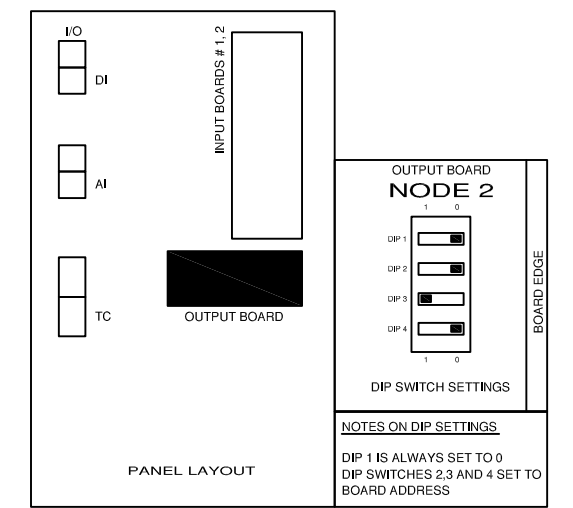
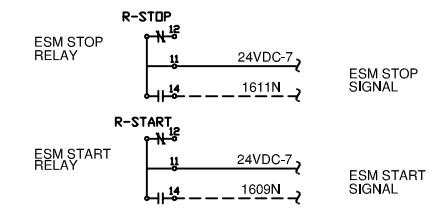
SPARE

AUTO BLOWDOWN VALVE SOLENOID

SPARE

ESM STOP RELAY

ESM START RELAY



NOTES:
1. NOT FOR CUSTOMER USE

LEGEND		WIRE COLOR LEGEND	
1.	PANEL WIRING	1. +24VDC: RED	
2.	FIELD WIRING	2. -24VDC: YELLOW	
3.	UNFUSED TERMINAL	3. SWITCHED: ORANGE	
4.	FUSED TERMINAL	4. ANALOG INPUT/OUTPUT -: BLACK	
5.	FEED THROUGH TERMINAL	5. ANALOG INPUT/OUTPUT +: WHITE	
6.	DISCONNECT TERMINAL	6. ANALOG LOOP: PURPLE	

Rev.	Soft Rev.	Revision Description	By	Date	Checked	Aprvd
1		PANEL SHOP AS BUILT	AK	29.08.2006	LH	
0		ISSUED FOR CONSTRUCTION	AK	24.08.2006	LH	

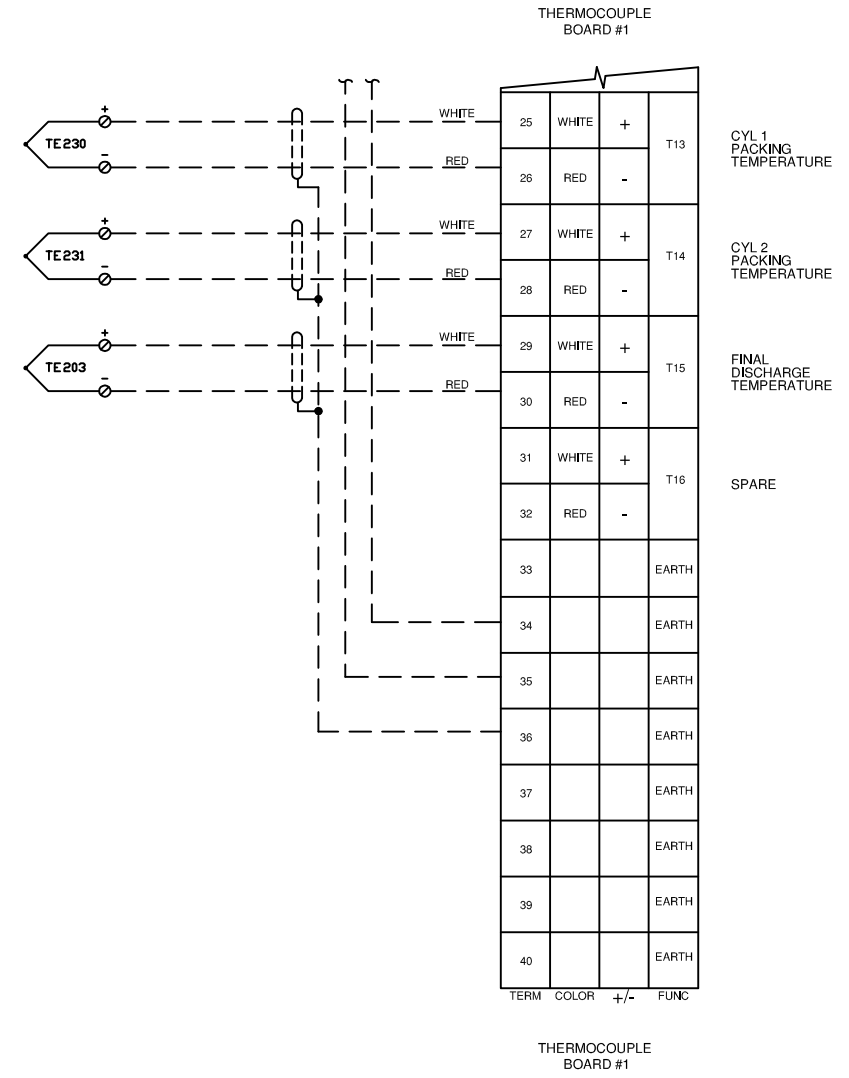
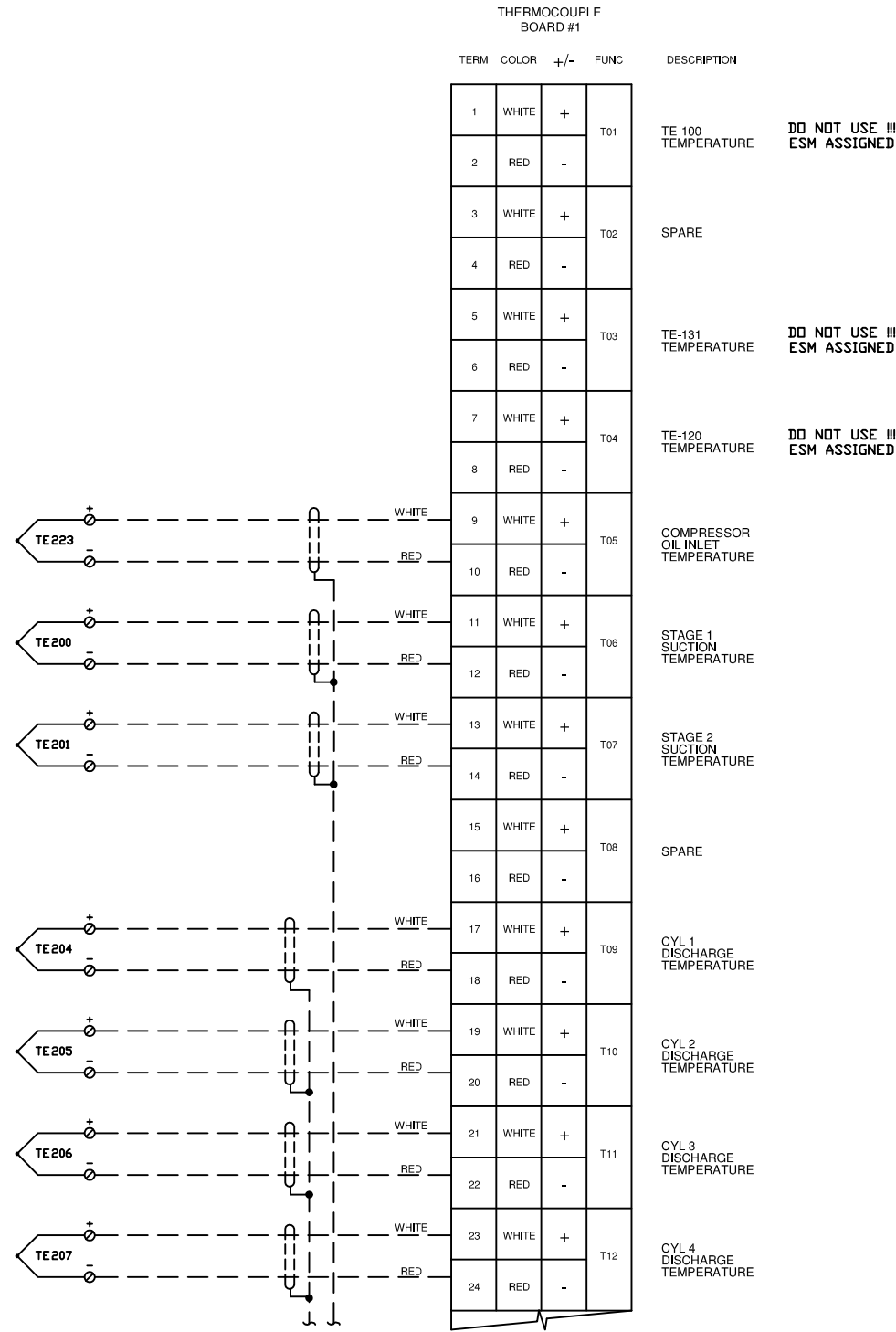
Project Title	ENCANA PANEL # 000145
Drawing Title	INCENDIVE OUTPUT BOARD #1 (cont.) LAYOUT DRAWING

		Drawing Number	SPR000145-08	1 of 1
		Customer Drawing Number	060158	NTS

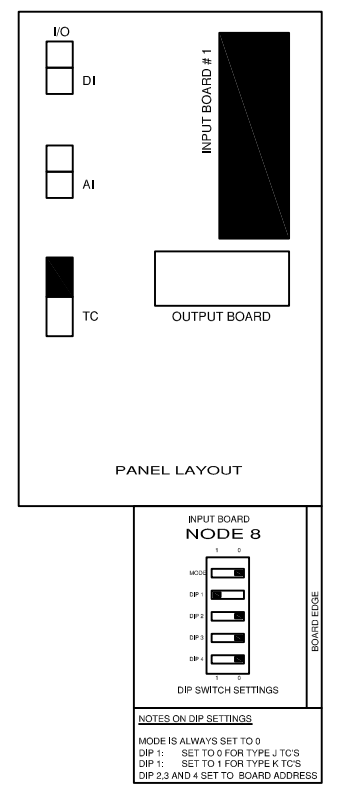
THIS DRAWING IS DESIGNED ENTIRELY FOR USE BY SYNTECH AND IS SOLE PROPERTY OF SYNTECH WHICH ASSUMES NO LIABILITY FOR REPRODUCTION OF THE DRAWING CONTENTS.

DESCRIPTION	TERMINATION	DWG. REF. NUMBER	SOFTWARE SETUP AND CONFIGURATION	
ESM START SIGNAL		SPR000145-08	ESM PORT SETTINGS	NODE ADDRESS: 17 BAUD RATE: 9600
ESM STOP SIGNAL		SPR000145-08	RC2000 PORT SETTINGS	PORT 4: RS 422 / 485 STATE: ON BAUD: 9600 PARITY: NONE SIZE: 8 BITS STOP BITS: 1 HS: NONE DEVICE: MODBUS MASTER MODE: RS 485 ACTIVATE 422 / 485: ON
ESM ESD SIGNAL		SPR000145-08		
GOVERNOR SPEED		SPR000145-07		
GOVERNOR REMOTE ENABLE	24 VDC-6 ▲ -----> GOVERNOR REMOTE ENABLE (1608N)	SPR000145-05		
ESM LOGIC GROUND	0 VDC-6 ▲ -----> LOGIC GROUND (FROM ESM)	SPR000145-05		
ESM COMMUNICATIONS		SPR000145-07		

LEGEND 1. PANEL WIRING 2. FIELD WIRING 3. UNFUSED TERMINAL 4. FUSED TERMINAL 5. FEED THROUGH TERMINAL 6. DISCONNECT TERMINAL	WIRE COLOR LEGEND 1. +24VDC: RED 2. -24VDC: YELLOW 3. SWITCHED: ORANGE 4. ANALOG INPUT/OUTPUT -: BLACK 5. ANALOG INPUT/OUTPUT +: WHITE 6. ANALOG LOOP: PURPLE	Project Title	ENCANA PANEL # 000145											
		Rev.	Soft Rev.	Revision Description		By	Date	Checked	Aprvd	Drawing Title	ESM WIRING AND CONFIGURATION LAYOUT DRAWING	Syntech Drawing Number	SPR000145-06	1 of 1
		1		PANEL SHOP AS BUILT		AK	29.08.2006	LH			Customer Drawing Number	060158	NTS	



THERMOCOUPLE FIELD WIRING
 J-TYPE: + = WHITE
 - = RED
 K-TYPE: + = YELLOW
 - = RED



LEGEND

1. PANEL WIRING
 2. FIELD WIRING
 3. UNFUSED TERMINAL
 4. FUSED TERMINAL
 5. FEED THROUGH TERMINAL
 6. DISCONNECT TERMINAL

WIRE COLOR LEGEND

1. +24VDC: RED
 2. -24VDC: YELLOW
 3. SWITCHED: ORANGE
 4. ANALOG INPUT/OUTPUT - : BLACK
 5. ANALOG INPUT/OUTPUT + : WHITE
 6. ANALOG LOOP: PURPLE

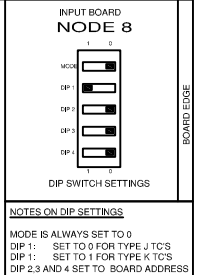
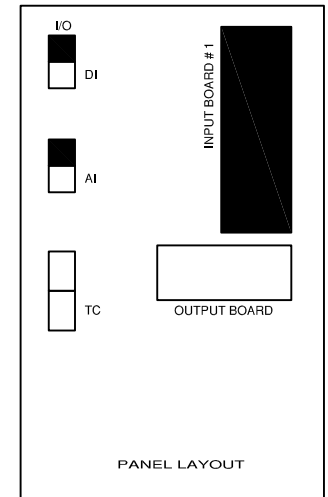
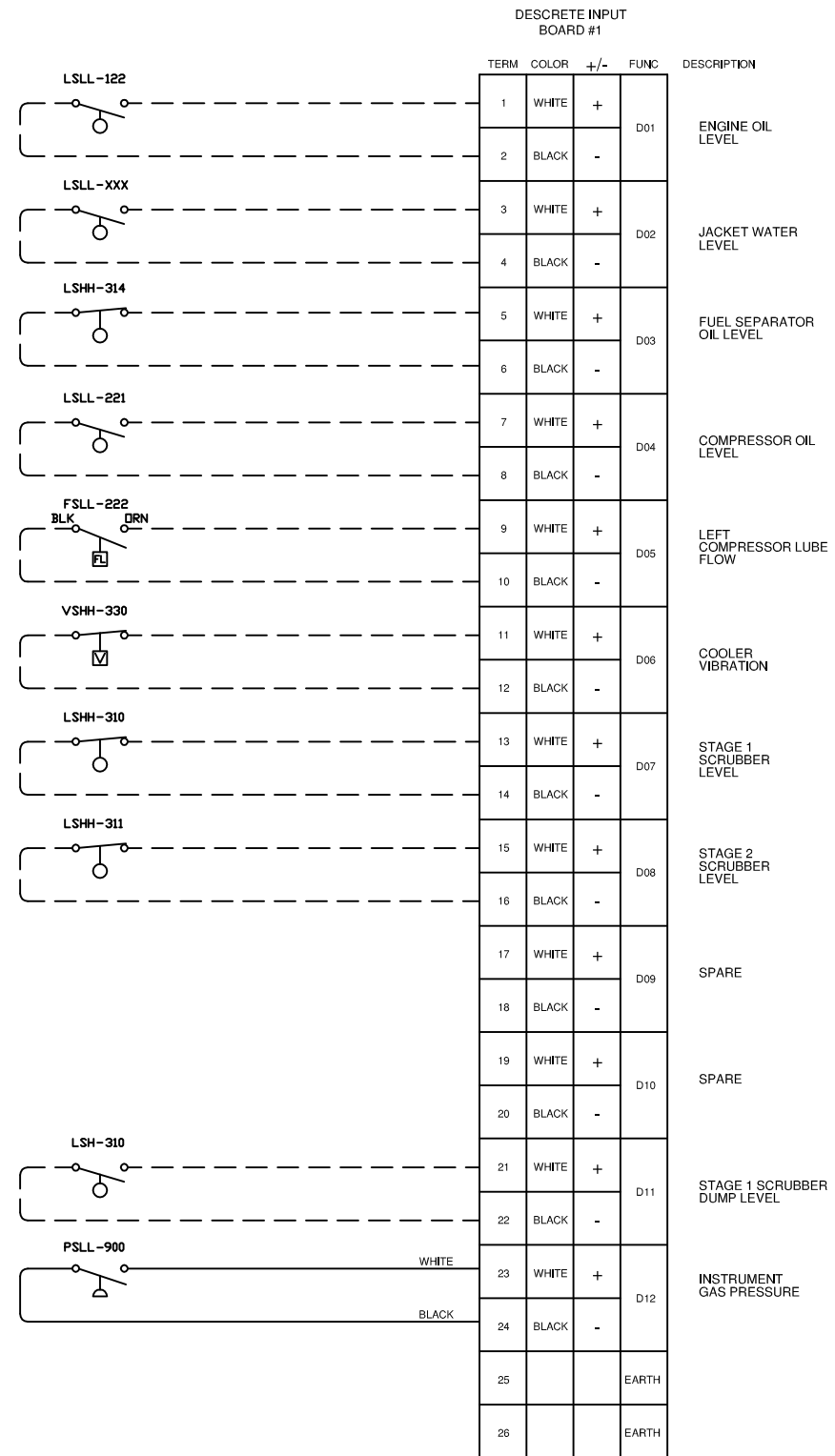
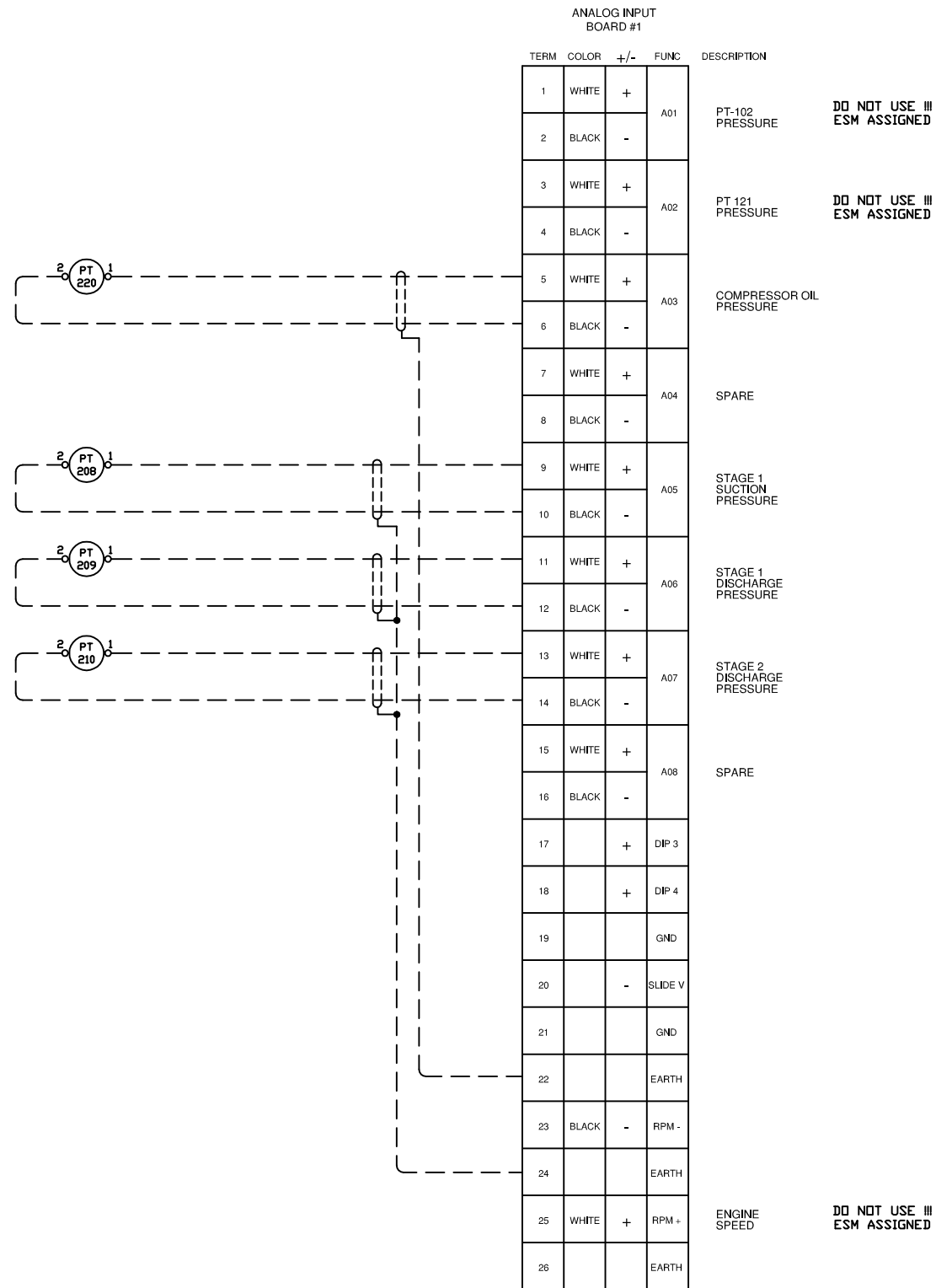
Rev.	Soft Rev.	Revision Description	By	Date	Checked	Aprvd
1		PANEL SHOP AS BUILT	AK	29.08.2006	LH	
0		ISSUED FOR CONSTRUCTION	AK	24.08.2006	LH	

Project Title
**ENCANA
 PANEL # 000145**

Drawing Title
**NON-INCENDIVE INPUT BOARD #1
 THERMOCOUPLE LAYOUT DRAWING**

Syntech

Syntech Drawing Number **SPR000145-09** 1 of 1
 Customer Drawing Number **060158** NTS

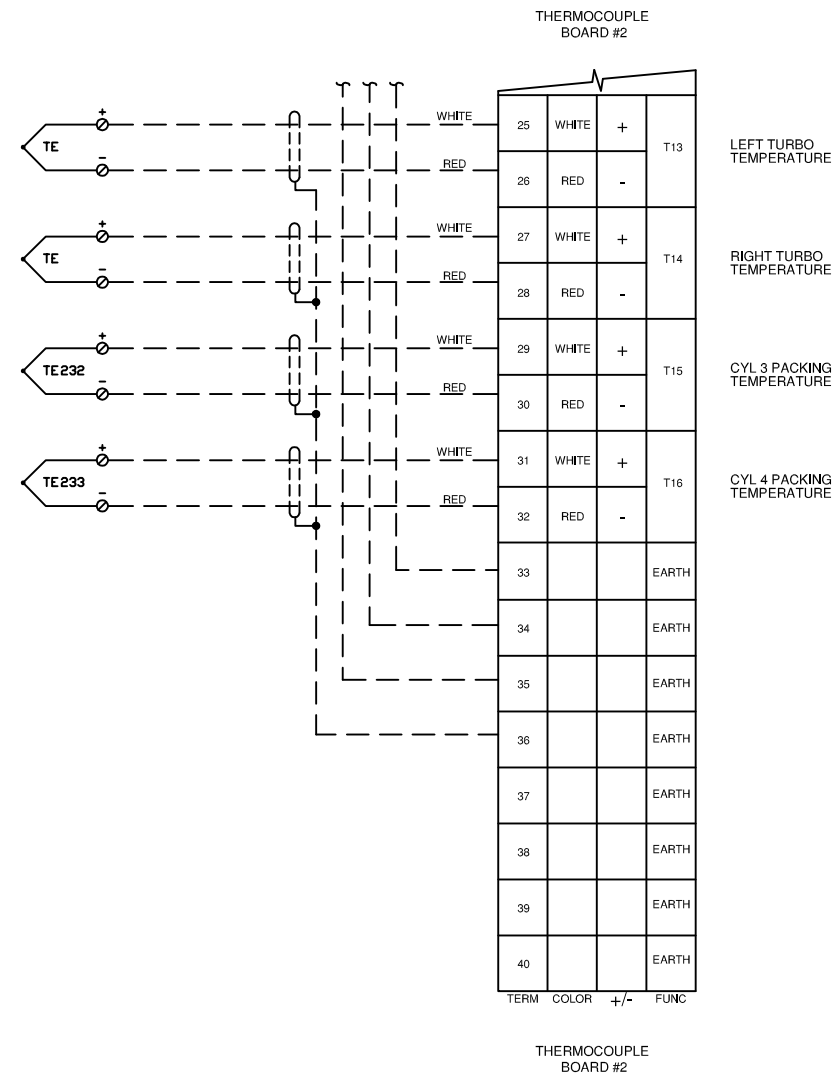
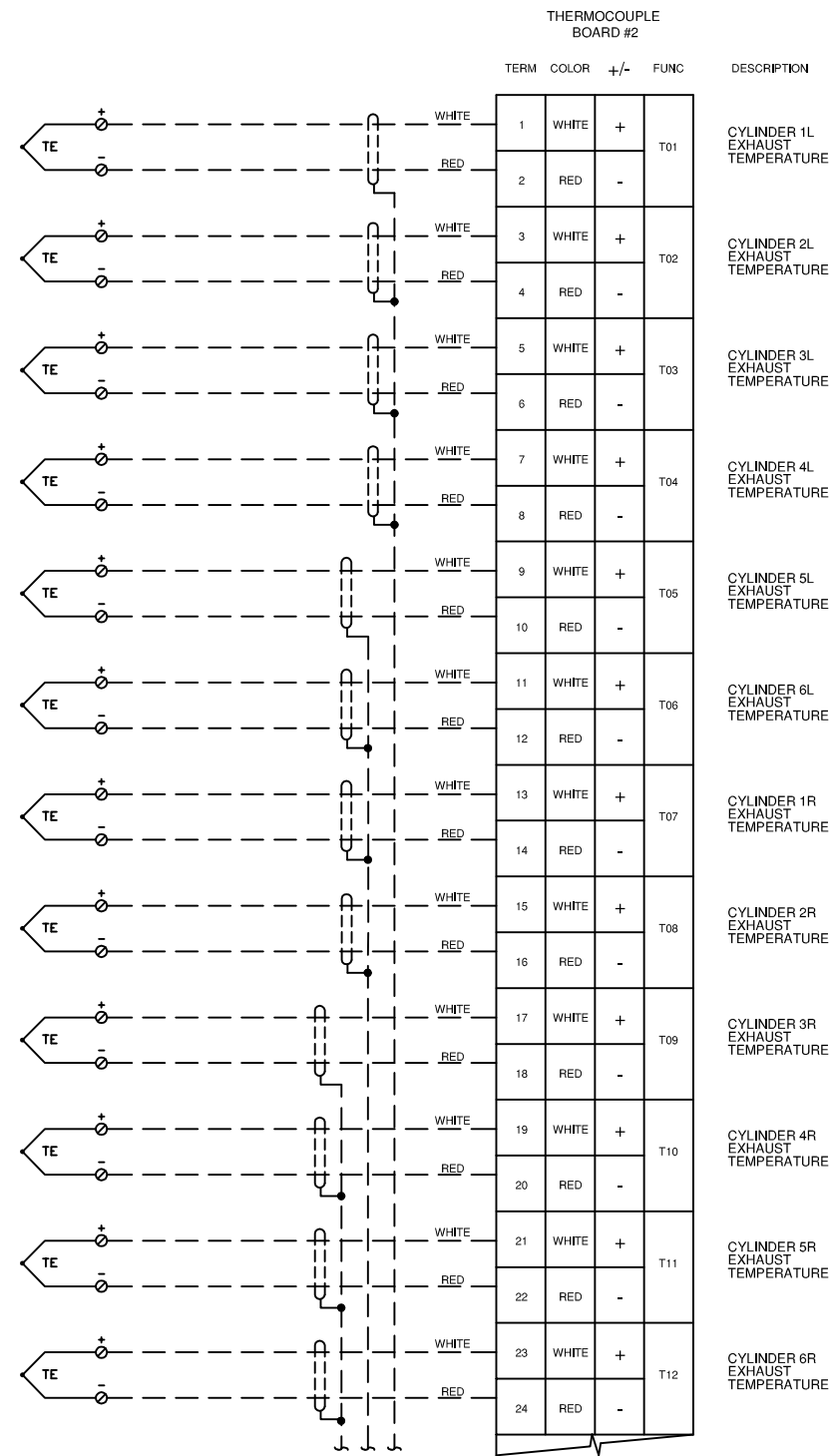


LEGEND		WIRE COLOR LEGEND	
1. [Symbol]	PANEL WIRING	1. +24VDC: RED	
2. [Symbol]	FIELD WIRING	2. -24VDC: YELLOW	
3. [Symbol]	UNFUSED TERMINAL	3. SWITCHED: ORANGE	
4. [Symbol]	FUSED TERMINAL	4. ANALOG INPUT/OUTPUT -: BLACK	
5. [Symbol]	FEED THROUGH TERMINAL	5. ANALOG INPUT/OUTPUT +: WHITE	
6. [Symbol]	DISCONNECT TERMINAL	6. ANALOG LOOP: PURPLE	

Rev.	Soft Rev.	Revision Description	By	Date	Checked	Aprvd
1		PANEL SHOP AS BUILT	AK	29.08.2006	LH	
0		ISSUED FOR CONSTRUCTION	AK	24.08.2006	LH	

Project Title	ENCANA PANEL # 000145		
Drawing Title	NON-INCENDIVE INPUT BOARD #1 ANALOG / DISCRETE LAYOUT DRAWING		

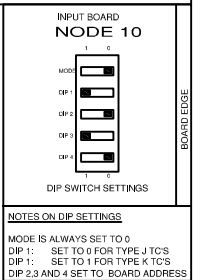
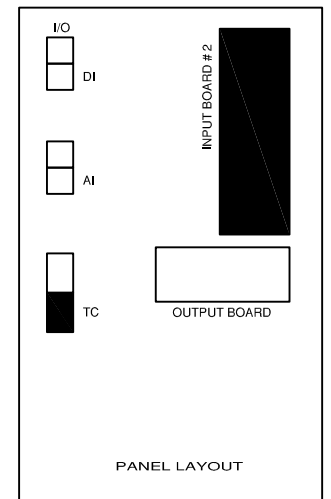
<h1>Syntech</h1>	
Syntech Drawing Number	SPR000145-10
Customer Drawing Number	060158
	1 of 1 NTS



THERMOCOUPLE FIELD WIRING

J-TYPE: + = WHITE
- = RED

K-TYPE: + = YELLOW
- = RED

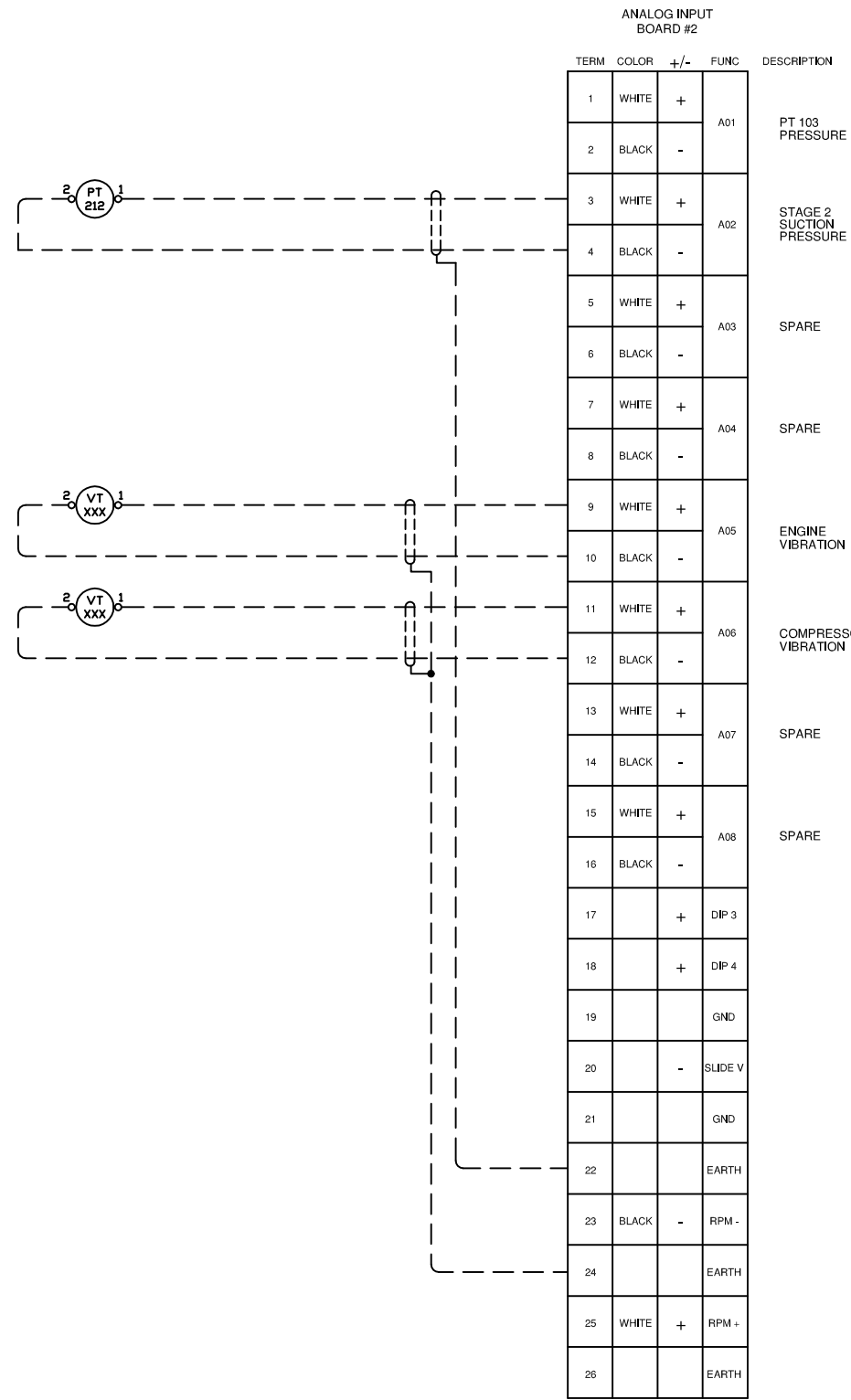


LEGEND		WIRE COLOR LEGEND	
1.	PANEL WIRING	1. +24VDC: RED	
2.	FIELD WIRING	2. -24VDC: YELLOW	
3.	UNFUSED TERMINAL	3. SWITCHED: ORANGE	
4.	FUSED TERMINAL	4. ANALOG INPUT/OUTPUT - : BLACK	
5.	FEED THROUGH TERMINAL	5. ANALOG INPUT/OUTPUT + : WHITE	
6.	DISCONNECT TERMINAL	6. ANALOG LOOP: PURPLE	

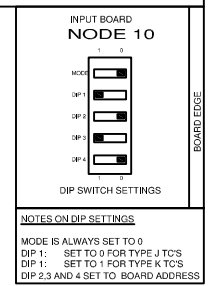
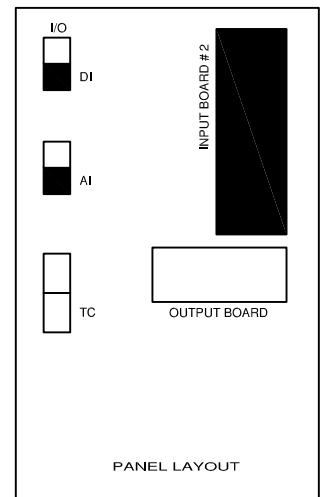
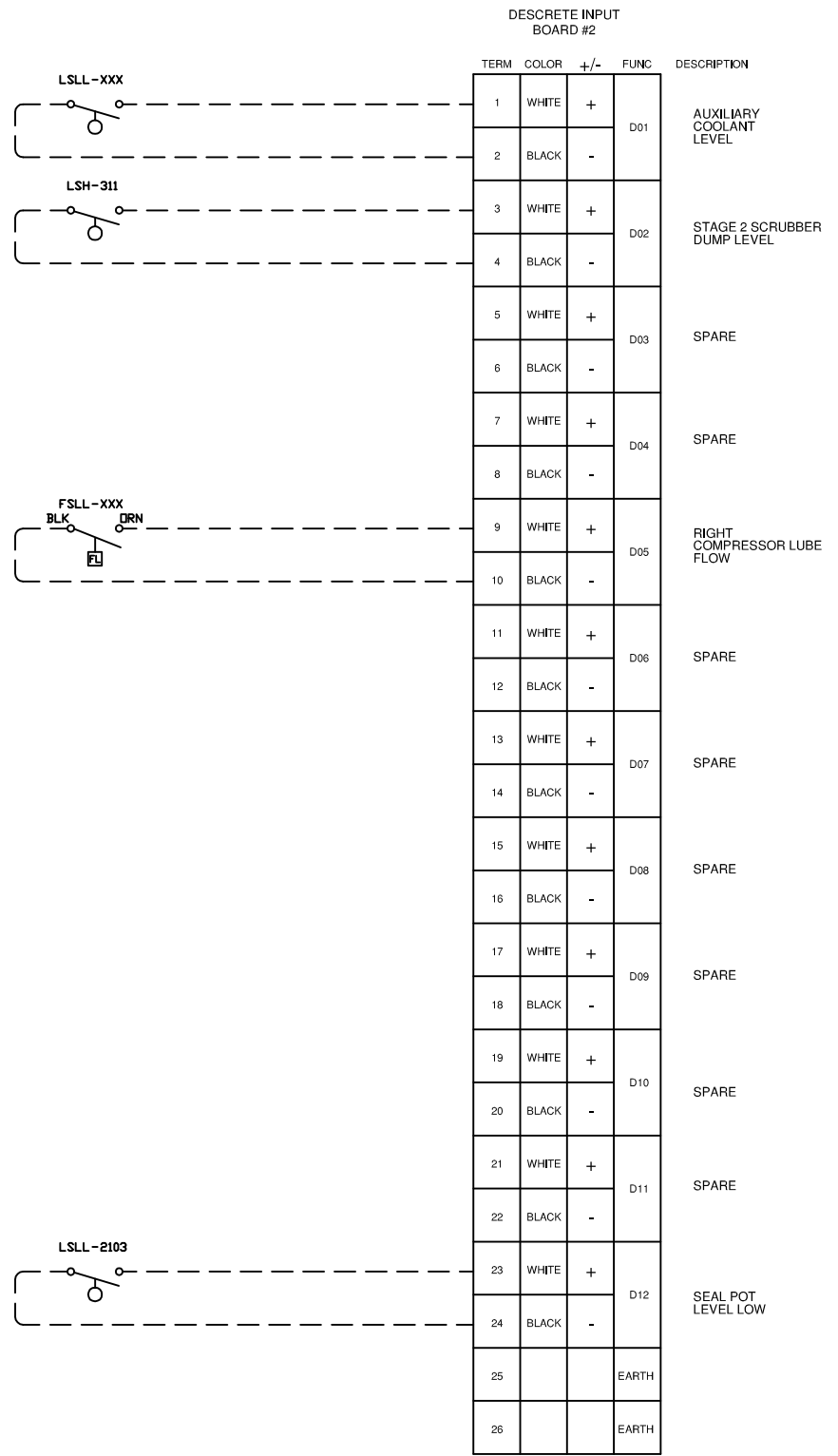
Rev.	Soft Rev.	Revision Description	By	Date	Checked	Aprvd
1		PANEL SHOP AS BUILT	AK	29.08.2006	LH	
0		ISSUED FOR CONSTRUCTION	AK	24.08.2006	LH	

Project Title	ENCANA PANEL # 000145
Drawing Title	NON-INCENDIVE INPUT BOARD #2 THERMOCOUPLE LAYOUT DRAWING

<h1>Syntech</h1>	
Syntech Drawing Number	SPR000145-11
Customer Drawing Number	060158
1 of 1	NTS



**DO NOT USE !!!
ESM ASSIGNED**



LEGEND		WIRE COLOR LEGEND	
1.	PANEL WIRING	1. +24VDC: RED	
2.	FIELD WIRING	2. -24VDC: YELLOW	
3.	UNFUSED TERMINAL	3. SWITCHED: ORANGE	
4.	FUSED TERMINAL	4. ANALOG INPUT/OUTPUT -: BLACK	
5.	FEED THROUGH TERMINAL	5. ANALOG INPUT/OUTPUT +: WHITE	
6.	DISCONNECT TERMINAL	6. ANALOG LOOP: PURPLE	

Rev.	Soft Rev.	Revision Description	By	Date	Checked	Aprvd
1		PANEL SHOP AS BUILT	AK	29.08.2006	LH	
0		ISSUED FOR CONSTRUCTION	AK	24.08.2006	LH	

Project Title	ENCANA PANEL # 000145
Drawing Title	NON-INCENDIVE INPUT BOARD #2 ANALOG / DISCRETE LAYOUT DRAWING

<h1>Syntech</h1>	
Syntech Drawing Number	SPR000145-12
Customer Drawing Number	060158
	1 of 1 NTS

ENERFLEX

VENDOR PARTS INFORMATION

ALBERTA STRAINERS LTD.
9577 - 60 AVENUE
EDMONTON, ALBERTA
CANADA, T6E 0C2
PHONE: (780) 448-0258 FAX: (780) 435-7146

ALTA STRAINERS

INSTALLATION AND MAINTENANCE INSTRUCTIONS

INSTALLATION:

"Y" STRAINERS SHOULD BE INSTALLED IN A HORIZONTAL LINE OR A VERTICAL LINE WITH THE FLOW GOING DOWN.
BASKET STRAINERS SHOULD BE INSTALLED IN A HORIZONTAL LINE.
IN BOTH STYLES ROOM MUST BE ALLOWED FOR SCREEN REMOVAL.
IDEALLY, PRESSURE GAUGES SHOULD BE INSTALLED UPSTREAM AND DOWNSTREAM OF A STRAINER TO INDICATE PRESSURE DROP CAUSED BY A PARTIALLY PLUGGED SCREEN.

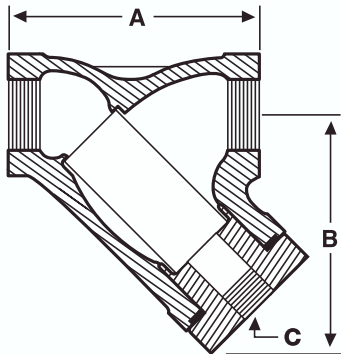
MAINTENANCE:

DETERMINE HOW LONG IT TAKES FOR THE SCREEN TO BECOME APPROXIMATELY 1/3 PLUGGED AND REMOVE AND CLEAN AT THE SAME TIME INTERVAL, OR WHEN THE PRESSURE GAUGES, IF INSTALLED, INDICATE A PRESSURE DROP ACROSS THE STRAINER.
IF A "Y" STRAINER HAS BEEN PROVIDED WITH A BLOW-DOWN VALVE ON THE DRAIN CONNECTION THEN IT MAY BE OPENED TO BLOW DOWN SEDIMENT.

SPARE PARTS:

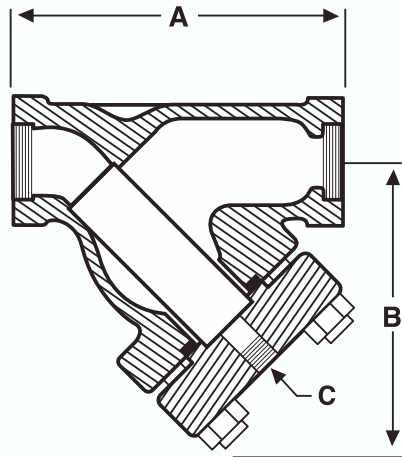
A SPARE SCREEN AND COVER GASKET ARE THE ONLY PARTS REQUIRED TO REFURBISH A STRAINER.
A SPARE SCREEN WILL DECREASE SHUT-DOWN TIME WHILE THE PLUGGED SCREEN IS BEING CLEANED.

ALTA	MODEL YS 600	DRAWING A 110
	600# ANSI CARBON STEEL SCREWED / SOCKET WELD "Y" STRAINER	



1 1/4" to 2" YS600

DESCRIPTION	MATERIAL
BODY	ASTM A216 GR. WCB
CAP / COVER	ASTM A216 GR. WCB
STUD	ASTM A193 GR. B7
NUT	ASTM A194 GR. 2H
GASKET	SPIRAL WOUND SS
SCREEN 1 1/4" - 2"	304 SS 1/32 PERF
SCREEN 3"	304 SS 1/8 PERF



3" YS600BC

TEMPERATURE		WORKING PRESSURE	
C	F	kPa	P.S.I.
-29 to 38	-20 to 100	10200	1480
95	200	9300	1350
150	300	9060	1315
200	400	8750	1270
260	500	8275	1200

ALL STRAINERS ARE INDIVIDUALLY HYDROSTATICALLY TESTED TO ANSI B16.5

SIZE		DIMENSIONS						NET WEIGHT	
		A		B		C			
mm	in.	mm	in.	mm	in.	mm	in.	Kg.	Lbs
32	1 1/4	133	5 1/4	96	3 7/8	15	1/2	2.7	6
40	1 1/2	159	6 1/4	127	5	20	3/4	4.5	10
50	2	190	7 1/2	165	6 1/2	25	1	7.3	16
75	3	298	11 3/4	279	11	25	1	25.5	56

FEATURES

BODY HAS A MACHINED SEAT TO HOLD SCREEN SECURELY.

CAP/COVER HAS A MACHINED SCREEN HOLDER TO ALIGN SCREEN DURING INSTALLATION AND TO RETAIN SEDIMENT WHEN CAP/COVER IS REMOVED.

BODY IS MACHINED TO HOLD CAP GASKET IN A BLOW-OUT PROOF DESIGN.

Apollo® 70-100 Series

Bronze Ball Valve

Threaded, 600 PSIG WOG, Cold Non-Shock. 150 PSIG Saturated Steam.
 Vacuum Service to 29 inches Hg.
 Federal Specification: WW-V-35C, Type: II, Composition: BZ, Style: 3.

FEATURES

- Chromium plated ball
- Reinforced TFE seats and stuffing box ring
- Blow-out-proof stem design
- Adjustable packing gland

STANDARD MATERIAL LIST

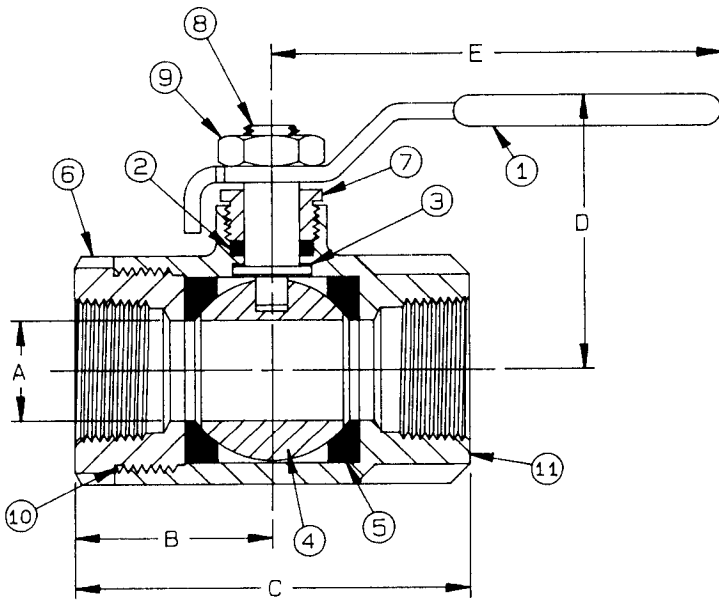
1. Lever and grip	Steel, zinc plated w/vinyl	7. Gland nut	B16
2. Stem packing	Reinforced TFE	8. Stem	B16
3. Stem bearing	Reinforced TFE	9. Lever nut	Steel, zinc plated
4. Ball	B16, chrome plated	10. Body seal	TFE
5. Seat (2)	Reinforced TFE	(1-1/4"-3")	
6. Retainer	B16 (1/4"-1")	11. Body	B584-C84400
	B584-C84400 (1-1/4"-3")		

VARIATIONS AVAILABLE ARE:

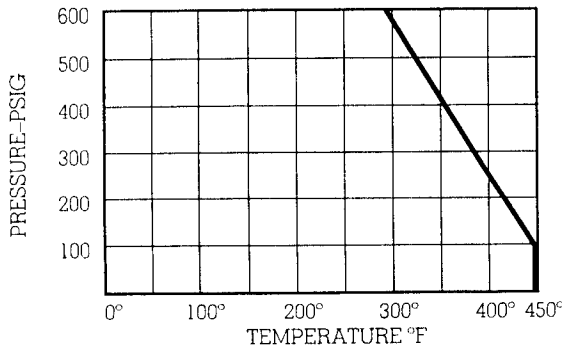
- 70-120 Series (Adjustable Stop Lever)
- 70-140 Series (316 SS Ball & Stem)
- 70-150 Series (Balancing Stop)
- 70-190 Series (Locked Retainer)

OPTIONS AVAILABLE ARE:

(SUFFIX NUMBER)	OPTION	SIZES
-02 -	Static Grounded	1/4" to 3"
-03 -	1-1/4" Stem Extension	1/4" to 3"
-04 -	2-1/4" Stem Extension	1/4" to 3"
-05 -	Plain Ball	1/4" to 3"
-07 -	Tee Handle	1/4" to 2"
-08 -	90° Reversed Stem	1/4" to 3"
-10 -	S. S. Lever & Nut	1/4" to 3"
-14 -	Vented Ball	1/4" to 3"
-15 -	Round Handle	1/4" to 2"
-16 -	Vertical Chain Lever	3/4" to 2"
-17 -	Rough Chrome Plating	1/4" to 3"
-21 -	UHMWPE Seats (Non-TFE)	1/4" to 3"
-24 -	Graphite Stem Packing	1/4" to 3"
-27 -	Latch Lock Lever	1/4" to 3"
-30 -	CamLock Handle	1/4" to 2"
-32 -	S. S. Tee Handle & Nut	1/4" to 2"
-35 -	Virgin TFE Trim	1/4" to 3"
-36 -	S. S. Hi-rise Round Handle & Nut	1/4" to 2"
-39 -	S. S. Latch Lock Wheel Handle	1/4" to 2"
-40 -	Cyl-Loc	1/4" to 2"
-41 -	Auto Drain	1/4" to 2"
-45 -	Less Lever & Nut	1/4" to 3"
-47 -	S. S. Latch-Lock Oval Handle	1/4" to 1"
-49 -	Assembled Dry	1/4" to 3"
-56 -	Multifill Seats	1/4" to 3"
-57 -	Cleaned for Gaseous Oxygen	1/4" to 3"
-58 -	Horizontal Chain Lever	3/4" to 2"
-60 -	Static Grounded Ball & Stem	1/4" to 3"
-63 -	Threaded x Solder	3/8" to 3"
-64 -	250 Lb. Steam Trim	1/4" to 3"



RTFE SEATS



BRONZE BALL VALVE

NUMBER	SIZE	A	B	C	D	E
70-101-01	1/4"	.37	1.03	2.06	1.75	3.87
70-102-01	3/8"	.37	1.03	2.06	1.75	3.87
70-103-01	1/2"	.50	1.12	2.25	1.75	3.87
70-104-01	3/4"	.68	1.50	3.00	2.12	4.87
70-105-01	1"	.87	1.68	3.37	2.25	4.87
70-106-01	1-1/4"	1.00	2.00	4.00	2.62	5.50
70-107-01	1-1/2"	1.25	2.18	4.37	3.06	8.00
70-108-01	2"	1.50	2.34	4.68	3.25	8.00
70-109-01	2-1/2"	2.50	3.25	6.50	4.12	8.00
70-100-01	3"	2.50	3.37	6.75	4.12	8.00

Apollo[®] 72-100 Series

Carbon Steel High Pressure Ball Valve

Threaded, 3000 PSIG WOG, Cold Non-Shock. 150 PSIG Saturated Steam.
 Vacuum Service to 29 inches Hg.
 Federal Specification: WW-V-35C, Type: II, Composition: CS, Style: 3.

FEATURES

- Barstock design
- Reinforced TFE seats and stuffing box ring
- Fire safe design when ordered with graphite packing.
- Nitride corrosion protection
- Adjustable packing gland
- Full port, except 2"
- Blow out proof stem design
- Heavy duty lever

STANDARD MATERIAL LIST

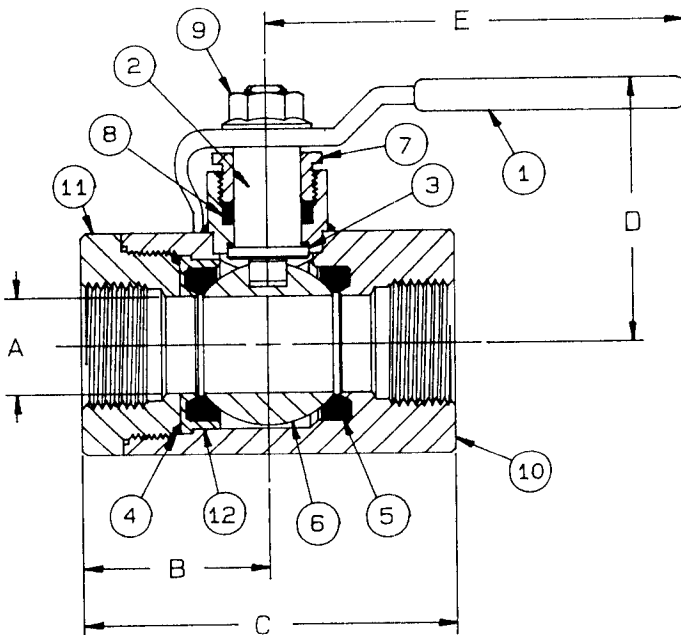
1. Lever and grip	Steel, zinc plated w/vinyl	7. Gland nut	A108-CS
2. Stem	A108-CS chrome plated	8. Stem packing	Reinforced TFE
3. Stem bearing	Reinforced TFE	9. Lever nut	Steel, zinc plated
4. Retainer seal	Reinforced TFE	10. Body	A108-CS
5. Seat (2)	Reinforced TFE	11. Retainer	A108-CS
6. Ball	A108-CS chrome plated	12. Seat holder	A108-CS

VARIATIONS AVAILABLE ARE:

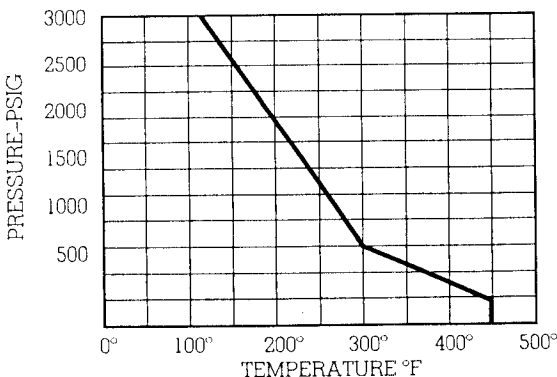
72-140 Series (316 SS Ball & Stem)

OPTIONS AVAILABLE ARE:

(SUFFIX NUMBER)	OPTION	SIZES
-02 -	Static Grounded	1/2" to 2"
-03 -	1-1/4" Stem: Extension	1" to 1-1/2"
-04 -	2-1/4" Stem Extension	1" to 1-1/2"
-07 -	Tee Handle	1/2" to 1-1/2"
-08 -	90° Reversed Stem	1/2" to 2"
-10 -	S. S. Lever & Nut	1/2" to 1-1/2"
-14 -	Vented Ball	1/2" to 2"
-15 -	Round Handle	1/2" to 1"
-19 -	Lock Plate	1/2" to 2"
-24 -	Graphite Stem Packing	1/2" to 2"
-45 -	Less Lever & Nut	1/2" to 2"
-56 -	Multifill Seats	1/2" to 2"
-60 -	Static Grounded Ball & Stem	1/2" to 2"
-64 -	250 Lb. Steam Trim	1/2" to 2"



RTFE SEATS



CARBON STEEL HIGH PRESSURE BALL VALVE

NUMBER	SIZE	A	B	C	D	E
72-103-01	1/2"	.62	1.46	2.87	2.50	5.62
72-104-01	3/4"	.81	1.87	3.71	2.62	5.62
72-105-01	1"	1.00	2.12	4.15	3.12	6.62
72-106-01	1-1/4"	1.25	2.32	4.65	3.43	8.00
72-107-01	1-1/2"	1.50	2.64	5.23	3.56	8.00
72-108-01	2"	1.75	3.00	5.84	4.18	8.00

Apollo® 73-100 Series

Carbon Steel Ball Valve

Threaded, 1/4"-1" 2000 PSIG WOG, 1-1/4"-2" 1500 PSIG WOG. Cold Non-Shock. 150 PSIG Saturated Steam. Vacuum Service to 29 inches Hg.
Federal Specification: WW-V-35C, Type: II, Composition: CS, Style: 3.

FEATURES

- Barstock design
- Reinforced TFE seats and stuffing box ring
- (-24) Certified to API standard 607, 4th Edition, Class 600 burn.
- Adjustable packing gland
- Blow out proof stem design
- Nitride corrosion protection

STANDARD MATERIAL LIST

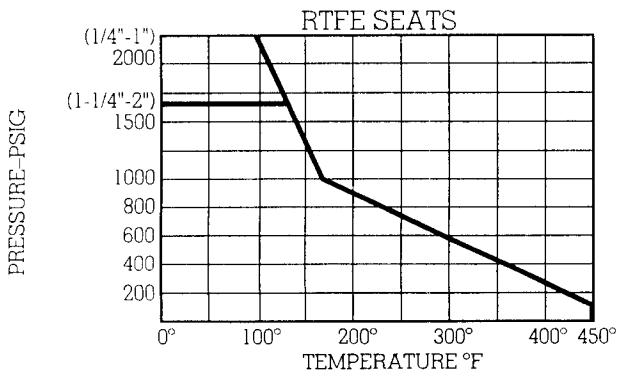
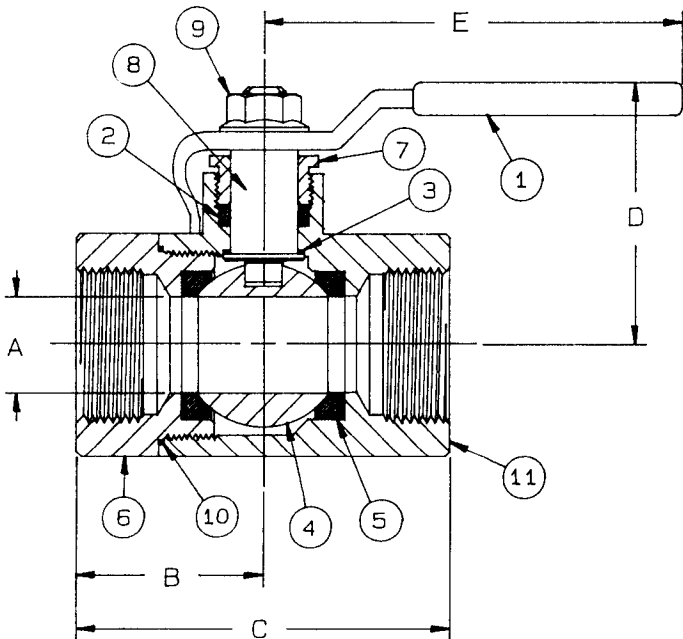
1. Lever and grip	Steel, zinc plated w/vinyl	7. Gland nut	A108-CS
2. Stem packing	Reinforced TFE	8. Stem	A108-CS
3. Stem bearing	Reinforced TFE	9. Lever nut	Steel, zinc plated
4. Ball	A108-CS chrome plated	10. Body seal (1-1/4"-2")	TFE
5. Seat (2)	Reinforced TFE	11. Body	A108-CS
6. Retainer	A108-CS		

VARIATIONS AVAILABLE ARE:

- 73-140 Series (316 SS Ball & Stem)
- 73-160 Series (N.A.C.E. Trim)

OPTIONS AVAILABLE ARE:

(SUFFIX NUMBER)	OPTION	SIZES
-02 -	Static Grounded	1/4" to 2"
-03 -	1-1/4" Stem Extension	1/4" to 2"
-04 -	2-1/4" Stem Extension	1/4" to 2"
-06 -	2000 PSIG WOG	1-1/4" to 2"
-07 -	Tee Handle	1/4" to 1-1/2"
-08 -	90° Reversed Stem	1/4" to 2"
-10 -	S. S. Lever & Nut	1/4" to 2"
-14 -	Vented Ball	1/4" to 2"
-15 -	Round Handle	1/4" to 1-1/2"
-19 -	Lock Plate	1/4" to 2"
-24 -	Graphite Stem Packing	1/4" to 2"
-45 -	Less Lever & Nut	1/4" to 2"
-56 -	Multifill Seats	1/4" to 2"
-60 -	Static Grounded Ball & Stem	1/4" to 2"
-64 -	250 Lb. Steam Trim	1/4" to 2"

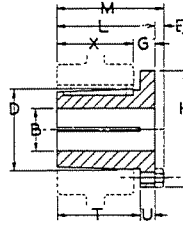
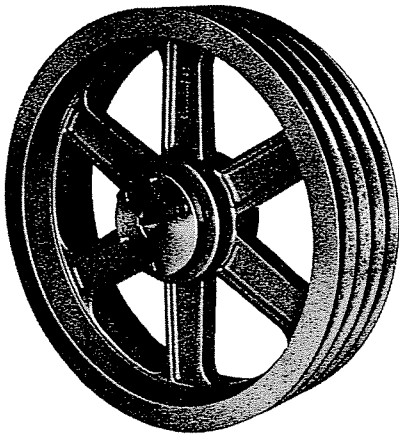


CARBON STEEL BALL VALVE

NUMBER	SIZE	A	B	C	D	E
73-101-01	1/4"	.37	1.03	2.06	1.75	3.87
73-102-01	3/8"	.37	1.03	2.06	1.75	3.87
73-103-01	1/2"	.50	1.12	2.25	1.81	3.87
73-104-01	3/4"	.68	1.50	3.00	2.12	4.87
73-105-01	1"	.87	1.68	3.37	2.25	4.87
73-106-01	1-1/4"	1.00	2.00	4.00	2.62	5.50
73-107-01	1-1/2"	1.25	2.18	4.37	2.87	5.50
73-108-01	2"	1.50	2.75	5.50	3.06	8.00

Browning Gripbelt Sheaves with Split Taper Bushings TA

For Use with All "A" Section Belts



Standard Keyseats

Table No. 1

Bore Range	Keyseat
1/2" — 9/16"	3/8" x 1/16"
5/8" — 7/8"	3/16" x 3/32"
15/16" — 1 1/4"	1/4" x 1/8"
1 5/16" — 1 3/8"	5/16" x 3/32"
1 7/16" — 1 3/4"	3/8" x 1/16"
1 11/16" — 2 1/4"	1/2" x 1/4"
2 3/16" — 2 11/16"	5/8" x 5/16"

1 3/8" Bore Bushings, also available with 3/8" x 3/16" Keyseat.

Table No. 2 Bushing Dimensions

Part No.	Dimensions									Bore Range	Wt. Lbs.
	M	L	G	X	E	T	U	D	H		
P1	2 3/16"	1 15/16"	5/8"	1 5/16"	1/2"	1 17/32"	1 3/32"	1 15/16"	3"	1/2" — 1 3/4"	1 1/4
P2	3 3/16"	2 15/16"	3/4"	2 5/16"	1/2"	2 17/32"	1 3/32"	1 15/16"	3	3/4" — 1 3/4"	1 1/2
Q1	2 25/32"	2 1/2"	3/4"	1 3/4"	9/32"	1 31/32"	1 7/32"	2 7/8"	4 1/8"	3/4" — 2 1/16"	3 1/2

Close Grain Cast Iron
Accurately Machined
Statically Balanced
Easy to Mount—Easy to Remove
Clamp Fit on Shaft

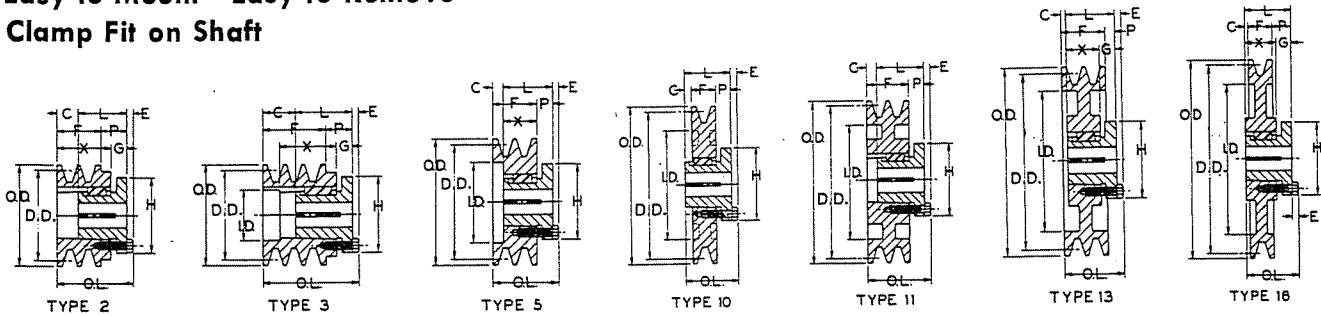


Table No. 3

Specifications—Stock "TA" Sheaves

DIAMETERS			2 GROOVES, F = 1 5/8"											
Datum "A"	Out-side	In-side	Part Number		Type	Dimensions							Wt. Less Bush.	
			Sheave	Bush-ing		OL	L	P	C	H	G	X		E
3.0"	3.25"	—	2TA30	P1	2	2 13/16"	1 15/16"	1 3/16"	5/8"	3"	5/8"	1 15/16"	1 1/4"	2.0
3.2	3.45	—	2TA32	P1	2	2 13/16"	1 15/16"	1 3/16"	5/8"	3	5/8"	1 15/16"	1 1/4	2.4
3.4	3.65	—	2TA34	P1	2	2 13/16"	1 15/16"	1 3/16"	5/8"	3	5/8"	1 15/16"	1 1/4	2.8
3.6	3.85	—	2TA36	P1	5	2 3/16"	1 15/16"	5/8"	1/16"	3	—	1 3/8"	1 1/4	2.3
3.8	4.05	—	2TA38	P1	5	2 3/16"	1 15/16"	5/8"	1/16"	3	—	1 3/8"	1 1/4	2.5
4.0	4.25	—	2TA40	P1	5	2 3/16"	1 15/16"	5/8"	1/16"	3	—	1 3/8"	1 1/4	2.9
4.2	4.45	—	2TA42	P1	5	2 3/16"	1 15/16"	5/8"	1/16"	3	—	1 3/8"	1 1/4	3.4
4.4	4.65	—	2TA44	P1	5-Web	2 3/16"	1 15/16"	5/8"	1/16"	3	—	1 3/8"	1 1/4	3.8
4.6	4.85	—	2TA46	P1	5-Web	2 3/16"	1 15/16"	5/8"	1/16"	3	—	1 3/8"	1 1/4	4.5
4.8	5.05	—	2TA48	P1	5-Web	2 3/16"	1 15/16"	5/8"	1/16"	3	—	1 3/8"	1 1/4	5.0
5.0	5.25	—	2TA50	P1	5-Web	2 3/16"	1 15/16"	5/8"	1/16"	3	—	1 3/8"	1 1/4	5.3
5.2	5.45	—	2TA52	P1	5-Web	2 3/16"	1 15/16"	5/8"	1/16"	3	—	1 3/8"	1 1/4	5.9
5.4	5.65	—	2TA54	P1	5-Web	2 3/16"	1 15/16"	5/8"	1/16"	3	—	1 3/8"	1 1/4	6.4
5.6	5.85	—	2TA56	P1	5-Web	2 3/16"	1 15/16"	5/8"	1/16"	3	—	1 3/8"	1 1/4	6.9
5.8	6.05	—	2TA58	P1	5-Web	2 3/16"	1 15/16"	5/8"	1/16"	3	—	1 3/8"	1 1/4	7.6
6.0	6.25	4 3/4"	2TA60	P1	11-Web	2 3/16"	1 15/16"	5/8"	1/16"	3	—	—	1 1/4	6.3
6.2	6.45	4 15/16"	2TA62	P1	11-Web	2 3/16"	1 15/16"	5/8"	1/16"	3	—	—	1 1/4	6.4
6.4	6.65	5 3/16"	2TA64	P1	11-Web	2 3/16"	1 15/16"	5/8"	1/16"	3	—	—	1 1/4	6.9
6.6	6.85	5 1/2"	2TA66	P1	11-Web	2 3/16"	1 15/16"	5/8"	1/16"	3	—	—	1 1/4	6.9
7.0	7.25	5 13/16"	2TA70	Q1	16-Web	2 25/32"	2 1/2"	1 5/16"	3/16"	4 1/8"	3/4"	9/32"	1 1/4	8.6
8.2	8.45	6 15/16"	2TA82	Q1	16-Arm	2 25/32"	2 1/2"	1 5/16"	3/16"	4 1/8"	3/4"	9/32"	1 1/4	11.6
9.0	9.25	7 13/16"	2TA90	Q1	16-Arm	2 25/32"	2 1/2"	1 5/16"	3/16"	4 1/8"	3/4"	9/32"	1 1/4	12.5
10.6	10.85	9 3/8"	2TA106	Q1	16-Arm	2 25/32"	2 1/2"	1 5/16"	3/16"	4 1/8"	3/4"	9/32"	1 1/4	14.4
12.0	12.25	10 7/16"	2TA120	Q1	16-Arm	2 25/32"	2 1/2"	1 5/16"	3/16"	4 1/8"	3/4"	9/32"	1 1/4	16.3
15.0	15.25	13 3/16"	2TA150	Q1	16-Arm	2 25/32"	2 1/2"	1 5/16"	3/16"	4 1/8"	3/4"	9/32"	1 1/4	21.3
18.0	18.25	16 13/16"	2TA180	Q1	16-Arm	2 25/32"	2 1/2"	1 5/16"	3/16"	4 1/8"	3/4"	9/32"	1 1/4	25.8
19.5	19.75	18 1/2"	2TA195	Q1	16-Arm	2 25/32"	2 1/2"	1 5/16"	3/16"	4 1/8"	3/4"	9/32"	1 1/4	29.8
24.5	24.75	23 3/4"	2TA245	Q1	16-Arm	2 25/32"	2 1/2"	1 5/16"	3/16"	4 1/8"	3/4"	9/32"	1 1/4	38.1

TA *Browning*® Gripbelt Sheaves with Split Taper Bushings

For Use with All "A" Section Belts

Table No. 1 Specifications—Stock "TA" Sheaves

DIAMETERS			3 GROOVES, F = 2"											Wt. Less Bush.
Datum "A"	Out-side	In-side	Part Number		Type	Dimensions								
			Sheave	Bush-ing		OL	L	P	C	H	G	X	E	
3.0"	3.25"	—	3TA30	P1	3	37/16"	1 15/16"	1 13/16"	1 1/4"	3"	5/8"	2 9/16"	1 1/4"	2.6
3.2	3.45	—	3TA32	P1	3	37/16	1 15/16	1 13/16	1 1/4	3	5/8	2 9/16	1 1/4	3.1
3.4	3.65	—	3TA34	P1	3	37/16	1 15/16	1 13/16	1 1/4	3	5/8	2 9/16	1 1/4	3.5
3.6	3.85	2 3/8"	3TA36	P1	5	2 7/8	1 15/16	7/8	1 1/16	3	—	1 3/8	1 1/4	2.9
3.8	4.05	2 9/16"	3TA38	P1	5	2 7/8	1 15/16	7/8	1 1/16	3	—	1 3/8	1 1/4	3.3
4.0	4.25	2 3/4"	3TA40	P1	5	2 7/8	1 15/16	5/8	1 1/16	3	—	1 3/8	1 1/4	3.6
4.2	4.45	2 15/16"	3TA42	P1	13-Sol.	2 1/4	1 15/16	0	1/16	3	5/8	1 3/8	1 1/4	4.0
4.4	4.65	3 3/16"	3TA44	P1	13-Sol.	2 1/4	1 15/16	0	1/16	3	5/8	1 3/8	1 1/4	4.5
4.6	4.85	3 3/8"	3TA46	P1	13-Web	2 1/4	1 15/16	0	1/16	3	5/8	1 3/8	1 1/4	5.3
4.8	5.05	3 9/16"	3TA48	P1	13-Web	2 1/4	1 15/16	0	1/16	3	5/8	1 3/8	1 1/4	5.8
5.0	5.25	3 3/4"	3TA50	P1	13-Web	2 1/4	1 15/16	0	1/16	3	5/8	1 3/8	1 1/4	6.3
5.2	5.45	3 15/16"	3TA52	P1	13-Web	2 1/4	1 15/16	0	1/16	3	5/8	1 3/8	1 1/4	7.0
5.4	5.65	4 3/16"	3TA54	P1	13-Web	2 1/4	1 15/16	0	1/16	3	5/8	1 3/8	1 1/4	7.8
5.6	5.85	4 3/8"	3TA56	P1	13-Web	2 1/4	1 15/16	0	1/16	3	5/8	1 3/8	1 1/4	8.1
5.8	6.05	4 9/16"	3TA58	P1	13-Web	2 1/4	1 15/16	0	1/16	3	5/8	1 3/8	1 1/4	8.8
6.0	6.25	4 3/4"	3TA60	P1	13-Web	2 1/4	1 15/16	0	1/16	3	5/8	1 3/8	1 1/4	7.3
6.2	6.45	4 15/16"	3TA62	P1	13-Web	2 1/4	1 15/16	0	1/16	3	5/8	1 3/8	1 1/4	7.8
6.4	6.65	5 3/16"	3TA64	P1	13-Web	2 1/4	1 15/16	0	1/16	3	5/8	1 3/8	1 1/4	8.6
7.0	7.25	5 13/16"	3TA70	Q1	13-Web	2 29/32	2 1/2	5/8	7/8	4 1/8	3/4	1 3/4	9/32	10.4
8.2	8.45	6 15/16"	3TA82	Q1	13-Arm	2 29/32	2 1/2	5/8	7/8	4 1/8	3/4	1 3/4	9/32	13.5
9.0	9.25	7 13/16"	3TA90	Q1	13-Arm	2 29/32	2 1/2	5/8	7/8	4 1/8	3/4	1 3/4	9/32	14.6
10.6	10.85	9 3/8"	3TA106	Q1	13-Arm	2 29/32	2 1/2	5/8	7/8	4 1/8	3/4	1 3/4	9/32	17.0
12.0	12.25	10 13/16"	3TA120	Q1	13-Arm	2 29/32	2 1/2	5/8	7/8	4 1/8	3/4	1 3/4	9/32	19.0
15.0	15.25	13 13/16"	3TA150	Q1	13-Arm	2 29/32	2 1/2	5/8	7/8	4 1/8	3/4	1 3/4	9/32	25.3
18.0	18.25	16 13/16"	3TA180	Q1	13-Arm	2 29/32	2 1/2	5/8	7/8	4 1/8	3/4	1 3/4	9/32	31.1
19.5	19.75	18 1/4"	3TA195	Q1	13-Arm	2 29/32	2 1/2	5/8	7/8	4 1/8	3/4	1 3/4	9/32	36.8
24.5	24.75	23 1/4"	3TA245	Q1	13-Arm	2 29/32	2 1/2	5/8	7/8	4 1/8	3/4	1 3/4	9/32	46.8

Table No. 2

DIAMETERS			4 GROOVES, F = 2 5/8"											Wt. Less Bush.
Datum "A"	Out-side	In-side	Part Number		Type	Dimensions								
			Sheave	Bush-ing		O. L.	L	P	C	H	G	X	E	
3.0"	3.25"	2"	4TA30	P2	3	4 1/16"	2 15/16"	1 3/16"	7/8"	3"	5/8"	2 5/16"	1 1/4"	2.9
3.2	3.45	2	4TA32	P2	3	4 1/16	2 15/16	1 3/16	7/8	3	5/8	2 5/16	1 1/4	3.6
3.4	3.65	2 3/16"	4TA34	P2	3	4 1/16	2 15/16	1 3/16	7/8	3	5/8	2 5/16	1 1/4	4.4
3.6	3.85	2 3/8"	4TA36	P1	5	3 1/2	1 15/16	5/8	1 5/16	3	—	1 5/16	1 1/4	3.6
3.8	4.05	2 9/16"	4TA38	P1	5	3 1/2	1 15/16	5/8	1 5/16	3	—	1 5/16	1 1/4	4.0
4.0	4.25	2 3/4"	4TA40	P1	5	3 1/2	1 15/16	5/8	1 5/16	3	—	1 5/16	1 1/4	4.5
4.2	4.45	2 15/16"	4TA42	P1	13-Web	2 7/8	1 15/16	0	1 1/16	3	5/8	1 5/16	1 1/4	5.0
4.4	4.65	3 3/16"	4TA44	P1	13-Web	2 7/8	1 15/16	0	1 1/16	3	5/8	1 5/16	1 1/4	5.3
4.6	4.85	3 3/8"	4TA46	P1	13-Web	2 7/8	1 15/16	0	1 1/16	3	5/8	1 5/16	1 1/4	6.3
4.8	5.05	3 9/16"	4TA48	P1	13-Web	2 7/8	1 15/16	0	1 1/16	3	5/8	1 5/16	1 1/4	6.8
5.0	5.25	3 3/4"	4TA50	P1	13-Web	2 7/8	1 15/16	0	1 1/16	3	5/8	1 5/16	1 1/4	7.6
5.2	5.45	3 15/16"	4TA52	P1	13-Web	2 7/8	1 15/16	0	1 1/16	3	5/8	1 5/16	1 1/4	7.9
5.4	5.65	4 3/16"	4TA54	P1	13-Web	2 7/8	1 15/16	0	1 1/16	3	5/8	1 5/16	1 1/4	9.0
5.6	5.85	4 3/8"	4TA56	P1	13-Web	2 7/8	1 15/16	0	1 1/16	3	5/8	1 5/16	1 1/4	9.3
5.8	6.05	4 9/16"	4TA58	P1	13-Web	2 7/8	1 15/16	0	1 1/16	3	5/8	1 5/16	1 1/4	10.3
6.0	6.25	4 3/4"	4TA60	P1	13-Web	2 7/8	1 15/16	0	1 1/16	3	5/8	1 5/16	1 1/4	8.9
6.2	6.45	4 15/16"	4TA62	P1	13-Web	2 7/8	1 15/16	0	1 1/16	3	5/8	1 5/16	1 1/4	9.3
6.4	6.65	5 3/16"	4TA64	P1	13-Web	2 7/8	1 15/16	0	1 1/16	3	5/8	1 5/16	1 1/4	10.3
7.0	7.25	5 13/16"	4TA70	Q1	13-Web	3 7/32	2 1/2	5/16	7/16	4 1/8	3/4	1 3/4	9/32	11.9
8.2	8.45	6 15/16"	4TA82	Q1	13-Arm	3 7/32	2 1/2	5/16	7/16	4 1/8	3/4	1 3/4	9/32	15.9
9.0	9.25	7 13/16"	4TA90	Q1	13-Arm	3 7/32	2 1/2	5/16	7/16	4 1/8	3/4	1 3/4	9/32	16.1
10.6	10.85	9 3/8"	4TA106	Q1	13-Arm	3 7/32	2 1/2	5/16	7/16	4 1/8	3/4	1 3/4	9/32	19.8
12.0	12.25	10 13/16"	4TA120	Q1	13-Arm	3 7/32	2 1/2	5/16	7/16	4 1/8	3/4	1 3/4	9/32	21.3
15.0	15.25	13 13/16"	4TA150	Q1	13-Arm	3 7/32	2 1/2	5/16	7/16	4 1/8	3/4	1 3/4	9/32	29.5
18.0	18.25	16 13/16"	4TA180	Q1	13-Arm	3 7/32	2 1/2	5/16	7/16	4 1/8	3/4	1 3/4	9/32	36.0
19.5	19.75	18 1/4"	4TA195	Q1	13-Arm	3 7/32	2 1/2	5/16	7/16	4 1/8	3/4	1 3/4	9/32	43.3
24.5	24.75	23 1/4"	4TA245	Q1	13-Arm	3 7/32	2 1/2	5/16	7/16	4 1/8	3/4	1 3/4	9/32	51.8

B5V *Browning* Gripbelt Sheaves with Split Taper Bushings

Table No. 1 Bushing Specifications

Part No.	Bore Range		Dimensions									Wt. (lbs)
	Type 1	Type 2	M	L	G	E	T	U	D	H		
P1	1/2 - 1 7/16	1 1/2 - 1 3/4	2 3/16	1 15/16	5/8	1/4	1 17/32	1 3/32	1 15/16	3	1.3	
B	1/2 - 1 15/16	2 - 2 7/16	2 3/16	1 15/16	3/4	1/4	1 7/16	1/2	2 5/8	3 11/16	1.8	

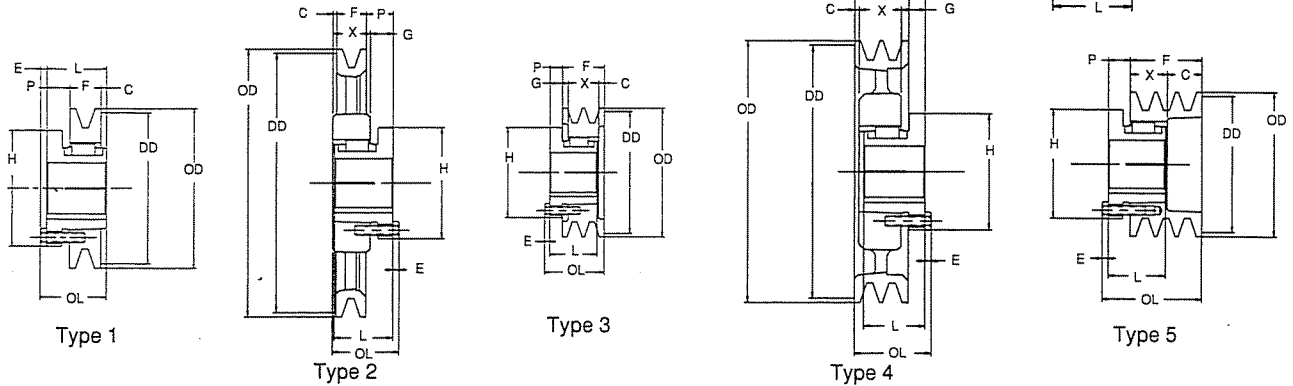
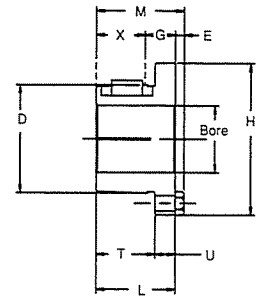


Table No. 2 Specifications - Stock "B5V" Sheaves

DIAMETERS				Part Number		Type	Dimensions (Inches)				Wt. (lbs) less Bush.
Datum "A" Belts	Datum "B" Belts	Pitch "5V" Belts	Outside	Sheave	Bushing		OL	P	C	X	
1 GROOVE, F = 1											
3.8	4.2	4.3	4.48	1B5V42	P1	1-Solid	2 3/16	5/8	3/16	1	2.5
4.0	4.4	4.5	4.68	1B5V44	P1	1-Solid	2 3/16	5/8	3/16	1	2.8
4.2	4.6	4.7	4.88	1B5V46	B	1-Solid	2 3/16	3/4	3/16	1	2.5
4.4	4.8	4.9	5.08	1B5V48	B	1-Solid	2 3/16	3/4	3/16	1	2.9
4.6	5.0	5.1	5.28	1B5V50	B	1-Solid	2 3/16	3/4	3/16	1	3.3
4.8	5.2	5.3	5.48	1B5V52	B	1-Solid	2 3/16	3/4	3/16	1	3.7
5.0	5.4	5.5	5.68	1B5V54	B	1-Solid	2 3/16	3/4	3/16	1	4.1
5.2	5.6	5.7	5.88	1B5V56	B	1-Solid	2 3/16	3/4	3/16	1	4.5
5.4	5.8	5.9	6.08	1B5V58	B	1-Solid	2 3/16	3/4	3/16	1	5.0
5.6	6.0	6.1	6.28	1B5V60	B	1-Solid	2 3/16	3/4	3/16	1	5.4
5.8	6.2	6.3	6.48	1B5V62	B	1-Web	2 3/16	3/4	3/16	1	5.3
6.0	6.4	6.5	6.68	1B5V64	B	1-Web	2 3/16	3/4	3/16	1	5.6
6.2	6.6	6.7	6.88	1B5V66	B	1-Web	2 3/16	3/4	3/16	1	6.0
6.4	6.8	6.9	7.08	1B5V68	B	1-Web	2 3/16	3/4	3/16	1	6.4
6.6	7.0	7.1	7.28	1B5V70	B	1-Web	2 3/16	3/4	3/16	1	6.8
7.0	7.4	7.5	7.68	1B5V74	B	1-Web	2 3/16	3/4	3/16	1	7.7
7.6	8.0	8.1	8.28	1B5V80	B	2-Arm	2 3/16	7/8	3/16	1 5/16	7.5
8.2	8.6	8.7	8.88	1B5V86	B	2-Arm	2 3/16	7/8	3/16	1 5/16	7.9
8.6	9.0	9.1	9.28	1B5V90	B	2-Arm	2 3/16	7/8	3/16	1 5/16	8.2
9.0	9.4	9.5	9.68	1B5V94	B	2-Arm	2 3/16	7/8	3/16	1 5/16	8.5
10.6	11.0	11.1	11.28	1B5V110	B	2-Arm	2 3/16	7/8	3/16	1 5/16	10.3
12.0	12.4	12.5	12.68	1B5V124	B	2-Arm	2 3/16	7/8	3/16	1 5/16	11.5
13.2	13.6	13.7	13.88	1B5V136	B	2-Arm	2 3/16	7/8	3/16	1 5/16	13.3
15.0	15.4	15.5	15.68	1B5V154	B	2-Arm	2 3/16	7/8	3/16	1 5/16	15.5
15.6	16.0	16.1	16.28	1B5V160	B	2-Arm	2 3/16	7/8	3/16	1 5/16	16.6
18.0	18.4	18.5	18.68	1B5V184	B	2-Arm	2 3/16	7/8	3/16	1 5/16	20.0
19.5	20.0	20.1	20.28	1B5V200	B	2-Arm	2 3/16	7/8	3/16	1 5/16	21.8
22.9	23.4	23.5	23.68	1B5V234	B	2-Arm	2 3/16	7/8	3/16	1 5/16	28.2
24.5	25.0	25.1	25.28	1B5V250	B	2-Arm	2 3/16	7/8	3/16	1 5/16	31.4
27.3	27.8	27.9	28.08	1B5V278	B	2-Arm	2 3/16	7/8	3/16	1 5/16	36.5
2 GROOVE, F = 1 23/32											
3.8	4.2	4.3	4.48	2B5V42	P1	5	2 19/32	5/8	1 3/32	1 5/16	3.7
4.0	4.4	4.5	4.68	2B5V44	P1	3	2 3/16	7/32	0	1 5/16	4.1
4.2	4.6	4.7	4.88	2B5V46	B	3	2 31/64	33/64	0	1 31/64	3.3
4.4	4.8	4.9	5.08	2B5V48	B	3	2 31/64	33/64	1 1/64	1 5/16	3.9
4.6	5.0	5.1	5.28	2B5V50	B	3	2 31/64	33/64	1 1/64	1 5/16	4.6
4.8	5.2	5.3	5.48	2B5V52	B	3	2 31/64	33/64	1 1/64	1 5/16	5.3
5.0	5.4	5.5	5.68	2B5V54	B	3	2 31/64	33/64	1 1/64	1 5/16	6.0
5.2	5.6	5.7	5.88	2B5V56	B	3	2 31/64	33/64	1 1/64	1 5/16	6.7
5.4	5.8	5.9	6.08	2B5V58	B	3	2 31/64	33/64	1 1/64	1 5/16	7.4
5.6	6.0	6.1	6.28	2B5V60	B	3	2 31/64	33/64	1 1/64	1 5/16	8.2
5.8	6.2	6.3	6.48	2B5V62	B	3	2 31/64	33/64	1 1/64	1 5/16	9.2
6.0	6.4	6.5	6.68	2B5V64	B	3	2 31/64	33/64	1 1/64	1 5/16	8.4
6.2	6.6	6.7	6.88	2B5V66	B	3	2 31/64	33/64	1 1/64	1 5/16	11.4

Table No. 3

Specifications – Stock "B5V" Sheaves

DIAMETERS				Part Number			Dimensions (Inches)				Wt. (lbs) less Bush.
Datum "A" Belts	Datum "B" Belts	Pitch "5V" Belts	Outside	Sheave	Bushing	Type	OL	P	C	X	
2 GROOVE (Cont.), F = 1 23/32											
6.4	6.8	6.9	7.08	2B5V68	B	4-Web	2 31/64	33/64	1 1/64	1 5/16	10.2
6.6	7.0	7.1	7.28	2B5V70	B	4-Web	2 31/64	33/64	1 1/64	1 5/16	12.3
7.0	7.4	7.5	7.68	2B5V74	B	4-Web	2 31/64	33/64	1 1/64	1 5/16	14.2
7.6	8.0	8.1	8.28	2B5V80	B	4-Arm	2 31/64	33/64	1 1/64	1 5/16	11.3
8.2	8.6	8.7	8.88	2B5V86	B	4-Arm	2 31/64	33/64	1 1/64	1 5/16	10.6
8.6	9.0	9.1	9.28	2B5V90	B	4-Arm	2 31/64	33/64	1 1/64	1 5/16	11.1
9.0	9.4	9.5	9.68	2B5V94	B	4-Arm	2 31/64	33/64	1 1/64	1 5/16	11.6
10.6	11.0	11.1	11.28	2B5V110	B	4-Arm	2 31/64	33/64	1 1/64	1 5/16	14.4
12.0	12.4	12.5	12.68	2B5V124	B	4-Arm	2 31/64	33/64	1 1/64	1 5/16	17.1
13.2	13.6	13.7	13.88	2B5V136	B	4-Arm	2 31/64	33/64	1 1/64	1 5/16	19.3
15.0	15.4	15.5	15.68	2B5V154	B	4-Arm	2 31/64	33/64	1 1/64	1 5/16	23.2
15.6	16.0	16.1	16.28	2B5V160	B	4-Arm	2 31/64	33/64	1 1/64	1 5/16	24.2
18.0	18.4	18.5	18.68	2B5V184	B	4-Arm	2 31/64	33/64	1 1/64	1 5/16	33.2
19.5	20.0	20.1	20.28	2B5V200	B	4-Arm	2 31/64	33/64	1 1/64	1 5/16	34.8
22.9	23.4	23.5	23.68	2B5V234	B	4-Arm	2 31/64	33/64	1 1/64	1 5/16	37.9
24.5	25.0	25.1	25.28	2B5V250	B	4-Arm	2 31/64	33/64	1 1/64	1 5/16	47.0
27.3	27.8	27.9	28.08	2B5V278	B	4-Arm	2 31/64	33/64	1 1/64	1 5/16	55.9
3 GROOVE, F = 2 7/16											
3.8	4.2	4.3	4.48	3B5V42	P1	5	3 5/16	5/8	1 1/8	1 5/16	4.8
4.0	4.4	4.5	4.68	3B5V44	P1	3	2 23/32	1/32	1 7/32	1 5/16	5.2
4.2	4.6	4.7	4.88	3B5V46	B	5	3 7/16	3/4	1 3/16	1 1/4	4.9
4.4	4.8	4.9	5.08	3B5V48	B	5	3 7/16	3/4	1 3/16	1 1/4	5.5
4.6	5.0	5.1	5.28	3B5V50	B	5	3 7/16	3/4	1 3/16	1 1/4	6.1
4.8	5.2	5.3	5.48	3B5V52	B	5	3 7/16	3/4	1 3/16	1 1/4	6.7
5.0	5.4	5.5	5.68	3B5V54	B	3	2 27/32	5/32	1 3/32	1 1/4	7.4
5.2	5.6	5.7	5.88	3B5V56	B	3	2 27/32	5/32	1 7/32	1 5/16	8.4
5.4	5.8	5.9	6.08	3B5V58	B	3	2 27/32	5/32	1 7/32	1 5/16	9.5
5.6	6.0	6.1	6.28	3B5V60	B	3	2 27/32	5/32	1 7/32	1 5/16	10.6
5.8	6.2	6.3	6.48	3B5V62	B	3	2 27/32	5/32	1 7/32	1 5/16	9.8
6.0	6.4	6.5	6.68	3B5V64	B	3	2 27/32	5/32	1 7/32	1 5/16	10.5
6.2	6.6	6.7	6.88	3B5V66	B	3	2 27/32	5/32	1 7/32	1 5/16	10.4
6.4	6.8	6.9	7.08	3B5V68	B	4-Web	2 27/32	5/32	1 7/32	1 5/16	10.9
6.6	7.0	7.1	7.28	3B5V70	B	4-Web	2 27/32	5/32	1 7/32	1 5/16	11.5
7.0	7.4	7.5	7.68	3B5V74	B	4-Web	2 27/32	5/32	1 7/32	1 5/16	12.6
7.6	8.0	8.1	8.28	3B5V80	B	4-Arm	2 27/32	5/32	1 7/32	1 5/16	14.2
8.2	8.6	8.7	8.88	3B5V86	B	4-Arm	2 27/32	5/32	1 7/32	1 5/16	13.7
8.6	9.0	9.1	9.28	3B5V90	B	4-Arm	2 27/32	5/32	1 7/32	1 5/16	14.5
9.0	9.4	9.5	9.68	3B5V94	B	4-Arm	2 27/32	5/32	1 7/32	1 5/16	17.0
10.6	11.0	11.1	11.28	3B5V110	B	4-Arm	2 27/32	5/32	1 7/32	1 5/16	19.8
12.0	12.4	12.5	12.68	3B5V124	B	4-Arm	2 27/32	5/32	1 7/32	1 5/16	22.1
13.2	13.6	13.7	13.88	3B5V136	B	4-Arm	2 27/32	5/32	1 7/32	1 5/16	24.9
15.0	15.4	15.5	15.68	3B5V154	B	4-Arm	2 27/32	5/32	1 7/32	1 5/16	30.4
15.6	16.0	16.1	16.28	3B5V160	B	4-Arm	2 27/32	5/32	1 7/32	1 5/16	31.7
18.0	18.4	18.5	18.68	3B5V184	B	4-Arm	2 27/32	5/32	1 7/32	1 5/16	40.9
19.5	20.0	20.1	20.28	3B5V200	B	4-Arm	2 27/32	5/32	1 7/32	1 5/16	47.6
22.9	23.4	23.5	23.68	3B5V234	B	4-Arm	2 27/32	5/32	1 7/32	1 5/16	61.5
24.5	25.0	25.1	25.28	3B5V250	B	4-Arm	2 27/32	5/32	1 7/32	1 5/16	66.6
27.3	27.8	27.9	28.08	3B5V278	B	4-Arm	2 27/32	5/32	1 7/32	1 5/16	79.1
4 GROOVE, F = 3 5/32											
3.8	4.2	4.3	4.48	4B5V42	P1	5	4 1/32	5/8	1 27/32	1 5/16	5.9
4.0	4.4	4.5	4.68	4B5V44	P1	3	3 23/64	3/64	1 17/64	1 5/16	6.3
4.2	4.6	4.7	4.88	4B5V46	B	5	4 3/32	3/4	1 23/32	1 1/4	6.1
4.4	4.8	4.9	5.08	4B5V48	B	5	4 3/32	3/4	1 23/32	1 1/4	6.7
4.6	5.0	5.1	5.28	4B5V50	B	5	4 3/32	3/4	1 23/32	1 1/4	7.4
4.8	5.2	5.3	5.48	4B5V52	B	5	4 3/32	3/4	1 23/32	1 1/4	8.0
5.0	5.4	5.5	5.68	4B5V54	B	3	3 13/64	—	5 1/64	1 1/4	8.9
5.2	5.6	5.7	5.88	4B5V56	B	3	3 13/64	—	5 7/64	1 5/16	9.5
5.4	5.8	5.9	6.08	4B5V58	B	3	3 13/64	—	5 7/64	1 5/16	10.3
5.6	6.0	6.1	6.28	4B5V60	B	3	3 13/64	—	5 7/64	1 5/16	11.0
5.8	6.2	6.3	6.48	4B5V62	B	3	3 13/64	—	5 7/64	1 5/16	11.3
6.0	6.4	6.5	6.68	4B5V64	B	3	3 13/64	—	5 7/64	1 5/16	12.1
6.2	6.6	6.7	6.88	4B5V66	B	3	3 13/64	—	5 7/64	1 5/16	12.0
6.4	6.8	6.9	7.08	4B5V68	B	3	3 13/64	—	5 7/64	1 5/16	12.6
6.6	7.0	7.1	7.28	4B5V70	B	4-Web	3 13/64	—	5 7/64	1 5/16	13.2
7.0	7.4	7.5	7.68	4B5V74	B	4-Web	3 13/64	—	5 7/64	1 5/16	14.5
7.6	8.0	8.1	8.28	4B5V80	B	4-Arm	3 13/64	—	5 7/64	1 5/16	15.2
8.2	8.6	8.7	8.88	4B5V86	B	4-Arm	3 13/64	—	5 7/64	1 5/16	16.6
8.6	9.0	9.1	9.28	4B5V90	B	4-Arm	3 13/64	—	5 7/64	1 5/16	17.6
9.0	9.4	9.5	9.68	4B5V94	B	4-Arm	3 13/64	—	5 7/64	1 5/16	20.0
10.6	11.0	11.1	11.28	4B5V110	B	4-Arm	3 13/64	—	5 7/64	1 5/16	22.8
12.0	12.4	12.5	12.68	4B5V124	B	4-Arm	3 13/64	—	5 7/64	1 5/16	26.5
13.2	13.6	13.7	13.88	4B5V136	B	4-Arm	3 13/64	—	5 7/64	1 5/16	30.7
15.0	15.4	15.5	15.68	4B5V154	B	4-Arm	3 13/64	—	5 7/64	1 5/16	37.9
15.6	16.0	16.1	16.28	4B5V160	B	4-Arm	3 13/64	—	5 7/64	1 5/16	40.5
18.0	18.4	18.5	18.68	4B5V184	B	4-Arm	3 13/64	—	5 7/64	1 5/16	50.7
19.5	20.0	20.1	20.28	4B5V200	B	4-Arm	3 13/64	—	5 7/64	1 5/16	58.5
22.9	23.4	23.5	23.68	4B5V234	B	4-Arm	3 13/64	—	5 7/64	1 5/16	73.9
24.5	25.0	25.1	25.28	4B5V250	B	4-Arm	3 13/64	—	5 7/64	1 5/16	83.8
27.3	27.8	27.9	28.08	4B5V278	B	4-Arm	3 13/64	—	5 7/64	1 5/16	94.3

Browning® Gripbelt Sheaves With Split Taper Bushings

B5V

Table No. 1

Bushing Specifications

DIAMETERS				Part Number		Type	Dimensions (Inches)				Wt. (lbs) less Bushing
Datum "A" Belts	Datum "B" Belts	Pitch "5V" Belts	Outside	Sheave	Bushing		OL	P	C	X	
5 GROOVE, F = 3 7/8											
3.8	4.2	4.3	4.48	5B5V42	P2	5	4 3/4	5/8	1 9/16	2 5/16	7.83
4.0	4.4	4.5	4.68	5B5V44	P2	5	4 3/4	5/8	1 9/16	2 5/16	8.73
4.2	4.6	4.7	4.88	5B5V46	P2	5	4 3/4	5/8	1 9/16	2 5/16	9.46
4.4	4.8	4.9	5.08	5B5V48	P2	5	4 3/4	5/8	1 9/16	2 5/16	10.31
4.6	5.0	5.1	5.28	5B5V50	Q2	5	4 29/32	3/4	1 1/8	2 3/4	9.63
4.8	5.2	5.3	5.48	5B5V52	Q2	5	4 29/32	3/4	1 1/8	2 3/4	10.79
5.0	5.4	5.5	5.68	5B5V54	Q2	5	4 29/32	3/4	1 1/8	2 3/4	11.98
5.2	5.6	5.7	5.88	5B5V56	Q1	3	4 9/32	1/8	1 1/2	1 3/4	10.41
5.4	5.8	5.9	6.08	5B5V58	Q1	3	4 9/32	1/8	1 1/2	1 3/4	12.35
5.6	6.0	6.1	6.28	5B5V60	Q1	3	4 9/32	1/8	1 1/2	1 3/4	13.86
5.8	6.2	6.3	6.48	5B5V62	Q1	3	4 9/32	1/8	1 1/2	1 3/4	14.94
6.0	6.4	6.5	6.68	5B5V64	Q1	3	4 9/32	1/8	1 1/2	1 3/4	16.78
6.2	6.6	6.7	6.88	5B5V66	Q1	3	4 9/32	1/8	1 1/2	1 3/4	17.19
6.4	6.8	6.9	7.08	5B5V68	Q1	3	4 9/32	1/8	1 1/2	1 3/4	18.09
6.6	7.0	7.1	7.28	5B5V70	Q2	4-Web	4 1/4	3/32	15/32	2 3/4	21.05
7.0	7.4	7.5	7.68	5B5V74	Q2	4-Web	4 1/4	3/32	15/32	2 3/4	20.95
7.6	8.0	8.1	8.28	5B5V80	R1	4-Web	4 5/32	-	1	2	28.44
8.2	8.6	8.7	8.88	5B5V86	R1	4-Web	4 5/32	-	1	2	26.89
8.6	9.0	9.1	9.28	5B5V90	R1	4-Web	4 5/32	-	1	2	87.84
9.0	9.4	9.5	9.68	5B5V94	R1	4-Web	4 5/32	-	1	2	28.61
10.6	11.0	11.1	11.28	5B5V110	R1	6-Web	4 3/32	1/16	15/16	2	42.31
12.0	12.4	12.5	12.68	5B5V124	R1	6-Web	4 3/32	1/16	15/16	2	52.15
13.2	13.6	13.7	13.88	5B5V136	R1	6-Arm	4 3/32	1/16	15/16	2	45.12
15.0	15.4	15.5	15.68	5B5V154	R1	6-Arm	4 3/32	1/16	15/16	2	55.98
15.6	16.0	16.1	16.28	5B5V160	R1	6-Arm	4 3/32	1/16	15/16	2	60.19
18.0	18.4	18.5	18.68	5B5V184	R1	6-Arm	4 3/32	1/16	15/16	2	77.25
19.5	20.0	20.1	20.28	5B5V200	R1	6-Arm	4 3/32	1/16	15/16	2	91.21
24.5	25.0	25.1	25.28	5B5V250	R1	6-Arm	4 3/32	1/16	15/16	2	130.19
5 GROOVE, F=4 7/16											
3.8	4.2	4.3	4.48	6B5V42	P2	5	5 15/32	5/8	2 9/32	2 5/16	8.97
4.0	4.4	4.5	4.68	6B5V44	P2	5	5 15/32	5/8	2 9/32	2 5/16	9.93
4.2	4.6	4.7	4.88	6B5V46	P2	5	5 15/32	5/8	2 9/32	2 5/16	10.64
4.4	4.8	4.9	5.08	6B5V48	P2	5	5 15/32	5/8	2 9/32	2 5/16	11.53
4.6	5.0	5.1	5.28	6B5V50	Q2	5	5 5/8	3/4	1 27/32	2 3/4	10.91
4.8	5.2	5.3	5.48	6B5V52	Q2	5	5 5/8	3/4	1 27/32	2 3/4	12.13
5.0	5.4	5.5	5.68	6B5V54	Q2	5	5 5/8	3/4	1 27/32	2 3/4	13.39
5.2	5.6	5.7	5.88	6B5V56	Q1	3	5 5/8	1/8	2 7/32	1 3/4	12.86
5.4	5.8	5.9	6.08	6B5V58	Q1	3	5 5/8	-	2 3/32	1 3/4	13.65
5.6	6.0	6.1	6.28	6B5V60	Q1	3	5 5/8	-	2 3/32	1 3/4	14.67
5.8	6.2	6.3	6.48	6B5V62	Q1	3	5 5/8	-	2 3/32	1 3/4	16.51
6.0	6.4	6.5	6.68	6B5V64	Q1	3	5 5/8	-	2 3/32	1 3/4	17.38
6.2	6.6	6.7	6.88	6B5V66	Q1	3	5 5/8	-	2 3/32	1 3/4	18.52
6.4	6.8	6.9	7.08	6B5V68	Q1	3	5 5/8	-	2 3/32	1 3/4	20.14
6.6	7.0	7.1	7.28	6B5V70	Q2	6-Web	4 39/64	17/64	53/64	2 3/4	23.01
7.0	7.4	7.5	7.68	6B5V74	Q2	6-Web	4 39/64	17/64	53/64	2 3/4	22.93
7.6	8.0	8.1	8.28	6B5V80	R1	6-Solid	4 19/32	23/64	1 23/64	2	32.55
8.2	8.6	8.7	8.88	6B5V86	R1	6-Web	4 19/32	23/64	1 23/64	2	29.63
8.6	9.0	9.1	9.28	6B5V90	R1	6-Web	4 19/32	23/64	1 23/64	2	30.67
9.0	9.4	9.5	9.68	6B5V94	R1	6-Web	4 19/32	19/64	1 27/64	2	31.35
10.6	11.0	11.1	11.28	6B5V110	R1	6-Web	4 19/32	27/64	1 19/64	2	45.69
12.0	12.4	12.5	12.68	6B5V124	R1	6-Web	4 19/32	27/64	1 19/64	2	52.23
13.2	13.6	13.7	13.88	6B5V136	R1	6-Arm	4 19/32	27/64	1 19/64	2	48.81
15.0	15.4	15.5	15.68	6B5V154	R1	6-Arm	4 19/32	27/64	1 19/64	2	60.36
15.6	16.0	16.1	16.28	6B5V160	R1	6-Arm	4 19/32	27/64	1 19/64	2	63.72
18.0	18.4	18.5	18.68	6B5V184	R1	6-Arm	4 19/32	27/64	1 19/64	2	82.89
19.5	20.0	20.1	20.28	6B5V200	R1	6-Arm	4 19/32	27/64	1 19/64	2	100.23
24.5	25.0	25.1	25.28	6B5V250	R1	6-Arm	4 19/32	27/64	1 19/64	2	140.18

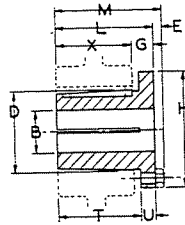
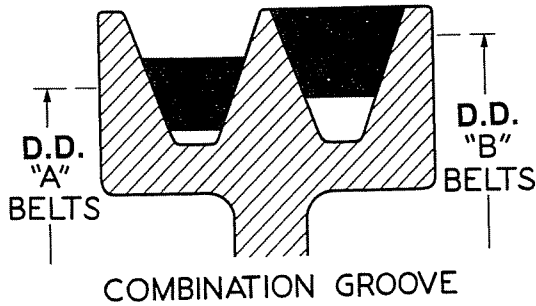
Mix and match with present drive components

Using the new B5V does not make present V-drive components obsolete. In fact, a B5V sheave may be used at any time as the driver or the driven sheave in the same drive with a traditional A/B or 5V sheave, and of course use the same belts. Because B and 5V sheaves utilize different groove spacing, B5V sheaves are not designed for use with banded belts.

Call your Browning Distributor for details.

TB *Browning* Gripbelt Sheaves with Split Taper Bushings

For Use with All "A" and "B" Section Belts



Standard Keyseats
Table No. 1

Bore Range	Keyseat
1/2" — 9/16"	1/8" x 1/16"
5/8" — 7/8"	3/16" x 3/32"
15/16" — 1"	1/4" x 1/8"
1 1/16" — 1 3/8"	5/16" x 5/32"
1 7/16" — 1 3/4"	3/8" x 3/16"
1 13/16" — 2 1/4"	1/2" x 1/4"
2 5/16" — 2 11/16"	5/8" x 5/16"

1 3/8" Bore Bushings also available with 3/8" x 3/16" Keyseat.

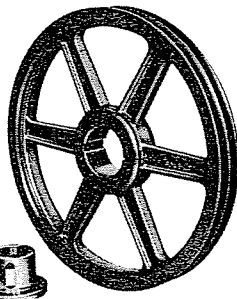
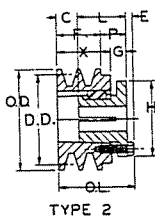


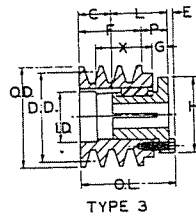
Table No. 2

Bushing Dimensions

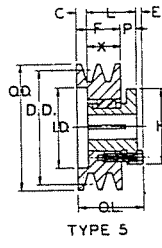
Part No.	Dimensions									Bore Range	Wt. Lbs.
	M	L	G	X	E	T	U	D	H		
P1	2 3/16"	1 15/16"	5/8"	1 5/16"	1/4"	1 17/32"	1 13/32"	1 115/16"	3"	1/2" — 1 3/4"	1 1/4
P2	3 3/16"	2 15/16"	5/8"	2 5/16"	1/4"	2 17/32"	1 13/32"	1 115/16"	3"	3/4" — 1 3/4"	1 1/2
Q1	2 25/32"	2 1/2"	3/4"	1 3/4"	9/32"	1 31/32"	1 7/32"	2 7/8"	4 1/8"	3/4" — 2 11/16"	3 1/2



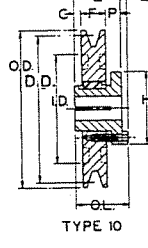
TYPE 2



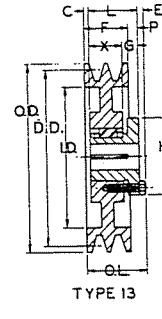
TYPE 3



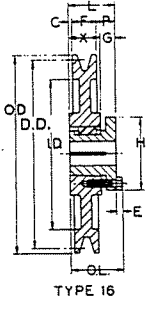
TYPE 5



TYPE 10



TYPE 13



TYPE 16

Table No. 3

Specifications—Stock "TB" Sheaves

DIAMETERS				1 GROOVE, F = 1"											Wt. Less Bush.
Datum "A"	Datum "B"	Out-side	In-side	Part Number		Type	Dimensions								
				Sheave	Bush-ing		O. L.	L	P	C	H	G	X	E	
3.0"	3.4"	3.75"	—	1TB34	P1	2	2 5/16"	1 15/16"	1 1/16"	1/8"	3"	5/8"	1 17/16"	1/4"	2.0
3.2	3.6	3.95	—	1TB36	P1	2	2 5/16"	1 15/16"	1 1/16"	1/8"	3"	5/8"	1 17/16"	1/4"	2.3
3.4	3.8	4.15	—	1TB38	P1	2	2 5/16"	1 15/16"	1 1/16"	1/8"	3"	5/8"	1 17/16"	1/4"	2.6
3.6	4.0	4.35	—	1TB40	P1	10-Sol.	2 3/16"	1 15/16"	5/8"	5/16"	3"	—	—	1/4"	2.1
3.8	4.2	4.55	—	1TB42	P1	10-Sol.	2 3/16"	1 15/16"	5/8"	5/16"	3"	—	—	1/4"	2.4
4.0	4.4	4.75	—	1TB44	P1	10-Sol.	2 3/16"	1 15/16"	5/8"	5/16"	3"	—	—	1/4"	2.8
4.2	4.6	4.95	—	1TB46	P1	10-Sol.	2 3/16"	1 15/16"	5/8"	5/16"	3"	—	—	1/4"	3.1
4.4	4.8	5.15	—	1TB48	P1	10-Sol.	2 3/16"	1 15/16"	5/8"	5/16"	3"	—	—	1/4"	3.5
4.6	5.0	5.35	—	1TB50	P1	10-Sol.	2 3/16"	1 15/16"	5/8"	5/16"	3"	—	—	1/4"	3.9
4.8	5.2	5.55	—	1TB52	P1	10-Sol.	2 3/16"	1 15/16"	5/8"	5/16"	3"	—	—	1/4"	4.1
5.0	5.4	5.75	—	1TB54	P1	10-Sol.	2 3/16"	1 15/16"	5/8"	5/16"	3"	—	—	1/4"	4.6
5.2	5.6	5.95	—	1TB56	P1	10-Sol.	2 3/16"	1 15/16"	5/8"	5/16"	3"	—	—	1/4"	5.1
5.4	5.8	6.15	—	1TB58	P1	10-Sol.	2 3/16"	1 15/16"	5/8"	5/16"	3"	—	—	1/4"	5.6
5.6	6.0	6.35	4 1/2"	1TB60	P1	10-Web	2 3/16"	1 15/16"	5/8"	5/16"	3"	—	—	1/4"	6.0
5.8	6.2	6.55	4 11/16"	1TB62	P1	10-Web	2 3/16"	1 15/16"	5/8"	5/16"	3"	—	—	1/4"	5.5
6.0	6.4	6.75	4 7/8"	1TB64	P1	10-Web	2 3/16"	1 15/16"	5/8"	5/16"	3"	—	—	1/4"	5.8
6.2	6.6	6.95	5 1/16"	1TB66	P1	10-Web	2 3/16"	1 15/16"	5/8"	5/16"	3"	—	—	1/4"	5.9
6.4	6.8	7.15	5 5/16"	1TB68	P1	10-Web	2 3/16"	1 15/16"	5/8"	5/16"	3"	—	—	1/4"	6.1
6.6	7.0	7.35	5 1/2"	1TB70	P1	16-Arm	2 3/16"	1 15/16"	2 5/32"	5/32"	3"	3/8"	1 5/16"	1/4"	6.4
7.0	7.4	7.75	5 15/16"	1TB74	P1	16-Arm	2 3/16"	1 15/16"	2 5/32"	5/32"	3"	3/8"	1 5/16"	1/4"	7.3
7.6	8.0	8.35	6 1/2"	1TB80	P1	16-Arm	2 3/16"	1 15/16"	2 5/32"	5/32"	3"	3/8"	1 5/16"	1/4"	7.8
8.2	8.6	8.95	7 1/16"	1TB86	P1	16-Arm	2 3/16"	1 15/16"	2 5/32"	5/32"	3"	3/8"	1 5/16"	1/4"	8.6
8.6	9.0	9.35	7 1/2"	1TB90	P1	16-Arm	2 3/16"	1 15/16"	2 5/32"	5/32"	3"	3/8"	1 5/16"	1/4"	8.9
9.0	9.4	9.75	7 9/16"	1TB94	P1	16-Arm	2 3/16"	1 15/16"	2 5/32"	5/32"	3"	3/8"	1 5/16"	1/4"	9.1
10.6	11.0	11.35	9 7/16"	1TB110	P1	16-Arm	2 3/16"	1 15/16"	2 5/32"	5/32"	3"	3/8"	1 5/16"	1/4"	11.1
12.0	12.4	12.75	10 15/16"	1TB124	Q1	16-Arm	2 25/32"	1 1/8"	1 1/8"	3/8"	4 1/8"	3/4"	1 3/4"	9/32"	17.8
13.2	13.6	13.95	12 1/16"	1TB136	Q1	16-Arm	2 25/32"	2 1/2"	1 1/8"	3/8"	4 1/8"	3/4"	1 3/4"	9/32"	18.2
15.0	15.4	15.75	13 15/16"	1TB154	Q1	16-Arm	2 25/32"	2 1/2"	1 1/8"	3/8"	4 1/8"	3/4"	1 3/4"	9/32"	20.3
15.6	16.0	16.35	14 1/2"	1TB160	Q1	16-Arm	2 25/32"	2 1/2"	1 1/8"	3/8"	4 1/8"	3/4"	1 3/4"	9/32"	22.0
18.0	18.4	18.75	16 15/16"	1TB184	Q1	16-Arm	2 25/32"	2 1/2"	1 1/8"	3/8"	4 1/8"	3/4"	1 3/4"	9/32"	27.5
19.5	20.0	20.35	18 1/2"	1TB200	Q1	16-Arm	2 25/32"	2 1/2"	1 1/8"	3/8"	4 1/8"	3/4"	1 3/4"	9/32"	27.2
24.5	25.0	25.35	23 1/2"	1TB250	Q1	16-Arm	2 25/32"	2 1/2"	1 1/8"	3/8"	4 1/8"	3/4"	1 3/4"	9/32"	42.4
29.5	30.0	30.35	28 1/2"	1TB300	Q1	16-Arm	2 25/32"	2 1/2"	1 1/8"	3/8"	4 1/8"	3/4"	1 3/4"	9/32"	56.0
37.5	38.0	38.35	36 1/2"	1TB380	Q1	16-Arm	2 25/32"	2 1/2"	1 1/8"	3/8"	4 1/8"	3/4"	1 3/4"	9/32"	78.0

For optimum sheave selection, see B5V Stock Sheave Listing on Page A-11.

For Use with All "A" and "B" Section Belts

Table No. 1

Specifications—Stock "TB" Sheaves

DIAMETERS				2 GROOVES, F = 1 3/4"											
Datum "A"	Datum "B"	Out-side	In-side	Part Number		Type	Dimensions								Wt. Less Bush.
				Sheave	Bush-ing		OL	L	P	C	H	G	X	E	
3.0"	3.4"	3.75"	—	2TB34	P1	2	3 1/16"	1 15/16"	1 1/16"	7/8"	3"	5/8"	2 3/16"	1/4"	2.9
3.2	3.6	3.95	—	2TB36	P1	2	3 1/16"	1 15/16"	1 1/16"	7/8"	3	5/8	2 3/16"	1/4	3.8
3.4	3.8	4.15	2 5/16"	2TB38	P1	5	2 5/8"	1 15/16"	5/8"	7/16"	3	—	1 5/16"	1/4	3.0
3.6	4.0	4.35	2 1/2"	2TB40	P1	5	2 5/8"	1 15/16"	5/8"	7/16"	3	—	1 5/16"	1/4	3.8
3.8	4.2	4.55	2 1 1/16"	2TB42	P1	5	2 5/8"	1 15/16"	5/8"	7/16"	3	—	1 5/16"	1/4	3.9
4.0	4.4	4.75	2 7/8"	2TB44	P1	13-Sol.	2 3/16"	1 15/16"	3/16"	0	3	5/8"	1 5/16"	1/4	3.9
4.2	4.6	4.95	3 1/16"	2TB46	P1	13-Sol.	2 3/16"	1 15/16"	3/16"	0	3	5/8"	1 5/16"	1/4	4.5
4.4	4.8	5.15	3 5/16"	2TB48	P1	13-Sol.	2 3/16"	1 15/16"	3/16"	0	3	5/8"	1 5/16"	1/4	5.3
4.6	5.0	5.35	3 1/2"	2TB50	P1	13-Sol.	2 3/16"	1 15/16"	3/16"	0	3	5/8"	1 5/16"	1/4	5.6
4.8	5.2	5.55	3 1 1/16"	2TB52	P1	13-Sol.	2 3/16"	1 15/16"	3/16"	0	3	5/8"	1 5/16"	1/4	6.1
5.0	5.4	5.75	3 3/8"	2TB54	P1	13-Sol.	2 3/16"	1 15/16"	3/16"	0	3	5/8"	1 5/16"	1/4	6.5
5.2	5.6	5.95	4 1/16"	2TB56	P1	13-Sol.	2 3/16"	1 15/16"	3/16"	0	3	5/8"	1 5/16"	1/4	7.4
5.4	5.8	6.15	4 5/16"	2TB58	P1	13-Sol.	2 3/16"	1 15/16"	3/16"	0	3	5/8"	1 5/16"	1/4	8.0
5.6	6.0	6.35	4 1/2"	2TB60	P1	13-Sol.	2 3/16"	1 15/16"	3/16"	0	3	5/8"	1 5/16"	1/4	8.9
5.8	6.2	6.55	4 1 1/16"	2TB62	P1	13-Web	2 3/16"	1 15/16"	3/16"	0	3	5/8"	1 5/16"	1/4	7.6
6.0	6.4	6.75	4 7/8"	2TB64	P1	13-Web	2 3/16"	1 15/16"	3/16"	0	3	5/8"	1 5/16"	1/4	7.8
6.2	6.6	6.95	5 1/16"	2TB66	P1	13-Web	2 3/16"	1 15/16"	3/16"	0	3	5/8"	1 5/16"	1/4	8.3
6.4	6.8	7.15	5 5/16"	2TB68	P1	13-Web	2 3/16"	1 15/16"	3/16"	0	3	5/8"	1 5/16"	1/4	8.8
6.6	7.0	7.35	5 1/2"	2TB70	Q1	13-Web	2 25/32"	2 1/2"	3/4	0	4 1/8"	3/4	1 3/4	9/32	11.1
7.0	7.4	7.75	5 5/16"	2TB74	Q1	13-Web	2 25/32"	2 1/2"	3/4	0	4 1/8"	3/4	1 3/4	9/32	11.5
7.6	8.0	8.35	6 1/2"	2TB80	Q1	13-Web	2 25/32"	2 1/2"	3/4	0	4 1/8"	3/4	1 3/4	9/32	12.8
8.2	8.6	8.95	7 1/16"	2TB86	Q1	13-Web	2 25/32"	2 1/2"	3/4	0	4 1/8"	3/4	1 3/4	9/32	16.0
8.6	9.0	9.35	7 1/2"	2TB90	Q1	13-Arm	2 25/32"	2 1/2"	3/4	0	4 1/8"	3/4	1 3/4	9/32	15.1
9.0	9.4	9.75	7 5/16"	2TB94	Q1	13-Arm	2 25/32"	2 1/2"	3/4	0	4 1/8"	3/4	1 3/4	9/32	15.5
10.6	11.0	11.35	9 7/16"	2TB110	Q1	13-Arm	2 25/32"	2 1/2"	3/4	0	4 1/8"	3/4	1 3/4	9/32	18.9
12.0	12.4	12.75	10 5/16"	2TB124	Q1	13-Arm	2 25/32"	2 1/2"	3/4	0	4 1/8"	3/4	1 3/4	9/32	21.1
13.2	13.6	13.95	12 1/16"	2TB136	Q1	13-Arm	2 25/32"	2 1/2"	3/4	0	4 1/8"	3/4	1 3/4	9/32	23.0
15.0	15.4	15.75	13 5/16"	2TB154	Q1	13-Arm	2 25/32"	2 1/2"	3/4	0	4 1/8"	3/4	1 3/4	9/32	24.8
15.6	16.0	16.35	14 1/2"	2TB160	Q1	13-Arm	2 25/32"	2 1/2"	3/4	0	4 1/8"	3/4	1 3/4	9/32	27.0
18.0	18.4	18.75	16 1/16"	2TB184	Q1	13-Arm	2 25/32"	2 1/2"	3/4	0	4 1/8"	3/4	1 3/4	9/32	32.3
19.5	20.0	20.35	18 1/2"	2TB200	Q1	13-Arm	2 25/32"	2 1/2"	3/4	0	4 1/8"	3/4	1 3/4	9/32	42.3
24.5	25.0	25.35	23 1/2"	2TB250	Q1	13-Arm	2 25/32"	2 1/2"	3/4	0	4 1/8"	3/4	1 3/4	9/32	50.3
29.5	30.0	30.35	28 1/2"	2TB300	Q1	13-Arm	2 25/32"	2 1/2"	3/4	0	4 1/8"	3/4	1 3/4	9/32	68.8
37.5	38.0	38.35	36 1/2"	2TB380	Q1	13-Arm	2 25/32"	2 1/2"	3/4	0	4 1/8"	3/4	1 3/4	9/32	95.5

For optimum sheave selection, see B5V Stock Sheave Listing on Page A-12.

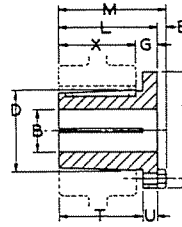
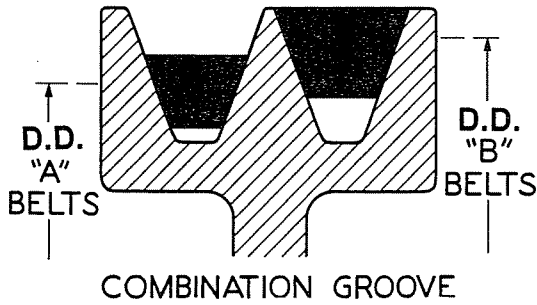
Table No. 2

DIAMETERS				3 GROOVES, F = 2 1/2"											
Datum "A"	Datum "B"	Out-side	In-side	Part Number		Type	Dimensions								Wt. Less Bush.
				Sheave	Bush-ing		OL	L	P	C	H	G	X	E	
3.0"	3.4"	3.75"	2"	3TB34	P2	3	3 13/16"	2 5/16"	1 1/16"	5/8"	3"	5/8"	2 5/16"	1/4"	3.8
3.2	3.6	3.95	2 1/16"	3TB36	P2	3	3 13/16"	2 5/16"	1 1/16"	5/8"	3	5/8	2 5/16"	1/4	4.4
3.4	3.8	4.15	2 5/16"	3TB38	P1	5	3 3/8"	1 15/16"	3/8"	1 3/16"	3	—	1 5/16"	1/4	3.8
3.6	4.0	4.35	2 1/2"	3TB40	P1	5	3 3/8"	1 15/16"	3/8"	1 3/16"	3	—	1 5/16"	1/4	4.5
3.8	4.2	4.55	2 1 1/16"	3TB42	P1	5	3 3/8"	1 15/16"	3/8"	1 3/16"	3	—	1 5/16"	1/4	4.9
4.0	4.4	4.75	2 7/8"	3TB44	P1	13-Sol.	2 3/4"	1 15/16"	0	9/16"	3	5/8"	1 5/16"	1/4	5.1
4.2	4.6	4.95	3 1/16"	3TB46	P1	13-Web	2 3/4"	1 15/16"	0	9/16"	3	5/8"	1 5/16"	1/4	6.0
4.4	4.8	5.15	3 5/16"	3TB48	P1	13-Web	2 3/4"	1 15/16"	0	9/16"	3	5/8"	1 5/16"	1/4	6.3
4.6	5.0	5.35	3 1/2"	3TB50	P1	13-Web	2 3/4"	1 15/16"	0	9/16"	3	5/8"	1 5/16"	1/4	6.9
4.8	5.2	5.55	3 1 1/16"	3TB52	P1	13-Web	2 3/4"	1 15/16"	0	9/16"	3	5/8"	1 5/16"	1/4	7.5
5.0	5.4	5.75	3 3/8"	3TB54	P1	13-Web	2 3/4"	1 15/16"	0	9/16"	3	5/8"	1 5/16"	1/4	8.3
5.2	5.6	5.95	4 1/16"	3TB56	P1	13-Web	2 3/4"	1 15/16"	0	9/16"	3	5/8"	1 5/16"	1/4	9.0
5.4	5.8	6.15	4 5/16"	3TB58	P1	13-Web	2 3/4"	1 15/16"	0	9/16"	3	5/8"	1 5/16"	1/4	9.6
5.6	6.0	6.35	4 1/2"	3TB60	P1	13-Web	2 3/4"	1 15/16"	0	9/16"	3	5/8"	1 5/16"	1/4	10.5
5.8	6.2	6.55	4 1 1/16"	3TB62	P1	13-Web	2 3/4"	1 15/16"	0	9/16"	3	5/8"	1 5/16"	1/4	9.4
6.0	6.4	6.75	4 7/8"	3TB64	P1	13-Web	2 3/4"	1 15/16"	0	9/16"	3	5/8"	1 5/16"	1/4	9.5
6.2	6.6	6.95	5 1/16"	3TB66	P1	13-Web	2 3/4"	1 15/16"	0	9/16"	3	5/8"	1 5/16"	1/4	10.0
6.4	6.8	7.15	5 5/16"	3TB68	P1	13-Web	2 3/4"	1 15/16"	0	9/16"	3	5/8"	1 5/16"	1/4	10.4
6.6	7.0	7.35	5 1/2"	3TB70	Q1	13-Web	3 3/32"	2 1/2"	3/8"	4 1/8"	3/4	1 3/4	9/32	13.0	13.0
7.0	7.4	7.75	5 5/16"	3TB74	Q1	13-Web	3 3/32"	2 1/2"	3/8"	4 1/8"	3/4	1 3/4	9/32	13.3	13.3
7.6	8.0	8.35	6 1/2"	3TB80	Q1	13-Web	3 3/32"	2 1/2"	3/8"	4 1/8"	3/4	1 3/4	9/32	15.3	15.3
8.2	8.6	8.95	7 1/16"	3TB86	Q1	13-Web	3 3/32"	2 1/2"	3/8"	4 1/8"	3/4	1 3/4	9/32	18.9	18.9
8.6	9.0	9.35	7 1/2"	3TB90	Q1	13-Arm	3 3/32"	2 1/2"	3/8"	4 1/8"	3/4	1 3/4	9/32	18.1	18.1
9.0	9.4	9.75	7 5/16"	3TB94	Q1	13-Arm	3 3/32"	2 1/2"	3/8"	4 1/8"	3/4	1 3/4	9/32	18.0	18.0
10.6	11.0	11.35	9 7/16"	3TB110	Q1	13-Arm	3 3/32"	2 1/2"	3/8"	4 1/8"	3/4	1 3/4	9/32	21.3	21.3
12.0	12.4	12.75	10 5/16"	3TB124	Q1	13-Arm	3 3/32"	2 1/2"	3/8"	4 1/8"	3/4	1 3/4	9/32	25.4	25.4
13.2	13.6	13.95	12 1/16"	3TB136	Q1	13-Arm	3 3/32"	2 1/2"	3/8"	4 1/8"	3/4	1 3/4	9/32	27.4	27.4
15.0	15.4	15.75	13 5/16"	3TB154	Q1	13-Arm	3 3/32"	2 1/2"	3/8"	4 1/8"	3/4	1 3/4	9/32	29.8	29.8
15.6	16.0	16.35	14 1/2"	3TB160	Q1	13-Arm	3 3/32"	2 1/2"	3/8"	4 1/8"	3/4	1 3/4	9/32	32.0	32.0
18.0	18.4	18.75	16 1/16"	3TB184	Q1	13-Arm	3 3/32"	2 1/2"	3/8"	4 1/8"	3/4	1 3/4	9/32	37.8	37.8
19.5	20.0	20.35	18 1/2"	3TB200	Q1	13-Arm	3 3/32"	2 1/2"	3/8"	4 1/8"	3/4	1 3/4	9/32	49.9	49.9
24.5	25.0	25.35	23 1/2"	3TB250	Q1	13-Arm	3 3/32"	2 1/2"	3/8"	4 1/8"	3/4	1 3/4	9/32	61.0	61.0
29.5	30.0	30.35	28 1/2"	3TB300	Q1	13-Arm	3 3/32"	2 1/2"	3/8"	4 1/8"	3/4	1 3/4	9/32	78.5	78.5
37.5	38.0	38.35	36 1/2"	3TB380	Q1	13-Arm	3 3/32"	2 1/2"	3/8"	4 1/8"	3/4	1 3/4	9/32	110	110

For optimum sheave selection, see B5V Stock Sheave Listing on Page A-13.

TB Browning Gripbelt Sheaves with Split Taper Bushings

For Use with All "A" and "B" Section Belts



Standard Keyseats
Table No. 1

Bore Range	Keyseat
1/2" - 9/16"	3/8" x 1/16"
5/8" - 1 1/8"	3/16" x 3/32"
1 1/8" - 1 1/4"	1/4" x 1/8"
1 1/4" - 1 3/8"	5/16" x 5/32"
1 3/8" - 1 1/2"	3/8" x 3/16"
1 1/2" - 2 1/4"	1/2" x 1/4"
2 1/4" - 2 1/2"	5/8" x 5/16"

1 3/8" Bore Bushings also available with 3/8" x 5/16" Keyseat.

Table No. 2 Bushing Dimensions

Part No.	Dimensions									Bore Range	Wt. Lbs.
	M	L	G	X	E	T	U	D	H		
P1	2 3/16"	1 15/16"	5/8"	1 5/16"	1/4"	1 17/32"	1 3/32"	1 15/16"	3"	1/4" - 1 3/4"	1 1/4
P2	3 3/16"	2 15/16"	5/8"	2 5/16"	1/4"	2 17/32"	1 3/32"	1 15/16"	3	3/4" - 1 3/4"	1 1/2
Q1	2 25/32"	2 1/2"	3/4"	1 3/4"	9/32"	1 31/32"	1 7/32"	2 7/8"	4 1/8"	3/4" - 2 1/16"	3 1/2
Q2	3 25/32"	3 1/2"	3/4"	2 3/4"	9/32"	2 31/32"	1 7/32"	2 7/8"	4 1/8"	1" - 2 5/8"	4 1/2

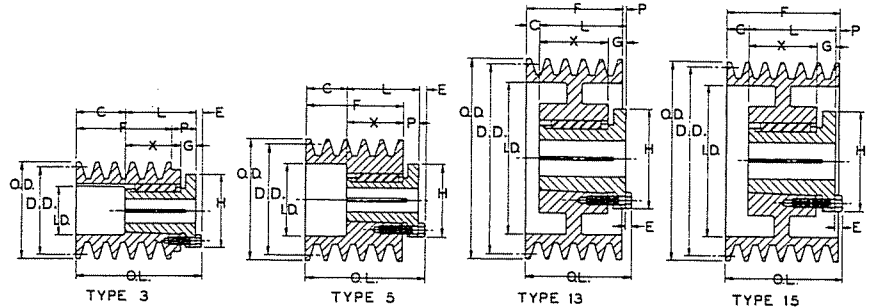
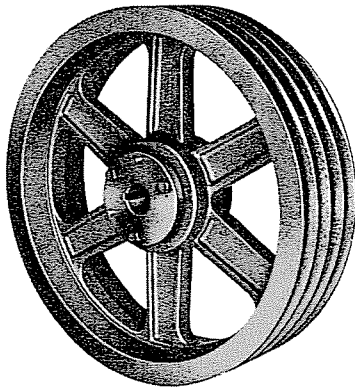


Table No. 3 Specifications—Stock "TB" Sheaves

DIAMETERS				4 GROOVES, F=3 1/4"											
Datum 'A'	Datum 'B'	Out-side	In-side	Part Number		Type	Dimensions						Wt. Less Bush.		
				Sheave	Bush-ing		O. L.	L	P	C	H	G	X	E	
3.0"	3.4"	3.75"	2"	4TB34	P2	3	4 9/16"	2 15/16"	1 1/16"	1 3/8"	3"	5/8"	2 5/16"	1 1/4"	4.5
3.2	3.6	3.95	2 1/16	4TB36	P2	3	4 9/16"	2 15/16"	1 1/16"	1 3/8"	3	5/8"	2 5/16"	1 1/4"	5.3
3.4	3.8	4.15	2 5/16	4TB38	P1	5	4 7/8"	1 15/16"	5/8"	1 15/16"	3	5/8"	1 5/16"	1 1/4"	4.8
3.6	4.0	4.35	2 1/2	4TB40	P1	5	4 7/8"	1 15/16"	5/8"	1 15/16"	3	5/8"	1 5/16"	1 1/4"	5.5
3.8	4.2	4.55	2 11/16	4TB42	P1	5	4 7/8"	1 15/16"	5/8"	1 15/16"	3	5/8"	1 5/16"	1 1/4"	5.9
4.0	4.4	4.75	2 7/8	4TB44	P1	13-Web	3 1/2"	1 15/16"	0	1 5/16"	3	5/8"	1 5/16"	1 1/4"	6.5
4.2	4.6	4.95	3 1/16	4TB46	P1	13-Web	3 1/2"	1 15/16"	0	1 5/16"	3	5/8"	1 5/16"	1 1/4"	7.1
4.4	4.8	5.15	3 5/16	4TB48	P1	13-Web	3 1/2"	1 15/16"	0	1 5/16"	3	5/8"	1 5/16"	1 1/4"	7.5
4.6	5.0	5.35	3 1/2	4TB50	P1	13-Web	3 1/2"	1 15/16"	0	1 5/16"	3	5/8"	1 5/16"	1 1/4"	8.3
4.8	5.2	5.55	3 11/16	4TB52	P1	13-Web	3 1/2"	1 15/16"	0	1 5/16"	3	5/8"	1 5/16"	1 1/4"	9.1
5.0	5.4	5.75	3 7/8	4TB54	P1	13-Web	3 1/2"	1 15/16"	0	1 5/16"	3	5/8"	1 5/16"	1 1/4"	9.6
5.2	5.6	5.95	4 1/16	4TB56	P1	13-Web	3 1/2"	1 15/16"	0	1 5/16"	3	5/8"	1 5/16"	1 1/4"	10.6
5.4	5.8	6.15	4 5/16	4TB58	P1	13-Web	3 1/2"	1 15/16"	0	1 5/16"	3	5/8"	1 5/16"	1 1/4"	11.6
5.6	6.0	6.35	4 1/2	4TB60	P1	13-Web	3 1/2"	1 15/16"	0	1 5/16"	3	5/8"	1 5/16"	1 1/4"	11.9
5.8	6.2	6.55	4 11/16	4TB62	P1	13-Web	3 1/2"	1 15/16"	0	1 5/16"	3	5/8"	1 5/16"	1 1/4"	11.1
6.0	6.4	6.75	4 7/8	4TB64	P1	13-Web	3 1/2"	1 15/16"	0	1 5/16"	3	5/8"	1 5/16"	1 1/4"	11.8
6.2	6.6	6.95	5 1/16	4TB66	P1	13-Web	3 1/2"	1 15/16"	0	1 5/16"	3	5/8"	1 5/16"	1 1/4"	12.0
6.4	6.8	7.15	5 5/16	4TB68	P1	13-Web	3 1/2"	1 15/16"	0	1 5/16"	3	5/8"	1 5/16"	1 1/4"	12.5
6.6	7.0	7.35	5 1/2	4TB70	Q1	13-Web	3 17/32"	2 1/2"	0	3/4"	4 1/8"	3/4"	1 3/4"	9/32"	15.3
7.0	7.4	7.75	5 15/16	4TB74	Q1	13-Web	3 17/32"	2 1/2"	0	3/4"	4 1/8"	3/4"	1 3/4"	9/32"	15.3
7.6	8.0	8.35	6 1/2	4TB80	Q1	13-Web	3 17/32"	2 1/2"	0	3/4"	4 1/8"	3/4"	1 3/4"	9/32"	17.0
8.2	8.6	8.95	7 1/16	4TB86	Q1	13-Web	3 17/32"	2 1/2"	0	3/4"	4 1/8"	3/4"	1 3/4"	9/32"	20.8
8.6	9.0	9.35	7 5/16	4TB90	Q1	13-Arm	3 17/32"	2 1/2"	0	3/4"	4 1/8"	3/4"	1 3/4"	9/32"	20.6
9.0	9.4	9.75	7 15/16	4TB94	Q1	13-Arm	3 17/32"	2 1/2"	0	3/4"	4 1/8"	3/4"	1 3/4"	9/32"	20.1
10.6	11.0	11.35	9 7/16	4TB110	Q1	13-Arm	3 17/32"	2 1/2"	0	3/4"	4 1/8"	3/4"	1 3/4"	9/32"	25.8
12.0	12.4	12.75	10 15/16	4TB124	Q1	13-Arm	3 17/32"	2 1/2"	0	3/4"	4 1/8"	3/4"	1 3/4"	9/32"	27.5
13.2	13.6	13.95	12 1/16	4TB136	Q1	13-Arm	3 17/32"	2 1/2"	0	3/4"	4 1/8"	3/4"	1 3/4"	9/32"	31.5
15.0	15.4	15.75	13 15/16	4TB154	Q1	13-Arm	3 17/32"	2 1/2"	0	3/4"	4 1/8"	3/4"	1 3/4"	9/32"	36.0
15.6	16.0	16.35	14 1/2	4TB160	Q1	13-Arm	3 17/32"	2 1/2"	0	3/4"	4 1/8"	3/4"	1 3/4"	9/32"	39.0
18.0	18.4	18.75	16 15/16	4TB184	Q1	13-Arm	3 17/32"	2 1/2"	0	3/4"	4 1/8"	3/4"	1 3/4"	9/32"	44.8
19.5	20.0	20.35	18 1/2	4TB200	Q1	13-Arm	3 17/32"	2 1/2"	0	3/4"	4 1/8"	3/4"	1 3/4"	9/32"	57.0
24.5	25.0	25.35	23 1/2	4TB250	Q1	13-Arm	3 17/32"	2 1/2"	0	3/4"	4 1/8"	3/4"	1 3/4"	9/32"	69.5
29.5	30.0	30.35	28 1/2	4TB300	Q1	13-Arm	3 17/32"	2 1/2"	0	3/4"	4 1/8"	3/4"	1 3/4"	9/32"	90.8
37.5	38.0	38.35	36 1/2	4TB380	Q1	13-Arm	3 17/32"	2 1/2"	0	3/4"	4 1/8"	3/4"	1 3/4"	9/32"	125

For optimum sheave selection, see B5V Stock Sheave Listing on Page A-14.

For Use with All "A" and "B" Section Belts

Specifications—Stock "TB" Sheaves

Table No. 1

DIAMETERS				5 GROOVES, F=4"											Wt. Less Bush.
Datum "A"	Datum "B"	Out- side	In- side	Part Number		Type	Dimensions								
				Sheave	Bush- ing		OL	L	P	C	H	G	X	E	
3.0"	3.4"	3.75"	2"	5TB34	P2	3	55/16"	215/16"	11/16"	27/8"	3"	5/8"	25/16"	1/4"	5.3
3.2	3.6	3.95	2 1/16	5TB36	P2	3	55/16	215/16	11/16	27/8	3	5/8	25/16	1/4	6.1
3.4	3.8	4.15	2 1/8	5TB38	P2	5	4 7/8	215/16	7/8	1 11/16	3	—	25/16	1/4	6.1
3.6	4.0	4.35	2 1/2	5TB40	P2	5	4 7/8	215/16	7/8	1 11/16	3	—	25/16	1/4	7.0
3.8	4.2	4.55	2 11/16	5TB42	P2	5	4 7/8	215/16	7/8	1 11/16	3	—	25/16	1/4	7.8
4.0	4.4	4.75	2 3/8	5TB44	P2	13-Web	4 1/4	215/16	0	1 1/16	3	5/8	25/16	1/4	8.5
4.2	4.6	4.95	3 1/16	5TB46	P2	13-Web	4 1/4	215/16	0	1 1/16	3	5/8	25/16	1/4	9.8
4.4	4.8	5.15	3 1/8	5TB48	P2	13-Web	4 1/4	215/16	0	1 1/16	3	5/8	25/16	1/4	10.5
4.6	5.0	5.35	3 1/2	5TB50	P2	13-Web	4 1/4	215/16	0	1 1/16	3	5/8	25/16	1/4	11.6
4.8	5.2	5.55	3 11/16	5TB52	P2	13-Web	4 1/4	215/16	0	1 1/16	3	5/8	25/16	1/4	12.5
5.0	5.4	5.75	3 3/8	5TB54	Q1	13-Web	4 3/32	2 1/2	0	1 1/2	4 1/8	3/4	1 3/4	9/32	10.4
5.2	5.6	5.95	4 1/16	5TB56	Q1	13-Web	4 3/32	2 1/2	0	1 1/2	4 1/8	3/4	1 3/4	9/32	11.8
5.4	5.8	6.15	4 1/8	5TB58	Q1	13-Web	4 3/32	2 1/2	0	1 1/2	4 1/8	3/4	1 3/4	9/32	12.8
5.6	6.0	6.35	4 1/2	5TB60	Q1	13-Web	4 3/32	2 1/2	0	1 1/2	4 1/8	3/4	1 3/4	9/32	13.8
5.8	6.2	6.55	4 11/16	5TB62	Q1	13-Web	4 3/32	2 1/2	0	1 1/2	4 1/8	3/4	1 3/4	9/32	14.6
6.0	6.4	6.75	4 3/8	5TB64	Q1	13-Web	4 3/32	2 1/2	0	1 1/2	4 1/8	3/4	1 3/4	9/32	16.4
6.2	6.6	6.95	5 1/16	5TB66	Q1	13-Web	4 3/32	2 1/2	0	1 1/2	4 1/8	3/4	1 3/4	9/32	17.1
6.4	6.8	7.15	5 1/8	5TB68	Q1	13-Web	4 3/32	2 1/2	0	1 1/2	4 1/8	3/4	1 3/4	9/32	17.9
6.6	7.0	7.35	5 1/2	5TB70	Q2	13-Web	4 13/32	3 1/2	1/8	5/8	4 1/8	3/4	2 3/4	9/32	20.9
7.0	7.4	7.75	5 11/16	5TB74	Q2	13-Web	4 13/32	3 1/2	1/8	5/8	4 1/8	3/4	2 3/4	9/32	19.8
7.6	8.0	8.35	6 1/2	5TB80	Q2	13-Web	4 13/32	3 1/2	1/8	5/8	4 1/8	3/4	2 3/4	9/32	22.3
8.2	8.6	8.95	7 1/16	5TB86	Q2	13-Web	4 13/32	3 1/2	1/8	5/8	4 1/8	3/4	2 3/4	9/32	29.5
8.6	9.0	9.35	7 1/2	5TB90	Q2	13-Arm	4 13/32	3 1/2	1/8	5/8	4 1/8	3/4	2 3/4	9/32	28.6
9.0	9.4	9.75	7 11/16	5TB94	Q2	13-Arm	4 13/32	3 1/2	1/8	5/8	4 1/8	3/4	2 3/4	9/32	29.5
10.6	11.0	11.35	9 1/16	5TB110	Q2	13-Arm	4 13/32	3 1/2	1/8	5/8	4 1/8	3/4	2 3/4	9/32	32.8
12.0	12.4	12.75	10 15/16	5TB124	Q2	13-Arm	4 13/32	3 1/2	1/8	5/8	4 1/8	3/4	2 3/4	9/32	35.4
13.2	13.6	13.95	12 1/16	5TB136	Q2	13-Arm	4 13/32	3 1/2	1/8	5/8	4 1/8	3/4	2 3/4	9/32	41.0
15.0	15.4	15.75	13 15/16	5TB154	Q2	13-Arm	4 13/32	3 1/2	1/8	5/8	4 1/8	3/4	2 3/4	9/32	45.3
15.6	16.0	16.35	14 1/2	5TB160	Q2	13-Arm	4 13/32	3 1/2	1/8	5/8	4 1/8	3/4	2 3/4	9/32	48.0
18.0	18.4	18.75	16 5/16	5TB184	Q2	13-Arm	4 13/32	3 1/2	1/8	5/8	4 1/8	3/4	2 3/4	9/32	57.3
19.5	20.0	20.35	18 1/2	5TB200	Q2	13-Arm	4 13/32	3 1/2	1/8	5/8	4 1/8	3/4	2 3/4	9/32	66.0
24.5	25.0	25.35	23 1/2	5TB250	Q2	13-Arm	4 13/32	3 1/2	1/8	5/8	4 1/8	3/4	2 3/4	9/32	82.5
29.5	30.0	30.35	28 1/2	5TB300	Q2	13-Arm	4 13/32	3 1/2	1/8	5/8	4 1/8	3/4	2 3/4	9/32	117
37.5	38.0	38.35	36 1/2	5TB380	Q2	13-Arm	4 13/32	3 1/2	1/8	5/8	4 1/8	3/4	2 3/4	9/32	159

For sheaves with larger bores, see Page A-46.

Table No. 2

DIAMETERS				6 GROOVES, F=4 3/4"											Wt. Less Bush.
Datum "A"	Datum "B"	Out- side	In- side	Part Number		Type	Dimensions								
				Sheave	Bush- ing		OL	L	P	C	H	G	X	E	
3.0"	3.4"	3.75"	2"	6TB34	P2	3	61/16"	215/16"	1 1/16"	27/8"	3"	5/8"	25/16"	1/4"	6.1
3.2	3.6	3.95	2 1/16	6TB36	P2	3	61/16	215/16	1 1/16	27/8	3	5/8	25/16	1/4	7.3
3.4	3.8	4.15	2 1/8	6TB38	P2	5	5 5/8	215/16	7/8	27/16	3	—	25/16	1/4	7.0
3.6	4.0	4.35	2 1/2	6TB40	P2	5	5 5/8	215/16	7/8	27/16	3	—	25/16	1/4	8.1
3.8	4.2	4.55	2 11/16	6TB42	P2	5	5 5/8	215/16	7/8	27/16	3	—	25/16	1/4	9.3
4.0	4.4	4.75	2 3/8	6TB44	P2	13-Web	5	215/16	0	1 13/16	3	5/8	25/16	1/4	9.9
4.2	4.6	4.95	3 1/16	6TB46	P2	13-Web	5	215/16	0	1 13/16	3	5/8	25/16	1/4	11.0
4.4	4.8	5.15	3 1/8	6TB48	P2	13-Web	5	215/16	0	1 13/16	3	5/8	25/16	1/4	11.8
4.6	5.0	5.35	3 1/2	6TB50	P2	13-Web	5	215/16	0	1 13/16	3	5/8	25/16	1/4	12.9
4.8	5.2	5.55	3 11/16	6TB52	P2	13-Web	5	215/16	0	1 13/16	3	5/8	25/16	1/4	14.8
5.0	5.4	5.75	3 3/8	6TB54	Q1	13-Web	5 1/32	2 1/2	0	2 1/4	4 1/8	3/4	1 3/4	9/32	11.8
5.2	5.6	5.95	4 1/16	6TB56	Q1	13-Web	5 1/32	2 1/2	0	2 1/4	4 1/8	3/4	1 3/4	9/32	17.3
5.4	5.8	6.15	4 1/8	6TB58	Q1	13-Web	5 1/32	2 1/2	0	2 1/4	4 1/8	3/4	1 3/4	9/32	14.5
5.6	6.0	6.35	4 1/2	6TB60	Q1	13-Web	5 1/32	2 1/2	0	2 1/4	4 1/8	3/4	1 3/4	9/32	15.4
5.8	6.2	6.55	4 11/16	6TB62	Q1	13-Web	5 1/32	2 1/2	0	2 1/4	4 1/8	3/4	1 3/4	9/32	16.4
6.0	6.4	6.75	4 3/8	6TB64	Q1	13-Web	5 1/32	2 1/2	0	2 1/4	4 1/8	3/4	1 3/4	9/32	18.6
6.2	6.6	6.95	5 1/16	6TB66	Q1	13-Web	5 1/32	2 1/2	0	2 1/4	4 1/8	3/4	1 3/4	9/32	18.5
6.4	6.8	7.15	5 1/8	6TB68	Q1	13-Web	5 1/32	2 1/2	0	2 1/4	4 1/8	3/4	1 3/4	9/32	20.8
6.6	7.0	7.35	5 1/2	6TB70	Q2	15-Web	4 29/32	3 1/2	1/4	1	4 1/8	3/4	2 3/4	9/32	22.8
7.0	7.4	7.75	5 11/16	6TB74	Q2	15-Web	4 29/32	3 1/2	1/4	1	4 1/8	3/4	2 3/4	9/32	26.5
7.6	8.0	8.35	6 1/2	6TB80	Q2	15-Web	4 29/32	3 1/2	1/4	1	4 1/8	3/4	2 3/4	9/32	24.1
8.2	8.6	8.95	7 1/16	6TB86	Q2	15-Web	4 29/32	3 1/2	1/4	1	4 1/8	3/4	2 3/4	9/32	27.1
8.6	9.0	9.35	7 1/2	6TB90	Q2	15-Web	4 29/32	3 1/2	1/4	1	4 1/8	3/4	2 3/4	9/32	30.6
9.0	9.4	9.75	7 11/16	6TB94	Q2	15-Arm	4 29/32	3 1/2	1/4	1	4 1/8	3/4	2 3/4	9/32	32.8
10.6	11.0	11.35	9 1/16	6TB110	Q2	15-Arm	4 29/32	3 1/2	1/4	1	4 1/8	3/4	2 3/4	9/32	36.6
12.0	12.4	12.75	10 15/16	6TB124	Q2	15-Arm	4 29/32	3 1/2	1/4	1	4 1/8	3/4	2 3/4	9/32	39.8
13.2	13.6	13.95	12 1/16	6TB136	Q2	15-Arm	4 29/32	3 1/2	1/4	1	4 1/8	3/4	2 3/4	9/32	44.9
15.0	15.4	15.75	13 15/16	6TB154	Q2	15-Arm	4 29/32	3 1/2	1/4	1	4 1/8	3/4	2 3/4	9/32	49.9
15.6	16.0	16.35	14 1/2	6TB160	Q2	15-Arm	4 29/32	3 1/2	1/4	1	4 1/8	3/4	2 3/4	9/32	54.0
18.0	18.4	18.75	16 5/16	6TB184	Q2	15-Arm	4 29/32	3 1/2	1/4	1	4 1/8	3/4	2 3/4	9/32	62.0
19.5	20.0	20.35	18 1/2	6TB200	Q2	15-Arm	4 29/32	3 1/2	1/4	1	4 1/8	3/4	2 3/4	9/32	74.0
24.5	25.0	25.35	23 1/2	6TB250	Q2	15-Arm	4 29/32	3 1/2	1/4	1	4 1/8	3/4	2 3/4	9/32	89.5
29.5	30.0	30.35	28 1/2	6TB300	Q2	15-Arm	4 29/32	3 1/2	1/4	1	4 1/8	3/4	2 3/4	9/32	128
37.5	38.0	38.35	36 1/2	6TB380	Q2	15-Arm	4 29/32	3 1/2	1/4	1	4 1/8	3/4	2 3/4	9/32	179

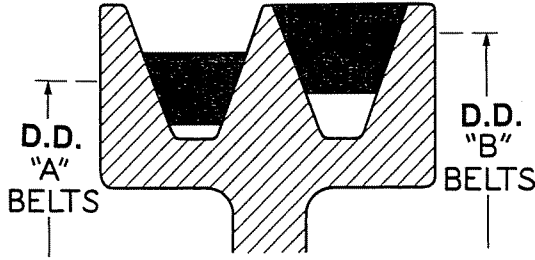
For sheaves with larger bores, see Page A-46.

B

Browning

Gripbelt Sheaves with Split Taper Bushings

For Use with All "A" and "B" Section Belts



COMBINATION GROOVE

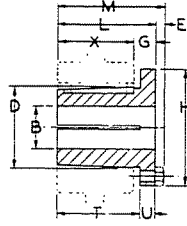


Table No. 2

Bushing Dimensions

Standard Keyseats

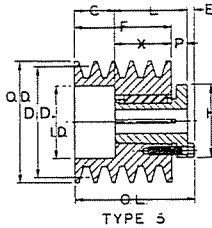
Table No. 1

Bore Range	Keyseat
3/4" — 7/8"	3/16" x 3/32"
15/16" — 1 1/4"	1/4" x 1/8"
1 1/16" — 1 1/8"	5/16" x 3/32"
1 1/16" — 1 1/4"	3/8" x 1/16"
1 13/16" — 2 1/4"	1/2" x 1/4"
2 5/16" — 2 3/4"	5/8" x 3/16"
2 13/16" — 3 1/4"	3/4" x 3/8"
3 3/8" — 3 3/4"	7/8" x 1/16"

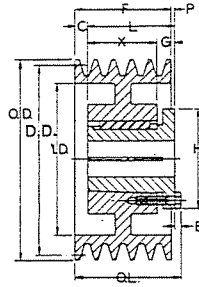
1 3/8" Bore Bushings also available with 3/8" x 3/16" Keyseat.

Close Grain Cast Iron
Accurately Machined
Statically Balanced

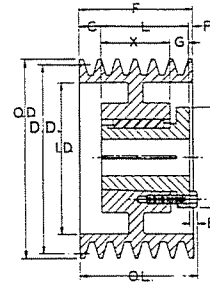
Part No.	Dimensions										Bore Range	Wt. Lbs.
	M	L	G	X	E	T	U	D	H			
Q1	2 25/32"	2 1/2"	3/4"	1 3/4"	9/32"	1 31/32"	1 7/32"	2 7/8"	4 1/8"	4 1/8"	1 3/4" — 2 1/16"	3 1/2
R1	3 5/32"	2 7/8"	7/8"	2"	9/32"	2 1/4"	5/8"	4"	5 3/8"	5 3/8"	1 1/8" — 3 3/4"	7 1/2



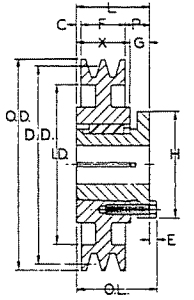
TYPE 5



TYPE 13



TYPE 15



TYPE 16

Table No. 3

Specifications—Stock "B" Sheaves

DIAMETERS				2 GROOVES, F=1 3/4"										Wt. Less Bush.	
Datum 'A'	Datum 'B'	Outside	In-side	Part Number		Type	Dimensions								
				Sheave	Bush-ing		OL	L	P	C	H	G	X		E
5.0"	5.4"	5.75"	—	2B54Q	Q1	5	2 25/32"	2 1/2"	3/4"	0"	4 1/8"	—	1 3/4"	9/32"	6.0
5.2	5.6	5.95	—	2B56Q	Q1	5	2 25/32"	2 1/2"	3/4"	0	4 1/8"	—	1 3/4"	9/32"	7.3
5.4	5.8	6.15	—	2B58Q	Q1	5	2 25/32"	2 1/2"	3/4"	0	4 1/8"	—	1 3/4"	9/32"	7.9
5.6	6.0	6.35	—	2B60Q	Q1	5	2 25/32"	2 1/2"	3/4"	0	4 1/8"	—	1 3/4"	9/32"	8.9
5.8	6.2	6.55	—	2B62Q	Q1	5	2 25/32"	2 1/2"	3/4"	0	4 1/8"	—	1 3/4"	9/32"	9.4
6.0	6.4	6.75	—	2B64Q	Q1	5	2 25/32"	2 1/2"	3/4"	0	4 1/8"	—	1 3/4"	9/32"	10.1
6.2	6.6	6.95	—	2B66Q	Q1	5	2 25/32"	2 1/2"	3/4"	0	4 1/8"	—	1 3/4"	9/32"	11.1
6.4	6.8	7.15	—	2B68Q	Q1	5	2 25/32"	2 1/2"	3/4"	0	4 1/8"	—	1 3/4"	9/32"	12.3
15.0	15.4	15.75	13 7/8"	2B154R	R1	16-Arm	3 5/32"	2 7/8"	1	1/8"	5 3/8"	7/8"	2	9/32"	30.6
15.6	16.0	16.35	14 1/2"	2B160R	R1	16-Arm	3 5/32"	2 7/8"	1	1/8"	5 3/8"	7/8"	2	9/32"	32.0
18.0	18.4	18.75	16 7/8"	2B184R	R1	16-Arm	3 5/32"	2 7/8"	1	1/8"	5 3/8"	7/8"	2	9/32"	39.1
19.5	20.0	20.35	18 1/2"	2B200R	R1	16-Arm	3 5/32"	2 7/8"	1	1/8"	5 3/8"	7/8"	2	9/32"	43.5
24.5	25.0	25.35	23 1/2"	2B250R	R1	16-Arm	3 5/32"	2 7/8"	1	1/8"	5 3/8"	7/8"	2	9/32"	58.0
29.5	30.0	30.35	28 1/2"	2B300R	R1	16-Arm	3 5/32"	2 7/8"	1	1/8"	5 3/8"	7/8"	2	9/32"	81.0
37.5	38.0	38.35	36 1/2"	2B380R	R1	16-Arm	3 5/32"	2 7/8"	1	1/8"	5 3/8"	7/8"	2	9/32"	92.0

For optimum sheave selection, see B5V Stock Sheave Listing on Page A-12.

Table No. 4

DIAMETERS				3 GROOVES, F=2 1/2"										Wt. Less Bush.	
Datum 'A'	Datum 'B'	Outside	In-side	Part Number		Type	Dimensions								
				Sheave	Bush-ing		OL	L	P	C	H	G	X		E
5.0"	5.4"	5.75"	3 7/8"	3B54Q	Q1	5	3 17/32"	2 1/2"	3/4"	3/4"	4 1/8"	—	1 3/4"	9/32"	7.9
5.2	5.6	5.95	4 1/16"	3B56Q	Q1	5	3 17/32"	2 1/2"	3/4"	3/4"	4 1/8"	—	1 3/4"	9/32"	9.0
5.4	5.8	6.15	4 1/4"	3B58Q	Q1	13-Web	3 5/32"	2 1/2"	3/8"	3/8"	4 1/8"	3/4"	1 3/4"	9/32"	9.4
5.6	6.0	6.35	4 7/16"	3B60Q	Q1	13-Web	3 5/32"	2 1/2"	3/8"	3/8"	4 1/8"	3/4"	1 3/4"	9/32"	10.4
5.8	6.2	6.55	4 11/16"	3B62Q	Q1	13-Web	3 5/32"	2 1/2"	3/8"	3/8"	4 1/8"	3/4"	1 3/4"	9/32"	11.3
6.0	6.4	6.75	4 7/8"	3B64Q	Q1	13-Web	3 5/32"	2 1/2"	3/8"	3/8"	4 1/8"	3/4"	1 3/4"	9/32"	12.1
6.2	6.6	6.95	5 1/16"	3B66Q	Q1	13-Web	3 5/32"	2 1/2"	3/8"	3/8"	4 1/8"	3/4"	1 3/4"	9/32"	13.0
6.4	6.8	7.15	5 1/4"	3B68Q	Q1	13-Web	3 5/32"	2 1/2"	3/8"	3/8"	4 1/8"	3/4"	1 3/4"	9/32"	14.3
15.0	15.4	15.75	13 7/8"	3B154R	R1	13-Arm	3 13/32"	2 7/8"	5/8"	1/4"	5 3/8"	7/8"	2	9/32"	35.5
15.6	16.0	16.35	14 1/2"	3B160R	R1	13-Arm	3 13/32"	2 7/8"	5/8"	1/4"	5 3/8"	7/8"	2	9/32"	38.0
18.0	18.4	18.75	16 7/8"	3B184R	R1	13-Arm	3 13/32"	2 7/8"	5/8"	1/4"	5 3/8"	7/8"	2	9/32"	44.8
19.5	20.0	20.35	18 1/8"	3B200R	R1	13-Arm	3 13/32"	2 7/8"	5/8"	1/4"	5 3/8"	7/8"	2	9/32"	50.3
24.5	25.0	25.35	23 1/2"	3B250R	R1	13-Arm	3 13/32"	2 7/8"	5/8"	1/4"	5 3/8"	7/8"	2	9/32"	65.0
29.5	30.0	30.35	28 1/2"	3B300R	R1	13-Arm	3 13/32"	2 7/8"	5/8"	1/4"	5 3/8"	7/8"	2	9/32"	89.0
37.5	38.0	38.35	36 1/2"	3B380R	R1	13-Arm	3 13/32"	2 7/8"	5/8"	1/4"	5 3/8"	7/8"	2	9/32"	106

For optimum sheave selection, see B5V Stock Sheave Listing on Page A-13.



Gripbelt Sheaves with Split Taper Bushings

B

For Use with All "A" and "B" Section Belts

Table No. 1 Specifications—Stock "B" Sheaves

DIAMETERS				4 GROOVES, F = 3 1/4"											
Datum "A"	Datum "B"	Out-side	In-side	Part Number		Type	Dimensions								Wt. Less Bush.
				Sheave	Bush-ing		OL	L	P	C	H	G	X	E	
5.0"	5.4"	5.75"	3 7/8"	4B54Q	Q1	5	4 9/32"	2 1/2"	3/4"	1 1/2"	4 1/8"	—	1 3/4"	9/32"	9.3
5.2	5.6	5.95	4 1/16	4B56Q	Q1	5	4 9/32"	2 1/2"	3/4"	1 1/2"	4 1/8"	—	1 3/4"	9/32"	10.5
5.4	5.8	6.15	4 1/4	4B58Q	Q1	13-Web	3 17/32"	2 1/2"	0	3/4"	4 1/8"	3/4"	1 3/4"	9/32"	11.5
5.6	6.0	6.35	4 7/16	4B60Q	Q1	13-Web	3 17/32"	2 1/2"	0	3/4"	4 1/8"	3/4"	1 3/4"	9/32"	12.6
5.8	6.2	6.55	4 11/16	4B62Q	Q1	13-Web	3 17/32"	2 1/2"	0	3/4"	4 1/8"	3/4"	1 3/4"	9/32"	12.6
6.0	6.4	6.75	4 7/8	4B64Q	Q1	13-Web	3 17/32"	2 1/2"	0	3/4"	4 1/8"	3/4"	1 3/4"	9/32"	14.1
6.2	6.6	6.95	5 1/16	4B66Q	Q1	13-Web	3 17/32"	2 1/2"	0	3/4"	4 1/8"	3/4"	1 3/4"	9/32"	14.8
6.4	6.8	7.15	5 1/4	4B68Q	Q1	13-Web	3 17/32"	2 1/2"	0	3/4"	4 1/8"	3/4"	1 3/4"	9/32"	16.9
15.0	15.4	15.75	13 7/8	4B154R	R1	13-Arm	3 25/32"	2 7/8	1/4"	5/8	5 3/8	7/8	2	9/32"	40.1
15.6	16.0	16.35	14 1/2	4B160R	R1	13-Arm	3 25/32"	2 7/8	1/4"	5/8	5 3/8	7/8	2	9/32"	44.0
18.0	18.4	18.75	16 7/8	4B184R	R1	13-Arm	3 25/32"	2 7/8	1/4"	5/8	5 3/8	7/8	2	9/32"	50.3
19.5	20.0	20.35	18 1/2	4B200R	R1	13-Arm	3 25/32"	2 7/8	1/4"	5/8	5 3/8	7/8	2	9/32"	54.0
24.5	25.0	25.35	23 1/2	4B250R	R1	13-Arm	3 25/32"	2 7/8	1/4"	5/8	5 3/8	7/8	2	9/32"	71.0
29.5	30.0	30.35	28 1/2	4B300R	R1	13-Arm	3 25/32"	2 7/8	1/4"	5/8	5 3/8	7/8	2	9/32"	99.0
37.5	38.0	38.35	36 1/2	4B380R	R1	13-Arm	3 25/32"	2 7/8	1/4"	5/8	5 3/8	7/8	2	9/32"	126

For optimum sheave selection, see B5V Stock Sheave Listing on Page A-14.

Table No. 2

DIAMETERS				5 GROOVES, F = 4"											
Datum "A"	Datum "B"	Out-side	In-side	Part Number		Type	Dimensions								Wt. Less Bush.
				Sheave	Bush-ing		OL	L	P	C	H	G	X	E	
6.6"	7.0"	7.35"	5 1/2"	5B70R	R1	15-Web	4 5/32"	2 3/8"	1/8"	1"	5 3/8"	7/8"	2"	9/32"	17.0
7.0	7.4	7.75	5 5/8	5B74R	R1	15-Web	4 5/32"	2 3/8"	1/8"	1"	5 3/8"	7/8"	2"	9/32"	20.3
7.6	8.0	8.35	6 1/2	5B80R	R1	15-Web	4 5/32"	2 3/8"	1/8"	1"	5 3/8"	7/8"	2"	9/32"	24.8
8.2	8.6	8.95	7 1/16	5B86R	R1	15-Web	4 5/32"	2 3/8"	1/8"	1"	5 3/8"	7/8"	2"	9/32"	27.3
8.6	9.0	9.35	7 1/2	5B90R	R1	15-Web	4 5/32"	2 3/8"	1/8"	1"	5 3/8"	7/8"	2"	9/32"	29.1
9.0	9.4	9.75	7 7/8	5B94R	R1	15-Web	4 5/32"	2 3/8"	1/8"	1"	5 3/8"	7/8"	2"	9/32"	30.0
10.6	11.0	11.35	9 1/2	5B110R	R1	15-Arm	4 5/32"	2 3/8"	1/8"	1"	5 3/8"	7/8"	2"	9/32"	32.8
12.0	12.4	12.75	10 7/8	5B124R	R1	15-Arm	4 5/32"	2 3/8"	1/8"	1"	5 3/8"	7/8"	2"	9/32"	36.0
13.2	13.6	13.95	12 1/16	5B136R	R1	15-Arm	4 5/32"	2 3/8"	1/8"	1"	5 3/8"	7/8"	2"	9/32"	40.3
15.0	15.4	15.75	13 3/8	5B154R	R1	15-Arm	4 5/32"	2 3/8"	1/8"	1"	5 3/8"	7/8"	2"	9/32"	45.0
15.6	16.0	16.35	14 1/2	5B160R	R1	15-Arm	4 5/32"	2 3/8"	1/8"	1"	5 3/8"	7/8"	2"	9/32"	48.0
18.0	18.4	18.75	16 7/8	5B184R	R1	15-Arm	4 5/32"	2 3/8"	1/8"	1"	5 3/8"	7/8"	2"	9/32"	54.0
19.5	20.0	20.35	18 1/2	5B200R	R1	15-Arm	4 5/32"	2 3/8"	1/8"	1"	5 3/8"	7/8"	2"	9/32"	64.0
24.5	25.0	25.35	23 1/2	5B250R	R1	15-Arm	4 5/32"	2 3/8"	1/8"	1"	5 3/8"	7/8"	2"	9/32"	79.0
29.5	30.0	30.35	28 1/2	5B300R	R1	15-Arm	4 5/32"	2 3/8"	1/8"	1"	5 3/8"	7/8"	2"	9/32"	115
37.5	38.0	38.35	36 1/2	5B380R	R1	15-Arm	4 5/32"	2 3/8"	1/8"	1"	5 3/8"	7/8"	2"	9/32"	150

For sheaves with smaller bores, see Page A-44.

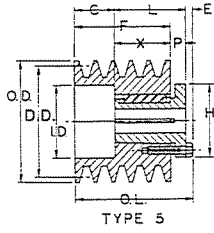
Table No. 3

DIAMETERS				6 GROOVES, F = 4 3/4"											
Datum "A"	Datum "B"	Out-side	In-side	Part Number		Type	Dimensions								Wt. Less Bush.
				Sheave	Bush-ing		OL	L	P	C	H	G	X	E	
6.6"	7.0"	7.35"	5 1/2"	6B70R	R1	15-Web	4 3/4"	2 3/8"	1/2"	1 3/8"	5 3/8"	7/8"	2"	9/32"	19.0
7.0	7.4	7.75	5 5/8	6B74R	R1	15-Web	4 3/4"	2 3/8"	1/2"	1 3/8"	5 3/8"	7/8"	2"	9/32"	21.8
7.6	8.0	8.35	6 1/2	6B80R	R1	15-Web	4 3/4"	2 3/8"	1/2"	1 3/8"	5 3/8"	7/8"	2"	9/32"	26.8
8.2	8.6	8.95	7 1/16	6B86R	R1	15-Web	4 3/4"	2 3/8"	1/2"	1 3/8"	5 3/8"	7/8"	2"	9/32"	29.4
8.6	9.0	9.35	7 1/2	6B90R	R1	15-Web	4 3/4"	2 3/8"	1/2"	1 3/8"	5 3/8"	7/8"	2"	9/32"	31.4
9.0	9.4	9.75	7 7/8	6B94R	R1	15-Web	4 3/4"	2 3/8"	1/2"	1 3/8"	5 3/8"	7/8"	2"	9/32"	32.8
10.6	11.0	11.35	9 1/2	6B110R	R1	15-Arm	4 3/4"	2 3/8"	1/2"	1 3/8"	5 3/8"	7/8"	2"	9/32"	37.0
12.0	12.4	12.75	10 7/8	6B124R	R1	15-Arm	4 3/4"	2 3/8"	1/2"	1 3/8"	5 3/8"	7/8"	2"	9/32"	39.4
13.2	13.6	13.95	12 1/16	6B136R	R1	15-Arm	4 3/4"	2 3/8"	1/2"	1 3/8"	5 3/8"	7/8"	2"	9/32"	45.3
15.0	15.4	15.75	13 3/8	6B154R	R1	15-Arm	4 3/4"	2 3/8"	1/2"	1 3/8"	5 3/8"	7/8"	2"	9/32"	49.1
15.6	16.0	16.35	14 1/2	6B160R	R1	15-Arm	4 3/4"	2 3/8"	1/2"	1 3/8"	5 3/8"	7/8"	2"	9/32"	52.0
18.0	18.4	18.75	16 7/8	6B184R	R1	15-Arm	4 3/4"	2 3/8"	1/2"	1 3/8"	5 3/8"	7/8"	2"	9/32"	59.0
19.5	20.0	20.35	18 1/2	6B200R	R1	15-Arm	4 3/4"	2 3/8"	1/2"	1 3/8"	5 3/8"	7/8"	2"	9/32"	69.0
24.5	25.0	25.35	23 1/2	6B250R	R1	15-Arm	4 3/4"	2 3/8"	1/2"	1 3/8"	5 3/8"	7/8"	2"	9/32"	83.0
29.5	30.0	30.35	28 1/2	6B300R	R1	15-Arm	4 3/4"	2 3/8"	1/2"	1 3/8"	5 3/8"	7/8"	2"	9/32"	126
37.5	38.0	38.35	36 1/2	6B380R	R1	15-Arm	4 3/4"	2 3/8"	1/2"	1 3/8"	5 3/8"	7/8"	2"	9/32"	170

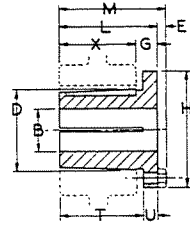
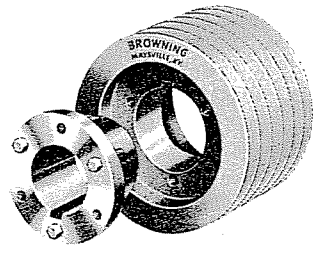
For sheaves with smaller bores, see Page A-44.

B Browning Gripbelt Sheaves with Split Taper Bushings

For Use with All "A" and "B" Section Belts



TYPE 5

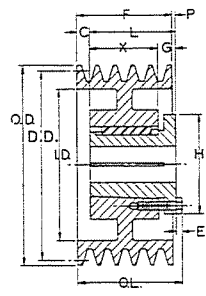


Standard Keyseats

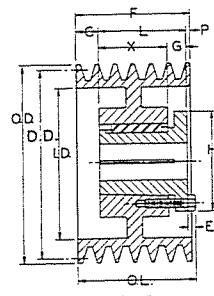
Table No. 1

Bore Range	Keyseat
1" — 1 1/4"	1/4" x 1/8"
1 1/16" — 1 3/8"	5/16" x 5/32"
1 1/8" — 1 3/4"	3/8" x 3/16"
1 13/16" — 2 1/4"	1/2" x 1/4"
2 5/16" — 2 3/4"	5/8" x 5/16"
2 3/16" — 3 1/4"	3/4" x 3/8"
3 3/8" — 3 5/8"	7/8" x 7/16"
3 7/8" — 4 1/2"	1" x 1/2"
4 5/8" — 5 1/2"	1 1/4" x 5/8"

1 3/8" Bore Bushings (except R2) also available with 3/8" x 3/16" Keyseat.



TYPE 13



TYPE 15

Table No. 2 Bushing Dimensions

Part No.	Dimensions										Bore Range	Wt. Lbs.
	M	L	G	X	E	T	U	D	H			
Q2	3 25/32"	3 1/2"	3/4"	2 3/4"	9/32"	2 31/32"	1 7/32"	2 7/8"	4 1/8"	1" — 2 5/8"	4 1/2	
R2	5 5/32"	4 7/8"	7/8"	4"	9/32"	4 1/4"	5/8"	4"	5 3/8"	1 3/8" — 3 5/8"	11	
S1	4 3/4"	4 3/8"	1 1/16"	3 5/16"	3/8"	3 5/8"	3/4"	4 5/8"	6 3/8"	1 11/16" — 4 1/4"	13 1/2	
U0	5 23/32"	5 1/4"	1 1/2"	3 3/4"	15/32"	4 3/16"	1 1/16"	6"	2 9/8"	— 3 3/16"	30	
U0	5 13/32"	4 15/16"	1 3/16"	3 3/4"	15/32"	4 3/16"	3/4"	6"	8 3/8"	3 1/4" — 5 1/2"	27	

Table No. 3 Specifications—Stock "B" Sheaves

DIAMETERS				Part Number		Type	Dimensions								Wt. Less Bush.
Datum 'A'	Datum 'B'	Out-side	In-side	Sheave	Bush-ing		O.L.	L	P	C	H	G	X	E	

8 GROOVES, F = 6 1/4"

5.0"	5.4"	5.75"	3 7/8"	8B54Q	Q2	5	7 9/32"	3 1/2"	3/4"	3 1/2"	4 1/8"	—	2 3/4"	9/32"	18.1
5.2	5.6	5.95	4 1/16"	8B56Q	Q2	5	7 9/32"	3 1/2"	3/4"	3 1/2"	4 1/8"	—	2 3/4"	9/32"	20.6
5.4	5.8	6.15	4 1/4"	8B58Q	Q2	15-Web	6 1/4"	3 1/2"	2"	3/4"	4 1/8"	3/4"	2 3/4"	9/32"	20.9
5.6	6.0	6.35	4 7/16"	8B60Q	Q2	15-Web	6 1/4"	3 1/2"	2"	3/4"	4 1/8"	3/4"	2 3/4"	9/32"	23.0
5.8	6.2	6.55	4 1 1/16"	8B62Q	Q2	15-Web	6 1/4"	3 1/2"	2"	3/4"	4 1/8"	3/4"	2 3/4"	9/32"	23.0
6.0	6.4	6.75	4 7/8"	8B64Q	Q2	15-Web	6 1/4"	3 1/2"	2"	3/4"	4 1/8"	3/4"	2 3/4"	9/32"	25.0
6.2	6.6	6.95	5 1/16"	8B66Q	Q2	15-Web	6 1/4"	3 1/2"	2"	3/4"	4 1/8"	3/4"	2 3/4"	9/32"	27.3
6.4	6.8	7.15	5 1/4"	8B68Q	Q2	15-Web	6 1/4"	3 1/2"	2"	3/4"	4 1/8"	3/4"	2 3/4"	9/32"	31.1
6.6	7.0	7.35	5 1/2"	8B70R	R2	15-Web	6 9/32"	4 7/8"	1/4"	1 1/8"	5 3/8"	7/8"	4"	9/32"	29.5
7.0	7.4	7.75	5 7/8"	8B74R	R2	15-Web	6 9/32"	4 7/8"	1/4"	1 1/8"	5 3/8"	7/8"	4"	9/32"	34.9
7.6	8.0	8.35	6 1/2"	8B80R	R2	15-Web	6 9/32"	4 7/8"	1/4"	1 1/8"	5 3/8"	7/8"	4"	9/32"	42.9
8.2	8.6	8.95	7 1/16"	8B86R	R2	15-Web	6 9/32"	4 7/8"	1/4"	1 1/8"	5 3/8"	7/8"	4"	9/32"	52.0
8.6	9.0	9.35	7 1/2"	8B90R	R2	15-Web	6 9/32"	4 7/8"	1/4"	1 1/8"	5 3/8"	7/8"	4"	9/32"	48.3
9.0	9.4	9.75	7 7/8"	8B94R	R2	15-Web	6 9/32"	4 7/8"	1/4"	1 1/8"	5 3/8"	7/8"	4"	9/32"	49.3
10.6	11.0	11.35	9 1/2"	8B110R	R2	15-Web	6 9/32"	4 7/8"	1/4"	1 1/8"	5 3/8"	7/8"	4"	9/32"	55.0
12.0	12.4	12.75	10 7/8"	8B124R	R2	15-Arm	6 9/32"	4 7/8"	1/4"	1 1/8"	5 3/8"	7/8"	4"	9/32"	60.0
13.2	13.6	13.95	12 1/16"	8B136R	R2	15-Arm	6 9/32"	4 7/8"	1/4"	1 1/8"	5 3/8"	7/8"	4"	9/32"	68.5
15.0	15.4	15.75	13 7/8"	8B154R	R2	15-Arm	6 9/32"	4 7/8"	1/4"	1 1/8"	5 3/8"	7/8"	4"	9/32"	77.3
18.0	18.4	18.75	16 1/8"	8B184R	R2	15-Arm	6 9/32"	4 7/8"	1/4"	1 1/8"	5 3/8"	7/8"	4"	9/32"	90.0
19.5	20.0	20.35	18 1/2"	8B200R	R2	15-Arm	6 9/32"	4 7/8"	1/4"	1 1/8"	5 3/8"	7/8"	4"	9/32"	96.0
24.5	25.0	25.35	23 1/2"	8B250R	R2	15-Arm	6 9/32"	4 7/8"	1/4"	1 1/8"	5 3/8"	7/8"	4"	9/32"	129
29.5	30.0	30.35	28 1/2"	8B300R	R2	15-Arm	6 9/32"	4 7/8"	1/4"	1 1/8"	5 3/8"	7/8"	4"	9/32"	163
29.5	30.0	30.35	28 1/2"	8B300S	S1	15-Arm	6 1/4"	4 3/8"	3/4"	1 1/8"	6 3/8"	1 1/16"	3 5/16"	3/8"	168
37.5	38.0	38.35	36 1/2"	8B380R	R2	15-Arm	6 9/32"	4 7/8"	1/4"	1 1/8"	5 3/8"	7/8"	4"	9/32"	228
37.5	38.0	38.35	36 1/2"	8B380S	S1	15-Arm	6 1/4"	4 3/8"	3/4"	1 1/8"	6 3/8"	1 1/16"	3 5/16"	3/8"	238

For Use with All "A" and "B" Section Belts

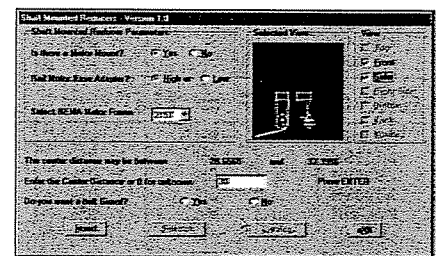
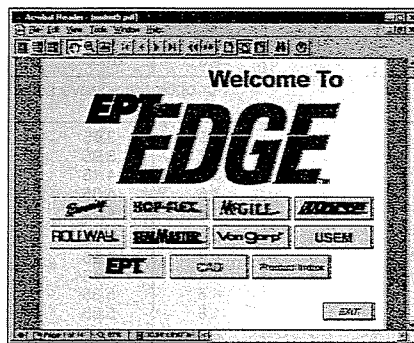
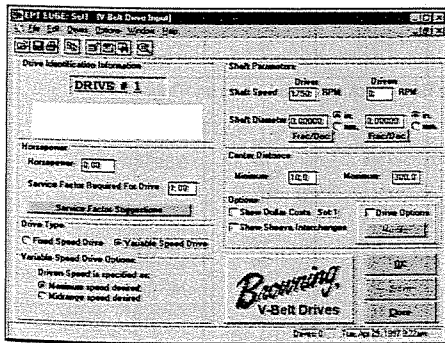
Table No. 1 Specifications—Stock "B" Sheaves

DIAMETERS				Part Number		Type	DIMENSIONS								Wt. Less Bush.
Datum "A"	Datum "B"	Out-side	In-side	Sheave	Bush-ing		O.L.	L	P	C	H	G	X	E	
10 GROOVES F = 7 3/4"															
5.0"	5.4"	5.75"	3 7/8"	10B54Q	Q2	5	8 25/32"	3 1/2"	3/4"	5"	4 1/8"	—	2 3/4"	9/32"	21.5
5.2	5.6	5.95	4 1/16	10B56Q	Q2	5	8 25/32"	3 1/2	3/4	5	4 1/8	—	2 3/4	9/32	24.9
5.4	5.8	6.15	4 1/4	10B58Q	Q2	15-Web	7 3/4	3 1/2	3/2	3/4	4 1/8	3/4"	2 3/4	9/32	23.5
5.6	6.0	6.35	4 7/16	10B60Q	Q2	15-Web	7 3/4	3 1/2	3/2	3/4	4 1/8	3/4	2 3/4	9/32	25.6
5.8	6.2	6.55	4 1 1/16	10B62Q	Q2	15-Web	7 3/4	3 1/2	3/2	3/4	4 1/8	3/4	2 3/4	9/32	27.5
6.0	6.4	6.75	4 7/8	10B64Q	Q2	15-Web	7 3/4	3 1/2	3/2	3/4	4 1/8	3/4	2 3/4	9/32	31.4
6.2	6.6	6.95	5 1/16	10B66Q	Q2	15-Web	7 3/4	3 1/2	3/2	3/4	4 1/8	3/4	2 3/4	9/32	32.5
6.4	6.8	7.15	5 1/4	10B68Q	Q2	15-Web	7 3/4	3 1/2	3/2	3/4	4 1/8	3/4	2 3/4	9/32	36.1
6.6	7.0	7.35	5 1/2	10B70R	R2	15-Web	7 3/4	4 7/8	1	1 7/8	5 3/8	7/8	4	9/32	34.0
7.0	7.4	7.75	5 7/8	10B74R	R2	15-Web	7 3/4	4 7/8	1	1 7/8	5 3/8	7/8	4	9/32	39.3
7.6	8.0	8.35	6 1/2	10B80R	R2	15-Web	7 3/4	4 7/8	1	1 7/8	5 3/8	7/8	4	9/32	48.5
8.2	8.6	8.95	7 1/16	10B86R	R2	15-Web	7 3/4	4 7/8	1	1 7/8	5 3/8	7/8	4	9/32	51.5
8.6	9.0	9.35	7 1/2	10B90R	R2	15-Web	7 3/4	4 7/8	1	1 7/8	5 3/8	7/8	4	9/32	52.3
9.0	9.4	9.75	7 7/8	10B94R	R2	15-Web	7 3/4	4 7/8	1	1 7/8	5 3/8	7/8	4	9/32	54.0
10.6	11.0	11.35	9 1/2	10B110R	R2	15-Arm	7 3/4	4 7/8	1	1 7/8	5 3/8	7/8	4	9/32	61.0
12.0	12.4	12.75	10 7/8	10B124R	R2	15-Arm	7 3/4	4 7/8	1	1 7/8	5 3/8	7/8	4	9/32	77.5
13.2	13.6	13.95	12 1/16	10B136R	R2	15-Arm	7 3/4	4 7/8	1	1 7/8	5 3/8	7/8	4	9/32	76.5
15.0	15.4	15.75	13 7/8	10B154R	R2	15-Arm	7 3/4	4 7/8	1	1 7/8	5 3/8	7/8	4	9/32	89.0
18.0	18.4	18.75	16 7/8	10B184R	R2	15-Arm	7 3/4	4 7/8	1	1 7/8	5 3/8	7/8	4	9/32	104
19.5	20.0	20.35	18 1/2	10B200R	R2	15-Arm	7 3/4	4 7/8	1	1 7/8	5 3/8	7/8	4	9/32	112
24.5	25.0	25.35	23 1/2	10B250R	R2	15-Arm	7 3/4	4 7/8	1	1 7/8	5 3/8	7/8	4	9/32	153
29.5	30.0	30.35	28 1/2	10B300R	R2	15-Arm	7 3/4	4 7/8	1	1 7/8	5 3/8	7/8	4	9/32	188
37.5	38.0	38.35	36 1/2	10B380R	R2	15-Arm	7 3/4	4 7/8	1	1 7/8	5 3/8	7/8	4	9/32	258
37.5	38.0	38.35	36 1/2	10B380U	U0	15-Arm	7 3/4	4 1 1/16	1 1/16	1 3/8	8 3/8	1 1/16	3 3/4	1 3/32	270



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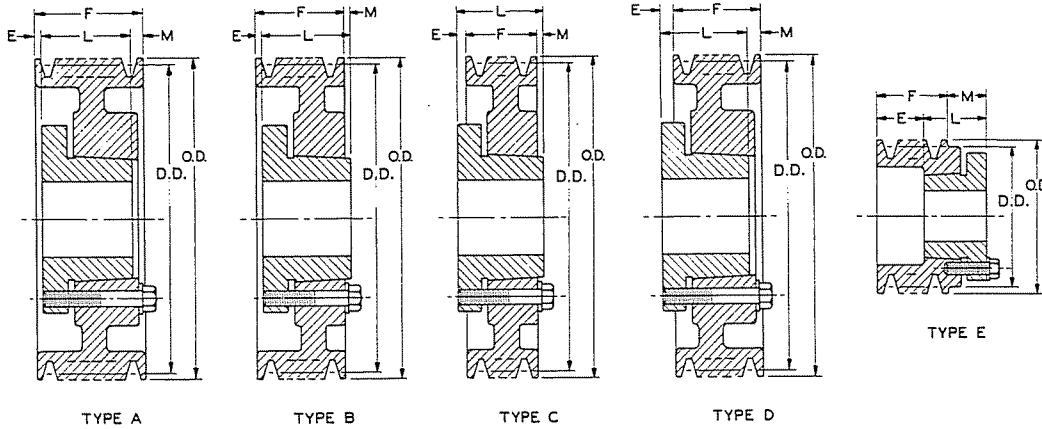
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B

Browning

Q-D® Sheaves for "A" and "B" Belts



Standard Keyseats Table No. 1

Bore Range	Keyseat
1/2" - 9/16"	1/8" x 1/16"
5/8" - 7/8"	3/16" x 3/32"
15/16" - 1 1/4"	1/4" x 1/8"
1 5/16" - 1 3/8"	5/16" x 5/32"
1 7/16" - 1 3/4"	3/8" x 3/16"
1 11/16" - 2 1/4"	1/2" x 1/4"
2 5/16" - 2 3/4"	5/8" x 5/16"
2 13/16" - 3 1/4"	3/4" x 3/8"
3 3/8" - 3 3/4"	7/8" x 7/16"

1 3/8" Bore Bushings also available with 3/8" x 3/16" Keyseat.

Specifications

Table No. 2

Part No.	Bushing	Bore Range	Type*	D. D.		O.D.	E	L	M	Wt. Less Bushing
				"B" Belts	"A" Belts					
1 GROOVE, F = 7/8" (1B34SH-1B70SDS) F = 1" (1B74SDS-1B200SK)										
1B34SH	SH	1/2" - 1 5/8"	E-1	3.4"	3.0"	3.75"	7/32"	1 5/16"	2 1/32"	2.0
1B36SH	SH	1/2" - 1 5/8"	D-1	3.6	3.2	3.95	19/32	1 5/16	5/32	2.2
1B38SH	SH	1/2" - 1 5/8"	D-1	3.8	3.4	4.15	19/32	1 5/16	5/32	2.4
1B40SH	SH	1/2" - 1 5/8"	C-1	4.0	3.6	4.35	1 1/32	1 5/16	3/32	2.7
1B42SH	SH	1/2" - 1 5/8"	C-1	4.2	3.8	4.55	1 1/32	1 5/16	3/32	2.9
1B44SH	SH	1/2" - 1 5/8"	C-1	4.4	4.0	4.75	1 1/32	1 5/16	3/32	3.4
1B46SDS	SDS	1/2" - 2"	C-1	4.6	4.2	4.95	1 1/32	1 5/16	3/32	4.0
1B48SDS	SDS	1/2" - 2"	C-1	4.8	4.4	5.15	1 1/32	1 5/16	3/32	4.3
1B50SDS	SDS	1/2" - 2"	C-1	5.0	4.6	5.35	1 1/32	1 5/16	3/32	4.7
1B52SDS	SDS	1/2" - 2"	C-1	5.2	4.8	5.55	1 1/32	1 5/16	3/32	5.0
1B54SDS	SDS	1/2" - 2"	C-1	5.4	5.0	5.75	1 1/32	1 5/16	3/32	5.3
1B56SDS	SDS	1/2" - 2"	C-1	5.6	5.2	5.95	1 1/32	1 5/16	3/32	5.6
1B58SDS	SDS	1/2" - 2"	C-2	5.8	5.4	6.15	1 1/32	1 5/16	3/32	5.9
1B60SDS	SDS	1/2" - 2"	C-2	6.0	5.6	6.35	1 1/32	1 5/16	3/32	6.2
1B62SDS	SDS	1/2" - 2"	C-2	6.2	5.8	6.55	1 1/32	1 5/16	3/32	6.5
1B64SDS	SDS	1/2" - 2"	C-2	6.4	6.0	6.75	1 1/32	1 5/16	3/32	6.8
1B66SDS	SDS	1/2" - 2"	C-2	6.6	6.2	6.95	1 1/32	1 5/16	3/32	7.2
1B68SDS	SDS	1/2" - 2"	C-3	6.8	6.4	7.15	1 1/32	1 5/16	3/32	7.5
1B70SDS	SDS	1/2" - 2"	C-3	7.0	6.6	7.35	1 1/32	1 5/16	3/32	7.8
1B74SDS	SDS	1/2" - 2"	D-3	7.4	7.0	7.75	1 1/32	1 5/16	7/32	8.8
1B80SDS	SDS	1/2" - 2"	D-3	8.0	7.6	8.35	1 1/32	1 5/16	7/32	9.6
1B86SDS	SDS	1/2" - 2"	D-3	8.6	8.2	8.95	1 1/32	1 5/16	7/32	10.0
1B94SDS	SDS	1/2" - 2"	D-3	9.4	9.0	9.75	1 1/32	1 5/16	7/32	10.5
1B110SDS	SDS	1/2" - 2"	D-3	11.0	10.6	11.35	1 1/32	1 5/16	7/32	11.0
1B124SDS	SDS	1/2" - 2"	D-3	12.4	12.0	12.75	1 1/32	1 5/16	7/32	12.0
1B136SDS	SDS	1/2" - 2"	D-3	13.6	13.2	13.95	1 1/32	1 5/16	7/32	14.0
1B154SK	SK	1/2" - 2 5/8"	C-3	15.4	15.0	15.75	2 1/32	1 15/16	9/32	16.0
1B160SK	SK	1/2" - 2 5/8"	C-3	16.0	15.6	16.35	2 1/32	1 15/16	9/32	16.6
1B184SK	SK	1/2" - 2 5/8"	C-3	18.4	18.0	18.75	2 1/32	1 15/16	9/32	18.0
1B200SK	SK	1/2" - 2 5/8"	C-3	20.0	19.6	20.35	2 1/32	1 15/16	9/32	20.0

2 GROOVES, F = 1 3/4"

For optimum sheave selection, see B5V Stock Sheave Listing on Page A-11.

2B34SH	SH	1/2" - 1 5/8"	E-1	3.4	3.0	3.75	1 3/32	1 5/16	2 1/32	3.2
2B36SH	SH	1/2" - 1 5/8"	D-1	3.6	3.2	3.95	19/32	1 5/16	29/32	3.4
2B38SH	SH	1/2" - 1 5/8"	D-1	3.8	3.4	4.15	19/32	1 5/16	29/32	3.9
2B40SH	SH	1/2" - 1 5/8"	A-1	4.0	3.6	4.35	1 1/32	1 5/16	13/32	4.1
2B42SH	SH	1/2" - 1 5/8"	A-1	4.2	3.8	4.55	1 1/32	1 5/16	13/32	4.4
2B44SH	SH	1/2" - 1 5/8"	A-1	4.4	4.0	4.75	1 1/32	1 5/16	13/32	4.6
2B46SDS	SDS	1/2" - 2"	A-1	4.6	4.2	4.95	1 1/32	1 5/16	13/32	5.0
2B48SDS	SDS	1/2" - 2"	A-1	4.8	4.4	5.15	1 1/32	1 5/16	13/32	5.4
2B50SDS	SDS	1/2" - 2"	A-1	5.0	4.6	5.35	1 1/32	1 5/16	13/32	6.0
2B52SDS	SDS	1/2" - 2"	A-1	5.2	4.8	5.55	1 1/32	1 5/16	13/32	6.3
2B54SDS	SDS	1/2" - 2"	A-1	5.4	5.0	5.75	1 1/32	1 5/16	13/32	6.6
2B56SDS	SDS	1/2" - 2"	A-2	5.6	5.2	5.95	1 1/32	1 5/16	13/32	6.9
2B58SDS	SDS	1/2" - 2"	A-2	5.8	5.4	6.15	1 1/32	1 5/16	13/32	7.2
2B60SDS	SDS	1/2" - 2"	A-2	6.0	5.6	6.35	1 1/32	1 5/16	13/32	7.5
2B62SDS	SDS	1/2" - 2"	A-2	6.2	5.8	6.55	1 1/32	1 5/16	13/32	7.8
2B64SDS	SDS	1/2" - 2"	A-2	6.4	6.0	6.75	1 1/32	1 5/16	13/32	8.2
2B66SDS	SDS	1/2" - 2"	A-2	6.6	6.2	6.95	1 1/32	1 5/16	13/32	8.6
2B68SDS	SDS	1/2" - 2"	A-3	6.8	6.4	7.15	1 1/32	1 5/16	13/32	9.0
2B70SK	SK	1/2" - 2 5/8"	D-1	7.0	6.6	7.35	1 1/32	1 15/16	5/32	9.3
2B74SK	SK	1/2" - 2 5/8"	D-3	7.4	7.0	7.75	1 1/32	1 15/16	5/32	10.6

*Suffix on Type indicates: 1 = Solid Construction, 2 = Web Construction, 3 = Arm Construction.

For optimum sheave selection, see B5V Stock Sheave Listing on Page A-12.

Specifications

Table No. 1

Part No.	Bushing	Bore Range	Type*	D. D.		O.D.	E	L	M	Wt. Less Bushing
				"B" Belts	"A" Belts					
2 GROOVES (Cont.), F = 1 3/4"										
2B80SK	SK	1/2 - 2 5/8"	D-3	8.0"	7.6"	8.35"	1 1/32"	1 15/16"	5/32"	11.0
2B86SK	SK	1/2 - 2 5/8"	D-3	8.6	8.2	8.95	1 1/32	1 15/16	5/32	11.6
2B94SK	SK	1/2 - 2 5/8"	D-3	9.4	9.0	9.75	1 1/32	1 15/16	5/32	13.0
2B110SK	SK	1/2 - 2 5/8"	D-3	11.0	10.6	11.35	1 1/32	1 15/16	5/32	14.0
2B124SK	SK	1/2 - 2 5/8"	D-3	12.4	12.0	12.75	1 1/32	1 15/16	5/32	18.0
2B136SK	SK	1/2 - 2 5/8"	D-3	13.6	13.2	13.95	1 1/32	1 15/16	5/32	20.0
2B154SK	SK	1/2 - 2 5/8"	D-3	15.4	15.0	15.75	1 1/32	1 15/16	5/32	23.0
2B160SK	SK	1/2 - 2 5/8"	D-3	16.0	15.6	16.35	1 1/32	1 15/16	5/32	24.0
2B184SK	SK	1/2 - 2 5/8"	D-3	18.4	18.0	18.75	1 1/32	1 15/16	5/32	29.0
2B200SF	SF	1/2 - 2 15/16"	D-3	20.0	19.6	20.35	1 5/32	2 1/16	5/32	33.0
2B250SF	SF	1/2 - 2 15/16"	D-3	25.0	24.6	25.35	1 5/32	2 1/16	5/32	41.0
2B300SF	SF	1/2 - 2 15/16"	D-3	30.0	29.6	30.35	1 5/32	2 1/16	5/32	51.0
2B380SF	SF	1/2 - 2 15/16"	D-3	38.0	37.6	38.35	1 5/32	2 1/16	5/32	64.0

3 GROOVES, F = 2 1/2"

For optimum sheave selection, see B5V Stock Sheave Listing on Page A-12.

3B34SH	SH	1/2 - 1 5/8"	E-1	3.4	3.0	3.75	1 27/32	1 5/16	2 1/32	4.4
3B36SH	SH	1/2 - 1 5/8"	D-1	3.6	3.2	3.95	1 5/32	1 5/16	1 21/32	4.7
3B38SH	SH	1/2 - 1 5/8"	D-1	3.8	3.4	4.15	1 5/32	1 5/16	1 21/32	5.3
3B40SH	SH	1/2 - 1 5/8"	D-1	4.0	3.6	4.35	1 5/32	1 5/16	1 21/32	5.6
3B42SH	SH	1/2 - 1 5/8"	D-1	4.2	3.8	4.55	1 5/32	1 5/16	1 21/32	5.9
3B44SH	SH	1/2 - 1 5/8"	D-1	4.4	4.0	4.75	1 5/32	1 5/16	1 21/32	6.3
3B46SD	SD	1/2 - 2	A-1	4.6	4.2	4.95	1 7/32	1 11/16	9/32	6.7
3B48SD	SD	1/2 - 2	A-1	4.8	4.4	5.15	1 7/32	1 11/16	9/32	7.1
3B50SD	SD	1/2 - 2	A-1	5.0	4.6	5.35	1 7/32	1 11/16	9/32	7.4
3B52SD	SD	1/2 - 2	A-1	5.2	4.8	5.55	1 7/32	1 11/16	9/32	7.8
3B54SD	SD	1/2 - 2	A-1	5.4	5.0	5.75	1 7/32	1 11/16	9/32	8.2
3B56SD	SD	1/2 - 2	A-1	5.6	5.2	5.95	1 7/32	1 11/16	9/32	8.5
3B58SD	SD	1/2 - 2	A-1	5.8	5.4	6.15	1 7/32	1 11/16	9/32	8.8
3B60SD	SD	1/2 - 2	A-1	6.0	5.6	6.35	1 7/32	1 11/16	9/32	9.1
3B62SD	SD	1/2 - 2	A-1	6.2	5.8	6.55	1 7/32	1 11/16	9/32	9.4
3B64SD	SD	1/2 - 2	A-1	6.4	6.0	6.75	1 7/32	1 11/16	9/32	9.7
3B66SD	SD	1/2 - 2	A-1	6.6	6.2	6.95	1 7/32	1 11/16	9/32	10.0
3B68SD	SD	1/2 - 2	B-3	6.8	6.4	7.15	1 7/32	1 11/16	9/32	10.5
3B70SK	SK	1/2 - 2 5/8"	D-1	7.0	6.6	7.35	7/32	1 15/16	2 1/32	11.0
3B74SK	SK	1/2 - 2 5/8"	D-3	7.4	7.0	7.75	7/32	1 15/16	2 1/32	12.0
3B80SK	SK	1/2 - 2 5/8"	D-3	8.0	7.6	8.35	7/32	1 15/16	2 1/32	12.5
3B86SK	SK	1/2 - 2 5/8"	D-3	8.6	8.2	8.95	7/32	1 15/16	2 1/32	13.0
3B94SK	SK	1/2 - 2 5/8"	D-3	9.4	9.0	9.75	7/32	1 15/16	2 1/32	16.0
3B110SK	SK	1/2 - 2 5/8"	D-3	11.0	10.6	11.35	7/32	1 15/16	2 1/32	19.0
3B124SK	SK	1/2 - 2 5/8"	D-3	12.4	12.0	12.75	7/32	1 15/16	2 1/32	24.0
3B136SK	SK	1/2 - 2 5/8"	D-3	13.6	13.2	13.95	7/32	1 15/16	2 1/32	27.0
3B154SK	SK	1/2 - 2 5/8"	D-3	15.4	15.0	15.75	7/32	1 15/16	2 1/32	30.0
3B160SK	SK	1/2 - 2 5/8"	D-3	16.0	15.6	16.35	7/32	1 15/16	2 1/32	33.0
3B184SK	SK	1/2 - 2 5/8"	D-3	18.4	18.0	18.75	7/32	1 15/16	2 1/32	38.0
3B200SF	SF	1/2 - 2 15/16"	D-3	20.0	19.6	20.35	7/32	2 1/16	2 1/32	43.0
3B250SF	SF	1/2 - 2 15/16"	D-3	25.0	24.6	25.35	7/32	2 1/16	2 1/32	54.0
3B300SF	SF	1/2 - 2 15/16"	D-3	30.0	29.6	30.35	7/32	2 1/16	2 1/32	67.0
3B380E	E	7/8 - 3 1/2"	D-3	38.0	37.6	38.35	1 7/32	2 3/4	9/32	90.0

4 GROOVES, F = 3 1/4"

For optimum sheave selection, see B5V Stock Sheave Listing on Page A-13.

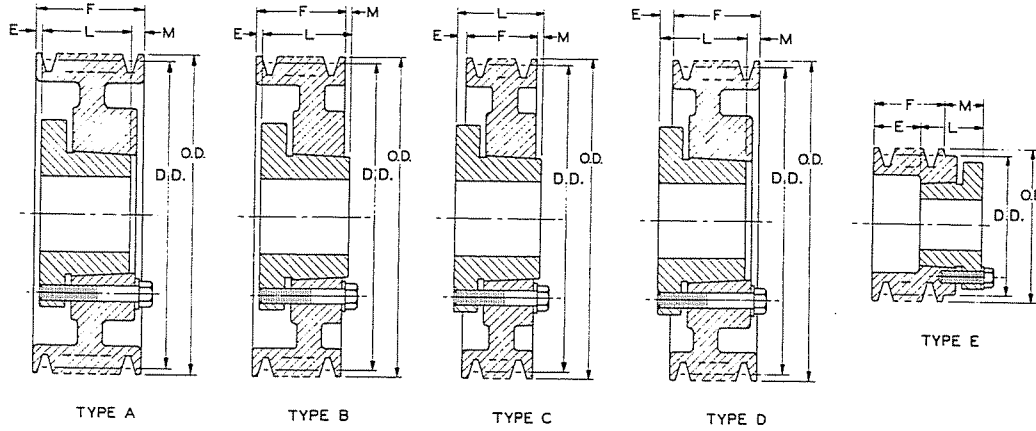
4B34SD	SD	1/2 - 2	E-1	3.4	3.0	3.75	2 15/32	1 13/16	1 1/32	5.5
4B36SD	SD	1/2 - 2	E-1	3.6	3.2	3.95	2 15/32	1 13/16	1 1/32	5.8
4B38SD	SD	1/2 - 2	E-1	3.8	3.4	4.15	2 15/32	1 13/16	1 1/32	6.2
4B40SD	SD	1/2 - 2	E-1	4.0	3.6	4.35	2 3/32	1 13/16	2 1/32	6.6
4B42SD	SD	1/2 - 2	E-1	4.2	3.8	4.55	2 3/32	1 13/16	2 1/32	6.9
4B44SD	SD	1/2 - 2	E-1	4.4	4.0	4.75	2 3/32	1 13/16	2 1/32	7.2
4B46SD	SD	1/2 - 2	A-1	4.6	4.2	4.95	2 1/32	1 13/16	2 5/32	7.6
4B48SD	SD	1/2 - 2	A-1	4.8	4.4	5.15	2 1/32	1 13/16	2 5/32	8.0
4B50SD	SD	1/2 - 2	A-1	5.0	4.6	5.35	2 1/32	1 13/16	2 5/32	8.4
4B52SD	SD	1/2 - 2	A-1	5.2	4.8	5.55	2 1/32	1 13/16	2 5/32	8.8
4B54SD	SD	1/2 - 2	A-1	5.4	5.0	5.75	2 1/32	1 13/16	2 5/32	9.2
4B56SD	SD	1/2 - 2	A-1	5.6	5.2	5.95	2 1/32	1 13/16	2 5/32	9.6
4B58SD	SD	1/2 - 2	A-1	5.8	5.4	6.15	2 1/32	1 13/16	2 5/32	10.0
4B60SD	SD	1/2 - 2	A-1	6.0	5.6	6.35	2 1/32	1 13/16	2 5/32	10.4
4B62SD	SD	1/2 - 2	A-1	6.2	5.8	6.55	2 1/32	1 13/16	2 5/32	10.8
4B64SD	SD	1/2 - 2	A-1	6.4	6.0	6.75	2 1/32	1 13/16	2 5/32	12.0
4B66SD	SD	1/2 - 2	A-1	6.6	6.2	6.95	2 1/32	1 13/16	2 5/32	12.4
4B68SD	SD	1/2 - 2	A-3	6.8	6.4	7.15	2 1/32	1 13/16	2 5/32	13.0
4B70SK	SK	1/2 - 2 5/8"	A-1	7.0	6.6	7.35	7/32	1 15/16	1 3/32	13.5
4B74SK	SK	1/2 - 2 5/8"	A-3	7.4	7.0	7.75	7/32	1 15/16	1 3/32	14.0
4B80SK	SK	1/2 - 2 5/8"	A-3	8.0	7.6	8.35	7/32	1 15/16	1 3/32	15.5
4B86SK	SK	1/2 - 2 5/8"	A-3	8.6	8.2	8.95	7/32	1 15/16	1 3/32	17.0
4B94SK	SK	1/2 - 2 5/8"	A-3	9.4	9.0	9.75	7/32	1 15/16	1 3/32	19.0
4B110SK	SK	1/2 - 2 5/8"	A-3	11.0	10.6	11.35	7/32	1 15/16	1 3/32	22.0
4B124SK	SK	1/2 - 2 5/8"	A-3	12.4	12.0	12.75	7/32	1 15/16	1 3/32	29.0
4B136SK	SK	1/2 - 2 5/8"	A-3	13.6	13.2	13.95	7/32	1 15/16	1 3/32	34.0
4B154SF	SF	1/2 - 2 15/16"	A-3	15.4	15.0	15.75	5/32	2 1/16	1 1/32	39.0
4B160SF	SF	1/2 - 2 15/16"	A-3	16.0	15.6	16.35	5/32	2 1/16	1 1/32	42.0
4B184SF	SF	1/2 - 2 15/16"	A-3	18.4	18.0	18.75	5/32	2 1/16	1 1/32	47.0
4B200SF	SF	1/2 - 2 15/16"	A-3	20.0	19.6	20.35	5/32	2 1/16	1 1/32	51.0
4B250E	E	7/8 - 3 1/2"	D-3	25.0	24.6	25.35	5/32	2 3/4	2 1/32	73.0
4B300E	E	7/8 - 3 1/2"	D-3	30.0	29.6	30.35	5/32	2 3/4	2 1/32	86.0
4B380E	E	7/8 - 3 1/2"	D-3	38.0	37.6	38.35	5/32	2 3/4	2 1/32	109

*Suffix on Type indicates: 1 = Solid Construction, 2 = Web Construction, 3 = Arm Construction.

For optimum sheave selection, see B5V Stock Sheave Listing on Page A-14.

B**Browning**

Q-D® Sheaves for "A" and "B" Belts

**Standard Keyseats****Table No. 1**

Bore Range	Keyseat
1/2" - 9/16"	1/8" x 1/16"
5/8" - 7/8"	3/16" x 3/32"
15/16" - 1 1/4"	1/4" x 1/8"
1 9/16" - 1 3/8"	5/16" x 5/32"
1 7/8" - 1 3/4"	3/8" x 3/16"
1 13/16" - 2 1/4"	1/2" x 1/4"
2 3/16" - 2 3/4"	5/8" x 5/16"
2 13/16" - 3 1/4"	3/4" x 3/8"
3 3/8" - 3 3/4"	7/8" x 7/16"
3 7/8" - 4 1/2"	1" x 1/2"

1 3/8" Bore Bushings also available with 3/8" x 3/16" Keyseat.

Specifications**Table No. 2**

Part No.	Bushing	Bore Range	Type*	D. D.		O. D.	E	L	M	Wt. Less Bushing
				"B" Belts	"A" Belts					
5 GROOVES, F = 4"										
5B34SD	SD	1/2"-2"	E-1	3.4"	3.0"	3.75"	3 7/32"	1 13/16"	1 1/32"	6.1
5B36SD	SD	1/2"-2"	E-1	3.6	3.2	3.95	3 7/32"	1 13/16"	1 1/32"	6.6
5B38SD	SD	1/2"-2"	E-1	3.8	3.4	4.15	3 7/32"	1 13/16"	1 1/32"	7.1
5B40SD	SD	1/2"-2"	E-1	4.0	3.6	4.35	2 27/32"	1 13/16"	2 1/32"	7.4
5B42SD	SD	1/2"-2"	E-1	4.2	3.8	4.55	2 27/32"	1 13/16"	2 1/32"	8.0
5B44SD	SD	1/2"-2"	E-1	4.4	4.0	4.75	2 27/32"	1 13/16"	2 1/32"	8.5
5B46SD	SD	1/2"-2"	A-1	4.6	4.2	4.95	2 1/32"	1 13/16"	1 17/32"	9.0
5B48SD	SD	1/2"-2"	A-1	4.8	4.4	5.15	2 1/32"	1 13/16"	1 17/32"	9.4
5B50SD	SD	1/2"-2"	A-1	5.0	4.6	5.35	2 1/32"	1 13/16"	1 17/32"	10.0
5B52SD	SD	1/2"-2"	A-1	5.2	4.8	5.55	2 1/32"	1 13/16"	1 17/32"	10.4
5B54SK	SK	1/2"-2 5/8"	A-1	5.4	5.0	5.75	1 7/32"	1 15/16"	1 17/32"	10.8
5B56SK	SK	1/2"-2 5/8"	A-1	5.6	5.2	5.95	1 7/32"	1 15/16"	1 17/32"	11.3
5B58SK	SK	1/2"-2 5/8"	A-1	5.8	5.4	6.15	1 7/32"	1 15/16"	1 17/32"	12.0
5B60SK	SK	1/2"-2 5/8"	A-1	6.0	5.6	6.35	1 7/32"	1 15/16"	1 17/32"	14.0
5B62SK	SK	1/2"-2 5/8"	A-1	6.2	5.8	6.55	1 7/32"	1 15/16"	1 17/32"	15.0
5B64SK	SK	1/2"-2 5/8"	A-1	6.4	6.0	6.75	1 7/32"	1 15/16"	1 17/32"	16.0
5B66SK	SK	1/2"-2 5/8"	A-1	6.6	6.2	6.95	1 7/32"	1 15/16"	1 17/32"	17.0
5B68SK	SK	1/2"-2 5/8"	A-1	6.8	6.4	7.15	1 7/32"	1 15/16"	1 17/32"	18.0
5B70SF	SF	1/2"-2 15/16"	A-1	7.0	6.6	7.35	1 5/32"	2 1/16"	1 15/32"	19.0
5B74SF	SF	1/2"-2 15/16"	A-2	7.4	7.0	7.75	1 5/32"	2 1/16"	1 15/32"	20.0
5B80SF	SF	1/2"-2 15/16"	A-2	8.0	7.6	8.35	1 5/32"	2 1/16"	1 15/32"	21.0
5B86SF	SF	1/2"-2 15/16"	A-2	8.6	8.2	8.95	1 5/32"	2 1/16"	1 15/32"	22.0
5B94SF	SF	1/2"-2 15/16"	A-3	9.4	9.0	9.75	1 5/32"	2 1/16"	1 15/32"	24.0
5B110SF	SF	1/2"-2 15/16"	A-3	11.0	10.6	11.35	1 5/32"	2 1/16"	1 15/32"	29.0
5B124SF	SF	1/2"-2 15/16"	A-3	12.4	12.0	12.75	1 5/32"	2 1/16"	1 15/32"	34.0
5B136SF	SF	1/2"-2 15/16"	A-3	13.6	13.2	13.95	1 5/32"	2 1/16"	1 15/32"	38.0
5B154SF	SF	1/2"-2 15/16"	A-3	15.4	15.0	15.75	1 5/32"	2 1/16"	1 15/32"	46.0
5B160SF	SF	1/2"-2 15/16"	A-3	16.0	15.6	16.35	1 5/32"	2 1/16"	1 15/32"	49.0
5B184SF	SF	1/2"-2 15/16"	A-3	18.4	18.0	18.75	1 5/32"	2 1/16"	1 15/32"	55.0
5B200E	E	7/8"-3 1/2"	A-3	20.0	19.6	20.35	3/32"	2 3/4"	1 5/32"	65.0
5B250E	E	7/8"-3 1/2"	A-3	25.0	24.6	25.35	3/32"	2 3/4"	1 5/32"	86.0
5B300E	E	7/8"-3 1/2"	A-3	30.0	29.6	30.35	3/32"	2 3/4"	1 5/32"	102
5B380E	E	7/8"-3 1/2"	A-3	38.0	37.6	38.35	3/32"	2 3/4"	1 5/32"	132

*Suffix on Type indicates: 1 = Solid Construction, 2 = Web Construction, 3 = Arm Construction.

Specifications

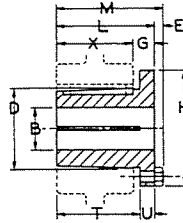
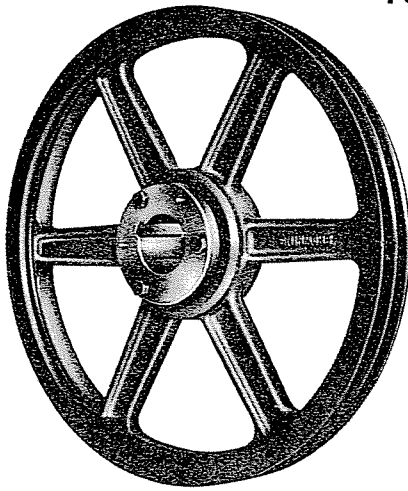
Table No. 1

Part No.	Bushing	Bore Range	Type*	D. D.		O.D.	E	L	M	Wt. Less Bushing
				"B" Belts	"A" Belts					
6 GROOVES, F = 4 3/4"										
6B34SD	SD	1/2"-2"	E-1	3.4"	3.0"	3.75"	3 1/32"	1 13/16"	1 1/32"	6.7
6B36SD	SD	1/2"-2"	E-1	3.6	3.2	3.95	3 3/32"	1 13/16"	1 1/32"	7.4
6B38SD	SD	1/2"-2"	E-1	3.8	3.4	4.15	3 1/2"	1 13/16"	1 1/32"	8.0
6B40SD	SD	1/2"-2"	E-1	4.0	3.6	4.35	3 9/32"	1 3/16"	2 1/32"	8.4
6B42SD	SD	1/2"-2"	E-1	4.2	3.8	4.55	3 1/2"	1 3/16"	2 1/32"	9.0
6B44SD	SD	1/2"-2"	E-1	4.4	4.0	4.75	3 9/32"	1 3/16"	2 1/32"	9.7
6B46SD	SD	1/2"-2"	A-1	4.6	4.2	4.95	2 1/32"	1 13/16"	2 3/32"	10.1
6B48SD	SD	1/2"-2"	A-1	4.8	4.4	5.15	2 1/32"	1 3/16"	2 3/32"	10.6
6B50SD	SD	1/2"-2"	A-1	5.0	4.6	5.35	2 1/32"	1 3/16"	2 3/32"	11.0
6B52SD	SD	1/2"-2"	A-1	5.2	4.8	5.55	2 1/32"	1 3/16"	2 3/32"	12.0
6B54SK	SK	1/2"-2 5/8"	A-1	5.4	5.0	5.75	1 7/32"	1 15/16"	2 3/32"	13.0
6B56SK	SK	1/2"-2 5/8"	A-1	5.6	5.2	5.95	1 1/2"	1 15/16"	2 3/32"	14.0
6B58SK	SK	1/2"-2 5/8"	A-1	5.8	5.4	6.15	1 7/32"	1 15/16"	2 3/32"	14.6
6B60SK	SK	1/2"-2 5/8"	A-1	6.0	5.6	6.35	1 1/2"	1 15/16"	2 3/32"	15.0
6B62SK	SK	1/2"-2 5/8"	A-1	6.2	5.8	6.55	1 1/2"	1 15/16"	2 3/32"	16.0
6B64SK	SK	1/2"-2 5/8"	A-1	6.4	6.0	6.75	1 7/32"	1 15/16"	2 3/32"	17.0
6B66SK	SK	1/2"-2 5/8"	A-1	6.6	6.2	6.95	1 1/2"	1 15/16"	2 3/32"	18.0
6B68SK	SK	1/2"-2 5/8"	A-1	6.8	6.4	7.15	1 7/32"	1 15/16"	2 3/32"	19.0
6B70SF	SF	1/2"-2 15/16"	A-1	7.0	6.6	7.35	2 7/32"	2 1/16"	1 27/32"	20.0
6B74SF	SF	1/2"-2 15/16"	A-1	7.4	7.4	7.75	2 1/32"	2 1/16"	1 27/32"	22.0
6B80SF	SF	1/2"-2 15/16"	A-2	8.0	7.6	8.35	2 7/32"	2 1/16"	1 27/32"	24.0
6B86SF	SF	1/2"-2 15/16"	A-2	8.6	8.2	8.95	2 1/2"	2 1/16"	1 27/32"	26.0
6B94SF	SF	1/2"-2 15/16"	A-3	9.4	9.0	9.75	2 7/32"	2 1/16"	1 27/32"	27.0
6B110SF	SF	1/2"-2 15/16"	A-3	11.0	10.6	11.35	2 1/2"	2 1/16"	1 27/32"	32.0
6B124SF	SF	1/2"-2 15/16"	A-3	12.4	12.0	12.75	2 7/32"	2 1/16"	1 27/32"	39.0
6B136SF	SF	1/2"-2 15/16"	A-3	13.6	13.2	13.95	2 1/2"	2 1/16"	1 27/32"	44.0
6B154SF	SF	1/2"-2 15/16"	A-3	15.4	15.0	15.75	2 7/32"	2 1/16"	1 27/32"	50.0
6B160SF	SF	1/2"-2 15/16"	A-3	16.0	15.6	16.35	2 1/2"	2 1/16"	1 27/32"	54.0
6B184SF	SF	1/2"-2 15/16"	A-3	18.4	18.0	18.75	2 7/32"	2 1/16"	1 27/32"	62.0
6B200E	E	7/8"-3 1/2"	A-3	20.0	19.6	20.35	1 3/32"	2 3/4"	1 25/32"	74.0
6B250E	E	7/8"-3 1/2"	A-3	25.0	24.6	25.35	1 3/32"	2 3/4"	1 25/32"	96.0
6B300E	E	7/8"-3 1/2"	A-3	30.0	29.6	30.35	1 3/32"	2 3/4"	1 25/32"	119
6B380E	E	7/8"-3 1/2"	A-3	38.0	37.6	38.35	1 3/32"	2 3/4"	1 25/32"	134
8 GROOVES, F = 6 1/4"										
8B54SK	SK	1/2"-2 5/8"	A-1	5.4	5.0	5.75	1 1/32"	1 15/16"	3 3/32"	15
8B56SK	SK	1/2"-2 5/8"	A-1	5.6	5.2	5.95	1 1/32"	1 15/16"	3 3/32"	16
8B60SF	SF	1/2"-2 15/16"	A-1	6.0	5.6	6.35	3 1/32"	2 1/16"	3 1/32"	20
8B64SF	SF	1/2"-2 15/16"	A-1	6.4	6.0	6.75	3 1/32"	2 1/16"	3 1/32"	23
8B68SF	SF	1/2"-2 15/16"	A-1	6.8	6.4	7.15	3 1/32"	2 1/16"	3 1/32"	25
8B74SF	SF	1/2"-2 15/16"	A-1	7.4	7.0	7.75	3 1/32"	2 1/16"	3 1/32"	28
8B86E	E	7/8"-3 1/2"	A-1	8.6	8.2	8.95	1 7/32"	2 3/4"	2 3/32"	40
8B94E	E	7/8"-3 1/2"	A-2	9.4	9.0	9.75	1 7/32"	2 3/4"	2 3/32"	43
8B110E	E	7/8"-3 1/2"	A-3	11.0	10.6	11.35	1 7/32"	2 3/4"	2 3/32"	49
8B124E	E	7/8"-3 1/2"	A-3	12.4	12.0	12.75	1 7/32"	2 3/4"	2 3/32"	56
8B154E	E	7/8"-3 1/2"	A-3	15.4	15.0	15.75	1 7/32"	2 3/4"	2 3/32"	69
8B184F	F	1"-4"	D-3	18.4	18.0	18.75	1 1/32"	3 3/4"	2 17/32"	91
8B200F	F	1"-4"	D-3	20.0	19.6	20.35	1 1/32"	3 3/4"	2 17/32"	98
8B250F	F	1"-4"	D-3	25.0	24.6	25.35	1 1/32"	3 3/4"	2 17/32"	121
8B300F	F	1"-4"	D-3	30.0	29.6	30.35	1 1/32"	3 3/4"	2 17/32"	148
8B380F	F	1"-4"	D-3	38.0	37.6	38.35	1 1/32"	3 3/4"	2 17/32"	194
10 GROOVES, F = 7 3/4"										
10B54SK	SK	1/2"-2 5/8"	A-1	5.4	5.0	5.75	1 25/32"	1 15/16"	4 1/32"	18
10B56SK	SK	1/2"-2 5/8"	A-1	5.6	5.2	5.95	1 25/32"	1 15/16"	4 1/32"	20
10B60SF	SF	1/2"-2 15/16"	A-1	6.0	5.6	6.35	1 23/32"	2 1/16"	3 31/32"	24
10B64SF	SF	1/2"-2 15/16"	A-1	6.4	6.0	6.75	1 23/32"	2 1/16"	3 31/32"	26
10B68SF	SF	1/2"-2 15/16"	A-1	6.8	6.4	7.15	1 23/32"	2 1/16"	3 31/32"	28
10B74SF	SF	1/2"-2 15/16"	A-1	7.4	7.0	7.75	1 23/32"	2 1/16"	3 31/32"	32
10B86E	E	7/8"-3 1/2"	A-1	8.6	8.2	8.95	1 31/32"	2 3/4"	3 1/32"	42
10B94E	E	7/8"-3 1/2"	A-2	9.4	9.0	9.75	1 31/32"	2 3/4"	3 1/32"	48
10B110E	E	7/8"-3 1/2"	A-3	11.0	10.6	11.35	1 31/32"	2 3/4"	3 1/32"	56
10B124E	E	7/8"-3 1/2"	A-3	12.4	12.0	12.75	1 31/32"	2 3/4"	3 1/32"	64
10B154F	F	1"-4"	A-3	15.4	15.0	15.75	1 3/8"	3 3/4"	3 3/32"	88
10B184F	F	1"-4"	A-3	18.4	18.0	18.75	1 3/8"	3 3/4"	3 3/32"	103
10B200F	F	1"-4"	A-3	20.0	19.6	20.35	5/8"	3 3/4"	3 3/32"	112
10B250F	F	1"-4"	A-3	25.0	24.6	25.35	5/8"	3 3/4"	3 3/32"	142
10B300F	F	1"-4"	A-3	30.0	29.6	30.35	5/8"	3 3/4"	3 3/32"	174
10B380J	J	1 1/2"-4 1/2"	A-3	38.0	37.6	38.35	1 1/8"	4 5/8"	3	230

*Suffix on Type indicates: 1 = Solid Construction, 2 = Web Construction, 3 = Arm Construction.

TC *Browning* Gripbelt Sheaves with Split Taper Bushings

For Use with All "C" Section Belts



Standard Keyseats

Table No. 1

Bore Range	Keyseat
3/4" — 7/8"	3/16" x 3/32"
15/16" — 1 1/4"	1/4" x 1/8"
1 5/16" — 1 3/8"	5/16" x 5/32"
1 7/16" — 1 3/4"	3/8" x 3/16"
1 13/16" — 2 1/4"	1/2" x 1/4"
2 5/16" — 2 11/16"	5/8" x 5/16"

1 3/8" Bore Bushings also available with 3/8" x 3/16" Keyseat.

Table No. 2 Bushing Dimensions

Part No.	Dimensions								Bore Range	Wt. Lbs.	
	M	L	G	X	E	T	U	D			H
Q1	2 ²⁵ / ₃₂ "	2 1/2"	3/4"	1 3/4"	9/32"	1 31/32"	17/32"	2 7/8"	4 1/8"	3/4" — 2 11/16"	3/2

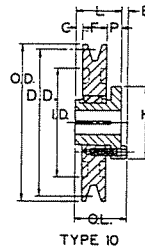
Close Grain
Cast Iron



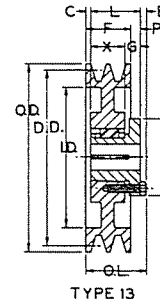
Accurately
Machined



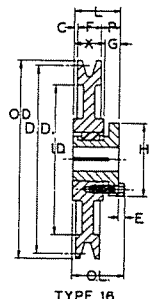
Statically
Balanced



TYPE 10



TYPE 13



TYPE 16

Table No. 3 Specifications—Stock "TC" Sheaves

DIAMETERS			1 GROOVE, F=1/4"											
Datum °C	Out-side	In-side	Part Number		Type	Dimensions								Wt. Less Bush.
			Sheave	Bush-ing		O. L.	L	P	C	H	G	X	E	
7.0"	7.40"	—	1TC70	Q1	10-Sol.	2 ²⁵ / ₃₂ "	2 1/2"	3/4"	1/2"	4 1/8"	—	—	9/32"	9.3
7.2	7.60	—	1TC72	Q1	10-Web	2 ²⁵ / ₃₂ "	2 1/2"	3/4"	1/2"	4 1/8"	—	—	9/32"	10.1
7.4	7.80	—	1TC74	Q1	10-Web	2 ²⁵ / ₃₂ "	2 1/2"	3/4"	1/2"	4 1/8"	—	—	9/32"	10.8
7.6	8.00	—	1TC76	Q1	10-Web	2 ²⁵ / ₃₂ "	2 1/2"	3/4"	1/2"	4 1/8"	—	—	9/32"	11.4
7.8	8.20	6"	1TC78	Q1	10-Web	2 ²⁵ / ₃₂ "	2 1/2"	3/4"	1/2"	4 1/8"	—	—	9/32"	9.8
8.0	8.40	6 1/4"	1TC80	Q1	10-Web	2 ²⁵ / ₃₂ "	2 1/2"	3/4"	1/2"	4 1/8"	—	—	9/32"	9.9
8.2	8.60	6 7/16"	1TC82	Q1	10-Web	2 ²⁵ / ₃₂ "	2 1/2"	3/4"	1/2"	4 1/8"	—	—	9/32"	10.1
8.4	8.80	6 9/16"	1TC84	Q1	10-Web	2 ²⁵ / ₃₂ "	2 1/2"	3/4"	1/2"	4 1/8"	—	—	9/32"	11.0
8.6	9.00	6 13/16"	1TC86	Q1	10-Web	2 ²⁵ / ₃₂ "	2 1/2"	3/4"	1/2"	4 1/8"	—	—	9/32"	10.6
8.8	9.20	7"	1TC88	Q1	10-Web	2 ²⁵ / ₃₂ "	2 1/2"	3/4"	1/2"	4 1/8"	—	—	9/32"	11.6
9.0	9.40	7 1/4"	1TC90	Q1	10-Web	2 ²⁵ / ₃₂ "	2 1/2"	3/4"	1/2"	4 1/8"	—	—	9/32"	11.4
9.2	9.60	7 7/16"	1TC92	Q1	10-Web	2 ²⁵ / ₃₂ "	2 1/2"	3/4"	1/2"	4 1/8"	—	—	9/32"	12.6
9.4	9.80	7 9/16"	1TC94	Q1	16-Arm	2 ²⁵ / ₃₂ "	2 1/2"	1	1/4"	4 1/8"	3/4"	1 3/4"	9/32"	14.8
9.6	10.00	7 13/16"	1TC96	Q1	16-Arm	2 ²⁵ / ₃₂ "	2 1/2"	1	1/4"	4 1/8"	3/4"	1 3/4"	9/32"	15.8
9.8	10.20	8"	1TC98	Q1	16-Arm	2 ²⁵ / ₃₂ "	2 1/2"	1	1/4"	4 1/8"	3/4"	1 3/4"	9/32"	15.9
10.0	10.40	8 1/4"	1TC100	Q1	16-Arm	2 ²⁵ / ₃₂ "	2 1/2"	1	1/4"	4 1/8"	3/4"	1 3/4"	9/32"	16.8
10.2	10.60	8 7/16"	1TC102	Q1	16-Arm	2 ²⁵ / ₃₂ "	2 1/2"	1	1/4"	4 1/8"	3/4"	1 3/4"	9/32"	16.1
10.6	11.00	8 13/16"	1TC106	Q1	16-Arm	2 ²⁵ / ₃₂ "	2 1/2"	1	1/4"	4 1/8"	3/4"	1 3/4"	9/32"	17.3
11.0	11.40	9 1/4"	1TC110	Q1	16-Arm	2 ²⁵ / ₃₂ "	2 1/2"	1	1/4"	4 1/8"	3/4"	1 3/4"	9/32"	17.5
11.4	11.80	9 9/16"	1TC114	Q1	16-Arm	2 ²⁵ / ₃₂ "	2 1/2"	1	1/4"	4 1/8"	3/4"	1 3/4"	9/32"	18.6
12.0	12.40	10 1/4"	1TC120	Q1	16-Arm	2 ²⁵ / ₃₂ "	2 1/2"	1	1/4"	4 1/8"	3/4"	1 3/4"	9/32"	19.5
13.0	13.40	11 1/4"	1TC130	Q1	16-Arm	2 ²⁵ / ₃₂ "	2 1/2"	1	1/4"	4 1/8"	3/4"	1 3/4"	9/32"	22.8
16.0	16.40	14 1/4"	1TC160	Q1	16-Arm	2 ²⁵ / ₃₂ "	2 1/2"	1	1/4"	4 1/8"	3/4"	1 3/4"	9/32"	28.5
20.0	20.40	18 1/4"	1TC200	Q1	16-Arm	2 ²⁵ / ₃₂ "	2 1/2"	1	1/4"	4 1/8"	3/4"	1 3/4"	9/32"	37.8
24.0	24.40	22 1/4"	1TC240	Q1	16-Arm	2 ²⁵ / ₃₂ "	2 1/2"	1	1/4"	4 1/8"	3/4"	1 3/4"	9/32"	49.5

For Use with All "C" Section Belts Specifications—Stock "TC" Sheaves

Table No. 1

DIAMETERS			2 GROOVES, F = 2 1/4"											Wt. Less Bush.
Datum °C	Out-side	In-side	Part Number		Type	Dimensions								
			Sheave	Bush-ing		OL	L	P	C	H	G	X	E	
7.0"	7.40"	5 1/4"	2TC70	Q1	13-Web	3 1/32"	2 1/2"	1/2"	1/4"	4 1/8"	3/4"	1 3/4"	9/32"	14.0
7.2	7.60	5 7/16	2TC72	Q1	13-Web	3 1/32	2 1/2	1/2	1/4	4 1/8	3/4	1 3/4	9/32	15.4
7.4	7.80	5 9/8	2TC74	Q1	13-Web	3 1/32	2 1/2	1/2	1/4	4 1/8	3/4	1 3/4	9/32	16.6
7.6	8.00	5 13/16	2TC76	Q1	13-Web	3 1/32	2 1/2	1/2	1/4	4 1/8	3/4	1 3/4	9/32	17.6
7.8	8.20	6	2TC78	Q1	13-Web	3 1/32	2 1/2	1/2	1/4	4 1/8	3/4	1 3/4	9/32	14.1
8.0	8.40	6 1/4	2TC80	Q1	13-Web	3 1/32	2 1/2	1/2	1/4	4 1/8	3/4	1 3/4	9/32	14.3
8.2	8.60	6 7/16	2TC82	Q1	13-Web	3 1/32	2 1/2	1/2	1/4	4 1/8	3/4	1 3/4	9/32	14.8
8.4	8.80	6 9/8	2TC84	Q1	13-Web	3 1/32	2 1/2	1/2	1/4	4 1/8	3/4	1 3/4	9/32	16.4
8.6	9.00	6 13/16	2TC86	Q1	13-Web	3 1/32	2 1/2	1/2	1/4	4 1/8	3/4	1 3/4	9/32	16.1
8.8	9.20	7	2TC88	Q1	13-Web	3 1/32	2 1/2	1/2	1/4	4 1/8	3/4	1 3/4	9/32	17.1
9.0	9.40	7 1/4	2TC90	Q1	13-Web	3 1/32	2 1/2	1/2	1/4	4 1/8	3/4	1 3/4	9/32	16.8
9.2	9.60	7 7/16	2TC92	Q1	13-Web	3 1/32	2 1/2	1/2	1/4	4 1/8	3/4	1 3/4	9/32	18.4
9.4	9.80	7 9/8	2TC94	Q1	13-Arm	3 1/32	2 1/2	1/2	1/4	4 1/8	3/4	1 3/4	9/32	19.1
9.6	10.00	7 13/16	2TC96	Q1	13-Arm	3 1/32	2 1/2	1/2	1/4	4 1/8	3/4	1 3/4	9/32	20.6
9.8	10.20	8	2TC98	Q1	13-Arm	3 1/32	2 1/2	1/2	1/4	4 1/8	3/4	1 3/4	9/32	19.5
10.0	10.40	8 1/4	2TC100	Q1	13-Arm	3 1/32	2 1/2	1/2	1/4	4 1/8	3/4	1 3/4	9/32	22.0
10.2	10.60	8 7/16	2TC102	Q1	13-Arm	3 1/32	2 1/2	1/2	1/4	4 1/8	3/4	1 3/4	9/32	21.3
10.6	11.00	8 13/16	2TC106	Q1	13-Arm	3 1/32	2 1/2	1/2	1/4	4 1/8	3/4	1 3/4	9/32	22.4
11.0	11.40	9 1/4	2TC110	Q1	13-Arm	3 1/32	2 1/2	1/2	1/4	4 1/8	3/4	1 3/4	9/32	22.4
11.4	11.80	9 9/8	2TC114	Q1	13-Arm	3 1/32	2 1/2	1/2	1/4	4 1/8	3/4	1 3/4	9/32	23.5
12.0	12.40	10 1/4	2TC120	Q1	13-Arm	3 1/32	2 1/2	1/2	1/4	4 1/8	3/4	1 3/4	9/32	24.9
13.0	13.40	11 1/4	2TC130	Q1	13-Arm	3 1/32	2 1/2	1/2	1/4	4 1/8	3/4	1 3/4	9/32	28.6
16.0	16.40	14 1/4	2TC160	Q1	13-Arm	3 1/32	2 1/2	1/2	1/4	4 1/8	3/4	1 3/4	9/32	36.0
20.0	20.40	18 1/4	2TC200	Q1	13-Arm	3 1/32	2 1/2	1/2	1/4	4 1/8	3/4	1 3/4	9/32	46.0
24.0	24.40	22 1/4	2TC240	Q1	13-Arm	3 1/32	2 1/2	1/2	1/4	4 1/8	3/4	1 3/4	9/32	59.5

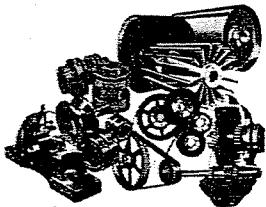
For sheaves with larger bores, see Page A-57.

Table No. 2

DIAMETERS			3 GROOVES, F = 3 1/4"											Wt. Less Bush.
Datum °C	Out-side	In-side	Part Number		Type	Dimensions								
			Sheave	Bush-ing		OL	L	P	C	H	G	X	E	
7.0"	7.40"	5 1/4"	3TC70	Q1	13-Web	3 17/32"	2 1/2"	0	3/4"	4 1/8"	3/4"	1 3/4"	9/32"	16.8
7.2	7.60	5 7/16	3TC72	Q1	13-Web	3 17/32	2 1/2	0	3/4	4 1/8	3/4	1 3/4	9/32	18.0
7.4	7.80	5 9/8	3TC74	Q1	13-Web	3 17/32	2 1/2	0	3/4	4 1/8	3/4	1 3/4	9/32	19.1
7.6	8.00	5 13/16	3TC76	Q1	13-Web	3 17/32	2 1/2	0	3/4	4 1/8	3/4	1 3/4	9/32	21.3
7.8	8.20	6	3TC78	Q1	13-Web	3 17/32	2 1/2	0	3/4	4 1/8	3/4	1 3/4	9/32	17.4
8.0	8.40	6 1/4	3TC80	Q1	13-Web	3 17/32	2 1/2	0	3/4	4 1/8	3/4	1 3/4	9/32	17.8
8.2	8.60	6 7/16	3TC82	Q1	13-Web	3 17/32	2 1/2	0	3/4	4 1/8	3/4	1 3/4	9/32	17.9
8.4	8.80	6 9/8	3TC84	Q1	13-Web	3 17/32	2 1/2	0	3/4	4 1/8	3/4	1 3/4	9/32	20.4
8.6	9.00	6 13/16	3TC86	Q1	13-Web	3 17/32	2 1/2	0	3/4	4 1/8	3/4	1 3/4	9/32	19.5
8.8	9.20	7	3TC88	Q1	13-Web	3 17/32	2 1/2	0	3/4	4 1/8	3/4	1 3/4	9/32	22.5
9.0	9.40	7 1/4	3TC90	Q1	13-Web	3 17/32	2 1/2	0	3/4	4 1/8	3/4	1 3/4	9/32	20.4
9.2	9.60	7 7/16	3TC92	Q1	13-Web	3 17/32	2 1/2	0	3/4	4 1/8	3/4	1 3/4	9/32	22.8
9.4	9.80	7 9/8	3TC94	Q1	13-Arm	3 17/32	2 1/2	0	3/4	4 1/8	3/4	1 3/4	9/32	23.0
9.6	10.00	7 13/16	3TC96	Q1	13-Arm	3 17/32	2 1/2	0	3/4	4 1/8	3/4	1 3/4	9/32	25.3
9.8	10.20	8	3TC98	Q1	13-Arm	3 17/32	2 1/2	0	3/4	4 1/8	3/4	1 3/4	9/32	24.4
10.0	10.40	8 1/4	3TC100	Q1	13-Arm	3 17/32	2 1/2	0	3/4	4 1/8	3/4	1 3/4	9/32	27.6
10.2	10.60	8 7/16	3TC102	Q1	13-Arm	3 17/32	2 1/2	0	3/4	4 1/8	3/4	1 3/4	9/32	24.9
10.6	11.00	8 13/16	3TC106	Q1	13-Arm	3 17/32	2 1/2	0	3/4	4 1/8	3/4	1 3/4	9/32	26.9
11.0	11.40	9 1/4	3TC110	Q1	13-Arm	3 17/32	2 1/2	0	3/4	4 1/8	3/4	1 3/4	9/32	27.4
11.4	11.80	9 9/8	3TC114	Q1	13-Arm	3 17/32	2 1/2	0	3/4	4 1/8	3/4	1 3/4	9/32	28.3
12.0	12.40	10 1/4	3TC120	Q1	13-Arm	3 17/32	2 1/2	0	3/4	4 1/8	3/4	1 3/4	9/32	30.3
13.0	13.40	11 1/4	3TC130	Q1	13-Arm	3 17/32	2 1/2	0	3/4	4 1/8	3/4	1 3/4	9/32	34.9
16.0	16.40	14 1/4	3TC160	Q1	13-Arm	3 17/32	2 1/2	0	3/4	4 1/8	3/4	1 3/4	9/32	46.0
20.0	20.40	18 1/4	3TC200	Q1	13-Arm	3 17/32	2 1/2	0	3/4	4 1/8	3/4	1 3/4	9/32	54.5
24.0	24.40	22 1/4	3TC240	Q1	13-Arm	3 17/32	2 1/2	0	3/4	4 1/8	3/4	1 3/4	9/32	71.0

For sheaves with larger bores, see Page A-57.

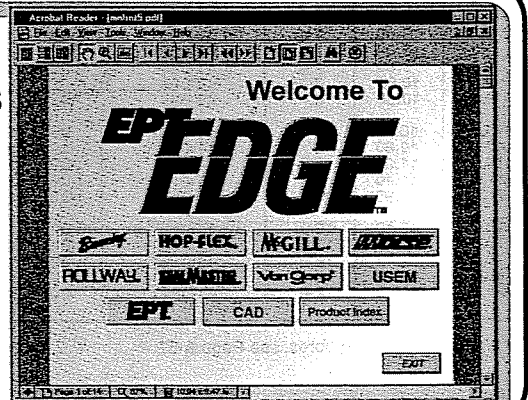
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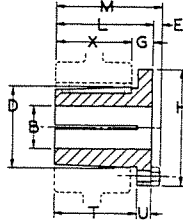
Gripbelt Sheaves with Split Taper Bushings

For Use with All "C" Section Belts

Close Grain
Cast Iron

Statically
Balanced

Accurately
Machined



Standard Keyseats

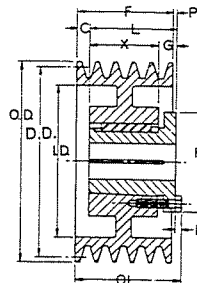
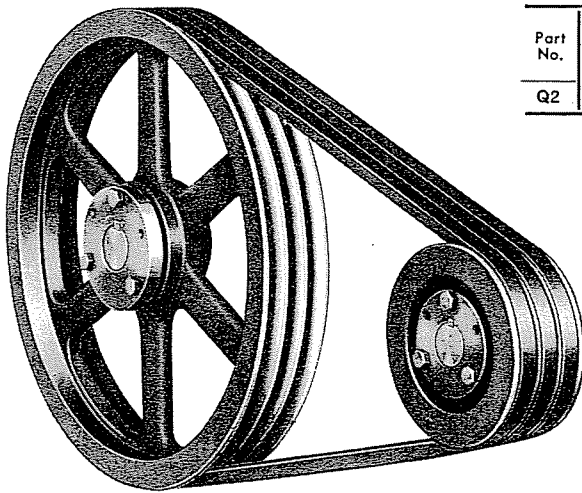
Table No. 1

Bore Range	Keyseat
1" — 1 1/4"	1/4" x 1/8"
1 5/16 — 1 3/8	5/16 x 3/32
1 7/16 — 1 1/2	3/8 x 3/16
1 9/16 — 1 5/8	1/2 x 1/4
1 11/16 — 2 1/8	5/8 x 3/16

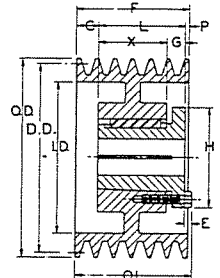
1 3/8" Bore Bushings also available with 3/8" x 3/16" Keyseat.

Table No. 2 Bushing Dimensions

Part No.	Dimensions									Bore Range	Wt. Lbs.
	M	L	G	X	E	T	U	D	H		
Q2	3 25/32"	3 1/2"	3/4"	2 3/4"	9/32"	2 31/32"	1 7/32"	2 7/8"	4 1/8"	1" — 2 5/8"	4 1/2



TYPE 13



TYPE 15

Table No. 3 Specifications—Stock "TC" Sheaves

DIAMETERS			4 GROOVES, F=4 1/4"											
Datum "C"	Out-side	In-side	Part Number		Type	Dimensions								Wt. Less Bush.
			Sheave	Bush-ing		O. L.	L	P	C	H	G	X	E	
7.0"	7.40"	5 1/4"	4TC70	Q2	13-Web	4 17/32"	3 1/2"	0	3/4"	4 1/8"	3/4"	2 3/4"	9/32"	23.8
7.2	7.60	5 7/16	4TC72	Q2	13-Web	4 17/32"	3 1/2"	0	3/4"	4 1/8"	3/4"	2 3/4"	9/32"	28.8
7.4	7.80	5 9/8	4TC74	Q2	13-Web	4 17/32"	3 1/2"	0	3/4"	4 1/8"	3/4"	2 3/4"	9/32"	27.5
7.6	8.00	5 13/16	4TC76	Q2	13-Web	4 17/32"	3 1/2"	0	3/4"	4 1/8"	3/4"	2 3/4"	9/32"	30.3
7.8	8.20	6	4TC78	Q2	13-Web	4 17/32"	3 1/2"	0	3/4"	4 1/8"	3/4"	2 3/4"	9/32"	26.4
8.0	8.40	6 1/4"	4TC80	Q2	13-Web	4 17/32"	3 1/2"	0	3/4"	4 1/8"	3/4"	2 3/4"	9/32"	29.0
8.2	8.60	6 7/16	4TC82	Q2	13-Web	4 17/32"	3 1/2"	0	3/4"	4 1/8"	3/4"	2 3/4"	9/32"	26.8
8.4	8.80	6 5/8	4TC84	Q2	13-Web	4 17/32"	3 1/2"	0	3/4"	4 1/8"	3/4"	2 3/4"	9/32"	28.8
8.6	9.00	6 13/16	4TC86	Q2	13-Web	4 17/32"	3 1/2"	0	3/4"	4 1/8"	3/4"	2 3/4"	9/32"	27.9
8.8	9.20	7	4TC88	Q2	13-Web	4 17/32"	3 1/2"	0	3/4"	4 1/8"	3/4"	2 3/4"	9/32"	31.6
9.0	9.40	7 1/4"	4TC90	Q2	13-Web	4 17/32"	3 1/2"	0	3/4"	4 1/8"	3/4"	2 3/4"	9/32"	28.4
9.2	9.60	7 7/16	4TC92	Q2	13-Web	4 17/32"	3 1/2"	0	3/4"	4 1/8"	3/4"	2 3/4"	9/32"	32.3
9.4	9.80	7 5/8	4TC94	Q2	13-Arm	4 17/32"	3 1/2"	0	3/4"	4 1/8"	3/4"	2 3/4"	9/32"	31.8
9.6	10.00	7 13/16	4TC96	Q2	13-Arm	4 17/32"	3 1/2"	0	3/4"	4 1/8"	3/4"	2 3/4"	9/32"	35.2
9.8	10.20	8	4TC98	Q2	13-Arm	4 17/32"	3 1/2"	0	3/4"	4 1/8"	3/4"	2 3/4"	9/32"	33.0
10.0	10.40	8 1/4"	4TC100	Q2	13-Arm	4 17/32"	3 1/2"	0	3/4"	4 1/8"	3/4"	2 3/4"	9/32"	37.0
10.2	10.60	8 7/16	4TC102	Q2	13-Arm	4 17/32"	3 1/2"	0	3/4"	4 1/8"	3/4"	2 3/4"	9/32"	33.5
10.6	11.00	8 13/16	4TC106	Q2	13-Arm	4 17/32"	3 1/2"	0	3/4"	4 1/8"	3/4"	2 3/4"	9/32"	36.3
11.0	11.40	9 1/4"	4TC110	Q2	13-Arm	4 17/32"	3 1/2"	0	3/4"	4 1/8"	3/4"	2 3/4"	9/32"	36.3
11.4	11.80	9 5/8	4TC114	Q2	13-Arm	4 17/32"	3 1/2"	0	3/4"	4 1/8"	3/4"	2 3/4"	9/32"	38.4
12.0	12.40	10 1/4"	4TC120	Q2	13-Arm	4 17/32"	3 1/2"	0	3/4"	4 1/8"	3/4"	2 3/4"	9/32"	40.5
13.0	13.40	11 1/4"	4TC130	Q2	13-Arm	4 17/32"	3 1/2"	0	3/4"	4 1/8"	3/4"	2 3/4"	9/32"	43.6
16.0	16.40	14 1/4"	4TC160	Q2	13-Arm	4 17/32"	3 1/2"	0	3/4"	4 1/8"	3/4"	2 3/4"	9/32"	56.0
20.0	20.40	18 1/4"	4TC200	Q2	13-Arm	4 17/32"	3 1/2"	0	3/4"	4 1/8"	3/4"	2 3/4"	9/32"	72.0
24.0	24.40	22 1/4"	4TC240	Q2	13-Arm	4 17/32"	3 1/2"	0	3/4"	4 1/8"	3/4"	2 3/4"	9/32"	85.3

For sheaves with larger bores, see Page A-57.

For Use with All "C" Section Belts

Specifications—Stock "TC" Sheaves

Table No. 1

DIAMETERS			5 GROOVES, F=5/4"											Wt. Less Bush.
Datum "C"	Out-side	In-side	Part Number		Type	Dimensions								
			Sheave	Bush-ing		OL	L	P	C	H	G	X	E	
7.0"	7.40"	5 1/2"	5TC70	Q2	15-Web	5 1/4"	3 1/2"	1/2"	1 1/4"	4 1/8"	3/4"	2 3/4"	9/32"	27.5
7.2	7.60	5 7/16	5TC72	Q2	15-Web	5 1/4"	3 1/2"	1/2"	1 1/4"	4 1/8"	3/4"	2 3/4"	9/32"	29.8
7.4	7.80	5 5/8	5TC74	Q2	15-Web	5 1/4"	3 1/2"	1/2"	1 1/4"	4 1/8"	3/4"	2 3/4"	9/32"	31.0
7.6	8.00	5 13/16	5TC76	Q2	15-Web	5 1/4"	3 1/2"	1/2"	1 1/4"	4 1/8"	3/4"	2 3/4"	9/32"	34.3
7.8	8.20	6	5TC78	Q2	15-Web	5 1/4"	3 1/2"	1/2"	1 1/4"	4 1/8"	3/4"	2 3/4"	9/32"	30.0
8.0	8.40	6 1/4	5TC80	Q2	15-Web	5 1/4"	3 1/2"	1/2"	1 1/4"	4 1/8"	3/4"	2 3/4"	9/32"	33.4
8.2	8.60	6 7/16	5TC82	Q2	15-Web	5 1/4"	3 1/2"	1/2"	1 1/4"	4 1/8"	3/4"	2 3/4"	9/32"	30.3
8.4	8.80	6 5/8	5TC84	Q2	15-Web	5 1/4"	3 1/2"	1/2"	1 1/4"	4 1/8"	3/4"	2 3/4"	9/32"	32.8
8.6	9.00	6 13/16	5TC86	Q2	15-Web	5 1/4"	3 1/2"	1/2"	1 1/4"	4 1/8"	3/4"	2 3/4"	9/32"	31.0
8.8	9.20	7	5TC88	Q2	15-Web	5 1/4"	3 1/2"	1/2"	1 1/4"	4 1/8"	3/4"	2 3/4"	9/32"	34.9
9.0	9.40	7 1/4	5TC90	Q2	15-Web	5 1/4"	3 1/2"	1/2"	1 1/4"	4 1/8"	3/4"	2 3/4"	9/32"	32.6
9.2	9.60	7 7/16	5TC92	Q2	15-Web	5 1/4"	3 1/2"	1/2"	1 1/4"	4 1/8"	3/4"	2 3/4"	9/32"	36.4
9.4	9.80	7 5/8	5TC94	Q2	15-Arm	5 1/4"	3 1/2"	1/2"	1 1/4"	4 1/8"	3/4"	2 3/4"	9/32"	35.6
9.6	10.00	7 13/16	5TC96	Q2	15-Arm	5 1/4"	3 1/2"	1/2"	1 1/4"	4 1/8"	3/4"	2 3/4"	9/32"	39.1
9.8	10.20	8	5TC98	Q2	15-Arm	5 1/4"	3 1/2"	1/2"	1 1/4"	4 1/8"	3/4"	2 3/4"	9/32"	37.3
10.0	10.40	8 1/4	5TC100	Q2	15-Arm	5 1/4"	3 1/2"	1/2"	1 1/4"	4 1/8"	3/4"	2 3/4"	9/32"	42.3
10.2	10.60	8 7/16	5TC102	Q2	15-Arm	5 1/4"	3 1/2"	1/2"	1 1/4"	4 1/8"	3/4"	2 3/4"	9/32"	39.4
10.6	11.00	8 13/16	5TC106	Q2	15-Arm	5 1/4"	3 1/2"	1/2"	1 1/4"	4 1/8"	3/4"	2 3/4"	9/32"	41.0
11.0	11.40	9 1/4	5TC110	Q2	15-Arm	5 1/4"	3 1/2"	1/2"	1 1/4"	4 1/8"	3/4"	2 3/4"	9/32"	42.4
11.4	11.80	9 5/8	5TC114	Q2	15-Arm	5 1/4"	3 1/2"	1/2"	1 1/4"	4 1/8"	3/4"	2 3/4"	9/32"	42.8
12.0	12.40	10 1/4	5TC120	Q2	15-Arm	5 1/4"	3 1/2"	1/2"	1 1/4"	4 1/8"	3/4"	2 3/4"	9/32"	46.3
13.0	13.40	11 1/4	5TC130	Q2	15-Arm	5 1/4"	3 1/2"	1/2"	1 1/4"	4 1/8"	3/4"	2 3/4"	9/32"	49.5
16.0	16.40	14 1/4	5TC160	Q2	15-Arm	5 1/4"	3 1/2"	1/2"	1 1/4"	4 1/8"	3/4"	2 3/4"	9/32"	64.5
20.0	20.40	18 1/4	5TC200	Q2	15-Arm	5 1/4"	3 1/2"	1/2"	1 1/4"	4 1/8"	3/4"	2 3/4"	9/32"	78.0
24.0	24.40	22 1/4	5TC240	Q2	15-Arm	5 1/4"	3 1/2"	1/2"	1 1/4"	4 1/8"	3/4"	2 3/4"	9/32"	96.0

For sheaves with larger bores, see Page A-58.

Table No. 2

DIAMETERS			6 GROOVES, F=6 1/4"											Wt. Less Bush.
Datum "C"	Out-side	In-side	Part Number		Type	Dimensions								
			Sheave	Bush-ing		OL	L	P	C	H	G	X	E	
7.0"	7.40"	5 1/2"	6TC70	Q2	15-Web	6 1/4"	3 1/2"	1"	1 3/4"	4 1/8"	3/4"	2 3/4"	9/32"	29.9
7.2	7.60	5 7/16	6TC72	Q2	15-Web	6 1/4"	3 1/2"	1"	1 3/4"	4 1/8"	3/4"	2 3/4"	9/32"	33.6
7.4	7.80	5 5/8	6TC74	Q2	15-Web	6 1/4"	3 1/2"	1"	1 3/4"	4 1/8"	3/4"	2 3/4"	9/32"	33.3
7.6	8.00	5 13/16	6TC76	Q2	15-Web	6 1/4"	3 1/2"	1"	1 3/4"	4 1/8"	3/4"	2 3/4"	9/32"	37.9
7.8	8.20	6	6TC78	Q2	15-Web	6 1/4"	3 1/2"	1"	1 3/4"	4 1/8"	3/4"	2 3/4"	9/32"	33.5
8.0	8.40	6 1/4	6TC80	Q2	15-Web	6 1/4"	3 1/2"	1"	1 3/4"	4 1/8"	3/4"	2 3/4"	9/32"	37.6
8.2	8.60	6 7/16	6TC82	Q2	15-Web	6 1/4"	3 1/2"	1"	1 3/4"	4 1/8"	3/4"	2 3/4"	9/32"	34.0
8.4	8.80	6 5/8	6TC84	Q2	15-Web	6 1/4"	3 1/2"	1"	1 3/4"	4 1/8"	3/4"	2 3/4"	9/32"	37.0
8.6	9.00	6 13/16	6TC86	Q2	15-Web	6 1/4"	3 1/2"	1"	1 3/4"	4 1/8"	3/4"	2 3/4"	9/32"	35.0
8.8	9.20	7	6TC88	Q2	15-Web	6 1/4"	3 1/2"	1"	1 3/4"	4 1/8"	3/4"	2 3/4"	9/32"	39.4
9.0	9.40	7 1/4	6TC90	Q2	15-Web	6 1/4"	3 1/2"	1"	1 3/4"	4 1/8"	3/4"	2 3/4"	9/32"	36.8
9.2	9.60	7 7/16	6TC92	Q2	15-Web	6 1/4"	3 1/2"	1"	1 3/4"	4 1/8"	3/4"	2 3/4"	9/32"	41.0
9.4	9.80	7 5/8	6TC94	Q2	15-Arm	6 1/4"	3 1/2"	1"	1 3/4"	4 1/8"	3/4"	2 3/4"	9/32"	39.4
9.6	10.00	7 13/16	6TC96	Q2	15-Arm	6 1/4"	3 1/2"	1"	1 3/4"	4 1/8"	3/4"	2 3/4"	9/32"	43.6
9.8	10.20	8	6TC98	Q2	15-Arm	6 1/4"	3 1/2"	1"	1 3/4"	4 1/8"	3/4"	2 3/4"	9/32"	42.0
10.0	10.40	8 1/4	6TC100	Q2	15-Arm	6 1/4"	3 1/2"	1"	1 3/4"	4 1/8"	3/4"	2 3/4"	9/32"	47.3
10.2	10.60	8 7/16	6TC102	Q2	15-Arm	6 1/4"	3 1/2"	1"	1 3/4"	4 1/8"	3/4"	2 3/4"	9/32"	44.4
10.6	11.00	8 13/16	6TC106	Q2	15-Arm	6 1/4"	3 1/2"	1"	1 3/4"	4 1/8"	3/4"	2 3/4"	9/32"	45.4
11.0	11.40	9 1/4	6TC110	Q2	15-Arm	6 1/4"	3 1/2"	1"	1 3/4"	4 1/8"	3/4"	2 3/4"	9/32"	47.0
11.4	11.80	9 5/8	6TC114	Q2	15-Arm	6 1/4"	3 1/2"	1"	1 3/4"	4 1/8"	3/4"	2 3/4"	9/32"	49.6
12.0	12.40	10 1/4	6TC120	Q2	15-Arm	6 1/4"	3 1/2"	1"	1 3/4"	4 1/8"	3/4"	2 3/4"	9/32"	51.0
13.0	13.40	11 1/4	6TC130	Q2	15-Arm	6 1/4"	3 1/2"	1"	1 3/4"	4 1/8"	3/4"	2 3/4"	9/32"	56.0
16.0	16.40	14 1/4	6TC160	Q2	15-Arm	6 1/4"	3 1/2"	1"	1 3/4"	4 1/8"	3/4"	2 3/4"	9/32"	72.0
20.0	20.40	18 1/4	6TC200	Q2	15-Arm	6 1/4"	3 1/2"	1"	1 3/4"	4 1/8"	3/4"	2 3/4"	9/32"	88.3
24.0	24.40	22 1/4	6TC240	Q2	15-Arm	6 1/4"	3 1/2"	1"	1 3/4"	4 1/8"	3/4"	2 3/4"	9/32"	108

For sheaves with larger bores, see Page A-58.

C Browning Gripbelt Sheaves with Split Taper Bushings

For Use with All "C" Section Belts

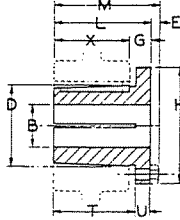


Table No. 1 Bushing Dimensions

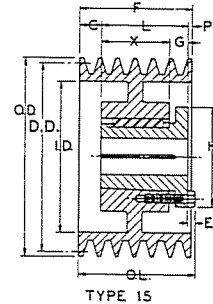
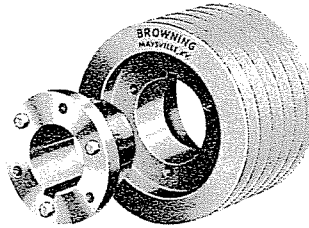
Part No.	Dimensions									Bore Range	Wt. Lbs.
	M	L	G	X	E	T	U	D	H		
Q3	5 ⁹ / ₃₂ "	5"	3/4"	4 1/4"	9/32"	4 15/32"	17/32"	27/8"	4 1/8"	1 3/8" — 2 1/2"	5 1/2
R2	5 ⁹ / ₃₂ "	4 7/8	7/8	4	9/32"	4 1/4	5/8	4	5 3/8"	1 3/8" — 3 5/8"	11
S2	7 1/8	6 3/4	1 1/16	5 1 1/16	3/8	6	3/4	4 5/8	6 3/8	1 7/8" — 4 3/16"	19
U0	5 ²³ / ₃₂ "	5 1/4	1 3/16	3 3/4	15/32"	4 3/16	1 1/16	6	8 3/8"	2 3/8" — 3 3/16"	30
U0	5 ¹³ / ₃₂ "	4 15/16	1 1/2	3 3/4	15/32"	4 3/16	3/4	6	8 3/8"	3 1/4" — 5 1/2"	27
U1	7 ¹⁹ / ₃₂ "	7 1/8	1 1/2	5 5/8	15/32"	6 1/16	1 1/16	6	8 3/8"	2 3/4" — 5 1/2"	40

Standard Keyseats

Table No. 2

Bore Range	Keyseat
1 3/8"	5/16" x 5/32"
1 7/16" — 1 3/4"	3/8 x 3/16
1 13/16" — 2 1/4"	1/2 x 1/4
2 5/16" — 2 3/4"	5/8 x 5/16
2 13/16" — 3 1/4"	3/4 x 3/8
3 3/8" — 3 3/4"	7/8 x 7/16
3 7/8" — 4 1/2"	1 x 1/2
4 5/8" — 5 1/2"	1 1/4 x 5/8

1 3/8" Bore Bushings also available with 3/8" x 3/16" Keyseat.



TYPE 15

Table No. 3 Specifications—Stock "C" Sheaves

Diameters			Part Number		Type	Dimensions							Wt. Less Bush.	
Datum "C"	Out-side	In-side	Sheave	Bush-ing		O.L.	L	P	C	H	G	X		E
8 GROOVES, F = 8 1/4"														
7.0"	7.40"	5 3/8"	8C70Q	Q3	15-Web	8 1/4"	5"	15 1/8"	15 1/8"	4 1/8"	3/4"	4 1/4"	9/32"	40
8.0	8.40	6 3/8	8C80R	R2	15-Web	8 1/4	4 7/8	1 3/4	1 5/8	5 3/8	7/8	4	9/32	49
8.6	9.00	6 15/16	8C86R	R2	15-Web	8 1/4	4 7/8	1 3/4	1 5/8	5 3/8	7/8	4	9/32	57
9.0	9.40	7 3/16	8C90R	R2	15-Web	8 1/4	4 7/8	1 3/4	1 5/8	5 3/8	7/8	4	9/32	62
9.2	9.60	7 3/8	8C92R	R2	15-Web	8 1/4	4 7/8	1 3/4	1 5/8	5 3/8	7/8	4	9/32	68
9.4	9.80	7 5/8	8C94R	R2	15-Web	8 1/4	4 7/8	1 3/4	1 5/8	5 3/8	7/8	4	9/32	73
9.6	10.00	7 13/16	8C96R	R2	15-Web	8 1/4	4 7/8	1 3/4	1 5/8	5 3/8	7/8	4	9/32	70
9.8	10.20	8	8C98R	R2	15-Web	8 1/4	4 7/8	1 3/4	1 5/8	5 3/8	7/8	4	9/32	76
10.0	10.40	8 3/16	8C100R	R2	15-Web	8 1/4	4 7/8	1 3/4	1 5/8	5 3/8	7/8	4	9/32	72
10.2	10.60	8 3/8	8C102R	R2	15-Web	8 1/4	4 7/8	1 3/4	1 5/8	5 3/8	7/8	4	9/32	79
10.6	11.00	8 13/16	8C106R	R2	15-Web	8 1/4	4 7/8	1 3/4	1 5/8	5 3/8	7/8	4	9/32	76
11.0	11.40	9 1/4	8C110R	R2	15-Web	8 1/4	4 7/8	1 1/4	2 1/8	5 3/8	7/8	4	9/32	73
12.0	12.40	10 1/4	8C120R	R2	15-Web	8 1/4	4 7/8	1 1/4	2 1/8	5 3/8	7/8	4	9/32	74
13.0	13.40	11 1/4	8C130R	R2	15-Arm	8 1/4	4 7/8	1 1/4	2 1/8	5 3/8	7/8	4	9/32	80
14.0	14.40	12 1/4	8C140R	R2	15-Arm	8 1/4	4 7/8	1 1/4	2 1/8	5 3/8	7/8	4	9/32	84
15.0	15.40	13 1/4	8C150R	R2	15-Arm	8 1/4	4 7/8	1 1/4	2 1/8	5 3/8	7/8	4	9/32	93
16.0	16.40	14 1/4	8C160R	R2	15-Arm	8 1/4	4 7/8	1 1/4	2 1/8	5 3/8	7/8	4	9/32	100
18.0	18.40	16 1/4	8C180S	S2	15-Arm	8 13/32	6 3/4	7/32	1 9/32	6 3/8	1 1/16	5 1 1/16	3/8	140
18.0	18.40	16 1/4	8C180U	U0	15-Arm	8 1/4	4 15/16	1 1/16	2 1/4	8 3/8	1 3/16	3 3/4	15/32	141
20.0	20.40	18 1/4	8C200S	S2	15-Arm	8 13/32	6 3/4	7/32	1 9/32	6 3/8	1 1/16	5 1 1/16	3/8	163
20.0	20.40	18 1/4	8C200U	U0	15-Arm	8 1/4	4 15/16	1 1/16	2 1/4	8 3/8	1 3/16	3 3/4	15/32	160
24.0	24.40	22 1/4	8C240S	S2	15-Arm	8 13/32	6 3/4	7/32	1 9/32	6 3/8	1 1/16	5 1 1/16	3/8	194
24.0	24.40	22 1/4	8C240U	U0	15-Arm	8 1/4	4 15/16	1 1/16	2 1/4	8 3/8	1 3/16	3 3/4	15/32	184
27.0	27.40	25 1/4	8C270S	S2	15-Arm	8 13/32	6 3/4	7/32	1 9/32	6 3/8	1 1/16	5 1 1/16	3/8	224
30.0	30.40	28 1/8	8C300S	S2	15-Arm	8 13/32	6 3/4	7/32	1 9/32	6 3/8	1 1/16	5 1 1/16	3/8	212
30.0	30.40	28 1/8	8C300U	U0	15-Arm	8 1/4	4 15/16	1 1/16	2 1/4	8 3/8	1 3/16	3 3/4	15/32	227
36.0	36.40	34 1/8	8C360S	S2	15-Arm	8 13/32	6 3/4	7/32	1 9/32	6 3/8	1 1/16	5 1 1/16	3/8	261
36.0	36.40	34 1/8	8C360U	U0	15-Arm	8 1/4	4 15/16	1 1/16	2 1/4	8 3/8	1 3/16	3 3/4	15/32	288
44.0	44.40	42 1/8	8C440S	S2	15-Arm	8 13/32	6 3/4	7/32	1 9/32	6 3/8	1 1/16	5 1 1/16	3/8	368
44.0	44.40	42 1/8	8C440U	U0	15-Arm	8 1/4	4 15/16	1 1/16	2 1/4	8 3/8	1 3/16	3 3/4	15/32	358
50.0	50.40	48 1/8	8C500S	S2	15-Arm	8 13/32	6 3/4	7/32	1 9/32	6 3/8	1 1/16	5 1 1/16	3/8	429
50.0	50.40	48 1/8	8C500U	U0	15-Arm	8 1/4	4 15/16	1 1/16	2 1/4	8 3/8	1 3/16	3 3/4	15/32	417

For Use with All "C" Section Belts

Table No. 1

Specifications—Stock "C" Sheaves

Diameters			Part Number		Type	Dimensions								Wt. Less Bush.
Datum "C"	Out-side	In-side	Sheave	Bush-ing		O.L.	L	P	C	H	G	X	E	
10 GROOVES, F = 10 1/4"														
8.0"	8.40"	6 3/8"	10C80R	R2	15-Web	10 1/4"	4 7/8"	3 3/4"	1 5/8"	5 3/8"	7/8"	4"	3/32"	70
8.6	9.00	6 15/16	10C86R	R2	15-Web	10 1/4"	4 7/8"	3 3/4"	1 5/8"	5 3/8"	7/8"	4	3/32	72
9.0	9.40	7 1/16	10C90R	R2	15-Web	10 1/4"	4 7/8"	3 3/4"	1 5/8"	5 3/8"	7/8"	4	3/32	72
9.2	9.60	7 3/16	10C92R	R2	15-Web	10 1/4"	4 7/8"	3 3/4"	1 5/8"	5 3/8"	7/8"	4	3/32	70
9.4	9.80	7 5/16	10C94R	R2	15-Web	10 1/4"	4 7/8"	3 3/4"	1 5/8"	5 3/8"	7/8"	4	3/32	78
9.6	10.00	7 13/16	10C96R	R2	15-Web	10 1/4"	4 7/8"	3 3/4"	1 5/8"	5 3/8"	7/8"	4	3/32	73
9.8	10.20	8	10C98R	R2	15-Web	10 1/4"	4 7/8"	3 3/4"	1 5/8"	5 3/8"	7/8"	4	3/32	88
10.0	10.40	8 3/16	10C100R	R2	15-Web	10 1/4"	4 7/8"	3 3/4"	1 5/8"	5 3/8"	7/8"	4	3/32	89
10.2	10.60	8 5/16	10C102R	R2	15-Web	10 1/4"	4 7/8"	3 3/4"	1 5/8"	5 3/8"	7/8"	4	3/32	97
10.6	11.00	8 13/16	10C106R	R2	15-Web	10 1/4"	4 7/8"	3 3/4"	1 5/8"	5 3/8"	7/8"	4	3/32	84
10.6	11.40	9 1/4	10C110R	R2	15-Web	10 1/4"	4 7/8"	2 1/4"	3 1/8"	5 3/8"	7/8"	4	3/32	84
11.0	11.40	9 1/4	10C110R	R2	15-Web	10 1/4"	4 7/8"	2 1/4"	3 1/8"	5 3/8"	7/8"	4	3/32	97
12.0	12.40	10 1/4	10C120R	R2	15-Web	10 1/4"	4 7/8"	2 1/4"	3 1/8"	5 3/8"	7/8"	4	3/32	102
13.0	13.40	11 1/4	10C130R	R2	15-Arm	10 1/4"	4 7/8"	2 1/4"	3 1/8"	5 3/8"	7/8"	4	3/32	106
14.0	14.40	12 1/4	10C140R	R2	15-Arm	10 1/4"	4 7/8"	2 1/4"	3 1/8"	5 3/8"	7/8"	4	3/32	110
15.0	15.40	13 3/4	10C150R	R2	15-Arm	10 1/4"	4 7/8"	2 1/4"	3 1/8"	5 3/8"	7/8"	4	3/32	111
16.0	16.40	14 1/4	10C160R	R2	15-Arm	10 1/4"	4 7/8"	2 1/4"	3 1/8"	5 3/8"	7/8"	4	3/32	164
18.0	18.40	16 1/4	10C180S	S2	15-Arm	10 1/4"	6 3/4"	1 5/32	2 3/32	6 3/8"	1 1/16	5 1/16	3/8	163
18.0	18.40	16 1/4	10C180U	U0	15-Arm	10 1/4"	4 19/16	2 1/16	3 1/4	8 3/8"	1 1/16	3 3/4	15/32	170
20.0	20.40	18 1/4	10C200S	S2	15-Arm	10 1/4"	6 3/4"	1 5/32	2 3/32	6 3/8"	1 1/16	5 1/16	3/8	178
20.0	20.40	18 1/4	10C200U	U0	15-Arm	10 1/4"	4 15/16	2 1/16	3 1/4	8 3/8"	1 1/16	3 3/4	15/32	210
24.0	24.40	22 1/4	10C240S	S2	15-Arm	10 1/4"	6 3/4"	1 5/32	2 3/32	6 3/8"	1 1/16	5 1/16	3/8	208
24.0	24.40	22 1/4	10C240U	U0	15-Arm	10 1/4"	4 19/16	2 1/16	3 1/4	8 3/8"	1 1/16	3 3/4	15/32	246
27.0	27.40	25 1/4	10C270S	S2	15-Arm	10 1/4"	6 3/4"	1 5/32	2 3/32	6 3/8"	1 1/16	5 1/16	3/8	278
30.0	30.40	28 3/8	10C300S	S2	15-Arm	10 1/4"	6 3/4"	1 5/32	2 3/32	6 3/8"	1 1/16	5 1/16	3/8	298
30.0	30.40	28 3/8	10C300U	U1	15-Arm	10 1/4"	7 1/8"	1 3/16	2 1/16	8 3/8"	1 1/2	5 5/8"	15/32	324
36.0	36.40	34 1/8	10C360S	S2	15-Arm	10 1/4"	6 3/4"	1 5/32	2 3/32	6 3/8"	1 1/16	5 1/16	3/8	362
36.0	36.40	34 1/8	10C360U	U1	15-Arm	10 1/4"	7 1/8"	1 3/16	2 1/16	8 3/8"	1 1/2	5 5/8"	15/32	463
44.0	44.40	42 1/8	10C440U	U1	15-Arm	10 1/4"	7 1/8"	1 3/16	2 1/16	8 3/8"	1 1/2	5 5/8"	15/32	480
50.0	50.40	48 3/8	10C500U	U1	15-Arm	10 1/4"	7 1/8"	1 3/16	2 1/16	8 3/8"	1 1/2	5 5/8"	15/32	480

12 GROOVES, F = 12 1/4"

9.0"	9.40"	7 3/16"	12C90S	S2	15-Web	12 1/4"	6 3/4"	3 1/2"	2"	6 3/8"	1 1/16"	5 1/16"	3/8"	88
9.2	9.60	7 5/16	12C92S	S2	15-Web	12 1/4"	6 3/4"	3 1/2"	2	6 3/8"	1 1/16"	5 1/16"	3/8	93
9.4	9.80	7 7/16	12C94S	S2	15-Web	12 1/4"	6 3/4"	3 1/2"	2	6 3/8"	1 1/16"	5 1/16"	3/8	104
9.6	10.00	7 9/16	12C96S	S2	15-Web	12 1/4"	6 3/4"	3 1/2"	2	6 3/8"	1 1/16"	5 1/16"	3/8	102
9.8	10.20	8	12C98S	S2	15-Web	12 1/4"	6 3/4"	3 1/2"	2	6 3/8"	1 1/16"	5 1/16"	3/8	111
10.0	10.40	8 3/16	12C100S	S2	15-Web	12 1/4"	6 3/4"	3 1/2"	2	6 3/8"	1 1/16"	5 1/16"	3/8	112
10.2	10.60	8 5/16	12C102S	S2	15-Web	12 1/4"	6 3/4"	3 1/2"	2	6 3/8"	1 1/16"	5 1/16"	3/8	121
10.6	11.00	8 13/16	12C106S	S2	15-Web	12 1/4"	6 3/4"	3 1/2"	2	6 3/8"	1 1/16"	5 1/16"	3/8	133
11.0	11.40	9 1/4	12C110S	S2	15-Web	12 1/4"	6 3/4"	2 7/32	3 3/32	6 3/8"	1 1/16"	5 1/16"	3/8	128
12.0	12.40	10 1/4	12C120S	S2	15-Web	12 1/4"	6 3/4"	2 7/32	3 3/32	6 3/8"	1 1/16"	5 1/16"	3/8	140
13.0	13.40	11 1/4	12C130S	S2	15-Web	12 1/4"	6 3/4"	2 7/32	3 3/32	6 3/8"	1 1/16"	5 1/16"	3/8	165
14.0	14.40	12 1/4	12C140S	S2	15-Arm	12 1/4"	6 3/4"	2 7/32	3 3/32	6 3/8"	1 1/16"	5 1/16"	3/8	148
15.0	15.40	13 3/4	12C150S	S2	15-Arm	12 1/4"	6 3/4"	2 7/32	3 3/32	6 3/8"	1 1/16"	5 1/16"	3/8	162
16.0	16.40	14 1/4	12C160S	S2	15-Arm	12 1/4"	6 3/4"	2 7/32	3 3/32	6 3/8"	1 1/16"	5 1/16"	3/8	163
18.0	18.40	16 1/4	12C180U	U1	15-Arm	12 1/4"	7 1/8"	1 13/16	3 5/16	8 3/8"	1 1/2	5 5/8"	15/32	204
20.0	20.40	18 1/4	12C200U	U1	15-Arm	12 1/4"	7 1/8"	1 13/16	3 5/16	8 3/8"	1 1/2	5 5/8"	15/32	224
24.0	24.40	22 1/4	12C240U	U1	15-Arm	12 1/4"	7 1/8"	1 13/16	3 5/16	8 3/8"	1 1/2	5 5/8"	15/32	257
27.0	27.40	25 1/4	12C270U	U1	15-Arm	12 1/4"	7 1/8"	1 13/16	3 5/16	8 3/8"	1 1/2	5 5/8"	15/32	300
30.0	30.40	28 3/8	12C300U	U1	15-Arm	12 1/4"	7 1/8"	1 13/16	3 5/16	8 3/8"	1 1/2	5 5/8"	15/32	327
36.0	36.40	34 1/8	12C360U	U1	15-Arm	12 1/4"	7 1/8"	1 13/16	3 5/16	8 3/8"	1 1/2	5 5/8"	15/32	397
44.0	44.40	42 1/8	12C440U	U1	15-Arm	12 1/4"	7 1/8"	1 13/16	3 5/16	8 3/8"	1 1/2	5 5/8"	15/32	519
50.0	50.40	48 3/8	12C500U	U1	15-Arm	12 1/4"	7 1/8"	1 13/16	3 5/16	8 3/8"	1 1/2	5 5/8"	15/32	551



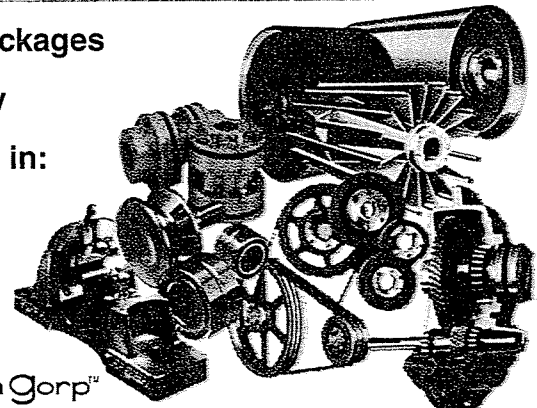
Bulk and Unit Material Handling
Pulp and Paper
HVAC

Complete Product Packages

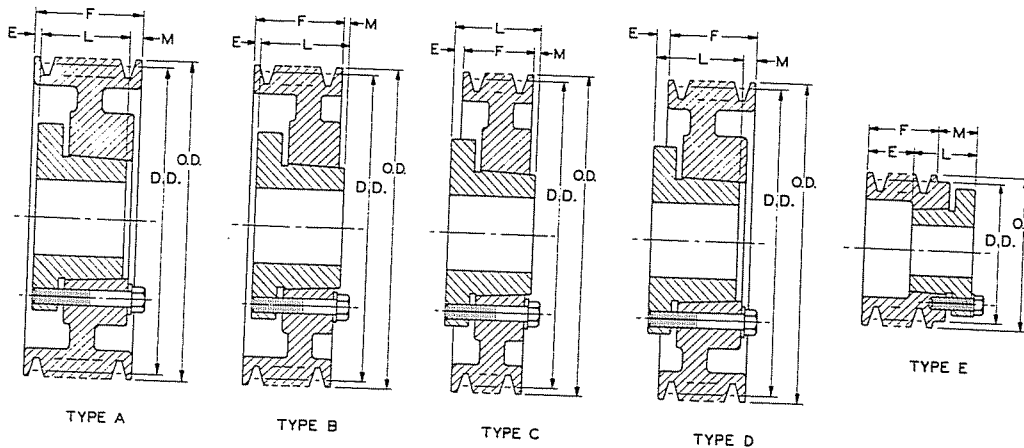
Designed for Industry

Specific Applications in:

Food and Beverage
Lumber
Packaging



Browning HOP-FLEX Mc GILL MORSE ROLLWAY SEALMASTER Van Gorp™



**Standard Keyseats
Table No. 1**

Bore Range	Keyseat
1/2" - 9/16"	1/8" x 1/16"
5/8" - 7/8"	3/16" x 3/32"
15/16" - 1 1/4"	1/4" x 1/8"
1 5/16" - 1 3/8"	5/16" x 3/32"
1 7/16" - 1 3/4"	3/8" x 1/16"
1 13/16" - 2 1/4"	1/2" x 1/4"
2 5/16" - 2 3/4"	5/8" x 5/16"
2 9/16" - 3 1/4"	3/4" x 3/8"
3 3/8" - 3 3/4"	7/8" x 7/16"
3 7/8" - 4 1/4"	1" x 1/2"

1 3/8" Bore Bushings also available with 3/8" x 3/16" Keyseat.

Table No. 2

Specifications

Part No.	Bushing	Bore Range	Type*	Datum "C"	O.D.	E	L	M	Wt. Less Bushing
1 GROOVE, F = 1 1/4"									
1C70SF	SF	1/2" - 2 15/16"	D-1	7.0"	7.40"	27/32"	2 1/16"	1/32"	10
1C75SF	SF	1/2" - 2 15/16"	D-2	7.5	7.90	27/32	2 1/16	1/32	12
1C80SF	SF	1/2" - 2 15/16"	D-2	8.0	8.40	27/32	2 1/16	1/32	13
1C85SF	SF	1/2" - 2 15/16"	D-2	8.5	8.90	27/32	2 1/16	1/32	14
1C90SF	SF	1/2" - 2 15/16"	D-3	9.0	9.40	27/32	2 1/16	1/32	15
1C95SF	SF	1/2" - 2 15/16"	D-3	9.5	9.90	27/32	2 1/16	1/32	16
1C100SF	SF	1/2" - 2 15/16"	D-3	10.0	10.40	27/32	2 1/16	1/32	17
1C105SF	SF	1/2" - 2 15/16"	D-3	10.5	10.90	27/32	2 1/16	1/32	18
1C110SF	SF	1/2" - 2 15/16"	D-3	11.0	11.40	27/32	2 1/16	1/32	19
1C120SF	SF	1/2" - 2 15/16"	D-3	12.0	12.40	27/32	2 1/16	1/32	20
1C130SF	SF	1/2" - 2 15/16"	D-3	13.0	13.40	27/32	2 1/16	1/32	22
1C140SF	SF	1/2" - 2 15/16"	D-3	14.0	14.40	27/32	2 1/16	1/32	24
1C160SF	SF	1/2" - 2 15/16"	D-3	16.0	16.40	27/32	2 1/16	1/32	26
1C180SF	SF	1/2" - 2 15/16"	D-3	18.0	18.40	27/32	2 1/16	1/32	30
1C200SF	SF	1/2" - 2 15/16"	D-3	20.0	20.40	27/32	2 1/16	1/32	35
1C240SF	SF	1/2" - 2 15/16"	D-3	24.0	24.40	27/32	2 1/16	1/32	41
2 GROOVES, F = 2 1/4"									
2C70SF	SF	1/2" - 2 15/16"	D-1	7.0	7.40	3/32	2 1/16	9/32	15
2C75SF	SF	1/2" - 2 15/16"	D-1	7.5	7.90	3/32	2 1/16	9/32	17
2C80SF	SF	1/2" - 2 15/16"	D-1	8.0	8.40	3/32	2 1/16	9/32	18
2C85SF	SF	1/2" - 2 15/16"	D-2	8.5	8.90	3/32	2 1/16	9/32	19
2C90SF	SF	1/2" - 2 15/16"	D-2	9.0	9.40	3/32	2 1/16	9/32	20
2C95SF	SF	1/2" - 2 15/16"	D-2	9.5	9.90	3/32	2 1/16	9/32	21
2C100SF	SF	1/2" - 2 15/16"	D-3	10.0	10.40	3/32	2 1/16	9/32	22
2C105SF	SF	1/2" - 2 15/16"	D-3	10.5	10.90	3/32	2 1/16	9/32	23
2C110SF	SF	1/2" - 2 15/16"	D-3	11.0	11.40	3/32	2 1/16	9/32	24
2C120SF	SF	1/2" - 2 15/16"	D-3	12.0	12.40	1 1/32	2 1/16	17/32	25
2C130SF	SF	1/2" - 2 15/16"	D-3	13.0	13.40	1 1/32	2 1/16	17/32	28
2C140SF	SF	1/2" - 2 15/16"	D-3	14.0	14.40	1 1/32	2 1/16	17/32	31
2C160SF	SF	1/2" - 2 15/16"	D-3	16.0	16.40	1 1/32	2 1/16	17/32	36
2C180SF	SF	1/2" - 2 15/16"	D-3	18.0	18.40	1 1/32	2 1/16	17/32	39
2C200SF	SF	1/2" - 2 15/16"	D-3	20.0	20.40	1 1/32	2 1/16	17/32	48
2C240SF	SF	1/2" - 2 15/16"	D-3	24.0	24.40	1 1/32	2 1/16	17/32	60
2C300F	F	1 - 4	C-3	30.0	30.40	1 7/32	3 3/4	9/32	85

*Suffix on Type indicates: 1 = Solid Construction, 2 = Web Construction, 3 = Arm Construction.

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Table No. 1

Specifications

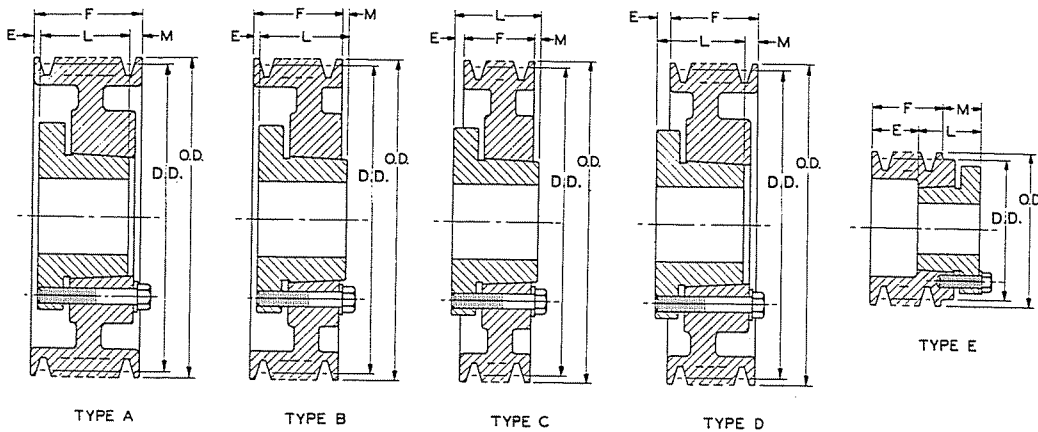
Part No.	Bushing	Bore Range	Type*	Datum 'C'	O.D.	E	L	M	Wt. Less Bushing
3 GROOVES, F = 3 1/4"									
3C50SD	SD	1/2"-2"	A-1	5.0"	5.40"	19/32"	113/16"	27/32"	10
3C55SD	SD	1/2"-2"	A-1	5.5	5.90	19/32	113/16	27/32	12
3C60SF	SF	1/2"-2 15/16	D-1	6.0	6.40	23/32	2 1/16	129/32	15
3C70SF	SF	1/2"-2 15/16	A-1	7.0	7.40	13/32	2 1/16	25/32	18
3C75SF	SF	1/2"-2 15/16	A-1	7.5	7.90	13/32	2 1/16	25/32	20
3C80E	E	7/8"-3 1/2"	B-1	8.0	8.40	17/32	2 3/4	1/32	26
3C85E	E	7/8"-3 1/2"	B-1	8.5	8.90	17/32	2 3/4	1/32	29
3C90E	E	7/8"-3 1/2"	A-1	9.0	9.40	15/32	2 3/4	1/32	32
3C95E	E	7/8"-3 1/2"	A-2	9.5	9.90	15/32	2 3/4	1/32	34
3C100E	E	7/8"-3 1/2"	A-2	10.0	10.40	15/32	2 3/4	1/32	36
3C105E	E	7/8"-3 1/2"	A-3	10.5	10.90	15/32	2 3/4	1/32	38
3C110E	E	7/8"-3 1/2"	A-3	11.0	11.40	15/32	2 3/4	1/32	40
3C120E	E	7/8"-3 1/2"	A-3	12.0	12.40	15/32	2 3/4	1/32	43
3C130E	E	7/8"-3 1/2"	A-3	13.0	13.40	15/32	2 3/4	1/32	45
3C140E	E	7/8"-3 1/2"	A-3	14.0	14.40	15/32	2 3/4	1/32	51
3C160E	E	7/8"-3 1/2"	A-3	16.0	16.40	15/32	2 3/4	1/32	59
3C180E	E	7/8"-3 1/2"	A-3	18.0	18.40	15/32	2 3/4	1/32	65
3C200E	E	7/8"-3 1/2"	D-3	20.0	20.40	7/32	2 3/4	23/32	70
3C240E	E	7/8"-3 1/2"	D-3	24.0	24.40	7/32	2 3/4	23/32	80
3C270F	F	1 -4	D-3	27.0	27.40	2 1/32	3 3/4	5/32	105
3C300F	F	1 -4	D-3	30.0	30.40	2 1/32	3 3/4	5/32	120
3C360F	F	1 -4	D-3	36.0	36.40	2 1/32	3 3/4	5/32	140
3C440F	F	1 -4	D-3	44.0	44.40	2 1/32	3 3/4	5/32	170
3C500F	F	1 -4	D-3	50.0	50.40	2 1/32	3 3/4	5/32	190
4 GROOVES, F = 4 1/4"									
4C50SD	SD	1/2"-2"	A-1	5.0	5.40	27/32	1 13/16	1 19/32	12
4C55SD	SD	1/2"-2"	A-1	5.5	5.90	27/32	1 13/16	1 19/32	14
4C60SF	SF	1/2"-2 15/16	A-1	6.0	6.40	2 1/32	2 1/16	1 17/32	17
4C70SF	SF	1/2"-2 15/16	A-1	7.0	7.40	2 1/32	2 1/16	1 17/32	21
4C75SF	SF	1/2"-2 15/16	A-1	7.5	7.90	2 1/32	2 1/16	1 17/32	25
4C80E	E	7/8"-3 1/2"	A-1	8.0	8.40	25/32	2 3/4	23/32	30
4C85E	E	7/8"-3 1/2"	A-1	8.5	8.90	25/32	2 3/4	23/32	33
4C90E	E	7/8"-3 1/2"	A-1	9.0	9.40	25/32	2 3/4	23/32	35
4C95E	E	7/8"-3 1/2"	A-2	9.5	9.90	25/32	2 3/4	23/32	38
4C100E	E	7/8"-3 1/2"	A-2	10.0	10.40	25/32	2 3/4	23/32	40
4C105E	E	7/8"-3 1/2"	A-2	10.5	10.90	25/32	2 3/4	23/32	43
4C110E	E	7/8"-3 1/2"	A-2	11.0	11.40	25/32	2 3/4	23/32	46
4C120E	E	7/8"-3 1/2"	A-3	12.0	12.40	25/32	2 3/4	23/32	50
4C130E	E	7/8"-3 1/2"	A-3	13.0	13.40	25/32	2 3/4	23/32	54
4C140E	E	7/8"-3 1/2"	A-3	14.0	14.40	25/32	2 3/4	23/32	59
4C160E	E	7/8"-3 1/2"	A-3	16.0	16.40	25/32	2 3/4	23/32	65
4C180E	E	7/8"-3 1/2"	A-3	18.0	18.40	25/32	2 3/4	23/32	73
4C200E	E	7/8"-3 1/2"	A-3	20.0	20.40	9/32	2 3/4	1 7/32	82
4C240F	F	1 -4	D-3	24.0	24.40	7/32	3 3/4	1 9/32	105
4C270F	F	1 -4	D-3	27.0	27.40	7/32	3 3/4	1 9/32	125
4C300F	F	1 -4	D-3	30.0	30.40	7/32	3 3/4	1 9/32	142
4C360F	F	1 -4	D-3	36.0	36.40	7/32	3 3/4	1 9/32	172
4C440J	J	1 1/2"-4 1/2"	C-3	44.0	44.40	0	4 5/8	7/8	225
4C500J	J	1 1/2"-4 1/2"	C-3	50.0	50.40	0	4 5/8	7/8	260
5 GROOVES, F = 5 1/4"									
5C60SF	SF	1/2"-2 15/16	A-1	6.0	6.40	1 1/32	2 1/16	2 5/32	21
5C70SF	SF	1/2"-2 15/16	A-1	7.0	7.40	1 1/32	2 1/16	2 5/32	26
5C75SF	SF	1/2"-2 15/16	A-1	7.5	7.90	1 1/32	2 1/16	2 5/32	28
5C80E	E	7/8"-3 1/2"	A-1	8.0	8.40	1 9/32	2 3/4	1 11/32	33
5C85E	E	7/8"-3 1/2"	A-1	8.5	8.90	1 9/32	2 3/4	1 11/32	37
5C90E	E	7/8"-3 1/2"	A-1	9.0	9.40	1 9/32	2 3/4	1 11/32	40
5C95E	E	7/8"-3 1/2"	A-2	9.5	9.90	1 9/32	2 3/4	1 11/32	42
5C100E	E	7/8"-3 1/2"	A-2	10.0	10.40	1 9/32	2 3/4	1 11/32	45
5C105E	E	7/8"-3 1/2"	A-2	10.5	10.90	1 9/32	2 3/4	1 11/32	47
5C110E	E	7/8"-3 1/2"	A-2	11.0	11.40	1 9/32	2 3/4	1 11/32	50
5C120E	E	7/8"-3 1/2"	A-2	12.0	12.40	1 9/32	2 3/4	1 11/32	53
5C130E	E	7/8"-3 1/2"	A-3	13.0	13.40	1 9/32	2 3/4	1 11/32	58
5C140E	E	7/8"-3 1/2"	A-3	14.0	14.40	1 9/32	2 3/4	1 11/32	64
5C160E	E	7/8"-3 1/2"	A-3	16.0	16.40	1 9/32	2 3/4	1 11/32	73
5C180E	E	7/8"-3 1/2"	A-3	18.0	18.40	1 9/32	2 3/4	1 11/32	85
5C200F	F	1 -4	D-3	20.0	20.40	7/32	3 3/4	1 19/32	98
5C240F	F	1 -4	D-3	24.0	24.40	7/32	3 3/4	1 19/32	119
5C270F	F	1 -4	D-3	27.0	27.40	7/32	3 3/4	1 19/32	153
5C300F	F	1 -4	D-3	30.0	30.40	7/32	3 3/4	1 19/32	174
5C360J	J	1 1/2"-4 1/2"	A-3	36.0	36.40	1/16	4 5/8	9/16	206
5C440J	J	1 1/2"-4 1/2"	A-3	44.0	44.40	1/16	4 5/8	9/16	254
5C500J	J	1 1/2"-4 1/2"	A-3	50.0	50.40	1/16	4 5/8	9/16	274

*Suffix on Type indicates: 1 = Solid Construction, 2 = Web Construction, 3 = Arm Construction.

C

Browning

Q-D® Sheaves for "C" Belts



Standard Keyseats
Table No. 1

Bore Range	Keyseat
1/2" - 9/16"	1/8" x 1/16"
5/8" - 7/8"	3/16" x 3/32"
15/16" - 1 1/4"	1/4" x 1/8"
1 1/4" - 1 3/8"	5/16" x 5/32"
1 3/8" - 1 1/2"	3/8" x 3/16"
1 1/2" - 2 1/4"	1/2" x 1/4"
2 1/4" - 2 3/4"	5/8" x 5/16"
2 3/4" - 3 1/4"	3/4" x 3/8"
3 1/4" - 4 1/2"	7/8" x 7/16"
4 1/2" - 5 1/2"	1" x 1/2"
	1 1/4" x 5/8"

1 3/8" Bore Bushings also available with 3/8" x 3/16" Keyseat.

Table No. 2 Specifications

Part No.	Bushing	Bore Range	Type*	Datum 'C'	O.D.	E	L	M	Wt. Less Bushing
6 GROOVES, F = 6 1/4"									
6C60SF	SF	1/2" - 2 15/16"	A-1	6.0"	6.40"	1 1/32"	2 1/16"	3 5/32"	20
6C70SF	SF	1/2" - 2 15/16"	A-1	7.0	7.40	1 1/32	2 1/16	3 5/32	26
6C75SF	SF	1/2" - 2 15/16"	A-1	7.5	7.90	1 1/32	2 1/16	3 5/32	29
6C80E	E	7/8" - 3 1/2"	A-1	8.0	8.40	1 5/32	2 3/4	2 11/32	36
6C85E	E	7/8" - 3 1/2"	A-1	8.5	8.90	1 5/32	2 3/4	2 11/32	39
6C90F	F	1" - 4"	A-1	9.0	9.40	1 1/32	3 3/4	2 11/32	51
6C95F	F	1" - 4"	A-1	9.5	9.90	1 1/32	3 3/4	2 11/32	55
6C100F	F	1" - 4"	A-1	10.0	10.40	1 1/32	3 3/4	2 11/32	59
6C105F	F	1" - 4"	A-2	10.5	10.90	1 1/32	3 3/4	2 11/32	62
6C110F	F	1" - 4"	A-2	11.0	11.40	1 1/32	3 3/4	2 11/32	66
6C120F	F	1" - 4"	A-2	12.0	12.40	1 1/32	3 3/4	2 11/32	70
6C130F	F	1" - 4"	A-3	13.0	13.40	1 1/32	3 3/4	2 11/32	74
6C140F	F	1" - 4"	A-3	14.0	14.40	1 1/32	3 3/4	2 11/32	80
6C160F	F	1" - 4"	A-3	16.0	16.40	1 1/32	3 3/4	2 11/32	89
6C180F	F	1" - 4"	A-3	18.0	18.40	1 1/32	3 3/4	2 11/32	102
6C200F	F	1" - 4"	A-3	20.0	20.40	1 1/32	3 3/4	2 11/32	112
6C240F	F	1" - 4"	A-3	24.0	24.40	1 1/32	3 3/4	2 11/32	131
6C270J	J	1 1/2" - 4 1/2"	A-3	27.0	27.40	1/16	4 5/8	1 9/16	160
6C300J	J	1 1/2" - 4 1/2"	A-3	30.0	30.40	1/16	4 5/8	1 9/16	190
6C360J	J	1 1/2" - 4 1/2"	A-3	36.0	36.40	1/16	4 5/8	1 9/16	232
6C440J	J	1 1/2" - 4 1/2"	A-3	44.0	44.40	1/16	4 5/8	1 9/16	299
6C500M	M	2" - 5 1/2"	B-3	50.0	50.40	7/32	6 3/4	2 3/32	320
8 GROOVES, F = 8 1/4"									
8C80E	E	7/8" - 3 1/2"	A-1	8.0	8.40	2 1/32	2 3/4	3 15/32	43
8C85E	E	7/8" - 3 1/2"	A-1	8.5	8.90	2 1/32	2 3/4	3 15/32	48
8C90F	F	1" - 4"	A-1	9.0	9.40	1 29/32	3 3/4	2 19/32	60
8C95F	F	1" - 4"	A-1	9.5	9.90	1 29/32	3 3/4	2 19/32	65
8C100F	F	1" - 4"	A-1	10.0	10.40	1 29/32	3 3/4	2 19/32	69
8C105F	F	1" - 4"	A-2	10.5	10.90	1 29/32	3 3/4	2 19/32	73
8C110F	F	1" - 4"	A-2	11.0	11.40	1 29/32	3 3/4	2 19/32	78
8C120F	F	1" - 4"	A-3	12.0	12.40	1 29/32	3 3/4	2 19/32	83
8C130F	F	1" - 4"	A-3	13.0	13.40	1 29/32	3 3/4	2 19/32	89
8C140F	F	1" - 4"	A-3	14.0	14.40	1 29/32	3 3/4	2 19/32	97
8C160F	F	1" - 4"	A-3	16.0	16.40	1 29/32	3 3/4	2 19/32	113
8C180F	F	1" - 4"	A-3	18.0	18.40	1 29/32	3 3/4	2 19/32	131
8C200J	J	1 1/2" - 4 1/2"	A-3	20.0	20.40	1/16	4 5/8	3 9/16	152
8C240J	J	1 1/2" - 4 1/2"	A-3	24.0	24.40	1/16	4 5/8	3 9/16	185
8C270J	J	1 1/2" - 4 1/2"	A-3	27.0	27.40	1/16	4 5/8	3 9/16	208
8C300J	J	1 1/2" - 4 1/2"	A-3	30.0	30.40	1/16	4 5/8	3 9/16	230
8C360M	M	2" - 5 1/2"	A-3	36.0	36.40	9/32	6 3/4	1 7/32	306
8C440M	M	2" - 5 1/2"	A-3	44.0	44.40	9/32	6 3/4	1 7/32	400
8C500M	M	2" - 5 1/2"	A-3	50.0	50.40	9/32	6 3/4	1 7/32	475

*Suffix on Type indicates: 1 = Solid Construction, 2 = Web Construction, 3 = Arm Construction.

Table No. 1

Specifications

Part No.	Bushing	Bore Range	Type*	Datum "C"	O.D.	E	L	M	Wt. Less Bushing
10 GROOVES, F = 10 1/4"									
10C80E	E	7/8"-3 1/2"	A-1	8.0"	8.40"	2 1/32"	2 3/4"	5 15/32"	65
10C85E	E	7/8"-3 1/2"	A-1	8.5	8.90	2 1/32	2 3/4	5 15/32	69
10C90J	J	1 1/2"-4 1/2"	A-1	9.0	9.40	2 1/16	4 5/8	3 9/16	73
10C95J	J	1 1/2"-4 1/2"	A-1	9.5	9.90	2 1/16	4 5/8	3 9/16	79
10C100J	J	1 1/2"-4 1/2"	A-1	10.0	10.40	2 1/16	4 5/8	3 9/16	84
10C105J	J	1 1/2"-4 1/2"	A-1	10.5	10.90	2 1/16	4 5/8	3 9/16	95
10C110J	J	1 1/2"-4 1/2"	A-1	11.0	11.40	2 1/16	4 5/8	3 9/16	104
10C120J	J	1 1/2"-4 1/2"	A-1	12.0	12.40	2 1/16	4 5/8	3 9/16	113
10C130J	J	1 1/2"-4 1/2"	A-3	13.0	13.40	2 1/16	4 5/8	3 9/16	121
10C140J	J	1 1/2"-4 1/2"	A-3	14.0	14.40	2 1/16	4 5/8	3 9/16	128
10C160J	J	1 1/2"-4 1/2"	A-3	16.0	16.40	2 1/16	4 5/8	3 9/16	146
10C180J	J	1 1/2"-4 1/2"	A-3	18.0	18.40	2 1/16	4 5/8	3 9/16	161
10C200J	J	1 1/2"-4 1/2"	A-3	20.0	20.40	2 1/16	4 5/8	3 9/16	175
10C240M	M	2"-5 1/2"	A-3	24.0	24.40	9/32	6 3/4	3 7/32	265
10C300M	M	2"-5 1/2"	A-3	30.0	30.40	9/32	6 3/4	3 7/32	310
10C360M	M	2"-5 1/2"	A-3	36.0	36.40	9/32	6 3/4	3 7/32	345
10C440M	M	2"-5 1/2"	A-3	44.0	44.40	9/32	6 3/4	3 7/32	450
10C500M	M	2"-5 1/2"	A-3	50.0	50.40	9/32	6 3/4	3 7/32	500

12 GROOVES, F = 12 1/4"

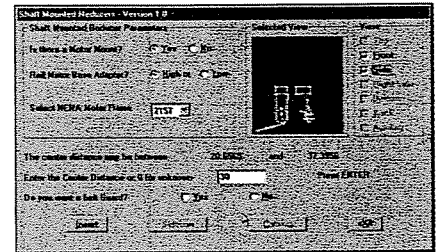
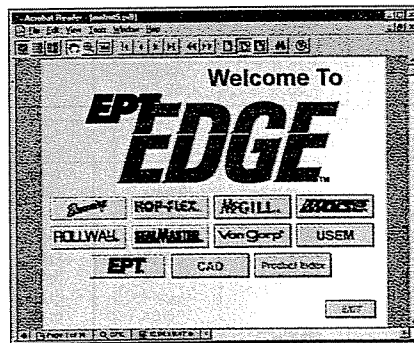
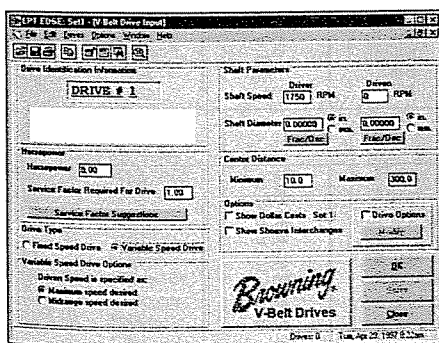
12C90J	J	1 1/2"-4 1/2"	A-1	9.0	9.40	2 9/16	4 5/8	5 1/16	80
12C95J	J	1 1/2"-4 1/2"	A-1	9.5	9.90	2 9/16	4 5/8	5 1/16	88
12C100J	J	1 1/2"-4 1/2"	A-1	10.0	10.40	2 9/16	4 5/8	5 1/16	95
12C105J	J	1 1/2"-4 1/2"	A-1	10.5	10.90	2 9/16	4 5/8	5 1/16	101
12C110J	J	1 1/2"-4 1/2"	A-1	11.0	11.40	2 9/16	4 5/8	5 1/16	111
12C120J	J	1 1/2"-4 1/2"	A-2	12.0	12.40	2 9/16	4 5/8	5 1/16	127
12C130J	J	1 1/2"-4 1/2"	A-3	13.0	13.40	2 9/16	4 5/8	5 1/16	137
12C140J	J	1 1/2"-4 1/2"	A-3	14.0	14.40	2 9/16	4 5/8	5 1/16	150
12C160J	J	1 1/2"-4 1/2"	A-3	16.0	16.40	2 9/16	4 5/8	5 1/16	170
12C180J	J	1 1/2"-4 1/2"	A-3	18.0	18.40	2 9/16	4 5/8	5 1/16	205
12C200M	M	2"-5 1/2"	A-3	20.0	20.40	9/32	6 3/4	5 7/32	245
12C240M	M	2"-5 1/2"	A-3	24.0	24.40	9/32	6 3/4	5 7/32	285
12C300M	M	2"-5 1/2"	A-3	30.0	30.40	9/32	6 3/4	5 7/32	355
12C360M	M	2"-5 1/2"	A-3	36.0	36.40	9/32	6 3/4	5 7/32	420
12C440M	M	2"-5 1/2"	A-3	44.0	44.40	9/32	6 3/4	5 7/32	515
12C500M	M	2"-5 1/2"	A-3	50.0	50.40	9/32	6 3/4	5 7/32	575

*Suffix on Type indicates: 1 = Solid Construction, 2 = Web Construction, 3 = Arm Construction.

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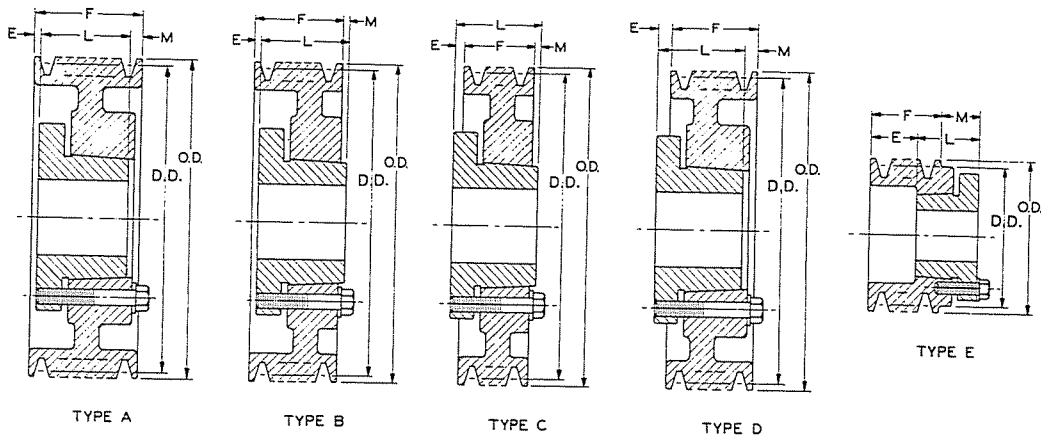
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D

Browning

Q-D® Sheaves for "D" Belts



Standard Keyseats
Table No. 1

Bore Range	Keyseat
15/16" - 1 1/4"	1/4" x 1/8"
1 5/16" - 1 1/2"	5/16" x 5/32"
1 7/16" - 1 3/4"	3/8" x 3/16"
1 13/16" - 2 1/4"	1/2" x 1/4"
2 5/16" - 2 3/4"	5/8" x 3/16"
2 13/16" - 3 1/4"	3/4" x 3/8"
3 3/8" - 3 3/4"	7/8" x 7/16"
3 7/8" - 4 1/2"	1" x 1/2"
4 9/16" - 5 1/2"	1 1/4" x 5/8"
5 3/16" - 6 1/2"	1 1/2" x 3/4"
6 3/16" - 7"	1 3/4" x 3/4"

1 3/8" Bore Bushings also available with 3/8" x 3/16" Keyseat.

Table No. 2

Specifications

Part No.	Bushing	Bore Range	Type*	Datum "D"	O.D.	E	L	M	Wt. Less Bushing
3 GROOVES, F = 4 5/8"									
3D120F	F	1" - 4"	A-2	12.0"	12.64"	5/32"	3 3/4"	23/32"	70
3D130F	F	1 - 4	A-2	13.0	13.64	5/32	3 3/4	23/32	76
3D135F	F	1 - 4	A-2	13.5	14.14	5/32	3 3/4	23/32	79
3D140F	F	1 - 4	A-2	14.0	14.64	5/32	3 3/4	23/32	82
3D145F	F	1 - 4	A-3	14.5	15.14	5/32	3 3/4	23/32	85
3D150F	F	1 - 4	A-3	15.0	15.64	5/32	3 3/4	23/32	89
3D155F	F	1 - 4	A-3	15.5	16.14	5/32	3 3/4	23/32	92
3D160F	F	1 - 4	A-3	16.0	16.64	5/32	3 3/4	23/32	96
3D180J	J	1 1/2 - 4 1/2	D-3	18.0	18.64	1/4	4 5/8	1/4	110
3D200J	J	1 1/2 - 4 1/2	D-3	20.0	20.64	1/4	4 5/8	1/4	120
3D220J	J	1 1/2 - 4 1/2	D-3	22.0	22.64	1/4	4 5/8	1/4	130
3D270J	J	1 1/2 - 4 1/2	D-3	27.0	27.64	1/4	4 5/8	1/4	173
3D330J	J	1 1/2 - 4 1/2	D-3	33.0	33.64	1/4	4 5/8	1/4	240
3D400J	J	1 1/2 - 4 1/2	D-3	40.0	40.64	1/4	4 5/8	1/4	300
4 GROOVES, F = 6 1/16"									
4D120F	F	1 - 4	A-2	12.0	12.64	31/32	3 3/4	1 11/32	83
4D130F	F	1 - 4	A-2	13.0	13.64	31/32	3 3/4	1 11/32	86
4D135F	F	1 - 4	A-2	13.5	14.14	31/32	3 3/4	1 11/32	89
4D140F	F	1 - 4	A-2	14.0	14.64	31/32	3 3/4	1 11/32	92
4D145F	F	1 - 4	A-3	14.5	15.14	31/32	3 3/4	1 11/32	95
4D150F	F	1 - 4	A-3	15.0	15.64	31/32	3 3/4	1 11/32	99
4D155F	F	1 - 4	A-3	15.5	16.14	31/32	3 3/4	1 11/32	102
4D160F	F	1 - 4	A-3	16.0	16.64	31/32	3 3/4	1 11/32	106
4D180J	J	1 1/2 - 4 1/2	A-3	18.0	18.64	1/8	4 5/8	1 5/16	120
4D200J	J	1 1/2 - 4 1/2	A-3	20.0	20.64	1/8	4 5/8	1 5/16	132
4D220J	J	1 1/2 - 4 1/2	A-3	22.0	22.64	1/8	4 5/8	1 5/16	155
4D270J	J	1 1/2 - 4 1/2	A-3	27.0	27.64	1/8	4 5/8	1 5/16	193
4D330M	M	2 - 5 1/2	B-3	33.0	33.64	1 1/32	6 3/4	1 1/32	280
4D400M	M	2 - 5 1/2	B-3	40.0	40.64	1 1/32	6 3/4	1 1/32	348
4D480M	M	2 - 5 1/2	B-3	48.0	48.64	1 1/32	6 3/4	1 1/32	380
4D580M	M	2 - 5 1/2	B-3	58.0	58.64	1 1/32	6 3/4	1 1/32	420
5 GROOVES, F = 7 1/2"									
5D120F	F	1 - 4	A-2	12.0	12.64	1 23/32	3 3/4	2 1/32	93
5D130F	F	1 - 4	A-2	13.0	13.64	1 23/32	3 3/4	2 1/32	96
5D135F	F	1 - 4	A-2	13.5	14.14	1 23/32	3 3/4	2 1/32	102
5D140F	F	1 - 4	A-2	14.0	14.64	1 23/32	3 3/4	2 1/32	106
5D145F	F	1 - 4	A-3	14.5	15.14	1 23/32	3 3/4	2 1/32	112
5D150F	F	1 - 4	A-3	15.0	15.64	1 23/32	3 3/4	2 1/32	120
5D155F	F	1 - 4	A-3	15.5	16.14	1 23/32	3 3/4	2 1/32	125
5D160F	F	1 - 4	A-3	16.0	16.64	1 23/32	3 3/4	2 1/32	130
5D180J	J	1 1/2 - 4 1/2	A-3	18.0	18.64	1 1/8	4 5/8	1	150
5D200J	J	1 1/2 - 4 1/2	A-3	20.0	20.64	1/8	4 5/8	2 3/4	160
5D220J	J	1 1/2 - 4 1/2	A-3	22.0	22.64	1/8	4 5/8	2 3/4	190
5D270M	M	2 - 5 1/2	A-3	27.0	27.64	1 1/32	6 3/4	1 3/32	260
5D330M	M	2 - 5 1/2	A-3	33.0	33.64	1 1/32	6 3/4	1 3/32	320
5D400M	M	2 - 5 1/2	A-3	40.0	40.64	1 1/32	6 3/4	1 3/32	390
5D480M	M	2 - 5 1/2	A-3	48.0	48.64	1 1/32	6 3/4	1 3/32	450
5D580M	M	2 - 5 1/2	A-3	58.0	58.64	1 1/32	6 3/4	1 3/32	500

*Suffix on Type indicates: 1 = Solid Construction, 2 = Web Construction, 3 = Arm Construction.

Table No. 1

Specifications

Part No.	Bushing	Bore Range	Type*	Datum "D"	O.D.	E	L	M	Wt. Less Bushing
6 GROOVES, F = 8¹⁵/₁₆"									
6D120J	J	1½"-4½"	A-1	12.0"	12.64"	1⅞"	4⅝"	2⅞"	115
6D130J	J	1½"-4½"	A-2	13.0	13.64	1⅞	4⅝	2⅞	125
6D135J	J	1½"-4½"	A-2	13.5	14.14	1⅞	4⅝	2⅞	135
6D140J	J	1½"-4½"	A-2	14.0	14.64	1⅞	4⅝	2⅞	145
6D145J	J	1½"-4½"	A-2	14.5	15.14	1⅞	4⅝	2⅞	150
6D150J	J	1½"-4½"	A-2	15.0	15.64	1⅞	4⅝	2⅞	160
6D155J	J	1½"-4½"	A-3	15.5	16.14	1⅞	4⅝	2⅞	165
6D160J	J	1½"-4½"	A-3	16.0	16.64	1⅞	4⅝	2⅞	170
6D180J	J	1½"-4½"	A-3	18.0	18.64	1⅞	4⅝	2⅞	180
6D200J	J	1½"-4½"	A-3	20.0	20.64	1⅞	4⅝	2⅞	215
6D220M	M	2"-5½"	A-3	22.0	22.64	1⅞	6¾	1 ²³ / ₃₂	250
6D270M	M	2"-5½"	A-3	27.0	27.64	1⅞	6¾	1 ²³ / ₃₂	300
6D330M	M	2"-5½"	A-3	33.0	33.64	1⅞	6¾	1 ²³ / ₃₂	360
6D400M	M	2"-5½"	A-3	40.0	40.64	1⅞	6¾	1 ²³ / ₃₂	440
6D480M	M	2"-5½"	A-3	48.0	48.64	1⅞	6¾	1 ²³ / ₃₂	560
6D580N	N	2⅞"-5⅞"	A-3	58.0	58.64	3⅞	8⅞	5⅞	660

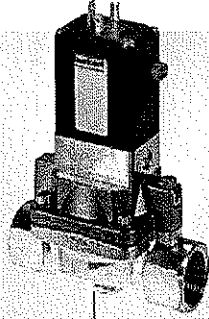
8 GROOVES, F = 11¹³/₁₆"									
8D120J	J	1½"-4½"	A-1	12.0	12.64	2⅞	4⅝	5⅞	140
8D130J	J	1½"-4½"	A-2	13.0	13.64	2⅞	4⅝	5⅞	150
8D135J	J	1½"-4½"	A-2	13.5	14.14	2⅞	4⅝	5⅞	160
8D140J	J	1½"-4½"	A-2	14.0	14.64	2⅞	4⅝	5⅞	170
8D145J	J	1½"-4½"	A-2	14.5	15.14	2⅞	4⅝	5⅞	178
8D150J	J	1½"-4½"	A-2	15.0	15.64	2⅞	4⅝	5⅞	182
8D155J	J	1½"-4½"	A-2	15.5	16.14	2⅞	4⅝	5⅞	190
8D160J	J	1½"-4½"	A-2	16.0	16.64	2⅞	4⅝	5⅞	201
8D180M	M	2"-5½"	A-3	18.0	18.64	2⅞	6¾	2 ²³ / ₃₂	260
8D200M	M	2"-5½"	A-3	20.0	20.64	2⅞	6¾	2 ²³ / ₃₂	270
8D220M	M	2"-5½"	A-3	22.0	22.64	1⅞	6¾	4 ²³ / ₃₂	300
8D270M	M	2"-5½"	A-3	27.0	27.64	1⅞	6¾	4 ²³ / ₃₂	350
8D330M	M	2"-5½"	A-3	33.0	33.64	1⅞	6¾	4 ²³ / ₃₂	450
8D400N	N	2⅞"-5⅞"	A-3	40.0	40.64	3⅞	8⅞	3⅞	550
8D480N	N	2⅞"-5⅞"	A-3	48.0	48.64	3⅞	8⅞	3⅞	720
8D580N	N	2⅞"-5⅞"	A-3	58.0	58.64	3⅞	8⅞	3⅞	900

10 GROOVES, F = 14¹¹/₁₆"									
10D120M	M	2"-5½"	A-1	12.0	12.64	2⅞	6¾	5⅞	190
10D130M	M	2"-5½"	A-1	13.0	13.64	2⅞	6¾	5⅞	220
10D135M	M	2"-5½"	A-1	13.5	14.14	2⅞	6¾	5⅞	240
10D140M	M	2"-5½"	A-1	14.0	14.64	2⅞	6¾	5⅞	250
10D145M	M	2"-5½"	A-2	14.5	15.14	2⅞	6¾	5⅞	260
10D150M	M	2"-5½"	A-2	15.0	15.64	2⅞	6¾	5⅞	270
10D155M	M	2"-5½"	A-2	15.5	16.14	2⅞	6¾	5⅞	280
10D160M	M	2"-5½"	A-2	16.0	16.64	2⅞	6¾	5⅞	290
10D180M	M	2"-5½"	A-2	18.0	18.64	2⅞	6¾	5⅞	310
10D200M	M	2"-5½"	A-2	20.0	20.64	2⅞	6¾	5⅞	330
10D220M	M	2"-5½"	A-3	22.0	22.64	1⅞	6¾	6⅞	350
10D270M	M	2"-5½"	A-3	27.0	27.64	1⅞	6¾	6⅞	440
10D330N	N	2⅞"-5⅞"	A-3	33.0	33.64	1⅞	8⅞	5⅞	500
10D400N	N	2⅞"-5⅞"	A-3	40.0	40.64	1⅞	8⅞	5⅞	650
10D480P	P	2⅞"-7"	A-3	48.0	48.64	¼	9⅞	5⅞	920
10D580P	P	2⅞"-7"	A-3	58.0	58.64	¼	9⅞	5⅞	1100

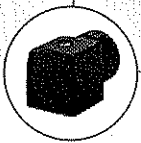
12 GROOVES, F = 17⁹/₁₆"									
12D120M	M	2"-5½"	A-1	12.0	12.64	3⅞	6¾	7⅞	220
12D130M	M	2"-5½"	A-1	13.0	13.64	3⅞	6¾	7⅞	250
12D135M	M	2"-5½"	A-1	13.5	14.14	3⅞	6¾	7⅞	270
12D140M	M	2"-5½"	A-1	14.0	14.64	3⅞	6¾	7⅞	280
12D145M	M	2"-5½"	A-1	14.5	15.14	3⅞	6¾	7⅞	300
12D150M	M	2"-5½"	A-2	15.0	15.64	3⅞	6¾	7⅞	305
12D155M	M	2"-5½"	A-1	15.5	16.14	3⅞	6¾	7⅞	310
12D160M	M	2"-5½"	A-2	16.0	16.64	3⅞	6¾	7⅞	320
12D180M	M	2"-5½"	A-2	18.0	18.64	3⅞	6¾	7⅞	340
12D200M	M	2"-5½"	A-2	20.0	20.64	3⅞	6¾	7⅞	360
12D220M	M	2"-5½"	A-3	22.0	22.64	2⅞	6¾	8⅞	400
12D270N	N	2⅞"-5⅞"	A-3	27.0	27.64	2⅞	8⅞	7⅞	520
12D330N	N	2⅞"-5⅞"	A-3	33.0	33.64	2⅞	8⅞	7⅞	665
12D400P	P	2⅞"-7"	A-3	40.0	40.64	¼	9⅞	7⅞	870
12D480P	P	2⅞"-7"	A-3	48.0	48.64	¼	9⅞	7⅞	1090
12D580P	P	2⅞"-7"	A-3	58.0	58.64	¼	9⅞	7⅞	1300

*Suffix on Type indicates: 1 = Solid Construction, 2 = Web Construction, 3 = Arm Construction.

2/2-way Solenoid Valve with servo diaphragm



Type 5282 can be combined with...



Type 2508
Cable plug



Type 1078
Timer unit



Type 2511
ASI cable plug



Type 8600
Dosing control

- Pivoted armature pilot drive with emergency manual operation
- Media separated
- Circuit function can be modified
- Adjustable switching times (waterhammer-free)
- Threaded port or flange connections

▪ Approvals:     

The Type 5282 is a pilot-controlled normally closed solenoid valve with a servo-diaphragm, media separated, for universal use with liquid and gaseous media corresponding to the material resistance. As standard, the 3-way pivoted armature pilot drive has an emergency manual operation. The closing and opening times are continuously adjustable.

Power consumption		
Inrush	Hold	
AC [VA]	AC [VA/W]	DC [W]
24	14/8	8

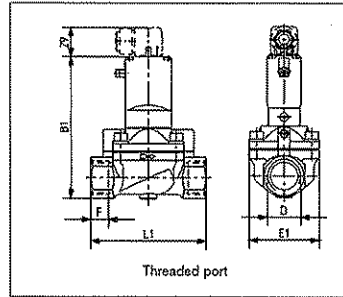
A differential pressure of 7 psi (0.5 bar) is required to open the full orifice. The response times can be changed by turning the restrictor screws (in the body cover).

Technical data	
Orifice	1/2" - 2" (DN 13 - 65 mm)
Body material	
Threaded port	Brass, stainless steel 1.4581
Flange	Stainless steel 1.4541
Seal material	NBR, FPM, EPDM (on request)
Media	
NBR	Neutral media, such as compressed air, water, hydraulic oil
EPDM	Oil and fat-free media, incl. alkalis, hot water
FPM	Hot air, oxygen, per-solutions, hot oil
Media temperature	
NBR	14°F to 194°F (-10°C to +90°C)
EPDM	-22°F to 194°F (-30°C to +90°C)
FPM	32°F to 194°F (0°C to +90°C)
Ambient temperature	Max. 131°F (+55°C)
Voltage tolerance	±10 %
Duty cycle	100% continuous rating
Electrical connection	Tag connector acc. DIN 43650 Form A for cable plug type 2508
Protection class	IP 65 with cable plug
Installation	As required, preferably with actuator upright

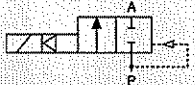

* See our HazEx™ guide for ATEX and for FM Class 1, Div. 1 versions

Solenoid valve dimensions

Dimensions [mm]								
Threaded port						Flange port		
DN	D	B1	E1	F	L1	B2	G	L2
13	NPT 1/2	123.0	40	14	65	-	-	-
20	NPT 3/4	131.0	60	16	100	-	-	-
25	NPT 1	141.0	70	18	115	184.5	120	160
32	NPT 1 1/4	147.0	85	20	126	192.0	140	180
40	NPT 1 1/2	156.0	85	22	126	201.0	150	200
50	NPT 2	177.5	115	24	164	225.0	165	230
65	NPT 2 1/2	185.0	115	27	180	-	-	-



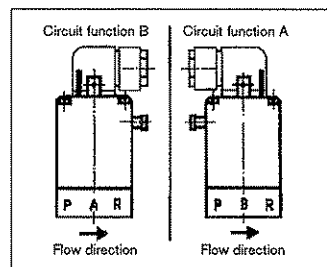
Ordering chart for valves (other versions on request) UL recognized / CSA/ CE
 Manual override, supplied without cable plug, different seal materials on request

Circuit function	Orifice [mm]	Port connection [NPT]	Cv value water [GPM]	Nominal pressure [psi]	Voltage/frequency [V/Hz]	Item no. Seal material NBR Seal Brass Body	Item no. Seal material FPM Seal Stainless Steel Body	
A 2/2-way valve, NC  or B 2/2-way valve, NO 	13.0 (Brass)	NPT 1/2	4.7	2.8 - 145	024/DC	456 890	456 914	
	20.0 (Stainless steel)				024/50-60	456 891	456 915	
	20.0				120/50-60	456 892	456 916	
	20.0				240/50-60	456 893	456 917	
	20.0	NPT 3/4	5.8	2.8 - 145	024/DC	456 894	456 918	
	20.0				024/50-60	456 895	456 919	
	20.0				120/50-60	456 896	456 920	
		25.0	NPT 1	11.7	2.8 - 145	240/50-60	456 897	456 921
		25.0				024/DC	456 898	456 922
		25.0				024/50-60	456 899	456 923
		32.0	NPT 1 1/4	23.5	2.8 - 145	120/50-60	456 900	456 924
		32.0				240/50-60	456 901	456 925
		32.0				024/DC	456 902	456 926
		40.0	NPT 1 1/2	23.5	2.8 - 145	024/50-60	456 903	456 927
		40.0				120/50-60	456 904	456 928
		40.0				240/50-60	456 905	456 929
	50.0	NPT 2	47.0	2.8 - 145	024/DC	456 906	456 930	
	50.0				024/50-60	456 907	456 931	
	50.0				120/50-60	456 908	456 932	
					240/50-60	456 909	456 933	
					024/DC	456 910	456 934	
					024/50-60	456 911	456 935	
					120/50-60	456 912	456 936	
					240/50-60	456 913	456 937	

Delivered as circuit function A
 Change to the circuit function B by turning the pilot drive through 180°

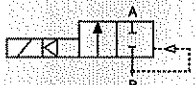
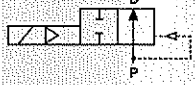
Mounting instructions:

Arrangement of the pilot control



Solenoid valve ordering chart

Ordering chart for valves (other versions on request) UL listed / FM class / Division 2 / CSA / CE
 Manual override, supplied with cable plug type 2509, different seal materials on request

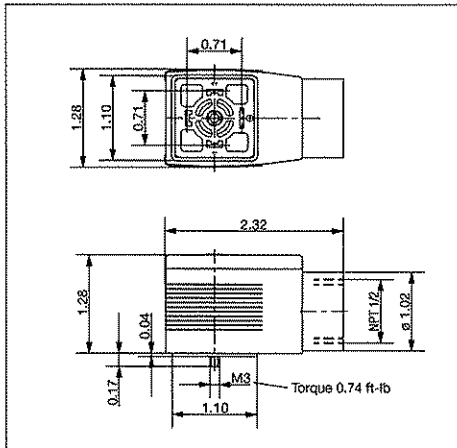
Circuit function	Orifice [mm]	Port connection [NPT]	Cv value water [GPM]	Pressure range [psij]	Voltage/frequency [V/Hz]	Item no. Threaded port NBR Brass	Item no. Threaded port FPM Stainless Steel
A 2/2-way valve NC 	13.0 (Brass)	NPT 1/2	4.7	2.8 - 145	024/DC	457 870	457 894
					024/50-60	457 871	457 895
	20.0 (Stainless steel)				120/50-60	457 872	457 896
					240/50-60	457 873	457 897
or B 2/2-way valve NO 	20.0 (Stainless steel)	NPT 3/4	5.8	2.8 - 145	024/DC	457 874	457 898
					024/50-60	457 875	457 899
					120/50-60	457 876	457 900
					240/50-60	457 877	457 901
	25.0	NPT 1	11.7	2.8 - 145	024/DC	457 878	457 902
					024/50-60	457 879	457 903
					120/50-60	457 880	457 904
					240/50-60	457 881	457 905
	32.0	NPT 1 1/4	23.5	2.8 - 145	024/DC	457 882	457 906
					024/50-60	457 883	457 907
					120/50-60	457 884	457 908
					240/50-60	457 885	457 909
	40.0	NPT 1 1/2	23.5	2.8 - 145	024/DC	457 886	457 910
					024/50-60	457 887	457 911
					120/50-60	457 888	457 912
					240/50-60	457 889	457 913
50.0	NPT 2	47.0	2.8 - 145	024/DC	457 890	457 914	
				024/50-60	457 891	457 915	
				120/50-60	457 892	457 916	
				240/50-60	457 893	457 917	

Delivered as circuit function A

Change to circuit function B by turning the pilot drive through 180°.

NOTE: All UL listed valves include type 2509 1/2" conduit cable plug

Type 2509 Dimensions [mm]





CAST
STEEL
GATE,
GLOBE &
CHECK
VALVES

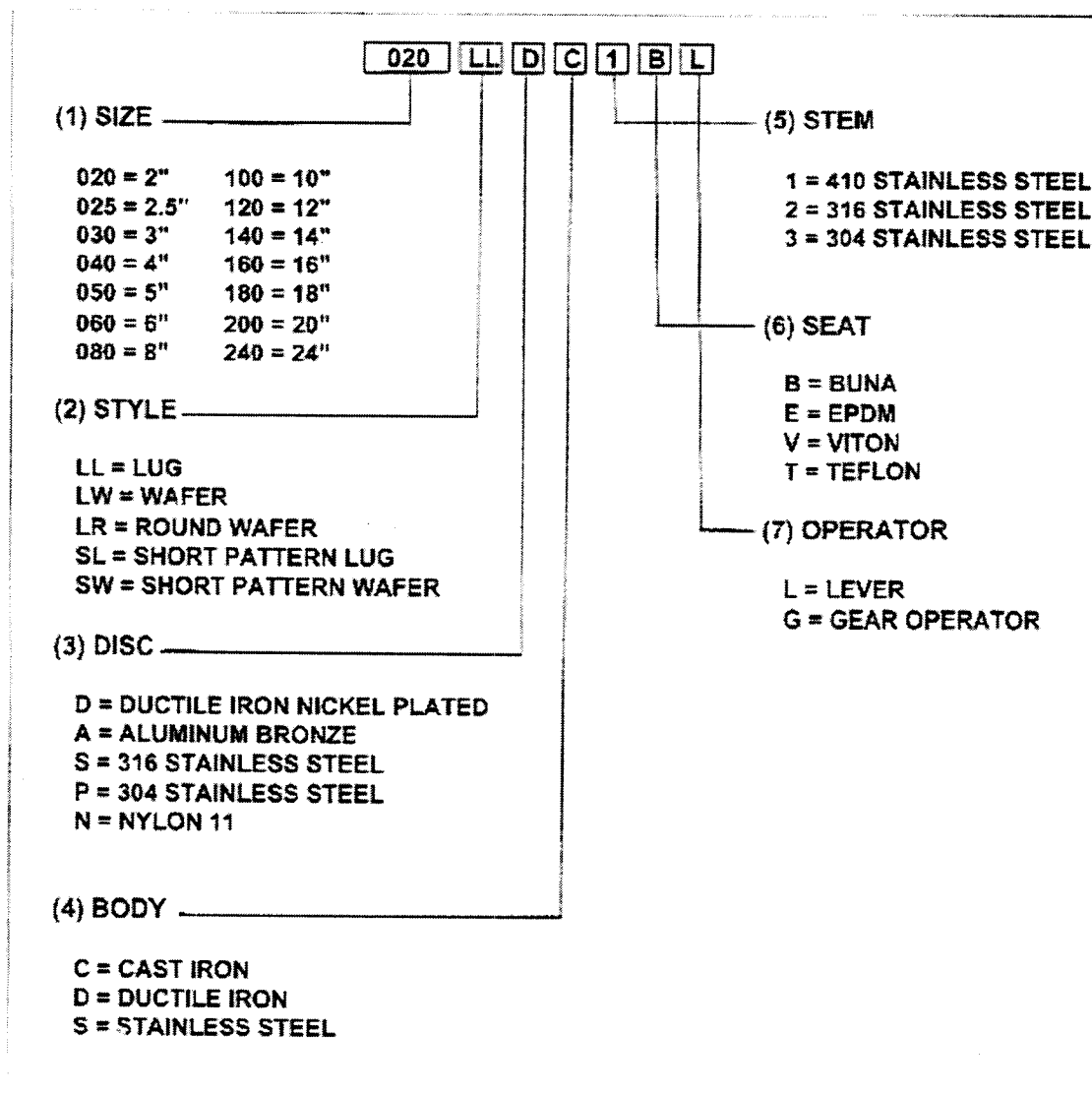
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HOME / CONTACT INFO

C200 WAFER STYLE BUTTERFLY VALVE DIMENSIONS

PRODUCT LIST

LUG BUTTERFLY VALVES

A = Body O.D.
B = Centerline of valve to top of mounting flange

WAFER BUTTERFLY VALVES

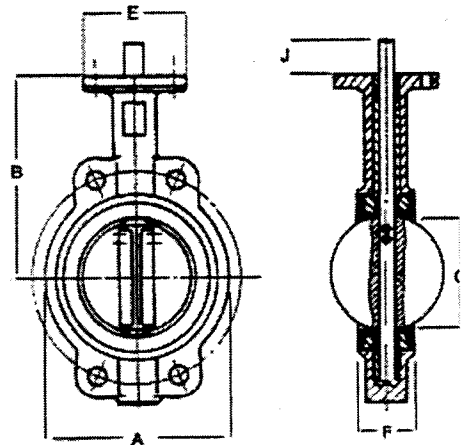
C = Valve Bore
E = O.D. of mounting flange

THREADED BODY STYLE BUTTERFLY VALVES

F = Face to Face
G = Stem Dimension - diameter
H = Stem Dimension - across flats

HAMMER UNIONS

J = Height of stem above mounting flange



MUD TANK UNIONS

VALVE SIZE											MOUNTING FLANGE DRILLING			
	in.	mm	A	B	C	E	F	G	H	J	ISO	BC	HOLES	HOL DIA
FLANGED-END BALL VALVES	2	50	3.94	6.34	2.09	3.03	1.65	0.51	0.35	1.14	F05	1.97	4	0.2
SPECIALTY FLANGED-END BALL VALVES	2.5	65	4.72	6.89	2.52	3.03	1.77	0.51	0.35	1.14	F05	1.97	4	0.2
	3	80	5.00	7.13	3.07	3.03	1.77	0.51	0.35	1.14	F05	1.97	4	0.2
THREADED BALL VALVES	4	100	6.14	7.87	4.09	3.62	2.05	0.63	0.43	1.14	F07	2.76	4	0.3
	5	125	7.48	8.39	4.88	3.62	2.13	0.75	0.51	1.14	F07	2.76	4	0.3
BRASS BALL VALVES	6	150	8.35	8.90	6.14	3.62	2.20	0.75	0.51	1.14	F07	2.76	4	0.3
	8	200	10.67	10.24	7.95	5.91	2.36	0.87	0.63	1.46	F12	4.92	4	0.5
	10	250	12.91	11.50	9.84	5.91	2.56	1.14	0.83	1.57	F12	4.92	4	0.5
	12	300	15.87	13.27	11.85	5.91	2.99	1.26	0.94	1.77	F12	4.92	4	0.5
	14	350	17.17	14.49	13.15	5.91	3.03	1.26	0.94	1.77	F12	4.92	4	0.5
	16	400	19.21	15.75	15.35	7.76	3.43	1.30	1.06	2.05	F14	5.51	4	0.7

CAST STEEL GATE, GLOBE & CHECK VALVES	18	450	21.22	16.61	17.36	7.76	4.17	1.50	1.06	2.05	F14	5.51	4	0.7
	20	500	23.35	18.90	19.37	7.76	5.20	1.61	1.26	2.56	F14	5.51	4	0.7
	24	600	27.27	22.13	23.35	10.87	5.98	2.01	1.42	2.83	F16	6.50	4	0.9

SWING
CHECK
VALVES

300# O-
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BRASS
CHECK
VALVES

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VALVES

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CATA-DYNE™ HEATER

STANDARD HEATER APPLICATIONS

INSTALLATION & OPERATION INSTRUCTIONS



ISO 9002 REGISTERED QUALITY SYSTEM

The CATA-DYNE heater can be used in all industrial indoor locations where a source of infra-red radiant heat is required, providing adequate ventilation is available.

CERTIFICATION

CATA-DYNE explosion-proof, flameless infra-red catalytic gas heaters (Series "X") are certified by the Canadian Standards Association (CSA)/Canadian Gas Association (CGA) for use in Class I, Divisions 1 and 2, Group D hazardous locations and by Factory Mutual Research (FM) in the USA for use in Class I, Division 2, Group D hazardous locations. Models listed are certified for industrial use only, for either natural gas or propane gas from altitudes 0- 4,500 ft (0-1,370 m) above sea level. These appliances are equipped for high altitudes.

All CATA-DYNE products are manufactured under an ISO 9002 registered quality system.

INSTALLATION

To ensure maximum efficiency of your CATA-DYNE heater, it should be installed with the heating surface positioned plus or minus 45° from the vertical plane at a height of no more than 8 ft (2.44m).

All heaters must be installed in accordance with the latest revisions of CAN/CGA-B149.1 and/or CAN/CGA-B149.2 and/or any local codes and regulations.

Before installing the heater, all information on the heater name plate must be carefully reviewed. The name plate lists all the fuel and electrical requirements for the heater.

Series "G"	Series "X"	Specifications	
BX 8x8	BX 8x8	3,500 BTU/hr	1.0 kW
BX 6x24	BX 6x24	6,000 BTU/hr	1.8 kW
BX 12x12	BX 12x12	6,000 BTU/hr	1.8 kW
BX 12x24	BX 12x24	12,000 BTU/hr	3.5 kW
BX 12x36	BX 12x36	18,000 BTU/hr	5.3 kW
BX 12x48	BX 12x48	24,000 BTU/hr	7.0 kW
BX 12x60	BX 12x60	30,000 BTU/hr	8.8 kW
BX 12x72	BX 12x72	36,000 BUT/hr	10.5 kW
BX 18x24	BX 18x24	18,000 BTU/hr	5.3 kW
BX 18x36	BX 18x36	27,000 BTU/hr	7.9 kW
BX 18x48	BX 18x48	36,000 BTU/hr	10.5 kW
BX 18x60	BX 18x60	45,000 BTU/hr	13.2 kW
BX 18x72	BX 18x72	54,000 BTU/hr	15.8 kW
BX 24x24	BX 24x24	24,000 BTU/hr	7.0 kW
BX 24x30	BX 24x30	30,000 BTU/hr	8.8 kW
BX 24x36	BX 24x36	36,000 BTU/hr	10.5 kW
BX 24x48	BX 24x48	48,000 BTU/hr	14.1 kW
BX 24x60	BX 24x60	60,000 BTU/hr	17.5 kW
BX 24x72	BX 24x72	72,000 BTU/hr	21.0 kW

Series "X" Heaters are certified for use in hazardous locations.
Series "G" Heaters are certified for general use only.



Head Office & Factory: 5918 Roper Road Edmonton, Alberta T6B 3E1
Telephone: (780) 466-3178 Fax: (780) 468-5904 Toll Free: 1-800-661-8529

E-mail: help@ciscan.com

www.ciscan.com

SPECIFICATIONS

Clearances

Appropriate clearances from the heating surface must be observed during the installation of the CATA-DYNE heaters (See Figure 1).

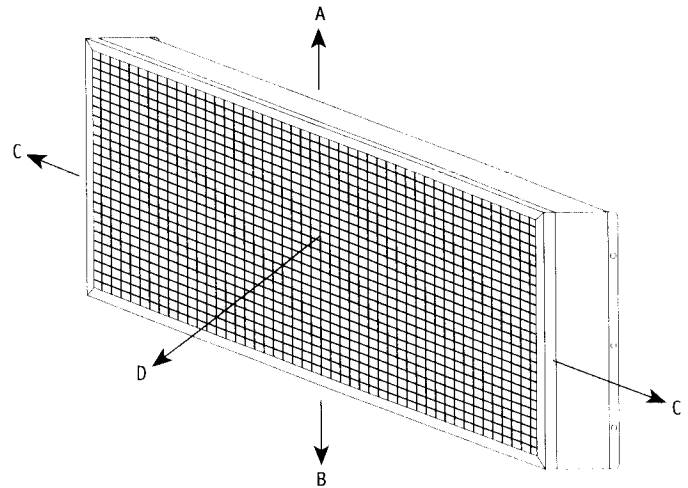
Fuels

The CATA-DYNE flameless gas heater is designed to operate on natural or propane gas as specified on the heater nameplate.

Natural Gas—these heaters are designed to use natural gas (1000 BTU/ft³, 37 mJ/m³) at 7 in w.c. (1.73 kPa). Heaters can be ordered to operate at 3.5 in w.c. (0.86 kPa).

Propane—these heaters are designed to use propane gas (2500 BTU/ft³, 88 mJ/m³) at 11 in w.c. (2.72 kPa).

FIGURE 1



HEATER CLEARANCE										
	Radiant Surface			Sides	Top			Bottom		
Radiant Surface Position	Heaters Up To 12,000 BTU/h	Over 12,000 Up To 48,000 BTU/h	Over 48,000 Up To 72,000 BTU/h	All Heaters Up To 72,000 BTU/h	Heaters Up To 12,000 BTU/h	Over 12,000 Up To 48,000 BTU/h	Over 48,000 Up To 72,000 BTU/h	Heaters Up To 12,000 BTU/h	Over 12,000 Up To 48,000 BTU/h	Over 48,000 Up To 72,000 BTU/h
Vertical (0°)	28 in	42 in	60 in	12 in	18 in	18 in	42 in	7 in	12 in	18 in
0-45° up	28 in	42 in	60 in	12 in	18 in	32 in	54 in	0 in	12 in	18 in
0-45° down	28 in	42 in	60 in	12 in	18 in	18 in	18 in	22 in	24 in	42 in

Piping

1. A main shut-off valve must be installed upstream of all auxiliary heater controls.
2. The 100% safety shut-off valve and appliance regulator (natural gas heaters only) must be installed in the upright position.
3. The thermostatic temperature controller should be installed with the dial shaft in the horizontal position.
4. The maximum inlet pressure to the 100% safety shut-off valve, thermostatic temperature controller and appliance regulator is 1/2 psi (3.4 kPa). If the inlet

pressure is higher than this, a low pressure regulator must be installed upstream of these components.

5. The maximum inlet pressure to the low pressure regulator is 250 psi (1.7 MPa). If the inlet pressure is higher than this, a high pressure regulator must be installed upstream.
6. All components should be installed as indicated in Figure 2.

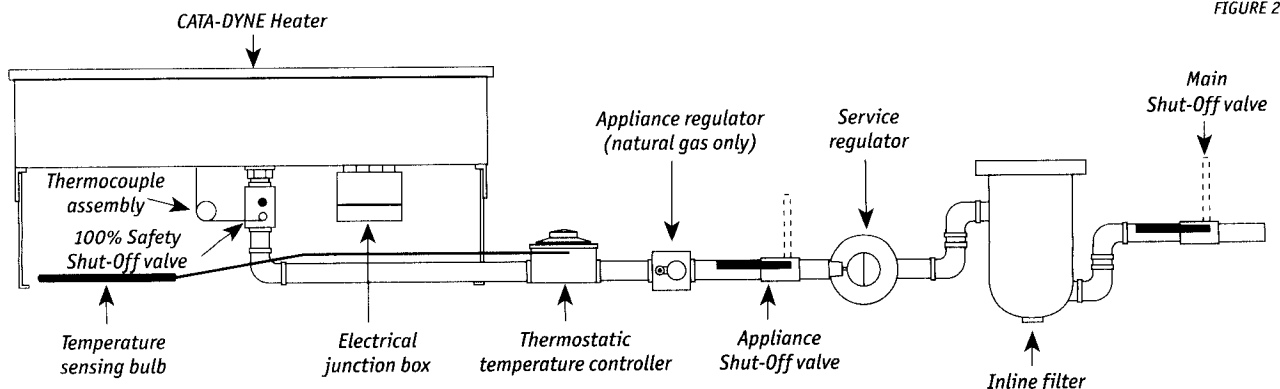


FIGURE 2

Electrical

1. All wiring is to be installed in accordance with the latest Canadian or National Electrical Codes and/or local codes.
2. It is desirable to install an indicating light on all starting systems. This will reduce the possibility of the power being left on once the heater is started, which can severely reduce the lifespan of the heater.
3. Ground connections for 120V and above heaters are provided on the bottom of the junction box.
4. The number of terminals in the junction box can be two or four depending on the number of elements used in the fabrication of the heater. The connection procedure for the different combinations is as described in Figures 3 and 4:

Ventilation

The catalytic reaction in CATA-DYNE heaters occurs when natural gas or propane reacts with oxygen to produce water vapour, carbon dioxide and infra-red energy. Ventilation must be provided to allow an adequate supply of oxygen for the reaction.

For every 1.0 ft² (0.093 m²) of heater surface, 60 ft³/hr (1.7 m³/hr) of air supply is required. For example, a BX 24x24 heater (24,000 BTU/hr 7.0 kW) would require 240 ft³/hr (6.8 m³) of air to ensure proper operation of the CATA-DYNE heater.

To reduce the carbon dioxide and water vapour concentrations in the building, a vent hood assembly can be installed to provide positive ventilation from the heater (See Figure 5).

FIGURE 3

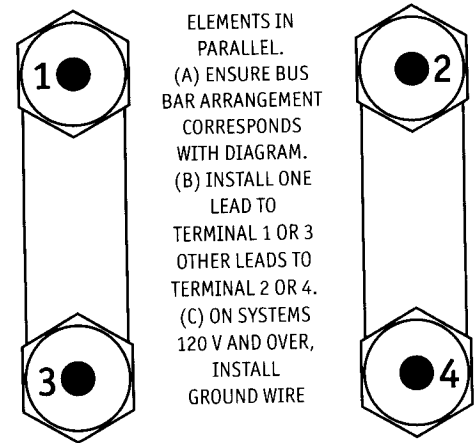


FIGURE 4

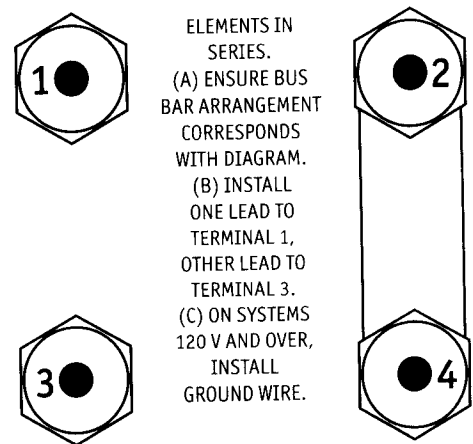
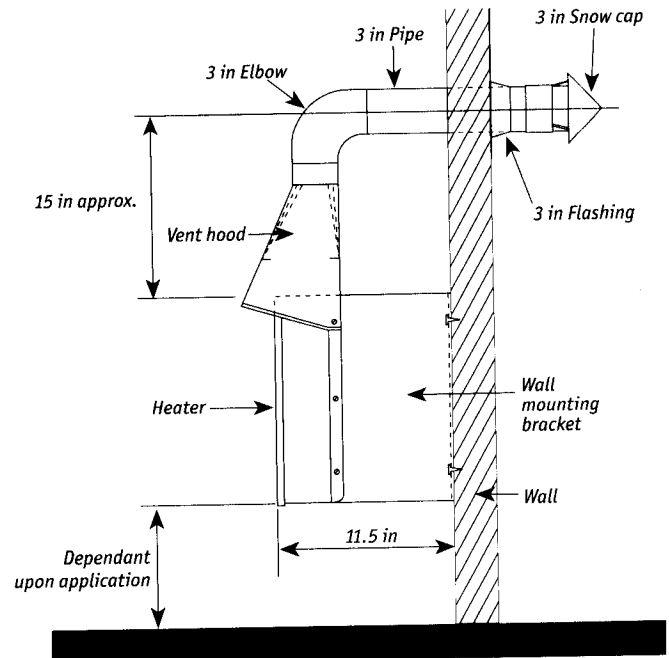


FIGURE 5



GUARANTEE

Ciscan warrants all CATA-DYNE flameless infra-red heaters sold to be free from defects in material or workmanship under normal use and service. The company agrees to repair or replace any CATA-DYNE heater which, upon its examination, reveals it to have been defective due to faulty workmanship or material, if returned to our factory, transportation PREPAID, within one (1) year from date of purchase. The company does not assume responsibility for misuse or misapplication of its heaters.

Warranty is void if CATA-DYNE heaters are used with sour, dirty or wet gas, or where sulphur content is greater than allowable for utility gas specifications. Warranty is void if, upon our inspection, the heater has been tampered with. Neither Ciscan Industries nor the selling dealer shall be held responsible for loss of time, inconvenience, commercial loss or consequential damages relating to the use of CATA-DYNE heaters.

RETURN GOODS POLICY

Prior written approval must be obtained from Ciscan Industries Ltd. for the return of any CATA-DYNE product(s). A restocking charge of 15% will apply. All returns must be shipped to our factory in Edmonton, freight prepaid. Final acceptance will be contingent on inspection at our factory.

REPAIRS

CATA-DYNE heaters may require periodic maintenance or repair. Our factory is staffed with technicians who are qualified to perform any required repairs. The procedure to follow to have a heater repaired is as follows. Send the heater to our factory in Edmonton. Include the following information with the heater:

- ◆ Company name and address
- ◆ Contact name
- ◆ Telephone number/fax number/e-mail
- ◆ P.O. number
- ◆ Advise if an estimate is required prior to starting the repair
- ◆ Details on the repair or conversion required
- ◆ Return shipping instructions

NOTE: Under the terms of our certification, all repairs must be performed at our factory in Edmonton.

TROUBLE SHOOTING

1. Ensure that the fuel matches that listed on the name plate.
2. Ensure that the voltage matches that listed on the name plate.
3. Check for any physical damage. All signs of physical damage to the catalyst pad such as holes, tears or a general deterioration of the catalyst bed signal that it is time to have the heater repaired.
4. Check the gas supply pressure at the heater—7 in w.c. (1.73 kPa) or 3.5 in w.c. (0.86 kPa) for natural gas and 11 in w.c. (2.72 kPa) for propane.
5. Check the gas orifice for obstructions or dirt and ensure the size matches that listed on name plate. It may be necessary to install a filter upstream of the heater or regulator if the gas supply is dirty. If the fuel supply is constantly dirty and/or wet it would be advisable to use bottled propane fuel.
6. Check the mounting position of the heater. The face of the heater should be preferably in the vertical position and should not vary more than 45° from the vertical position for maximum efficiency.
7. Check for saturation of the catalyst face caused by condensation or rain running down the face of the heater. If the heater has been exposed to water, it is advisable to place the unit in a warm area for a period of a few hours or longer if required. Once the moisture is removed, the heater can be re-installed and re-started.
8. Check the jumper cable size to ensure that the resistance of the cable is not reducing the current to the heater. This would not allow sufficient power to the electrical element to preheat the catalyst to the activity temperature. It is suggested to run the service vehicle at fast idle while starting the heater.
9. CATA-DYNE heaters are designed to use clean fuel and to be used in non-contaminated atmospheres. Sulphur compounds in the fuel or atmosphere will poison the catalyst bed over a period of time and render the heater inoperative. If the heater has been exposed to sulphur compounds, it should be sent to the factory for service.
10. Avoid spraying the face of the heater with high pressure air, steam or water because this can damage the catalyst bed. If physical damage is visible, return the heater to the factory for servicing.
11. The minimum setting of temperature controller corresponds to the heater(s) it is controlling. If temperature controller is too low, the heater will not have sufficient fuel rating to operate and will stop.

Separate Installation and Operation Instructions are available for oven and industrial heating applications.

OPERATION

All CATA-DYNE heaters are supplied with a Safety Shut-Off Valve/Thermocouple assembly to ensure the safe operation of the heater. Under no circumstances should the reset button be held or locked into the depressed position by use of a mechanical restraint.

Start-up

1. Ensure the heater has been installed according to all instructions and relevant codes.
2. Turn on the main gas supply to the system.
3. If the heater is equipped with a thermostatic temperature controller, rotate the dial completely clockwise to the fully open position.
4. Turn on the power to the electrical elements.
5. After 15 minutes, depress the reset button on the top of the 100% safety shut-off valve. The button should return to the original position and internally open the valve and allow gas to flow to the heater. If the valve does not stay open when the reset button is released, it may be necessary to wait an additional few minutes and then depress the reset button again. This will allow the electrical elements additional time to warm up.
6. When the catalytic reaction is well established, turn off the electrical power to the elements.
7. If the heater is equipped with a thermostatic temperature controller, it can be set to the desired setting after the catalytic reaction has been established for at least one hour.

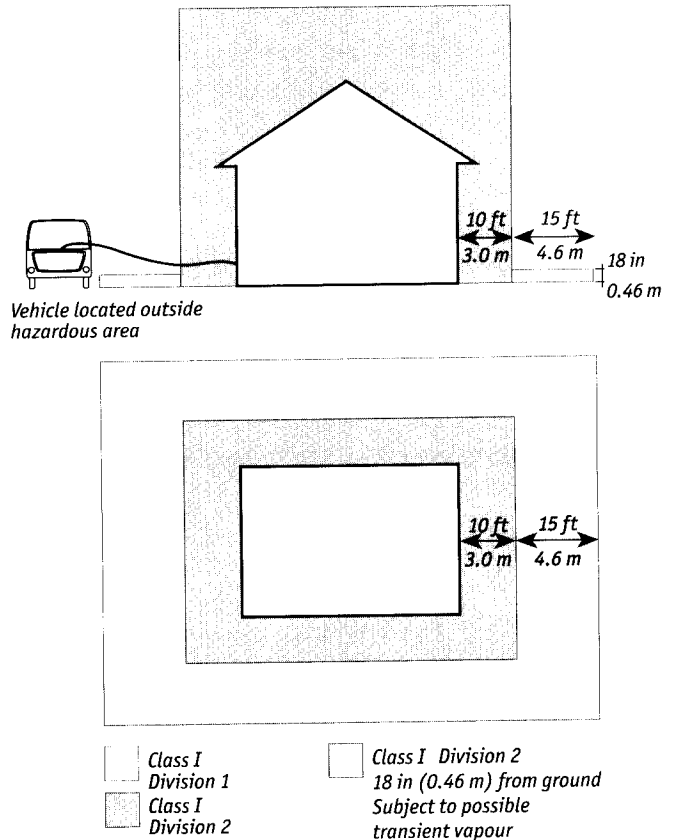
Shut down

Turn off the gas supply to the heater.

Multi-heater start-up

CATA-DYNE heaters can also be purchased/installed in multi-heater assemblies. If these assemblies are 12V, each heater *must* be started individually. This ensures the correct voltage and current will be reaching the heater from the power supply.

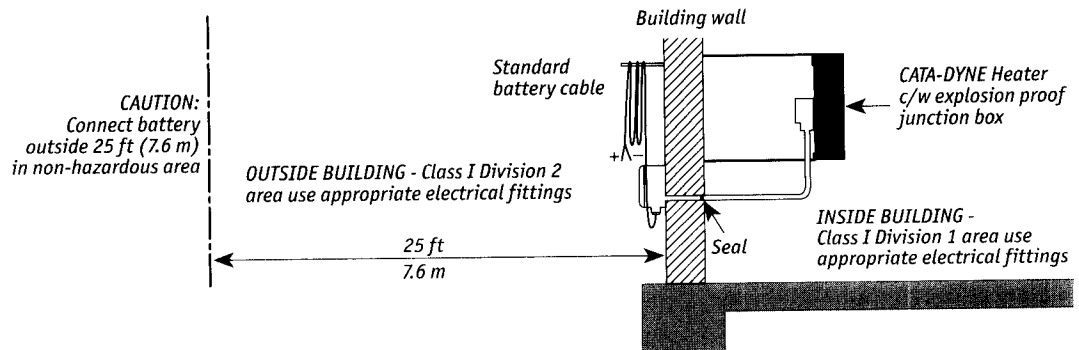
12 V HAZARDOUS ELECTRICAL INSTALLATIONS



Most oil and gas production buildings have an area classification as follows:

1. Class I, Division 1, within the building
2. Class I, Division 2, outside the building for a distance of 10 ft (3.0 m) from the building at all elevations
3. Class I, Division 2, outside the building for a distance of 25 ft (4.5 m) from the building at an elevation of 18 in (0.45 m) from the ground

All electrical apparatus and wiring within this area must conform to the appropriate codes. Connection to the power supply must be outside of the Class I, Division 2 location.



SPOT HEATING

There are several factors to consider when CATA-DYNE heaters are utilized for spot heating.

Infra-red energy travels in straight lines from the face of the CATA-DYNE heater covering approximately 160° of arc and is inversely proportional to the square of the distance. The heater should therefore be mounted as close as practical (min. of 8 in (20 cm)) to the object requiring heat for maximum temperature rise.

Match the shape of the object requiring heat with the appropriate CATA-DYNE heater, e.g. BX 6x24 for long narrow objects or BX 12x12 for a square object.

Objects requiring heat should be painted dull, dark colours for maximum infra-red absorption and objects not requiring heat should be painted light or reflective colours.

Maintain name plate clearances from combustible materials such as wood, cloth, paper, etc.

Insulate and protect plastic, rubber and similar materials from direct intense infra-red heat.

SPACE HEATING

A separate heat load calculation should be done for each building in which a CATA-DYNE will be installed for space heating purposes.

The heat load calculation determines the building heat losses through the structure and allows for air infiltration (refer to the sample Heat Load Calculation in the CATA-DYNE catalogue).

CATA-DYNE heaters produce low intensity infra-red heat which is absorbed by objects within the range of the heat source. The closer the object is to the source of heat, the more heat the object will absorb. CATA-DYNE heaters should be placed close to the floor level within the building to heat objects close to the floor.

Ideally, CATA-DYNE heaters should be mounted 1-3 ft (0.3-1 m) from the floor and equally spaced around the building perimeter for space heating applications.

If low mounting is not practical, then overhead mounting may be utilized. Overhead mounted heaters should be sloped face down to a maximum 45° angle to direct the infra-red energy towards the floor. Overhead mounting should be restricted to heaters of 30,000 BTU/hr (8.8 kW) capacity and larger.

If the building requires only one heater, place the CATA-DYNE heater as close as possible to the centre of the longest wall.

For multiple heater installations, space the CATA-DYNE heaters as evenly as possible around the perimeter of the building.

Make sure the piping is large enough to handle the gas load (refer to the sample Piping Calculation in the CATA-DYNE catalogue for sizing information).

Make sure the electrical starting system has sufficient current carrying capacity and conforms to all applicable electrical codes.

It is advisable to install an indicator light in the electrical circuit to reduce the possibility of the power being left on once the heater is started.

PERSONAL SAFETY

The CATA-DYNE flameless infra-red catalytic gas heater does not produce harmful carbon monoxide gas when used with natural gas or propane. Adequate ventilation must be incorporated in any building design to ensure oxygen replenishment and removal of any carbon dioxide. Protective grills should be used on any installation where personnel may come in contact with the face of the heater.

ORDERING INFORMATION

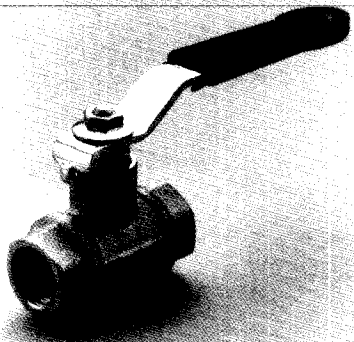
You can order any of Ciscan's products by telephone, fax, mail or e-mail. To assist us in processing your order as quickly and efficiently as possible, please provide us with the following information:

- ◆ CATA-DYNE product name
- ◆ CATA-DYNE model number
- ◆ Fuel gas - natural gas or propane
- ◆ Starting voltage - 12, 24, 120, 208, 240, 480, or 600 volt
- ◆ Accessories required:
 - Protection Grill
 - Wall Mount Brackets
 - Thermostat
 - Regulator
 - Start Up Leads (12 volt system only)
 - Vent Hood
 - Other
- ◆ Company name and contact
- ◆ Billing address, phone number, fax or e-mail
- ◆ Shipping address and phone number
- ◆ Shipping instructions
- ◆ Special tagging instructions
- ◆ Date required
- ◆ Method of payment:
 - on account – P.O. number required
 - credit card – Visa or Mastercard number
 - cash or cheque

CATA-DYNE™

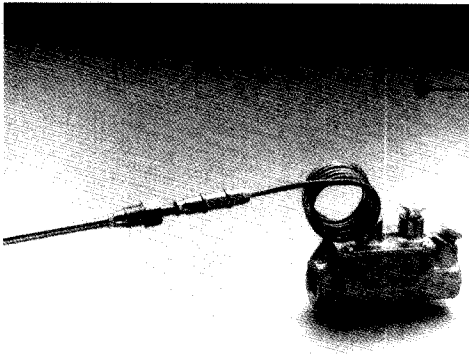
ACCESSORIES

A variety of quality accessories are available for use with CATA-DYNE infrared catalytic gas heaters. These accessories enhance and expand the operation and use of the heaters.



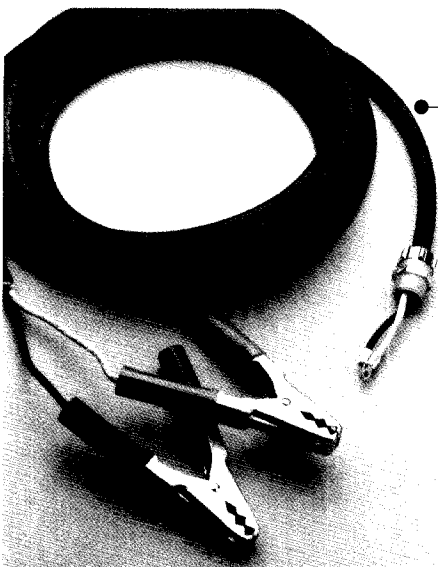
MANUAL SHUT-OFF VALVE

A 3/8" NPT manual shut-off ball valve is supplied with all manually controlled CATA-DYNE heaters. Standard equipment includes female NPT inlet and outlets and forged brass, which increases the strength of the body. The hard chrome-plated ball has teflon seats and an anti-corrosion dacromet treated handle.



100% SAFETY SHUT-OFF VALVE/THERMOCOUPLE

This assembly is a standard feature for all manually controlled CATA-DYNE heaters. The fuel supply to the CATA-DYNE must be manually introduced and the catalytic reaction established before the fuel supply will remain on unattended. The SSOV works in conjunction with the thermocouple as a safety feature. The valve will automatically shut off the gas supply to the heater if, for any reason, the thermocouple senses that the heater face temperature has dropped below the activation temperature. Connections are 3/8" NPT female. The maximum inlet pressure the valve will withstand is 1/2 psi (3.5 kPa).



ELECTRICAL START-UP LEADS (for 12 volt systems)

Leads are available for starting 12 volt heaters from a battery or other power supply. These leads are manufactured with heavy duty spring loaded serrated jaw clamps at one end and closed loop terminal ends at the other. A strain relief connector is also attached to enable the user to seal the connection between the cable and the heater junction box. Standard lengths are 25' (7.6 m), 30' (9.14 m) and 40' (12.19 m). See installation instructions for typical oil and gas field applications.

THERMOSTATIC TEMPERATURE CONTROL VALVE

The thermostatic temperature control valve is used to control building temperature for space heating applications. It will control temperatures ranging from 32° - 110° F (0 - 44° C), has a connection size of 3/8" NPT female, and a capillary length of 5' (1.5 m). Thermostats are also available for temperatures ranging from 200° - 550° F (93° - 287° C) for oven applications.

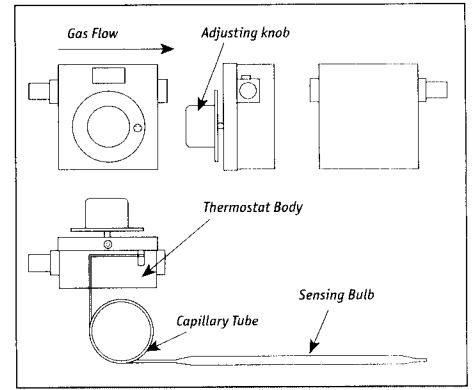
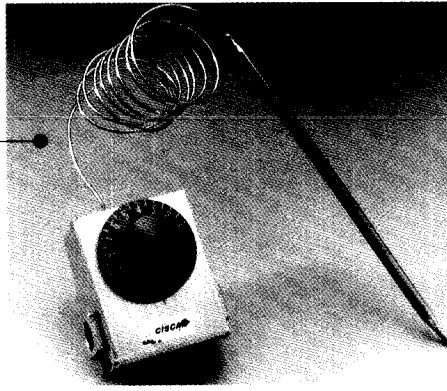
This unit automatically regulates the fuel flow to the CATA-DYNE heater(s) from 100% when heat is required to approximately 30% when the thermostat is satisfied. No electrical power is required to operate this unit.

All thermostats are factory set to specific BTU (kW) and fuel ratings. If the thermostat is to be used with a heater of a different rating or fuel, it must be sent to Ciscan's factory to be reset. Maximum pressure to the valve is 1/2 psi (3.5 kPa).

With CATA-DYNE heaters larger than 18,000 BTU/hr (5.3 kW), Ciscan recommends that one temperature controller be used per heater. This allows each heating unit to be independent and makes the heating system more efficient.

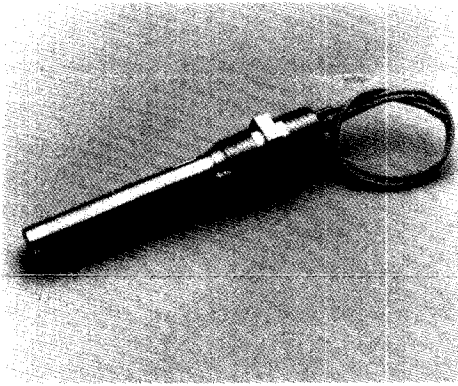
The accompanying chart is a guide to the different minimum and maximum settings for each heater size and fuel gas.

Note: The thermostatic temperature control valve is considered an optional accessory and is not mandatory. No aspect of safety will be compromised by not using a thermostat.



Minimum and Maximum Settings

Heater Size	Fuel	Min/Max. (BTU/HR)	Min/Max. (kW)
BX 8x8	Natural Gas	1,200/3,500	0.35/1.02
	Propane Gas	1,000/3,500	0.29/1.02
BX 6x24	Natural Gas	2,000/6,000	0.59/1.76
	Propane Gas	1,500/6,000	0.44/1.76
BX 12x12	Natural Gas	2,000/6,000	0.59/1.76
	Propane Gas	1,500/6,000	0.44/1.76
BX 12x24	Natural Gas	4,000/12,000	1.17/3.51
	Propane Gas	3,000/12,000	0.88/3.51
BX 12x36	Natural Gas	6,000/18,000	2.34/5.27
	Propane Gas	4,500/18,000	1.76/5.27
BX 12x48	Natural Gas	8,000/24,000	2.34/7.03
	Propane Gas	6,000/24,000	1.76/7.03
BX 12x 60	Natural Gas	10,000/30,000	2.93/8.79
	Propane Gas	8,000/30,000	2.34/8.79
BX 12x72	Natural Gas	12,000/36,000	2.93/8.79
	Propane Gas	9,000/36,000	2.34/8.79
BX 18x24	Natural Gas	6,000/18,000	1.76/5.27
	Propane Gas	4,500/18,000	1.32/5.27
BX 18x36	Natural Gas	9,000/27,000	2.64/7.91
	Propane Gas	6,750/27,000	1.98/7.91
BX 18x48	Natural Gas	12,000/36,000	3.51/10.5
	Propane Gas	9,000/36,000	2.64/10.5
BX 18x60	Natural Gas	16,000/45,000	4.10/12.3
	Propane Gas	12,000/45,000	3.08/12.3
BX 18x72	Natural Gas	18,000/54,000	5.27/15.8
	Propane Gas	13,500/54,000	3.95/15.8
BX 24x24	Natural Gas	8,000/24,000	2.34/7.03
	Propane Gas	6,000/24,000	1.76/7.03
BX 24x30	Natural Gas	10,000/30,000	2.93/8.79
	Propane Gas	7,500/30,000	2.20/8.79
BX 24x36	Natural Gas	12,000/36,000	3.51/10.5
	Propane Gas	9,000/36,000	2.64/10.5
BX 24x48	Natural Gas	16,000/48,000	4.69/14.1
	Propane Gas	12,000/48,000	3.51/14.1
BX 24x60	Natural Gas	20,000/60,000	5.86/17.6
	Propane Gas	15,000/60,000	4.39/17.6
BX 24x72	Natural Gas	24,000/72,000	7.03/21.1
	Propane Gas	18,000/72,000	5.27/21.1



THERMOSWITCHES

A thermoswitch senses temperature and opens or closes a pair of electrical contacts when the pre-set temperature is reached. When used with a CATA-DYNE heater, this device senses the internal temperature of the heater and adjusts accordingly.

When the heater reaches operating temperature during the start-up phase, the thermoswitch contacts close the electrical circuit to the solenoid valve control circuitry, allowing the fuel gas to flow to the heater. If the heater temperature drops below operating temperature, the thermoswitch contacts open the solenoid valve control circuitry, the valve closes and the gas flow to the heater is stopped.

Thermoswitches are used on CATA-DYNE electronic control systems. They are available for general purpose and hazardous applications.

PRESSURE REGULATORS

Ciscan Industries carries a selection of gas appliance pressure regulators capable of controlling pressure at very low flows. These regulators are designed primarily for applications where precise control of flow is an essential operating requirement.

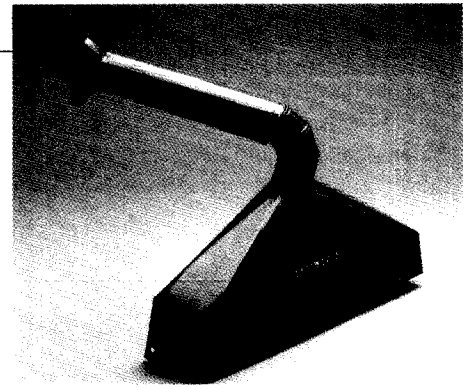
Appliance: This regulator has a maximum inlet pressure of 1/2 psi (3.5 kPa) inlet and is factory set at 7" w.c. (1.7 kPa) outlet pressure. Connection size is 3/8" NPT inlet and outlet.

VENT HOOD ASSEMBLY

This galvanized steel assembly vents the products of reaction (carbon dioxide and water vapour) outside the building. Its main function is to eliminate excessive moisture buildup that could condense and form ice around windows and doorways.

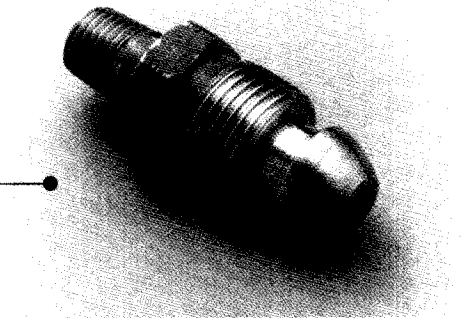
Each vent hood assembly consists of:

- 1 exhaust hood
- 1 length of vent pipe
- 1 elbow
- 1 flashing, and
- 1 snow cap



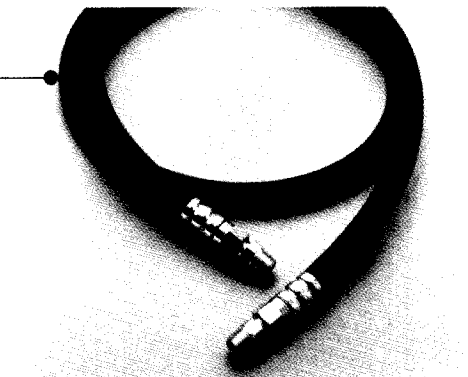
POL ADAPTERS

This product is a straight adapter that reduces a propane cylinder adapter to 1/4" NPT.



FUEL GAS HOSE

This product is a CGA approved propane hose, rated for 350 psi (2.4 Mpa) maximum working pressure. Ciscan carries standard stock in lengths of 5' (1.5 m), 10' (3 m), 15' (4.5 m) and 20' (6 m), and other lengths are also available. The connection size at each end is 3/8" NPT male.



(A pressure regulator is supplied with all certified natural gas models.)

Low Pressure: Maximum inlet pressure of 250 psi (1.7 MPa) and is factory set at 11" w.c. (2.7 kPa) outlet pressure. Connection size is 1/4" NPT inlet by 3/8" NPT outlet.

Maximum rating - 140,000 BTU/hr (41 kW) propane

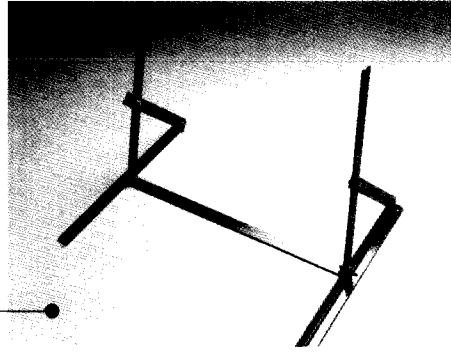
Maximum rating - 70,000 BTU/hr (20.5 kW) natural gas. A screwed vent connection is provided.



High Pressure: Maximum rating of 6,000 psi (41 MPa) inlet pressure and is factory set at 50 psi (345 kPa) outlet pressure. Connection size is 1/4" NPT inlet and outlet.

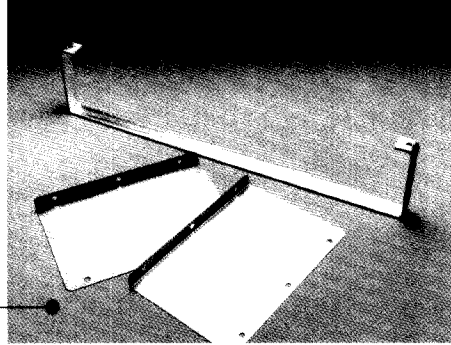
FLOOR STANDS

Floor stands are available for all CATA-DYNE heater models. These stands allow the heater to be placed closer to the object being heated than with the wall mounting system. The face of the heater can also be adjusted to the optimum heating angle. To ensure proper installation, consult the appropriate local codes and/or regulations.



WALL MOUNTING BRACKETS

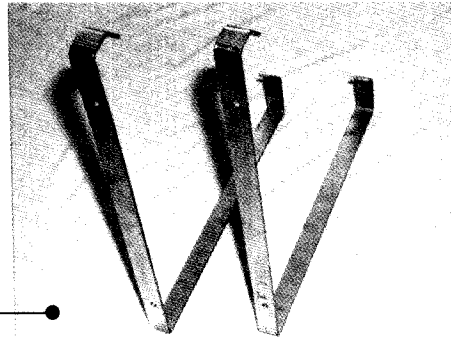
Standard wall mounting brackets are manufactured from stainless steel with 3/8" diameter holes for wall mounting bolts. The brackets mount heaters 7 1/2" (19 cm) away from the wall to allow access to the back of the heater. Brackets for large units over 12,000 BTU/hr (3.5 kW) are manufactured from heavy gauge mild steel flat bar.



45° WALL MOUNTING BRACKETS

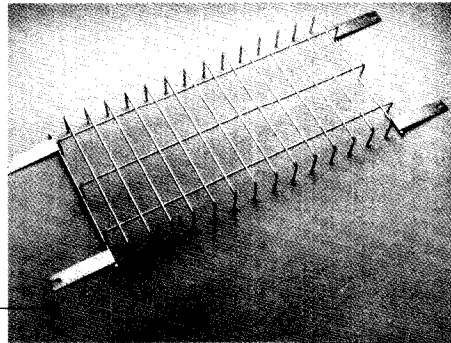
This specialized bracket simplifies installation of all 18" (457 mm) and 24" (610 mm) CATA-DYNE heaters. Made from mild rolled steel with a zinc plate finish, it is ideal for the following heater sizes:

<i>BX 18x24</i>	<i>BX 18x36</i>
<i>BX 18x48</i>	<i>BX 18x60</i>
<i>BX 18x72</i>	<i>BX 24x24</i>
<i>BX 24x30</i>	<i>BX 24x36</i>
<i>BX 24x48</i>	<i>BX 24x60</i>
<i>BX 24x72</i>	



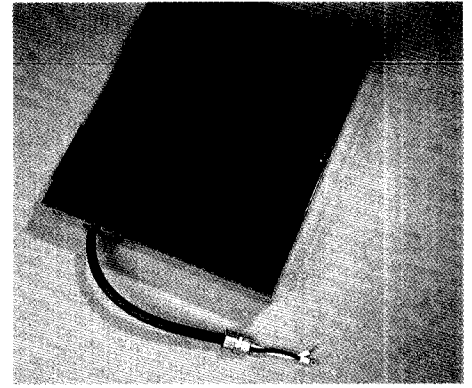
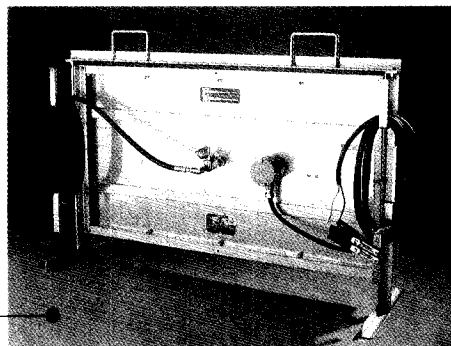
PROTECTION GRILLS

Ciscan offers a range of protective grills designed to protect personnel from coming in direct contact with the face of the CATA-DYNE heater. A protection grill should be used when the heater is mounted along walkways or other areas where personnel may come in contact with the face of the heater.



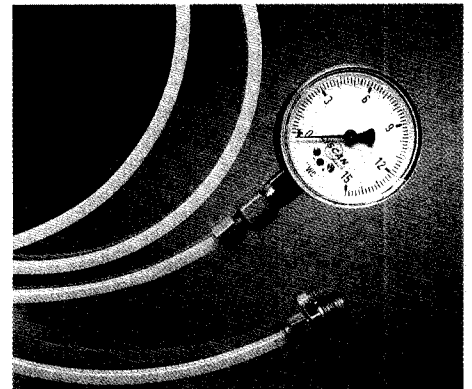
PORTABLE HEATER STAND

Portable heater stands are available in sizes BX 12x24, BX 24x24, BX 24x36, and BX 24x48. Easily moveable, they feature durable steel angle frames and hooks for hoses and start-up cables. The heater swivels about the centre bolt to direct heat. Follow local codes and regulations.



BATTERY CABLE CABINET

The Battery Cable Cabinet offers a convenient solution for storing battery start-up leads. Manufactured from heavy duty 20 gauge mild steel, it can be used with all lengths of battery cables from 25' - 40' (7.6 - 12.2 m). Not only will this durable cabinet help prevent leads from being stolen, the sturdy casing will protect them from adverse weather conditions, thereby increasing the life of your battery cables. The cabinet is finished with a durable high-gloss powder coat, and it is lockable and easy to install.



GAS PRESSURE TEST KIT

This portable kit accurately tests and measures the gas pressure going into a CATA-DYNE heater. Ideal for all heater sizes, it eliminates pressure "guess work" when checking heater performance and also replaces the need to fit test ports on pipelines used for heater operation. The Gas Pressure Test Kit includes a 15" w.c. (3.7 kPa) pressure gauge, a 6' (1.8 m) PVC tube and the connection to the SSOV. It is compatible with both natural gas and propane heaters.

FLO-DRI GAS SCRUBBERS

Fuel gas from natural gas wells may contain some form of contamination such as water, salt, H₂S, aerosols, and/or particulates that can interfere with the operation of a CATA-DYNE heater, resulting in costly repairs and down time. Flo-Dri gas scrubbers have been designed to remove contaminants, thereby greatly reducing your operating costs. Use of a scrubber will help reduce wear and corrosion of the SSOV.

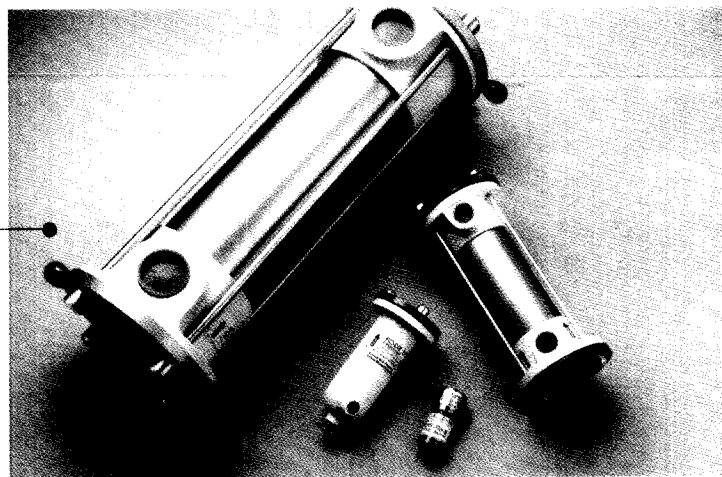
Flo-Dri works in three stages:

1 Impaction - As the contaminated fuel gas enters the lower chamber of the Flo-Dri Scrubber, it expands and impacts on the surface of the diffuser assembly which causes the larger droplets to fall to the bottom.

2 Absorption - Fuel gas continues upward through the scrubber media where the contaminants are absorbed.

3 Mechanical Entrapment (low micron rating to .5μ) - In the final filtration stage, the gas leaves through a special filter which traps any remaining particles. The result is gas that is virtually free of any contaminants.

Flo-Dri has been designed with a patented "quick change" feature that offers the easiest replacement in the industry. Simply relieve pressure, twist and lift. The units can be serviced without removing them from the gas line.



All housings are mounted vertically and the flow is always upward. Plumbing can be accomplished on any model with a minimum of effort. Channeling is eliminated by Flo-Dri's exclusive spring loaded feature which compresses the cartridge within the housing.

FLO-DRI FILTER SIZING CHART

Gas Flow in Cu. Ft. per hour	Heater Size	Recommended Filter
3.6	8x8	G10
6	12x12	G10
12	12x24	G10
18	18x24	G10
24	24x24	G25
30	24x30	G25
36	24x36	G25
48	24x48	G60
60	24x60	G60
72	24x72	G60
84	Combination of the above	G100
96	"	G100
108	"	G100
120	"	G100
132	"	G100
144	"	G100
156	"	G100
168	"	G150
336	"	2 - G150

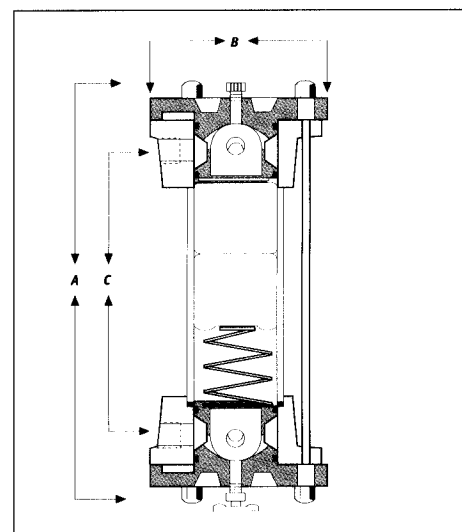
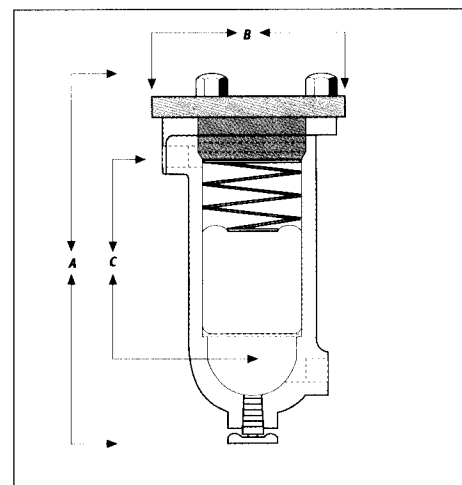
*Note: The above recommendations are for moisture, contaminants and oil. For H₂S, increase the filter size to next larger filter starting at the 12x24 heater size.

Types of Cartridge Media

AA - Moisture MS - Contamination Removal
 AC - Oil and Odour XX - H₂S Removal

MEDIA SELECTION AND CHANGE OUT CHART

Media	Contaminant Removed	Change Out Recommendations
AA - Cartridge	Moisture only	2 months
MS - Cartridge	Moisture, other contaminants (No H ₂ S)	3 months
XX - Cartridge	H ₂ S, moisture, other contaminants	1 month (this cartridge requires frequent change outs)
R - Cartridge	Oil, water, heavy liquids (may be used in series with any of the above)	1 month or when used in series change with other cartridges as above



***Note:** Good filtration will maintain the efficiency of the heater. For extremely contaminated gas streams, more frequent change outs may be required.

FLO-DRI CARTRIDGES

Model No.	Working PSIG	No. of Cartridges	Overall Length A	Overall Diameter B	Port to Port C	Pipe Size NPT	Replacement Cartridge No.	Bed Volume Cu. Inch
G-10A	150	1	7 1/3"	4"	5"	1/4"	1	12.56
G-25A	250	2	12 7/8"	5"	8 1/8"	3/4"	25	30.78
G-25A-5	250	5	21"	5"	16 1/4"	3/4"	25	74.02
G-60A	250	3	18"	6 1/4"	12"	1"	60-2	84.47
G100A	250	4	23 1/2"	7"	17 1/2"	1 1/2"	100-3	199.06
G-150A	250	2	25 1/4"	9 1/2"	9 1/2"	2"	150-4	376.52

Ciscan will include a tag with every Flo-Dri Gas Scrubber that will help you keep track of information such as when you installed the cartridge and how long it lasted. Return the tag to Ciscan and we will monitor this information for you.

When ordering, please specify:

Model No.

Cartridge Replacement No.



C. E. Niehoff & Co.

BRUSHLESS ALTERNATORS

A1-101
A1-103
A1-105

INSTALLATION INSTRUCTIONS

INSTALLATION

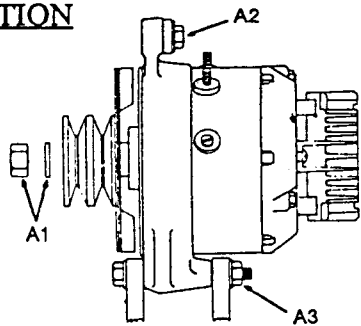


Figure A

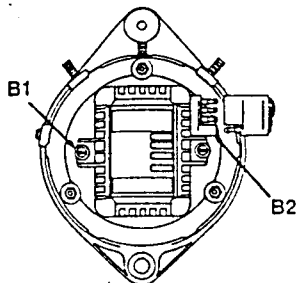


Figure B

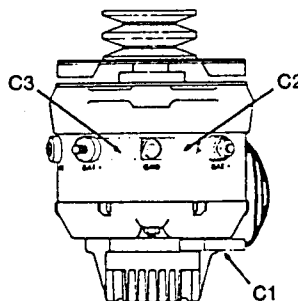


Figure C

Alternators intended for marine use must be installed in conformance with TITLE 33 CFR PART 183 SUBPART I - ELECTRICAL SYSTEMS.

1. MOUNT FAN AND PULLEY (Figure A).

Torque to 50 ft. lbs. using locknut and hardened washer (A1) supplied on alternator shaft.

b. Insert mounting bolt and hand tighten nut (A3). Bolt should be new and SAE Grade 5 or better. Nut should be self locking or coated with "Loctite Lock and Seal" or equivalent.

2. MOUNT AND CONNECT REGULATOR (Figures B and C).

- a. Position regulator plug and secure regulator with screws (B1) provided in regulator package. Regulator plug must be securely held in place by regulator (B2).
- b. Connect alternator plug to regulator plug (C1).

5. SET BELT TENSION (Figure A).

- a. On engines where the belt drives only the alternator, use a belt tension gauge and set tension at 40 to 50 lbs. New belts should be set at 75 lbs. On engines where the belt also drives other accessories, consult manufacturer's specifications. If belt tension gauge is not available, set tension so that the fan cannot be turned by hand. CAUTION: DO NOT SET TENSION TOO HIGH AS THIS WILL CAUSE PREMATURE BEARING FAILURE.
- b. Tighten bolt (A2) on belt adjusting bracket. Torque to 17 ft. lbs.
- c. Tighten mounting bolt (A3). Torque to 35 ft. lbs.

3. POSITION GROUND LINK (Figure C).

Units are shipped with the ground link installed for negative ground as shown (C2). Reverse connections for positive ground as indicated by dotted line (C3).

4. INSTALL ALTERNATOR (Figure A).

- a. Attach belt adjusting bracket with bolt (A2) included in parts package.

WIRING

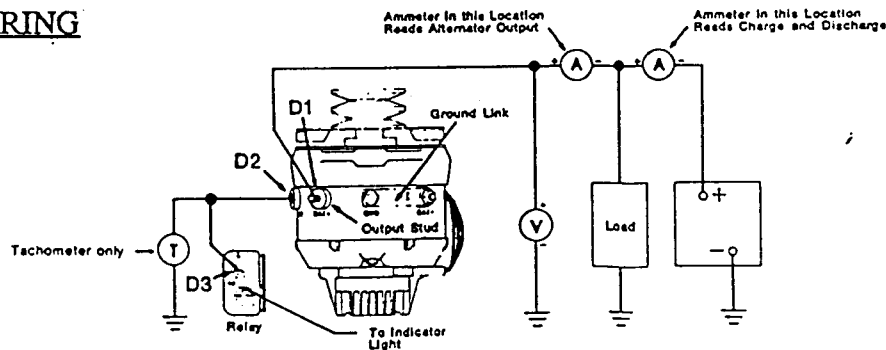


Figure D

CAUTION: Do not ground "REL" or "R" terminal to frame.

CAUTION: Connecting the alternator improperly can cause serious damage.

1. For negative ground systems, connect existing battery wire to "BAT+" (D1) on alternator. For positive ground systems, connect battery wire to "BAT-" on alternator. Be sure ground link is positioned correctly (C2 or C3).
2. On negative ground applications where a warning light is used, connect wire from "R" (D2) terminal on the alternator to the A2-250 relay (D3).

NOTE: For isolated ground applications, discard the ground link. Attach both the positive and negative leads directly to the alternator.

SYSTEM SPECIFICATIONS									
BRUSHLESS ALTERNATOR	EXTERNAL REGULATOR	MINIMUM WIRE SIZE (AWG)	VOLTS	AMPS	GROUND	MAXIMUM RPM	REGULATOR		WEIGHT (POUNDS)
							STEPS	VOLTAGE SETTINGS	
A1-101	A2-101	10	24	30	N OR P	10,000	2	27.6 / 29.0	18
A1-101	A2-103	10	32	30	N OR P	10,000	2	36.8 / 38.4	18
A1-103	A2-101	6	24	50	N OR P	10,000	2	27.6 / 29.0	18
A1-105	A2-108	4	24	65	N OR P	10,000	2	27.6 / 29.0	18

TROUBLE SHOOTING

If, after installation, the system does not meet specifications:

1. Review installation instructions step by step.
2. Check all wiring for clean and secure connections.
3. Excite field coil to re-establish magnetic field in rotor core. See instructions below for details.
4. If system still does not operate properly, connect ammeter and voltmeter to read alternator output. Set engine R.P.M. at 1500 to 2000. Read amps and voltage and compare to chart.

AMPS	VOLTS	
LOW or 0	NORMAL 27.0 (36.0)* to 29.6 (39.2)*	Charging system operating properly.
LOW or 0	LOW Less than 27.0 (38.0)*	1. Check belt tension. 2. Bypass regulator. See figure E below.
HIGH	HIGH More than 29.6 (39.2)*	1. Check regulator connections and grounds. 2. If voltage is still high, replace regulator.
HIGH	LOW Less than 27.0 (36.0)*	Discharged or defective battery. Charge or replace battery.

* On 32 Volt Systems.

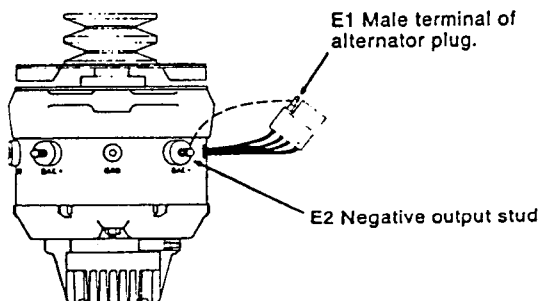
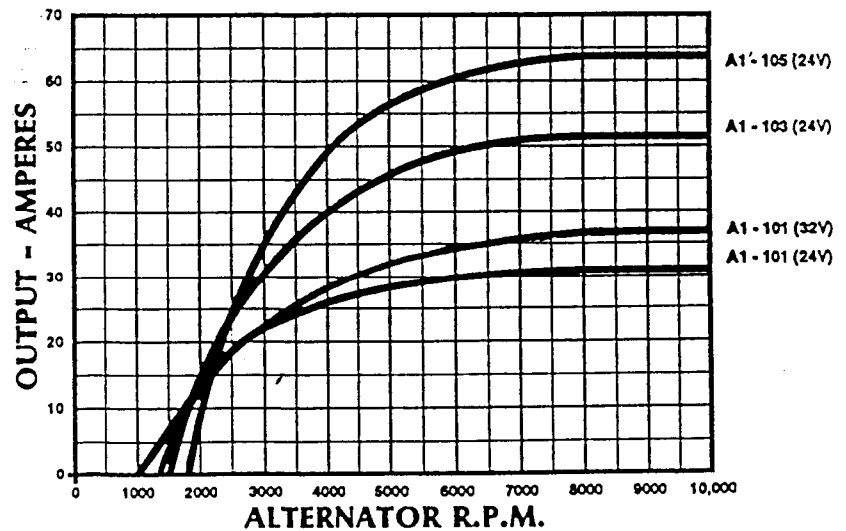


Figure E



Re-establishing magnetic field.

There are several conditions which may cause the alternator to lose its magnetic field. To re-establish the magnetic field, perform the following procedure:

With engine running, disconnect plug between alternator and regulator and momentarily touch the male terminal (E1) from the alternator plug to the negative output stud (E2) on the alternator (Figure E). **Caution:** Touching regulator terminal to the negative output stud must be rapid to avoid possible alternator damage.

If no output is obtained - See Service Manual for specific alternator test.

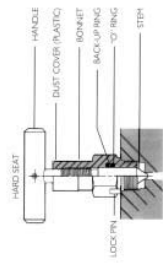
FAN AND PULLEY INFORMATION

Use Fan & Pulley Assembly: A3-300, A3-301, A3-302, A3-303; or, Fan A3-101 with A3-403 Bushing and A3-202 or A3-203 Pulley. Any keyed alternator pulley with appropriate dimensions can be used with A3-403 Bushing and A3-101 Fan.

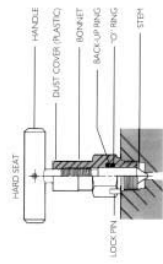
Century Valve's exclusive gauge valve line utilizes several different bonnet styles to increase operational flexibility and process compatibility. In addition to traditional rotating stem configuration, Century Valve offers the exclusive patented "non-rotating stem" bonnet assemblies on most gauge valve models. The patented non-rotating stems share these outstanding features:

- Greatly improved packing life
- Eliminates seat tearing or galling
- Maximum sealing integrity with minimum operating torque
- Actuating threads completely isolate threads, ensuring no possibility of thread contamination
- Self-aligning non-rotating plug for rottable valves

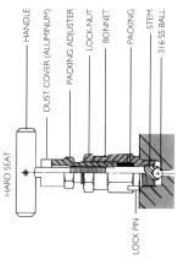
TYPE 'A' BONNET ASSEMBLY
(interchangeable with 'C' bonnet)



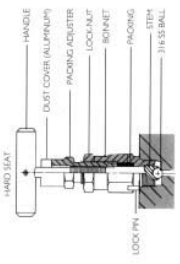
TYPE 'B' BONNET ASSEMBLY
(interchangeable with 'D' bonnet)



TYPE 'C' BONNET ASSEMBLY
optional needle stem available (CN)
(interchangeable with 'A' bonnet)



TYPE 'D' BONNET ASSEMBLY
optional needle stem available (DN)
(interchangeable with 'B' bonnet)



STEM SEAL MATERIAL & TEMPERATURE RANGE	NEEDLE/TIPPED STEM	BALL/TIPPED STEM	NON-ROTATING STEM, NEEDLE
A - AELASH - 23°F (-5°C) TO +400°F (204°C)			
G - GRAFOIL® - 40°F (4°C) TO +1000°F (538°C)			
T - TETLON® - 320°F (160°C) TO +400°F (204°C)			
V - VITON® - 20°F (-29°C) TO +400°F (204°C)			

Servicing
Canada,
the United
States,
the Middle
East,
China,
Europe,
Russia,
and the
North Sea



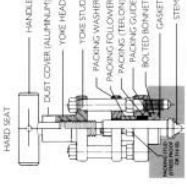
CENTURY VALVE OFFERS
A COMPLETE LINE OF
INSTRUMENTATION VALVES AND
CM BRAND™ THERMOVELLS
MANUFACTURED IN CANADA.
CENTURY'S NEEDLE, GAUGE
AND MANIFOLD VALVES ARE
KNOWN WORLDWIDE FOR
PERFORMANCE
AND RELIABILITY.



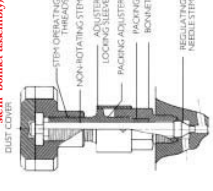
GAUGE VALVES

PRACTICED
DESIGN ...
PROVEN
PERFORMANCE

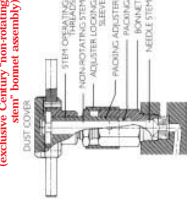
TYPE 'E' BONNET ASSEMBLY



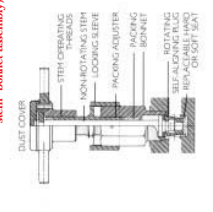
TYPE 'M' BONNET ASSEMBLY
(exclusive Century "non-rotating stem" bonnet assembly)



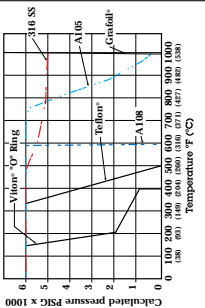
TYPE 'L' BONNET ASSEMBLY
(exclusive Century "non-rotating stem" bonnet assembly)



TYPE 'P' BONNET ASSEMBLY
(exclusive Century "non-rotating stem" bonnet assembly)



PRESSURE/TEMPERATURE RATINGS
Pressures are constant from -223°F (-196°C) to 1000°F (538°C) for all materials. For temperatures above 1000°F (538°C) and pressures above 1000 PSIG (68.9 MPa), contact Century Valve for code designation. For temperatures down to -429°F (254°C) contact Century Valve.



All of Century's valves are hydraulically pressure tested to rated pressure.

Century Valve reserves the right to alter the specifications given in this publication. Subject to change without notice. Century Valve is not responsible for any omissions or errors. Century Valve is not responsible for any damage or injury resulting from the use of its products and accessories.



PRINTED IN CANADA

M A T E R I A L S A F E T Y D A T A S H E E T

Prod.ID: 76002

=====
SECTION I - PRODUCT IDENTIFICATION
=====

PRODUCT NAME: SPEED ENAMEL CLEAR BASE

PRODUCT IDENTIFIER: 76002

HMIS CODES: H 1 F 3 R 1 P B

PRODUCT USE: General purpose coating.

PRODUCT IDENTIFICATION NUMBER: UN1263

WHMIS INFO: B2,D2B

MANUFACTURER'S NAME: Cloverdale Paint Inc

ADDRESS : 6950 King George Hwy

Surrey, BC,

EMERGENCY PHONE : 613-996-6666

REVISION DATE : 30-Mar-04

INFORMATION PHONE : 604-596-6261

ABBREVIATIONS : N/AP - NOT APPLICABLE N/AV - NOT AVAILABLE

=====
SECTION II - HAZARDOUS INGREDIENTS
=====

REPORTABLE COMPONENTS	CAS NUMBER	WEIGHT PERCENT	O.E.L.
*XYLENE	1330-20-	15-40	
	7		ACGIH TLV: 100 PPM LD50: ORAL:4g/kg rat, LC50: 6500 ppm/4H(RAT) LD50: SKIN:5000 mg/kg (RABBIT)
ETHYLBENZENE	100-41-	10-30	
	4		TWA: 100ppm LD50 (ORAL-RAT): 3500 mg/kg LD50: SKIN:17800 mg/kg (RABBIT)
LIGHT NAPHTHA - HYDROTREATED	64742- 49-0	10-30	
			ACGIH TLV: 400 ppm LD50:ORAL:>25000 mg/kg (RAT), LC50:16000 ppm/4H (RAT)

* Indicates toxic chemical(s) subject to the reporting requirements of section 313 of Title III and of 40 CFR 372.

=====
SECTION III - PHYSICAL/CHEMICAL CHARACTERISTICS
=====

BOILING POINT: Not available. SPECIFIC GRAVITY (H2O=1): 0.92
VAPOR DENSITY: Heavier than air. PHYSICAL STATE: Liquid.
EVAPORATION RATE: Faster than n-Butyl Acetate.
COATING V.O.C.: 563 g/l
SOLUBILITY IN WATER: Insoluble.
APPEARANCE AND ODOR: Moderately thick liquid; Aromatic odor.
FREEZING POINT: Not available. pH: Not available.
COEFFICIENT OF WATER/OIL DIST: N/AV ODOR THRESHOLD:1-30 ppm

=====
SECTION IV - FIRE AND EXPLOSION HAZARD DATA
=====

FLASH POINT: -7 C METHOD USED: TCC
FLAMMABLE LIMITS IN AIR BY VOLUME- LOWER: 1.0 UPPER: 12.1

EXTINGUISHING MEDIA:
Foam, CO2, dry chemical, water fog.

SPECIAL FIREFIGHTING PROCEDURES
Respiratory equipment should be worn to avoid inhalation of concentrated vapours. Water should not be used except as a fog to keep nearby containers cool.

UNUSUAL FIRE AND EXPLOSION HAZARDS
Handle as a flammable liquid. Vapours form an explosive mixture in air between the upper and lower explosive limits, which, can be ignited by many sources such as pilot lights, open flames, electrical boxes and switches. Vapour may travel along the ground and flashback along vapour trail may occur.

FLAMMABILITY - T.D.G.R. CLASS:
TDG CLASS 3

SENSITIVITY TO IMPACT: NO

AUTO-IGNITION TEMPERATURE:

Not available

SENSITIVITY TO STATIC DISCHARGE: Yes

HAZARDOUS COMBUSTION PRODUCTS:

Carbon Monoxide, Carbon Dioxide and Oxides of Nitrogen.

===== SECTION V - REACTIVITY DATA =====

CHEMICAL STABILITY: STABLE

CONDITIONS TO AVOID:

Excessive heat, poor ventilation, corrosive atmospheres, excessive aging.

INCOMPATIBILITY (MATERIALS TO AVOID)

Alkaline materials, strong acids and oxidizing agents.

HAZARDOUS DECOMPOSITION OR BYPRODUCTS: NONE KNOWN

HAZARDOUS POLYMERIZATION:

Will not occur.

===== SECTION VI - TOXICOLOGICAL DATA =====

INHALATION HEALTH RISKS AND SYMPTOMS OF EXPOSURE

May cause respiratory irritation, dizziness, breathing difficulty, headaches and loss of co-ordination.

SKIN AND EYE CONTACT HEALTH RISKS AND SYMPTOMS OF EXPOSURE

Eye Contact: May cause severe irritation, tearing, redness and blurred vision.

Skin Contact: May cause irritation.

SKIN ABSORPTION HEALTH RISKS AND SYMPTOMS OF EXPOSURE

May dry and defat skin causing cracks, irritation and dermatitis.

INGESTION HEALTH RISKS AND SYMPTOMS OF EXPOSURE

May cause gastrointestinal irritation, vomiting, nausea and diarrhea.

HEALTH HAZARDS (ACUTE AND CHRONIC)

Acute health hazards are as listed above. No chronic health hazards.

SENSITIZING CAPABILITY: NONE KNOWN

CARCINOGENICITY: NTP CARCINOGEN:No IARC MONOGRAPHS:Yes OSHA REGULATED:No

Ethylbenzene has been classified by the IARC as a Group 2B substance on the basis of sufficient evidence for carcinogenicity in laboratory animals but inadequate evidence for cancer in humans.

TERATOGENICITY AND EMBRYOTOXICITY

High exposures to xylenes in some animal studies have been reported to cause health effects on the developing embryo/fetus. These effects were often at levels toxic to the mother. The significance of these findings to humans has not been determined.

REPRODUCTIVE TOXICITY

Not available.

MUTAGENICITY

Not available.

TOXICOLOGICALLY SYNERGISTIC PRODUCTS

None known.

MEDICAL CONDITIONS GENERALLY AGGRAVATED BY EXPOSURE

Anesthesia, respiratory tract irritation, dermatitis, nausea, vomiting.

===== SECTION VII - PREVENTIVE MEASURES =====

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED

Eliminate ignition sources. Provide good ventilation or wear appropriate breathing apparatus. Absorb small spills with non-flammable absorbent. Contain spills by diking with non-flammable

absorbent. Notify environmental agency.

WASTE DISPOSAL METHOD

Reclaim or dispose of through a licensed waste disposal company according to Federal, Provincial and local regulations.

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING

Flammable. Store in a cool, dry, well ventilated area away from heat and ignition sources. Keep containers closed when not in use. Avoid breathing vapours or mist and prolonged or repeated contact with skin. Launder contaminated clothing prior to re-use. Use good personal hygiene. Product is a static accumulator. Transfer equipment should be grounded or bonded.

OTHER PRECAUTIONS: Smoking in the area where this material is used must be strictly prohibited.

RESPIRATORY PROTECTION

NIOSH approved for organic vapours and particulate matter.

VENTILATION

General mechanical ventilation or local exhaust should be suitable to keep vapour concentrations below TLV. Ventilation equipment must be explosion proof. Make up air should be supplied to balance air exhausted.

PROTECTIVE GLOVES

Solvent impervious e.g. Viton, Nitrile, PVC.

EYE PROTECTION

Chemical safety glasses, goggles or face shield.

OTHER PROTECTIVE CLOTHING OR EQUIPMENT

Use impermeable aprons and protective clothing whenever possible to prevent skin contact.

WORK/HYGIENIC PRACTICES

Eye washes and safety showers in the workplace are recommended.

==== SECTION VIII - FIRST AID MEASURES =====

INHALATION OVEREXPOSURE: Move person to fresh air. If breathing stops, apply artificial respiration and seek immediate medical attention.

EYE CONTACT: Flush with water for at least 15 minutes. Seek medical attention.

SKIN CONTACT: Wash thoroughly with mild soap and water.

INGESTION: Do not induce vomiting. Aspiration of solvents in this product can cause inflammation of the lungs.

==== SECTION IX - PREPARATION =====

PREPARED BY: TECHNICAL DEPARTMENT

==== SECTION X - DISCLAIMER =====

To the best of our knowledge, the information contained herein is accurate, obtained from sources believed by Cloverdale Paint Inc. to be accurate. No warranty concerning the accuracy of these sources is made and Cloverdale Paint Inc. will not be held liable for claims relating to use of this information or recommendations.

M A T E R I A L S A F E T Y D A T A S H E E T

Prod.ID: 78011

===== SECTION I - PRODUCT IDENTIFICATION =====

PRODUCT NAME: CLOVA THINNER #11
PRODUCT IDENTIFIER: 78011
PRODUCT USE : Paint thinner
PRODUCT IDENTIFICATION NUMBER: UN1307
WHMIS INFO.: B2,D2B

HMIS CODES: H F R P
1 3 1 I

MANUFACTURER'S NAME: Cloverdale Paint Inc.
ADDRESS : 6950 King George Highway
Surrey, BC, Canada
V3W 4Z1

EMERGENCY PHONE : (613) 996-6666 REVISION DATE: 03/05/01
INFORMATION PHONE : (604) 596-6261
ABBREVIATIONS: N/AP - NOT APPLICABLE N/AV - NOT AVAILABLE

===== SECTION II - HAZARDOUS INGREDIENTS =====

REPORTABLE COMPONENTS CAS NUMBERWEIGHT PERCENTOCCUPATIONAL EXPOSURE LIMITS

* XYLENE 1330-20-7 60-100
ACGIH TLV: 100 PPM
LD50: ORAL:4g/kg rat, LC50: 6500 ppm/4H(RAT)

ETHYLBENZENE 100-41-4 10-30
TWA: 100ppm LD50 (ORAL-RAT): 3500 mg/kg

* Indicates toxic chemical(s) subject to the reporting requirements of section 313 of Title III and of 40 CFR 372.

===== SECTION III - PHYSICAL/CHEMICAL CHARACTERISTICS =====

BOILING POINT: 136.2 C SPECIFIC GRAVITY (H2O=1): 0.87
VAPOR DENSITY: Heavier than air.

PHYSICAL STATE: Liquid.

EVAPORATION RATE: Slower than n-Butyl Acetate.

VAPOR PRESSURE: mm Hg @ TEMP (F)
5 68
7 20C

COATING V.O.C. : 867 g/l
SOLUBILITY IN WATER: Insoluble.
APPEARANCE AND ODOR: Clear, Thin liquid; Aromatic odor.
FREEZING POINT: Not available. pH: N/AP
COEFFICIENT OF WATER/OIL DIST: N/AV ODOR THRESHOLD: 1-30 ppm

===== SECTION IV - FIRE AND EXPLOSION HAZARD DATA =====

FLASH POINT: 15 C METHOD USED: CC
FLAMMABLE LIMITS IN AIR BY VOLUME(%)- LOWER: 1% UPPER: 7

EXTINGUISHING MEDIA: Foam,CO2,Dry chemical, Water fog.

SPECIAL FIREFIGHTING PROCEDURES

Respiratory equipment should be worn to avoid inhalation of concentrated vapours. Water should not be used except as a fog to keep nearby containers cool.

UNUSUAL FIRE AND EXPLOSION HAZARDS

Handle as a flammable liquid. Vapours form an explosive mixture in air between the upper and lower explosive limits, which, can be ignited by many sources such as pilot lights, open flames, electrical boxes and switches. Vapour may travel

along the ground and flashback along vapour trail may occur.

FLAMMABILITY - T.D.G.R. CLASS
3.3,9.2

SENSITIVITY TO IMPACT: NO

AUTO-IGNITION TEMPERATURE:
Not available 527 deg C

SENSITIVITY TO STATIC DISCHARGE
Yes

HAZARDOUS COMBUSTION PRODUCTS:

Carbon Monoxide, Carbon Dioxide and Oxides of Nitrogen.

===== SECTION V - REACTIVITY DATA =====

CHEMICAL STABILITY: STABLE

CONDITIONS TO AVOID

Excessive heat, Poor ventilation, Corrosive atmospheres, Excessive aging.

INCOMPATIBILITY (MATERIALS TO AVOID)

Alkaline materials, strong acids and oxidizing agents.

HAZARDOUS DECOMPOSITION OR BYPRODUCTS: NONE KNOWN

HAZARDOUS POLYMERIZATION: Will not occur.

===== SECTION VI - TOXICOLOGICAL DATA =====

INHALATION HEALTH RISKS AND SYMPTOMS OF EXPOSURE

May cause respiratory irritation, dizziness, breathing difficulty, headaches and loss of co-ordination.

SKIN AND EYE CONTACT HEALTH RISKS AND SYMPTOMS OF EXPOSURE

Eye Contact: May cause severe irritation, tearing, redness and blurred vision.

Skin Contact: May cause irritation.

SKIN ABSORPTION HEALTH RISKS AND SYMPTOMS OF EXPOSURE

May dry and defat skin causing cracks, irritation and dermatitis.

INGESTION HEALTH RISKS AND SYMPTOMS OF EXPOSURE

May cause gastrointestinal irritation, vomiting, nausea and diarrhea.

HEALTH HAZARDS (ACUTE AND CHRONIC)

Acute health hazards are as listed above.

No chronic health hazards.

SENSITIZING CAPABILITY: NONE KNOWN

CARCINOGENICITY: NTP CARCINOGEN: No IARC MONOGRAPHS: Yes OSHA REGULATED: No

Ethylbenzene has been classified by the IARC as a Group 2B substance on the basis of sufficient evidence for carcinogenicity in laboratory animals but inadequate evidence for cancer in humans.

TERATOGENICITY AND EMBRYOTOXICITY

High exposures to xylenes in some animal studies have been reported to cause health effects on the developing embryo/fetus. These effects were often at levels toxic to the mother. The significance of these findings to humans has not been determined.

REPRODUCTIVE TOXICITY

Not available.

MUTAGENICITY

Not available.

TOXICOLOGICALLY SYNERGISTIC PRODUCTS

None known.

MEDICAL CONDITIONS GENERALLY AGGRAVATED BY EXPOSURE

Anesthesia, respiratory tract irritation, dermatitis, nausea, vomiting.

===== SECTION VII - PREVENTIVE MEASURES =====

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED

Eliminate ignition sources. Provide good ventilation or wear appropriate breathing apparatus. Absorb small spills with non-flammable absorbent. Contain spills by diking with non-flammable absorbent. Notify environmental agency.

WASTE DISPOSAL METHOD

Reclaim or dispose of through a licensed waste disposal company according to Federal, Provincial and local regulations.

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING

Flammable. Store in a cool, dry, well ventilated area away from heat and ignition sources. Keep containers closed when not in use. Avoid breathing vapours or mist and prolonged or repeated contact with skin. Launder contaminated clothing prior to re-use. Use good personal hygiene. Product is a static accumulator. Transfer equipment should be grounded or bonded.

OTHER PRECAUTIONS

Smoking in the area where this material is used must be strictly prohibited.

RESPIRATORY PROTECTION

NIOSH approved for organic vapours and particulate matter.

VENTILATION

General mechanical ventilation or local exhaust should be suitable to keep vapour concentrations below TLV. Ventilation equipment must be explosion proof. Make up air should be supplied to balance air exhausted.

PROTECTIVE GLOVES

Solvent impervious e.g. Viton, Nitrile, PVC.

EYE PROTECTION

Chemical safety glasses, goggles or face shield.

OTHER PROTECTIVE CLOTHING OR EQUIPMENT

Use impermeable aprons and protective clothing whenever possible to prevent skin contact.

WORK/HYGIENIC PRACTICES

Eye washes and safety showers in the workplace are recommended.

===== SECTION VIII - FIRST AID MEASURES =====

INHALATION OVEREXPOSURE: Move person to fresh air. If breathing stops, apply artificial respiration and seek immediate medical attention.

EYE CONTACT: Flush with water for at least 15 minutes. Seek medical attention.

SKIN CONTACT: Wash thoroughly with mild soap and water.

INGESTION: Do not induce vomiting. Aspiration of solvents in this product can cause inflammation of the lungs.

===== SECTION IX - PREPARATION =====

PREPARED BY: TECHNICAL DEPARTMENT

===== SECTION X - DISCLAIMER =====

To the best of our knowledge, the information contained herein is accurate, obtained from sources believed by Cloverdale Paint Inc. to be accurate. No warranty concerning the accuracy of these sources is made and Cloverdale Paint Inc. will not be held liable for claims relating to use of this information or recommendations.

SENSITIVITY TO STATIC DISCHARGE
Yes

HAZARDOUS COMBUSTION PRODUCTS:
Carbon Monoxide, Carbon Dioxide and Oxides of Nitrogen.

===== SECTION V - REACTIVITY DATA =====

CHEMICAL STABILITY: STABLE

CONDITIONS TO AVOID
Excessive heat, Poor ventilation, Corrosive atmospheres, Excessive aging.

INCOMPATIBILITY (MATERIALS TO AVOID)
Alkaline materials, strong acids and oxidizing agents.

HAZARDOUS DECOMPOSITION OR BYPRODUCTS: NONE KNOWN

HAZARDOUS POLYMERIZATION: Will not occur.

===== SECTION VI - TOXICOLOGICAL DATA =====

INHALATION HEALTH RISKS AND SYMPTOMS OF EXPOSURE
May cause respiratory irritation, dizziness, breathing difficulty, headaches and loss of co-ordination.

SKIN AND EYE CONTACT HEALTH RISKS AND SYMPTOMS OF EXPOSURE
Eye Contact: May cause severe irritation, tearing, redness and blurred vision.
Skin Contact: May cause irritation.

SKIN ABSORPTION HEALTH RISKS AND SYMPTOMS OF EXPOSURE
May dry and defat skin causing cracks, irritation and dermatitis.

INGESTION HEALTH RISKS AND SYMPTOMS OF EXPOSURE
May cause gastrointestinal irritation, vomiting, nausea and diarrhea.

HEALTH HAZARDS (ACUTE AND CHRONIC)
Acute health hazards are as listed above.
No chronic health hazards.

SENSITIZING CAPABILITY: NONE KNOWN

CARCINOGENICITY: NTP CARCINOGEN: No IARC MONOGRAPHS: Yes OSHA REGULATED: No
Ethylbenzene has been classified by the IARC as a Group 2B substance on the basis of sufficient evidence for carcinogenicity in laboratory animals but inadequate evidence for cancer in humans.

TERATOGENICITY AND EMBRYOTOXICITY
High exposures to xylenes in some animal studies have been reported to cause health effects on the developing embryo/fetus. These effects were often at levels toxic to the mother. The significance of these findings to humans has not been determined.

REPRODUCTIVE TOXICITY
Not available.

MUTAGENICITY
Not available.

TOXICOLOGICALLY SYNERGISTIC PRODUCTS
None known.

MEDICAL CONDITIONS GENERALLY AGGRAVATED BY EXPOSURE
Anesthesia, respiratory tract irritation, dermatitis, nausea, vomiting.

===== SECTION VII - PREVENTIVE MEASURES =====

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED
Eliminate ignition sources. Provide good ventilation or wear appropriate breathing apparatus. Absorb small spills with non-flammable absorbent. Contain spills by diking with non-flammable absorbent. Notify environmental agency.

WASTE DISPOSAL METHOD
Reclaim or dispose of through a licensed waste disposal company according to Federal, Provincial and local regulations.

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING

Flammable. Store in a cool, dry, well ventilated area away from heat and ignition sources. Keep containers closed when not in use. Avoid breathing vapours or mist and prolonged or repeated contact with skin. Launder contaminated clothing prior to re-use. Use good personal hygiene. Product is a static accumulator. Transfer equipment should be grounded or bonded.

OTHER PRECAUTIONS

Smoking in the area where this material is used must be strictly prohibited.

RESPIRATORY PROTECTION

NIOSH approved for organic vapours and particulate matter.

VENTILATION

General mechanical ventilation or local exhaust should be suitable to keep vapour concentrations below TLV. Ventilation equipment must be explosion proof. Make up air should be supplied to balance air exhausted.

PROTECTIVE GLOVES

Solvent impervious e.g. Viton, Nitrile, PVC.

EYE PROTECTION

Chemical safety glasses, goggles or face shield.

OTHER PROTECTIVE CLOTHING OR EQUIPMENT

Use impermeable aprons and protective clothing whenever possible to prevent skin contact.

WORK/HYGIENIC PRACTICES

Eye washes and safety showers in the workplace are recommended.

===== SECTION VIII - FIRST AID MEASURES =====

INHALATION OVEREXPOSURE: Move person to fresh air. If breathing stops, apply artificial respiration and seek immediate medical attention.

EYE CONTACT: Flush with water for at least 15 minutes. Seek medical attention.

SKIN CONTACT: Wash thoroughly with mild soap and water.

INGESTION: Do not induce vomiting. Aspiration of solvents in this product can cause inflammation of the lungs.

===== SECTION IX - PREPARATION =====

PREPARED BY: TECHNICAL DEPARTMENT

===== SECTION X - DISCLAIMER =====

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M A T E R I A L S A F E T Y D A T A S H E E T

Prod.ID: 83203

===== SECTION I - PRODUCT IDENTIFICATION =====

PRODUCT NAME: HI-HEAT ALUMINUM

PRODUCT IDENTIFIER: 83203

HMIS CODES: H 1 F 2 R 0 P H

PRODUCT USE: General purpose coating.

PRODUCT IDENTIFICATION NUMBER: UN1263

WHMIS INFO:

MANUFACTURER'S NAME: Cloverdale Paint Inc

ADDRESS : 6950 King George Hwy

Surrey, BC,

EMERGENCY PHONE : 613-996-6666

REVISION DATE : 31-Mar-04

INFORMATION PHONE : 604-596-6261

ABBREVIATIONS : N/AP - NOT APPLICABLE N/AV - NOT AVAILABLE

===== SECTION II - HAZARDOUS INGREDIENTS =====

REPORTABLE COMPONENTS	CAS NUMBER	WEIGHT PERCENT	O.E.L.
*XYLENE	1330-20-7	15-40	ACGIH TLV: 100 PPM LD50: ORAL:4g/kg rat, LC50: 6500 ppm/4H(RAT) LD50: SKIN:5000 mg/kg (RABBIT)
*TOLUENE	108-88-3	7-13	ACGIH TLV: 100 ppm LD50: >2g/kg ORAL RAT, LC50: 8000 ppm/4H(RAT)
ETHYLBENZENE	100-41-4	5-10	TWA: 100ppm LD50 (ORAL-RAT): 3500 mg/kg LD50: SKIN:17800 mg/kg(RABBIT)
*ALUMINUM POWDER	7429-90-5	5-10	TWA: 10 mg/m3
STODDARD SOLVENT	8052-41-3	1-5	ACGIH TLV: 100 ppm LD50: ORAL:>5g/kg(RAT), LC50:>5g/M3/4H(RAT)

* Indicates toxic chemical(s) subject to the reporting requirements of section 313 of Title III and of 40 CFR 372.

===== SECTION III - PHYSICAL/CHEMICAL CHARACTERISTICS =====

BOILING POINT: Not available. SPECIFIC GRAVITY (H2O=1): 1.00
 VAPOR DENSITY: Heavier than air. PHYSICAL STATE: Liquid.
 EVAPORATION RATE: Slower than n-Butyl Acetate.
 COATING V.O.C.: 634 g/l
 SOLUBILITY IN WATER: Insoluble.
 APPEARANCE AND ODOR: Moderately thick liquid; Aromatic odor.
 FREEZING POINT: Not available. pH: Not available.
 COEFFICIENT OF WATER/OIL DIST: N/AV ODOR THRESHOLD:1-30 ppm

===== SECTION IV - FIRE AND EXPLOSION HAZARD DATA =====

FLASH POINT: 6 C METHOD USED: Not available.
 FLAMMABLE LIMITS IN AIR BY VOLUME- LOWER: 1.0 UPPER: 7.1

EXTINGUISHING MEDIA:
 Foam,CO2,dry chemical, water fog.

SPECIAL FIREFIGHTING PROCEDURES
 Respiratory equipment should be worn to avoid inhalation of concentrated vapours. Water should not be used except as a fog to keep nearby containers cool.

UNUSUAL FIRE AND EXPLOSION HAZARDS
 Handle as a flammable liquid. Vapours form an explosive mixture in air between the upper and lower explosive limits, which, can be ignited by many sources such as pilot lights, open flames, electrical boxes and switches. Vapour may travel along the ground and flashback along vapour trail may occur.

FLAMMABILITY - T.D.G.R. CLASS:
 TDG CLASS 3

SENSITIVITY TO IMPACT: NO

AUTO-IGNITION TEMPERATURE:
 Not available

SENSITIVITY TO STATIC DISCHARGE: Yes

HAZARDOUS COMBUSTION PRODUCTS:
 Carbon Monoxide, Carbon Dioxide and Oxides of Nitrogen.

===== SECTION V - REACTIVITY DATA =====

CHEMICAL STABILITY: STABLE

CONDITIONS TO AVOID:

Excessive heat, poor ventilation, corrosive atmospheres, excessive aging.

INCOMPATIBILITY (MATERIALS TO AVOID)

Alkaline materials, strong acids and oxidizing agents.

HAZARDOUS DECOMPOSITION OR BYPRODUCTS: NONE KNOWN

HAZARDOUS POLYMERIZATION:

Will not occur.

===== SECTION VI - TOXICOLOGICAL DATA =====

INHALATION HEALTH RISKS AND SYMPTOMS OF EXPOSURE

May cause respiratory irritation, dizziness, breathing difficulty, headaches and loss of co-ordination.

SKIN AND EYE CONTACT HEALTH RISKS AND SYMPTOMS OF EXPOSURE

Eye Contact: May cause severe irritation, tearing, redness and blurred vision.

Skin Contact: May cause irritation.

SKIN ABSORPTION HEALTH RISKS AND SYMPTOMS OF EXPOSURE

May dry and defat skin causing cracks, irritation and dermatitis.

INGESTION HEALTH RISKS AND SYMPTOMS OF EXPOSURE

May cause gastrointestinal irritation, vomiting, nausea and diarrhea.

HEALTH HAZARDS (ACUTE AND CHRONIC)

Acute health hazards are as listed above. No chronic health hazards.

SENSITIZING CAPABILITY: NONE KNOWN

CARCINOGENICITY: NTP CARCINOGEN:No IARC MONOGRAPHS:Yes OSHA REGULATED:No

Ethylbenzene has been classified by the IARC as a Group 2B substance on the basis of sufficient evidence for carcinogenicity in laboratory animals but inadequate evidence for cancer in humans.

TERATOGENICITY AND EMBRYOTOXICITY

High exposures to xylenes in some animal studies have been reported to cause health effects on the developing embryo/fetus. These effects were often at levels toxic to the mother. The significance of these findings to humans has not been determined.

REPRODUCTIVE TOXICITY

Not available.

MUTAGENICITY

Not available.

TOXICOLOGICALLY SYNERGISTIC PRODUCTS

None known.

MEDICAL CONDITIONS GENERALLY AGGRAVATED BY EXPOSURE

Anesthesia, respiratory tract irritation, dermatitis, nausea, vomiting.

===== SECTION VII - PREVENTIVE MEASURES =====

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED

Eliminate ignition sources. Provide good ventilation or wear appropriate breathing apparatus. Absorb small spills with non-flammable absorbent. Contain spills by diking with non-flammable absorbent. Notify environmental agency.

WASTE DISPOSAL METHOD

Reclaim or dispose of through a licensed waste disposal company according to Federal, Provincial and local regulations.

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING

Flammable. Store in a cool, dry, well ventilated area away from heat and ignition sources. Keep containers closed when not in use. Avoid breathing vapours or mist and prolonged or repeated contact with skin. Launder contaminated clothing prior to re-use. Use good personal hygiene. Product is a static accumulator. Transfer equipment should be grounded or bonded.

OTHER PRECAUTIONS: Smoking in the area where this material is used must be strictly prohibited.

RESPIRATORY PROTECTION

NIOSH approved for organic vapours and particulate matter.

VENTILATION

General mechanical ventilation or local exhaust should be suitable to keep vapour concentrations below TLV. Ventilation equipment must be explosion proof. Make up air should be supplied to balance air exhausted.

PROTECTIVE GLOVES

Solvent impervious e.g. Viton, Nitrile, PVC.

EYE PROTECTION

Chemical safety glasses, goggles or face shield.

OTHER PROTECTIVE CLOTHING OR EQUIPMENT

Use impermeable aprons and protective clothing whenever possible to prevent skin contact.

WORK/HYGIENIC PRACTICES

Eye washes and safety showers in the workplace are recommended.

===== SECTION VIII - FIRST AID MEASURES =====

INHALATION OVEREXPOSURE: Move person to fresh air. If breathing stops, apply artificial respiration and seek immediate medical attention.

EYE CONTACT: Flush with water for at least 15 minutes. Seek medical attention.

SKIN CONTACT: Wash thoroughly with mild soap and water.

INGESTION: Do not induce vomiting. Aspiration of solvents in this product can cause inflammation of the lungs.

===== SECTION IX - PREPARATION =====

PREPARED BY: TECHNICAL DEPARTMENT

===== SECTION X - DISCLAIMER =====

To the best of our knowledge, the information contained herein is accurate, obtained from sources believed by Cloverdale Paint Inc. to be accurate. No warranty concerning the accuracy of these sources is made and Cloverdale Paint Inc. will not be held liable for claims relating to use of this information or recommendations.

M A T E R I A L S A F E T Y D A T A S H E E T

Prod.ID: T-240

PRODUCT NAME: IND. ENAMEL URETHANE/ACRYLIC - WHITE
 PRODUCT CODE: T-240
 PRODUCT USE : INDUSTRIAL COATING
 WHMIS INFO.:

HMIS CODES: H F R P
 1 2 1 H

===== SECTION I - MANUFACTURER IDENTIFICATION =====

MANUFACTURER'S NAME: TOWER PAINT DIVISION OF CLOVERDALE PAINT

ADDRESS : 15846 - 111 AVENUE
 EDMONTON, ALBERTA, CANADA
 T5M 2R8

EMERGENCY PHONE : (780) 451 - 3830 DATE PRINTED : 24/12/02
 INFORMATION PHONE : (780) 451 - 3830 NAME OF PREPARER : TECHNICAL DEPT.

===== SECTION II - HAZARDOUS INGREDIENTS/SARA III INFORMATION =====

REPORTABLE COMPONENTS	CAS NUMBER	VAPOR PRESSURE mm Hg @ TEMP	WEIGHT PERCENT
ALIPHATIC HYDROCARBON SOLVENT	64742-47-87	100 25	
ACGIH TLV: 100 PPM			
LD50: ORAL: >5000mg/kg (RAT), LC50: >2500 PPM/4HRS (RAT)			
* XYLENE (MIXED ISOMERS)	1330-20-7	>5 68 6	
ACGIH TLV: 100 PPM			
LD50: ORAL: 4300 mg/kg (RAT), LC50: 5000 ppm/4H (RAT)			
LD50: SKIN: 5000 mg/kg (RABBIT)			
AROMATIC HYDROCARBON SOLVENT	64742-94-50	0 0	
ACGIH TLV: 50 ppm			
LD50: ORAL: >10 ml/kg (RAT), LC50: >3800 mg/m3 /4H (RAT)			
ETHYL BENZENE (COMPONENT OF XYLENE)	100-41-4	7 20deg.C	1.04
LD50: ORAL: 3500 mg/kg (RAT)			
LD50: SKIN: 17800 mg/kg (RABBIT)			
TWA: 100ppm			
* ETHYLENE GLYCOL MONOBUTYL ETHER	111-76-2	0.6 68 deg.F	1
OSHA PEL: N/E, ACGIH TLV: 25 ppm, TWA: N/E			
LD50 ORAL: 1480 mg/kg (RAT), LC50: 450 ppm/4H (RAT)			
LD50 DERMAL : 490 mg/kg (RABBIT)			

* Indicates toxic chemical(s) subject to the reporting requirements of section 313 of Title III and of 40 CFR 372.

N/A

===== SECTION III - PHYSICAL/CHEMICAL CHARACTERISTICS =====

BOILING RANGE: 136.2deg.C SPECIFIC GRAVITY (H2O=1): 1.12
 VAPOR DENSITY: HEAVIER THAN AIR
 EVAPORATION RATE: FASTER THAN n-BUTYL ACETATE
 COATING V.O.C. : 4.66 lb/g1
 SOLUBILITY IN WATER: INSOLUBLE
 APPEARANCE AND ODOR: LIQUID WITH SOLVENT ODOUR.
 FREEZING POINT: NOT AVAILABLE pH: N/AP
 COEFFICIENT OF WATER/OIL DIST: N/A ODOR THRESHOLD: N/A

===== SECTION IV - FIRE AND EXPLOSION HAZARD DATA =====

FLASH POINT: 24 C METHOD USED: TCC
 FLAMMABLE LIMITS IN AIR BY VOLUME- LOWER: 1 UPPER: 10.6

EXTINGUISHING MEDIA: FOAM, CO2, DRY CHEMICAL, WATER FOG

SPECIAL FIREFIGHTING PROCEDURES
 EXCLUDE AIR; DO NOT USE WATER EXCEPT AS A FOG. HANDLE AS A FLAMMABLE LIQUID. WEAR

ADEQUATE RESPIRATORY PROTECTION.

UNUSUAL FIRE AND EXPLOSION HAZARDS
 VAPOUR FORMS AN EXPLOSIVE MIXTURE BETWEEN UPPER AND LOWER FLAMMABLE LIMITS.

FLAMMABILITY - T.D.G.R. CLASS
 3 P.I.N.: 1263

SENSITIVITY TO IMPACT
 N/A

SENSITIVITY TO STATIC DISCHARGE
 YES

=====
SECTION V - REACTIVITY DATA
=====

STABILITY: STABLE
CONDITIONS TO AVOID
SPARKS, OPEN FLAMES AND OTHER SOURCES OF IGNITION.

INCOMPATIBILITY (MATERIALS TO AVOID)
STRONG OXIDIZING AGENTS.

HAZARDOUS DECOMPOSITION OR BYPRODUCTS
CARBON MONOXIDE, CARBON DIOXIDE, OXIDES OF NITROGEN, ALDEHYDES MAY BE GENERATED BY
THERMAL DECOMPOSITION.

HAZARDOUS POLYMERIZATION: WILL OCCUR

=====
SECTION VI - HEALTH HAZARD DATA
=====

INHALATION HEALTH RISKS AND SYMPTOMS OF EXPOSURE
MODERATELY IRRITATING TO RESPIRATORY PASSAGES. PROLONGED EXPOSURE TO HIGH VAPOUR
CONCENTRATIONS CAN CAUSE HEADACHES, NAUSEA, DIZZINESS, ANESTHESIA AND CENTRAL
NERVOUS SYSTEM DEPRESSION. IN RARE CASES MAY SENSITIZE HEART CAUSING ARRHYTHMIA.

SKIN AND EYE CONTACT HEALTH RISKS AND SYMPTOMS OF EXPOSURE
SKIN AND EYE IRRITATION WHICH MAY LEAD TO DERMATITIS WITH REPEATED
OVEREXPOSURES. OVEREXPOSURE MAY RESULT IN ALLERGIC SENSITIVITY.

SKIN ABSORPTION HEALTH RISKS AND SYMPTOMS OF EXPOSURE
REPEAT OR PROLONGED CONTACT CAN CAUSE DERMATITIS.

INGESTION HEALTH RISKS AND SYMPTOMS OF EXPOSURE
MAY CAUSE GASTROINTESTINAL IRRITATION, VOMITING, NAUSEA AND DIARRHEA.

HEALTH HAZARDS (ACUTE AND CHRONIC)
ACUTE HEALTH HAZARDS ARE AS LISTED ABOVE. NO CHRONIC HEALTH HAZARDS.

CARCINOGENICITY: NTP CARCINOGEN: No IARC MONOGRAPHS: Yes OSHA REGULATED: No
ETHYL BENZENE HAS BEEN CLASSIFIED AS A GROUP 2B SUBSTANCE ON THE BASIS OF
SUFFICIENT EVIDENCE FOR CARCINOGENICITY IN LABORATORY ANIMALS BUT INADEQUATE
EVIDENCE FOR CANCER IN HUMANS.

TERATOGENICITY
HIGH EXPOSURE TO XYLENE IN SOME ANIMAL STUDIES HAVE BEEN REPORTED TO CAUSE
HEALTH EFFECTS ON THE DEVELOPING EMBRYO/FETUS. THESE EFFECTS ARE OFTEN AT LEVELS
TOXIC TO THE MOTHER. THE SIGNIFICANCE OF THESE FINDING TO HUMANS HAS NOT BEEN
DETERMINED.

MUTAGENICITY
NOT AVAILABLE

TOXICOLOGICALLY SYNERGISTIC PRODUCTS
NOT AVAILABLE

MEDICAL CONDITIONS GENERALLY AGGRAVATED BY EXPOSURE
ANESTHESIA, RESPIRATORY TRACT IRRITATION, DERMATITIS, NAUSEA, VOMITING.

EMERGENCY AND FIRST AID PROCEDURES
INHALATION OVEREXPOSURE: MOVE PERSON TO FRESH AIR. IF BREATHING STOPS, APPLY
ARTIFICIAL RESPIRATION AND SEEK IMMEDIATE MEDICAL ATTENTION. EYE CONTACT: FLUSH
WITH WATER FOR AT LEAST 15 MINUTES, SEEK MEDICAL ATTENTION. SKIN CONTACT: WASH
THOROUGHLY WITH MILD SOAP AND WATER. INGESTION: DO NOT INDUCE
VOMITING, ASPIRATION OF THIS PRODUCT CAN CAUSE INFLAMMATION OF LUNGS.

=====
SECTION VII - PRECAUTIONS FOR SAFE HANDLING AND USE
=====

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED
ELIMINATE IGNITION SOURCES, PROVIDE GOOD VENTILATION OR WEAR APPROPRIATE
BREATHING APPARATUS, ABSORB SMALL SPILLS WITH NON FLAMMABLE ABSORBENT, CONTAIN
SPILLS BY DIKING WITH NON-FLAMMABLE ABSORBENT. NOTIFY ENVIRONMENTAL AGENCY.

WASTE DISPOSAL METHOD
RECLAIM OR DISPOSE OF THROUGH A LICENSED WASTE DISPOSAL COMPANY ACCORDING TO
FEDERAL, PROVINCIAL AND LOCAL REGULATIONS.

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING
COMBUSTIBLE. STORE IN A COOL, DRY, WELL VENTILATED AREA AWAY FROM HEAT AND IGNITION
SOURCES. KEEP CONTAINERS CLOSED WHEN NOT IN USE. AVOID BREATHING VAPOURS OR MIST
AND PROLONGED OR REPEATED CONTACT WITH SKIN.

OTHER PRECAUTIONS

SMOKING IN AREA WHERE THIS MATERIAL IS USED SHOULD BE STRICTLY PROHIBITED. EMPTY CONTAINERS MAY CONTAIN HAZARDOUS RESIDUES AND CAN BE DANGEROUS. USE GOOD PERSONAL HYGIENE.

===== SECTION VIII - CONTROL MEASURES =====

RESPIRATORY PROTECTION

NIOSH APPROVED FOR SOLVENT VAPOURS AND PARTICULATE MATTER.

VENTILATION

GENERAL MECHANICAL VENTILATION OR LOCAL EXHAUST SHOULD BE SUITABLE TO KEEP VAPOUR CONCENTRATIONS BELOW TLV. VENTILATION EQUIPMENT MUST BE EXPLOSION PROOF.

PROTECTIVE GLOVES

SOLVENT IMPERVIOUS.

EYE PROTECTION

CHEMICAL SAFETY GLASSES, GOGGLES OR FACE SHIELD.

OTHER PROTECTIVE CLOTHING OR EQUIPMENT

USE IMPERMEABLE APRONS AND PROTECTIVE CLOTHING WHENEVER POSSIBLE TO PREVENT SKIN CONTACT.

WORK/HYGIENIC PRACTICES

EYE WASHES AND SAFETY SHOWERS IN THE WORKPLACE IS RECOMMENDED.

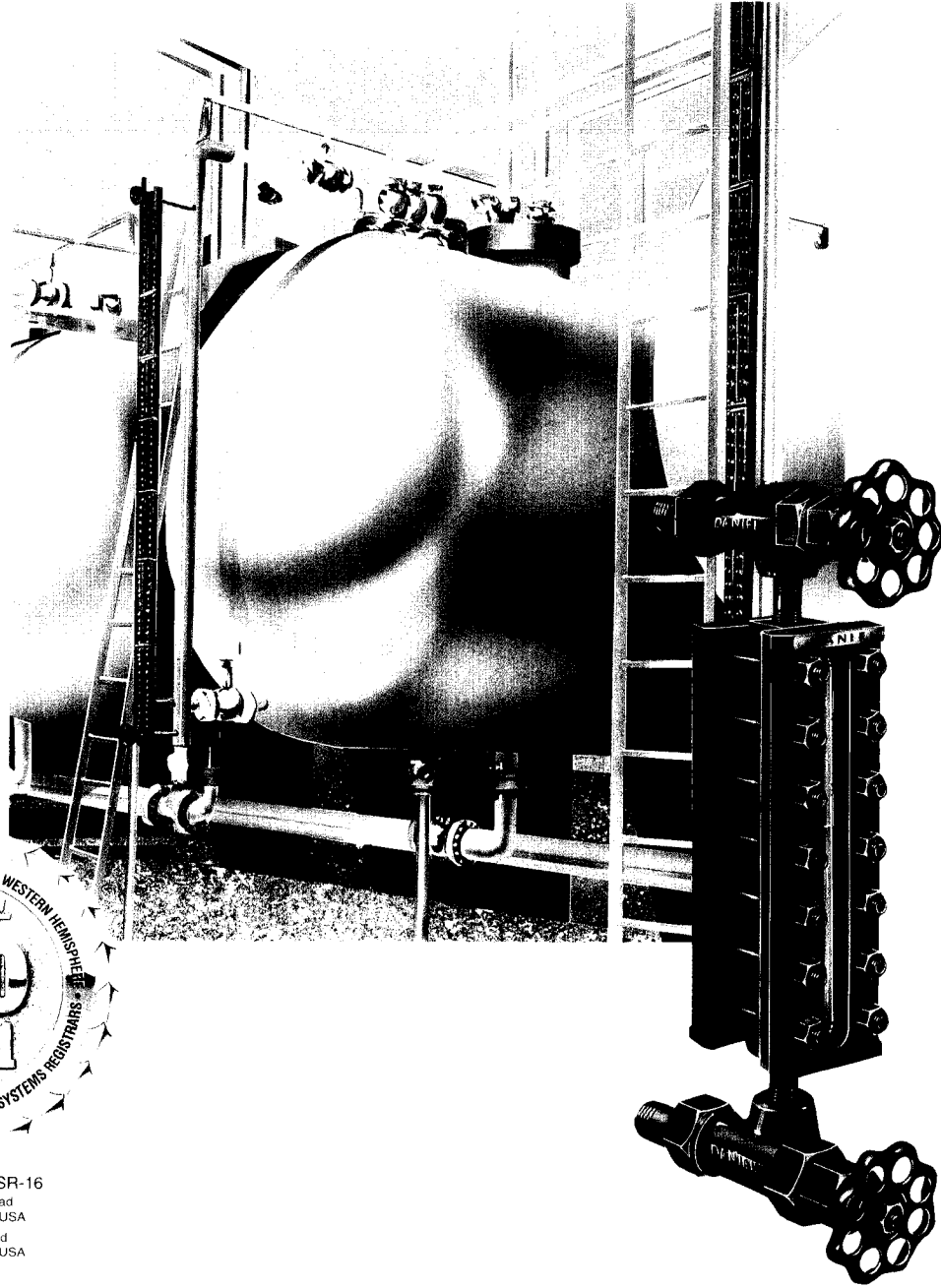
===== SECTION IX - DISCLAIMER =====

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CLOVERDALE PAINT INC. WILL NOT BE HELD LIABLE FOR CLAIMS RELATING TO USE OF THIS INFORMATION OR RECOMMENDATIONS.

Liquid Level Gages and Valves

CATALOG 1200



CERTIFICATE QSR-16
9720 Old Katy Road
Houston, TX 77055 USA
19203 Hemsplead
Houston, TX 77065 USA

DANIEL

DANIEL LIQUID LEVEL GAGES and VALVES

ORDERING INFORMATION

Please Specify:

- Gage Size Number
- Type of Service
- Temperature Limits
- Pressure Limits
- Type of Connections
- Special Function
- Vessel Centers if Close Hook-up

GAGE NUMBERING SYSTEM

Example: 71-RL:

7 is #7 Glass (#1 through #9)

1 is One-Section Gage (1, 2, 3, 4, . . .)

R is Reflex (T-Transparent)

L is Low Pressure Series (M = Mid, H = High,
WP = Weld Pad)

(Add appropriate digits or letters to indicate special purpose gage or accessory)

HC Externally Heating/Cooling Gages

FP Frost Preventive Extensions

LC Large Chamber Gage

EP Explosion Proof Illuminators

CH Close Hook-up Connections

CONTENTS

REFLEX GAGES	
With Straight-Thru Connections	2
With Close Hook-up Connections	2
Pressure Ratings and Dimensions	3-4
TRANSPARENT GAGES	
With Straight-Thru Connections	5
With Close Hook-up Connections	5
Pressure Ratings and Dimensions	6-7
OFFSET VALVES	
Type 1S and 1U	8
Type 2S and 2U	8
Type 3S and 3U (OS&Y)	9
Type 7S and 7U (OS&Y)	10
STRAIGHT-THRU VALVES	
Type 4S and 4U	11
Type 5S and 5U (OS&Y)	12
TUBULAR GAGES AND VALVES	
Gages	13
Tubular Valves (Brass)	14
Tubular Valves (Type 1T and 2T)	15
SPECIALTY GAGES	
Welding Pad Gages	16
Large Chamber for Viscous Liquids	17-18
Heated/Cooled Externally	19-20
Frost-Prevention Extensions	21-22
Illuminators (Explosion-Proof)	23
Quick-Opening Levers	24
DIMENSIONAL DATA	
Flat Gage Glasses	24
Gage Connections	25
Tank Connections	26-27
Installation: Standard Gages	28
Installation: Close Hook-up	29

Carbon steel is the standard material for all Daniel low, mid and high pressure liquid level gages. The percentages of carbon steel pressure ratings for optional gage materials are listed below.

GAGES

Stainless Steel 300 & 400 Series	100%
Monel, Hastelloy B & C	90%
Brass	50%

GASKETS

Special Acid Sheet Gasketing	75%
Blue African®, Teflon®, KEL-F®	50%
Glass Filled Teflon	100%

REFLEX GAGES

Daniel Reflex Gages use prism glass to provide an excellent indication of the liquid level. All liquids appear black in high contrast to the mirror-like surface above. This clean line of separation can be sighted from many yards away. Reflex Gages are made in three pressure series (maximum 4000 psig @ 100°F) and are tapped for 1/2" or 3/4" NPT connections. The standard Daniel level gages are designed for minimum -20°F service.

On Daniel Reflex Close Hook-up Gages with 1/2" NPT connections the center-to-center dimension is the same as the overall length on standard gages. On Close Hook-up Gages with 3/4" NPT connections the center-to-center dimension is the same as the overall length on standard gages plus 3/8". All gage bodies are drilled and tapped for close hook-up.

MATERIALS

BODY (LIQUID CHAMBER): Accurately machined from square tubes to provide perfect gasket seating for gage glasses. Glass is recessed for protection. Body materials include Types 304 and 316 stainless steels and carbon steel.

COVER: Daniel gage covers are made of carbon steel or stainless steel (Type 304) in all their sizes and pressure ratings for higher strength and dependable service. Carbon steel covers are rust-proofed. All covers are machined to provide recessed seating protection for the glass.

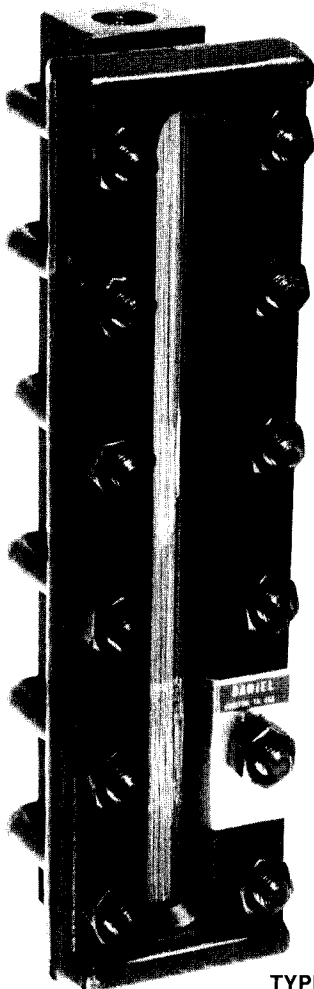
GLASS: All standard Daniel Reflex Gages use tempered borosilicate glass in nine standard lengths. Each glass has expertly molded reflecting prisms.

GASKETS & CUSHIONS: High grade non-asbestos is used in gaskets and cushions for Daniel gages. The machined recess in the gage body and cover protects the gasket and cushion as well as the glass.

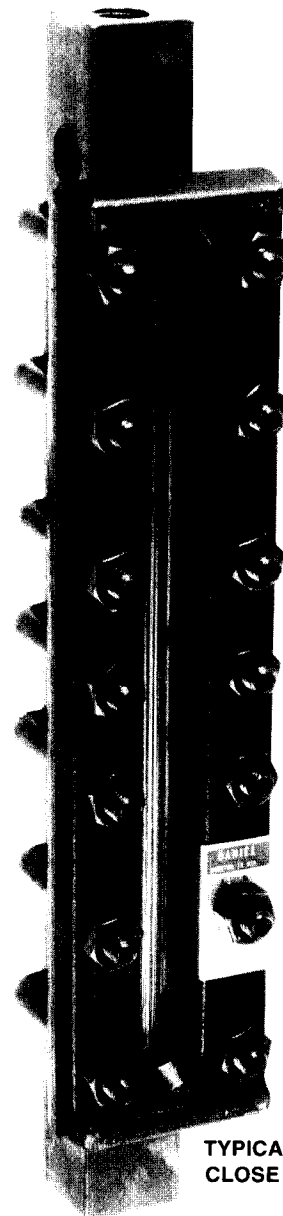
BOLTS: Daniel gage bolts are made of alloy steel, A.S.T.M. A-193 Grade B7, and rust-proofed for long life.

NUTS: Gage nuts are made of steel, A.S.T.M., A-194 Grade 2H, and are rust-proofed.

(Torque instructions for gage bolts are on Back Cover.)



TYPICAL REFLEX
TOP/BOTTOM

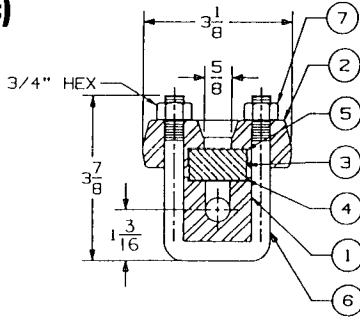


TYPICAL-REFLEX
CLOSE HOOK-UP

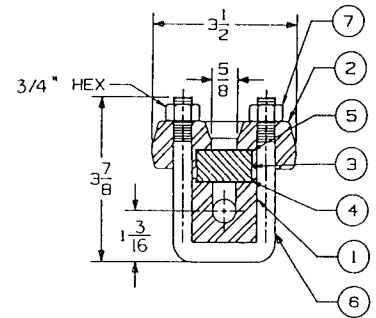
PRESSURE RATINGS & DIMENSIONS:

Reflex Gages

(With Straight-Thru Connections)



SECTION "X-X"
LOW PRESSURE



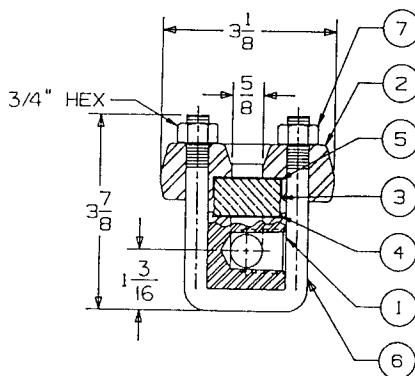
SECTION "X-X"
MID/HIGH PRESSURE

SIZES AND WEIGHTS											
SIZE NUMBERS			OVER-ALL LENGTH (IN.)			VISIBLE GLASS (IN.) B	GLASS SIZE C	CLOSE HOOK-UP CENTER-TO-CENTER (IN.)		APPROX. WT. (LBS.)	
LOW PRESS.	MID-PRESS.	HIGH PRESS.	A (STD)* 1/2 or 3/4 NPT	A(CH) 1/2" NPT	A (CH) 3/4 NPT			D 1/2" NPT	D 3/4" NPT	LOW PRESS.	MID-HIGH PRESS.
SINGLE-SECTION GAGE											
11 RL	11 RM	11 RH	5 1/4	8 7/8	9 1/4	3 3/4	3 3/4	5 1/4	5 5/8	7	8
21 RL	21 RM	21 RH	6 1/4	9 7/8	10 1/4	4 3/4	4 3/4	6 1/4	6 5/8	8	9
31 RL	31 RM	31 RH	7 1/4	10 7/8	11 1/4	5 3/4	5 3/4	7 1/4	7 5/8	9	11
41 RL	41 RM	41 RH	8 1/4	11 7/8	12 1/4	6 3/4	6 3/4	8 1/4	8 5/8	10	12
51 RL	51 RM	51 RH	9 3/8	13	13 3/8	7 7/8	7 7/8	9 3/8	9 3/4	12	14
61 RL	61 RM	61 RH	10 5/8	14 1/4	14 5/8	9 1/8	9 1/8	10 5/8	11	14	16
71 RL	71 RM	71 RH	11 3/4	15 3/8	15 3/4	10 1/4	10 1/4	11 3/4	12 1/8	15	18
81 RL	81 RM	81 RH	13 3/8	17	17 3/8	11 7/8	11 7/8	13 3/8	13 3/4	17	20
91 RL	91 RM	91 RH	14 1/8	17 3/4	18 1/8	12 5/8	12 5/8	14 1/8	14 1/2	18	21
TWO-SECTION GAGE											
32 RL	32 RM	32 RH	14 1/2	18 1/8	18 1/2	13	5 3/4	14 1/2	14 7/8	19	22
42 RL	42 RM	42 RH	16 1/2	20 1/8	20 1/2	15	6 3/4	16 1/2	16 7/8	22	25
52 RL	52 RM	52 RH	18 3/4	22 3/8	22 3/4	17 1/4	7 7/8	18 3/4	19 1/8	24	28
62 RL	62 RM	62 RH	21 1/4	24 7/8	25 1/4	19 3/4	9 1/8	21 1/4	21 5/8	27	32
72 RL	72 RM	72 RH	23 1/2	27 1/4	27 1/2	22	10 1/4	23 1/2	23 7/8	29	35
82 RL	82 RM	82 RH	26 3/4	30 3/8	30 3/4	25 1/4	11 7/8	26 3/4	27 1/8	34	40
92 RL	92 RM	92 RH	28 1/4	31 7/8	32 1/4	26 3/4	12 5/8	28 1/4	28 5/8	37	43
THREE-SECTION GAGE											
63 RL	63 RM	63 RH	31 7/8	35 1/2	35 7/8	30 3/8	9 1/8	31 7/8	32 1/4	41	48
73 RL	73 RM	73 RH	35 1/4	38 7/8	39 1/4	33 3/4	10 1/4	35 1/4	35 5/8	45	53
83 RL	83 RM	83 RH	40 1/8	43 3/4	44 1/8	38 5/8	11 7/8	40 1/8	40 1/2	52	60
93 RL	93 RM	93 RH	42 3/8	46	46 3/8	40 7/8	12 5/8	42 3/8	42 3/4	55	64
FOUR-SECTION GAGE											
74 RL	74 RM	74 RH	47	50 5/8	51	45 1/2	10 1/4	47	47 3/8	60	71
84 RL	84 RM	84 RH	53 1/2	57 1/8	57 1/2	52	11 7/8	53 1/2	53 7/8	69	80
94 RL	94 RM	94 RH	56 1/2	60 1/8	60 1/2	55	12 5/8	56 1/2	56 7/8	72	85
FIVE-SECTION GAGE											
75 RL	75 RM	75 RH	58 3/4	62 3/8	62 3/4	57 1/4	10 1/4	58 3/4	59 1/8	74	88
85 RL	85 RM	85 RH	66 7/8	70 1/2	70 7/8	65 5/8	11 7/8	66 7/8	67 1/4	86	100
95 RL	95 RM	95 RH	70 5/8	74 1/4	74 5/8	69 1/8	12 5/8	70 5/8	71	90	106

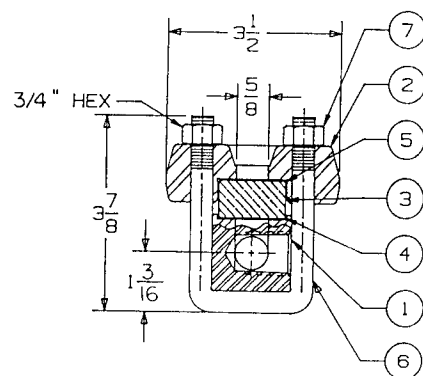
*3/4" NPT Tapped High Pressure Gages Add 1 1/2" to 'A' Dimension.

Reflex Gages (With Close Hook-Up Connections)

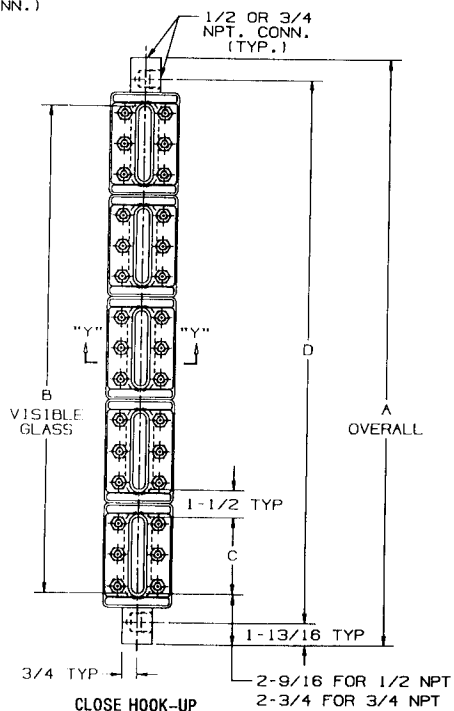
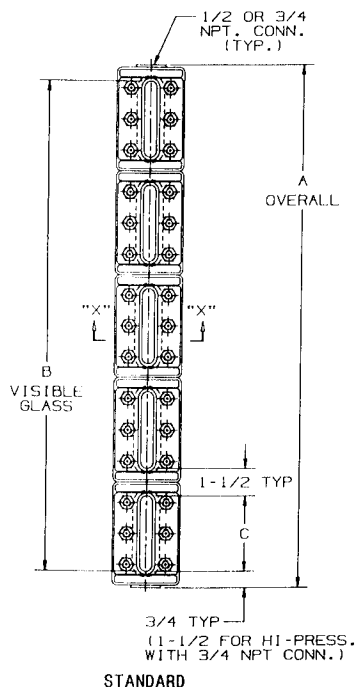
PARTS		
ITEM NO.	NAME	MATERIAL
1	CHAMBER	CARBON STEEL
2	COVER	ASTM A350 LF2
3	GLASS	TEMPERED
4	GASKET	NON-ASBESTOS
5	CUSHION	NON-ASBESTOS
6	BOLT	ASTM A193 B7
7	NUT	ASTM A194 2H



SECTION "Y-Y"
LOW PRESSURE



SECTION "Y-Y"
MID/HIGH PRESSURE



PRESSURE RATINGS AT °F*							
LOW PRESSURE GAGE**							
Glass Size	100°	200°	300°	400°	500°	600°	700°
1	2400	2320	2240	2150	2000	1780	1520
2	2325	2250	2170	2090	1940	1720	1470
3	2250	2180	2100	2020	1880	1670	1420
4	2175	2100	2020	1940	1820	1600	1370
5	2100	2030	1960	1880	1750	1550	1320
6	2025	1950	1890	1810	1680	1500	1280
7	1950	1890	1820	1750	1630	1440	1230
8	1875	1820	1750	1680	1560	1390	1180
9	1800	1740	1680	1620	1510	1340	1140
MID-PRESSURE GAGE**							
Glass Size	100°	200°	300°	400°	500°	600°	700°
1	3000	2900	2800	2690	2500	2220	1890
2	2910	2820	2720	2600	2420	2150	1840
3	2820	2720	2625	2530	2350	2080	1780
4	2725	2640	2560	2460	2270	2040	1740
5	2630	2540	2460	2360	2190	1950	1660
6	2535	2450	2360	2270	2110	1875	1600
7	2440	2360	2280	2190	2030	1805	1540
8	2345	2270	2190	2110	1960	1740	1480
9	2250	2180	2100	2020	1880	1670	1420
HIGH-PRESSURE GAGE**							
Glass Size	100°	200°	300°	400°	500°	600°	700°
1	4000	3860	3735	3580	3330	2960	2530
2	3850	3720	3590	3440	3210	2850	2430
3	3750	3620	3500	3355	3120	2775	2370
4	3600	3465	3360	3220	3000	2660	2270
5	3500	3360	3260	3120	2900	2580	2220
6	3360	3240	3135	3010	2800	2490	2120
7	3240	3120	3020	2900	2700	2400	2050
8	3120	3020	2910	2790	2600	2310	1970
9	3000	2900	2800	2690	2500	2220	1890

* Gages for service up to 800°F are available. Consult the factory for the application and ratings.
** Saturated steam to 350 WSP. Above 350 WSP, use transparent gage with mica shields.

TRANSPARENT GAGES

Daniel Transparent Gages use clear, see-through glass on both sides so that both the color and the interface of liquids can be viewed. Electric lighted gage illuminators are available for use on Transparent Gages and provide easy viewing of liquid levels on dimly lighted areas. Transparent Gages are made in three pressure series (maximum 3000 psig @ 100°F) and are tapped for 1/2" or 3/4" NPT connections. The standard Daniel level gages are designed for -20°F service.

On Daniel Transparent Close Hook-up Gages with 1/2" NPT connections the center-to-center dimension is the same as the overall length on standard gages. On Close Hook-up Gages with 3/4" NPT connections the center-to-center dimension is the same as the overall length on standard gages plus 3/8". All gage bodies are drilled and tapped for close hook-up.

MATERIALS

BODY (LIQUID CHAMBER): Accurately machined from square tubes to provide perfect seating for gasket, and gage glasses. Both glasses are recessed for protection. Body material include Types 304 and 316 stainless steel and carbon steel.

COVERS: Both covers on transparent gages are carefully machined to provide perfect seating for cushions and gage glasses. This machining also provides deep recessed seating in the cover for added glass protection. Covers are available in Type 304 stainless steel and in carbon steel. The latter is rust-proofed.

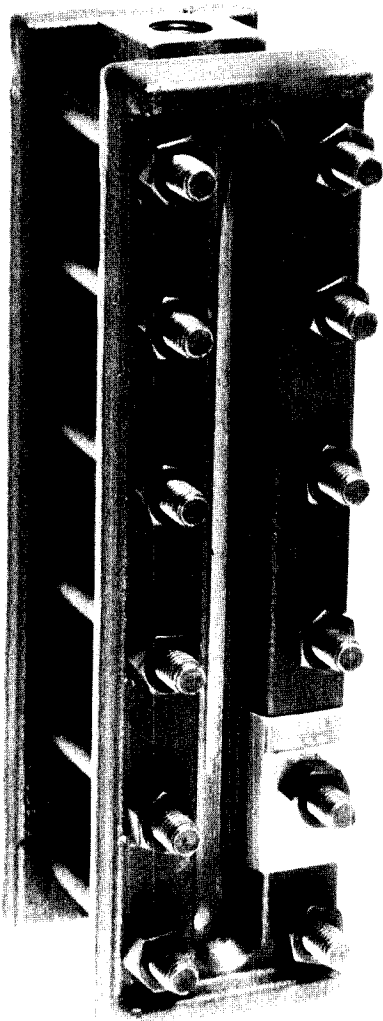
GLASS: All standard Daniel Transparent Gages use tempered borosilicate glass in nine standard lengths. Each transparent glass is crystal clear and has the highest strength possible.

GASKETS & CUSHIONS: High grade non-asbestos is used in gaskets and cushions for Daniel gages. The machined recess in the gage body and cover protects the gasket and cushion as well as the glass.

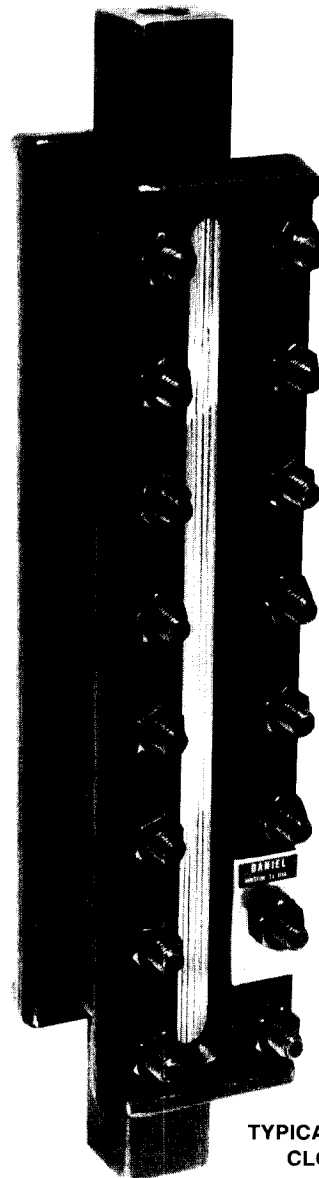
BOLTS: Daniel gage bolts are made of alloy steel, A.S.T.M. A-193 Grade B7, and rust-proofed for long life.

NUTS: Gage nuts are made of steel, A.S.T.M., A-194 Grade 2H, and are rust-proofed.

(Torque instructions for gage bolts are on Back Cover.)



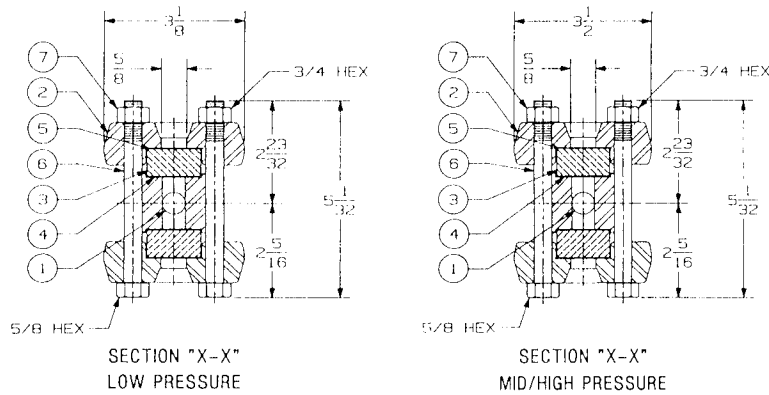
TYPICAL TRANSPARENT
TOP/BOTTOM



TYPICAL-TRANSPARENT
CLOSE HOOK-UP

PRESSURE RATINGS & DIMENSIONS:

Transparent Gages (With Straight-thru Connections)

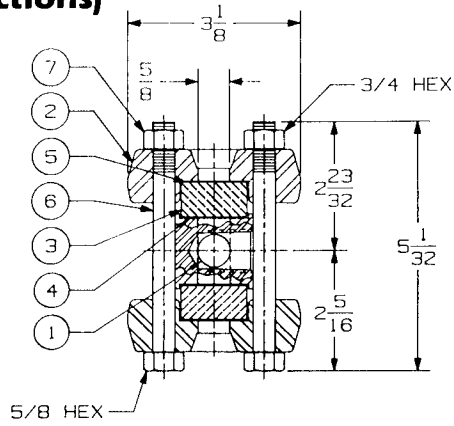


SIZES AND WEIGHTS											
SIZE NUMBERS			OVER-ALL LENGTH (IN.)			VISIBLE GLASS (IN.) B	GLASS SIZE C	CLOSE HOOK-UP CENTER-TO-CENTER (IN.)		APPROX. WT. (LBS.)	
LOW PRESS.	MID-PRESS.	HIGH PRESS.	A(STD)* 1/2 or 3/4 NPT	A(CH) 1/2 NPT	A(CH) 3/4 NPT			D 1/2" NPT	D 3/4" NPT	LOW PRESS.	MID-HIGH PRESS.
SINGLE-SECTION GAGE											
11 TL	11 TM	11 TH	5 1/4	8 7/8	9 1/4	3 3/4	3 3/4	5 1/4	5 5/8	10	12
21 TL	21 TM	21 TH	6 1/4	9 7/8	10 1/4	4 3/4	4 3/4	6 1/4	6 5/8	11	14
31 TL	31 TM	31 TH	7 1/4	10 7/8	11 1/4	5 3/4	5 3/4	7 1/4	7 5/8	14	17
41 TL	41 TM	41 TH	8 1/4	11 7/8	12 1/4	6 3/4	6 3/4	8 1/4	8 5/8	16	19
51 TL	51 TM	51 TH	9 3/8	13	13 3/8	7 7/8	7 7/8	9 3/8	9 3/4	17	21
61 TL	61 TM	61 TH	10 5/8	14 1/4	14 5/8	9 1/8	9 1/8	10 5/8	11	19	24
71 TL	71 TM	71 TH	11 3/4	15 3/8	15 3/4	10 1/4	10 1/4	11 3/4	12 1/8	21	27
81 TL	81 TM	81 TH	13 3/8	17	17 3/8	11 7/8	11 7/8	13 3/8	13 3/4	24	30
91 TL	91 TM	91 TH	14 7/8	17 3/4	18 1/8	12 5/8	12 5/8	14 7/8	14 1/2	26	32
TWO-SECTION GAGE											
32 TL	32 TM	32 TH	14 1/2	18 1/8	18 1/2	13	5 3/4	14 1/2	14 7/8	27	33
42 TL	42 TM	42 TH	16 1/2	20 1/8	20 1/2	15	6 3/4	16 1/2	16 7/8	32	38
52 TL	52 TM	52 TH	18 3/4	22 3/8	22 3/4	17 1/4	7 7/8	18 3/4	19 1/8	36	43
62 TL	62 TM	62 TH	21 1/4	24 7/8	25 1/4	19 3/4	9 1/8	21 1/4	21 5/8	40	49
72 TL	72 TM	72 TH	23 1/2	27 1/4	27 1/2	22	10 1/4	23 1/2	23 7/8	43	54
82 TL	82 TM	82 TH	26 3/4	30 3/8	30 3/4	25 1/4	11 7/8	26 3/4	27 1/8	50	61
92 TL	92 TM	92 TH	28 1/4	31 7/8	32 1/4	26 3/4	12 5/8	28 1/4	28 5/8	51	64
THREE-SECTION GAGE											
63 TL	63 TM	63 TH	31 7/8	35 1/2	35 7/8	30 3/8	9 1/8	31 7/8	32 1/4	59	73
73 TL	73 TM	73 TH	35 1/4	38 7/8	39 1/4	33 3/4	10 1/4	35 1/4	35 5/8	63	80
83 TL	83 TM	83 TH	40 1/8	43 3/4	44 1/8	38 5/8	11 7/8	40 1/8	40 1/2	75	92
93 TL	93 TM	93 TH	42 3/8	46	46 3/8	40 7/8	12 5/8	42 3/8	42 3/4	78	97
FOUR-SECTION GAGE											
74 TL	74 TM	74 TH	47	50 3/8	51	45 1/2	10 1/4	47	47 3/8	85	107
84 TL	84 TM	84 TH	53 1/2	57 1/8	57 1/2	52	11 7/8	53 1/2	53 7/8	100	122
94 TL	94 TM	94 TH	56 1/2	60 1/8	60 1/2	55	12 5/8	56 1/2	56 7/8	104	129
FIVE-SECTION GAGE											
75 TL	75 TM	75 TH	58 3/4	62 3/8	62 3/4	57 1/4	10 1/4	58 3/4	59 1/8	106	134
85 TL	85 TM	85 TH	66 7/8	70 1/2	70 7/8	65 3/8	11 7/8	66 7/8	67 1/4	124	152
95 TL	95 TM	95 TH	70 5/8	74 1/4	74 5/8	69 1/8	12 5/8	70 5/8	71	129	161

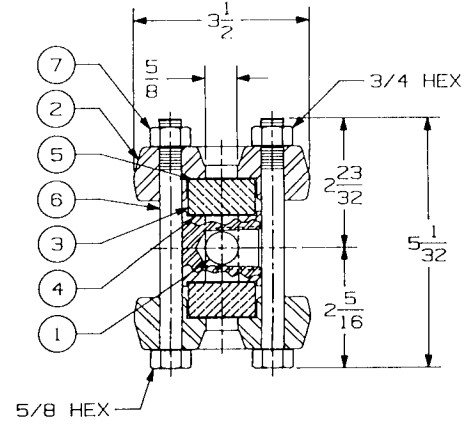
*3/4" NPT Tapped High Pressure Gages Add 1 1/2" to 'A' Dimension.

Transparent Gages (With Close Hook-up Connections)

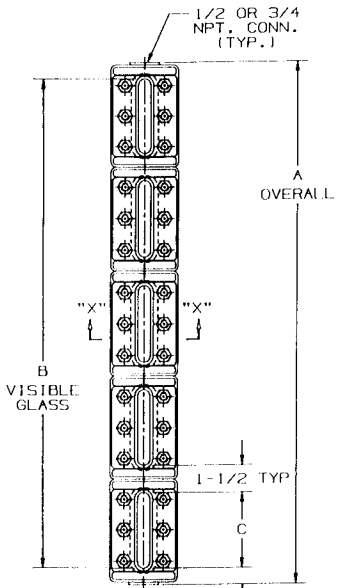
PARTS		
ITEM NO.	NAME	MATERIAL
1	CHAMBER	CARBON STEEL
2	COVER	ASTM A350 LF2
3	GLASS	TEMPERED
4	GASKET	NON-ASBESTOS
5	CUSHION	NON-ASBESTOS
6	BOLT	ASTM A193 B7
7	NUT	ASTM A194 2H



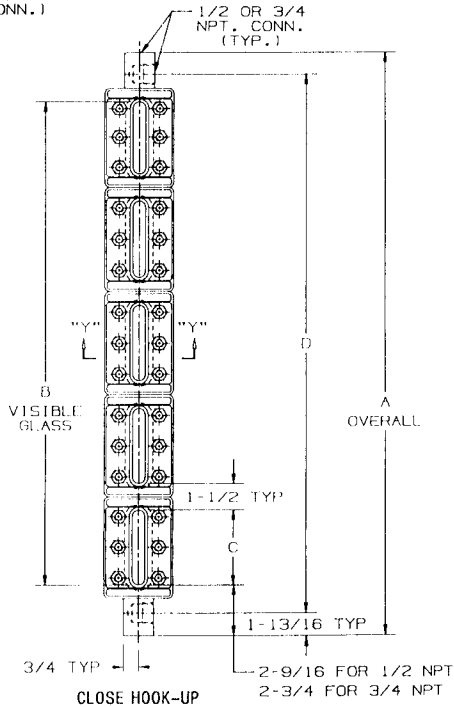
SECTION "Y-Y"
LOW PRESSURE



SECTION "Y-Y"
MID/HIGH PRESSURE



STANDARD
3/4 TYP.
(1-1/2 FOR HI-PRESS.
WITH 3/4 NPT CONN.)



CLOSE HOOK-UP

PRESSURE RATINGS AT °F*

LOW PRESSURE GAGE

Glass Size	100°	200°	300°	400°	500°	600°	700°
1	2000	1935	1870	1790	1660	1480	1260
2	1815	1750	1690	1620	1510	1340	1150
3	1630	1580	1520	1460	1360	1210	1050
4	1440	1390	1340	1290	1200	1060	900
5	1250	1210	1170	1120	1040	920	790
6	1065	1030	995	950	890	790	680
7	875	845	815	785	730	645	550
8	690	665	645	620	575	510	440
9	500	480	465	445	415	370	320

Maximum Saturated Steam 350 WSP

MID-PRESSURE GAGE

Glass Size	100°	200°	300°	400°	500°	600°	700°
1	2500	2420	2340	2240	2080	1850	1580
2	2315	2250	2170	2090	1940	1720	1470
3	2130	2060	1990	1910	1770	1575	1340
4	1940	1875	1810	1740	1620	1435	1230
5	1750	1690	1630	1570	1460	1295	1100
6	1565	1510	1460	1400	1305	1160	990
7	1375	1330	1280	1230	1145	1015	870
8	1190	1150	1110	1065	990	880	750
9	1000	970	935	895	835	740	630

Maximum Saturated Steam 600 WSP with Mica Shields

HIGH-PRESSURE GAGE

Glass Size	100°	200°	300°	400°	500°	600°	700°
1	3000	2900	2805	2690	2500	2220	1890
2	2900	2800	2710	2600	2420	2145	1830
3	2750	2660	2570	2465	2295	2035	1740
4	2600	2515	2430	2330	2170	1925	1640
5	2500	2420	2340	2240	2080	1850	1590
6	2380	2280	2200	2120	1970	1745	1490
7	2250	2165	2090	2010	1865	1660	1410
8	2120	2050	1980	1900	1770	1570	1340
9	2000	1935	1870	1790	1670	1480	1270

Maximum Saturated Steam 750 WSP with Mica Shields

* Gages for service up to 800°F are available. Consult the factory for application and ratings.

OFFSET VALVES

TYPE 1S & 1U

STEM THREADS INTO BODY

TYPE 2S & 2U

RENEWABLE INTERNAL STEM BONNET

4000 psig CWP 6000 psig Test

3/4" NPT Male Union Tank Connection

1/2" NPT Female Gage Connection

1/2" NPT Female Drain Connection

PRESSURE — TEMPERATURE RATING			
Teflon Packing		Wire-Graphite Packing	
4000 psi	100°F	2950 psi	500°F
3730 psi	200°F	2700 psi	600°F
3470 psi	300°F	2430 psi	700°F
3200 psi	400°F		

Daniel Type 1 & 2 Offset Gage Valves are available with screwed (S), union (U), (illustrated below) and tubular (T) gage connections (Page 15). Both 1 and 2 Valves are used with Reflex and Transparent Gages in working pressures up to 4000 psi and with Tubular Gages to their maximum rating. The Teflon ring is standard and used in services up to 450° F. For temperatures to 700° F, valves are fitted with special wire graphite packing. Both valves have stainless steel ball checks to shut off the flow automatically in case of gage glass breakage.

The "offset" feature permits easy cleaning of gages. A 1/16" eccentric tailpiece on Type 1 valves permits an overall vertical adjustment of 1/8" if the gage center-to-centers are not precisely located. Installation is quicker and gage strain is eliminated.

Type 2 Valves have an optional backseating stem, allowing the packing to be changed without shutting down the vessel.

PARTS

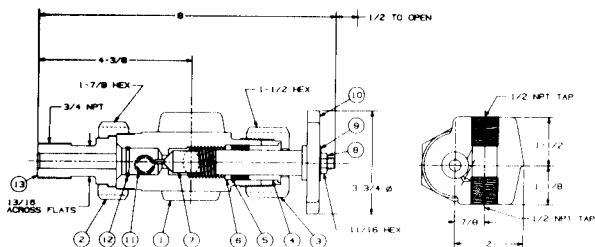
ITEM NO.	NAME	STANDARD	304 S.S. WETTED PARTS	316 S.S. WETTED PARTS
		MATERIAL	MATERIAL	MATERIAL
1	BODY	ASTM A350 LF2	304 S.S.	316 S.S.
2	UNION NUT	CARBON STEEL	CARBON STEEL	CARBON STEEL
3	PACKING NUT	CARBON STEEL	CARBON STEEL	CARBON STEEL
4	PACKING FOLLOWER	316 S.S.	316 S.S.	316 S.S.
5	PACKING RING	TEFLON	TEFLON	TEFLON
6	PACKING WASHER	17-4 PH S.S.	17-4 PH S.S.	17-4 PH S.S.
7	STEM	304 S.S.	304 S.S.	316 S.S.
8	STEM NUT	CARBON STEEL	CARBON STEEL	CARBON STEEL
9	NAME PLATE	304 S.S.	304 S.S.	304 S.S.
10	HAND WHEEL	ALLOY ZINC	ALLOY ZINC	ALLOY ZINC

ITEM NO.	NAME	STANDARD	304 S.S. WETTED PARTS	316 S.S. WETTED PARTS
		MATERIAL	MATERIAL	MATERIAL
11	BALL	440 S.S.	316 S.S.	316 S.S.
12	BALL RETAINER	316 S.S.	316 S.S.	316 S.S.
13	MALE CONNECTOR	CARBON STEEL	304 S.S.	316 S.S.
14	BONNET	416 S.S.	304 S.S.	316 S.S.
15	SEAT	416 S.S.	304 S.S.	316 S.S.
17	FEMALE CONNECTOR	CARBON STEEL	304 S.S.	316 S.S.

* Item No. 13 has hole with 1/16 eccentricity for ± 1.8 maximum misalignment on the overall center-to-center.
 Note: Valve shown is for bottom left hand (or top right hand) location. Opposite hand is reversed. Valves are furnished in pairs of one bottom left hand and one top left hand.
 Note: 304 S.S. and 316 S.S. wetted parts not available in Type 1 valves.

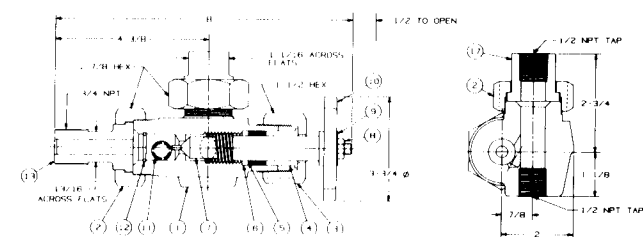
TYPE 1S

Weight per set approximately 10 lbs. 6 ozs.



TYPE 1U

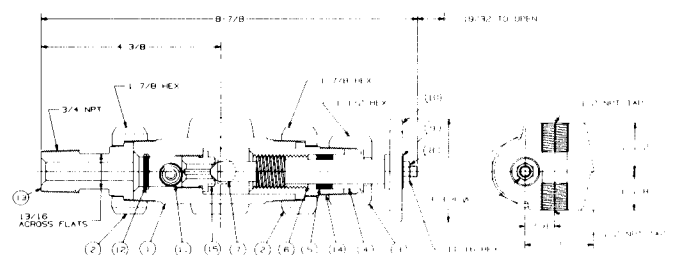
Weight per set approximately 11 lbs. 6 ozs.



Type 1T Tubular Gage Valve shown on page 15.
 Optional Gage Connections shown on page 25.
 Optional Tank Connections shown on pages 26 and 27.

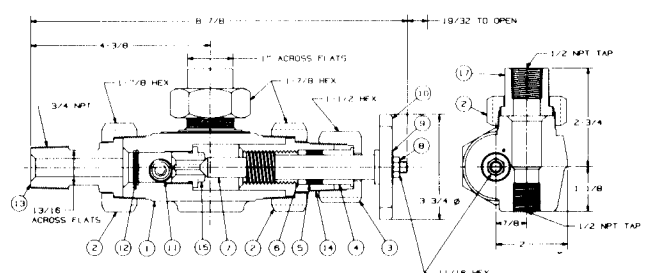
TYPE 2S

Weight per set approximately 11 lbs. 6 ozs.



TYPE 2U

Weight per set approximately 12 lbs. 6 ozs.



Type 2T Tubular Gage Valve shown on page 15.
 Optional Gage Connections shown on page 25.
 Optional Tank Connections shown on pages 26 and 27.
 Optional Quick Opening Valve shown on page 24.

OFFSET OS&Y VALVES

TYPE 3S & 3U

HEAVY DUTY OUTSIDE SCREW & YOKE

4000 psig CWP 6000 psig Test
1/2", 3/4" (Std.) or 1" NPT or IPS Solid Shank Tank
Connection or Flanged Tank Connection
1/2" NPT Female Gage Connection
1/2" NPT Female Drain Connection

PRESSURE — TEMPERATURE RATING			
Teflon Packing		Wire-Graphite Packing	
4000 psi	100°F	2950 psi	500°F
3730 psi	200°F	2700 psi	600°F
3470 psi	300°F	2430 psi	700°F
3200 psi	400°F		

The Daniel Type 3 Offset Gage Valve has the Outside Screw & Yoke design which prevents excessively hot and corrosive fluids from contracting stem threads, causing possible malfunction. The stem backs directly off the regrindable valve seat, using the positive, non-rotating stem principle. The valve is offset for ease in gage cleaning and comes in both screwed (S) and union (U) gage connections as standard. On special order, a tubular (T) gage or other type connection can be supplied. Type 3 Valves are used with Reflex and Transparent Gages in working pressures up to 4000 psi.

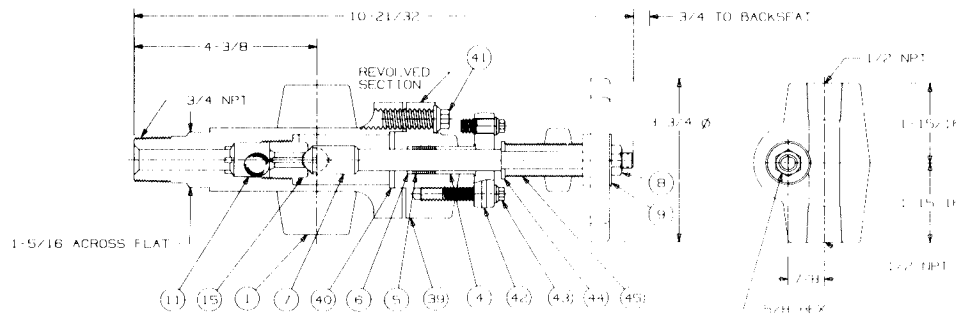
The standard tank connection for Type 3 OS&Y Offset Gage Valves is a 3/4" NPT solid shank, with optional 1/2" and 1" NPT sizes. Ends beveled for welding also are available. Valve materials include forged carbon steel, 304 stainless steel and 316 stainless steel. A molded Teflon packing ring is standard at no extra cost in valves for services up to 450°F. For temperatures to 700°F, valves have wire-graphite packing. The Type 3 Valve has stainless steel safety ball checks to shut off the flow automatically in case of gage glass breakage.

PARTS

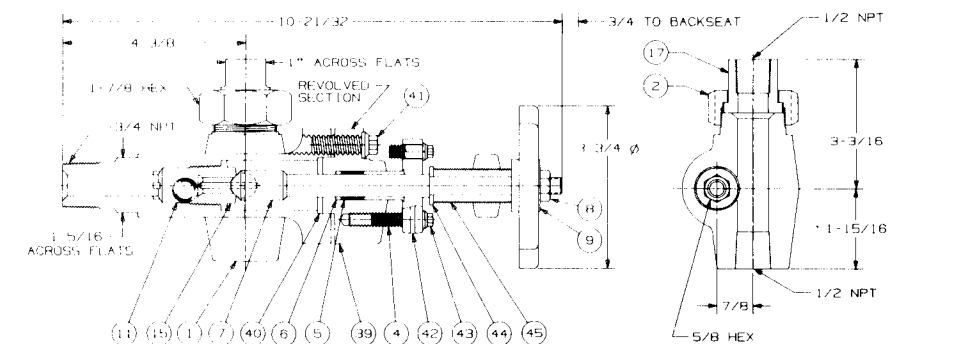
ITEM NO.	NAME	STANDARD	304 S.S. WETTED PARTS	316 S.S. WETTED PARTS
		MATERIAL	MATERIAL	MATERIAL
1	BODY	ASTM A350 LF2	304 S.S.	316 S.S.
4	PACKING FOLLOWER	316 S.S.	316 S.S.	316 S.S.
*5	PACKING RING	TEFLON	TEFLON	TEFLON
6	PACKING WASHER	17-4 PH S.S.	17-4 PH S.S.	17-4 PH S.S.
7	STEM	304 S.S.	304 S.S.	316 S.S.
8	STEM NUT	CARBON STEEL	CARBON STEEL	CARBON STEEL
9	NAME PLATE	304 S.S.	304 S.S.	304 S.S.
11	BALL	440 S.S.	316 S.S.	316 S.S.
15	SEAT	416 S.S.	304 S.S.	316 S.S.
17	FEMALE CONNECTOR	CARBON STEEL	304 S.S.	316 S.S.

ITEM NO.	NAME	STANDARD	304 S.S. WETTED PARTS	316 S.S. WETTED PARTS
		MATERIAL	MATERIAL	MATERIAL
39	YOKE	FORGED STEEL	304 S.S.	316 S.S.
40	YOKE GASKET	ASB .304 S.S.	ASB .304 S.S.	ASB .304 S.S.
*41	YOKE SCREW	CARBON STEEL	CARBON STEEL	CARBON STEEL
42	PRESSURE BAR	FORGED STEEL	FORGED STEEL	FORGED STEEL
**43	PRESS BAR SCREW	ALLOY STEEL	ALLOY STEEL	ALLOY STEEL
44	INR THRST WASHER	17-4 PH S.S.	17-4 PH S.S.	17-4 PH S.S.
45	HANDWHEEL ASSY	AL-BZ/ZINC	AL-BZ/ZINC	AL-BZ/ZINC
46	OUT THRST WASHER	17-4 PH S.S.	17-4 PH S.S.	17-4 PH S.S.

* 4 REQUIRED
 ** 2 REQUIRED



TYPE 3S
 Weight per set approximately 17 lbs. 8 ozs.



TYPE 3U
 Weight per set approximately 17 lbs. 8 ozs.

A Tubular Gage Connection is available on request. Optional Tank Connections shown on pages 26 and 27. Optional Gage Connections shown on page 25.

OFFSET OS&Y VALVES

Type 7S & 7U

STANDARD OUTSIDE SCREW & YOKE

1440 psig CWP, 2160 psig Test (600 lbs. Class)

3/4" NPT Male Tank Connection

1/2" NPT Female Union Gage Connection

The Daniel Type 7 Offset Gage Valve features the Outside Screw & Yoke (OS&Y) design which prevents excessively hot and corrosive fluids from contacting stem threads. The stem uses the positive non-rotating stem principle and backs directly off the regrindable seat. This valve is offset for ease in gage cleaning and is available in screwed (S) and union (U) gage connections. The Type 7 Valve also has a backseating stem as a standard feature. Stainless steel ball checks are available upon request.

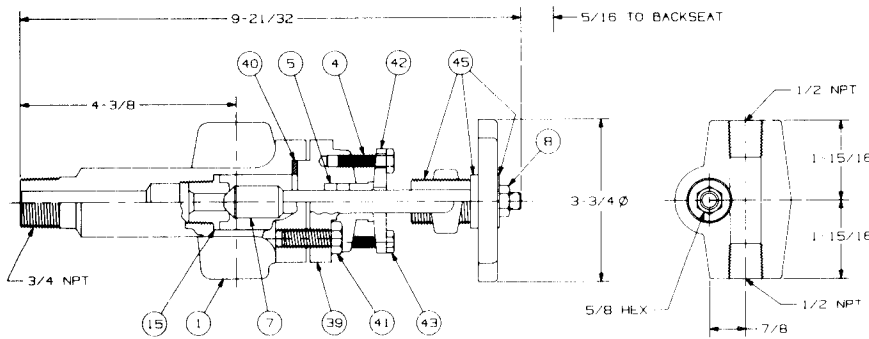
PRESSURE — TEMPERATURE RATING			
Teflon Packing		Wire-Graphite Packing	
1440 psi	100°F	1250 psi	500°F
1400 psi	200°F	1110 psi	600°F
1365 psi	300°F	1065 psi	700°F
1330 psi	400°F		

PARTS

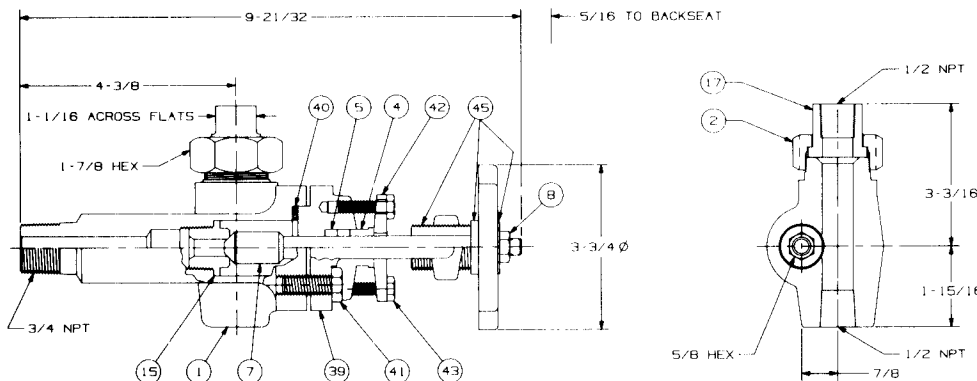
ITEM NO.	NAME	MATERIAL
1	BODY	ASTM A350 LF2
2	UNION NUT	CARBON STEEL
4	PACKING FOLLOWER	STEEL
5	PACKING RING	TEFLON
7	STEM	416 S.S.
8	STEM NUT	CARBON STEEL
15	SEAT	416 S.S.
17	FEMALE CONNECTOR	CARBON STEEL
39	YOKE	FORGED STEEL

ITEM NO.	NAME	MATERIAL
40	YOKE GASKET	SPIRAL ASB-304 S.S.
41	YOKE BOLT	ALLOY STEEL
42	PRESSURE BAR	FORGED STEEL
43	PRESSURE BAR SCREW	ALLOY STEEL
45	STEM-SCREW-HANDLE NAME PLATE ASSEMBLY	304 S.S./ZINC IRON/304 S.S.
46	OUTER THRUST WASHER	STEEL

Note: Valve shown is for bottom left hand (or top right hand) location. Opposite hand is reversed. Valves are furnished in pairs of one bottom left hand and one top left hand.



TYPE 7S
Weight per set approximately 12 lbs.



TYPE 7U
Weight per set approximately 12 lbs.

A Tubular Gage Connection is available on request. Optional Gage Connections shown on page 25. Optional Tank Connections shown on pages 26 and 27. A Ball Check Valve is available on request.

STRAIGHT-THRU VALVES

Type 4S & 4U

RENEWABLE INTERNAL STEM BONNET

4000 psig CWP 6000 psig Test
3/4" NPT Male Union Tank Connection
1/2" NPT Female Gage Connection
1/2" NPT Female Drain Connection

The Daniel Type 4 Straight-Thru Gage Valve is available with screwed (S) and union (U) gage connections and used with Reflex and Transparent Gages in working pressures up to 4000 psi. The "straight-thru" valve body design is popularly used with close hook-up (side connection) gages because the gage side connection centers and vessel centers can be identical. (With offset valves, vessel centers must be inside or outside side connection centers.) Type 4 Valves have a 3/4" NPT Male Tank Connection as standard, with other connections available on order.

Type 4 Straight-Thru Gage Valves are stocked in carbon steel with stainless steel trims. A molded Teflon packing ring is standard at no extra cost in valves for services to 450°F. For temperatures to 700°F, valves have wire-graphite packing. The Type 4 Valve has stainless steel ball checks to shut off the flow automatically in case of gage glass breakage. An optional backseating stem available on request.

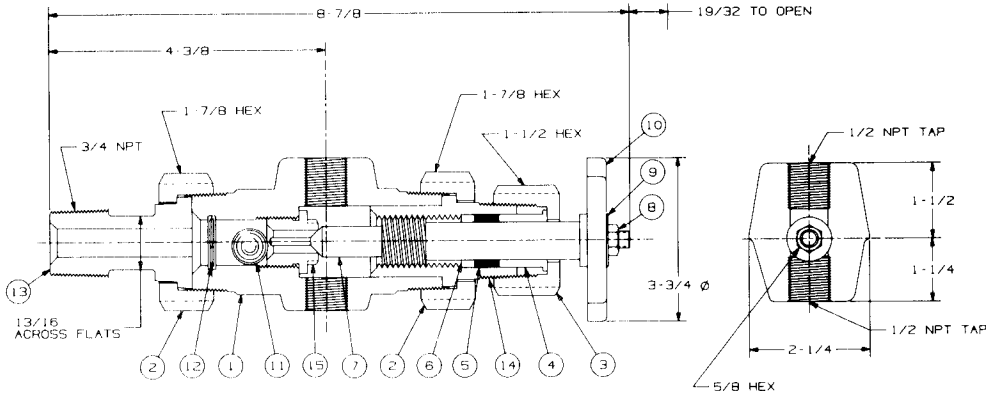
PRESSURE — TEMPERATURE RATING			
Teflon Packing		Wire-Graphite Packing	
4000 psi	100°F	2950 psi	500°F
3730 psi	200°F	2700 psi	600°F
3470 psi	300°F	2430 psi	700°F
3200 psi	400°F		

PARTS

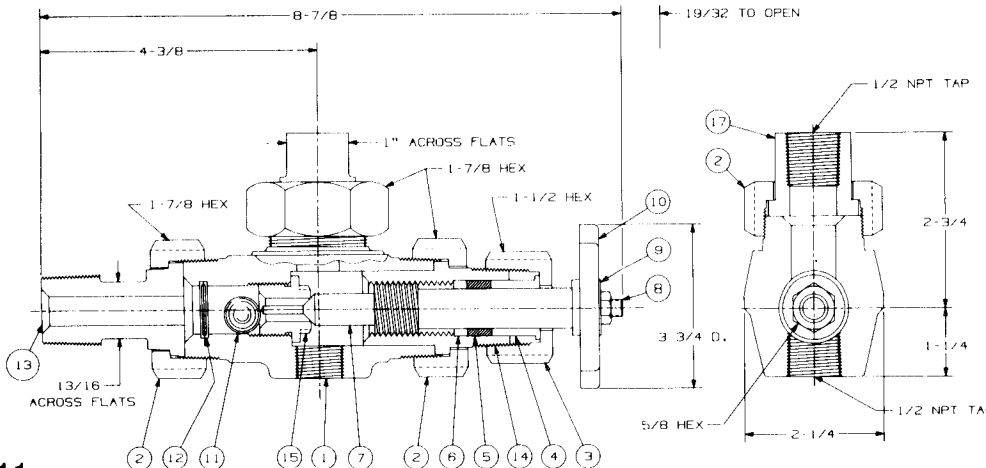
ITEM NO.	NAME	STANDARD	304 S.S. WETTED PARTS	316 S.S. WETTED PARTS
		MATERIAL	MATERIAL	MATERIAL
1	BODY	ASTM A350 LF2	304 S.S.	316 S.S.
2	UNION NUT	CARBON STEEL	CARBON STEEL	CARBON STEEL
3	PACKING NUT	CARBON STEEL	CARBON STEEL	CARBON STEEL
4	PACKING FOLLOWER	316 S.S.	316 S.S.	316 S.S.
5	PACKING RING	TEFLON	TEFLON	TEFLON
6	PACKING WASHER	17-4 PH S.S.	17-4 PH S.S.	17-4 PH S.S.
7	STEM	304 S.S.	304 S.S.	316 S.S.
8	STEM NUT	CARBON STEEL	CARBON STEEL	CARBON STEEL
9	NAME PLATE	304 S.S.	304 S.S.	304 S.S.
10	HAND WHEEL	ALLOY ZINC	ALLOY ZINC	ALLOY ZINC

ITEM NO.	NAME	STANDARD	304 S.S. WETTED PARTS	316 S.S. WETTED PARTS
		MATERIAL	MATERIAL	MATERIAL
11	BALL	440 S.S.	316 S.S.	316 S.S.
12	BALL RETAINER	316 S.S.	316 S.S.	316 S.S.
*13	MALE CONNECTOR	CARBON STEEL	304 S.S.	316 S.S.
14	BONNET	416 S.S.	304 S.S.	316 S.S.
15	SEAT	416 S.S.	304 S.S.	316 S.S.
17	FEMALE CONNECTOR	CARBON STEEL	304 S.S.	316 S.S.

* Item No. 13 has hole with 1/16 eccentricity for 1/8 maximum misalignment on the overall center-to-center. Note: Valve shown is for bottom lefthand (or top righthand) location. Opposite hand is reversed. Valves are furnished in pairs of one bottom left hand and one top left hand.



TYPE 4S
 Weight per set approximately 12 lbs.



TYPE 4U
 Weight per set approximately 12 lbs.

A Tubular Gage Connection is available on request. Optional Tank Connections shown on pages 26 and 27. Optional Gage Connections shown on page 25. Quick Opening Valve model shown on page 24.

STRAIGHT-THRU OS&Y VALVES

Type 5S & 5U

STANDARD OUTSIDE SCREW & YOKE

1440 psig CWP, 2160 psig Test (600 lbs. Class)

3/4" NPT Male Tank Connection

1/2" NPT Female Gage Connection

1/2" NPT Female Drain Connection only

PRESSURE — TEMPERATURE RATING			
Teflon Packing		Wire-Graphite Packing	
1440 psi	100°F	1250 psi	500°F
1400 psi	200°F	1100 psi	600°F
1365 psi	300°F	1065 psi	700°F
1330 psi	400°F		

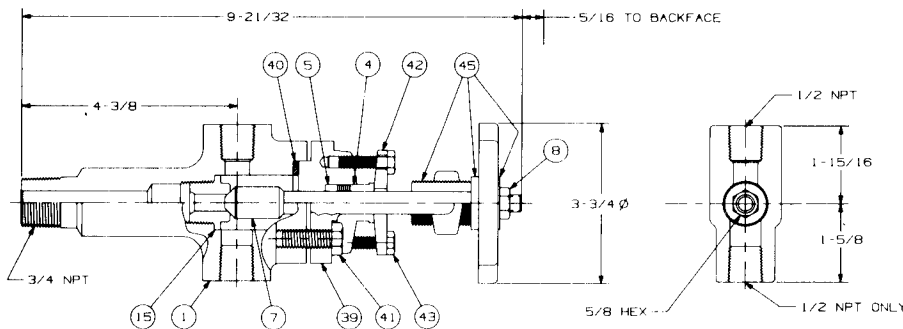
The Daniel Type 5 Gage Valve has the Outside Screw & Yoke design which prevents excessively hot and corrosive fluids from contacting stem threads, causing possible malfunction. The stem backs directly off the regrindable valve seat, using the positive, nonrotating stem principle. The valve has a "straight-thru" body design and, with an optional bleed valve, can be used in a block and bleed application. Standard gage connections are screwed (S) and union (U) but any other type connection can be supplied on special order.

The standard tank connection for Type 5 OS&Y Straight-Thru Gage Valves is a 3/4" NPT solid shank, with optional 1/2" and 1" NPT sizes. Ends beveled for welding also are available. Valve materials include forged carbon steel with stainless steel trims. A molded Teflon packing ring is standard at no extra cost in valves for services up to 450°F. For temperatures to 700°F, valves have wire-graphite packing. The standard Type 5 Valve has a backseating stem that allows the packing to be changed without shutting down the vessel. Stainless steel ball checks are available upon request.

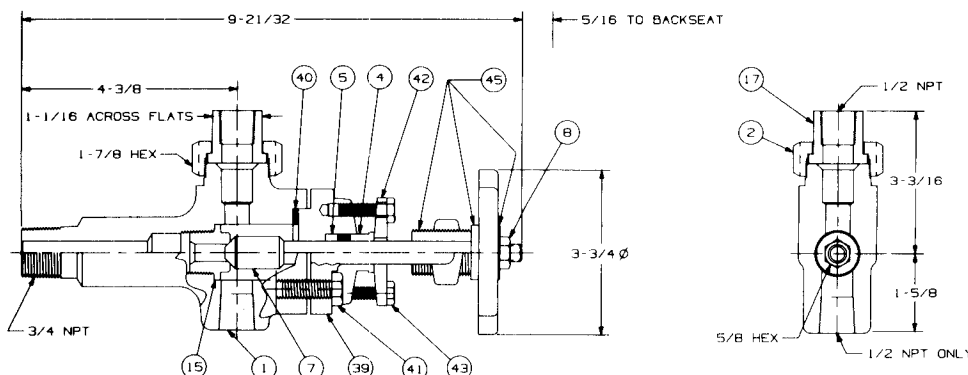
PARTS

ITEM NO.	NAME	MATERIAL
1	BODY	ASTM A350 LF2
2	UNION NUT	CARBON STEEL
4	PACKING FOLLOWER	STEEL
5	PACKING RING	TEFLON
7	STEM	416 S.S.
8	STEM NUT	CARBON STEEL
15	SEAT	416 S.S.
17	FEMALE CONNECTOR	CARBON STEEL

ITEM NO.	NAME	MATERIAL
39	YOKE	FORGED STEEL
40	YOKE GASKET	SPIRAL ASB.-S.S.
41	YOKE BOLT	ALLOY STEEL
42	PRESSURE BAR	FORGED STEEL
43	PRESSURE BAR SCREW	ALLOY STEEL
45	STEM-SCREW-HANDLE NAME PLATE ASSEMBLY	304 S.S./ZINC IRON/304 S.S.
46	OUTER THRUST WASHER	STEEL



TYPE 5S
Weight per set approximately 12 lbs.



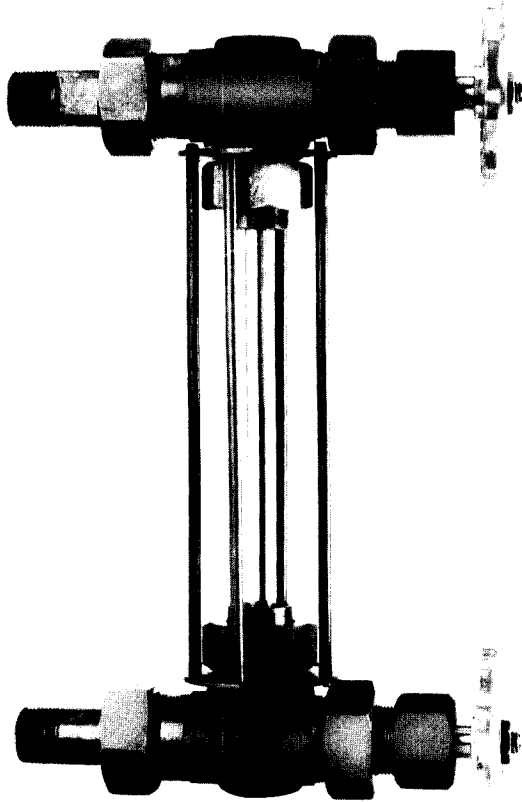
TYPE 5U
Weight per set approximately 12 lbs.

1/2" NPT & 1" NPT OPTIONAL.
1/2" IPS & 1" IPS BEVELED
ENDS OPTIONAL

A Tubular Gage Connection is available on request. Optional Tank Connections shown on pages 26 and 27. Optional Gage Connections shown on page 25. A Ball Check Valve is available on request.

TUBULAR GAGES AND VALVES

5/8" O.D. Glass Standard, 3/4" O.D. Glass Optional



Shown with Type 2T valves

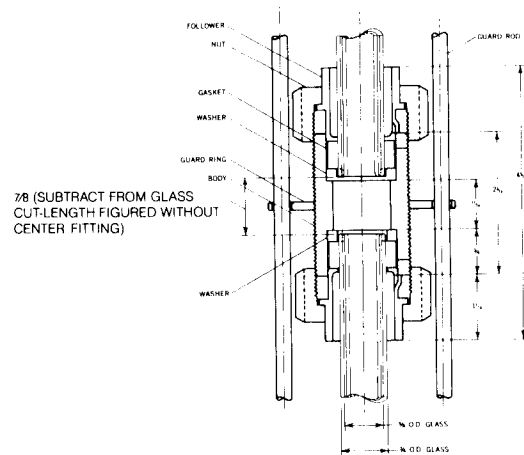
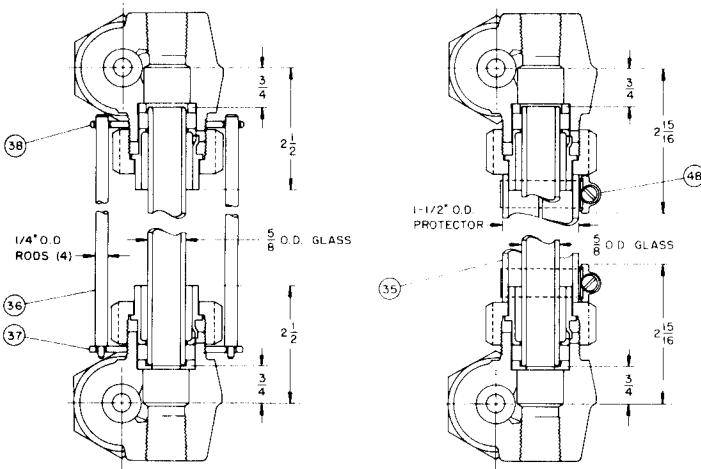
Daniel Tubular Glass Gages are available in any length desired and can be fitted with Type 1T or 2T Gage Valves (see Page 18). These gages provide 360° visibility of the liquid level through strong, clear glass. Tubular glass is used in three types: Red Line, High Pressure and Heavy Wall. Pressure ratings are different for each type and also depend upon glass length (see next page). If glass breakage occurs, a stainless steel ball check shuts off each valve. Glass tubes should be cut 1 1/2" shorter than valve center-to-center. The resulting visible glass length is 5" less than the valve center-to-center.

Red Line glass provides a bright crimson stripe against a narrow white strip throughout the length of the tube. Liquid levels are easy to see against this special optical effect. The glass is heat-resistant and ends are fire polished. Red Line is available in both 5/8" and 3/4" O.D.

High Pressure glass is a versatile, medium-strong type of tube used in many applications. It is crystal clear and ends are fire polished.

Heavy Wall glass has the highest pressure rating of all tubular glass. It is extremely clear, corrosion resistant, will not scratch easily and is extra resistant to heat shock. Ends are ground.

Four carbon steel guard rods and two guard rod rings are used to protect tubular glass gages. The rods are anchored in each ring which is fastened to the valve behind the union nut. Rods should be cut 1 3/4" shorter than valve center-to-center. A transparent plastic sheath also is available to clamp around the glass tube. Sheath length should be 4 3/8" shorter than valve center-to-center. Also available is an expanded metal gage glass protector for additional protection of the glass. Specify gage valve center-to-center for proper sizing of this assembly.



CENTER FITTING
(Recommended when valve centers exceed maximum recommended service length)

NOTE: Type 1T 4000 psi Tubular Valve and Type 2T 4000 psi Tubular Valve shown on page 15.

MAXIMUM RECOMMENDED WORKING PRESSURE, PSIG

GLASS LENGTH	5/8" O.D. Red Line		3/4" O.D. Red Line		5/8" O.D. High Pressure	
	TO 150°F*	TO 425°F**	TO 150°F*	TO 425°F**	TO 150°F*	TO 425°F**
8"	370	285	360	280	435	320
10"	345	280	340	275	420	315
12"	335	280	330	275	410	305
14"	325	275	320	270	390	295
15"	320	275	315	270	380	290
16"	315	270	310	265	375	285
18"	305	265	300	260	360	280
20"	290	265	285	260	350	270
22"	280	260	275	255	335	265
24"	265	255	260	250	320	255
30"	235	†	230	†	280	†
36"	205	†	200	†	245	†
48"	165	†	160	†	195	†
60"	125	†	125	†	150	†
72"	90	†	90	†	100	†

GLASS LENGTH	3/4" O.D. High Pressure		5/8" O.D. Heavy Wall		3/4" O.D. Heavy Wall	
	TO 150°F*	TO 425°F**	TO 150°F*	TO 425°F**	TO 150°F*	TO 425°F**
8"	425	315	600	350	600	350
10"	410	310	600	345	600	345
12"	400	300	600	340	600	340
14"	385	290	600	335	600	335
15"	375	285	600	330	600	330
16"	370	280	600	325	600	325
18"	355	275	600	320	600	320
20"	345	265	600	315	600	315
22"	330	260	590	310	590	310
24"	315	250	580	300	580	300
30"	275	†	550	†	550	†
36"	240	†	500	†	500	†
48"	190	†	340	†	340	†
60"	145	†	†	†	†	†
72"	100	†	†	†	†	†

* To 150°F and/or CORROSIVE SERVICES **For 150-425°F and/or CORROSIVE SERVICES
† Maximum recommended length in this service is 24"
‡ Maximum recommended length in this service is 48"

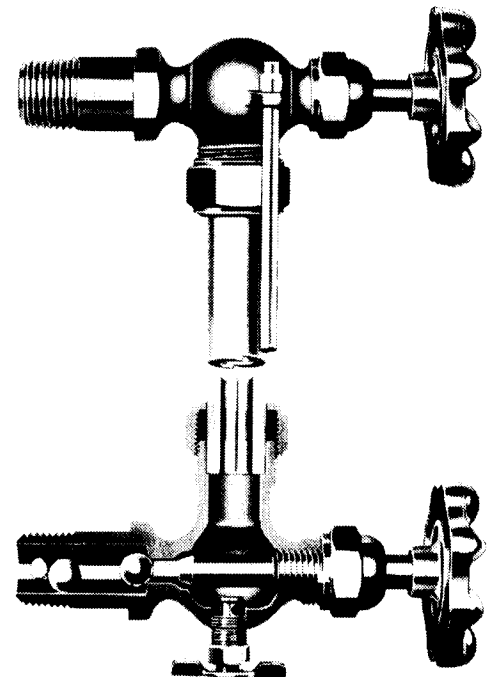
TUBULAR VALVES (Brass)

1/2" NPT Male Tank Connection
5/8" O.D. Tubular Glass Gage Connection

For low pressure water vessels, storage tanks, containers, etc., Daniel provides Type OT Brass Valves for Tubular Gages. The valves are made up with 5/8" O.D. Pyrex Red Line, High Pressure or Heavy Wall Glass from stock. Each valve contains a brass ball check which closes the valve in the event of glass breakage. Two guard rods are used. The lower valve also is fitted with a threaded drain cock. Type OT Brass Valves are suitable for working pressures up to 200 psig at or under 400°F.

Tubular glasses are available in any length and should be cut 1 1/2" shorter than valve center-to-centers. Guard rods should be 3/4" longer than the valve center-to-centers.

Visible length is 3" less than the valve centers.



TUBULAR VALVES

Type 1T & 2T

4000 psig CWP 6000 psig Test

3/4" NPT Male Union Tank Connection

5/8" O.D. Tubular Glass Gage Connection

1/2" NPT Female Drain Connection

Daniel Offset Tubular Gage Valves are identical to Type 1 and 2 S and U Valves except they are fitted with the 5/8" O.D. tubular glass connection. The Type 2T Valve also can be furnished in the coarse thread design and with quick-operating lever for remote operation by chain. Both valves have a molded Teflon packing ring and rubber glass gaskets as standard for services up to 250°F. For temperatures to 425°F, valves have wire-graphite packing and viton glass gaskets. In the event of tubular glass breakage, a stainless steel ball check closes the valve to prevent further loss of fluid.

PRESSURE—TEMPERATURE RATING			
Teflon Packing/ Rubber Gaskets		Teflon Packing/ Viton Gaskets	
4000 psi	100°F	3470 psi	300°F
3730 psi	200°F	3200 psi	400°F
3600 psi	250°F	3150 psi	425°F

NOTES: These ratings are for the valves only and not the tubular glass gages. See glass gage ratings on page 14.

PARTS

ITEM NO.	NAME	STANDARD	304 S.S. WETTED PARTS	316 S.S. WETTED PARTS
		MATERIAL	MATERIAL ¹	MATERIAL ²
1	BODY	ASTM A350 LF2	304 S.S.	316 S.S.
2	UNION NUT	CARBON STEEL	CARBON STEEL	CARBON STEEL
3	PACKING NUT	CARBON STEEL	CARBON STEEL	CARBON STEEL
4	PACKING FOLLOWER	316 S.S.	316 S.S.	316 S.S.
5	PACKING RING	TEFLON	TEFLON	TEFLON
6	PACKING WASHER	17-4 PH S.S.	17-4 PH S.S.	17-4 PH S.S.
7	STEM	304 S.S. ¹	304 S.S.	316 S.S.
8	STEM NUT	CARBON STEEL	CARBON STEEL	CARBON STEEL
9	NAME PLATE	304 S.S.	304 S.S.	304 S.S.
10	HAND WHEEL	ALLOY ZINC	ALLOY ZINC	ALLOY ZINC
11	BALL	440 S.S.	440 S.S.	440 S.S.
12	BALL RETAINER	316 S.S.	316 S.S.	316 S.S.

ITEM NO.	NAME	STANDARD	304 S.S. WETTED PARTS	316 S.S. WETTED PARTS
		MATERIAL	MATERIAL ¹	MATERIAL ²
*13	MALE CONNECTOR	CARBON STEEL	304 S.S.	316 S.S.
14	BONNET ²	416 S.S.	304 S.S.	316 S.S.
15	SEAT ²	416 S.S.	304 S.S.	316 S.S.
18	GLASS FOLLOWER	CARBON STEEL	CARBON STEEL	CARBON STEEL
19	GLASS GASKET	RUBBER	RUBBER	RUBBER
**20 or 21	LOWER GLASS SUPPORT	CARBON STEEL	304 S.S.	316 S.S.

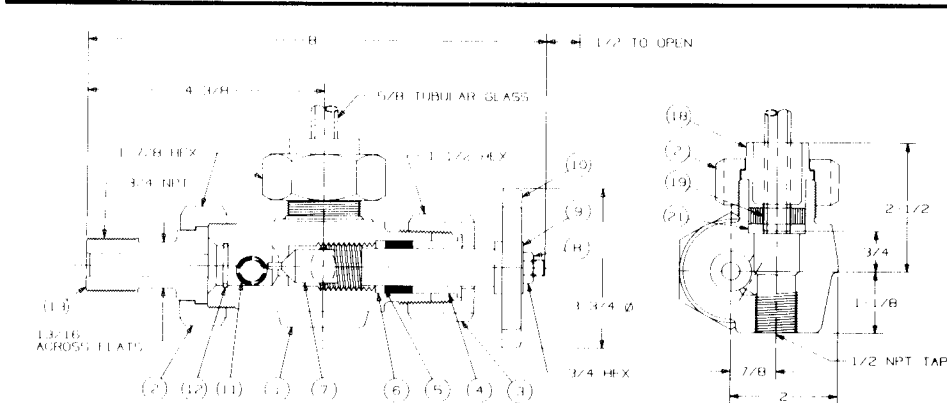
* ITEM NO. 13 HAS HOLE WITH 1/16 ECCENTRICITY FOR 1/8 MAXIMUM MISALIGNMENT ON THE OVERALL CENTER-TO-CENTER

** ITEM NO. 21 IS USED IN LOWER VALVE; ITEM NO. 20 IN UPPER VALVE

NOTE: Valve shown is for bottom left hand (or top right hand) location. Opposite hand is reversed. Valves are furnished in pairs of one bottom left hand and one top left hand.

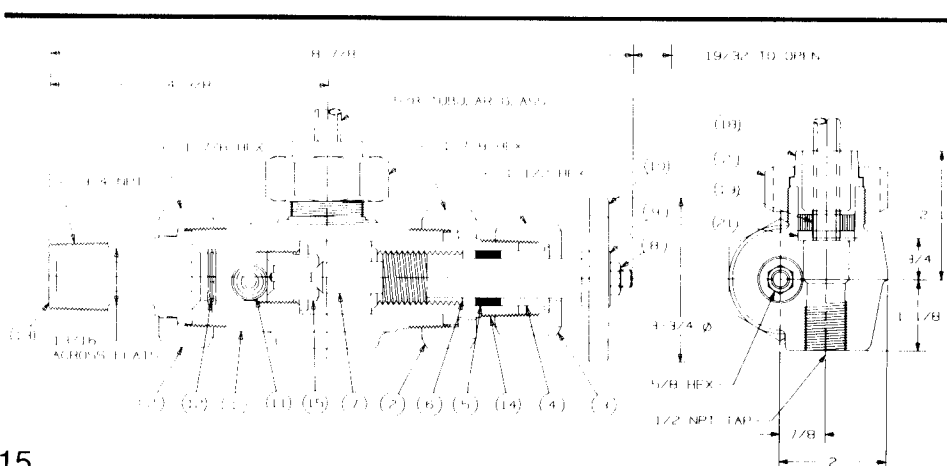
¹ For Type 1 — 416 S.S.

² Available in Type 2 Valve only



TYPE 1T

Weight per set approximately 10 lbs. 12 ozs.



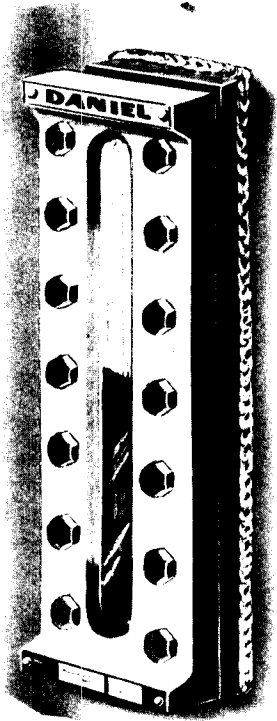
TYPE 2T

Weight per set approximately 11 lbs. 12 ozs.

Optional Tank Connections shown on pages 26 and 27. Optional Gage Connections shown on page 25.

SPECIALTY GAGES:

Welding Pad

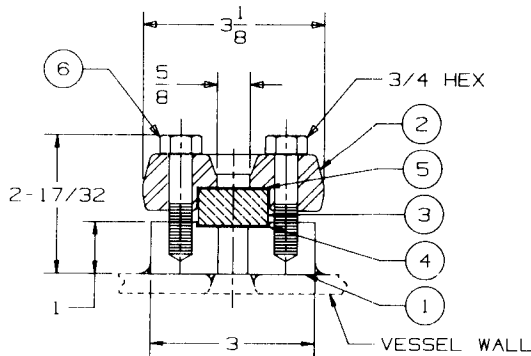
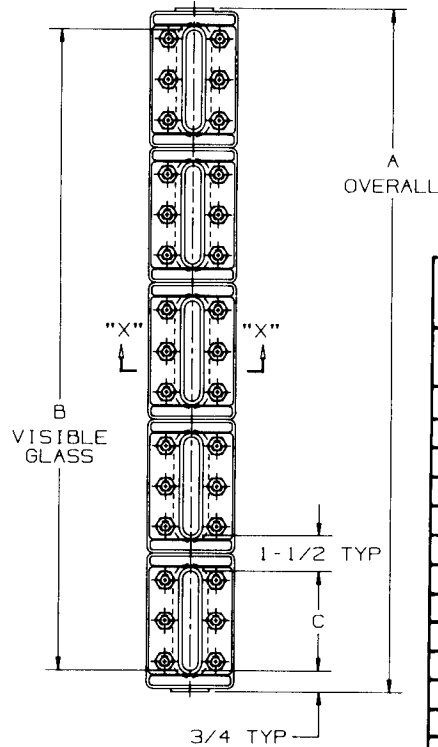


Daniel Welding Pad Gages are used when standard tank connections cannot be used or when the liquid has solids in suspension. The gage becomes an integral part of the vessel because it is welded right onto the outer wall. Reflex glass is used in any of nine standard lengths. Standard covers are 3 1/8" wide. **NOTE:** Welding pad gages to be used on vessels less than 36" in diameter must be special ordered. The welding pad body must be machined to allow proper fit up.

Method of Installation:

1. Assemble complete gage with spacer plate (available on request) in place of gage glass.
2. Place gage in exact location desired on empty vessel and weld around circumference of the pad.
3. Allow gage to cool, then remove cover and spacer. Drill or burn top and bottom holes in vessel wall at the top and bottom of each gage slot. Slot is 5/8" wide.
4. Replace gage glass, gasket, cushion and cover. Torque bolts to prescribed foot/pounds.

NOTE: While the gage itself can be designed to withstand certain pressures, Daniel cannot control the installation of each gage or the load applied to the gage by the vessel. Because of this, Daniel cannot rate Weld Pad Gages. When ordering, add WP to gage size number.



SECTION X-X
REFLEX

PARTS

ITEM NO.	NAME	MATERIAL
1	WELDING PAD	AISI 1020 HR
2	COVER	A350 LF2
3	GLASS	TEMPERED
4	GASKET	NON-ASBESTOS
5	CUSHION	NON-ASBESTOS
6	BOLT	ASTM A193 B7

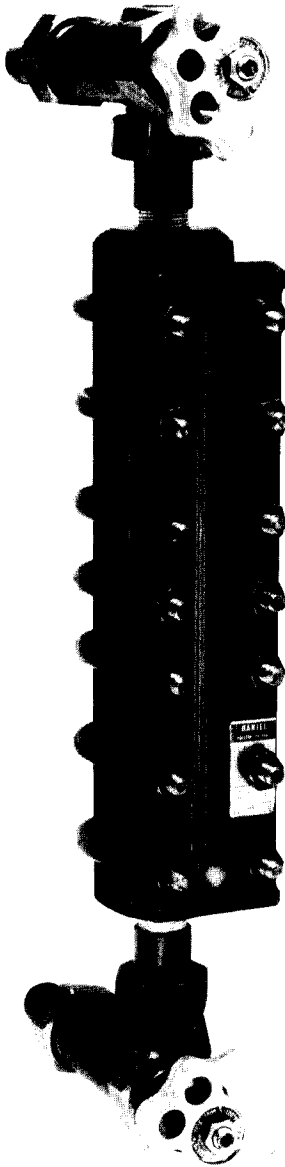
DIMENSIONS

SIZE NO.		DIMENSIONS (IN INCHES)		
Glass Size	NO. SECT.	A	B	C
1	1	5 1/4	3 3/4	3 3/4
2	1	6 1/4	4 3/4	4 3/4
3	1	7 1/4	5 3/4	5 3/4
4	1	8 1/4	6 3/4	6 3/4
5	1	9 3/8	7 7/8	7 7/8
6	1	10 5/8	9 1/8	9 1/8
7	1	11 3/4	10 1/4	10 1/4
8	1	13 3/8	11 7/8	11 7/8
9	1	14 1/8	12 5/8	12 5/8
3	2	14 1/2	13	5 3/4
4	2	16 1/2	15	6 3/4
5	2	18 3/4	17 1/4	7 7/8
6	2	21 1/4	19 3/4	9 1/8
7	2	23 1/2	22	10 1/4
8	2	26 3/4	25 1/4	11 7/8
9	2	28 3/4	26 3/4	12 5/8
6	3	31 7/8	30 3/8	9 1/8
7	3	35 1/4	33 3/4	10 1/4
8	3	40 1/8	38 5/8	11 7/8
9	3	42 3/8	40 7/8	12 5/8
7	4	47	45 1/2	10 1/4
8	4	53 1/2	52	11 7/8
9	4	56 1/2	55	12 5/8
7	5	58 3/4	57 1/4	10 1/4
8	5	66 7/8	65 3/8	11 7/8
9	5	70 5/8	69 1/8	12 5/8

SPECIALTY GAGES:

Large-Chamber for Viscous Liquids

Example: 71 RL-LC (No. 7 glass, 1-section, Reflex, Low Pressure, Large Chamber)



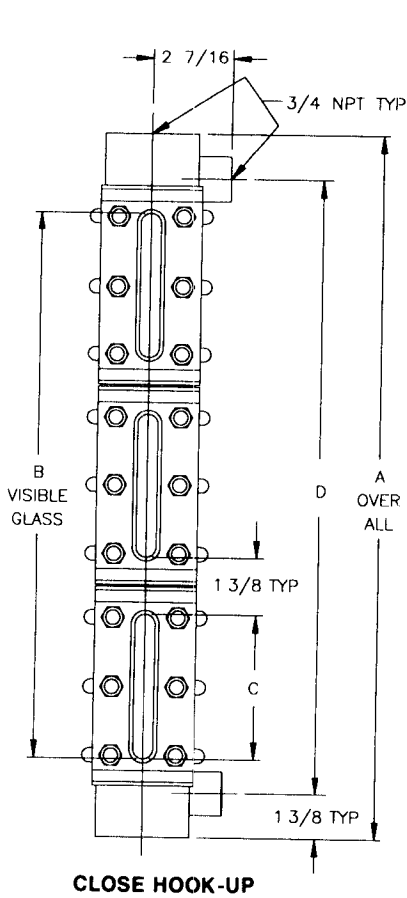
Daniel Large Chamber Gages are made in a special low pressure series of both Reflex and Transparent Gages. The large diameter chamber makes accurate liquid level readings possible under unusual conditions such as boiling, flashing or foaming of the liquid. The chamber is manufactured from heavy duty seamless steel pipe with inside diameter of 2 1/8". Each end of the pipe is closed off with a welded plug which is drilled and tapped for 3/4" NPT connection. For close hook-ups, 3/4" NPT side connections are made and ends may be drilled, tapped and plugged for cleaning as required.

Recessed seats are machined into the liquid chamber and gage covers for protection of glass, gasket and cushion. Special bolts are used. Large Chamber Gages are made in lengths for standard flat glasses and multiple section gages are available.

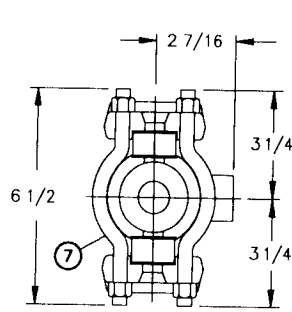
When ordering, add LC for large chamber to gage size number and CH for close hook-up.

DIMENSIONS

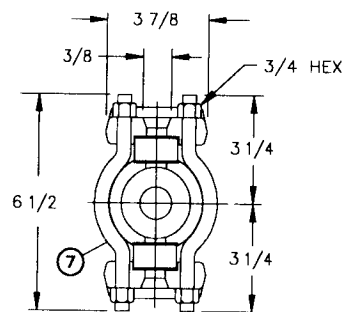
SIZE NO.		DIMENSIONS (IN INCHES)							
GLASS SIZE	NO. SECT.	STANDARD			CLOSE HOOK-UP				
		A	B	C	A	B	C	D	
1	1	6 1/4	3 3/4	3 3/4	8 3/8	3 3/4	3 3/4	5 5/8	
2	1	7 1/4	4 3/4	4 3/4	9 3/8	4 3/4	4 3/4	6 5/8	
3	1	8 1/4	5 3/4	5 3/4	10 3/8	5 3/4	5 3/4	7 5/8	
4	1	9 1/4	6 3/4	6 3/4	11 3/8	6 3/4	6 3/4	8 5/8	
5	1	10 3/8	7 7/8	7 7/8	12 1/2	7 7/8	7 7/8	9 3/4	
6	1	11 5/8	9 1/8	9 1/8	13 3/4	9 1/8	9 1/8	11	
7	1	12 3/4	10 1/4	10 1/4	14 7/8	10 1/4	10 1/4	12 1/8	
8	1	14 3/8	11 7/8	11 7/8	16 1/2	11 7/8	11 7/8	13 3/4	
9	1	15 1/8	12 5/8	12 5/8	17 1/4	12 5/8	12 5/8	14 1/2	
3	2	15 1/2	13	5 3/4	17 5/8	13	5 3/4	14 7/8	
4	2	17 1/2	15	6 3/4	19 5/8	15	6 3/4	16 7/8	
5	2	19 3/4	17 1/4	7 7/8	21 7/8	17 1/4	7 7/8	19 1/8	
6	2	22 1/4	19 3/4	9 1/8	24 3/8	19 3/4	9 1/8	21 5/8	
7	2	24 1/2	22	10 1/4	26 5/8	22	10 1/4	23 7/8	
8	2	27 3/4	25 1/4	11 7/8	29 7/8	25 1/4	11 7/8	27 1/8	
9	2	29 1/4	26 3/4	12 5/8	31 3/8	26 3/4	12 5/8	28 5/8	
6	3	32 7/8	30 3/8	9 1/8	35	30 3/8	9 1/8	32 1/4	
7	3	36 1/4	33 3/4	10 1/4	38 3/8	33 3/4	10 1/4	35 5/8	
8	3	41 1/8	38 5/8	11 7/8	43 1/4	38 5/8	11 7/8	40 1/2	
9	3	43 3/8	40 7/8	12 5/8	45 1/2	40 7/8	12 5/8	42 3/4	
7	4	48	45 1/2	10 1/4	50 1/8	45 1/2	10 1/4	47 3/8	
8	4	54 1/2	52	11 7/8	56 5/8	52	11 7/8	53 7/8	
9	4	57 1/2	55	12 5/8	59 5/8	55	12 5/8	56 7/8	
7	5	59 3/4	57 1/4	10 1/4	61 7/8	57 1/4	10 1/4	59 1/8	
8	5	67 7/8	65 3/8	11 7/8	70	65 3/8	11 7/8	67 1/4	
9	5	71 5/8	69 1/8	12 5/8	73 3/4	69 1/8	12 5/8	71	



CLOSE HOOK-UP

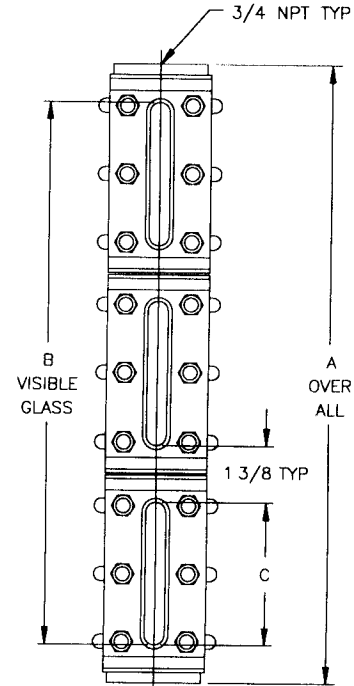


TRANSPARENT (STD.)

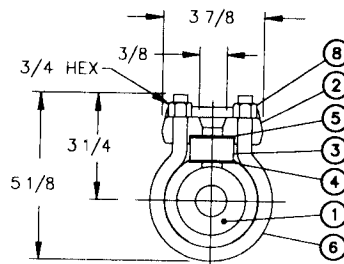


TRANSPARENT (CH)

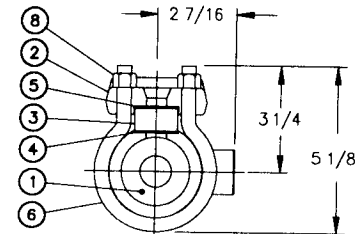
ITEM NO.	NAME	MATERIAL
1	CHAMBER	ASTM A106 GRB
2	COVER	ASTM A350 LF2
3	GLASS	TEMPERED
4	GASKET	NON-ASBESTOS
5	CUSHION	NON-ASBESTOS
6	U-BOLT	ASTM A193 B7
7	BOLT	ASTM A193 B7
8	NUT	ASTM A194 2H



STANDARD



REFLEX (STD.)



REFLEX (CH)

PRESSURES-TEMPERATURE RATINGS (psig)

REFLEX — LARGE CHAMBER							
Glass Size	100°F	200°F	300°F	400°F	500°F	600°F	700°F
1	1020	990	950	910	850	755	620
2	980	950	915	875	815	725	600
3	940	910	880	840	780	695	590
4	900	870	840	805	750	665	560
5	860	830	800	770	715	635	540
6	830	805	775	745	690	610	530
7	790	765	735	710	660	585	510
8	750	725	700	670	625	555	500
9	720	695	670	645	600	530	480

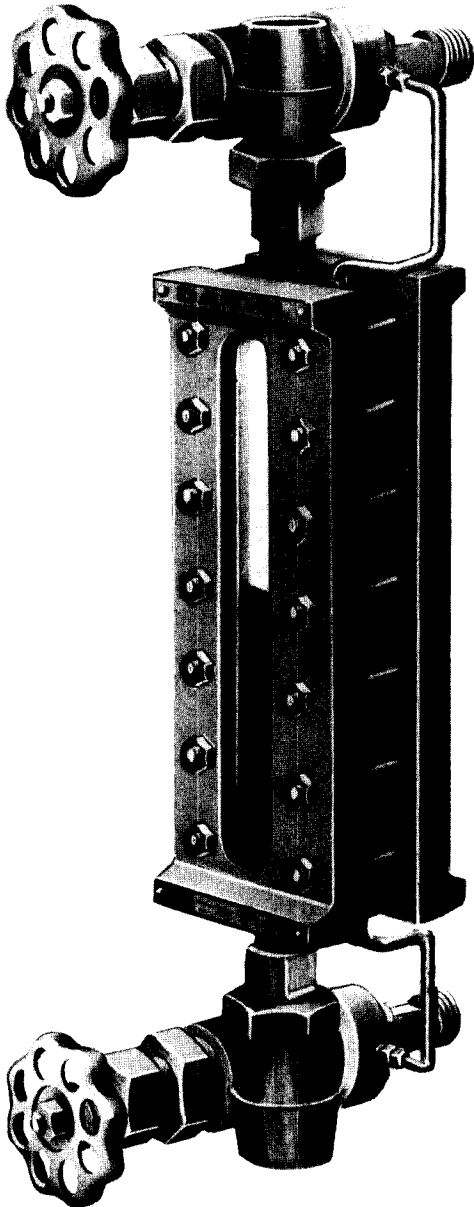
TRANSPARENT — LARGE CHAMBER							
Glass Size	100°F	200°F	300°F	400°F	500°F	600°F	700°F
1	790	765	740	705	660	585	390
2	750	725	700	670	625	555	380
3	720	695	670	645	600	530	360
4	680	655	635	610	565	500	340
5	650	630	605	580	540	480	330
6	610	590	570	545	510	450	310
7	580	560	540	520	485	430	300
8	540	520	505	480	450	400	280
9	500	485	465	445	415	370	260

SPECIALTY GAGES:

Heated/Cooled Externally

Example: 71 TL-HC (No. 7 glass, 1-section, Transparent, Low Pressure, Externally Heated/Cooled Gage)

Also available in close hook-up (CH) and internally heated/cooled type.



Daniel Externally Heated/Cooled Gages may be either low Pressure or Mid Pressure, Reflex or Transparent and have $\frac{1}{2}$ " or $\frac{3}{4}$ " NPT Connections. Pressure-temperature ratings and sizes remain the same as standard flat gages.

On externally heated/cooled gages a metal tube is employed to transmit heating or cooling fluid. The tubing starts from an adaptor nut on one valve, passes along a machined groove in the gage body wall and connects to the adaptor nut in the opposite valve. Fluid piped through the tubing serves as the heating or cooling media. Gage bodies (liquid chambers) are made extra long to accommodate the groove and tubing.

Most common heating fluids are steam and hot water. To cool gages, methane, propane, freon and ammonia refrigerants are used.

The adaptor nut on the gage valves can be fitted with either a $\frac{1}{2}$ " NPT Female Tank connection or a $\frac{3}{4}$ " NPT Male Tank connection. Valve Types 1, 2 and 4 may be used.

When ordering Daniel Externally Heated/Cooled Gages, add HC to the gage size number.

Tank Connections (Also see pages 26 and 27)

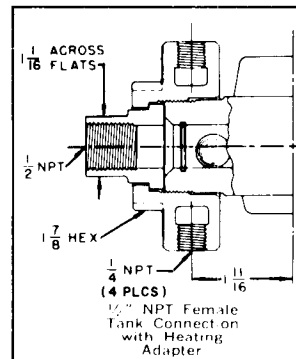


FIG. V

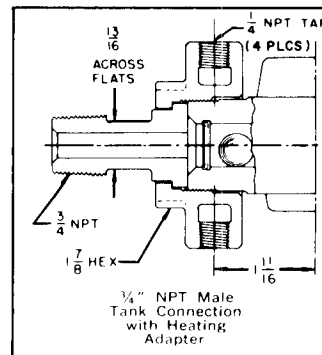
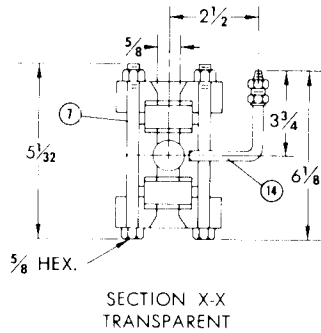
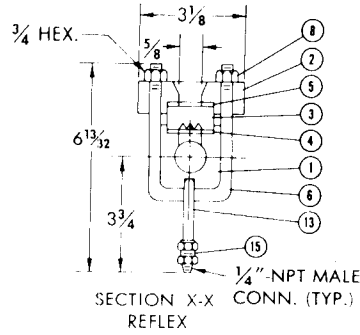
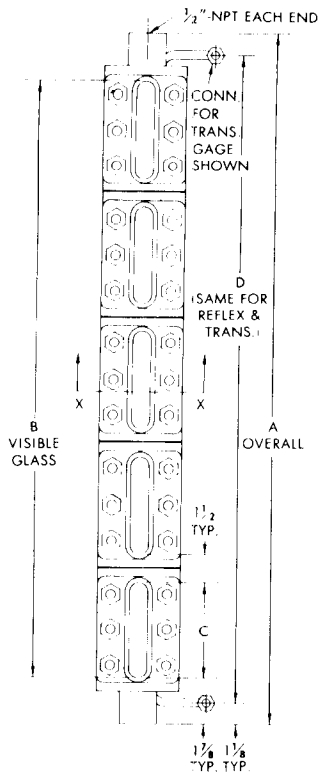


FIG. VI



PARTS

ITEM NO.	NAME	MATERIAL
1	CHAMBER	CARBON STEEL
2	COVER	ASTM A350 LF2
3	GLASS	TEMPERED
4	GASKET	NON-ASBESTOS
5	CUSHION	NON-ASBESTOS
6	U-BOLT	ASTM A193 B7
7	BOLT	ASTM A193 B7
8	NUT	ASTM A194 2H
13	TUBING	COPPER
14	TUBING	COPPER
15	FITTING	STEEL

DIMENSIONS AND PRESSURE RATINGS

SIZE NO.		DIMENSIONS (IN INCHES)				LOW-PRESSURE				MID-PRESSURE			
GLASS SIZE	NO. SECT.	A	B	C	D	REFLEX MAX. PSIG @ TEMP.*		TRANSPARENT MAX. PSIG @ TEMP.*		REFLEX MAX. PSIG @ TEMP.*		TRANSPARENT MAX. PSIG @ TEMP.**	
						100°F	700°F	100°F	700°F	100°F	700°F	100°F	700°F
						1	1	7 1/2	3 3/4	3 3/4	5 1/4	2400	1520
2	1	8 1/2	4 3/4	4 3/4	6 1/4	2325	1470	1815	1150	2910	1840	2315	1470
3	1	9 1/2	5 3/4	5 3/4	7 1/4	2250	1420	1630	1050	2820	1780	2130	1340
4	1	10 1/2	6 3/4	6 3/4	8 1/4	2175	1370	1440	900	2725	1740	1940	1230
5	1	11 5/8	7 7/8	7 7/8	9 3/8	2100	1320	1250	790	2630	1660	1750	1100
6	1	12 7/8	9 1/8	9 1/8	10 5/8	2025	1280	1065	680	2535	1600	1565	990
7	1	14	10 1/4	10 1/4	11 3/4	1950	1230	875	550	2440	1540	1375	870
8	1	15 5/8	11 7/8	11 7/8	13 3/8	1875	1180	690	440	2345	1480	1190	750
9	1	16 3/4	12 5/8	12 5/8	14 1/8	1800	1140	500	320	2250	1420	1000	630
3	2	16 3/4	13	5 3/4	14 1/2	2250	1420	1630	1050	2820	1780	2130	1340
4	2	18 3/4	15	6 3/4	16 1/2	2175	1370	1440	900	2725	1740	1940	1230
5	2	21	17 1/4	7 7/8	18 3/4	2100	1320	1250	790	2630	1660	1750	1100
6	2	23 1/2	19 3/4	9 1/8	21 1/4	2025	1280	1065	680	2535	1600	1565	990
7	2	25 3/4	22	10 1/4	23 1/2	1950	1230	975	550	2440	1540	1375	870
8	2	29	25 1/4	11 7/8	26 3/4	1875	1180	690	440	2345	1480	1190	750
9	2	30 1/2	26 3/4	12 5/8	28 1/4	1800	1140	500	320	2250	1420	1000	630
6	3	34 1/8	30 3/8	9 1/8	31 7/8	2025	1280	1065	680	2535	1600	1565	990
7	3	37 1/2	33 3/4	10 1/4	35 1/4	1950	1230	875	550	2440	1540	1375	870
8	3	42 3/8	38 5/8	11 7/8	40 1/8	1875	1180	690	440	2345	1480	1190	750
9	3	44 5/8	40 7/8	12 5/8	42 3/8	1800	1140	500	320	2250	1420	1000	630
7	4	49 1/4	45 1/2	10 1/4	47	1950	1230	875	550	2440	1540	1375	870
8	4	55 3/4	52	11 7/8	53 1/2	1875	1180	690	440	2345	1480	1190	750
9	4	58 3/4	55	12 5/8	56 1/2	1800	1140	500	320	2250	1420	1000	630
7	5	61	57 1/4	10 1/4	58 3/4	1950	1230	875	550	2440	1540	1375	870
8	5	69 1/8	65 3/8	11 7/8	66 7/8	1875	1180	690	440	2345	1480	1190	750
9	5	72 7/8	69 1/8	12 5/8	70 5/8	1800	1140	500	320	2250	1420	1000	630

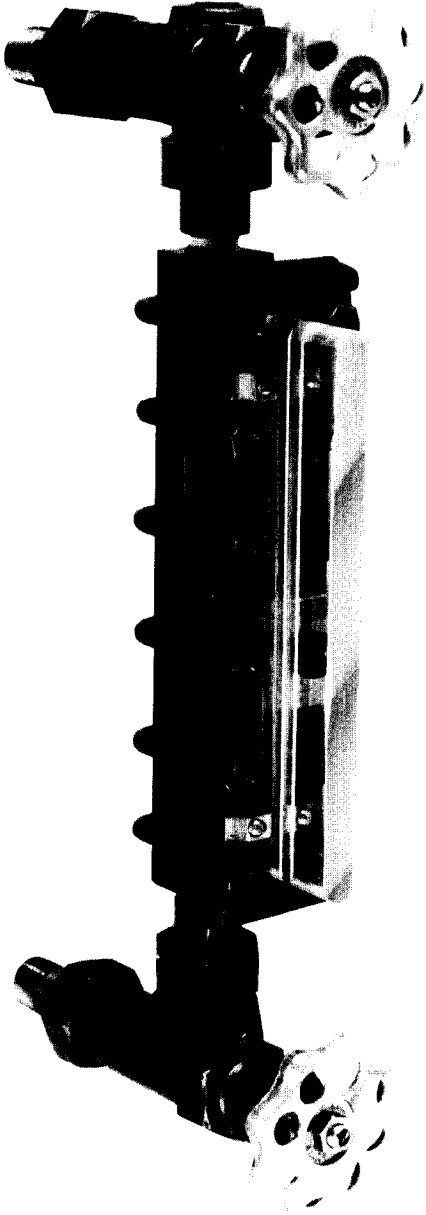
* Saturated steam to 350 WSP

** Maximum saturated steam 600 WSP with mica shields.

SPECIALTY GAGES:

Frost-Prevention Extensions

Example: 81 RL-FP w/ 3 $\frac{5}{8}$ " extensions (No. 8 glass, 1-section, Reflex, Low Pressure, Frost Preventive Gage with 3 $\frac{5}{8}$ " extensions).

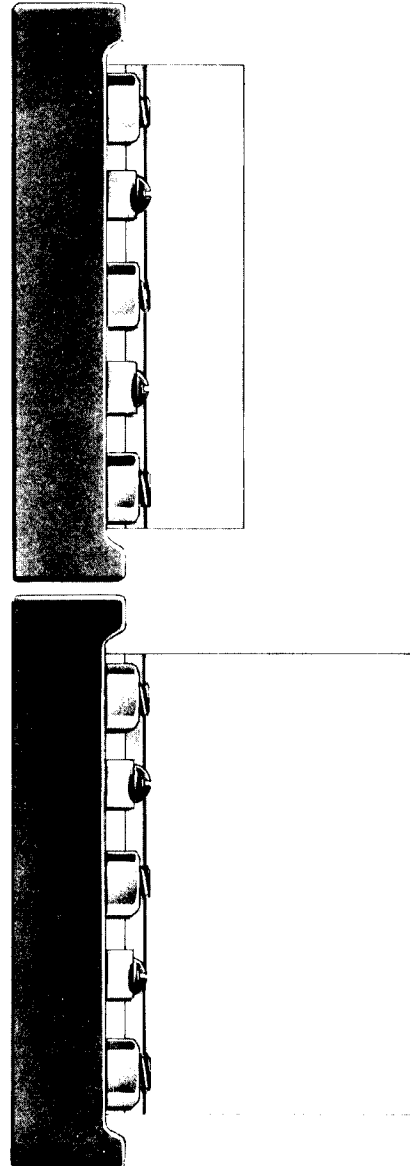


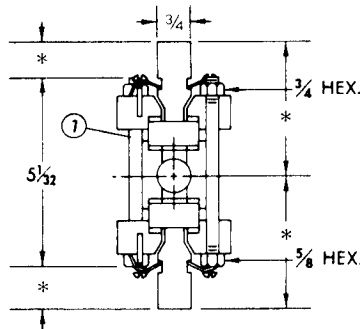
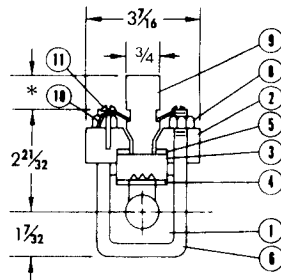
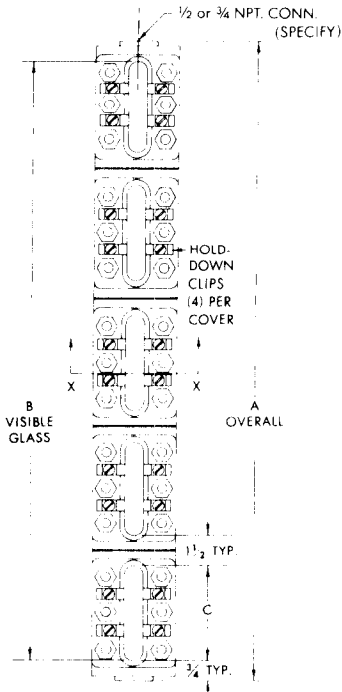
Daniel plastic extensions for flat gage glasses prevent frost from forming in the liquid level view slot in low temperature services. Reflex and Transparent Gages in all pressure ratings can be fitted with plastic extensions.

Projecting from the view slot, the clear plastic extension keeps the liquid level indication clearly visible. Stocked extensions are 1 $\frac{5}{8}$ " and 3 $\frac{5}{8}$ " in length. If the gage is thickly insulated, longer extensions are available. The extension is held in place by stainless steel clamps fastened to the gage cover. For extra low temperature services, Daniel gages can be made of special metals.

Recommended length for Frost Preventive Extensions: 1 $\frac{5}{8}$ " extension is standard from 80°F ambient to 0°F temperature. Add 1" extension length for each 100°F below 0°F.

When ordering, specify length and add FP to gage size number.





*Depends on Extension Length

PARTS

ITEM NO.	NAME	MATERIAL
1	CHAMBER	CARBON STEEL
2	COVER	ASTM A350 LF2
3	GLASS	TEMPERED
4	GASKET	NON-ASBESTOS
5	CUSHION	NON-ASBESTOS
6	U-BOLT	ASTM A193 B7
7	BOLT	ASTM A193 B7
8	NUT	ASTM A194 2H
9	EXTENSION	PLASTIC
10	CLIP	303 S.S.
11	SCREW	303 S.S.

DIMENSIONS AND PRESSURE RATINGS

SIZE NO.		DIMENSIONS (IN INCHES)			LOW-PRESSURE				MID-PRESSURE			
					REFLEX MAX. PSIG @ TEMP.*		TRANSPARENT MAX. PSIG @ TEMP.*		REFLEX MAX. PSIG @ TEMP.*		TRANSPARENT MAX PSIG @ TEMP.**	
					100°F	700°F	100°F	700°F	100°F	700°F	100°F	700°F
GLASS SIZE	NO. SECT.	A	B	C								
1	1	5 1/4	3 3/4	3 3/4	2400	1520	2000	1260	3000	1890	2500	1580
2	1	6 1/4	4 3/4	4 3/4	2325	1470	1815	1150	2910	1840	2315	1470
3	1	7 1/4	5 3/4	5 3/4	2250	1420	1630	1050	2820	1780	2130	1340
4	1	8 1/4	6 3/4	6 3/4	2175	1370	1440	900	2725	1740	1940	1230
5	1	9 3/8	7 7/8	7 7/8	2100	1320	1250	790	2630	1660	1750	1100
6	1	10 5/8	9 1/8	9 1/8	2025	1280	1065	680	2535	1600	1565	990
7	1	11 3/4	10 1/4	10 1/4	1950	1230	875	550	2440	1540	1375	870
8	1	13 3/8	11 7/8	11 7/8	1875	1180	690	440	2345	1480	1190	750
9	1	14 1/8	12 5/8	12 5/8	1800	1140	500	320	2250	1420	1000	630
3	2	14 1/2	13	5 3/4	2250	1420	1630	1050	2820	1780	2130	1340
4	2	16 1/2	15	6 3/4	2175	1370	1440	900	2725	1740	1940	1230
5	2	18 3/4	17 1/4	7 7/8	2100	1320	1250	790	2630	1660	1750	1100
6	2	21 1/4	19 3/4	9 1/8	2025	1280	1065	680	2535	1600	1565	990
7	2	23 1/2	22	10 1/4	1950	1230	875	550	2440	1540	1375	870
8	2	26 3/4	25 1/4	11 7/8	1875	1180	690	440	2345	1480	1190	750
9	2	28 1/4	26 3/4	12 5/8	1800	1140	500	320	2250	1420	1000	630
6	3	31 7/8	30 3/8	9 1/8	2025	1280	1065	680	2535	1600	1565	990
7	3	35 1/4	33 3/4	10 1/4	1950	1230	875	550	2440	1540	1375	870
8	3	40 1/8	38 5/8	11 7/8	1875	1180	690	440	2345	1480	1190	750
9	3	42 3/8	40 7/8	12 5/8	1800	1140	500	320	2250	1420	1000	630
7	4	47	45 1/2	10 1/4	1950	1230	875	550	2440	1540	1375	870
8	4	53 1/2	52	11 7/8	1875	1180	690	440	2345	1480	1190	750
9	4	56 1/2	55	12 5/8	1800	1140	500	320	2250	1420	1000	630
7	5	58 3/4	57 1/4	10 1/4	1950	1230	875	550	2440	1540	1375	870
8	5	66 7/8	65 3/8	11 7/8	1875	1180	690	440	2345	1480	1190	750
9	5	70 5/8	69 1/8	12 5/8	1800	1140	500	320	2250	1420	1000	630

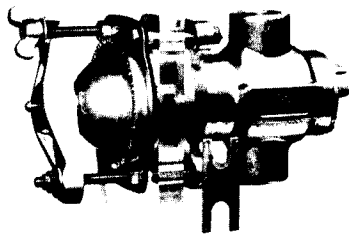
* Saturated steam to 350 WSP

** Maximum saturated steam 600 WSP with mica shields

SPECIALTY GAGES:

Illuminators (Explosion-Proof)

TYPE EP-HW

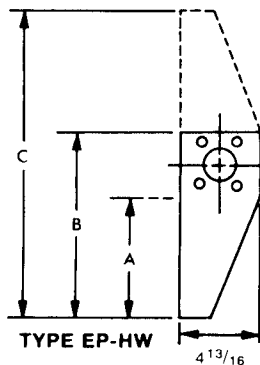


Daniel Explosion-Proof Gage Illuminators give bright, evenly diffused light for easy viewing of liquid levels in Transparent Gages. The illuminator spreads light from a single source throughout the length of its Lucite plastic reflector(s). The reflectors are 3/4" thick and come in lengths to fit 9 standard glass sizes. Single section illuminators are made to fit 1-section gages, double sections to fit 2-section gages. On 3-section gages, one single section and one double section illuminator are used.

Daniel Standard illuminators are approved by Underwriter Laboratories under their Standard for Electric Lighting Fixtures for use in hazardous locations, Class 1, Group "C" and "D" Services, Divisions I & II. Group B service is available upon request. Illuminators are 110 voltage.

The explosion-proof fitting is separable from the plastic reflector and consists of an aluminum housing for the wiring and bulb socket and a thick, heat-resistant glass housing for the light bulb. A bracket is furnished for fastening the illuminator to the two top bolts on the left side of the gage cover. On multiple-section illuminators, a 1" NPT pipe nipple can be supplied for wiring conduit between lamps.

EP-HW type
are available in
single or double
sections.



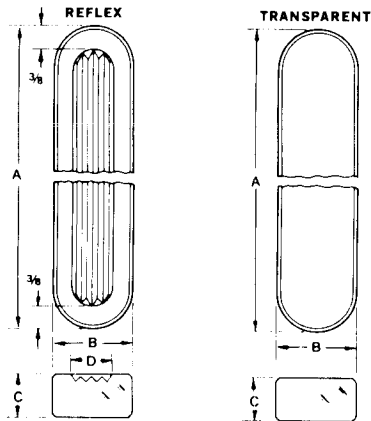
DIMENSIONS (IN INCHES) EP-HW ILLUMINATOR					
SIZE NO.	A	SINGLE		DOUBLE	
	VISIBLE LENGTH	B OVER-ALL	CAT. NO.	C OVER-ALL	CAT. NO.
1	3 3/4	7	11-HW	9	12-HW
2	4 3/4	8	21-HW	11	22-HW
3	5 3/4	9	31-HW	13	32-HW
4	6 3/4	10	41-HW	15	42-HW
5	7 7/8	11 1/8	51-HW	17 1/4	52-HW
6	9 1/8	12 3/8	61-HW	19 3/4	62-HW
7	10 1/4	13 1/2	71-HW	22	72-HW
8	11 7/8	15 1/8	81-HW	25 1/4	82-HW
9	12 5/8	15 7/8	91-HW	26 3/4	92-HW

Catalog No. EP-HW has a 58-watt threaded base lamp bulb.

When ordering, specify Catalog Number, gage length and number of sections.

DIMENSIONAL DATA

Flat Gage Glasses



Glass Size No.	A
1	4½"
2	5½"
3	6½"
4	7½"
5	8½"
6	9½"
7	11"
8	12½"
9	13½"

B	C	D
1⅞"	1⅞"	1⅞"

**TOLERANCES
FOR DIMENSIONS ABOVE**

A	B	C
+0 -½"	+½" -0	+0 -½"

Daniel standard gage glass is made of borosilicate glass. For higher temperature service or requirements, aluminosilicate glass can be supplied.

Mica shields are available for use with Transparent Gages in steam boiler service enabling glass to be used in higher pressures. They are placed between gasket and glass. KEL-F shields are available for use with Transparent Gages in corrosive service.

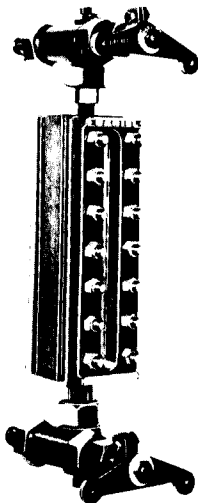
NOTE: For cyclic temperature applications, or to aid in torque retention, spring washers are available upon request.

LIQUID LEVEL GAGE VOLUMES

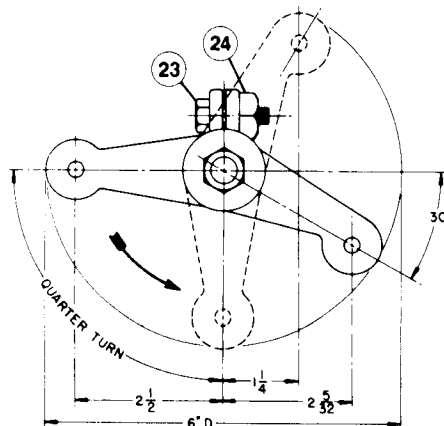
Glass Size No.	Visible Length (inches)	STANDARD GAGE VOLUMES (approximate)				LARGE CHAMBER GAGE VOLUMES (approximate)			
		REFLEX		TRANSPARENT		REFLEX		TRANSPARENT	
		Cu. In.	Cu. Cm.	Cu. In.	Cu. Cm.	Cu. In.	Cu. Cm.	Cu. In.	Cu. Cm.
1	3¾	2.07	34	3.17	52	15.49	254	15.92	261
2	4¾	2.61	43	3.99	65	19.16	314	19.70	323
3	5¾	3.21	53	4.82	79	22.82	374	23.48	385
4	6¾	3.68	60	5.63	92	26.49	434	27.26	447
5	7¾	4.28	70	6.55	107	30.61	501	31.51	516
6	9¾	4.94	81	7.58	124	35.19	577	36.24	594
7	10¼	5.55	91	8.50	139	39.31	644	40.49	664
8	11¾	6.42	105	9.83	161	45.26	742	46.64	764
9	12¾	6.82	112	10.45	171	48.01	787	49.47	811
		C = .271 Cu. In. = 4.4 Cu. Cm.				C = 3.54 Cu. In. = 58.1 Cu. Cm.			

NOTE: For multiple section level gages, add "C" volume for each additional section. "C" is volume between gage sections.

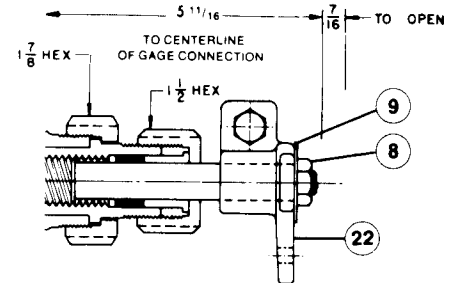
QUICK-OPENING LEVERS



**FOR TYPE 2 & TYPE 4
(S, U AND T) VALVES RATED
4000 PSI @ 100°F**



Daniel Type 2 & Type 4 (S, U and T) Offset Gage Valves are available with a coarse thread stem design and levers for fast, remote operation by chain. Only ¼ turn of the lever opens or closes the valves, which may be mounted in hard-to-reach areas. A ¼" hole is drilled in the end of each lever for connecting the chain.



PARTS

ITEM NO.	NAME	MATERIAL
8	STEM NUT	CARBON STEEL
9	NAME PLATE	304 S.S.
22	LEVER	DUCTILE IRON
23	BOLT	CARBON STEEL
24	NUT	CARBON STEEL

GAGE CONNECTIONS

All Daniel gage valves, types 1 thru 7, can be fitted with any gage connection shown here.

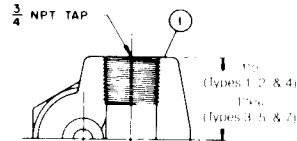


FIG. VII

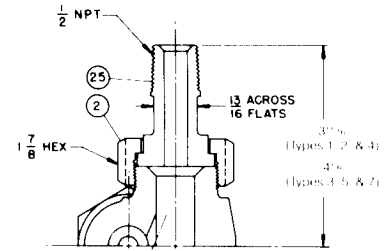


FIG. VIII

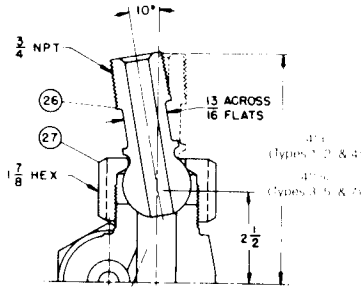


FIG. X

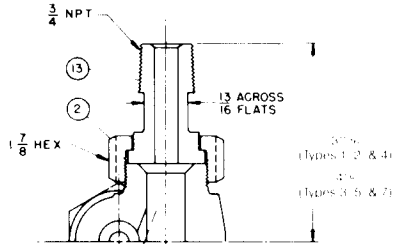


FIG. XI

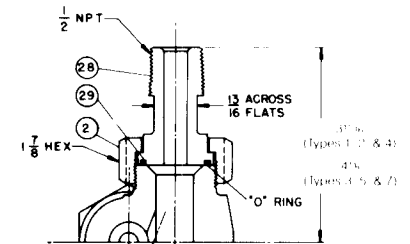


FIG. XIII

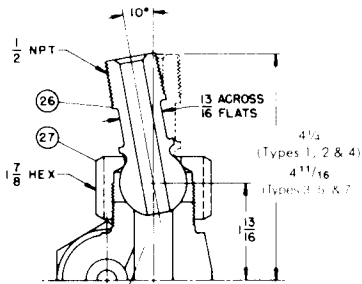


FIG. XIV

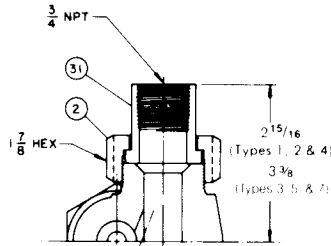


FIG. XV

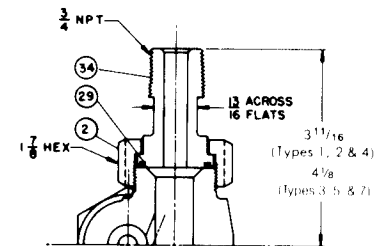


FIG. XVI

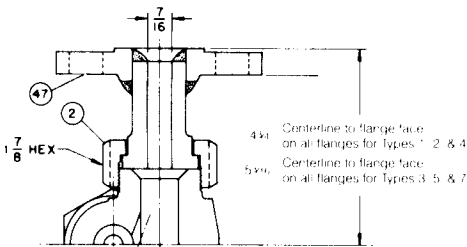


FIG. XVII

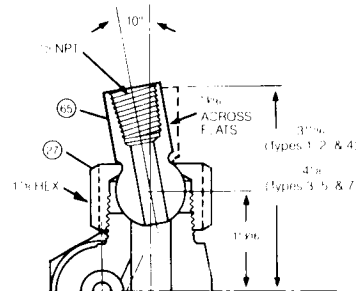


FIG. XXIX

PARTS

ITEM NO.	NAME	STANDARD TRIM	304 S.S. WETTED PARTS	316 S.S. WETTED PARTS
		MATERIAL	MATERIAL	MATERIAL
1	BODY	FORGED STEEL	304 SS	316 SS
2	UNION NUT	CARBON STEEL	CARBON STEEL	CARBON STEEL
25	MALE CONNECTOR-1/2"	CARBON STEEL	304 SS	316 SS
26	MALE SPHERICAL CONN.-3/4"	CARBON STEEL	304 SS	316 SS
26	MALE SPHERICAL CONN.-1/2"	CARBON STEEL	304 SS	316 SS
27	SPHERICAL NUT	CARBON STEEL	CARBON STEEL	CARBON STEEL
28	MALE "O" RING CONN.-1/2"	CARBON STEEL	304 SS	316 SS
*29	"O" RING	BUNA-N	BUNA-N	BUNA-N
31	FEMALE UNION-3/4"	ALLOY STEEL	—	—
34	MALE "O" RING CONN.-3/4"	CARBON STEEL	304 SS	316 SS
47	ANSI RF SLIP-ON FLG'D ASSY.	CARBON STEEL	304 SS	316 SS
**65	FEMALE SPHER. CONN.-1/2"	CARBON STEEL	304 SS	316 SS

* O-Ring of Teflon® or Viton® on request.

** 3/4" NPT female spherical connections are not available.

NOTE: Valve shown is for bottom left hand (or top right hand) location. Opposite hand is reversed. Valves are furnished in pairs of one bottom left hand and one top left hand.

TANK CONNECTIONS

All Tank Connections for Daniel Gage Valves are shown here, including the standard connections illustrated on the valves. For Types 1, 2 and 4 Valves, Fig. II thru XXVIII are available.

For Types 3, 5, and 7 Valves, Fig. XXV thru XXVIII are available.

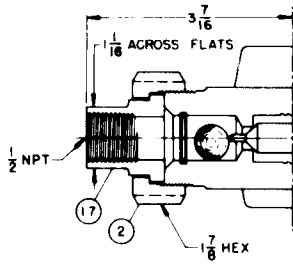


FIG. II

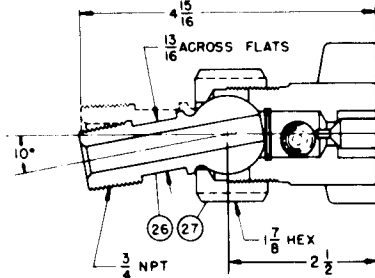


FIG. III

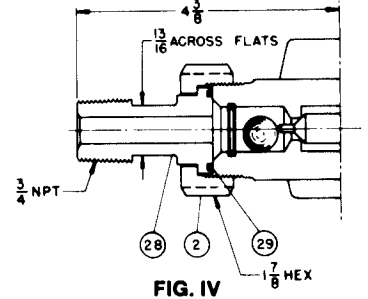


FIG. IV

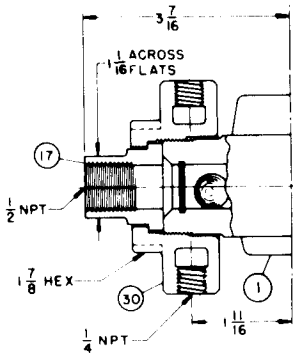


FIG. V

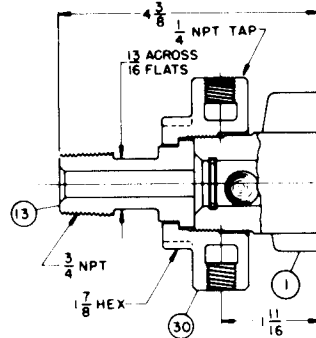


FIG. VI

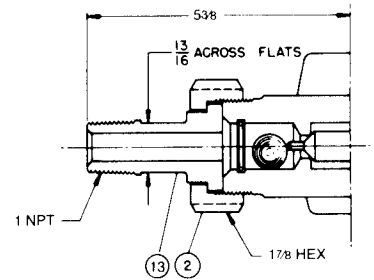


FIG. VII

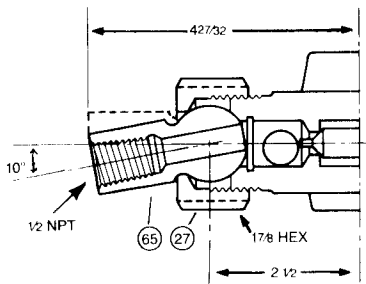


FIG. XVIII

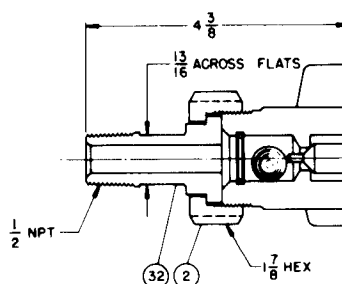


FIG. XIX

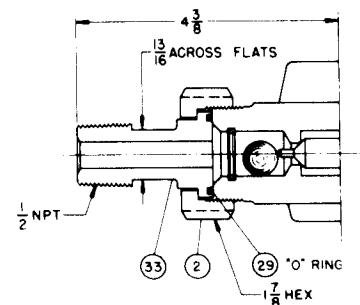


FIG. XX

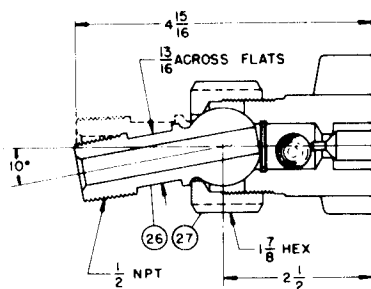


FIG. XXI

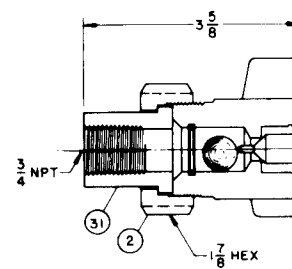


FIG. XXII

TANK CONNECTIONS (CONTINUED)

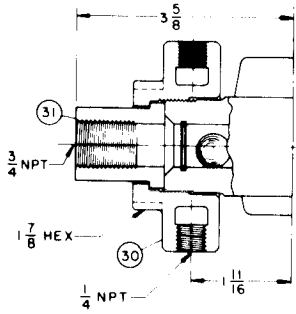


FIG. XXIII

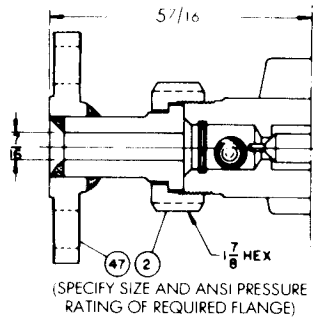


FIG. XXIV

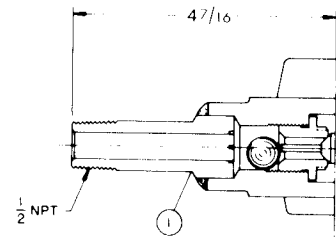


FIG. XXV

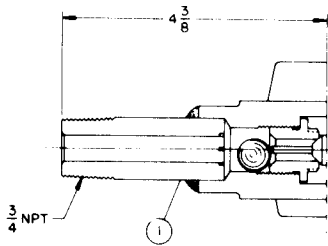


FIG. XXVI

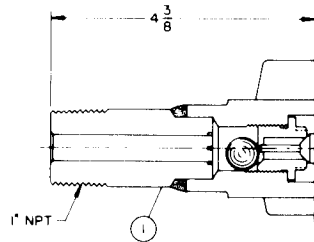


FIG. XXVII

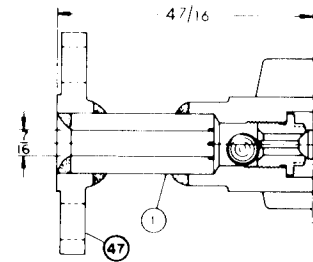


FIG. XXVIII

PARTS

ITEM NO.	NAME	STANDARD TRIM	304 S.S. WETTED PARTS	316 S.S. WETTED PARTS
		MATERIAL	MATERIAL	MATERIAL
1	BODY	FORGED STEEL	304 SS	316 SS
1	BODY-1/2" NPT SHANK	FORGED STEEL	304 SS	316 SS
1	BODY-3/4" NPT SHANK	FORGED STEEL	304 SS	316 SS
1	BODY-1" NPT SHANK	FORGED STEEL	304 SS	316 SS
1	BODY-RF FLG'D SHANK	FORGED STEEL	304 SS	316 SS
2	UNION NUT	CARBON STEEL	CARBON STEEL	CARBON STEEL
*13	MALE CONNECTOR	CARBON STEEL	304 SS	316 SS
17	FEMALE CONNECTOR 1/2"	CARBON STEEL	304 SS	316 SS
26	MALE SPHERICAL CONN.	CARBON STEEL	304 SS	316 SS
27	SPHERICAL NUT	CARBON STEEL	CARBON STEEL	CARBON STEEL
*28	MALE "O" RING CONN. 3/4"	CARBON STEEL	304 SS	316 SS
**29	"O" RING	BUNA-N	BUNA-N	BUNA-N
30	HEATED/COOLED NUT	CARBON STEEL	CARBON STEEL	CARBON STEEL
31	FEMALE CONNECTION 3/4"	ALLOY STEEL	—	—
*32	MALE CONNECTOR-1/2"	CARBON STEEL	304 SS	316 SS
*33	MALE "O" RING CONN.-1/2"	CARBON STEEL	304 SS	316 SS
47	ANSI RF SLIP-ON FLG'D ASSY.	CARBON STEEL	304 SS	316 SS
***65	FEMALE SPHER. CONN.-1/2"	CARBON STEEL	304 SS	316 SS

* Has hole with 1/16 eccentricity for ± 1/8 maximum misalignment on the overall center-to-center.

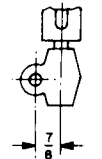
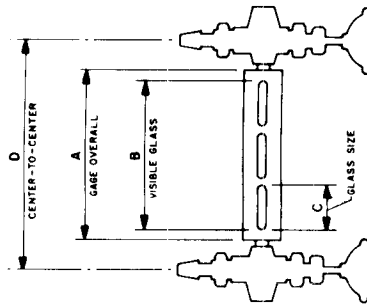
** O-Ring of Teflon® or Viton® on request.

*** 3/4" NPT female connection is not available.

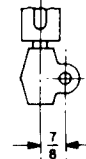
NOTE: Valve shown is for bottom left hand (or top right hand) location. Opposite hand is reversed. Valves are furnished in pairs of one bottom left hand and one top left hand.

Viton® is a registered trademark of DuPont.

INSTALLATION: STANDARD GAGES



BOTTOM
LEFT HAND
OFFSET
GAGE VALVE



TOP
LEFT HAND
OFFSET
GAGE VALVE

NOTE: A, B, C & D Dimensions are in inches.

SIZE NO.	A GAGE OVERALL	B VISIBLE GLASS	C GLASS SIZE	D* MINIMUM VALVE CENTER-TO-CENTER WITH GAGE CONNECTION								
				FOR GAGES TAPPED 1/2" NPT				FOR GAGES TAPPED 3/4" NPT				
				1/2"-NPT Female Screwed CAT. 1S, 2S, 4S	**1/2"-NPT Female Union ⁵ CAT. 1U, 2U, 4U	1/2"-NPT Male Union Fig. VIII	1/2"-NPT Male Spherical Fig. XIV	**3/4"-NPT Female Screwed CAT. 1S, 2S, 4S	3/4"-NPT Female Union CAT. 1U, 2U, 4U	3/4"-NPT Male Union Fig. XI	3/4"-NPT Male Spherical Fig. X	
Glass No.	No. Sect.											
1	1	5 1/4	3 3/4	3 3/4	8 1/2	11	11 5/8	12 3/4	8 3/4	11 5/8	11 1/2	12 5/8
2	1	6 1/4	4 3/4	4 3/4	9 1/2	12	12 5/8	13 3/4	9 3/4	12 5/8	12 1/2	13 5/8
3	1	7 1/4	5 3/4	5 3/4	10 1/2	13	13 5/8	14 3/4	10 3/4	13 5/8	13 1/2	14 5/8
4	1	8 1/4	6 3/4	6 3/4	11 1/2	14	14 5/8	15 3/4	11 3/4	14 5/8	14 1/2	15 5/8
5	1	9 3/8	7 7/8	7 7/8	12 5/8	15 1/8	15 3/4	16 7/8	12 7/8	15 3/4	15 5/8	16 3/4
6	1	10 5/8	9 1/8	9 1/8	13 7/8	16 3/8	17	18 1/8	14 1/8	17	16 7/8	18
7	1	11 3/4	10 1/4	10 1/4	15	17 1/2	18 1/8	19 1/4	15 1/4	18 1/8	18	19 1/8
8	1	13 3/8	11 7/8	11 7/8	16 5/8	19 1/8	19 3/4	20 7/8	16 7/8	19 3/4	19 5/8	20 3/4
9	1	14 1/8	12 5/8	12 5/8	17 3/8	19 7/8	20 1/2	21 5/8	17 5/8	20 1/2	20 3/8	21 1/2
3	2	14 1/2	13	5 3/4	17 3/4	20 1/4	20 7/8	22	18	20 7/8	20 3/4	21 7/8
4	2	16 1/2	15	6 3/4	19 3/4	22 1/4	22 7/8	24	20	22 7/8	22 3/4	23 7/8
5	2	18 3/4	17 1/4	7 7/8	22	24 1/2	25 1/8	26 1/4	22 1/4	25 1/8	25	26 1/8
6	2	21 1/4	19 3/4	9 1/8	24 1/2	27	27 5/8	28 3/4	24 3/4	27 5/8	27 1/2	28 5/8
7	2	23 1/2	22	10 1/4	26 3/4	29 1/4	29 7/8	31	27	29 7/8	29 3/4	30 7/8
8	2	26 3/4	25 1/4	11 7/8	30	32 1/2	33 1/8	34 1/4	30 1/4	33 1/8	33	34 1/8
9	2	28 1/4	26 3/4	12 5/8	31 1/2	34	34 5/8	35 3/4	31 3/4	34 5/8	34 1/2	35 5/8
6	3	31 7/8	30 3/8	9 1/8	35 1/8	37 5/8	38 1/4	39 3/8	35 3/8	38 1/4	38 1/8	39 1/4
7	3	35 1/4	33 3/4	10 1/4	38 1/2	41	41 5/8	42 3/4	38 3/4	41 5/8	41 1/2	42 5/8
8	3	40 1/8	38 5/8	11 7/8	43 3/8	45 7/8	46 1/2	47 5/8	43 5/8	46 1/2	46 3/8	47 1/2
9	3	42 3/8	40 7/8	12 5/8	45 5/8	48 1/8	48 3/4	49 7/8	45 7/8	48 3/4	48 5/8	49 3/4
7	4	47	45 1/2	10 1/4	50 1/4	52 3/4	53 3/8	54 1/2	50 1/2	53 3/8	53 1/4	54 3/8
8	4	53 1/2	52	11 7/8	56 3/4	59 1/4	59 7/8	61	57	59 7/8	59 3/4	60 7/8
9	4	56 1/2	55	12 5/8	59 3/4	62 1/4	62 7/8	64	60	62 7/8	62 3/4	63 7/8
7	5	58 3/4	57 1/4	10 1/4	62	64 1/2	65 1/8	66 1/4	62 1/4	65 1/8	65	66 1/8
8	5	66 7/8	65 3/8	11 7/8	70 1/8	72 5/8	73 1/4	74 3/8	70 3/8	73 1/4	73 1/8	74 1/4
9	5	70 5/8	69 1/8	12 5/8	73 7/8	76 3/8	77	78 1/8	74 1/8	77	76 7/8	78
8	6	80 1/4	78 3/4	11 7/8	83 1/2	86	86 5/8	87 3/4	83 3/4	86 5/8	86 1/2	87 5/8
9	6	84 3/4	83 1/4	12 5/8	88	90 1/2	91 1/8	92 1/4	88 1/4	91 1/8	91	92 1/8
8	7	93 3/8	92 1/8	11 7/8	96 7/8	99 3/8	100	101 1/8	97 1/8	100	99 7/8	101
9	7	98 7/8	97 3/8	12 5/8	102 1/8	104 5/8	105 1/4	106 3/8	102 3/8	105 1/4	105 1/8	106 1/4
8	8	107	105 1/2	11 7/8	110 1/4	112 3/4	113 3/8	114 1/2	110 1/2	113 3/8	113 1/4	114 3/8
9	8	113	111 1/2	12 5/8	116 1/4	118 3/4	119 3/8	120 1/2	116 1/2	119 3/8	119 1/4	120 3/8
8	9	120 3/8	118 7/8	11 7/8	123 5/8	126 1/4	126 3/4	127 7/8	123 7/8	126 3/4	126 5/8	127 3/4
9	9	127 1/8	125 5/8	12 5/8	130 3/8	132 7/8	133 1/2	134 5/8	130 5/8	133 1/2	133 3/8	134 1/2

*Dimensions in column "D" apply to low-pressure (series "L"), mid-pressure (series "M"), 1/2" NPT high-pressure (series "H"), frost-free (all series), and internally heated/cooled reflex and transparent level gages tapped 1/2" NPT or 3/4" NPT. For installation dimensions on other level gages see footnote.

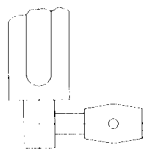
**These dimensions use close pipe nipples. For short 1/2" nipple add 3/4"; for short 3/4" nipple add 1 1/4".

NOTE: Use the following constants for other level gages:

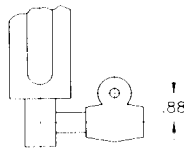
1. Low pressure (series "L") large chamber, add 1" to above "A" and "D" dimensions.
2. Low-pressure (series "L"), mid-pressure (series "M") externally heated/cooled, add 2 1/4" to above "D" dimensions.
3. For valve Types 3, 5, or 7, add 7/8" to Column "D" to obtain minimum centers.
4. For High Pressure (series "H") with 3/4" NPT, add 1 1/2" to dimensions "A" and "D".
5. For a 1/2" NPT Female Spherical Gage connection (Figure XXIX), add 1 7/8".

INSTALLATION: CLOSE HOOK-UP GAGES (GAGE CONNECTIONS)

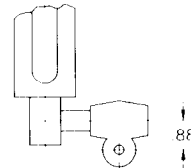
SIZE NO.	MINIMUM CENTER-TO-CENTER TANK CONNECTIONS					
	STRAIGHT-THRU 1/2" VALVE 3/4"		OFFSET VALVE HANDLES 1/2" INSIDE 3/4"		OFFSET VALVE HANDLES 1/2" OUTSIDE 3/4"	
11	5 1/4"	5 5/8"	3 1/2"	3 7/8"	7"	7 3/8"
21	6 1/4"	6 5/8"	4 1/2"	4 7/8"	8"	8 3/8"
31	7 1/4"	7 5/8"	5 1/2"	5 7/8"	9"	9 3/8"
41	8 1/4"	8 5/8"	6 1/2"	6 7/8"	10"	10 3/8"
51	9 3/8"	9 3/4"	7 5/8"	8"	11 1/8"	11 1/2"
61	10 5/8"	11"	8 7/8"	9 1/4"	12 3/8"	12 3/4"
71	11 3/4"	12 1/8"	10"	10 3/8"	13 1/2"	13 7/8"
81	13 3/8"	13 3/4"	11 5/8"	12"	15 1/8"	15 1/2"
91	14 1/8"	14 1/2"	12 3/8"	12 3/4"	15 7/8"	16 1/4"
32	14 1/2"	14 7/8"	12 3/4"	13 1/8"	16 1/4"	16 5/8"
42	16 1/2"	16 7/8"	14 3/4"	15 1/8"	18 1/4"	18 5/8"
52	18 3/4"	19 1/8"	17"	17 3/8"	20 1/2"	20 7/8"
62	21 1/4"	21 5/8"	19 1/2"	19 7/8"	23"	23 3/8"
72	23 1/2"	23 7/8"	21 3/4"	22 1/8"	25 1/4"	25 5/8"
82	26 3/4"	27 1/8"	25"	25 5/8"	28 1/2"	28 7/8"
92	28 1/4"	28 5/8"	26 1/2"	26 7/8"	30"	30 3/8"
63	31 7/8"	32 1/4"	30 1/8"	30 1/2"	33 5/8"	34"
73	35 1/4"	35 5/8"	33 1/2"	33 7/8"	37"	37 3/8"
83	40 1/8"	40 1/2"	38 3/8"	38 3/4"	41 7/8"	42 1/4"
93	42 3/8"	42 3/4"	40 5/8"	41"	44 1/8"	44 1/2"
74	47"	47 3/8"	45 1/4"	45 5/8"	48 3/4"	49 1/8"
84	53 1/2"	53 7/8"	51 3/4"	52 1/8"	55 1/4"	55 5/8"
94	56 1/2"	56 7/8"	54 3/4"	55 1/8"	58 1/4"	58 5/8"
75	58 3/4"	59 1/8"	57"	57 3/8"	60 1/2"	60 7/8"
85	66 7/8"	67 1/4"	65 1/8"	65 1/2"	68 5/8"	69"
95	70 5/8"	71"	68 7/8"	69 1/4"	72 3/8"	72 3/4"
86	80 1/4"	80 5/8"	78 1/2"	78 7/8"	82"	82 3/8"
96	84 3/4"	85 1/8"	83"	83 3/8"	86 1/2"	86 7/8"
87	93 5/8"	94"	91 7/8"	92 1/4"	95 3/8"	95 3/4"
97	98 7/8"	99 1/4"	97 1/8"	97 1/2"	100 5/8"	101"
88	107"	107 3/8"	105 1/4"	105 5/8"	108 3/4"	109 1/8"
98	113"	113 3/8"	111 1/4"	111 5/8"	114 3/4"	115 1/8"
89	120 3/8"	120 3/4"	118 5/8"	119"	122 1/8"	122 1/2"
99	127 1/8"	127 1/2"	125 3/8"	125 3/4"	128 7/8"	129 1/4"



STRAIGHT-THRU VALVE



CLOSE HOOK-UP WITH HANDLE INSIDE



CLOSE HOOK-UP WITH HANDLE OUTSIDE

CAUTION

Gage glasses may fail from improper external mechanical stress or accident rather than from internal pressure, but both factors should be considered. Four basic precautions when heeded will assure the gage glass user of safe, satisfactory performance:

1. Proper glass selection.
2. Correct installation.
3. Periodic inspection and cleaning.
4. Replacement as necessary.

Proper glass selection involves size, pressure rating and quality of glass. Flat and tubular glasses should fit perfectly without stress; glass should be crystal clear and without blemish; length determines pressure rating; if longer glass results in breakage, a multiple-section gage with shorter glasses should be considered.

Installation involves proper seating on gaskets and cushions; glass-to-metal contact should not occur; do not install any glass with scratches or chipped edges; do not

tighten gage bolts when gage is in use; use torque instructions provided with gage; use gage valves with ball checks that shut-off automatically if breakage occurs; make sure vessel center-to-centers are correct and *vertical*.

Proper tightening of bolts with torque wrench is extremely important, so that no unusual stress is introduced into the glass.

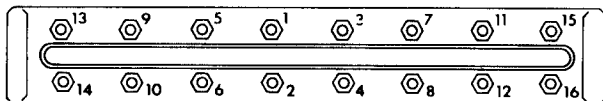
Clean outside of glasses with ordinary glass cleaners, not harsh chemicals; check for scratches, chipped edges on glass; inspect glass for clarity.

Glass should be replaced if any blemish mars surface. If gage is taken apart, glass, gaskets and cushions should be automatically replaced to reduce risk; make sure gage or tubular valve surfaces are clean and dry before installing glasses.

For safety purposes, glasses in high temperature service should be replaced more often than similar glasses used in low temperature service.

DANIEL GAGE ASSEMBLY

(Numbers Indicate Proper Bolt Torquing Sequence.)



Gage Series	Torque (Tighten in 4-5 Ft.-Lb. Steps)
Low Press. Large Cham.	20 Ft.-Lb.
Mid-Press.	32 Ft.-Lb.
High Press.	40 Ft.-Lb.

DANIEL

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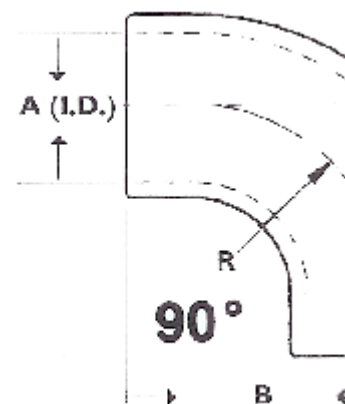


Donalds
Filtration Solutions

Donaldson offers a complete line of intake system accessories. They are designed to solve specific problems such as excess dirt in the intake, leaves/debris clogging the air inlet, excessive intake system noise and extending the service life of your engine. Some of the accessories such as the filter service indicators, rubber reducers/adapters and Vacuator™ Valves help your engine system more efficiently.

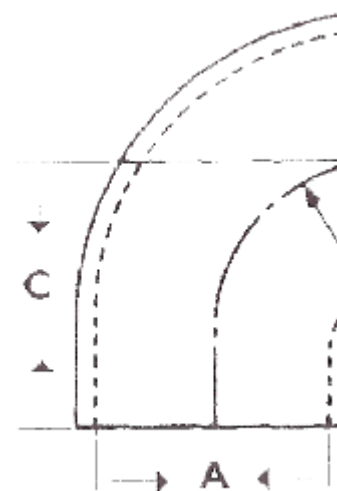
90° Rubber Elbow

Inner Diameter (A) in	Inner Diameter (A) mm	Center Height (B) in	Center Height (B) mm	Radius (R) in	Radius (R) mm	Part Number
2.00	51	3.50	76	2.00	51	P105529
2.25	57	3.75	95	2.25	57	P105530
2.50	64	4.00	102	2.50	64	P105531
3.00	76	5.00	127	3.25	89	P105532
3.50	89	5.50	140	4.00	102	P114318
4.00	102	5.75	146	4.13	105	P105533
4.50	114	5.75	146	3.50	89	P113733
5.00	127	6.00	152	4.13	105	P107844
5.50	140	6.38	162	4.63	118	P105534
6.00	152	7.00	179	5.00	127	P105535
7.00	179	7.56	192	5.56	141	P105536
8.00	203	8.50	216	6.50	165	P112605
10.00	254	10.50	267	8.50	216	P114314



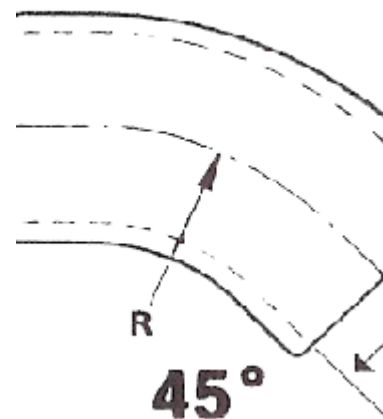
90° Rubber Reducing Elbow

Inner Diameter (A) in	Inner Diameter (A) mm	Inner Diameter (B) in	Inner Diameter (B) mm	Center Height (C) in	Center Height (C) mm	Radius (R) in	Radius (R) mm	Part Number
3.0	76	3.5	89	3.50	89	2.25	57	P123462
4.0	102	5.0	127	5.75	146	3.75	95	P121482
5.0	127	6.0	152	4.74	120	3.50	89	P537468
5.0	127	6.0	152	6.25	159	3.81	97	P143895
5.0	127	7.0	179	6.75	171	5.00	127	P159820
5.5	140	6.0	152	6.75	171	5.00	127	P117724
5.5	140	7.0	179	6.25	159	4.38	111	P128990



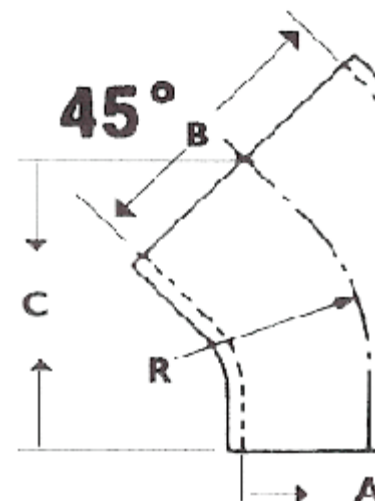
45° Rubber Elbow

Inner Diameter (A) in	Inner Diameter (A) mm	Radius (R) in	Radius (R) mm	Part Number
2.00	51	2.00	51	P105541
2.25	57	2.25	57	P105542
2.50	64	2.50	64	P105543
3.00	76	3.25	83	P105544
3.50	89	3.50	89	P109331
4.00	102	3.75	95	P105545
4.50	114	3.50	89	P114316
5.00	127	4.13	105	P109021
5.50	140	4.38	111	P105546
6.00	152	5.00	127	P105547
7.00	178	5.56	141	P105548
8.00	203	6.50	165	P112606
10.00	254	8.50	216	P114313



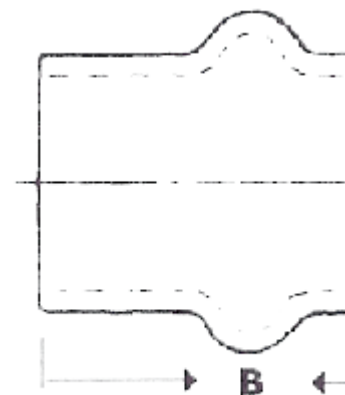
45° Rubber Reducing Elbow

Inner Diameter (A) in	Inner Diameter (A) mm	Inner Diameter (B) in	Inner Diameter (B) mm	Center Height (C) in	Center Height (C) mm	Radius (R) in	Radius (R) mm	Part Number
5.50	140	6.00	152	6.44	165	4.88	124	P133338
6.00	152	7.00	179	7.38	187	5.56	141	P133339



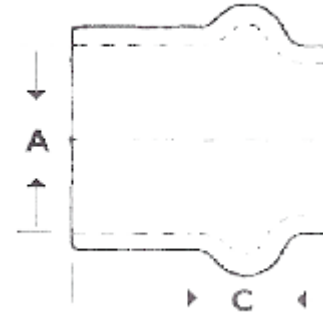
Straight Rubber Hump Hose

Inner Diameter (A) in	Inner Diameter (A) mm	Length (B) in	Length (B) mm	Part Number
3.00	76	5.25	133	P105608
3.50	89	5.25	133	P114319
4.00	102	5.25	133	P105609
4.50	114	6.00	152	P114317
5.00	127	6.00	152	P105610
5.50	140	6.00	152	P105611
6.00	152	7.00	165	P105612
7.00	179	6.50	165	P105613
8.00	203	5.00	127	P112608
10.00	254	6.00	152	P111414



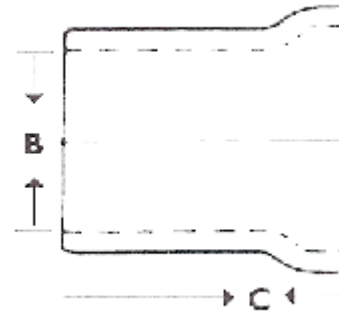
Straight Rubber Hump Reducer

Inner Diameter (A) in	Inner Diameter (A) mm	Inner Diameter (B) in	Inner Diameter (B) mm	Length (C) in	Length (C) mm	Part Number
3.00	76	2.50	64	4.50	114	P102820
3.00	76	2.75	70	3.50	102	P520883
3.50	87	3.00	76	5.25	127	P101290
3.50	87	2.75	70	4.00	87	P520882
4.00	102	2.75	70	4.00	87	P520884
4.00	102	3.00	76	5.00	127	P101291
4.00	102	3.50	87	5.00	127	P101292
4.50	114	4.00	102	6.00	152	P540256
5.00	127	4.00	102	5.75	146	P101293
5.50	140	4.00	102	5.75	146	P101891
5.50	140	5.00	127	6.00	152	P103516
6.00	152	5.00	127	6.00	152	P112611
6.00	152	5.50	140	6.00	152	P101294
7.00	179	5.00	127	7.00	179	P136494
7.00	179	5.50	140	7.00	179	P126530
7.00	179	6.00	152	5.50	140	P112610
8.00	203	5.50	140	7.00	179	P129660
8.00	203	6.00	152	6.00	140	P114315
8.00	203	7.00	179	6.00	152	P112609
10.00	254	8.00	203	6.00	152	P112607



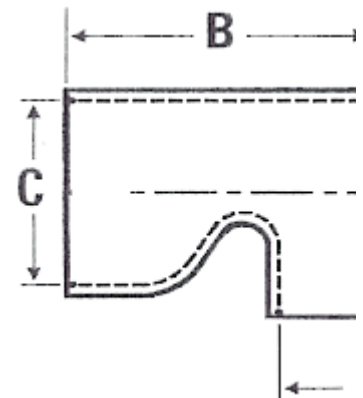
Straight Rubber Reducer Sleeves

Inner Diameter (A) in	Inner Diameter (A) mm	Inner Diameter (B) in	Inner Diameter (B) mm	Length (C) in	Length (C) mm	Part Number
2.00	51	1.50	38	2.50	64	P104087
2.00	51	1.75	44	2.50	64	P102948
2.25	57	2.00	51	2.50	64	P104088
2.50	64	2.00	51	2.50	64	P104089
2.50	64	2.25	57	2.50	64	P104090



90° Cobra Adapter

Inner Diameter (A) in	Inner Diameter (A) mm	Inner Diameter (C) in	Inner Diameter (C) mm	Length (B) in	Length (B) mm	Length (D) in	Length (D) mm	Part Number
2.75	70	6.50	165	4.00	102	1.81	46	P600328
3.30	84	5.22	133	3.00	76	1.91	49	P547694
4.00	102	6.41	163	4.00	102	2.69	68	P600325
4.00	102	6.41	163	4.00	102	3.19	81	P600326
4.00	102	6.44	164	5.00	127	3.19	81	P600327



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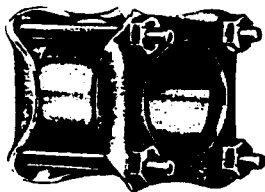
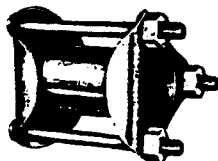
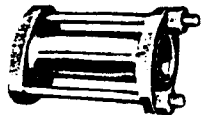
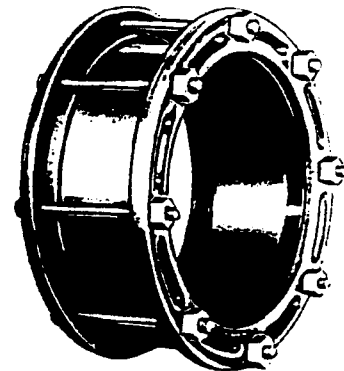
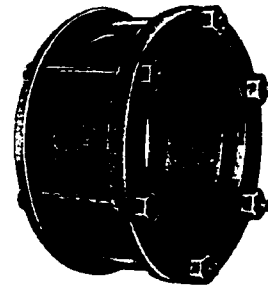
Style 38 Dresser Couplings for Steel Pipe Sizes

Shown below are the most commonly used sizes of Style 38 Couplings, (sizes 1-1/2" through 12"). However, Dresser has the facilities to supply the proper coupling for every pipe joining requirement, details and prices on larger sizes are available on request.

Most sizes through 12" nominal are furnished in standard packaged quantities.

All Dresser couplings can also be furnished with Dresser AL-CLAD® factory coatings. Details on request. Specifications of all products shown in this catalog are subject to change without notice.

For prices, refer to current Dresser Price List or write for quotations.



MATERIALS OF CONSTRUCTION

Sizes 1/2" thru 1 1/2":

Followers: Ductile Iron or Malleable Iron

Middle Ring: ASTM A513

Bolts: AWWA C 111/ANSI A 21.11

Sizes 2" and Up:

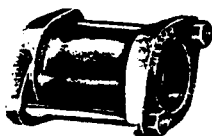
Followers: AISI C1012 or ASME SA36

Middle Ring: ASTM A513, ASTM A635 or

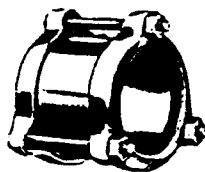
ASME SA675 GR60

Bolts: AWWA C 111/ANSI A 21.11

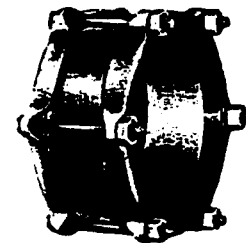
Light Pattern Couplings for Light Wall Steel Pipe



2" Style 38, showing 2-bolt construction supplied also for 2" OD and 3" OD sizes.



4" Style 38, showing 3-bolt construction supplied also for 3-1/2" OD and 4" OD sizes.



8" Style 38, showing 6-bolt construction supplied for that size. Sizes 5" OD, 5-1/2" OD, 6" OD and 6" (4-bolt) and sizes 7" OD and 8" OD (5-bolt) are of similar construction.

Style 38

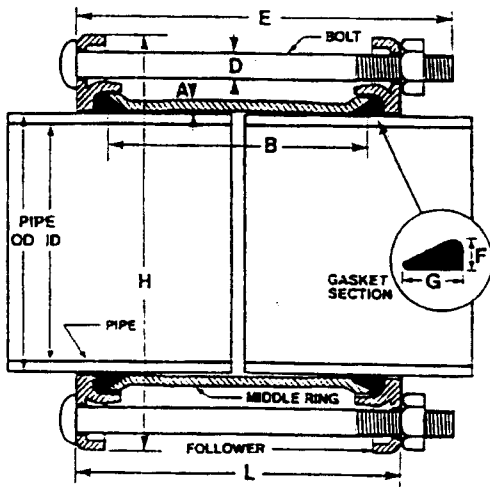
Dresser Couplings for Steel Pipe Sizes and Specifications

Table 1—Style 38 Steel Couplings for Steel Pipe 1/2" ID through 12" ID—Sizes, Specifications

PIPE (STEEL)		MIDDLE RING ¹ Thickness and Length (A & B)	BOLTS ² Number, Diameter and Length (D x E)	GASKETS ³ Section Dimens. Thickness & Length (F & G)	OVERALL DIMENSIONS		WORK- ING ⁶ PRESS Lbs. per Sq. In.	MAX. TEST PRESS Lbs. per Sq. In.	WEIGHT Approx. Shipping Each (Lbs.)
Nominal Size	Outside Diam. (OD)				Diam. (H)	Length (L) ⁵			
1/2	.840	.120 x 3 1/2	2—1/2 x 6 1/2	1/2 x 1 1/2	3 1/2	4 1/2	1500	2250	2
3/4	1.050	.120 x 5	2—1/2 x 6 1/2	1/2 x 1 1/2	3 3/4	5 1/2	1500	2250	3
1	1.315	.134 x 5	2—1/2 x 6 1/2	1/2 x 1 1/2	4 1/4	5 1/2	1500	2250	4
1 1/4	1.660	.140 x 5	2—1/2 x 6 1/2	1/2 x 1 1/2	4 1/4	5 1/2	1500	2250	4
1 1/2	1.900	.148 x 5	2—1/2 x 6 1/2	1/2 x 1 1/2	4 1/4	5 1/2	1500	2250	5
2	*2.375	.154 x 4	2—1/2 x 8 1/2	1/2 x 1 1/2	5 1/2	5 1/2	1500	2250	4 1/2
2	2.375	.154 x 5	2—1/2 x 8 1/2	1/2 x 1 1/2	6	6 1/2	1500	2250	7
2	2.375	.154 x 7	3—1/2 x 8 1/2	1/2 x 1 1/2	6 1/4	7	1500	2250	10
2	2.375	.154 x 7	3—1/2 x 10 1/2	1/2 x 1 1/2	6 1/4	9	1500	2250	13
2 1/2	2.875	.203 x 5	3—1/2 x 8 1/2	1/2 x 1 1/2	7	7	1500	2250	13
3	*3.000	.203 x 4	2—1/2 x 6	1/2 x 1 1/2	6	5 1/2	1100	1650	6 1/2
3	*3.500	.156 x 4	3—1/2 x 6	1/2 x 1 1/2	6 1/2	5 1/2	1100	1650	7
3	3.500	.156 x 5	4—1/2 x 8 1/2	1/2 x 1 1/2	7 1/2	7	1100	1650	13.5
3	3.500	.156 x 7	4—1/2 x 10 1/2	1/2 x 1 1/2	7 1/2	9	1100	1650	17.5
3 1/2	*4.000	.134 x 4	3—1/2 x 6	1/2 x 1 1/2	7	5 1/2	1500	2250	7 1/2
3 1/2	4.000	.203 x 5	4—1/2 x 8 1/2	1/2 x 1 1/2	7 1/4	7	1500	2250	17
4	*4.500	.188 x 4	3—1/2 x 6	1/2 x 1 1/2	7 1/2	5 1/2	1000	1500	8
4	4.500	.188 x 5	4—1/2 x 8 1/2	1/2 x 1 1/2	8 1/4	7	1000	1500	16.8
4	4.500	.188 x 7	4—1/2 x 10 1/2	1/2 x 1 1/2	8 1/4	9	1000	1500	23.5
5	*5.500	1/2 x 4	4—1/2 x 6	1/2 x 1 1/2	8 1/2	5 1/2	1205	1808	10
5	5.500	1/2 x 5	4—1/2 x 8 1/2	1/2 x 1 1/2	8 1/2	5 1/2	1205	1808	23.5
5	*5.563	1/2 x 4	4—1/2 x 6	1/2 x 1 1/2	8 1/2	5 1/2	1205	1808	20
5	5.563	1/2 x 5	4—1/2 x 8 1/2	1/2 x 1 1/2	9 1/4	6 1/2	1205	1808	23.5
5	5.563	1/2 x 7	4—1/2 x 10 1/2	1/2 x 1 1/2	9 1/4	8 1/2	1205	1808	25
6	*6.000	.134 x 4	4—1/2 x 6	1/2 x 1 1/2	9	5 1/2	1126	1689	11
6	6.000	1/2 x 5	5—1/2 x 8 1/2	1/2 x 1 1/2	9 1/2	6 1/2	1126	1689	26.5
6	*6.625	1/2 x 4	4—1/2 x 6	1/2 x 1 1/2	9 1/2	5 1/2	1029	1544	22.5
6	6.625	1/2 x 5	5—1/2 x 8 1/2	1/2 x 1 1/2	11 1/4	6 1/2	1029	1544	25.5
6	6.625	1/2 x 7	5—1/2 x 10 1/2	1/2 x 1 1/2	11 1/4	8 1/2	1029	1544	31
8	*8.000	1/2 x 4	5—1/2 x 6	1/2 x 1 1/2	11	5 1/2	866	1299	15
8	8.000	1/2 x 5	6—1/2 x 8 1/2	1/2 x 1 1/2	11 1/2	6 1/2	866	1299	31
8	*8.625	1/2 x 4	5—1/2 x 6	1/2 x 1 1/2	11 1/2	5 1/2	807	1211	16
8	8.625	1/2 x 5	6—1/2 x 8 1/2	1/2 x 1 1/2	13 1/4	6 1/2	807	1211	32
8	8.625	1/2 x 7	6—1/2 x 10 1/2	1/2 x 1 1/2	13 1/4	8 1/2	807	1211	38
10	10.000	1/2 x 5	8—1/2 x 8 1/2	1/2 x 1 1/2	13 1/2	6 1/2	703	1055	39
10	10.750	1/2 x 5	8—1/2 x 8 1/2	1/2 x 1 1/2	14 1/4	6 1/2	657	986	40
10	10.750	1/2 x 7	8—1/2 x 10 1/2	1/2 x 1 1/2	14 1/4	8 1/2	657	986	49
10	10.750	1/2 x 7	8—1/2 x 10 1/2	1/2 x 1 1/2	14 1/4	8 1/2	813	1220	53
12	12.000	1/2 x 7	8—1/2 x 10 1/2	1/2 x 1 1/2	16	8 1/2	591	887	53
12	12.750	1/2 x 5	8—1/2 x 8 1/2	1/2 x 1 1/2	16 1/4	6 1/2	558	837	45
12	12.750	1/2 x 7	8—1/2 x 10 1/2	1/2 x 1 1/2	16 1/4	8 1/2	558	837	56
12	12.750	1/2 x 7	8—1/2 x 10 1/2	1/2 x 1 1/2	16 1/4	8 1/2	691	1036	65

- ¹MIDDLE RINGS thicker or longer than those listed can be furnished. Please specify if pipe stop is required—supplied at extra charge.
- ²BOLTS furnished as standard are shopcoated steel. Plated or coated bolts can be furnished, if specified.
- ³GASKET information appears on Page 19.
- ⁵DIMENSION "L" (over-all length exclusive of bolts) is taken with bolts drawn up finger tight.
- ⁶WORKING PRESSURE. The pressures shown were determined on the basis of Barlow's formula using a working stress equal to one half the minimum yield of the middle ring material. Couplings for higher pressures can be furnished.
- *LIGHT PATTERN COUPLINGS. See opposite page for views showing construction of these sizes.

These pressure ratings and test pressures represent the sealing capability of the products involved.



⚠ WARNING

When pipe pullout could occur, pipe joint **MUST** be anchored. Failure to anchor pipe joint could result in escaping line content and cause property damage, serious injury or death.

Style 38

Dresser Couplings for Steel Pipe Sizes Sizes and Specifications

Style 38 Steel Couplings for Steel Pipe 14" OD and Larger—Sizes, Specifications								
PIPE (Steel)		MIDDLE RING' Thickness and Length (A & B)	BOLTS' Number, Diameter and Length (D & E)	WORKING PRESSURE ³ lbs. per sq. in.	TEST PRESSURE lbs. per sq. in.	OVERALL DIMENSIONS		WEIGHT Approx. Shipping Each (Lbs.)
Nominal Size	Outside Diameter (OD)					Diam. (H)	Length (L) ¹	
14.000	14.000	1/4 x 7	8—1/2 x 10 3/4	510	765	18	9 1/2	60
	14.000	3/8 x 7	8—1/2 x 10 3/4	633	949	18	9 1/2	72
16.000	16.000	1/4 x 7	10—1/2 x 10 3/4	449	673.5	20	9 1/2	70
	16.000	3/8 x 7	10—1/2 x 10 3/4	557	835	20	9 1/2	82
18.000	18.000	1/4 x 7	10—1/2 x 10 3/4	401	601.5	22	9 1/2	75
	18.000	3/8 x 7	10—1/2 x 10 3/4	498	747	22	9 1/2	88
20.000	20.000	1/4 x 7	12—1/2 x 10 3/4	362	543	24 1/2	9 1/2	86
	20.000	3/8 x 7	12—1/2 x 10 3/4	450	675	24 1/2	9 1/2	99
22.000	22.000	1/4 x 7	14—1/2 x 10 3/4	330	495	26	9 1/2	98
	22.000	3/8 x 7	14—1/2 x 10 3/4	411	616	26	9 1/2	108
24.000	24.000	1/4 x 7	14—1/2 x 10 3/4	304	456	28	9 1/2	105
	24.000	3/8 x 7	14—1/2 x 10 3/4	378	567	28	9 1/2	120
30.000	30.000	1/4 x 7	16—1/2 x 10 3/4	243	364.5	34	9 1/2	120
	30.000	3/8 x 7	16—1/2 x 10 3/4	303	454	34	9 1/2	153
	30.500	1/4 x 7	16—1/2 x 10 3/4	240	360	34 1/2	9 1/2	125
	30.750	3/8 x 7	16—1/2 x 10 3/4	295	442	34 1/2	9 1/2	158
36.000	36.000	1/2 x 7	18—1/2 x 10 3/4	253	379	40	9 1/2	181
	36.750	3/8 x 7	18—1/2 x 10 3/4	298	447	41 1/2	9 1/2	227
42.000		1/2 x 10	20—1/2 x 15	346	519	47	12 1/2	351
48.000		1/2 x 10	22—1/2 x 15	304	456	53	12 1/2	399
49.000		1/2 x 10	22—1/2 x 15	299	448.5	54	12 1/2	401
55.00		1/2 x 10	24—1/2 x 15	287	430.5	60	13	447
61.000		1/2 x 10	26—1/2 x 15	241	361.5	66	13	494
67.000		1/2 x 10	30—1/2 x 15	220	330	72	13	545
73.000		1/2 x 10	32—1/2 x 15	202	303	78	13	598

Only Couplings for most commonly used sizes of steel pipe are shown. Couplings are supplied for all sizes of steel pipe, and are regularly available in any special sizes. Details and prices will be furnished on request for any size of pipe, or for any special condition.

Dimensions are approximate, given in inches.

¹MIDDLE RINGS thicker or longer than those listed can be supplied. Details and prices on request.

²BOLTS furnished as standard are shopcoated. Plated or coated bolts can be furnished if specified.

³WORKING PRESSURE. The working pressures shown were determined on the basis of Barlow's formula using a working stress equal to one half the minimum yield of the middle ring material. Couplings for higher pressures can be furnished.

⁴DIMENSION "L" (over-all length exclusive of bolts) is taken with bolts drawn up finger tight.

NOTE: Specifications of all products shown in this catalog are subject to change without notice.

These pressure ratings and test pressures represent the sealing capability of the products involved.



WARNING

When pipe pullout could occur, pipe joint **MUST** be anchored. Failure to anchor pipe joint could result in escaping line content and cause property damage, serious injury or death.

Style 38 & 138

Dresser Steel Couplings for Cast-Iron Pipe Sizes

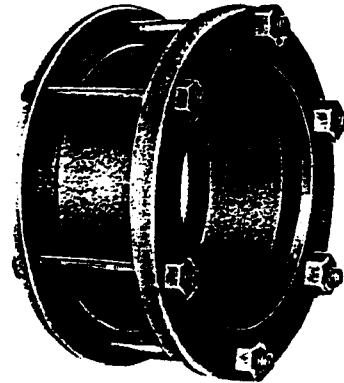
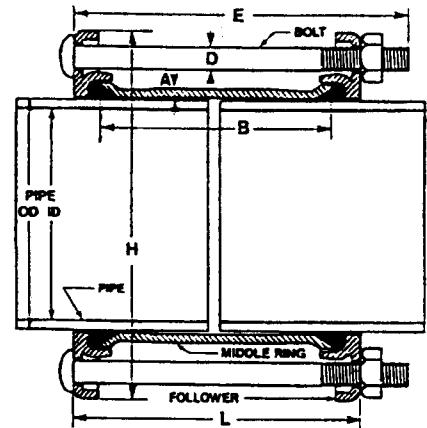
Dresser Couplings Style 38 are also available in cast-iron sizes from 2" to 72". These Couplings have long been used by gas and water companies for the joining of plain-end cast-iron pipe. Dresser Couplings combine the advantages of absolutely tight joints and easier, faster joint making. Style 38's also permit the salvage and use of random

lengths of cast-iron pipe from which bell-ends or cracked sections have been removed.

Materials of construction are the same as those for Steel Pipe Size Style 38 unless otherwise noted.

Style 38 Steel Couplings for Plain-End Cast-Iron Pipe—Sizes, Specifications							
PIPE (CAST-IRON)		MIDDLE RING Thickness and Length (A & B)	BOLTS Number, Diameter and Length (D & E)	OVERALL DIMENSIONS		WEIGHT Approx. Shipping Each (Lbs.)	MAX. W.P. PSI
Nominal Size (CIP)	Outside Diameter (OD)			Diam. (H)	Length (L)		
2	2.500	.187 x 5	3— $\frac{1}{8}$ x 8	6 $\frac{1}{2}$	7	12	1500
2 $\frac{1}{2}$	2.750	.203 x 5	3— $\frac{1}{8}$ x 8	7	7	13	1500
14	15.300	$\frac{1}{2}$ x 7	10— $\frac{1}{2}$ x 10 $\frac{1}{2}$	19 $\frac{1}{2}$	9 $\frac{1}{2}$	74	575
14	15.650	$\frac{1}{2}$ x 7	10— $\frac{1}{2}$ x 10 $\frac{1}{2}$	20 $\frac{1}{2}$	9 $\frac{1}{2}$	102	563
16	17.400	$\frac{3}{4}$ x 7	10— $\frac{3}{4}$ x 10 $\frac{1}{2}$	19 $\frac{1}{2}$	9 $\frac{1}{2}$	88	509
16	17.800	$\frac{3}{4}$ x 7	10— $\frac{3}{4}$ x 10 $\frac{1}{2}$	22 $\frac{1}{2}$	9 $\frac{1}{2}$	111	498
18	19.500	$\frac{3}{4}$ x 7	12— $\frac{3}{4}$ x 10 $\frac{1}{2}$	23 $\frac{1}{2}$	9 $\frac{1}{2}$	105	450
18	19.920	$\frac{3}{4}$ x 7	12— $\frac{3}{4}$ x 10 $\frac{1}{2}$	24 $\frac{1}{2}$	9 $\frac{1}{2}$	124	448
20	21.800	$\frac{3}{4}$ x 7	12— $\frac{3}{4}$ x 10 $\frac{1}{2}$	25 $\frac{1}{2}$	9 $\frac{1}{2}$	114	411
20	22.060	$\frac{3}{4}$ x 7	14— $\frac{3}{4}$ x 10 $\frac{1}{2}$	27 $\frac{1}{2}$	9 $\frac{1}{2}$	141	406
24	25.800	$\frac{3}{4}$ x 7	15— $\frac{3}{4}$ x 10 $\frac{1}{2}$	29 $\frac{1}{2}$	9 $\frac{1}{2}$	134	349
24	26.320	$\frac{3}{4}$ x 7	15— $\frac{3}{4}$ x 10 $\frac{1}{2}$	31 $\frac{1}{2}$	9 $\frac{1}{2}$	163	343
30	31.740	$\frac{1}{2}$ x 7	16— $\frac{1}{2}$ x 11	36 $\frac{1}{2}$	10	222	455
30	32.000	$\frac{1}{2}$ x 10	16— $\frac{1}{2}$ x 14	37	13	270	451
36	37.960	$\frac{1}{2}$ x 10	18— $\frac{1}{2}$ x 14	42 $\frac{1}{2}$	13	332	382
36	38.300	$\frac{1}{2}$ x 10	18— $\frac{1}{2}$ x 14	43 $\frac{1}{2}$	13	337	378
42	44.200	$\frac{1}{2}$ x 10	20— $\frac{1}{2}$ x 14	49 $\frac{1}{2}$	13	394	327
42	44.500	$\frac{1}{2}$ x 10	20— $\frac{1}{2}$ x 14	49 $\frac{1}{2}$	13	398	324
48	50.500	$\frac{1}{2}$ x 10	22— $\frac{1}{2}$ x 14	55 $\frac{1}{2}$	13	440	285
48	50.800	$\frac{1}{2}$ x 10	22— $\frac{1}{2}$ x 14	55 $\frac{1}{2}$	13	445	283

Only Couplings for most commonly used sizes of cast-iron & ductile iron are shown. Couplings are supplied for all makes of pipe, and are regularly available in any special sizes. Details and prices will be furnished on request for any size or class of pipe, or for any special condition. Can be furnished factory pre-coated where required. Details on request.



Style 138 Couplings for Plain-End Cast-Iron Pipe Sizes

Nominal Pipe Size	Pipe O.D. Range Inches	Middle Ring Thickness, Length	BOLTS Number, Diameter and Length	Approx. Weight Each Coupling	Max. W. P. PSI
2"	2.38- 2.56	.185 x 5	3— $\frac{1}{8}$ x 8 $\frac{1}{4}$	12 $\frac{1}{2}$	250
3"	3.74- 4.02	.203 x 5	4— $\frac{1}{8}$ x 8 $\frac{1}{4}$	18	250
4"	4.74- 5.06	$\frac{1}{8}$ x 5	4— $\frac{1}{8}$ x 8 $\frac{1}{4}$	15.8	250
4"	4.74- 5.06	$\frac{1}{8}$ x 7	4— $\frac{1}{8}$ x 10 $\frac{1}{4}$	17.8	250
6"	6.84- 7.16	$\frac{1}{8}$ x 5	6— $\frac{1}{8}$ x 8 $\frac{1}{4}$	21	250
6"	6.84- 7.16	$\frac{1}{8}$ x 7	6— $\frac{1}{8}$ x 10 $\frac{1}{4}$	21.5	250
8"	8.99- 9.36	$\frac{1}{8}$ x 5	6— $\frac{1}{8}$ x 8 $\frac{1}{4}$	27	250
8"	8.99- 9.36	$\frac{1}{8}$ x 7	6— $\frac{1}{8}$ x 10 $\frac{1}{4}$	30	250
10"	11.04-11.46	$\frac{1}{8}$ x 7	8— $\frac{1}{8}$ x 10 $\frac{1}{4}$	47.8	250
12"	13.14-13.56	$\frac{1}{8}$ x 7	8— $\frac{1}{8}$ x 10 $\frac{1}{4}$	54.4	250

*Sizes 4", 6", 8", 10" & 12" have Ductile Iron Followers. All metal parts are coated with Dresser Shop Coat.

Now you can buy ONE coupling in each nominal size 2" thru 12" and be sure of a fit, whether the cast-iron was made in 1890 or from your latest shipment. Generous range of fit of the couplings permits water-tight connection of pipes within these diameter ranges: (See table).

These pressure ratings represent the sealing capability of the products involved.

WARNING When pipe pullout could occur, pipe joint MUST be anchored. Failure to anchor pipe joint could result in escaping line content and cause property damage, serious injury or death.

DRESSER[®]

Style 90 Gas Service Fittings

For Joining Steel Pipe to Steel Pipe (Seal Only)

Over the years, millions of Dresser[®] Style 90 fittings have been installed on natural gas service lines where they have helped to speed installation and cut costs.

Style 90 couplings and fittings consist of a cast iron or forged steel body; two resilient, specially compounded gaskets; two steel, self-centering protective gasket retainer cups; and two heavy end nuts. All fittings are shipped assembled, ready-to-use.

End Nut

- High grade iron, perfectly formed and rigidly inspected.
- Long threading affords reserve "take-up" on gasket when needed and prevents stripping.
- Clearance between pipe and nut permits more deflection of pipe (possible because gasket-retainer cup also confines gasket).
- Robust thread design resists stripping. (Test torques of 600 ft. lbs. reveal no stripping.)
- Coarse, rugged threads make for easy starting.

Body

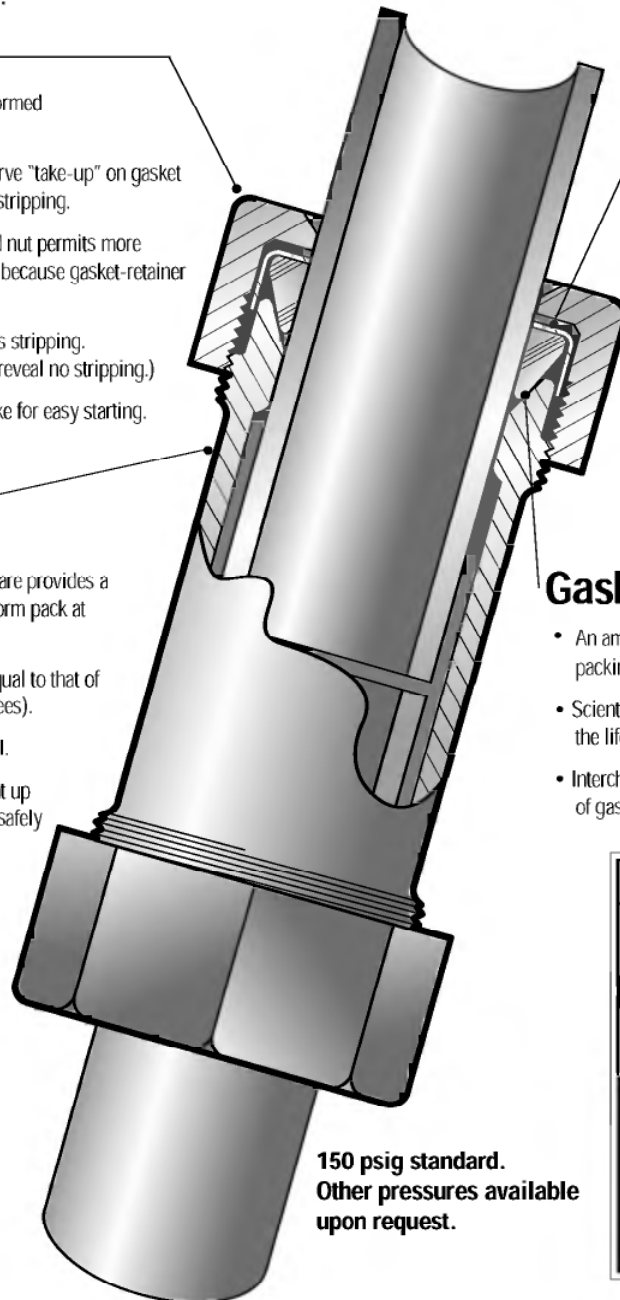
- Machined, wedge-shaped flare provides a perfect gasket seat and uniform pack at all points.
- Thickness always at least equal to that of pipe (on couplings, ells & tees).
- Made of rugged iron or steel.
- Longitudinal pipe movement up to 1/16" per gasket may be safely absorbed.

Gasket Retainer Cup

- Cup-shaped design protects gasket.
- Prevents friction between the gasket and end nut, resulting in consistent high performance.
- Eliminates gasket interference in end nut threads, providing an accurate sense of tightness.
- Closely confines the gasket, permitting more clearance between the end nut and pipe, and greater pipe deflection.

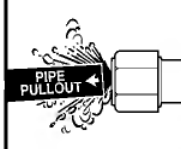
Gasket

- An ample, wedge-shaped section gives reserve packing power and high gasket pressure.
- Scientifically compounded rubber is made to last the life of the pipe.
- Interchangeable with most of the corresponding sizes of gaskets used in Style 38 bolted couplings.



150 psig standard.
Other pressures available upon request.

WARNING



When pipe pullout could occur, pipe joint **MUST** be anchored. Failure to anchor pipe joint could result in escaping line content and cause property damage, serious injury or death.

Style 90 Insulating Couplings with Full-sleeve Insulators

With the Style 90 insulating coupling, a full length body insulator, together with the insulating gasket, effectively isolates the insulating end of the coupling from the pipe. The body insulator also facilitates installation of the coupling and aids correct reassembly if the coupling is disassembled. A high resistance, gas-tight insulating joint is provided, even with pipe-end deflection of up to 3 degrees.

Also, the sliding pipe-end spacer assures proper separation of pipe ends within the coupling for effective insulation. The full-sleeve insulator working in combination with the pipe-end spacer makes proper installation of the Style 90 insulating coupling virtually foolproof.



Style 90 Tap-N-Valve® Tees

Dresser "Tap-N-Valve" service fittings are equipped with tools which retain the slug cut from the main. During the tapping process, a gradual inward deformation of the abrading edges of the tool forms a positive, mechanical interlock between the tool and the slug, holding it permanently.

The tapered design of the tool forms a raised conical valve seat on the surface of the main, providing a honed metal-to-metal seal for positive shut-off at any time.

All weld inlet tees are supplied with weld splatter caps as standard.

Style 90 Meter Bend Adapters

Here is a flexible meter bend which permits shop prefabrication of meter settings, and protects meter and service from many of the hazards of trenching, grading and landscaping at a later date.

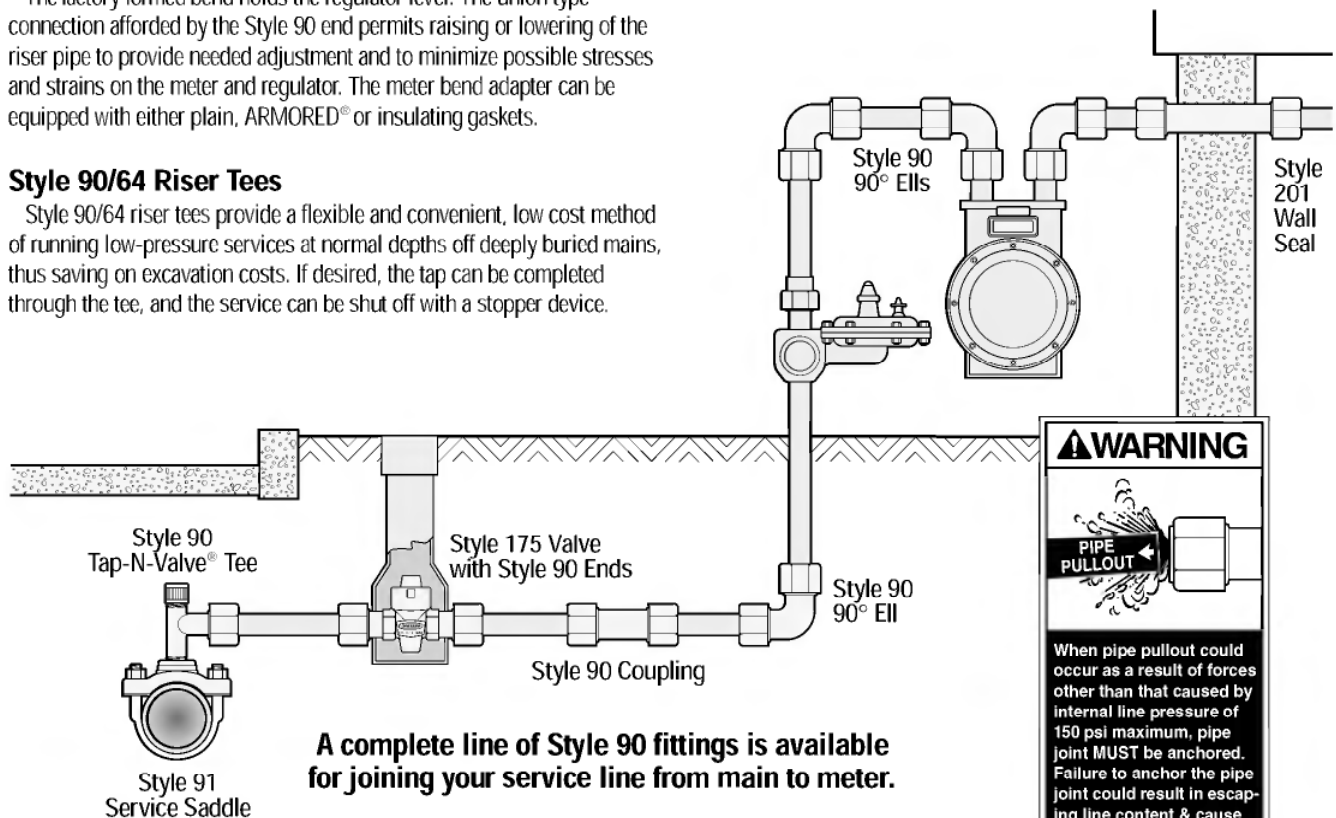
The factory-formed bend holds the regulator level. The union type connection afforded by the Style 90 end permits raising or lowering of the riser pipe to provide needed adjustment and to minimize possible stresses and strains on the meter and regulator. The meter bend adapter can be equipped with either plain, ARMORED® or insulating gaskets.

Style 90/64 Riser Tees

Style 90/64 riser tees provide a flexible and convenient, low cost method of running low-pressure services at normal depths off deeply buried mains, thus saving on excavation costs. If desired, the tap can be completed through the tee, and the service can be shut off with a stopper device.

Style 90 Brass Insulating Street Tees

Style 90 brass insulating street tees are recommended for use in place of malleable street tees on cast iron mains where excessive corrosion is a problem. This street tee is cathodic to cast iron pipe and is insulated from the steel service line. These tees are manufactured to meet A.S.A. standards for brass fittings by a special method which assures more uniform wall thickness, better surface finish and greater dimensional accuracy.



A complete line of Style 90 fittings is available for joining your service line from main to meter.

Style 90 Gas Service Fittings

For Joining Steel Pipe (Seal Only)

Nominal Size (IPS) (In.)	Outside Diameter (O.D.) (In.)	E-Coat Part Number	Overall Dimensions					Dimension Drawings
			A	B	C	D	E	
CAST COUPLINGS WITH 5" MIDDLE RING - SEAL ONLY								
1/2	.840	0090-0014-082	2	5/8	5	--	--	
3/4	1.050	0090-0001-082	2 ^{7/32}	5/8	5	--	--	
1	1.315	0090-0002-082	2 ^{9/16}	5/8	5	--	--	
1 1/4	1.660	0090-0003-082	3	5/8	5	--	--	
1 1/2	1.900	0090-0004-082	3 ^{3/8}	5 ^{5/16}	5	--	--	
2	2.375	0090-0005-082	4	6 ^{1/8}	5	--	--	
STEEL COUPLINGS WITH 5" MIDDLE RING - SEAL ONLY								
3/4	1.050	0090-2101-082	2 ^{7/32}	5/8	5	--	--	
1	1.315	0090-2102-082	2 ^{9/16}	5/8	5	--	--	
1 1/4	1.660	0090-2103-082	3	5/8	5	--	--	
1 1/2	1.900	0090-2104-082	3 ^{3/8}	5 ^{5/16}	5	--	--	
2	2.375	0090-2105-082	4	6 ^{1/8}	5	--	--	
STEEL COUPLINGS WITH 10" MIDDLE RING -- SEAL ONLY								
3/4	1.050	0090-0090-082	2 ^{7/32}	10 ^{7/8}	10	--	--	
1	1.315	0090-0091-082	2 ^{9/16}	10 ^{7/8}	10	--	--	
1 1/4	1.660	0090-0092-082	3	10 ^{7/8}	10	--	--	
1 1/2	1.900	0090-0093-082	3 ^{3/8}	10 ^{7/8}	10	--	--	
2	2.375	0090-0094-082	4	11 ^{1/8}	10	--	--	
REDUCING COUPLINGS -- SEAL ONLY								
3/4 x 1/2	1.050 x .840	0090-0590-082	2 ^{7/32}	5/8	5	2	--	
1 x 3/4	1.315 x 1.050	0090-0580-082	2 ^{9/16}	5/8	5	2 ^{7/32}	--	
1 1/4 x 3/4	1.660 x 1.050	0090-0581-082	3	5/8	5	2 ^{7/32}	--	
1 1/4 x 1	1.660 x 1.315	0090-0582-082	3	5/8	5	2 ^{9/16}	--	
1 1/2 x 3/4	1.900 x 1.050	0090-0583-082	3 ^{3/8}	5/8	5	2 ^{7/32}	--	
1 1/2 x 1	1.900 x 1.315	0090-0584-082	3 ^{3/8}	5/8	5	--	--	
1 1/2 x 1 1/4	1.900 x 1.660	0090-0585-082	3 ^{3/8}	5/8	5	3	--	
2 x 3/4	2.375 x 1.050	0090-0586-082	4	6	5	2 ^{7/32}	--	
2 x 1	2.375 x 1.315	0090-0587-082	4	6	5	--	--	
2 x 1 1/4	2.375 x 1.660	0090-0588-082	4	6	5	3	--	
2 x 1 1/2	2.375 x 1.900	0090-0591-082	4	6	5	3 ^{3/8}	--	
45° ELLS -- SEAL ONLY								
1	1.315	0090-0212-082	2 ^{9/16}	2 ^{13/32}	1 ^{5/8}	1 ^{11/32}	--	
1 1/4	1.660	0090-0213-082	3	2 ^{11/16}	1 ^{7/8}	3/8	--	
1 1/2	1.900	0090-0214-082	3 ^{3/8}	2 ^{29/32}	2	7/16	--	
2	2.375	0090-0215-082	4	3 ^{3/8}	2 ^{1/4}	9/16	--	

Style 90 Gas Service Fittings

For Joining Steel Pipe (Seal Only)

Nominal Size (IPS) (In.)	Outside Diameter (O.D.) (In.)	E-Coat Part Number	Overall Dimensions					Dimension Drawings
			A	B	C	D	E	
90° ELLS -- SEAL ONLY								
3/4	1.050	0090-0241-082	2 ⁷ / ₃₂	3 ¹ / ₈	2	1 ¹¹ / ₁₆	--	
1	1.315	0090-0242-082	2 ⁹ / ₁₆	3 ³ / ₁₆	2	3/4	--	
1 1/4	1.660	0090-0243-082	3	3 ¹ / ₄	1 ⁷ / ₈	1 ⁵ / ₁₆	--	
1 1/2	1.900	0090-0244-082	3 ³ / ₈	3 ¹⁵ / ₃₂	2	1 ¹ / ₈	--	
2	2.375	0090-0245-082	4	4 ³ / ₁₆	2 ¹ / ₄	1 ³ / ₈	--	
PLAIN END 90° STREET ELLS -- SEAL ONLY								
3/4	1.050	0090-0270-082	2 ⁷ / ₃₂	3 ⁹ / ₁₆	3	2	9/16	
1	1.315	0090-0271-082	2 ⁹ / ₁₆	3 ³ / ₈	2 ¹³ / ₁₆	1 ⁵ / ₈	3/4	
1 1/4	1.660	0090-0272-082	3	4	3 ³ / ₁₆	1 ⁷ / ₈	7/8	
1 1/2	1.900	0090-0273-082	3 ³ / ₈	4 ⁵ / ₁₆	3 ¹⁵ / ₃₂	2	1	
2	2.375	0090-0274-082	4	5 ¹ / ₈	4 ¹ / ₁₆	2 ¹ / ₄	1 ¹ / ₄	
THREADED END 90° ELLS								
3/4	1.050	0090-0330-082	2 ⁷ / ₃₂	2	3	2	9/16	
1	1.315	0090-0331-082	2 ⁹ / ₁₆	2 ⁷ / ₁₆	2 ¹³ / ₁₆	1 ⁵ / ₈	3/4	
1 1/4	1.660	0090-0332-082	3	2 ⁷ / ₈	3 ³ / ₁₆	1 ⁷ / ₈	7/8	
1 1/2	1.900	0090-0333-082	3 ³ / ₈	2 ⁷ / ₈	3 ¹⁵ / ₃₂	2	1	
2	2.375	0090-0334-082	4	3 ¹ / ₂	4 ¹ / ₁₆	2 ¹ / ₄	1 ¹ / ₄	
STREET TEES -- SEAL ONLY								
3/4	1.050	0090-0390-082	2 ⁷ / ₃₂	1 ¹⁵ / ₁₆	2 ¹ / ₁₆	3	2	
1	1.315	0090-0391-082	2 ⁹ / ₁₆	1 ⁵ / ₈	2 ³ / ₄	2 ¹³ / ₁₆	1 ⁵ / ₈	
1 1/4	1.660	0090-0392-082	3	1 ¹³ / ₁₆	2 ⁷ / ₈	3 ³ / ₁₆	1 ⁷ / ₈	
1 1/2	1.900	0090-0393-082	3 ³ / ₈	2	3 ¹ / ₁₆	3 ¹⁵ / ₃₂	2	
2	2.375	0090-0394-082	4	2 ⁵ / ₁₆	3 ⁵ / ₁₆	4 ¹ / ₁₆	2 ¹ / ₄	
REDUCING STREET TEES -- SEAL ONLY								
1 1/4 x 1 1/4 x 1	1.660 x 1.660 x 1.315	0090-0451-082	2 ⁹ / ₁₆	1 ³ / ₄	2 ³ / ₄	2 ¹⁵ / ₁₆	1 ⁵ / ₈	
1 1/4 x 1 x 1 1/4	1.660 x 1.315 x 1.660	0090-0452-082	3	1 ¹³ / ₁₆	2 ⁷ / ₈	3 ³ / ₁₆	1 ⁷ / ₈	
1 1/2 x 1 1/2 x 1	1.900 x 1.900 x 1.315	0090-0453-082	2 ⁹ / ₁₆	2	2 ⁷ / ₄	3 ¹ / ₁₆	1 ⁵ / ₈	
1 1/2 x 1 1/2 x 1 1/4	1.900 x 1.900 x 1.660	0090-0454-082	3	2	2 ⁷ / ₈	3 ⁵ / ₁₆	1 ⁷ / ₈	
1 1/2 x 1 x 1 1/2	1.900 x 1.315 x 1.900	0090-0455-082	3 ³ / ₈	2	3 ¹ / ₁₆	3 ¹⁵ / ₃₂	2	
1 1/2 x 1 1/4 x 1 1/2	1.900 x 1.660 x 1.900	0090-0456-082	3 ³ / ₈	2	3 ¹ / ₈	3 ¹⁵ / ₃₂	2	
2 x 1 1/4 x 2	2.375 x 1.660 x 2.375	0090-0458-082	4	2 ⁵ / ₁₆	3 ³ / ₈	4 ¹ / ₁₆	2 ¹ / ₄	
2 x 1 1/2 x 2	2.375 x 1.900 x 2.375	0090-0459-082	4	2 ⁵ / ₁₆	3 ⁵ / ₁₆	4 ¹ / ₁₆	2 ¹ / ₄	

Style 90 Gas Service Fittings

For Joining Steel Pipe (Seal Only)

Nominal Size (IPS) (In.)	Outside Diameter (O.D.) (In.)	E-Coat Part Number	Overall Dimensions					Dimension Drawings
			A	B	C	D	E	
WELDING STREET TEES -- SEAL ONLY								
3/4	1.050	0090-0550-082	2 ⁷ / ₃₂	2 ⁵ / ₈	2 ¹ / ₄	3 ¹ / ₃₂	2 ¹ / ₁₆	
1	1.315	0090-0551-082	2 ⁹ / ₁₆	2 ⁷ / ₈	2 ¹ / ₂	3 ¹ / ₁₆	1 ³¹ / ₃₂	
1 1/4	1.660	0090-0552-082	3	2 ⁹ / ₁₆	3 ⁵ / ₁₆	3 ⁷ / ₃₂	1 ¹⁵ / ₁₆	
1 1/2	1.900	0090-0553-082	3 ³ / ₈	2 ²⁹ / ₃₂	3 ¹⁵ / ₃₂	3 ¹⁵ / ₁₆	2 ¹ / ₂	
2	2.375	0090-0554-082	4	3 ¹⁵ / ₃₂	1 ²⁵ / ₃₂	4 ¹ / ₄	2 ¹ / ₂	
REGULAR TEES -- SEAL ONLY								
3/4 x 3/4 x 3/4	1.050 x 1.050 x 1.050	0090-0710-082	2 ⁷ / ₃₂	6 ¹ / ₄	5 ³ / ₈	1 ¹ / ₁₆	3 ³ / ₈	
1 x 1 x 1	1.315 x 1.315 x 1.315	0090-0711-082	2 ⁹ / ₁₆	5 ⁷ / ₈	5	1 ¹ / ₁₆	3 ⁷ / ₁₆	
1 1/4 x 1 1/4 x 1 1/4	1.660 x 1.660 x 1.660	0090-0712-082	3	6 ¹⁹ / ₃₂	5 ¹⁷ / ₃₂	1 ⁵ / ₁₆	3 ¹ / ₄	
1 1/2 x 1 1/2 x 1 1/2	1.900 x 1.900 x 1.900	0090-0713-082	3 ³ / ₈	5 ⁷ / ₈	5	1 ⁵ / ₁₆	4 ⁵ / ₁₆	
2 x 2 x 1 1/4	2.375 x 2.375 x 1.660	0090-0717-082	4	5 ⁷ / ₈	5	1 ⁵ / ₁₆	4 ³ / ₁₆	
2 x 2 x 2	2.375 x 2.375 x 2.375	0090-0716-082	4	8 ¹ / ₈	7 ¹ / ₄	1 ³ / ₈	4 ³ / ₁₆	
MALE ADAPTERS -- SEAL ONLY								
1 x 1 MIPS	1.315	0090-0741-082	2 ⁹ / ₁₆	4 ¹ / ₄	3 ¹³ / ₁₆	--	--	
1 x 1 1/4 MIPS	1.315	0090-0749-082	2 ⁹ / ₁₆	5 ³ / ₁₆	4 ³ / ₄	--	--	
1 1/4 x 1 1/4 MIPS	1.660	0090-0757-082	3	4 ⁷ / ₁₆	3 ⁷ / ₈	--	--	
1 1/2 x 1 1/2 MIPS	1.900	0090-0743-082	3 ³ / ₈	4 ⁹ / ₁₆	3 ⁷ / ₈	--	--	
2 x 2 MIPS	2.375	0090-0744-082	4	4 ¹¹ / ₁₆	4	--	--	
LINE CAPS -- SEAL ONLY								
3/4	1.050	0090-0860-082	2 ⁷ / ₃₂	3 ³ / ₈	2 ¹¹ / ₁₆	--	--	
1	1.315	0090-0861-082	2 ⁹ / ₁₆	3 ³ / ₈	2 ¹¹ / ₁₆	--	--	
1 1/4	1.660	0090-0862-082	3	3 ³ / ₈	2 ¹¹ / ₁₆	--	--	
1 1/2	1.900	0090-0863-082	3 ³ / ₈	3 ⁵ / ₃₂	2 ¹¹ / ₁₆	--	--	
2	2.375	0090-0864-082	4	3 ¹ / ₄	2 ¹¹ / ₁₆	--	--	

Insulating Fittings For Joining Steel Pipe (Seal Only)

Nominal Size (IPS) (In.)	Outside Diameter (O.D.) (In.)	E-Coat Part Number	Overall Dimensions					Dimension Drawings
			A	B	C	D	E	
CAST INSULATING COUPLINGS -- 5" MIDDLE RING -- SEAL ONLY								
3/4	1.050	0090-1677-192	2 ⁷ / ₃₂	6 ³ / ₈	5	--	--	
1	1.315	0090-1678-192	2 ⁹ / ₁₆	6 ³ / ₈	5	--	--	
1 1/4	1.660	0090-1679-192	3	6 ³ / ₈	5	--	--	
1 1/2	1.900	0090-1680-192	3 ³ / ₈	5 ¹³ / ₁₆	5	--	--	
2	2.375	0090-1681-192	4	6 ⁵ / ₈	5	--	--	

Style 90 Gas Service Fittings

Insulating Fittings For Joining Steel Pipe (Seal Only)

Nominal Size (IPS) (In.)	Outside Diameter (O.D.) (In.)	E-Coat Part Number	Overall Dimensions					Dimension Drawings
			A	B	C	D	E	
STEEL INSULATING COUPLINGS -- 5" MIDDLE RING -- SEAL ONLY								
3/4	1.050	0090-2127-192	2 ⁷ / ₃₂	6 ³ / ₈	5	--	--	
1	1.315	0090-2128-192	2 ⁹ / ₁₆	6 ³ / ₈	5	--	--	
1 1/4	1.660	0090-2129-192	3	6 ³ / ₈	5	--	--	
1 1/2	1.900	0090-2130-192	3 ³ / ₈	5 ¹³ / ₁₆	5	--	--	
2	2.375	0090-2131-192	4	6 ⁵ / ₈	5	--	--	
STEEL INSULATING COUPLINGS -- 10" MIDDLE RING -- SEAL ONLY								
3/4	1.050	0090-0120-091	2 ⁷ / ₃₂	11 ³ / ₈	10	--	--	
1	1.315	0090-0121-091	2 ⁹ / ₁₆	11 ³ / ₈	10	--	--	
1 1/4	1.660	0090-0122-091	3	11 ³ / ₈	10	--	--	
1 1/2	1.900	0090-0123-091	3 ³ / ₈	11 ³ / ₈	10	--	--	
2	2.375	0090-0124-091	4	11 ⁵ / ₈	10	--	--	
MALE INSULOK ADAPTERS -- SEAL ONLY								
3/4	1.050	0090-0800-039	2 ⁷ / ₃₂	3 ⁷ / ₁₆	2 ³ / ₄	--	--	
1	1.315	0090-0801-039	2 ⁹ / ₁₆	3 ⁵ / ₁₆	2 ⁵ / ₈	--	--	
1 1/4	1.660	0090-0802-039	3	3 ⁹ / ₁₆	2 ⁷ / ₈	--	--	
FEMALE INSULOK ADAPTERS -- SEAL ONLY								
3/4	1.050	0090-0833-039	2 ⁷ / ₃₂	2 ⁹ / ₁₆	1 ⁷ / ₈	--	--	
1	1.315	0090-0831-039	2 ⁹ / ₁₆	2 ¹³ / ₁₆	2 ¹ / ₈	--	--	
1 1/4	1.660	0090-0835-039	3	2 ¹⁵ / ₁₆	2 ¹ / ₄	--	--	
INSULATING REDUCING STREET TEES -- SEAL ONLY								
1 1/4 x 1 1/4 x 1	1.660 x 1.660 x 1.315	0090-0500-033	2 ⁹ / ₁₆	1 ³ / ₄	2 ³ / ₄	3 ⁷ / ₁₆	1 ⁵ / ₈	
1 1/4 x 1 x 1 1/4	1.660 x 1.315 x 1.660	0090-0501-033	3	1 ¹³ / ₁₆	2 ⁷ / ₈	3 ¹¹ / ₁₆	1 ⁷ / ₈	
1 1/2 x 1 x 1 1/2	1.900 x 1.315 x 1.900	0090-0502-033	3 ³ / ₈	2	3 ¹ / ₁₆	4	2	
1 1/2 x 1 1/4 x 1 1/2	1.900 x 1.660 x 1.900	0090-0503-033	3 ³ / ₈	2	3 ¹ / ₈	4	2	
1 1/2 x 1 1/2 x 1 1/4	1.900 x 1.900 x 1.660	0090-0506-033	3	2	2 ⁷ / ₈	3 ¹¹ / ₁₆	1 ⁷ / ₈	
2 x 1 1/4 x 2	2.375 x 1.660 x 2.375	0090-0504-033	4	2 ⁵ / ₁₆	3 ³ / ₈	4 ⁹ / ₁₆	2 ¹ / ₄	
2 x 1 1/2 x 2	2.375 x 1.900 x 2.375	0090-0505-033	4	2 ⁵ / ₁₆	3 ⁵ / ₁₆	4 ⁹ / ₁₆	2 ¹ / ₄	
INSULATING WELDING STREET TEES -- SEAL ONLY								
3/4	1.050	0090-1470-033	2 ⁷ / ₃₂	2 ⁵ / ₈	2 ¹ / ₄	3 ¹ / ₂	2 ¹ / ₁₆	
1	1.315	0090-1471-033	2 ⁹ / ₁₆	2 ⁷ / ₈	2 ¹ / ₂	3 ⁹ / ₁₆	1 ³¹ / ₃₂	
1 1/4	1.660	0090-1472-033	3	2 ³ / ₁₆	3 ⁵ / ₁₆	3 ³ / ₄	1 ¹⁵ / ₁₆	
1 1/2	1.900	0090-1473-033	3 ³ / ₈	2 ²⁹ / ₃₂	3 ¹⁵ / ₃₂	4 ⁷ / ₁₆	2 ¹ / ₂	
2	2.375	0090-1474-033	4	3 ¹⁵ / ₃₂	3 ²⁵ / ₃₂	4 ³ / ₄	2 ¹ / ₂	

Style 90 Gas Service Fittings

Insulating Fittings For Joining Steel Pipe (Seal Only)

Nominal Size (IPS) (In.)	Outside Diameter (O.D.) (In.)	E-Coat Part Number	Overall Dimensions					Dimension Drawings
			A	B	C	D	E	
INSULATING REDUCING COUPLINGS -- LARGER END INSULATED -- SEAL ONLY								
3/4 x 1/2	1.050 x .840	0090-0638-084	2 ⁷ / ₃₂	6 ³ / ₈	5	2	--	
1 x 3/4	1.315 x 1.050	0090-0630-084	2 ⁹ / ₁₆	6 ³ / ₈	5	2 ⁷ / ₃₂	--	
1 1/4 x 3/4	1.660 x 1.050	0090-0631-084	3	6 ³ / ₈	5	2 ⁷ / ₃₂	--	
1 1/4 x 1	1.660 x 1.315	0090-0632-084	3	6 ³ / ₈	5	2 ⁹ / ₁₆	--	
1 1/2 x 1	1.900 x 1.315	0090-0633-084	3 ³ / ₈	6 ³ / ₈	5	2 ⁹ / ₁₆	--	
1 1/2 x 1 1/4	1.900 x 1.660	0090-0634-084	3 ³ / ₈	6 ³ / ₈	5	3	--	
2 x 1 1/4	2.375 x 1.660	0090-0637-084	4	6 1/2	5	3	--	
2 x 1 1/2	2.375 x 1.900	0090-0636-084	4	6 1/2	5	3 ³ / ₈	--	
INSULATING 90° ELL -- SEAL ONLY								
3/4	1.050	0090-1451-084	2 ⁷ / ₃₂	3 ⁵ / ₈	2	1 ¹ / ₁₆	--	
1	1.315	0090-1452-084	2 ⁹ / ₁₆	3 ¹¹ / ₁₆	2	3/4	--	
1 1/4	1.660	0090-1453-084	3	3 ³ / ₄	1 ⁷ / ₈	1 ⁵ / ₁₆	--	
1 1/2	1.900	0090-1454-084	3 ³ / ₈	4 ¹ / ₈	2	1 ¹ / ₈	--	
2	2.375	0090-1455-084	4	4 ¹¹ / ₁₆	2 ¹ / ₄	1 ³ / ₈	--	
INSULATING 90° PLAIN END STREET ELLS -- SEAL ONLY								
3/4	1.050	0090-0300-033	2 ⁷ / ₃₂	3 ⁹ / ₁₆	3 ¹ / ₂	2	9/16	
1	1.315	0090-0301-033	2 ⁹ / ₁₆	3 ³ / ₈	3 ⁵ / ₁₆	1 ⁵ / ₈	3/4	
1 1/4	1.660	0090-0302-033	3	4	3 ¹¹ / ₁₆	1 ⁷ / ₈	7/8	
1 1/2	1.900	0090-0303-033	3 ³ / ₈	4 ⁵ / ₁₆	4	2	1	
2	2.375	0090-0304-033	4	5 ¹ / ₈	4 ⁹ / ₁₆	2 ¹ / ₄	1 ¹ / ₄	
INSULATING STREET TEES -- SEAL ONLY								
3/4	1.050	0090-0420-033	2 ⁷ / ₃₂	1 ¹⁵ / ₁₆	2 ¹ / ₁₆	3 ¹ / ₂	2	
1	1.315	0090-0421-033	2 ⁹ / ₁₆	1 ⁵ / ₈	2 ⁹ / ₁₆	3 ⁵ / ₁₆	1 ⁵ / ₈	
1 1/4	1.660	0090-0422-033	3	1 ¹³ / ₁₆	2 ⁷ / ₈	3 ¹¹ / ₁₆	1 ⁷ / ₈	
1 1/2	1.900	0090-0423-033	3 ³ / ₈	2	3 ¹ / ₁₆	4	2	
2	2.375	0090-0424-033	4	2 ⁵ / ₁₆	3 ⁵ / ₁₆	4 ⁹ / ₁₆	2 ¹ / ₄	
INSULATING 90° THREADED END STREET ELLS -- SEAL ONLY								
3/4	1.050	0090-0360-033	2 ⁷ / ₃₂	2	3 ¹ / ₂	2	9/16	
1	1.315	0090-0361-033	2 ⁹ / ₁₆	2 ⁵ / ₁₆	3 ⁵ / ₁₆	1 ⁵ / ₈	3/4	
1 1/4	1.660	0090-0362-033	3	2 ⁷ / ₈	3 ¹¹ / ₁₆	1 ⁷ / ₈	7/8	
1 1/2	1.900	0090-0364-033	3 ³ / ₈	2 ⁷ / ₈	4	2	1	
2	2.375	0090-0365-033	4	3 ¹ / ₂	4 ⁹ / ₁₆	2 ¹ / ₄	1 ¹ / ₄	

Style 90 Gas Service Fittings

Insulating Fittings For Joining Steel Pipe (Seal Only)

Nominal Size (IPS) (In.)	Outside Diameter (O.D.) (In.)	E-Coat Part Number	Overall Dimensions					Dimension Drawings
			A	B	C	D	E	
INSULATING MALE ADAPTERS -- SEAL ONLY								
1 x 1 MIPS	1.315	0090-0772-033	2 ⁹ / ₁₆	4 ³ / ₄	3 ²⁷ / ₃₂	--	--	
1 ¹ / ₄ x 1 ¹ / ₄ MIPS	1.660	0090-0784-033	3	4 ¹⁵ / ₁₆	3 ⁷ / ₈	--	--	
1 x 1 ¹ / ₄ MIPS	1.315	0090-0771-033	3	4 ¹³ / ₁₆	3 ⁷ / ₈	--	--	
1 ¹ / ₂ x 1M	1.900	0090-0770-033	3 ³ / ₈	4 ¹³ / ₁₆	3 ⁷ / ₈	--	--	
STYLE 90 BRASS INSULATING STREET TEES -- SEAL ONLY								
1 ¹ / ₄ x 1 x 1 ¹ / ₄	1.660 x 1.315 x 1.660	0090-1429-048	3	1 ¹³ / ₁₆	2 ¹⁵ / ₁₆	3 ³ / ₁₆	1 ⁷ / ₈	
1 ¹ / ₄ x 1 ¹ / ₄ x 1 ¹ / ₄	1.660 x 1.660 x 1.660	0090-1430-048	3	1 ¹³ / ₁₆	2 ¹⁵ / ₁₆	3 ³ / ₁₆	1 ⁷ / ₈	

Plastisol Coated Fittings For Joining Steel Pipe (Seal Only)

Nominal Size (IPS) (In.)	Outside Dia. (O.D.) (In.)	Conductive Part Number	Insulating Part Number	Overall Dimensions					Dimension Drawings
				A	B	C	D	E	
PLASTISOL COATED CAST COUPLINGS -- 5" MIDDLE RING -- SEAL ONLY									
1/2	.840	0090-0014-205	--	2 ¹ / ₈	6 ⁷ / ₈	5	--	--	
3/4	1.050	0090-0001-205	0090-1677-212	2 ¹¹ / ₃₂	6 ⁷ / ₈	5	--	--	
1	1.315	0090-0002-205	0090-1678-212	2 ¹¹ / ₁₆	6 ⁷ / ₈	5	--	--	
1 ¹ / ₄	1.660	0090-0003-205	0090-1679-212	3 ¹ / ₈	6 ⁷ / ₈	5	--	--	
1 ¹ / ₂	1.900	0090-0004-205	0090-1680-212	3 ¹ / ₂	6 ⁵ / ₁₆	5	--	--	
2	2.375	0090-0005-205	0090-1681-212	4 ¹ / ₈	7 ¹ / ₈	5	--	--	
PLASTISOL COATED STEEL COUPLINGS -- 5" MIDDLE RING -- SEAL ONLY									
3/4	1.050	0090-2101-205	0090-2127-212	2 ¹¹ / ₃₂	6 ⁷ / ₈	5	--	--	
1	1.315	0090-2102-205	0090-2128-212	2 ¹¹ / ₁₆	6 ⁷ / ₈	5	--	--	
1 ¹ / ₄	1.660	0090-2103-205	0090-2129-212	3 ¹ / ₈	6 ⁷ / ₈	5	--	--	
1 ¹ / ₂	1.900	0090-2104-205	0090-2130-212	3 ¹ / ₂	6 ⁵ / ₁₆	5	--	--	
2	2.375	0090-2105-205	0090-2131-212	4 ¹ / ₈	7 ¹ / ₈	5	--	--	
PLASTISOL COATED STEEL COUPLINGS -- 10" MIDDLE RING -- SEAL ONLY									
3/4	1.050	0090-0090-205	0090-0120-213	2 ¹¹ / ₃₂	11 ⁷ / ₈	10	--	--	
1	1.315	0090-0091-205	0090-0121-213	2 ¹¹ / ₁₆	11 ⁷ / ₈	10	--	--	
1 ¹ / ₄	1.660	0090-0092-205	0090-0122-213	3 ¹ / ₈	11 ⁷ / ₈	10	--	--	
1 ¹ / ₂	1.900	0090-0093-205	0090-0123-213	3 ¹ / ₂	11 ⁷ / ₈	10	--	--	
2	2.375	0090-0094-205	0090-0124-213	4 ¹ / ₈	12 ¹ / ₈	10	--	--	

Style 90 Gas Service Fittings

Plastisol Coated Fittings For Joining Steel Pipe (Seal Only)

Nominal Size (IPS) (In.)	Outside Dia. (O.D.) (In.)	Conductive Part Number	Insulating Part Number	Overall Dimensions					Dimension Drawings
				A	B	C	D	E	
PLASTISOL COATED REDUCING COUPLINGS -- SEAL ONLY									
1 x 3/4	1.315 x 1.050	0090-0580-205	0090-0630-207	2 ¹¹ / ₁₆	6 ⁷ / ₁₆	5	2 ¹¹ / ₃₂	--	
1 1/4 x 3/4	1.660 x 1.050	0090-0581-205	0090-0631-207	3 ¹ / ₁₆	6 ⁷ / ₁₆	5	2 ¹¹ / ₃₂	--	
1 1/4 x 1	1.660 x 1.315	0090-0603-205	0090-0632-207	3 ¹ / ₁₆	6 ⁷ / ₁₆	5	2 ¹¹ / ₁₆	--	
1 1/2 x 1	1.900 x 1.315	0090-0604-205	--	3 ¹ / ₂	6 ⁷ / ₈	5	2 ¹¹ / ₁₆	--	
1 1/2 x 1 1/4	1.900 x 1.660	0090-0605-205	0090-0634-207	3 ¹ / ₂	6 ⁷ / ₁₆	5	3 ¹ / ₈	--	
2 x 1 1/4	2.375 x 1.660	0090-0588-205	--	4 ¹ / ₈	7	5	3 ¹ / ₈	--	
2 x 1 1/2	2.375 x 1.900	0090-0606-205	--	4 ¹ / ₈	7	5	3 ¹ / ₂	--	
PLASTISOL COATED 90° ELL -- SEAL ONLY									
3/4	1.050	0090-0241-205	0090-1451-207	2 ¹¹ / ₃₂	3 ⁵ / ₁₆	2	1 ¹ / ₁₆	--	
1	1.315	0090-0242-205	0090-1452-207	2 ¹¹ / ₁₆	3 ¹¹ / ₁₆	2	3/4	--	
1 1/4	1.660	0090-0243-205	0090-1453-207	3 ¹ / ₁₆	3 ³ / ₄	1 ⁷ / ₁₆	1 ⁵ / ₁₆	--	
1 1/2	1.900	0090-0244-205	0090-1454-207	3 ¹ / ₂	4 ³ / ₃₂	2	1 ¹ / ₈	--	
2	2.375	0090-0245-205	0090-1455-207	4 ¹ / ₁₆	4 ¹¹ / ₁₆	2 ¹ / ₄	1 ³ / ₈	--	
PLASTISOL COATED STREET TEES -- SEAL ONLY									
3/4	1.050	0090-0390-205	0090-0420-208	2 ¹¹ / ₃₂	1 ¹⁵ / ₁₆	2 ¹ / ₁₆	3 ¹ / ₂	2	
1	1.315	0090-0391-205	0090-0421-208	2 ¹¹ / ₁₆	1 ⁵ / ₁₆	2 ³ / ₄	3 ⁵ / ₁₆	1 ⁵ / ₁₆	
1 1/4	1.660	0090-0392-205	0090-0422-208	3 ¹ / ₁₆	1 ¹³ / ₁₆	2 ⁷ / ₁₆	3 ¹¹ / ₁₆	1 ⁷ / ₁₆	
1 1/2	1.900	0090-0393-205	0090-0423-208	3 ¹ / ₂	2	3 ¹ / ₁₆	3 ³¹ / ₃₂	2	
2	2.375	0090-0394-205	0090-0424-208	4 ¹ / ₁₆	2 ⁵ / ₁₆	3 ⁵ / ₁₆	4 ⁹ / ₁₆	2 ¹ / ₄	
PLASTISOL COATED PLAIN END 90° STREET ELLS -- SEAL ONLY									
3/4	1.050	0090-0270-205	0090-0300-208	2 ¹¹ / ₃₂	3 ⁹ / ₁₆	3 ¹ / ₂	2	9/16	
1	1.315	0090-0271-205	0090-0301-208	2 ¹¹ / ₁₆	3 ³ / ₈	3 ⁵ / ₁₆	1 ⁵ / ₈	3/4	
1 1/4	1.660	0090-0272-205	0090-0302-208	3 ¹ / ₈	4	3 ¹¹ / ₁₆	1 ⁷ / ₈	7/8	
1 1/2	1.900	0090-0273-205	0090-0303-208	3 ¹ / ₂	4 ⁵ / ₁₆	3 ³¹ / ₃₂	2	1	
2	2.375	0090-0274-205	0090-0304-208	4 ¹ / ₈	5 ¹ / ₈	4 ⁹ / ₁₆	2 ¹ / ₄	1 ¹ / ₄	
PLASTISOL COATED THREADED END 90° STREET ELLS -- SEAL ONLY									
3/4	1.050	0090-0330-205	0090-0360-208	2 ¹¹ / ₃₂	2	3 ¹ / ₂	2	9/16	
1	1.315	0090-0331-205	0090-0361-208	2 ¹¹ / ₁₆	2 ⁵ / ₁₆	3 ⁵ / ₁₆	1 ⁵ / ₈	3/4	
1 1/4	1.660	0090-0332-205	0090-0362-208	3 ¹ / ₁₆	2 ⁷ / ₁₆	3 ¹¹ / ₁₆	1 ⁷ / ₈	7/8	
PLASTISOL COATED LINE CAP -- LOCK TYPE									
3/4	1.050	0090-0860-206	--	2 ¹¹ / ₃₂	3 ⁵ / ₈	2 ¹¹ / ₁₆	--	--	
1	1.315	0090-0861-206	--	2 ¹¹ / ₁₆	3 ⁵ / ₈	2 ¹¹ / ₁₆	--	--	
1 1/4	1.660	0090-0862-206	--	3 ¹ / ₁₆	3 ⁵ / ₈	2 ¹¹ / ₁₆	--	--	
1 1/2	1.900	0090-0863-206	--	3 ¹ / ₂	3 ²¹ / ₃₂	2 ¹¹ / ₁₆	--	--	
2	2.375	0090-0864-206	--	4 ¹ / ₁₆	3 ³ / ₄	2 ¹¹ / ₁₆	--	--	

Style 90 Tap-N-Valve[®] Tees

For Joining Steel Pipe (Seal Only)

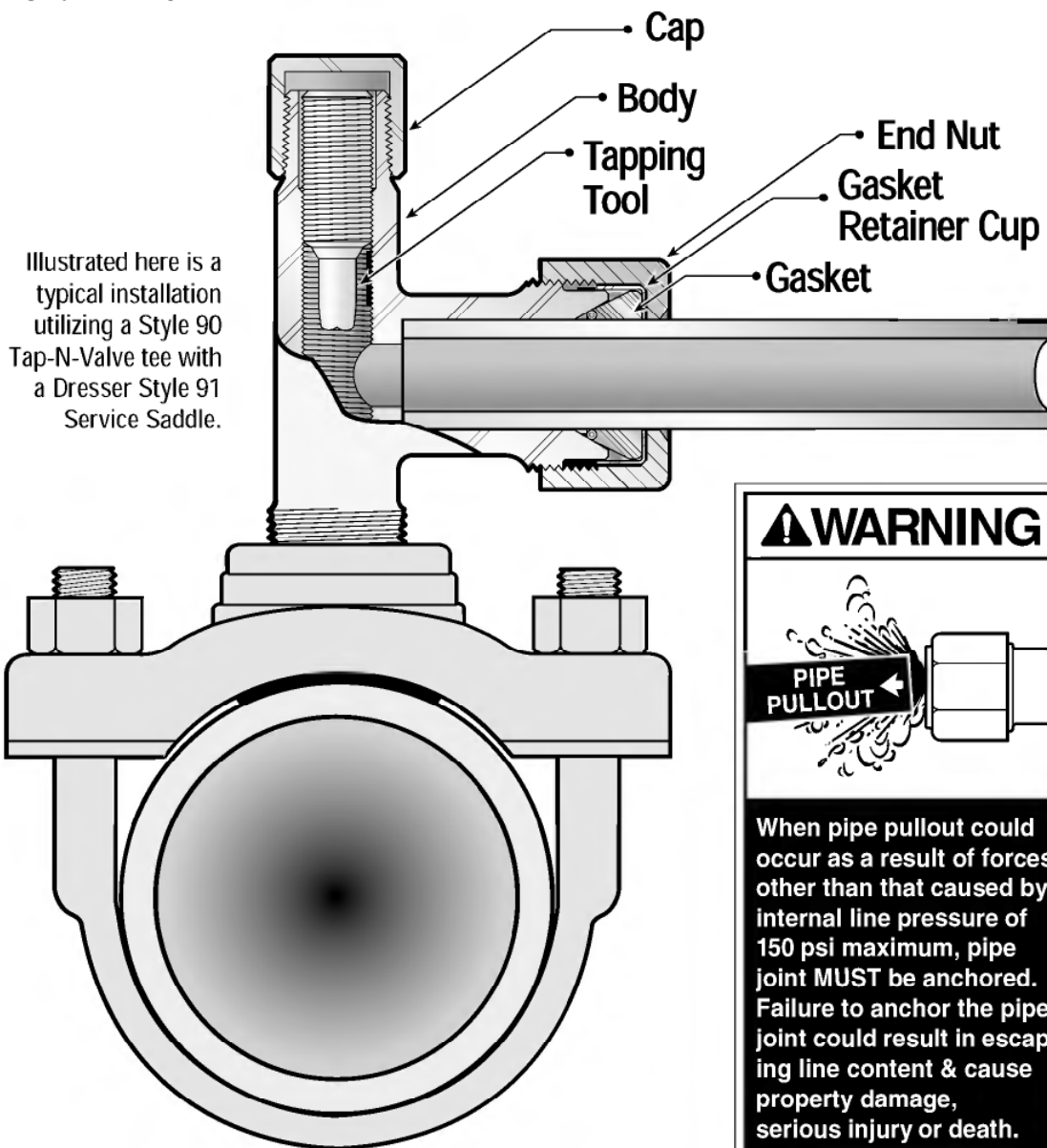
Dresser[®] Style 90 Tap-N-Valve[®] tees are available with either weld or MIPS inlets and a wide range of outlets, including plain branch, FIPS, MIPS, butt weld/socket, compression end and insulating compression end. All weld inlet tees are supplied with weld splatter caps as standard.

Retains the Slug...

All Dresser[®] Tap-N-Valve[®] tees are equipped with cutting tools which retain the slug cut from the main. During the tapping process, a gradual deformation of the abrading edges of the tool forms a positive, mechanical interlock between the tool and the slug, holding it permanently.

A Positive Shut-Off...

The tapered design of the tapping tool forms a raised conical valve seat on the surface of the main, providing a honed metal-to-metal seat for positive shut-off at any time.



Style 90 Tap-N-Valve® Tees

For Joining Steel Pipe (Seal Only)

(Inlet) Nominal Size (IPS) (In.)	Outside Diameter (O.D.) (In.)	(Outlet) Size (In.)	Tapping Tool (In.)	Part Number	Overall Dimensions					Dimension Drawing
					A	B	C	D	E	
TAP-N-VALVE TEE WITH WELD INLET AND PLAIN BRANCH OUTLET -- SEAL ONLY										
3/4 WELD	1.050	3/4 PL. BR.	1/4	0090-1592-301	4 ¹³ / ₁₆	2 ⁵ / ₁₆	2 ³ / ₈	--	--	
3/4 WELD	1.050	3/4 PL. BR.	3/8	0090-1592-199	4 ¹³ / ₁₆	2 ⁵ / ₁₆	2 ³ / ₈	--	--	
3/4 WELD	1.050	3/4 PL. BR.	1/2	0090-1592-302	4 ¹³ / ₁₆	2 ⁵ / ₁₆	2 ³ / ₈	--	--	
3/4 WELD	1.315	1 PL. BR.	1/4	0090-1600-301	4 ¹³ / ₁₆	2 ⁵ / ₁₆	2 ³ / ₈	--	--	
3/4 WELD	1.315	1 PL. BR.	3/8	0090-1600-199	4 ¹³ / ₁₆	2 ⁵ / ₁₆	2 ³ / ₈	--	--	
3/4 WELD	1.315	1 PL. BR.	1/2	0090-1600-302	4 ¹³ / ₁₆	2 ⁵ / ₁₆	2 ³ / ₈	--	--	
TAP-N-VALVE TEE WITH WELD INLET AND FIPS OUTLET -- SEAL ONLY										
3/4 WELD	1.050	3/4 FIPS	1/4	0090-1593-301	4 ¹³ / ₁₆	2 ⁵ / ₁₆	1 ⁷ / ₈	--	--	
3/4 WELD	1.050	3/4 FIPS	3/8	0090-1593-199	4 ¹³ / ₁₆	2 ⁵ / ₁₆	1 ⁷ / ₈	--	--	
3/4 WELD	1.050	3/4 FIPS	1/2	0090-1593-302	4 ¹³ / ₁₆	2 ⁵ / ₁₆	1 ⁷ / ₈	--	--	
TAP-N-VALVE TEE WITH WELD INLET AND MIPS OUTLET -- SEAL ONLY										
3/4 WELD	1.050	3/4 MIPS	1/4	0090-1594-301	4 ¹³ / ₁₆	2 ⁵ / ₁₆	1 ⁷ / ₈	--	--	
3/4 WELD	1.050	3/4 MIPS	3/8	0090-1594-199	4 ¹³ / ₁₆	2 ⁵ / ₁₆	1 ⁷ / ₈	--	--	
3/4 WELD	1.050	3/4 MIPS	1/2	0090-1594-302	4 ¹³ / ₁₆	2 ⁵ / ₁₆	1 ⁷ / ₈	--	--	
3/4 WELD	1.315	1 MIPS	1/4	0090-1599-301	4 ¹³ / ₁₆	2 ⁵ / ₁₆	1 ⁷ / ₈	--	--	
3/4 WELD	1.315	1 MIPS	3/8	0090-1599-199	4 ¹³ / ₁₆	2 ⁵ / ₁₆	1 ⁷ / ₈	--	--	
3/4 WELD	1.315	1 MIPS	1/2	0090-1599-302	4 ¹³ / ₁₆	2 ⁵ / ₁₆	1 ⁷ / ₈	--	--	
TAP-N-VALVE TEE WITH WELD INLET AND BUTT WELD/SOCKET OUTLET -- SEAL ONLY										
3/4 WELD	--	3/4 BUTT WELD 1/2 SOCKET	1/4	0090-1595-301	4 ¹³ / ₁₆	2 ⁵ / ₁₆	1 ⁷ / ₈	--	--	
3/4 WELD	--	3/4 BUTT WELD 1/2 SOCKET	3/8	0090-1595-199	4 ¹³ / ₁₆	2 ⁵ / ₁₆	1 ⁷ / ₈	--	--	
3/4 WELD	--	3/4 BUTT WELD 1/2 SOCKET	1/2	0090-1595-302	4 ¹³ / ₁₆	2 ⁵ / ₁₆	1 ⁷ / ₈	--	--	
3/4 WELD	--	1 BUTT WELD 3/4 SOCKET	1/4	0090-1601-301	4 ¹³ / ₁₆	2 ⁵ / ₁₆	1 ⁷ / ₈	--	--	
3/4 WELD	--	1 BUTT WELD 3/4 SOCKET	3/8	0090-1601-199	4 ¹³ / ₁₆	2 ⁵ / ₁₆	1 ⁷ / ₈	--	--	
3/4 WELD	--	1 BUTT WELD 3/4 SOCKET	1/2	0090-1601-302	4 ¹³ / ₁₆	2 ⁵ / ₁₆	1 ⁷ / ₈	--	--	

Style 90 Tap-N-Valve® Tees

For Joining Steel Pipe (Seal Only)

(Inlet) Nominal Size (IPS) (In.)	Outside Diameter (O.D.) (In.)	(Outlet) Size (In.)	Tapping Tool (In.)	Part Number	Overall Dimensions					Dimension Drawing
					A	B	C	D	E	
TAP-N-VALVE TEE WITH WELD INLET, COMPRESSION OUTLET & ARMORED GASKET-- SEAL ONLY										
³ / ₄ WELD	.840	¹ / ₂ ST. 90	¹ / ₄	0090-1604-195	5 ¹ / ₂	2 ⁵ / ₁₆	3 ¹ / ₈	2 ¹ / ₁₆	--	
³ / ₄ WELD	.840	¹ / ₂ ST. 90	³ / ₈	0090-1604-107	5 ¹ / ₂	2 ⁵ / ₁₆	3 ¹ / ₈	2 ¹ / ₁₆	--	
³ / ₄ WELD	.840	¹ / ₂ ST. 90	¹ / ₂	0090-1604-304	5 ¹ / ₂	2 ⁵ / ₁₆	3 ¹ / ₈	2 ¹ / ₁₆	--	
³ / ₄ WELD	1.050	³ / ₄ ST. 90	¹ / ₄	0090-1590-195	5 ¹ / ₂	2 ⁵ / ₁₆	3 ¹ / ₁₆	2 ⁷ / ₃₂	--	
³ / ₄ WELD	1.050	³ / ₄ ST. 90	³ / ₈	0090-1590-107	5 ¹ / ₂	2 ⁵ / ₁₆	3 ¹ / ₁₆	2 ⁷ / ₃₂	--	
³ / ₄ WELD	1.050	³ / ₄ ST. 90	¹ / ₂	0090-1590-304	5 ¹ / ₂	2 ⁵ / ₁₆	3 ¹ / ₁₆	2 ⁷ / ₃₂	--	
³ / ₄ WELD	1.315	1 ST. 90	¹ / ₄	0090-1613-195	5 ¹ / ₂	2 ⁵ / ₁₆	2 ¹ / ₁₆	2 ⁹ / ₁₆	--	
³ / ₄ WELD	1.315	1 ST. 90	³ / ₈	0090-1613-107	5 ¹ / ₂	2 ⁵ / ₁₆	2 ¹ / ₁₆	2 ⁹ / ₁₆	--	
³ / ₄ WELD	1.315	1 ST. 90	¹ / ₂	0090-1613-304	5 ¹ / ₂	2 ⁵ / ₁₆	2 ¹ / ₁₆	2 ⁹ / ₁₆	--	
TAP-N-VALVE TEE WITH WELD INLET AND INSULATED COMPRESSION OUTLET -- SEAL ONLY										
³ / ₄ WELD	1.050	³ / ₄ INS. ST. 90	³ / ₈	0090-1591-106	5 ¹ / ₂	2 ⁵ / ₁₆	3 ⁹ / ₁₆	2 ⁷ / ₃₂	--	
³ / ₄ WELD	1.050	³ / ₄ INS. ST. 90	¹ / ₂	0090-1591-305	5 ¹ / ₂	2 ⁵ / ₁₆	3 ⁹ / ₁₆	2 ⁷ / ₃₂	--	
³ / ₄ WELD	1.315	1 INS. ST. 90	³ / ₈	0090-1614-106	5 ¹ / ₂	2 ⁵ / ₁₆	3 ³ / ₁₆	2 ⁹ / ₁₆	--	
³ / ₄ WELD	1.315	1 INS. ST. 90	¹ / ₂	0090-1614-305	5 ¹ / ₂	2 ⁵ / ₁₆	3 ³ / ₁₆	2 ⁹ / ₁₆	--	
TAP-N-VALVE TEE WITH MIPS INLET AND PLAIN BRANCH OUTLET -- SEAL ONLY										
1 MIPS	1.315	1 PL. BR.	¹ / ₄	0090-1570-301	4 ¹³ / ₁₆	2 ⁵ / ₁₆	2 ³ / ₈	--	--	
1 MIPS	1.315	1 PL. BR.	³ / ₈	0090-1570-199	4 ¹³ / ₁₆	2 ⁵ / ₁₆	2 ³ / ₈	--	--	
1 MIPS	1.315	1 PL. BR.	¹ / ₂	0090-1570-302	4 ¹³ / ₁₆	2 ⁵ / ₁₆	2 ³ / ₈	--	--	
TAP-N-VALVE TEE WITH MIPS INLET AND FIPS OUTLET -- SEAL ONLY										
1 MIPS	1.050	³ / ₄ FIPS	¹ / ₄	0090-1571-301	4 ¹³ / ₁₆	2 ⁵ / ₁₆	1 ⁷ / ₈	--	--	
1 MIPS	1.050	³ / ₄ FIPS	³ / ₈	0090-1571-199	4 ¹³ / ₁₆	2 ⁵ / ₁₆	1 ⁷ / ₈	--	--	
1 MIPS	1.050	³ / ₄ FIPS	¹ / ₂	0090-1571-302	4 ¹³ / ₁₆	2 ⁵ / ₁₆	1 ⁷ / ₈	--	--	
1 MIPS	1.315	1 FIPS	¹ / ₄	0090-1568-301	5 ¹ / ₂	2 ⁵ / ₁₆	2 ⁵ / ₈	--	--	
1 MIPS	1.315	1 FIPS	³ / ₈	0090-1568-199	5 ¹ / ₂	2 ⁵ / ₁₆	2 ⁵ / ₈	--	--	
1 MIPS	1.315	1 FIPS	¹ / ₂	0090-1568-302	5 ¹ / ₂	2 ⁵ / ₁₆	2 ⁵ / ₈	--	--	

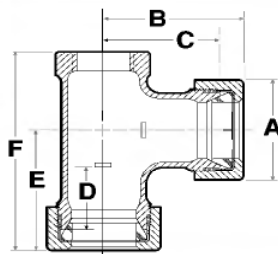
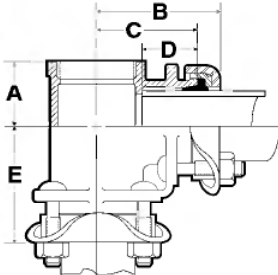
Style 90 Tap-N-Valve® Tees

For Joining Steel Pipe (Seal Only)

(Inlet) Nominal Size (IPS) (In.)	Outside Diameter (O.D.) (In.)	(Outlet) Size (In.)	Tapping Tool (In.)	Part Number	Overall Dimensions					Dimension Drawing
					A	B	C	D	E	
TAP-N-VALVE TEE WITH MIPS INLET AND MIPS OUTLET -- SEAL ONLY										
1 MIPS	1.315	1 MIPS	1/4	0090-1569-301	4 ¹³ / ₁₆	2 ⁵ / ₁₆	1 ⁷ / ₈	--	--	
1 MIPS	1.315	1 MIPS	3/8	0090-1569-199	4 ¹³ / ₁₆	2 ⁵ / ₁₆	1 ⁷ / ₈	--	--	
1 MIPS	1.315	1 MIPS	1/2	0090-1569-302	4 ¹³ / ₁₆	2 ⁵ / ₁₆	1 ⁷ / ₈	--	--	
TAP-N-VALVE TEE WITH MIPS INLET, COMPRESSION OUTLET & ARMORED GASKET-- SEAL ONLY										
1 MIPS	.540	1/4 ST. 90	1/4	0090-1562-195	5 ¹ / ₂	2 ⁵ / ₁₆	3 ¹ / ₈	1 ²³ / ₃₂	--	
1 MIPS	.540	1/4 ST. 90	3/8	0090-1562-107	5 ¹ / ₂	2 ⁵ / ₁₆	3 ¹ / ₈	1 ²³ / ₃₂	--	
1 MIPS	.540	1/4 ST. 90	1/2	0090-1562-304	5 ¹ / ₂	2 ⁵ / ₁₆	3 ¹ / ₈	1 ²³ / ₃₂	--	
1 MIPS	.675	3/8 ST. 90	1/4	0090-1563-195	5 ¹ / ₂	2 ⁵ / ₁₆	3 ¹ / ₈	1 ¹³ / ₁₆	--	
1 MIPS	.675	3/8 ST. 90	3/8	0090-1563-107	5 ¹ / ₂	2 ⁵ / ₁₆	3 ¹ / ₈	1 ¹³ / ₁₆	--	
1 MIPS	.675	3/8 ST. 90	1/2	0090-1563-304	5 ¹ / ₂	2 ⁵ / ₁₆	3 ¹ / ₈	1 ¹³ / ₁₆	--	
1 MIPS	.840	1/2 ST. 90	1/4	0090-1564-195	5 ¹ / ₂	2 ⁵ / ₁₆	3 ¹ / ₈	2 ¹ / ₁₆	--	
1 MIPS	.840	1/2 ST. 90	3/8	0090-1564-107	5 ¹ / ₂	2 ⁵ / ₁₆	3 ¹ / ₈	2 ¹ / ₁₆	--	
1 MIPS	.840	1/2 ST. 90	1/2	0090-1564-304	5 ¹ / ₂	2 ⁵ / ₁₆	3 ¹ / ₈	2 ¹ / ₁₆	--	
1 MIPS	1.050	3/4 ST. 90	1/4	0090-1560-195	5 ¹ / ₂	2 ⁵ / ₁₆	3 ¹ / ₁₆	2 ⁷ / ₃₂	--	
1 MIPS	1.050	3/4 ST. 90	3/8	0090-1560-107	5 ¹ / ₂	2 ⁵ / ₁₆	3 ¹ / ₁₆	2 ⁷ / ₃₂	--	
1 MIPS	1.050	3/4 ST. 90	1/2	0090-1560-304	5 ¹ / ₂	2 ⁵ / ₁₆	3 ¹ / ₁₆	2 ⁷ / ₃₂	--	
1 MIPS	1.315	1 ST. 90	1/4	0090-1579-195	5 ¹ / ₂	2 ⁵ / ₁₆	2 ¹¹ / ₁₆	2 ⁹ / ₁₆	--	
1 MIPS	1.315	1 ST. 90	3/8	0090-1579-107	5 ¹ / ₂	2 ⁵ / ₁₆	2 ¹¹ / ₁₆	2 ⁹ / ₁₆	--	
1 MIPS	1.315	1 ST. 90	1/2	0090-1579-304	5 ¹ / ₂	2 ⁵ / ₁₆	2 ¹¹ / ₁₆	2 ⁹ / ₁₆	--	
TAP-N-VALVE TEE WITH MIPS INLET AND INSULATED COMPRESSION OUTLET -- SEAL ONLY										
1 MIPS	1.050	3/4 ST. 90	3/8	0090-1561-106	5 ¹ / ₂	2 ⁵ / ₁₆	3 ⁹ / ₁₆	2 ⁷ / ₃₂	--	
1 MIPS	1.050	3/4 ST. 90	1/2	0090-1561-305	5 ¹ / ₂	2 ⁵ / ₁₆	3 ⁹ / ₁₆	2 ⁷ / ₃₂	--	
1 MIPS	1.315	1 ST. 90	3/8	0090-1580-106	5 ¹ / ₂	2 ⁵ / ₁₆	3 ³ / ₁₆	2 ⁹ / ₁₆	--	
1 MIPS	1.315	1 ST. 90	1/2	0090-1580-305	5 ¹ / ₂	2 ⁵ / ₁₆	3 ³ / ₁₆	2 ⁹ / ₁₆	--	

Style 90/64 Riser Tees

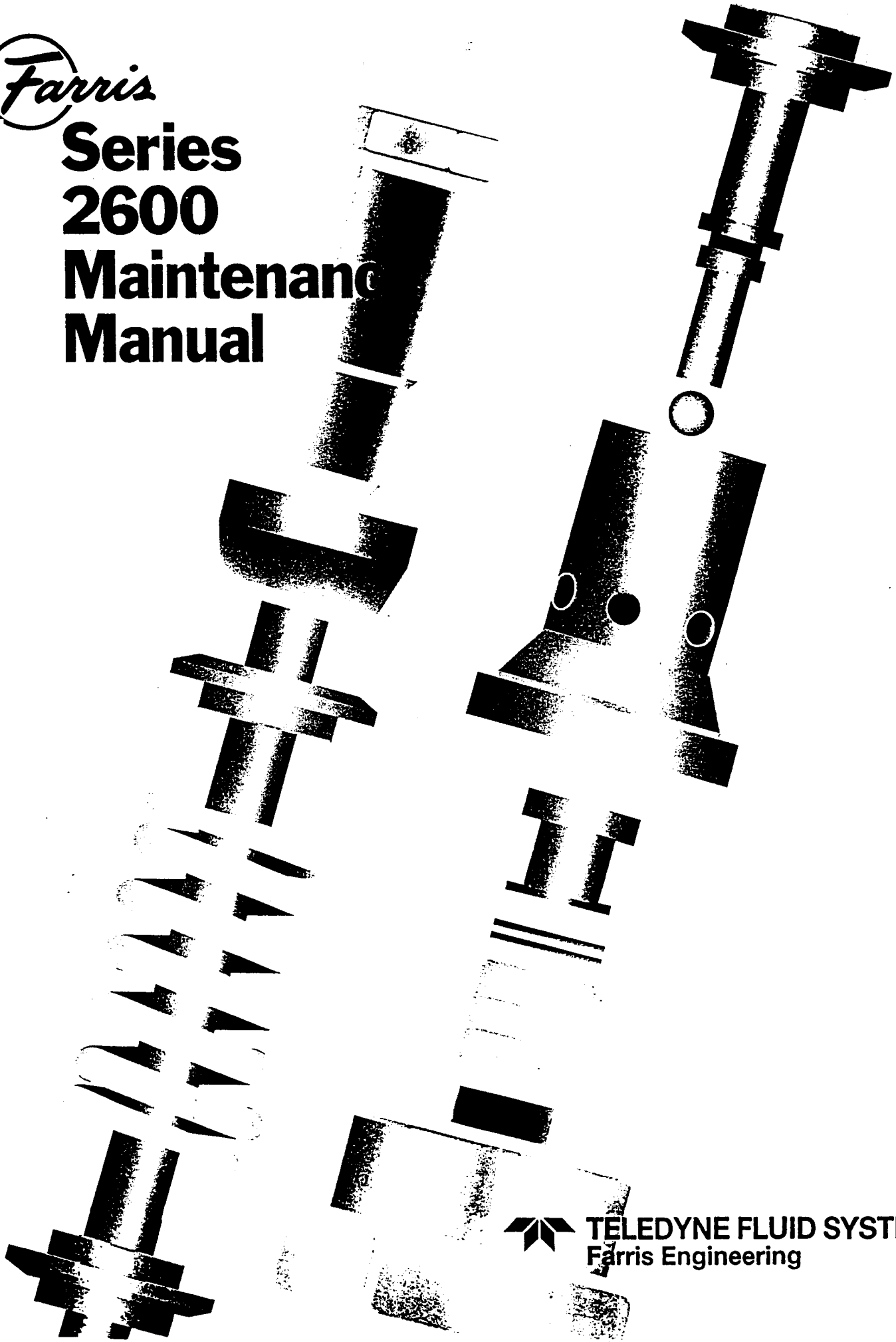
For Raising Low-Pressure Services to Normal Depths Off Deeply Buried Mains (Seal Only)

Nominal Size (IPS) (In.)	Outside Diameter (O.D.) (In.)	Part Number	Overall Dimensions						Dimension Drawings
			A	B	C	D	E	F	
STYLE 90 RISER TEES -- WITH ARMORED GASKETS -- SEAL ONLY									
1 1/2 x 1 1/2 x 1 1/2 2 x 2 x 2	1.050 2.375	0090-0890-205 0090-0891-205	3 7/32 4	4 3/8 4 5/16	3 1/2 3 3/4	2 1/2 2 1/2	4 4 5/16	6 7/16 7 5/16	
STYLE 64 RISER TEES (3" SIZE ONLY) -- WITH ARMORED GASKETS -- SEAL ONLY									
3	3.500	0064-0001-202	3 1/16	5 5/8	4 5/8	2 5/8	5 5/8	--	

If desired, the tap can be completed through the tee; and the service can be shut off with a stopper device.

Farris

Series 2600 Maintenance Manual



TELEDYNE FLUID SYSTEMS
Farris Engineering

This Maintenance Manual is provided because you have Farris Pressure Relief Valves protecting equipment and personnel in your plant. We trust that you will find this manual useful, as it is intended to clearly present all the essential information you will need in order to keep your Farris Valves in perfect operating condition.

Generally, maintenance becomes necessary as a result of dirt or scale in the lines, exposure to service conditions, incorrect servicing, improper testing procedure, or improper installation. If you follow the instructions in this Manual, the maintenance of your valves should be reduced in effort and expense.

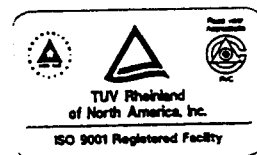
These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be

met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to Farris Engineering.

On the following pages you will find definitions of commonly used pressure relief valve terminology, cross-sectional illustrations of both conventional (A10) and Balanseal bellows (A11) 2600 Series valve designs along with a page explaining the numbering system used on this valve series. In order to get the most out of this maintenance manual you should familiarize yourself with the information on these pages and the design of the Farris 2600 Series valve line.



PRESSURE RELIEF
VALVES
AND TESTING EQUIPMENT



Series 2600
Table of Contents
(Manual Revision 3, May 1998)

Page	Topic
1&2	Type and Serial Numbering Systems
3	2600 Series Terminology
4	Conventional Valve Cross-Section and Typical Nameplates
5	Cross-Section of Valve Internals
6	Standard Bill of Material
7 - 8	Installation, Storage and Handling
7 - 8	Maintenance and Inspection
9 - 15	Disassembly of Valves
16	O-Ring Construction
17	Nozzle and Disc Refacing
17 - 18	Lapping Procedures & Compounds
19 - 22	Assembly Procedures, Lubrication, and Sealants
23 - 27	Setting, Testing, Blowdown, Leak, and Differentials
28	Trouble Shooting
Appendix A (page 29)	Required Tools
Appendix B (page 30)	External Loads
Appendix C (page 31)	Specification and Historical Record
Back Cover	General Reference Sources

TYPE AND SERIAL NUMBERING SYSTEMS

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

Serial Numbering System

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

Serial Number Suffix	Valve Type	Description	Production Dates
-A	Full nozzle valves, conventional and bellows types	This serial number suffix covered all types of constructions, i.e. Conventional, FarrisSeal, BalanSeal, Enclosed and Exposed Spring.	1943- 1955
-A2, A4 & A6	Conventional Design	Includes both 2605 and 2675 Series	1955 - 1967
-A3, A5 & A7	BalanSeal Bellows Design		
-A8	Conventional Design	Full nozzle valves conforming to API RP-526	1959 - 1976
-A9	BalanSeal Bellows Design		
-A10	2600 Conventional Design (air, steam & vapor)	Full nozzle valves conforming to API RP-526 with nozzles revised to incorporate ASME 0.9 capacity reduction factor.	1976 - present
-A11	2600 BalanSeal Design (air, steam & vapor)		
-A14	2600L Conventional Design (liquid service)	Full nozzle valves conforming to API RP-526 ASME Section VIII certified for liquid service.	1985 - present
-A15	2600L BalanSeal Design (liquid service)		
-A10/M	2600 Conventional - "O" Ring (air, steam & vapor)	Modified "D" through "K" orifice "O" ring seat design that replaced the original A10 & A11 "O" ring seat design. Starts at serial #'s above 300000.	July 1993 - July 1996
-A11/M	2600 BalanSeal - "O" Ring (air, steam & vapor)		
-A14/M	2600L Conventional - "O" Ring (liquid service)	Modified "D" through "K" orifice "O" ring seat design that replaced the original A14 & A15 "O" ring seat design. Starts at serial #'s above 300000 & above.	July 1993 - present
-A15/M	2600L BalanSeal - "O" Ring (liquid service)		
-A10/R	2600 Conventional - "O" Ring (air, steam & vapor)	"D" through "K" orifice "O" ring seat design that replaced the modified A10/M & A11 /M"O" ring seat design. Starts at serial #'s above 312123.	August 1996 - present
-A11/R	2600 BalanSeal - "O" Ring (air, steam & vapor)		

TELEDYNE FARRIS ENGINEERING BRECKSVILLE, OHIO U.S.A.			
TYPE	26FB10-120		
SIZE AND ORIFICE	1-1/2F2	SET PRESS.	110 PSIG
BACK PRESSURE	10		PSIG
COLD DIFF. TEST PRESS.	110		PSIG
CAPACITY AT 10% OVER PRESSURE	790	STD. SCFM AIR	
		LBS/HR SAT. STEAM	
SERIAL	21310-A11	TAG	PSV-13469A

Figure 1.2

Type Numbering System

The diagram below illustrates the Farris 2600 Series valve type numbering system. You will find this type of number on the nameplate of every Farris 2600 Series valve. The number found on each valve nameplate describes the valve with its construction and metallurgy. Valve types with numbers ending in "SP" are special valves. Example; (26DA10-120/S4/SP).

It may be necessary to contact the factory for assistance when replacement parts or maintenance is required on such valves.

Complete standard metallurgy details for individual parts in the 2600 Series valve line can be obtained by consulting a current sales catalog.

Example: Valve Type H26QA10L-120/S4



VALVE TERMINOLOGY

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

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

SAFETY RELIEF VALVE - An automatic pressure actuated relieving device suitable for use as either a safety or relief valve, depending on application.

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

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

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

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

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

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

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

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

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

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

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

CONSTANT BACK PRESSURE - Back pressure which does not change appreciably under any condition of operation whether the pressure relief valve is closed or open.

VARIABLE BACK PRESSURE - The pressure existing at the outlet of a pressure relief device, which does not remain constant when the pressure relief valve is closed.

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

SUPERIMPOSED BACK PRESSURE - Superimposed back pressure is the static pressure existing at the outlet of a pressure relief device at the time the device is required to operate. It is the result of pressure in the discharge system from other sources.

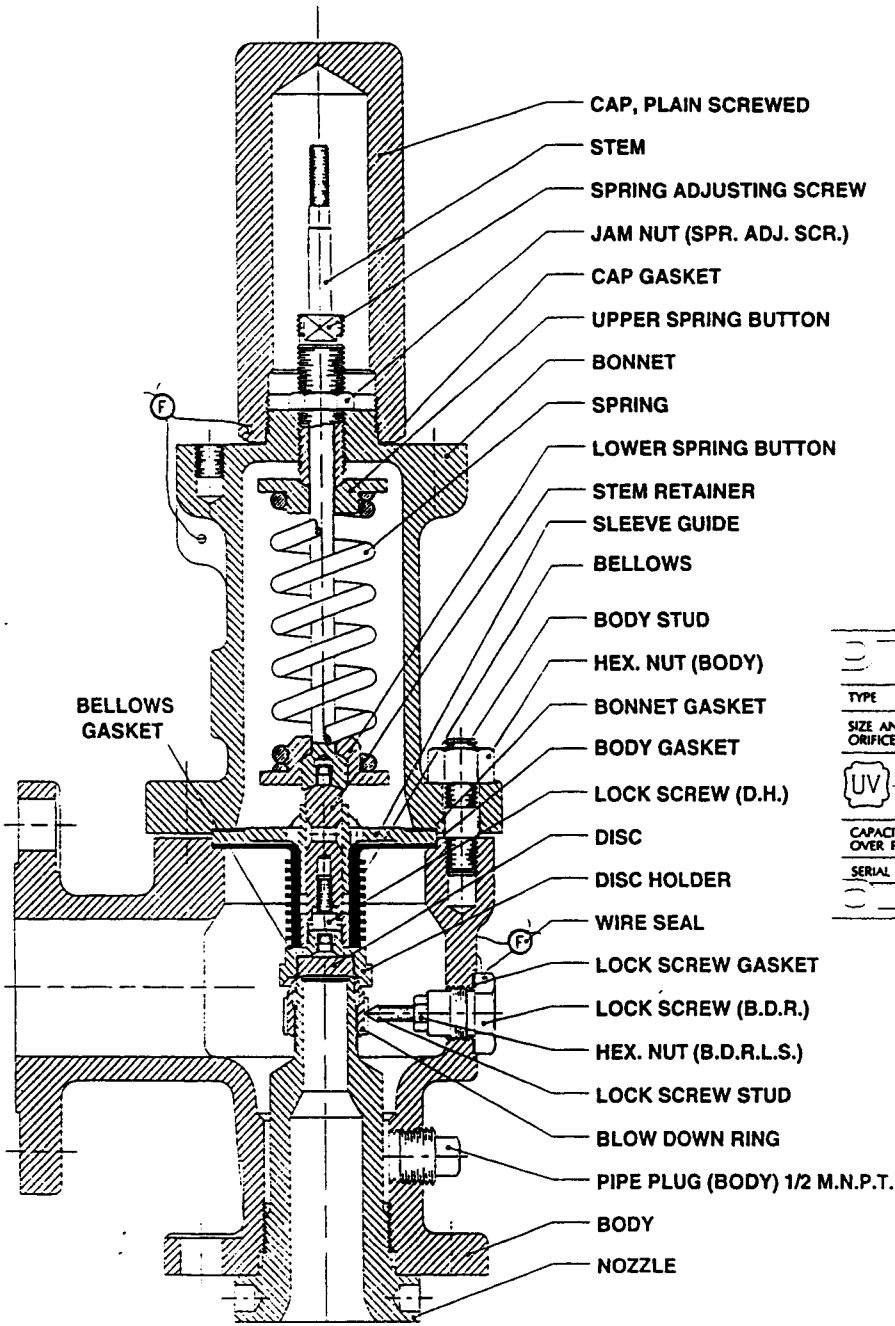


Figure 1.3



Figure 1.1

TELEDYNE FLUID SYSTEMS FARRIS ENGINEERING			
TYPE	26FB10-120		
SIZE AND ORIFICE	1-1/2F2	SET PRESS.	110 PSIG
UV	BACK PRESSURE	10	PSIG
	COLD DIFF. TEST PRESS.	110	PSIG
CAPACITY AT 10% OVER PRESSURE	790	ST'D. SCFM AIR	NB
SERIAL	21310-A11	TAG	PSV-13489A
			LBS/HR SAT. STEAM

Figure 1.2

Notes: Figure 1.1 Only BalanSeal® bellows equipped valves are supplied with this identifying plate. The maximum backpressure figure indicated thereon is a design rating and in actual usage the backpressure should not exceed 80% of the valve set pressure as applicable for the particular model.

Figure 1.2 The nameplate illustrated is typical and may contain more or less information depending on the actual valve model supplied.

Figure 1.3 The BalanSeal® safety valve cross-section illustrated is typical and actual construction details will vary depending on valve size and pressure rating. Consult the other illustrations contained elsewhere in this manual for greater detail or consult the factory for a cross-section drawing for the actual valve size and pressure rating.

INTERNALS FOR A10/A11 & A14/A15 SERIES

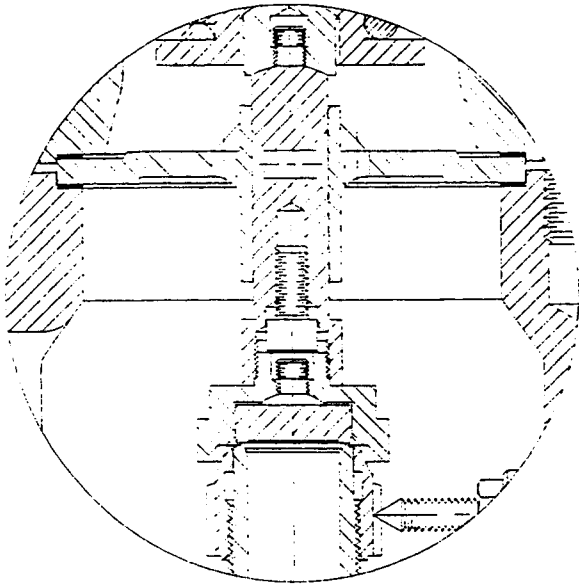


Figure 1.4

Internals for Orifice D-J

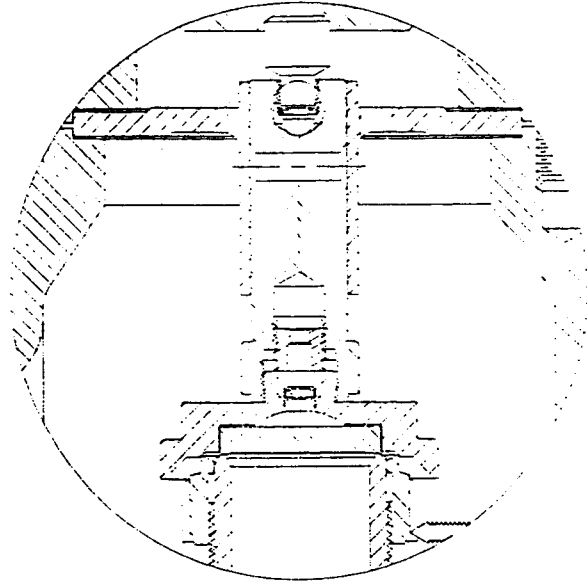


Figure 1.5

Internals for Orifice K-P

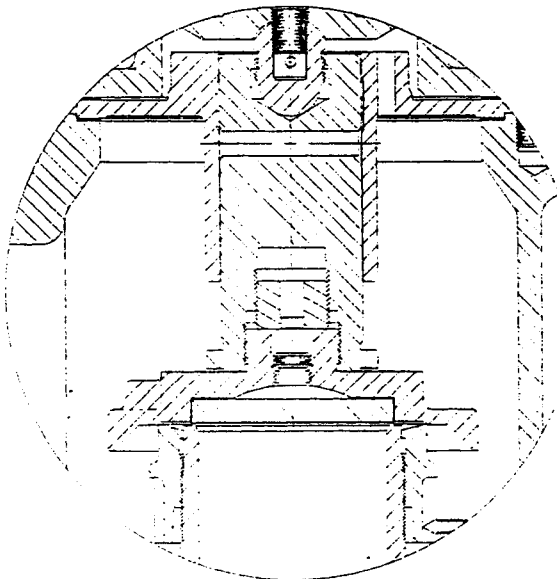


Figure 1.6

Internals for Orifice Q-T

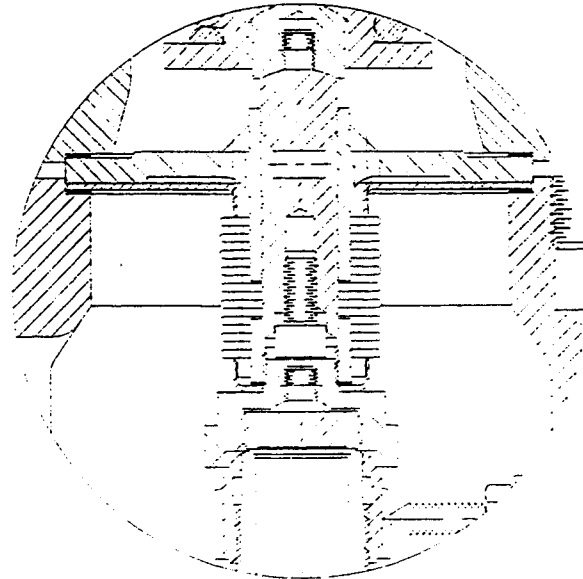


Figure 1.7

BalanSeal® Bellows Safety Valve

GENERAL DISASSEMBLY OF VALVES

After the valve is received and checked it is ready for shop inspection and repair. The valve should be carefully dismantled. If you are unfamiliar with this line of Farris valves carefully study the cross-sectional drawings in Figures 1.3 through 1.7 to familiarize yourself with part terminology and location. Proper facilities should be available for segregating parts as the valve is dismantled. At each stage in the dismantling process all parts of the valve should be visually inspected for evidence of wear and corrosion. If parts are worn, replace them. See Appendix A for necessary tools.

BILL OF MATERIALS

Conventional (A10)		BalanSeal® (A11)		
PART NAME	MATERIAL	VALVE TYPE	MATERIAL	
Body	26()A10 thru 26()A26	SA-216 GR.WCB. Carbon Steel	26()B10 thru 26()B26	SA-216 GR.WCB. Carbon Steel
	26()A32 thru 26()A36	SA-217 GR.WC6, Alloy St. (1-1/4 CR—1/2Moly)	26()B32 thru 26()B36	SA-217 GR.WC6, Alloy St. (1-1/4 CR—1/2Moly)
Bonnet	26()A10 thru 26()A26	SA-216 GR.WCB. Carbon Steel	26()B10 thru 26()B26	SA-216 GR.WCB. Carbon Steel
	26()A32 thru 26()A36	SA-217 GR.WC6, Alloy St. (1-1/4 CR—1/2 Moly)	26()B32 thru 26()B36	SA-217 GR.WC6, Alloy St. (1-1/4 CR—1/2Moly)
Cap. Plain Screwed	Carbon Steel		Carbon Steel	
Disc	Stainless Steel		Stainless Steel	
Nozzle	316 Stainless Steel		316 Stainless Steel	
Disc Holder	316 Stainless Steel		316 Stainless Steel	
Blow Down Ring	300 Series Stainless Steel		300 Series Stainless Steel	
Sleeve Guide	300 Series Stainless Steel		300 Series Stainless Steel	
Stem	Stainless Steel		Stainless Steel	
Spring Adjusting Screw	Stainless Steel		Stainless Steel	
Jam Nut (Spr. Adj. Scr.)	Stainless Steel		Stainless Steel	
Lock Screw (B.D.R.)	Stainless Steel		Stainless Steel	
Lock Screw Stud	Stainless Steel		Stainless Steel	
Stem Retainer	Stainless Steel		Stainless Steel	
Bellows	N/A		Inconel Composite	
Bellows Gasket	N/A		Flexible Graphite	
Spring Button	Carbon Steel, Rust Proofed		Carbon Steel, Rust Proofed	
Body Stud	ASTM A193 Gr. B7, Alloy Steel		ASTM A193 Gr. B7, Alloy Steel	
Hex Nut (Body)	ASTM A194 Gr. 2H, Alloy Steel		ASTM A194 Gr. 2H, Alloy Steel	
Spring	26()A10 thru 26()A26	Chrome Alloy, Rust Proofed	26()B10 thru 26()B26	Chrome Alloy, Rust Proofed
	26()A32 thru 26()A36	High Temp. Alloy Rust Proofed	26()B32 thru 26()B36	High Temp. Alloy Rust Proofed
Gasket, Cap	316 St. St.		316 St. St.	
Gasket, Body	316 St. St.		316 St. St.	
Gasket, Bonnet	316 St. St.		316 St. St.	
Gasket, Lock Screw	316 St. St.		316 St. St.	
Hex Nut (B.D.R.L.S.)	Stainless Steel		Stainless Steel	
Lock Screw (D.H.)	Stainless Steel		Stainless Steel	
Pipe Plug (Bonnet)	Steel		N/A	
Pipe Plug (Body)	Steel		Steel	

Table 1.1

General Notes:

1. Parenthesis in type number indicates orifice designation, as 26FA10, for conventional and 26FB10 for BalanSeal® bellows design.
2. Materials listed are for general purpose valves. For materials used in specific applications such as high or low temperatures, for open and packed lever valve materials, please refer to a current sales catalog.

2. INSTALLATION, STORAGE, & HANDLING

Installation guidelines are provided in Technical Bulletin 286T available free on request from your Farris Engineering Representative or the factory. A more thorough discussion of installation can be found in this bulletin.

Installation is the keynote of any successful valve operation. Maintain cleanliness in all installation work. Pipelines, connecting flanges and connecting spools should be carefully cleaned. At all cost, avoid foreign material which might lodge between the disc and seat, such as loose pieces of gasketing material, pipe turnings, dirt, rust, etc.. Pipelines should be blown out to clean the lines on both the inlet and outlet sides of the valve. Failure to do so may cause seat leakage. Tighten all bolts evenly. Prevent strain on the valve body and outlet flanges by supporting the discharge piping. Mount the valve in a vertical position with the inlet down and keep inlet and discharge piping as short as possible. Never use inlet or outlet piping of sizes less than the size of the valve connection. Where direct connection of the pressure relief valve to its pressure source or point of discharge is not possible then pipe sizes larger than the nominal connections on the pressure relief valve may be necessary to minimize the inlet pressure drop or the back pressure build-up. A 1/2" NPT drain connection is provided on all 2600 Series A10/A11 valve bodies and is fitted with a pipe plug as shipped from the factory. The pipe plug should be removed and a drain pipe fitted, otherwise discharge piping should be self draining.

Because cleanliness is essential for the satisfactory operation and tightness of a pressure relief valve, all necessary precautions should be taken to keep out all foreign materials. Valves which are not installed soon after

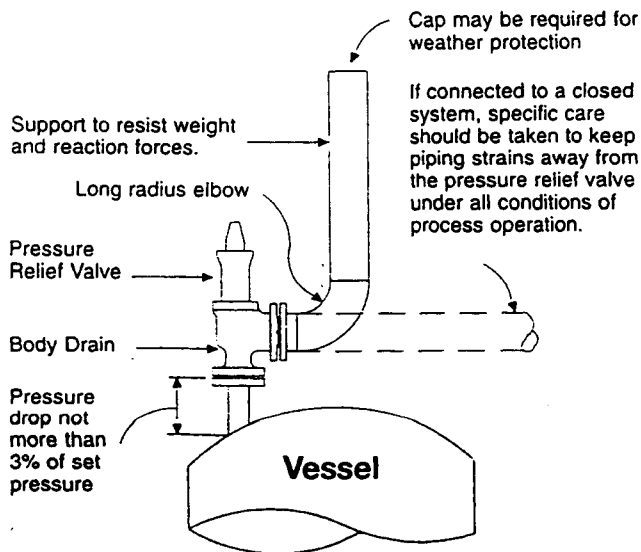


Figure 2.1

receipt should be closed off properly at both inlet and outlet flanges. Particular care should be taken to keep the valve inlet and internals absolutely clean. Preferably, valves should be stored indoors or in location where dirt and other forms of contamination are at a minimum. Valves should be handled carefully and not subjected to heavy shocks. If due consideration is not given to this point, some internal damage or misalignment can result and seat tightness may be adversely affected. Store, transport and install valves with the stem in the vertical position.

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

MAINTENANCE AND INSPECTION

After a manufacturer or one of their authorized assemblers has delivered a valve that meets all the requirements of ASME Section VIII or other construction code, a continuity of this level of integrity and safety should be maintained. In practice, a repaired pressure relief valve (including one that has been only cleaned or readjusted) is called upon to provide the same degree of protection

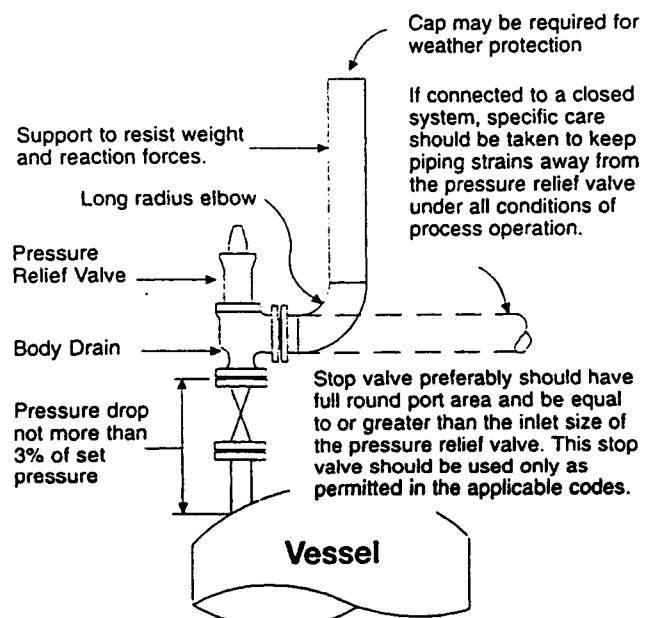


Figure 2.2

as a new valve. It follows that maintenance personnel must be trained to a level of proficiency that enables them to restore a valve to original condition and function. Complete individual hands-on training by Farris Engineering is recommended to maintain warranties and becomes most effective when monitored and coordinated by the owner/user and conducted at the users repair facility or at a Farris factory. The company also supports the prerequisite training activities promoted by jurisdictions, and the National Board of Boiler and Pressure Vessel Inspectors. It is recommended that historical records be established and maintained including brief test reports. This will provide data to determine the frequency of inspection and repair for various services. One excellent publication for reference on pressure relieving devices is the American Petroleum Institute's Guide for Inspection of Refinery Equipment, Chapter XVI. The use of original manufacturer's replacement parts is necessary to maintain new valve performance, capacity flow and warranty. Teledyne Fluid Systems expressly voids its warranty and will not be responsible for faulty valve operation if non-factory replacement parts or methods are utilized in product repair.

FIELD REMOVAL

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

Inspection of Inlet and Outlet Piping

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

In-Situ Testing

In-situ or in place testing is frequently performed as a substitute for valve removal and in-shop testing. This

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

In-Shop Inspection

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

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

Preparation For Maintenance

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

3. DISASSEMBLY OF VALVES

GENERAL DISASSEMBLY OF VALVES

After the valve is received and checked it is ready for shop inspection and repair. The valve should be carefully dismantled. If you are unfamiliar with this line of Farris valves carefully study the cross-sectional drawings in Figures 1.3 through 1.7 of Chapter 1, to familiarize yourself with part terminology and location. Proper facilities should be available for segregating parts as the valve is dismantled. At each stage in the dismantling process all parts of the valve should be visually inspected for evidence of wear and corrosion. If parts are worn, replace them. See Appendix A for necessary tools.

CLEANING AND CHECKING OF PARTS

All parts should be properly marked and segregated by individual valve. At this point, the valve parts should be thoroughly cleaned and inspected. Cleaning methods should be carefully selected to avoid part damage. Abrasive blasting of ground surfaces can alter the factory supplied finish. Threads can also be damaged by excessive blasting or shot cleaning. These surfaces should be protected during such cleaning processes.

The following discussion on parts inspection will precede the detailed valve disassembly. However, detailed inspection should be given separate attention to assure that only serviceable parts are used. This inspection should be completed after the proper parts cleaning.

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

- Presence of Wire Seal at all points of adjustment.
- Complete and properly identified nameplates and tags.
- Condition of flanges; for evidence of pitting, roughening, deterioration of gasket surface, distortion, etc.
- Springs, for evidence of corrosion or cracking, and correct selection.
- Bellows (if the valve is of bellows type).
- O-Ring condition (if applicable).
- Inlet and outlet openings, for evidence of deposits of foreign material and for corrosion.
- Condition of the external surfaces; for any indication of corrosion or evidence of mechanical damage.

- Body, nozzle, and bonnet wall thickness, thread and stud condition.
- Valve components and material; to check against identification tag and specification card.

NOZZLE AND DISC

The nozzle and disc require the greatest inspection of all the critical parts. Inspect for the following:

1. Nozzle length and disc thickness. It is important to replace the nozzle and/or disc when they are below the minimum length or thickness. Failure to do so may cause part failure or faulty valve operation due to the change in the critical parts respective relationship.
2. Seating surfaces should conform to the manufacturer's dimensions and profile. Normal lapping will alter these dimensions and profiles. Machining or refacing of the seat surfaces should be in accordance with the original manufacturer's specifications. Any refacing should be followed by a confirmation that the minimum nozzle length and disc thickness are within specification.

Since the nozzle and disc contain the primary or inlet pressure of the protected system these parts should be checked for any cracks or other detrimental material conditions. Corrosion and service stresses induce cracking which must be found during valve repair. Applicable NDE procedures should be employed to detect these conditions. When the set pressure is changed substantially, consideration should be given to hydrostatically test these components at the new pressure conditions.

SLEEVE GUIDE AND STEM RETAINER

The sleeve guide and stem retainer make up an important part of the guiding for the valve. Their mating surfaces are machined to close tolerances. The outside of the stem retainer and the inside barrel of the sleeve guide should be closely examined for any sign of galling or scoring. The stem retainer should move freely within the barrel of the sleeve guide. The drainage holes in the sleeve guide flange should be clear and open.

SPRING

Springs are always stressed once the valve is set. Large orifice or high set pressure valves will have higher stressed springs. Surface corrosion or surface defects can quickly cause stress concentration points.

These conditions can lead to corrosion failure or load loss capacity. Springs should be adequately examined for such defects and even minor defects should be cause for considering spring replacement. NDE processes should be employed for spring examination as visual examination alone may not be sufficient to adequately accept springs for further service.

It is common for springs to be blasted clean however the remaining surface will readily allow corrosion to take hold. Spring surfaces should be painted or coated after cleaning and inspection to retard any further deterioration.

Spring identification during repair is important. Small springs may not contain any permanent marking thus making record keeping vital to retain spring integrity.

BELLOWS

Bellows require very thin materials to provide the required flexibility. This results in a delicate assembly which should be carefully handled. Do not attempt to repair a bellows assembly and cleaning should be limited to solvent methods. Any pitting or surface corrosion are sure signs of limited service life even though the bellows may be pressure tight. All bellows assemblies should be pressure tested in accordance with Figure 3.0. Any leakage should be cause for bellows replacement.

BELLOWS ASSEMBLY LEAK TESTING

1. Place bellows/stem retainer/disc holder assembly into bellows leak test fixture with the bellows flange at the base.
2. Seal the flange of the bellows to the base of the bellows test fixture as illustrated in Figure 3.0 below.
3. Compress the bellows approximately 1/8 inch with a securing bar so that the bellows does not elongate when pressure is applied as in Figure 3.0.
4. Fill the disc holder with water. Omit this step for D & E Balanseal® designs as these designs have a one piece disc holder/stem retainer.
5. Apply 30 psig pressure to the bellows.
6. Apply soapy water to bellows exterior to check for bellows integrity.
7. If bubbles appear on bellows exterior there are pin holes or a tear. Replace bellows and repeat the procedure.
8. Check to be sure the bellows/disc holder connection is leak tight. If water in disc holder bubbles or the connection bubbles, tighten the connection or replace gasket.
9. Vent pressure.
10. Release bellows assembly.
11. Air dry bellows assembly to remove soapy water.

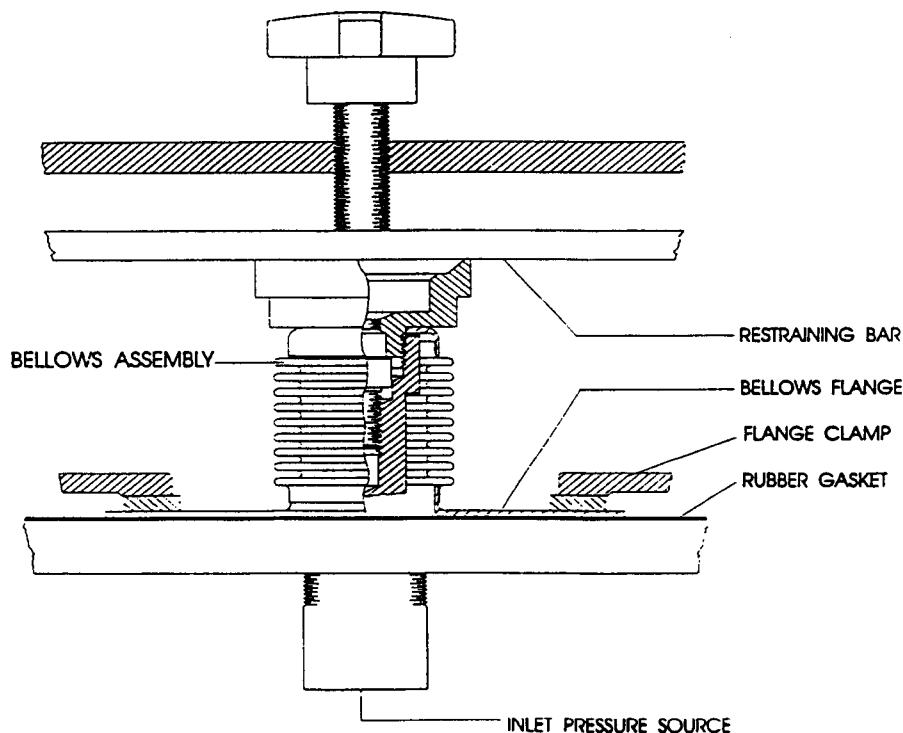


Figure 3.0

STEM

The stem transmits the spring load to the stem retainer. This load must be transmitted axially otherwise a side load will exist which will cause binding. Over-gagging is a common cause for bent stems. The stem is also integral to any lifting gear. Abuse of the lifting gear may result in stem damage. Check the bearing point on the stem tip for a smooth surface. Lap if necessary against the mating part to improve the surface. However excessive lapping will destroy the spherical contact. At this point replace the stem.

To check the critical stem areas for eccentricity use the following procedures; Take Vee Blocks of bench rollers and check the stem at the mid point and also at the lower spring button radius for any eccentricity. By applying a machinist's dial indicator and rotating the stem the total indicator reading should not exceed .007". Straighten if necessary. (Figure 3.1)

The top area of the stem (A) just below the thread serves as the valve internals upper guide surface in conjunction with the spring adjusting screw. This area should be free from any signs of galling or pitting. This area is supplied from the factory with a 63 AARH finish.

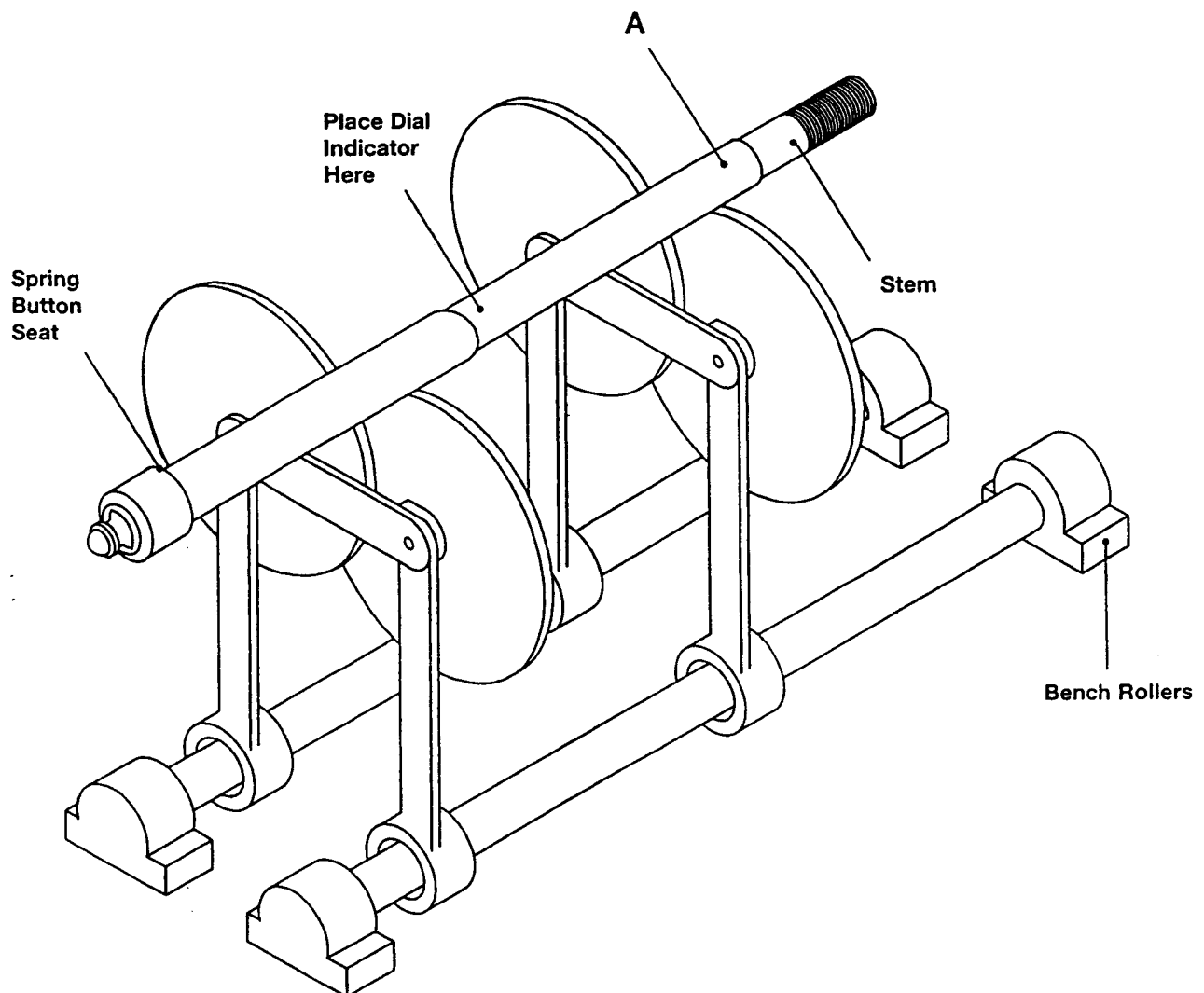
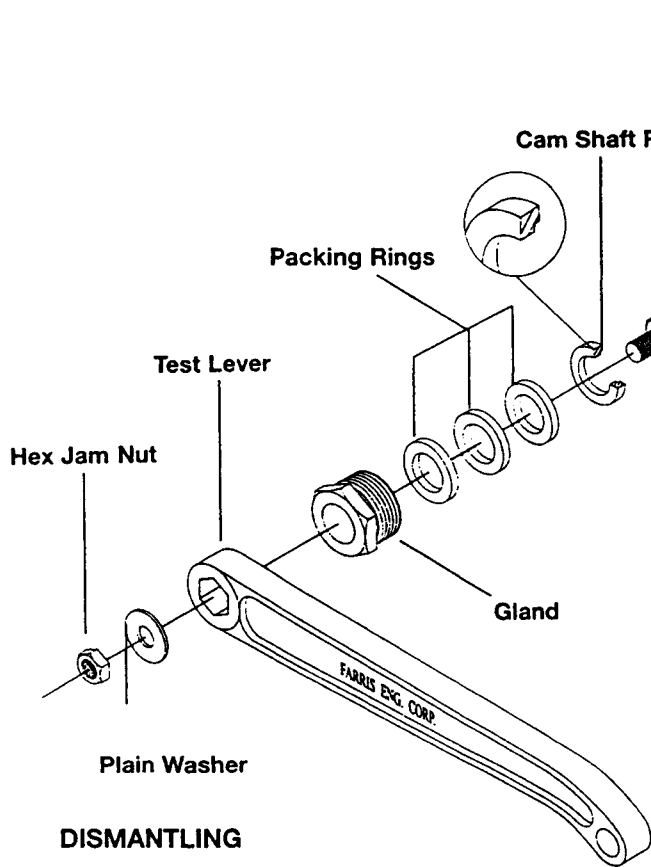


Figure 3.1



DISMANTLING

Place the internal assembly at a suitable work height. The work surface should be clean and strong enough to handle the weight of the parts and the forces required during disassembly and assembly.

When dismantling valves with lifting gear, record the position of the lever relative to the outlet as some installation positions may require a nonstandard lever position

Plain Cap

Unscrew the cap from the valve (see Figure 3.2). Remove the cap gasket.

Figure 3.2

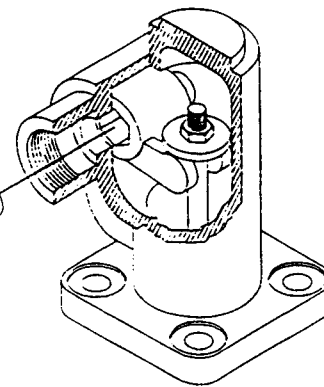
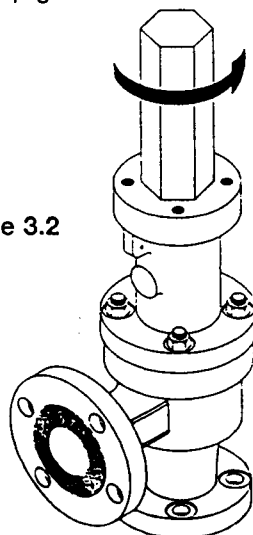


Figure 3.3

Packed Lever Cap

A packed lever cap assembly does not require complete disassembly in order to remove it from the valve. Complete disassembly is required only when the packing rings require replacement or internal inspection of the packed lever parts is required.

To remove the packed cap assembly from the valve, remove the hex nuts from the cap studs. Rotate the lever assembly down and lift up on the cap assembly until free from the stem and stem test washer.

To disassemble the packed cap lever assembly, (Figure 3.3), remove the hex jam nut, plain washer and test lever from the camshaft. Remove the gland nut. Considerable force is required to remove the camshaft and packing rings from the cam as the packing rings will have been compressed into place. Place a short 1/2" drive socket over the end of the camshaft and using a standard hex nut and plain washer tighten the hex nut to exert a pulling force on the camshaft and packing ring assembly. Continue until the camshaft and packing rings have been freed from the cap housing.

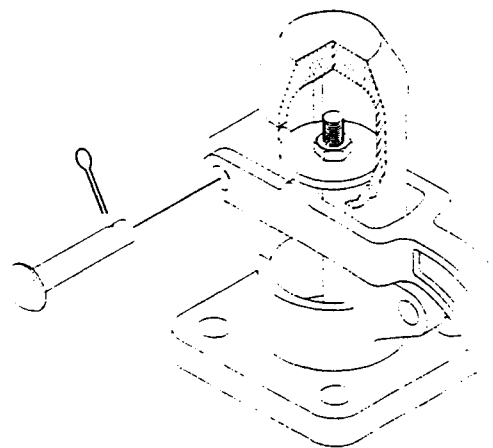


Figure 3.4

FARRIS ENG. CO.

OPEN LEVER CAP ASSEMBLIES

Open lever caps may be classified as single or double acting. Double acting levers use a fork and two fulcrum points for increased lifting advantage. This type of open lever is found on larger orifice valves as well as high pressure models.

Open Lever-Single Acting

Remove the cotter pin from the rivet holding the test lever. Remove the rivet and lever. Remove the cap bolts and lift off the cap. Remove the stem jam nut and stem test nut from the end of the stem (Figure 3.4).

Open Lever-Double Acting

Remove the cotter pins from the test lever and test lever fork. Remove both rivets, test lever and test lever fork. Remove cap studs and lift off the cap. Remove the stem jam nut and stem test nut from the stem (Figure 3.5).

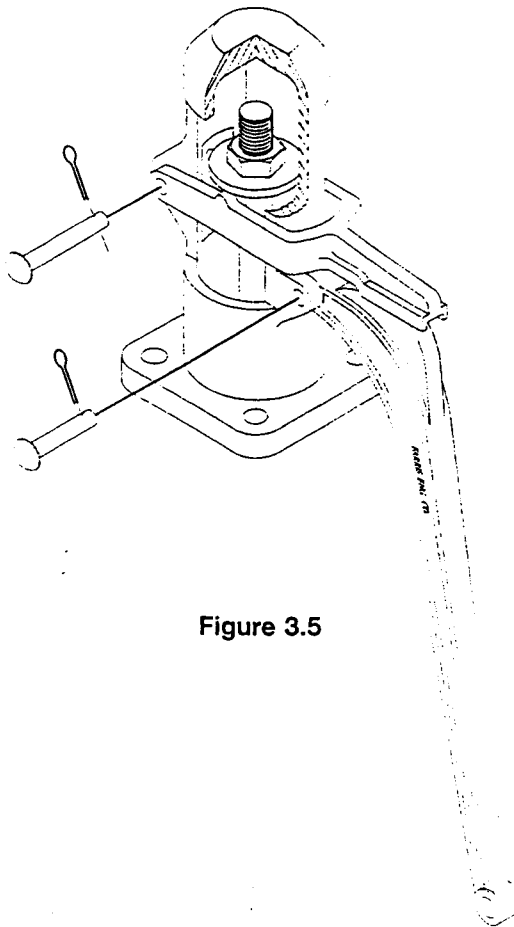


Figure 3.5

VALVE DISASSEMBLY

Remove the lock screw assembly (Figure 3.6). Count the number of notches the blowdown ring is from contacting the disk holder. Measure location of spring adjusting screw by marking spring adjusting screw above jam nut before loosening the jam nut (Figure 3.7), or by counting the number of counter clockwise revolutions of the spring adjusting screw until the spring is no longer compressed. This will allow the approximate set pressure to be re-established when reassembling the valve. Once the data are recorded, remove the jam nut and spring adjusting screw. Recording the spring adjusting screw position and blowdown ring position will save time in the reassembly of the valve.

Remove the body hex nuts (**first ensure that the spring is not compressed**) and remove the bonnet. On larger valves the combination of bonnet weight and the height that it must be lifted to clear the stem requires that a hoist be used to remove the bonnet. During this

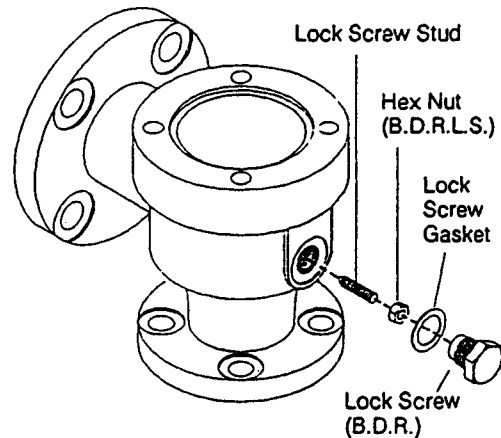


Figure 3.6

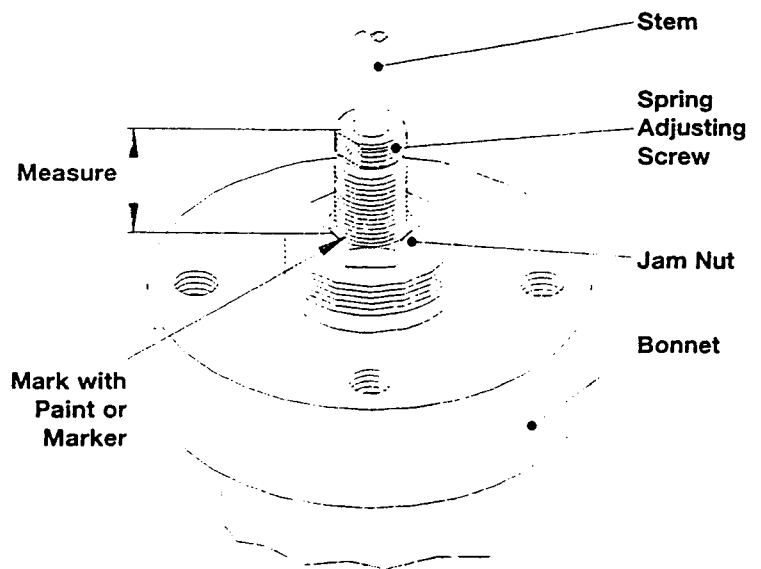


Figure 3.7

operation the valve body should be secure to prevent it from tipping over once the bonnet is removed. The weight of the spring assembly at an angle to the rest of the valve will be sufficient to cause the valve to tip over. Record the position of the bonnet drain relative to the valve outlet. Remove spring assembly from the stem (spring and spring buttons) and bonnet gasket (Figure 3.8)

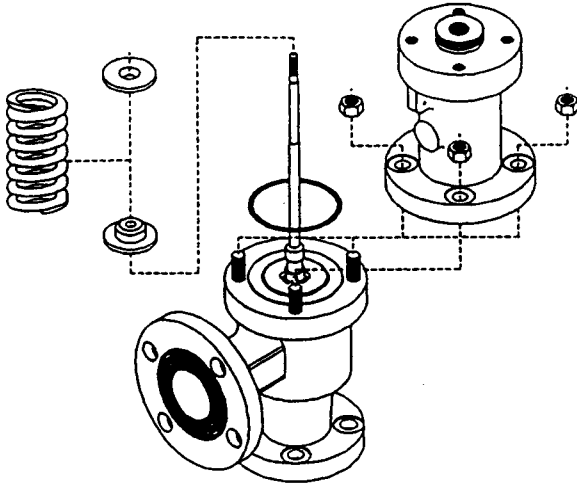


Figure 3.8

To remove the stem from the stem retainer, lift up on the stem and rotate counter-clockwise at the same time. This will engage the thread. Continue rotating until the stem is removed (Figure 3.10).

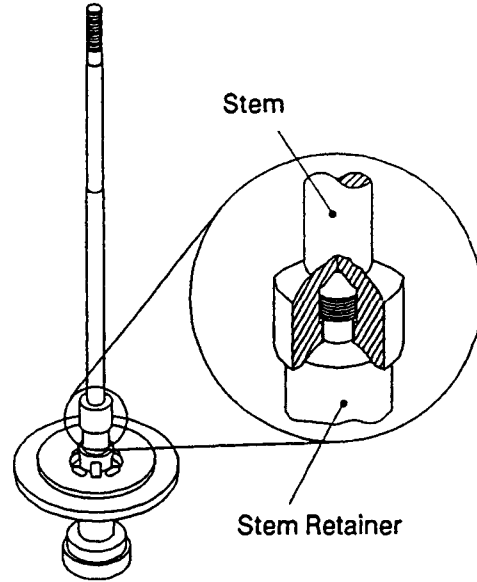


Figure 3.10

Using stem as a handle lift the complete internal assembly from the body. On larger valves a hoist is advisable due to the weight of the internal assembly. An eye bolt may be attached to the stem test washer thread at the end of the stem to assist in lifting. Remove body gasket (Figure 3.9).

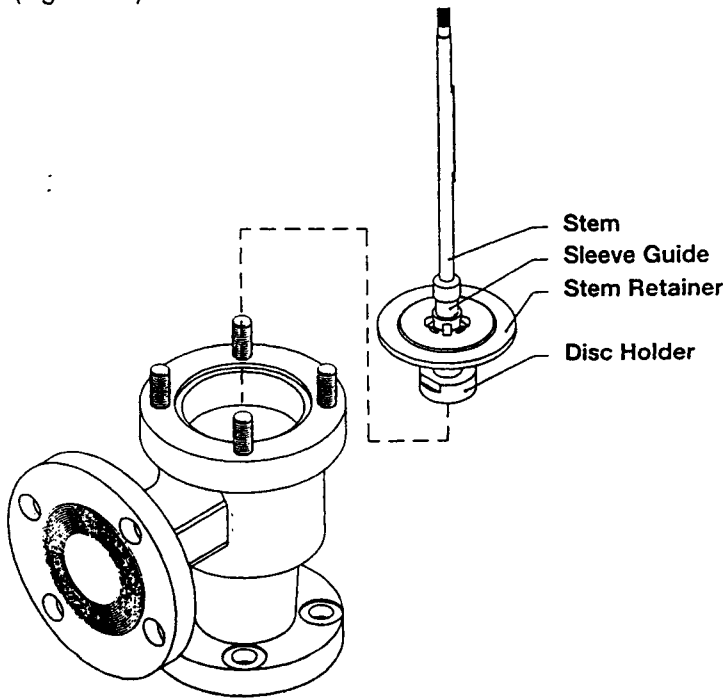


Figure 3.9

Lift off the sleeve guide (Figure 3.11) and place it such that it cannot fall or roll.

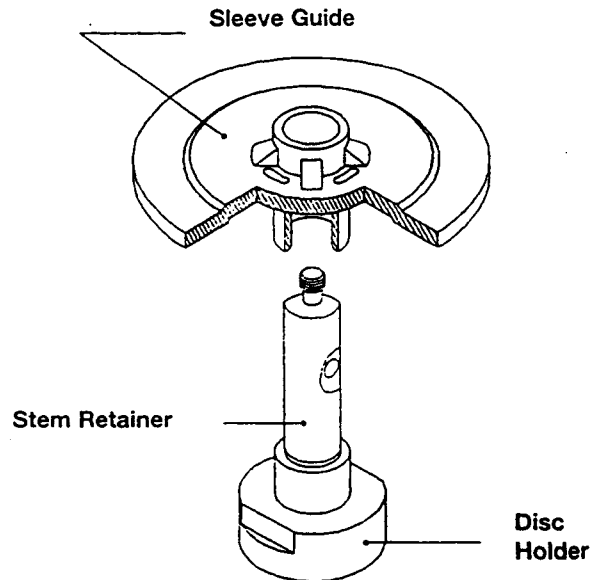


Figure 3.11

Remove the disc from the disc holder (Figure 3.12). Hold assembly and rotate disc with tip of finger. For O-Ring seat type valves, refer to Figure 3.15 and 3.16 (page 16).

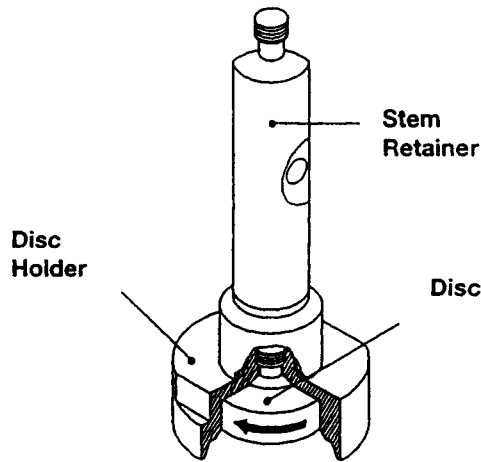


Figure 3.12

Except for the D & E orifice bellows (A11) designs (which have a one piece stem retainer/disc holder) the stem retainer and disc holder are held together with a "disc holder lock screw". The disc holder lock screw has a hex socket requiring use of an allen key (Figure 3.14). Locking tension is relieved by threading the lock screw UP INTO the stem retainer. To separate the two parts first thread the lock screw up into the stem retainer using the fixture shown in Figure 3.13 to hold the assembly. Allen key wrench sizes are shown in Table 3.1. **DO NOT USE A VISE OR ANY METHOD THAT MIGHT MAR THE GUIDING SURFACE OF THE STEM RETAINER.**

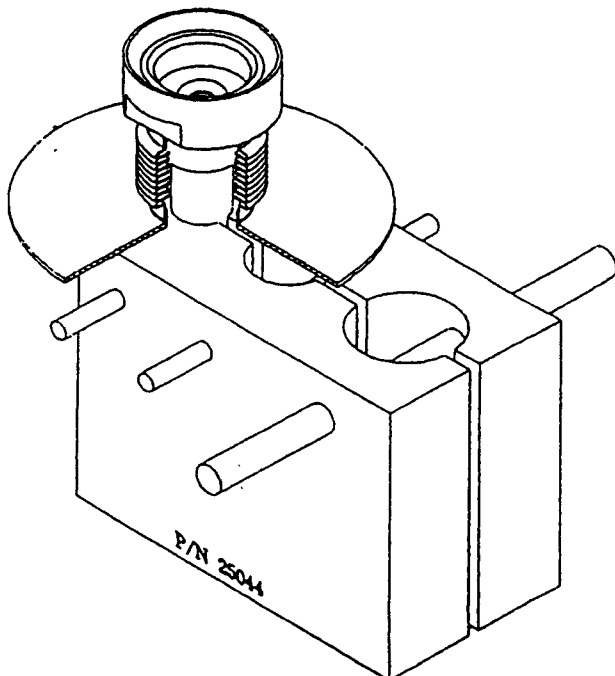


Figure 3.13

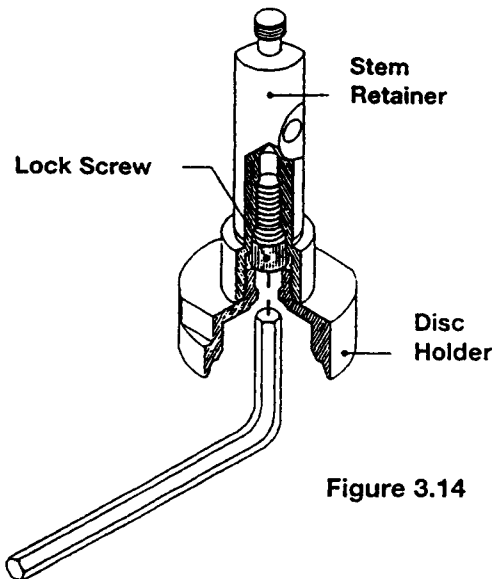


Figure 3.14

ALLEN KEY SIZES	
DISC HOLDER LOCK SCREW	
ORIFICES	ALLEN KEY SIZE
D THRU J	3/16"
K THRU P	7/32"
Q THRU T	3/8"

Table 3.1

For Balanseal bellows equipped valves use the same fixture shown in Figure 3.13. Exercise care in handling the internal assembly when equipped with a bellows as any damage to the bellows in the form of a nick or dent will render the bellows unfit for service. Bellows are not repairable.

To finish the disassembly of the entire valve take the blowdown ring lock screw assembly and remove the hex nut from the lock screw stud. Remove the lock screw stud from the lock screw thus separating all parts in the assembly. (See Figure 3.15).

Next remove the blowdown ring from the nozzle and remove the nozzle by unscrewing it from the body. Be careful not to damage the seat while removing the nozzle.

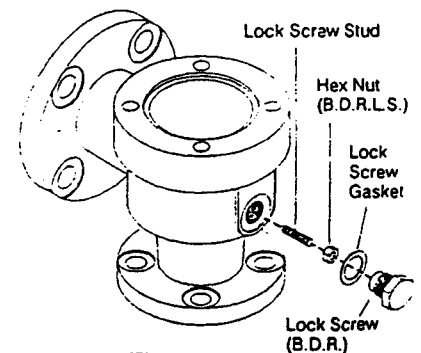


Figure 3.15

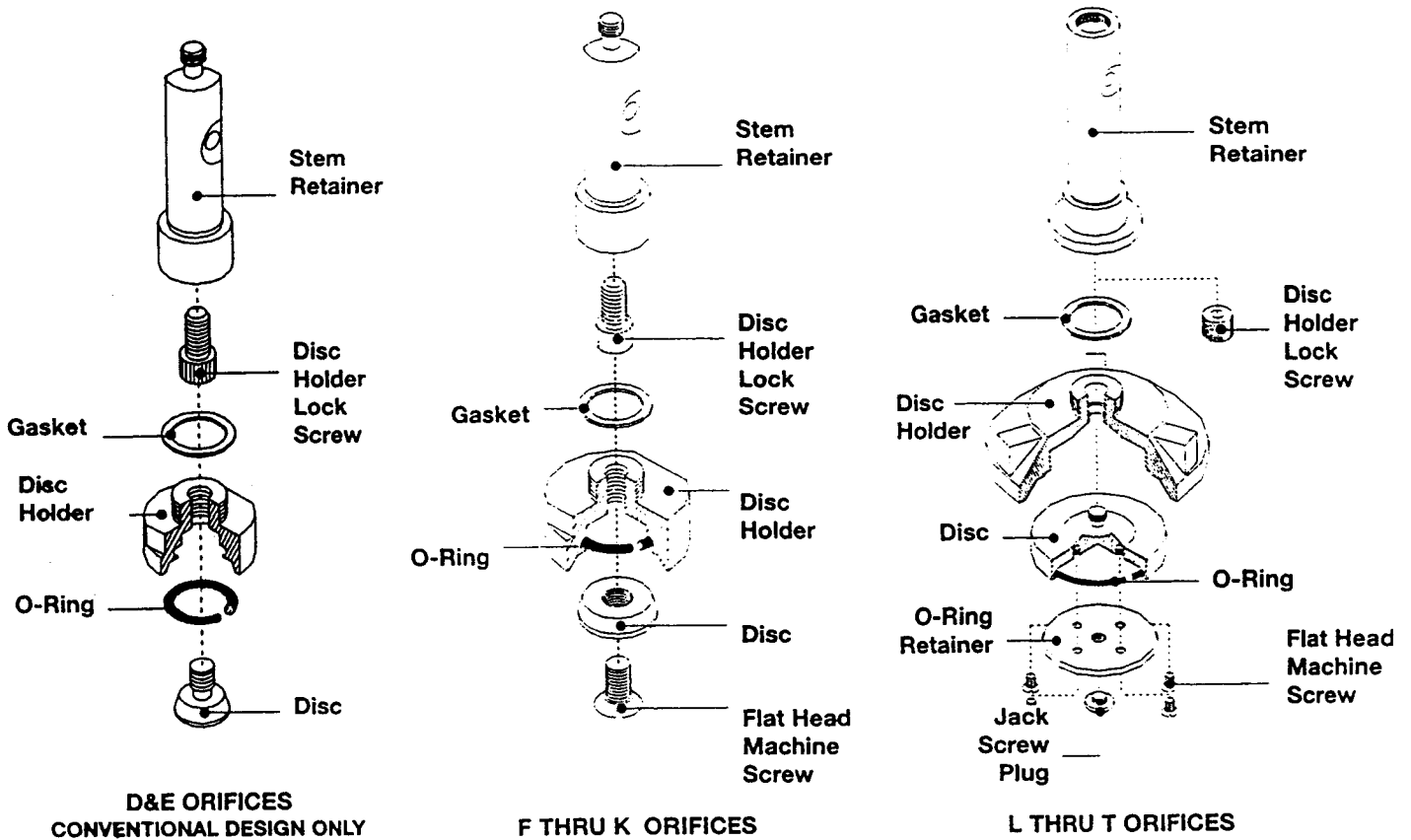
Finally, if the body studs are damaged or corroded and need to be replaced they can be removed by unscrewing them from the valve body. This will complete the disassembly of the valve.

O-RING CONSTRUCTION

Follow the standard disassembly instructions except for the removal of the disc. The following diagrams (Figure 3.16) illustrate 2600 Series Soft Seat design. These illustrations are typical for conventional (A10) construction.

For Balanseal® bellows construction a bellows and gasket(s) are added in all orifices except D and E. For D and E orifice O-ring bellows construction refer to Figure 3.17.

Figure 3.16

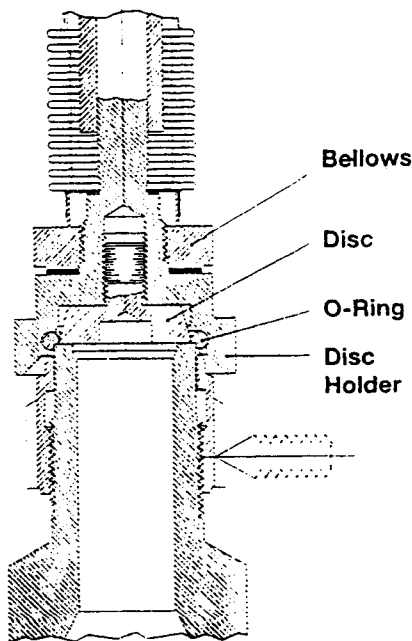


Note that disc holder/stem retainer is a one piece design, for the D & E orifice Balanseal® valves.

To Remove the "O"-ring on D thru K orifice valves first remove the discs and use an "O-ring extractor" to reach into the disc holder and pull the "O"-ring out.

On orifice sizes L and above, first remove the "O"-ring retainer from the disc by removing the outer flat head machine screws. Next remove the Jack screw plug and thread a long screw into the retainer in its place such that it bottoms out on the disc and forces the retainers to separate from the disc. The "O"-ring can then be removed with the aid of an "O"-ring extractor if necessary.

Figure 3.17



**D&E O-RING SEAT WITH
BALANSEAL® BELLOWS**

Figure 3.16 is a typical example of this one design found on both the soft & metal seat bellows designs for these orifices.

4. NOZZLE AND DISC REFACING

Nozzle Refacing

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

Disc Refacing

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

5. Discard and replace the disc when the raised seating surface has been depleted.

LAPPING COMPOUNDS

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

FARRIS LAPPING COMPOUNDS			
PART NO.	GRADE	FINISH	SIZE
18635 (055)	3F	ROUGHING	2 OZ. TUBE
18636 (075)	38-500	MEDIUM	2 OZ. TUBE
18637 (105)	38-1200	FINAL	2 OZ. TUBE

LAPPING PROCEDURES (Manual)

1. Use a cast iron lapping block or Pyrex lapping glass which is known to have a perfectly flat face.
2. Select the appropriate lapping compound. When lapping the disc, operate with a light figure eight motion over entire block surface. In this way complete contact will be made (Figure 4.1).

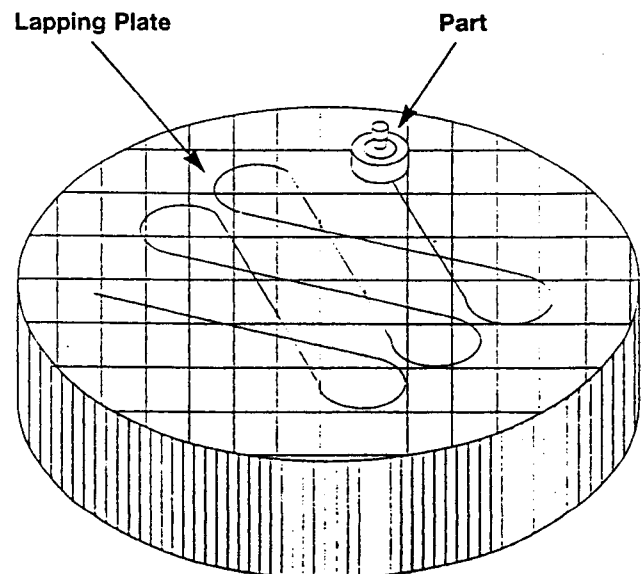


Figure 4.1

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

LAPPING PROCEDURES (Machine)

Machine Lapping Instructions

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

Limitations:

1. The size of the lapping machine.
Obviously, you will be limited by the size of the lapping plate on the machine. A part that is larger than the lapping plate capacity will have to be hand lapped.
2. The weight of the part to be lapped.
Some parts will be too heavy to lap on the machine, relative to the area to be lapped. These parts will have to be hand lapped.
3. How well the part can be balanced on the lapping machine.

Due to geometry and weight distribution of the part, the part may tend to wobble or fall over in the lapping machine. For these types of parts a holding fixture should be designed or the part should be lapped by hand.

General Operation

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

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

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

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

LAPPING MACHINE MAINTENANCE AND SEAT INSPECTION

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

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

5. 2600 ASSEMBLY PROCEDURE

Lubrication and Sealant:

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

- Only a light film lubricant should be applied to the guiding surfaces. Too much lubricant will hinder valve performance.
- Always use new gaskets and packing when reassembling valves.

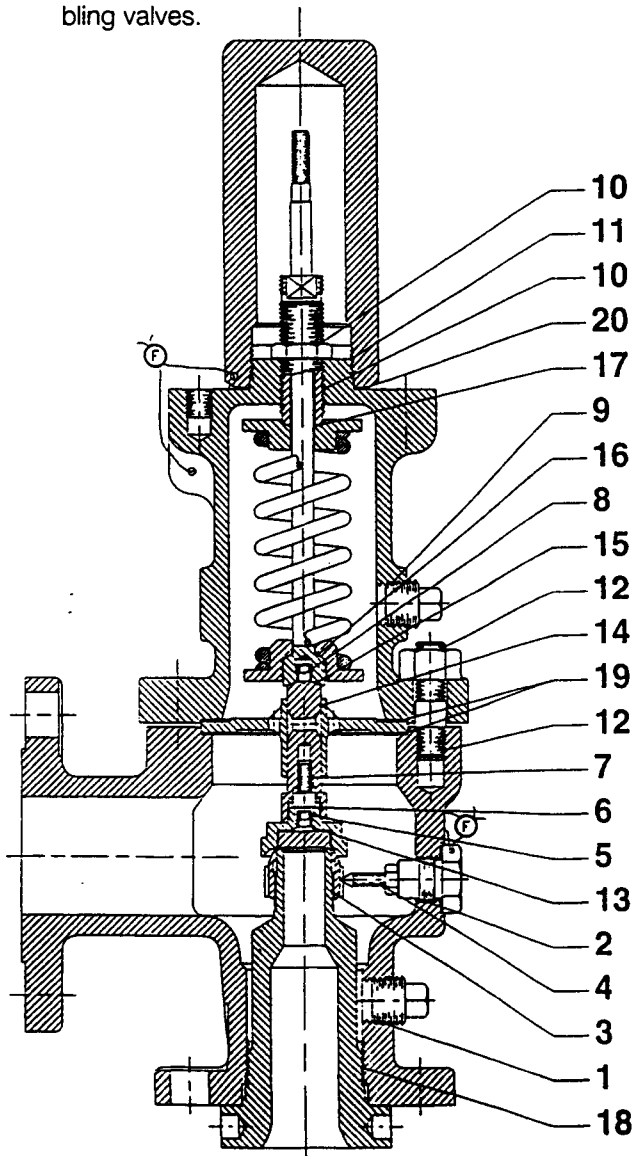


Figure 5.1

ITEM	THREAD LUBRICATION	AIR	STEAM	LIQUID
1	PIPE PLUG/BODY	A	A	A
2	LOCK SCREW (BDR) BODY	A	A	A
3	BLOWDOWN RING/NOZZLE	A	A	A
4	LOCK SCREW STUD/JAM NUT (BDRLS)	A	A	A
5	DISC/DISC HOLDER	A	A	A
6	STEM RETAINER/ DISC HOLDER (IF APPLICABLE)	A	A	A
7	LOCK SCREW (DH)/STEM RETAINER	A	A	A
8	STEM RETAINER/STEM	A	A	A
9	PIPE PLUG/BONNET (IF APPLICABLE)	A	A	A
10	SPRING ADJUSTING SCREW/BONNET/ JAM NUT	A	A	A
11	PLAIN CAP/BONNET (IF APPLICABLE)	A	A	A
12	BODY STUD/BODY/HEX NUT	A	A	A
GUIDING AND PIVOT LUBRICATION:				
13	DISC/DISC HOLDER	A	A	B
14	SLEEVE GUIDE /STEM RETAINER	D	D	D
15	STEM RETAINER/STEM	A	A	A
16	SPRING BUTTON/STEM	A	A	B
17	SPRING BUTTON/SPRING ADJUSTING SCREW	A	A	B
SEALANT:				
18	BODY/NOZZLE	A	A	A
19	BODY/BONNET/SLEEVE GUIDE/GASKETS	C	A	C
20	BONNET/GASKET/CAP (IF APPLICABLE)	C	A	C

CODE FOR ABOVE RECOMMENDED LUBRICATION AND SEALANT

A = BOSTIC NEVER SEEZ

B = MOLYKOTE 3452

C = PERMATEx FORM-A-GASKET OR RECTOSEAL #5

D = NO LUBRICATION

* SERVICE CONDITIONS MAY REQUIRE AN ALTERNATE LUBRICANT OR SEALANT

I. Conventional Construction

1. Thread Nozzle into Body.
2. Thread Pipe Plug (Body) into Body.
3. Thread Blow Down Ring onto Nozzle.
4. Thread Hex Nut (BDRLS) onto Lock Screw Stud. Thread Lock Screw Stud into Lock Screw (BDR).
5. Thread Lock Screw assembly into Body including Lock Screw Gasket. Adjust position of LOCK Screw Stud so that it prevents rotation of the Blow Down Ring yet does not bind the Blow Down Ring. Tighten hex nut to lock screw stud in correct position.
6. Thread Body Studs into Body.
7. Place Body Gasket in Body counterbore.
8. Thread Disc Holder Lock Screw into Stem Retainer.
9. Thread Disc Holder onto Stem Retainer using special assembly block (see Figure 5.2). Do not attempt to hold Stem Retainer on the guiding surface. Thread Disc Holder Lock Screw counter clockwise until contact is made with Disc Holder. Tighten to lock the assembly together.

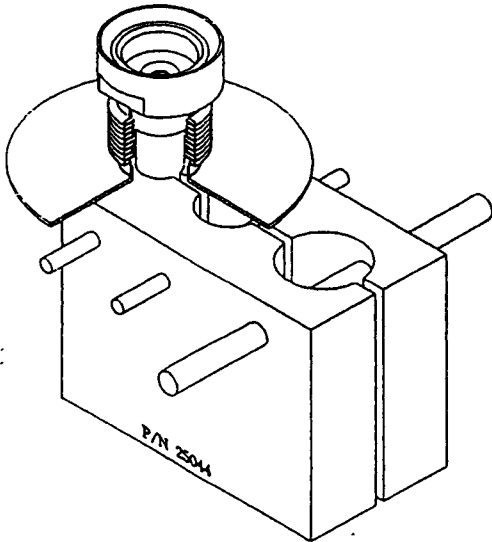


Figure 5.2

10. Thread Disc into Disc Holder. Be sure Disc is free floating.
11. Place Guide over Stem Retainer with long Lift Stop down. Be sure that the guiding motion is smooth with the least resistance possible.
12. Thread Stem and Stem Retainer together. Be sure connection is free floating.

13. Lower Stem, Sleeve Guide, and Disc Holder assembly into Body counterbore.
14. Place Bonnet Gasket on Sleeve Guide, or secure with sealant in Bonnet counterbore.
15. Place Lower Spring Button on Stem (Caution—in some valve sizes the upper and lower buttons are different).
16. Place Spring on Lower Spring Button.
17. Place Upper Spring Button on Spring.
18. Thread Pipe Plug (Bonnet) into Bonnet.
19. Place Bonnet on Body aligning Pipe Plug to the position indicated in disassembly notes. Normal convention is to position Pipe Plug opposite the valve outlet.
20. Thread Hex Nut (Body) onto Body Studs. Be sure that Body and Bonnet Gaskets are properly positioned in the respective counterbores.
21. Thread Jam Nut onto Spring Adjusting Screw.
22. Thread Spring Adjusting Screw into Bonnet to the position indicated in disassembly notes.
23. Valve should now be ready for testing, final assembly and sealing.

II. BalanSeal® Bellows Construction

Follow the same procedure as for Conventional type valves except as follows:

For D and E orifice valves only:

Place Bellows Gasket on Disc Holder. Thread Bellows onto Disc Holder and securely tighten. See Figure 5.3 for bellows leak test.

Do not thread Pipe Plug (Bonnet) into Bonnet (omit step 18). Bonnet must be vented.

For J and K orifice valves only:

Place Gasket on Stem Retainer. Place Bellows on Stem Retainer. Thread Disc Holder to Stem Retainer using special assembly block. Thread Disc Holder Lock Screw counter clockwise until contact is made with the Disc Holder. See Figure 5.3 for bellows leak test.

Do not thread Pipe Plug (Bonnet) into Bonnet (omit step 18). Bonnet must be vented.

For all other orifices:

Place Bellows on Stem Retainer. Place Gasket on Stem Retainer. Thread Disc Holder to Stem Retainer using special assembly block. Thread Lock Screw counter clockwise until contact is made with the Disc Holder.

Do not thread Pipe Plug (Bonnet) into Bonnet (omit step 18). Bonnet must be vented.

See Figure 5.3 for Bellows Leak Test.

III. O-Ring Seat Construction (Figure 5.4)

Follow the same procedure as for Conventional type valves except for as follows:

For D and E orifices only:

Place O-Ring in Disc Holder groove. Thread Disc into Disc Holder.

For orifices F through K only:

Place O-Ring in Disc Holder groove. Place Disc into Disc Holder. Thread Flat Head Machine Screw through Disc into Disc Holder.

For orifices L through T only:

Thread Disc into Disc Holder. Be sure Disc is free Floating. Place O-Ring into Disc groove. Place O-Ring Retainer on Disc. Thread Flat Head Machine Screws through Stem O-Ring Retainer into Disc. Thread Jack Screw Plug into O-Ring Retainer.

IV. Plain Cap Construction

23. Place Cap Gasket on Bonnet.

24. Thread Cap onto Bonnet.

V. Open Lever Cap Construction

For single acting lever only: (Figure 3.4, page 12)

23. Thread Stem Test Washer onto Stem.

1. Place bellows/stem retainer/disc holder assembly into bellows leak test fixture with the bellows flange at the base.
2. Seal the flange of the bellows to the base of the bellows test fixture as illustrated in Figure 5.3.
3. Compress the bellows approximately 1/8 inch with a securing bar so that the bellows does not elongate when pressure is applied as in Figure 5.3.
4. Fill the disc holder with water. Omit this step for D & E Balanseal® designs as these designs have a one piece disc holder/stem retainer.
5. Apply 30 psig pressure to the bellows.
6. Apply soapy water to bellows exterior to check for bellows integrity.
7. If bubbles appear on bellows exterior there are pin holes or a tear. Replace bellows and repeat the procedure.
8. Check to be sure the bellows/disc holder connection is leak tight. If water in disc holder bubbles or the connection bubbles, tighten the connection or replace gasket.
9. Vent pressure.
10. Release bellows assembly.
11. Air dry bellows assembly to remove soapy water.

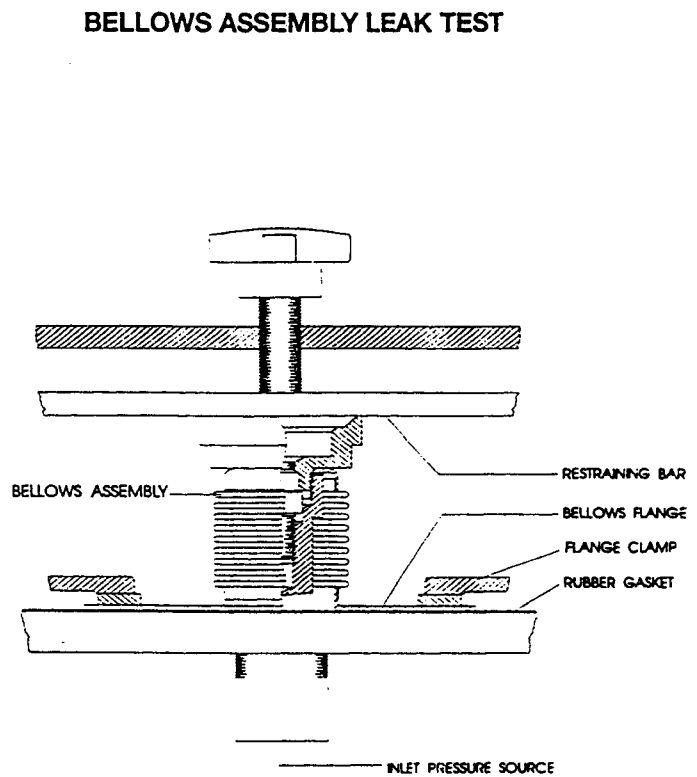


Figure 5.3

24. Thread Jam Nut (Stem) onto Stem.
25. Place Cap onto Bonnet so that Test Lever is in the same position as in disassembly notes. The standard position is opposite the valve outlet.
26. Thread Cap Studs through Cap into Bonnet.
27. Place Rivet through Test Lever and Cap hole and secure with Cotter Pin. Adjust Stem Test Washer so there is 1/8" clearance between Test Lever fulcrum and Stem Test Washer.

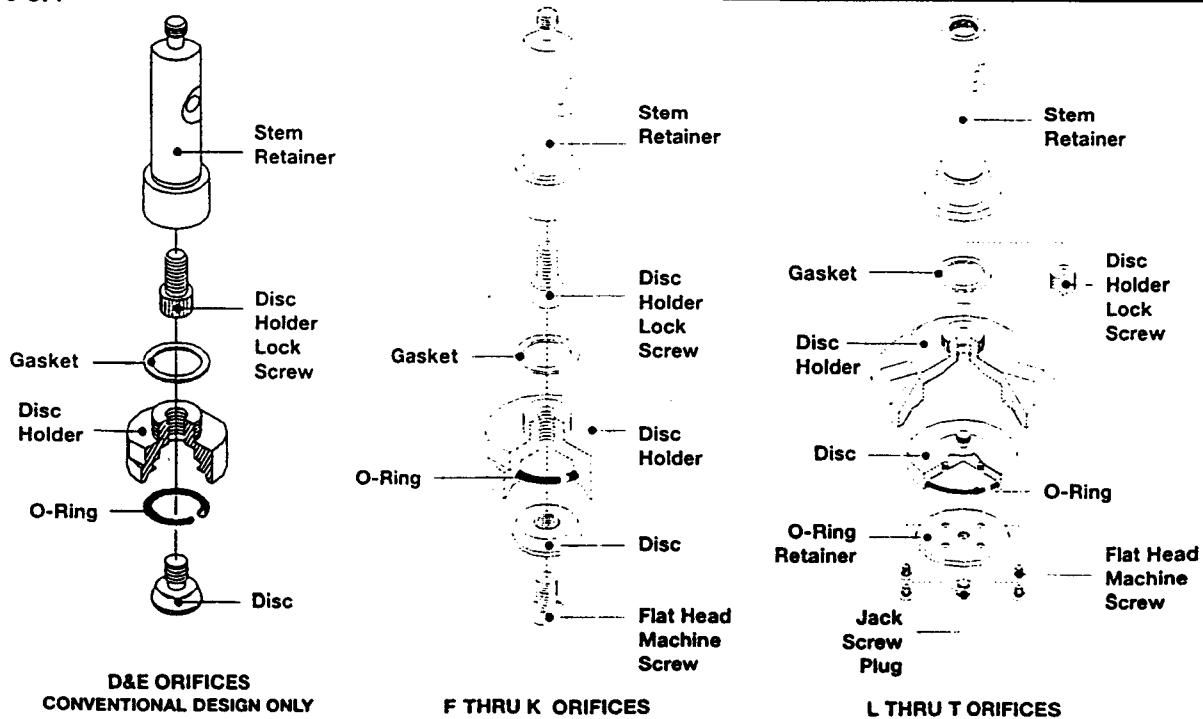
For double acting lever only: (Figure 3.5, page 13)

23. Thread Stem Test Washer onto Stem.
24. Thread Jam Nut (Stem) onto Stem.
25. Place Cap onto Bonnet so that Test Lever is in the same position as in disassembly notes. The standard position is opposite the valve outlet.
26. Thread Cap Studs through Cap into Bonnet.
27. Place Rivet through Test Lever Fork and Cap hole. Secure Rivet with Cotter Pin.
28. Place Rivet through Test Lever and Cap hole and secure with Cotter Pin. Adjust Stem Test Washer so there is 1/8" clearance between Test Lever Fork fulcrum and Stem Test Washer.

VI. Packed Lever Construction (Figure 3.3, page 12)

23. Thread Stem Test Washer onto Stem.
24. Thread Jam Nut (stem) onto Stem.
25. Place Cap Gasket on Bonnet.
26. Place Cam Shaft Ring on Cam Shaft.
27. Place counter-bored side of Retaining Ring on cam shaft against cam shaft ring.
28. Place Packing Rings over Cam Shaft and into Retaining Ring cavity.
29. Slide Cam Shaft through hole in cap and through Cam while holding Cam in place inside Cap.
30. Place Cap onto Bonnet so that Test Lever is in the same position as in disassembly notes. The standard position is opposite the valve outlet.
31. Thread Cap Studs through Cap into Bonnet.
32. Adjust Stem Test Washer so there is 1/8" clearance between Stem Test Washer and Cam.
33. Thread Gland into Cap.
34. Place Test Lever on Cam Shaft.
35. Place Plain Washer over Cam Shaft.
36. Thread Hex Jam Nut (Lever) onto Cam Shaft.

Figure 5.4



6. SETTING & TESTING

TRAINING COURSES

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

Equipment

Air testing is the usual method of testing and setting pressure relief valves. A pressure source supplies air to a test drum usually having 1-1/2 cubic feet internal volume. The air pressure to the test drum is controlled by a quick opening valve (approximately 1 inch). The valve being tested is mounted directly on the test drum without restrictions. If considerable numbers of valves are tested, it is advisable to provide an air receiver between the compressor and the quick opening valve. This arrangement allows a small-volume high-pressure compressor to store air during off-hours. Farris Engineering offers a complete line of valve test stands designed to facilitate the proper layout of a test center. They can be augmented by existing or new air receivers to suit the plant or repairer's particular requirements. A worthwhile advantage to these is the accompanying adaptors and clamping arrangements which enable quick test set-ups.

Adjustments & Performance

The use of the correct spring is a matter of critical importance. Attempting to employ a spring below its rated pressure range may result in a loss of lift with resulting loss of capacity and a generally sluggish valve action. Using a spring above or below its rated temperature range may cause a change in spring characteristics and possibly failure of the spring itself. Before changing the set pressure of any valve verify that the new pressure is within the range of the spring and valve construction. When raising the set pressure, check the applicable design code and the design pressure of the protected equipment to ensure compliance with equipment design and local requirements. Before reducing the set pressure, make certain that the capacity at the reduced pressure is sufficient for the protection of your equipment. Valves which are properly installed on steam, gas, or vapor services will relieve with a pronounced pop when opening. After the excess pressure has been relieved, the valve will generally reseal at approximately 5% to 7% below the set pressure. Actual blowdown will vary with each valve and installation.

There is generally no distinct pop with liquid service relief valves as the opening will generally be proportional to the rise in pressure. It is usual for a sudden increase in lift to occur at some overpressure. Where such data are not available, blowdown rings should be set carefully and accurately in accordance with the table values.

Procedure

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

Adjusting Valve to Required Set Pressure

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

Air Test Stand Settings

For spring Adjustment or checking set point on air test stands with a capacity under 1-1/2 cu. ft., raise ring to a position 2 notches down from contact with disc holder. On air test stands with capacity over 1-1/2 cu. ft., raise ring to a position of approximately 1/2 of tabulated number of notches down from contact with disc holder. Return ring to tabulated field setting or setting established through in-place testing before installation... Be sure to include temperature compensation of set pressure where applicable.

Liquid Service

Liquid relief valves must be set on water at the first continuous flow as the inlet pressure is raised. Intermittent opening and closing indicates leakage. The reduction in inlet pressure required to reseal the valve depends on the rate of flow and operator manipulation.

Set the blow down ring to the position indicated in Table 6.3. Do not attempt to adjust the blow down ring without gagging the valve first (or reducing inlet pressure to zero). Remove the gag. When the valve is first mounted there will be some air under the disc of the valve. This may cause the valve to pop open suddenly. To remove the air lift up on the stem to let the air slowly seep out, if possible. Pressure may need to be added under the valve to assist in lifting the stem. Next, raise the pressure to the desired set point. When the pressure is within 90% of the set pressure, raise the pressure at a rate of 1 psig per 2 seconds. Adjust the spring adjusting screw until the desired set pressure is reached. We define set pressure for a liquid valve as the first continuous flow which is flowing 90 degrees from the outlet. Be patient with liquid valves. They will sometimes exhibit a "false" set point. By holding the pressure at the point which appears to be the set pressure the system operator can prevent the valve from thinking that this is the correct set pressure. If the valve is exhibiting a "false" set point and the operator holds the pressure constant, the flow from the valve will taper off and may even completely stop flowing. The operator should then continue to raise the pressure until the valve is correctly set.

Securing The Blowdown Ring

The adjusted position of the ring is maintained by a Blow Down Ring Lock Screw which threads into the valve body from the outside and engages notches (like gear teeth) on the outside diameter of the blowdown ring. To make an adjustment, loosen and remove the blowdown ring lock screw assembly. Insert a screw driver and rotate the nearest notch toward the left to lower the ring or toward the right to raise it, counting the notches as they are moved. Reinstall the lock screw assembly, ensuring that it intercepts a notch without exerting side-pressure on the ring. **CAUTION!** When making the adjustments under pressure, be sure the valve is lightly gagged to avoid accidental popping. The gag screw must be removed immediately after use. Failure to do so will render the valve inoperable.

SEAT TIGHTNESS TESTING

After the valve is satisfactorily checked for set pressure it is necessary to check the valve for leakage. It is important

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

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

Air Testing Blow Down Ring Position

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

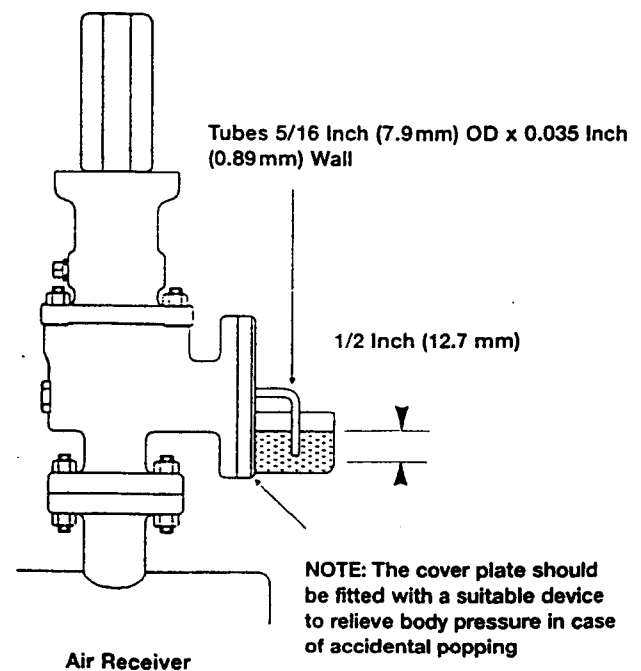


Figure 6.1

Air at ambient temperature shall be used as the pressure medium. The valve shall be observed for leakage for at least 1 minute. The leakage rate in bubbles per minutes shall not exceed the numbers listed in Table 6.1. For an O-Ring seated valve, there shall be no leakage for 1 minute (0 bubbles per minute @ 95% of set pressure). (Figure 6.1)

Maximum Seat Leakage Rates for Metal-Seated Pressure Relief Valves		
SET PRESSURE psig	LEAKAGE RATE (BUBBLES PER MINUTE)	
	F ORIFICE AND SMALLER	G ORIFICE AND LARGER
15-1000	40	20
1500	60	30
2000	80	40
2500	100	50
3000	100	60
4000	100	80
5000	100	100
6000	100	100

Table 6.1

Steam Testing

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

Liquid Testing

Liquid service pressure relief valves which are set and adjusted on water shall be leak-tested on water at near ambient conditions. Before starting the seat tightness test, the set pressure shall be verified, and the outlet body bowl shall be filled with water, which shall be allowed to stabilize with no visible flow from the valve

BLOW DOWN RING SETTINGS

AIR, GAS, AND VAPOR APPLICATIONS									
ORIFICE	SET PRESSURE RANGE, PSIG								
	15-100	101-200	201-300	301-400	401-500	501-600	601-800	801-1000	1000 & UP
D (note 1)	37 2	37 2	38 3	39 4	39 4	40 5	40 5	41 6	42 7
E (note 1)	37 2	37 2	38 3	39 4	39 4	40 5	40 5	41 6	42 7
F	2	3	4	5	6	7	8	9	10
G	3	4	5	6	7	8	9	10	11
H	3	4	5	6	7	8	9	10	11
J	3	5	5	6	7	8	9	10	11
K	4	5	6	7	8	9	10	11	12
L	4	6	9	9	10	10	10	11	12
M	4	6	12	12	12	12	12	12	12
N	5	10	15	15	15	15	15	15	15
P	6	16	20	20	20	20	20	20	20
Q	6	16	20	20	20	20	20	20	—
R	4	16	20	20	—	—	—	—	—
T	4	16	20	—	—	—	—	—	—

STEAM APPLICATIONS									
ORIFICE	SET PRESSURE RANGE, PSIG								
	15-100	101-200	201-300	301-400	401-500	501-600	601-800	801-1000	1000 & UP
D (note 1)	37 2	38 3	39 4	40 5	41 6	42 7	43 8	44 9	45 10
E (note 1)	37 2	38 3	39 4	40 5	41 6	42 7	43 8	44 9	45 10
F	2	4	5	6	7	8	9	10	12
G	3	5	6	7	8	9	10	11	13
H	3	5	6	7	8	9	10	11	13
J	3	6	6	7	8	9	10	11	13
K	4	6	7	8	9	10	11	12	14
L	4	7	7	8	9	10	11	12	14
M	4	7	7	8	9	10	11	12	14
N	4	7	7	8	9	10	11	12	14
P	4	7	7	8	9	10	11	12	14
Q	4	8	9	10	11	12	13	15	—
R	4	8	9	10	—	—	—	—	—
T	4	8	9	—	—	—	—	—	—

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

Table 6.2

outlet. The inlet pressure shall be increased to the test pressure. The valve shall be observed for 1 minute at the test pressure. For valves set at 50 PSIG or below, the pressure shall be held at 5 PSIG below the set pressure. Above 50 PSIG set pressure hold the pressure at 90% of the set pressure.

For O-Ring seated valves there shall be no visible leakage when held at the test pressure for 1 minute regardless of valve size. For metal seated valves less than 1 inch inlet size the allowable leakage rate shall not exceed 10 cubic centimeters per hour. For metal seated valves one inch inlet size or larger the allowable leakage rate shall not exceed 10 cubic centimeters per hour per inch of inlet size. Example: The maximum allowable leakage rate from a 4 inch inlet metal seated pressure relief valve shall not exceed 40 cubic centimeters per hour. This is a difficult test to conduct and it is easier to aim for zero leakage during this test by proper repair procedures. Should seat leakage be encountered a more quantitative test can be conducted to determine valve acceptability.

BLOWDOWN RING SETTING

Tables 6.2 and 6.3 give blow down ring settings in the number of notches down from disc holder contact. The higher the ring the sharper the pop and longer the blowdown. The lower the ring, the poorer the pop, the shorter the blowdown.

LIQUID SERVICE APPLICATIONS			
ORIFICE			NUMBER OF NOTCHES
D	E		2
F			3
G	H	J	4
K	L		8
M	N	P	12
Q	R	T	20

Table 6.3

FIELD SETTINGS

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

COMPENSATION FOR TEMPERATURE

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

It is customary to compensate for this effect by increasing the setting when a valve is set at ambient conditions on a test stand and the valve is intended for a higher operating temperature in service. Although the adjustment is approximate and may be outweighed by other differences caused by variations in media and blowdown ring adjustments, compensation for temperature as an independent variable improves the accuracy of the setting. It is not recommended to reduce a spring setting for valves intended for sub-zero service. (Table 6.4)

Normal Operating Temperature	% Increase in Set Pressure At Atmospheric Temp.
minus 400°F to +300°F	none
+300°F to +600°F	1%
+601°F to +900°F	2%
+901°F to +1200°F	3%

Table 6.4

COLD DIFFERENTIAL TEST PRESSURE (CDTP) is the inlet pressure at which the valve is adjusted to open on a test stand at ambient temperature conditions, discharging to atmosphere. Computation includes compensation for constant back pressure (if required) and inlet operation temperature. Cold Differential Test Pressure is the sum of the Spring Selection and the Increase in Setting to compensate for temperature. The abbreviation is Cold Set. (Table 6.4)

COMPENSATION FOR BACKPRESSURE

BACK PRESSURE is the pressure existing at the valve outlet and in the valve outlet and in the downstream portion of the valve body. It may be superimposed, built-up, constant, or variable. The spring setting should be compensated for constant and superimposed back pressure, except for BalanSeal[®] valves. For these type valves variable back pressure is not compensated for, but the maximum pressure limit of the bellows is stamped on the nameplate.

OPERATING DIFFERENTIALS

The variety of service conditions for section VIII applications precludes a rigid set of rules. Operating difficulties can be minimized by providing as much differential as possible for known conditions on a particular application. Table 6.6 lists the suggested minimum differentials.

SET PRESSURE TOLERANCE AND OPERATING DIFFERENTIALS GASES, VAPORS, AND LIQUIDS

	SET PRESSURE psig	SET PRESSURE TOLERANCE (+) OR (-)	MINIMUM DIFFERENTIAL SUGGESTED (Gases & Vapors)	MINIMUM DIFFERENTIAL SUGGESTED (Liquids)
METAL SEAT SOFT SEAT	15 To 70	2 PSI	5PSI	5PSI
METAL SEAT SOFT SEAT	71 To 1000	3%	10%	10%
METAL SEAT SOFT SEAT	1001 To 6000	3%	10%	10%

Table 6.6

FINAL NOTES

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

appears in Appendix C which can be photocopied and used for this purpose.

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

TROUBLE SHOOTING

TYPICAL PROBLEMS WITH PRESSURE RELIEF VALVES

CHATTER

The valve is oversized for installation.

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

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

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

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

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

INCORRECT SET PRESSURE

Misreading the nameplate

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

The blowdown ring position changed

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

Internals are misaligned.

See section on leakage.

Jam nut is loose.

Tighten jam nut.

Rough handling.

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

Pressure surge at inlet.

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

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

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

LEAKAGE

The seats are damaged.

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

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

Always have at least 10% (or 5 psig, whichever is greater) differential between operating pressure vs. set pressure for metal seated valves, and 7% (or 5 psig, whichever is greater) for soft seated valves. See table 6.6. page 27

Misaligned lifting gear.

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

Excessive external loads to the outlet piping.

Support outlet piping so that the maximum recommended weight on the outlet is not exceeded. See Appendix E, Table 7.1

Horizontal mounting.

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

Lock screw stud not adjusted properly.

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

Misaligned internals.

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

Other.

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

BLOWDOWN

Blowdown is excessive/the valve is hanging up

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

Blowdown is too short.

Raise the blowdown ring to lengthen the desired blowdown.

REQUIRED TOOLS	ORIFICE													
	D	E	F	G	H	J	K	L	M	N	P	Q	R	T
OPEN END WRENCHES														
7/16"	•	•	•	•	•	•	•	•	•	•	•	•	•	•
9/16"	•	•	•	•	•	•	•	•	•	•	•	•	•	•
3/4"	•	•	•	•	•	•	•	•	•	•	•			
13/16"	•	•	•	•	•	•	•	•	•	•	•			
7/8"	•	•	•	•	•	•	•	•	•	•	•	•	•	•
1"	•	•	•	•	•	•	•	•	•	•	•	•	•	•
1-1/16"	•	•	•	•	•	•	•	•	•	•	•	•	•	
1-1/8"								•	•	•	•	•	•	•
1-1/4"			•	•	•	•	•	•	•	•	•	•	•	•
1-3/8"	•	•	•	•	•									
1-1/2"				•										
1-5/8"					•									
1-3/4"						•	•	•	•	•	•			
2"								•	•	•	•	•	•	•
2-1/4"	•	•	•	•	•	•	•	•	•	•	•			
2-3/4"							•							
3-1/4"						•	•	•	•	•	•	•	•	•
3-1/2"								•	•					
3-11/16"				•	•									
3-3/4"										•				
5"							•			•				
5-1/4"						•								
5-3/4"												•		
6"													•	
6-3/16"							•	•	•	•	•	•	•	
ALLEN WRENCHES														
3/16"	•	•	•	•	•	•								
7/32"							•	•	•	•	•			
3/8"												•	•	•
ADJUSTABLE PIN SPANNERS														
1-1/4" TO 3"	•	•	•		•									
2" TO 4-3/4"				•	•	•								
4-1/2" TO 6-1/4"							•	•	•	•	•	•	•	
8-1/2"												•	•	
10 5/8"														•
ADJUSTABLE HOOK SPANNERS														
2" TO 4-3/4"								•	•	•				
4-1/2" TO 6-1/4"											•			
6-1/8" TO 8-3/4"												•	•	
9-1/4"														•
ADJUSTABLE WRENCHES	•	•	•	•	•	•	•	•	•	•	•	•	•	•
FLAT HEAD SCREW DRIVERS	•	•	•	•	•	•	•	•	•	•	•	•	•	•
WIRE CUTTERS	•	•	•	•	•	•	•	•	•	•	•	•	•	•
SUPER JOINT PLIERS	•	•	•	•	•	•	•	•	•	•	•	•	•	•
PIPE WRENCH	•	•												
O-RING PICK	•	•	•	•	•	•	•	•	•	•	•	•	•	•
FLASHLIGHT	•	•	•	•	•	•	•	•	•	•	•	•	•	•

APPENDIX B EXTERNAL LOADS

Mechanical forces may be applied to the valve by discharge piping as a result of thermal expansion, movement away from anchors and weight of any unsupported piping. The resultant bending movements on a closed pressure relief valve may cause valve seat leakage and excessive stress in inlet piping. The design of the installation should consider these factors.

The determination of bending movements, stresses and supports is the responsibility of the designer of the pressure relief system in accordance with the appropriate codes, recommended practices and site conditions. However, since a closed pressure relief valve cannot tolerate as much load applied to the outlet as a fitting or line valve, the manufacturer is often requested to provide guidelines to avoid seat leakage.

For this purpose, we are considering small deflections at moderate stress levels principally in a vertical plane through the horizontal and vertical axes of the valve. Let us examine a maximum allowable dead weight applied vertically at the outlet flange, being a function of the moment of inertia of the inlet neck, the horizontal moment arm, a constant and an empirical factor determined by tests. The result would be a great number of computations compared with a fitting whose bending moment is simply 1500 times the section modulus.

Similarly, the bending moments in X, Y and Z axes could be calculated by dimensional analyses of the great number of valve bodies in the catalog. However, lacking industry standardization in presenting such data in a uniformly acceptable manner, the use of weight units provide a quantitative reference for improving installation designs. It is preferable to the general instruction of supporting all discharge piping independently.

The following approximate method tabulates only the most significant factor, which is the maximum dead weight load F_z in pounds which we recommend as a limit to avoid seat leakage.

MAXIMUM RECOMMENDED WEIGHT ON OUTLET F_z POUNDS					
ORIFICE	TYPE	F_z	ORIFICE	TYPE	F_z
D	26DA10	85	K	26KA10	630
	11	85		11	940
	12	85		12	940
	13	85		13	400
	14	158		14	400
	15	158		15	470
	16	230		—	—
	—	—		—	—
E	26EA10	85	L	26LA10	600
	11	85		11	900
	12	85		12	2000
	13	85		13	1070
	14	158		14	820
	15	158		—	—
	16	230		—	—
	—	—		—	—
F	26FA10	205	M	26MA10	1220
	11	275		11	1900
	12	140		12	1900
	13	140		13	1240
	14	155		14	820
	15	155		—	—
	16	230		—	—
	—	—		—	—
G	26GA10	350	N	26NA10	830
	11	400		11	900
	12	145		12	900
	13	155		13	815
	14	155		14	815
	15	330		—	—
	16	330		—	—
	—	—		—	—
H	26HA10	330	P	26PA10	600
	11	370		11	700
	12	590		12	730
	13	300		13	730
	14	430		14	730
	15	430		—	—
	—	—		—	—
	—	—		—	—
I	26IA10	330	Q	26QA10	1350
	11	370		11	1350
	12	590		12	2700
	13	300		13	2700
	14	430		H26QA13	—
	15	430		26RA10	1500
	—	—		11	2700
	—	—		12	1800
J	26JA10	490	R	13	2200
	11	620		H26RA13	—
	12	770		26TA10	2400
	13	445		11	2400
	14	870		12	2400
	15	870		—	—
	—	—		—	—
	—	—		—	—
K	26KA10	630	T	H26TA12	2400
	11	940		11	2400
	12	940		12	2400
	13	400		—	—

Table 7.1

APPENDIX C

MAINTENANCE & INSPECTION SPECIFICATION RECORD

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

No	Unit	Location

HISTORICAL RECORD

Date Tested	Popped	Reseat	Disposition	Condition	Repairs	Remarks

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

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

GENERAL REFERENCE SOURCES

These reference materials are available and should be helpful in the installation and testing of Pressure Relief Valves. Since it is impossible to include all industry practices that are used in the installation of a Pressure Relief Valve, this manual has been prepared to describe routine field handling and installation procedures to make a safe and acceptable installation.

American National Standards Institute

New York, NY

ANSI B16.5 - Pipe Flanges and Flanged Fittings

ANSI B16.34 - Valves - Flanged, Threaded and Welding End.

ASME PTC 25 - Performance Test Code.

ANSI/ASHRAE 15-78 - Safety Code for Mechanical Refrigeration, [B9.1].

American Petroleum Institute Washington, D.C.

API RP 520, Sizing, Selection and Installation of Pressure-Relieving Devices in Refineries, Part-1 Sizing and Selection.

API RP 520, Part II - Installation

API RP 521, Guide for Pressure-Relieving and Depressuring Systems.

API Standard 526, Flanges Steel Safety Relief Valves.

API Standard 527, Seat Tightness of Pressure Relief Valves.

API Standard 2510, Design and Construction of LP-Gas Installations at Marine and Pipeline Terminals, Natural Gas Processing Plants, Refiner- and Tank Farms.

API RP 576, Inspection of Pressure-Relieving Devices.

API PAPER 62-73, Computerized Safety Valve Maintenance Records by JH Forrester, Jr., May 17, 1973

American Society of Mechanical Engineers New York, NY

ASME Boiler and Pressure Vessel Code Section VIII, Rules for Construction of Pressure Vessels, Division I.

ASME Boiler and Pressure Vessel Code Section I, Rules for Construction of Power Boilers

Compressed Gas Association, Inc. Arlington, VA

Safety Relief Device Standards:

Part 1 - Cylinders for Compressed Gases, Pamphlet S-1.1.

Part 2 - Cargo and Portable Tanks for Compressed Gases, Pamphlet S-1.2.

Part 3 - Compressed Gas Storage Containers, Pamphlet S-1.3.

National Board of Boiler and Pressure Vessel Inspectors Columbus, Ohio

National Board Inspection Code, NB-23.

National Fire Protection Association Quincy, Massachusetts

NFPA No. 30, Flammable and Combustible Liquids Code.

NFPA No. 58, Standard for the Storage and Handling of Liquefied Petroleum Gases.

NFPA No. 59, Standard for the Storage & Handling of Liquefied Petroleum Gases at Utility Gas Plants.

TELEDYNE FLUID SYSTEMS **Farris Engineering** An Allegheny Teledyne Company

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PRESSURE RELIEF VALVE INSTALLATION INSTRUCTIONS

1. Introduction

Pressure relief valves are precision instruments. Correct installation is essential for plant, property, personnel and public safety. Failure of a pressure relief valve can lead to catastrophic overpressure of equipment and/or the release of fluid under pressure. The fluids may be hazardous and all precautions should be taken to ensure safe disposal.

2. Storage & Handling

Cleanliness is essential to the satisfactory operation and tightness of a pressure relief valve. Every precaution should be taken to ensure that dirt or other foreign matter does not enter the valve.

- Valves that are not immediately installed in service should be stored indoors.
- Inlet and outlet covers should be left in place until the valve is to be installed.
- Valves should be moved and installed with the stem in the vertical position.
- Care should be taken to keep the inlet and outlet clean.

3. Receiving Inspection

A visual inspection of the valve should be made when it is first received. Any problems should be recorded and reported to the manufacturer or his local representative. Points that should be checked include:

- Looking for any shipping damage.
- Confirming the nameplate data against ordering documents.
- Verifying the factory wire seals are in place.
- Storing properly if the valve will not be installed immediately.

4. Confirmation of Set Pressure

Before the valve is installed, it is important to confirm the set pressure. This step should only be performed by trained personnel using proper test equipment. If trained personnel and/or proper test equipment are not available, this step should be skipped. Use of improper test procedures or equipment can damage the valve and will void any warranties.

5. Confirmation of Seat Tightness

After the set pressure has been verified, the valve's seat tightness should be checked using the procedures outlined in the appropriate maintenance manual. As a general rule, seat tightness testing is performed at 90% of the set pressure. This testing should only be performed by trained personnel using proper test equipment. If trained personnel and/or proper test equipment are not available, this step should be skipped. Use of improper test procedures or equipment can damage the valve and will void any warranties.

6. Inspection of Inlet and Outlet Piping

Before a pressure relief valve is installed in service, the upstream and downstream piping should be inspected for foreign matter such as welding beads, pipe scale, and other material that could damage the valve during relief. Wherever possible, the system should be thoroughly purged before the valve is installed.

7. Pressure Relief Valve Installation

Pressure relief valve performance can be adversely affected by improper installation. To ensure good performance, the following guidelines should be followed.

- Always install pressure relief valves upright with the stem in the vertical position and the inlet at the bottom.
- Avoid mounting valves close to equipment that can cause pressure fluctuations, such as compressor discharge lines.
- Avoid installing valves close to equipment that emits excessive heat.
- Install valves close to the pressure source so that the inlet pressure loss is no more than 3%.
- Mount valves away from equipment that may cause turbulence, such as reducing stations, orifice plates and nozzles, and other valves and fittings.
- Make sure all inlet and outlet piping is properly supported to avoid putting an excessive load on the valve. Provide drainage from the piping or from the valve body.
- Remove the inlet and outlet flange protectors. Any extraneous materials inside the valve body or nozzle should be removed.

- Make sure inlet piping is at least equal to or greater than the inlet size of the valve. Outlet piping should be equal to or greater than the valve's outlet size.
- On bellows valves remove the plastic shipping plug from the bonnet. Discharge vent in a safe direction.
- Tighten all inlet and outlet flange bolts evenly.
- Leave enough room to allow for in-line maintenance and adjustments.

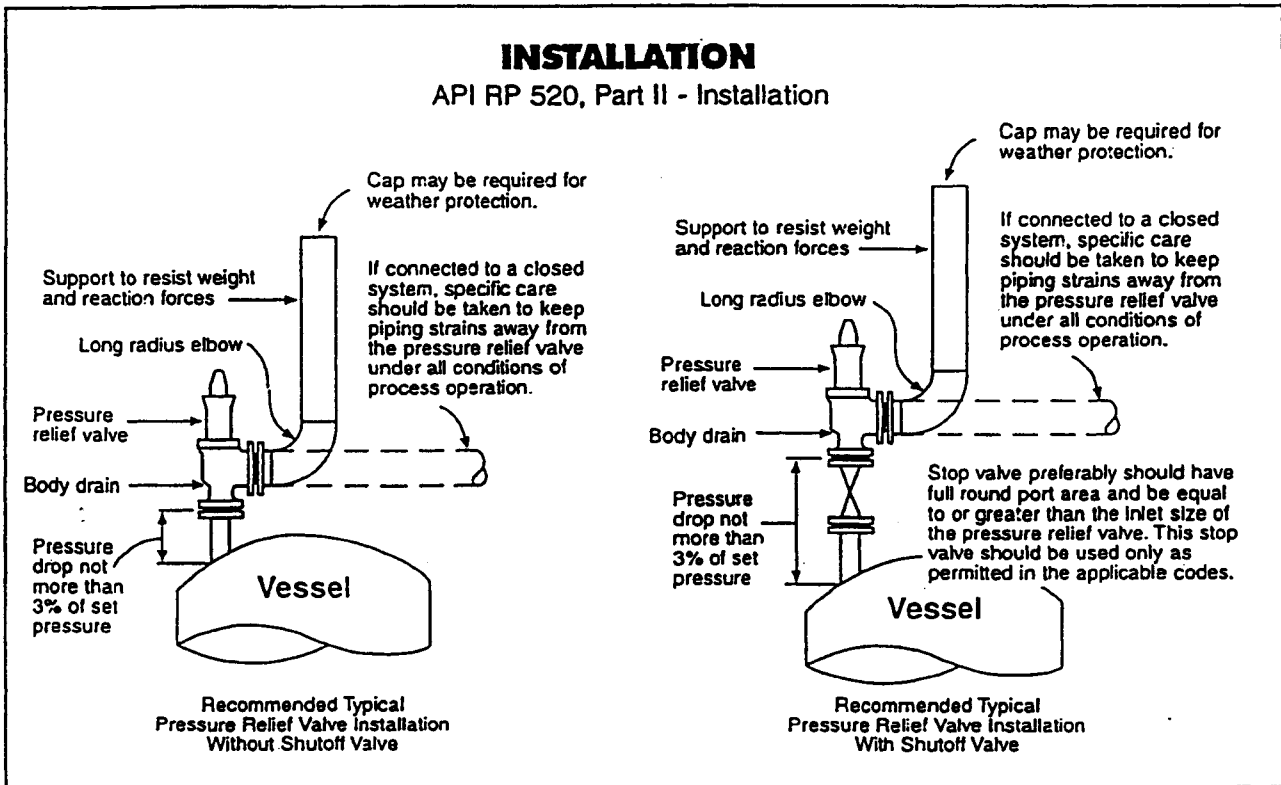
8. Lifting Levers

Lifting levers are provided on some valves to allow the user to manually verify that the valve trim is free to move when the operating pressure exceeds the set pressure.

To prevent stem damage, the valve should have a minimum of 75% of the set pressure under the disc before operating the test lever. In addition, the valve should never be carried by the lever as this can move the disc off the seat, resulting in damage to both parts.

9. System Start Up and Testing

It is recommended that the valve be isolated during pressure testing of the system, either by blanking or closing a stop valve. If gagging is used, extreme caution should be used to avoid damaging the valve stem or seat by overtightening the gag screw. Gag screws should be installed hand tight and should always be removed after system testing has been completed.



Farris Engineering

Division of Curtiss-Wright Flow Control Corporation

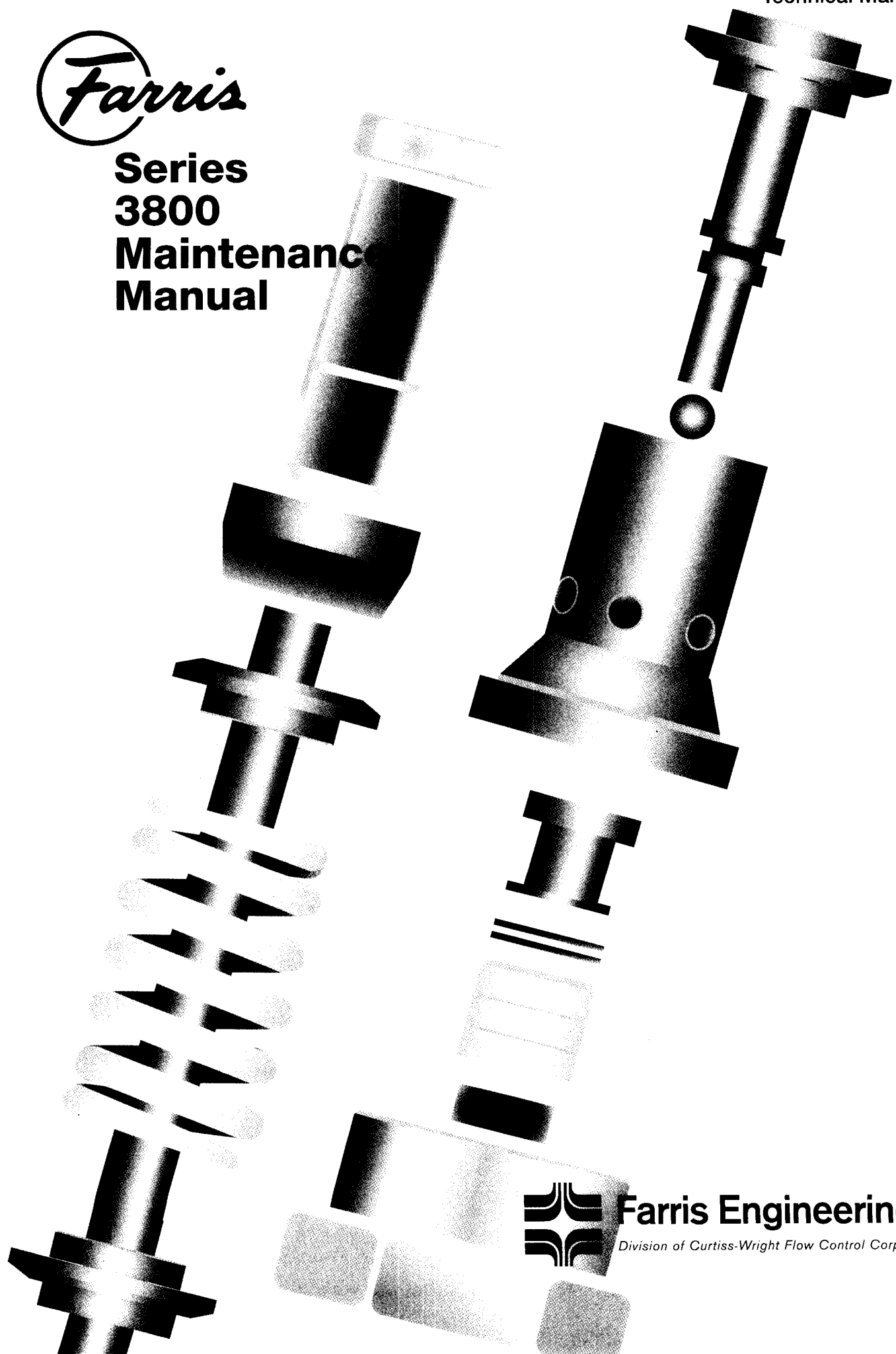
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TABLE OF CONTENTS

I. INTRODUCTION 2

II. SAFETY TIPS 2

III. OPERATIONAL PRINCIPLES 3

IV. PILOT CONTROLS 4

 (i) Disassembly 5

 (ii) Cleaning and Repairing 5

 (iii) Assembly 6

 (iv) Setting and Testing 8

V. MAIN VALVE 10

 (i) Disassembly 11

 (ii) Cleaning and Repairing 11

 (iii) Assembly 11

VI. FINAL ASSEMBLY 12

I. Introduction

This Maintenance Manual is intended to present all the essential information you will need in order to keep your Farris valves in perfect operating condition. Generally, maintenance becomes necessary as a result of dirt or scale in the lines, exposure to service conditions, incorrect servicing, improper testing procedure, or improper installation.

This manual covers Series 3800 pilot-operated safety relief valves, which consist of two basic components: a pilot control (PCF 3) and the main valve. The pilot control is a spring-loaded valve which senses the pressure and controls the opening and closing of the main valve.

Once the pilot-operated safety relief valve is isolated from the system pressure, relieve the pressure from the inlet valve. Disconnect the pilot control from the main valve. Take particular note of the tubing connection orientation.

Follow Section IV to perform maintenance on the pilot control. Follow Section V to perform maintenance on the main valve.

If a valve repair requires replacement of parts, only Farris components should be used. Use of parts from other than the original manufacturer will lead to potentially dangerous operating conditions. This valve is ASME Code certified. Unauthorized tampering and repair is in violation of the Code and will void certification that may apply to an ASME Code certified system. If faced with repairs exceeding the scope of this manual, you should contact the Farris Factory.

II. Safety Tips



- Make sure that the safety relief valve is isolated from the pressure source before it is removed.
- Stand clear and wear protective clothing when removing safety relief valve to prevent exposure to any types of deposits or corrosive debris which may have been trapped inside the valve.
- Do not stand near the discharge side of a safety relief valve when testing the valve.
- Always install a safety valve vertically as the internal parts are designed to operate in that position.
- Avoid hammer blows to the valve.
- Eliminate stress on the valve body whenever possible.
- Be careful when checking a safety valve for visible leakage.



III. Operational Principles

(Refer to Figures 3.3 and 3.4)

Pressure in the protected vessel is sensed through a pressure tap (remotely connected or on the main valve body). The pressure tap is piped to the pilot control sensing line port. The vessel pressure is transmitted to the dome from the pilot control dome port.

When vessel pressure is below pilot control set pressure, the relief seat of the pilot control is closed. Inlet pressure of the main valve is equal to the dome pressure. The difference in the main valve nozzle seat area (smaller) and the dome area (larger) guarantees the main valve to be closed.

When the vessel pressure reaches set pressure, the pilot control relief seat opens instantaneously with the closing of the lower seat. The pilot control relieves the dome pressure to the atmosphere. The force of the

pressure in the inlet of the main valve causes the piston to lift from its closed position to relieve excess vessel pressure. The relationship between the downward force on the main valve piston and vessel pressure is illustrated in Figure 3.1.

When vessel pressure reaches re-seat pressure (typically 95% of set pressure), the spring force overcomes the pressure force on the lower seat of the pilot control. The relief seat closes instantaneously with the opening of the lower seat. Pressure re-enters the dome and develops the force to move the piston down and close the main valve. In Figure 3.2, the lift of the main valve piston is plotted against vessel pressure.

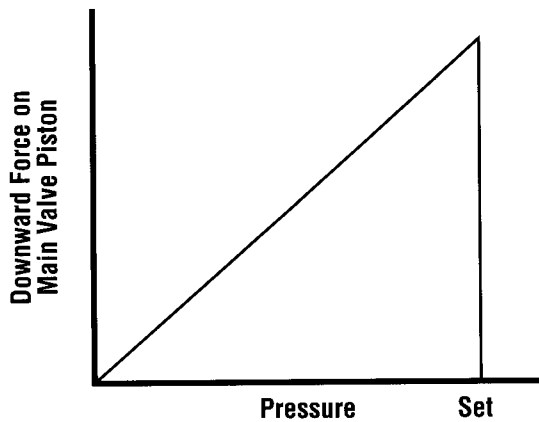


Fig. 3.1

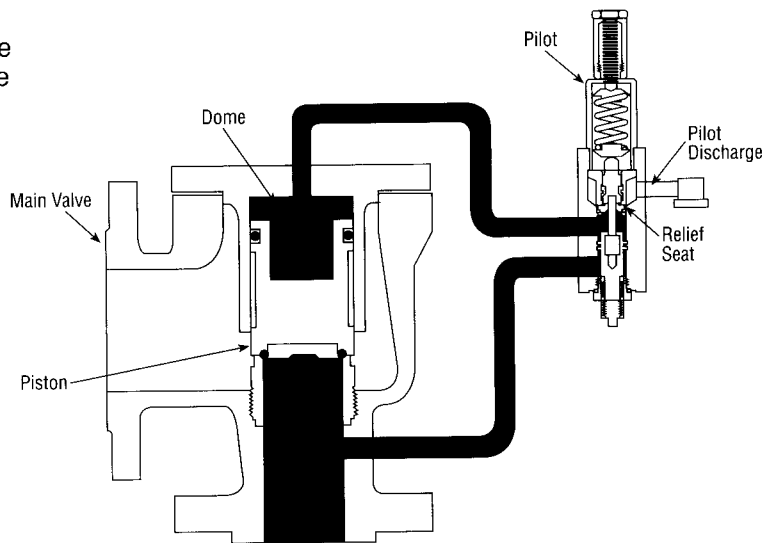


Fig. 3.3

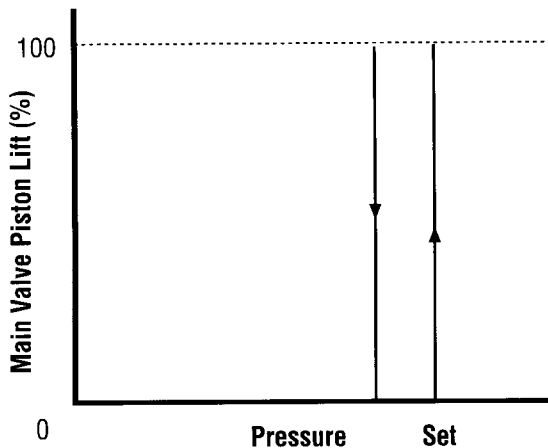


Fig. 3.2

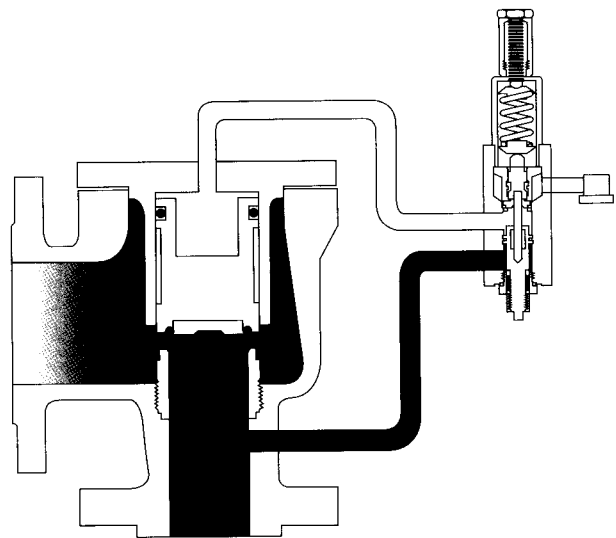


Fig. 3.4

IV. Pilot Control

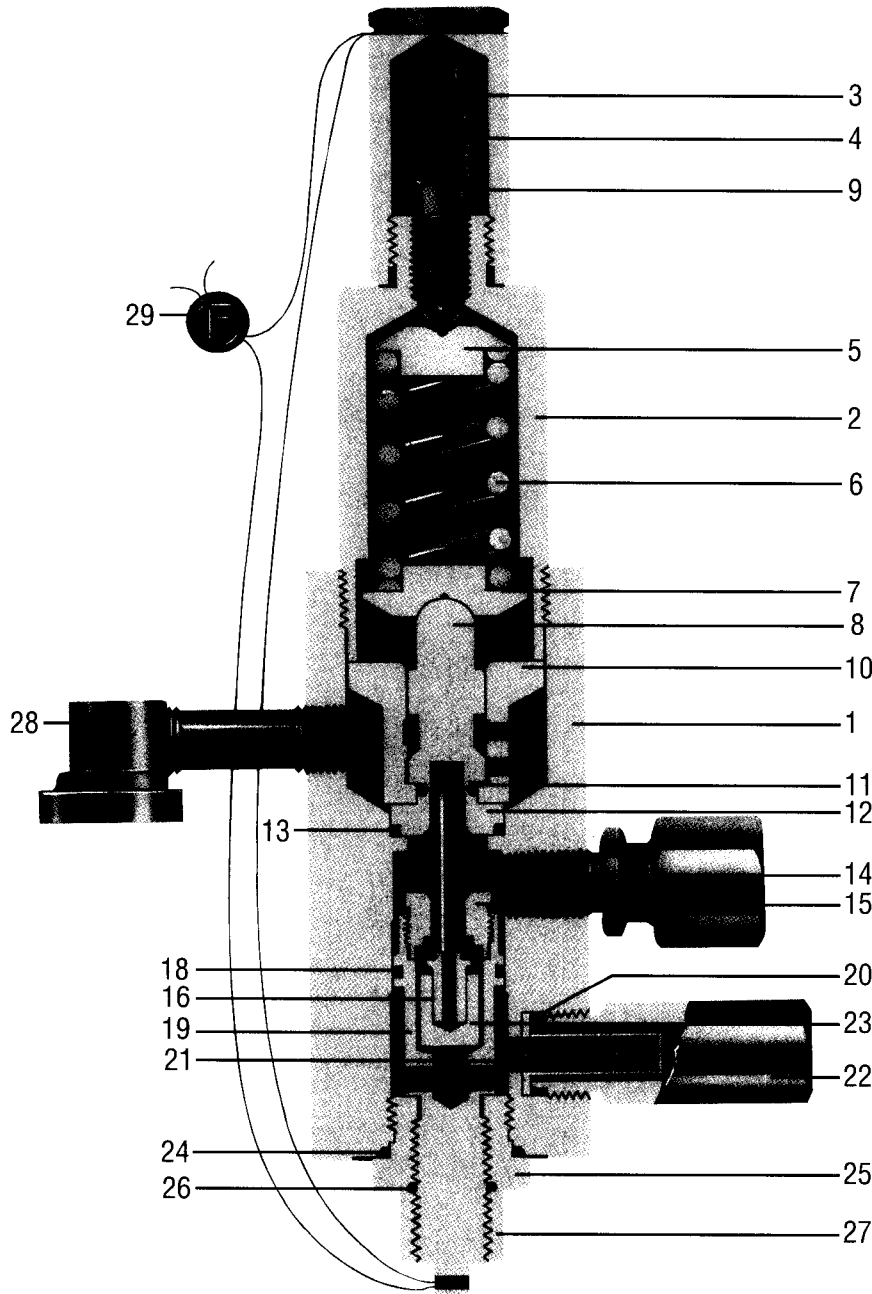


Fig. 4.1
PCF3 Pilot Control

ITEM	PART NAME
1	Body
2	Bonnet
3	Cap
4	Spring Adjusting Screw
5	Upper Spring Button
6	Spring
7	Lower Spring Button
8	Disc
9	Jam Nut
10	Guide
11	Upper Seat Seal
12	Upper Seat
13	Static Seal, Body
14	Blow Down Relay
15	Lower Seat
16	Retainer, Lower Seat Seal
17	Lower Seat Seal
18	Static Seal, Adjuster
19	Blow Down Adjuster
20	Filter Static Seal
21	Filter
22	Filter Housing
23	Lower Disc
24	Adjuster Cap Seal
25	Blow Down Adjuster Cap
26	Thread Seal, O-Ring
27	Blow Down Adjuster Lock Nut
28	Bug Vent Housing
29	Wire Seal
30	Name Plate (Fig. 4.1a)

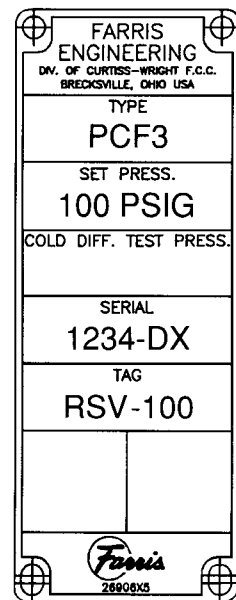


Fig. 4.1a
Sample PCF3 Nameplate

(i) Disassembly

Like any other safety relief device, the PCF3 pilot control requires maintenance on a regular basis. Scheduling of maintenance is the responsibility of the end-user.

The PCF3 pilot control shall be taken off-line before any maintenance and service work can be performed. Arrangements for an alternate safety relief device shall be made, if system protection is to remain in effect. Only authorized repair facility with qualified personnel shall do any maintenance/repair.

It is necessary to have the right tools (Table 4.1) and a replacement elastomer kit.

Table 4.1

ITEM	TOOL DESCRIPTION	SIZES
1	Soft Jaw Bench Vise	
2	Adjustable Wrenches	
3	Set of Open End Wrenches	1/4, 7/16, 9/16, 5/8, 3/4, 1-1/8, 1-1/2, & 2 Inch Span
4	O-Ring Pick	
5	Wire Cutters	

Once the pilot control is out of service:

1. Place the pilot control on a clean and well-lit workbench.
2. Make a note of the physical condition of the valve before disassembly.
3. Cut and discard lead seals.
4. Remove the strainer assembly, the fitting for the piston (dome) line, and the exhaust port attachment.
5. Clamp the body of the valve on a bench vise. Remove the cap by unscrewing it from the bonnet.
6. Relieve the spring compression by loosening the spring adjustment screw. Take note of the number of turns from the locked position to the point where spring resistance is not felt. This will aid in setting the valve to its original set pressure.
7. Remove the bonnet from the body to expose the internals of the upper sub-assembly. CAREFULLY pull each part and arrange neatly on top of the workbench.
8. Loosen the blow down adjuster. Take note of the number of turns from the locked position to the lowest position. This will be helpful when setting the valve to its original setting.
9. Remove the lower sub-assembly by unscrewing the bushing from the body.
10. Unscrew the seat insert from the adjuster to access the lower disc assembly.

(ii) Cleaning and Repairing

Clean all parts with solvent and blow dry with air, being particularly careful on seating surfaces.

Inspect all parts and seating surfaces for excessive wear and corrosion. Discard and replace as necessary. NO REMACHINING IS ALLOWED. Replace all seals. Identify each new elastomer piece from the kit by matching it with Figure 4.2. Be sure to replace with proper compound for the particular service. If in doubt, contact the Farris Factory giving the serial number on the nameplate.

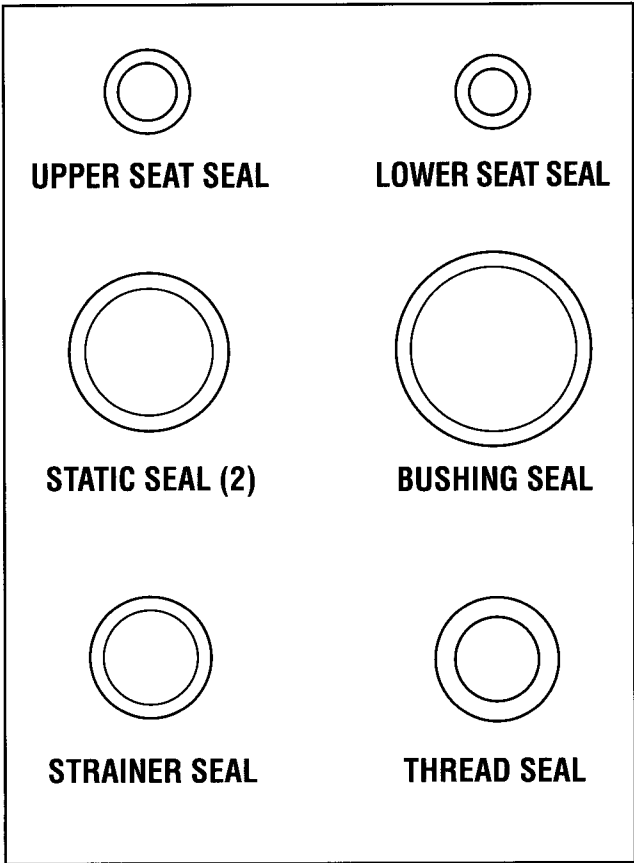


Fig. 4.2
Seals for PCF3 Pilot Control
(Full Scale)

(iii) Assembly

The upper and adjuster sub-assemblies have been identified in Figure 4.3 to help in distinguishing the vertical position of the PCF3. Orientation of all the parts in each sub-assembly is likewise referred to in their vertical position.

Lubricate all threaded and mating surfaces with Bostik Never Seez (or equivalent).

a. Upper Sub-Assembly

1. Orient body with its length vertical, and the wider opening facing upward.
2. Place a static seal into the counter-bore of the body, via the upper opening.
3. Place the upper seat over the static seal, making sure the side with the bigger outside diameter protrusion faces downward.
4. Orient the guide with its flange upward. Insert the upper seat seal into the recess on the lower side of the guide.
5. Lower the guide onto the upper seat inside the body, making sure that the upper seat seal does not fall out and is in good contact with the upper seat and the guide. Also make sure that the two holes on the guide's side face the outlet (uppermost side-hole) of the body.
6. Slide disc into the guide, taking care not to damage the seats, and making sure that the upper disc rests fully on the upper seat seal. The correct orientation of the disc is with its rounded end facing upwards.
7. Place the two (2) spring buttons over the two ends of the spring. Hold the buttons over the ends of the spring with thumb and forefinger.
8. Match the lower spring button over the rounded top of the disc making sure that rounded top of the disc fits into the recess in the lower spring button.
9. Lower the bonnet over the spring button's sub-assembly and screw tightly into the body.
10. Screw the spring adjusting screw into the jam nut until the jam nut is about two thirds (2/3) up the spring adjusting screw.
11. Screw the spring adjusting screw – jam nut sub-assembly into the top of the bonnet. Stop as soon as resistance from the upper spring button is felt.

b. Adjuster Sub-Assembly

1. Position the lower seat seal on the retainer making sure it fits evenly and symmetrically.
2. Lower the retainer into the lower disc with the lower seat seal fitting snugly between the retainer and the lower seat.
3. Lower the lower seat – retainer sub-assembly into the adjuster with the lower disc entering the adjuster first.
4. Screw the seat insert into the adjuster and tighten.
5. Place the second static seal in the groove on the side of the adjuster, making sure it fits evenly.
6. Place the bushing seal on the bushing beyond the threads and against the flat back of the bushing's hex head.
7. Screw the bushing onto the adjuster with the hex head of the bushing facing downward.
8. Position a thread seal on the threads of the adjuster and against the hex head of the bushing.
9. Screw the lock nut onto the adjuster and tighten.
10. Place the spacer rod into the hole of the seat insert until it rests on the top of the retainer.
11. Insert the adjuster sub-assembly into the body through its lower end, making sure the spacer rod passes through the hole of the upper seat.

c. Strainer

1. Position the strainer into the inlet (lowest) port of the body, flange first.
2. Place the second thread seal into the inlet port, bottoming on the strainer flange.
3. Screw the strainer housing into the inlet port and tighten.

d. Connections

1. Connect the sensing line into the strainer housing in the sensing line port of the body.
2. Use the dome line port in the middle of the body to connect to the dome of the main valve.
3. Leave the exhaust port open to the atmosphere for exhaust, or connect it to an exhaust plenum.

The PCF3 pilot control is ready to be set and tested.

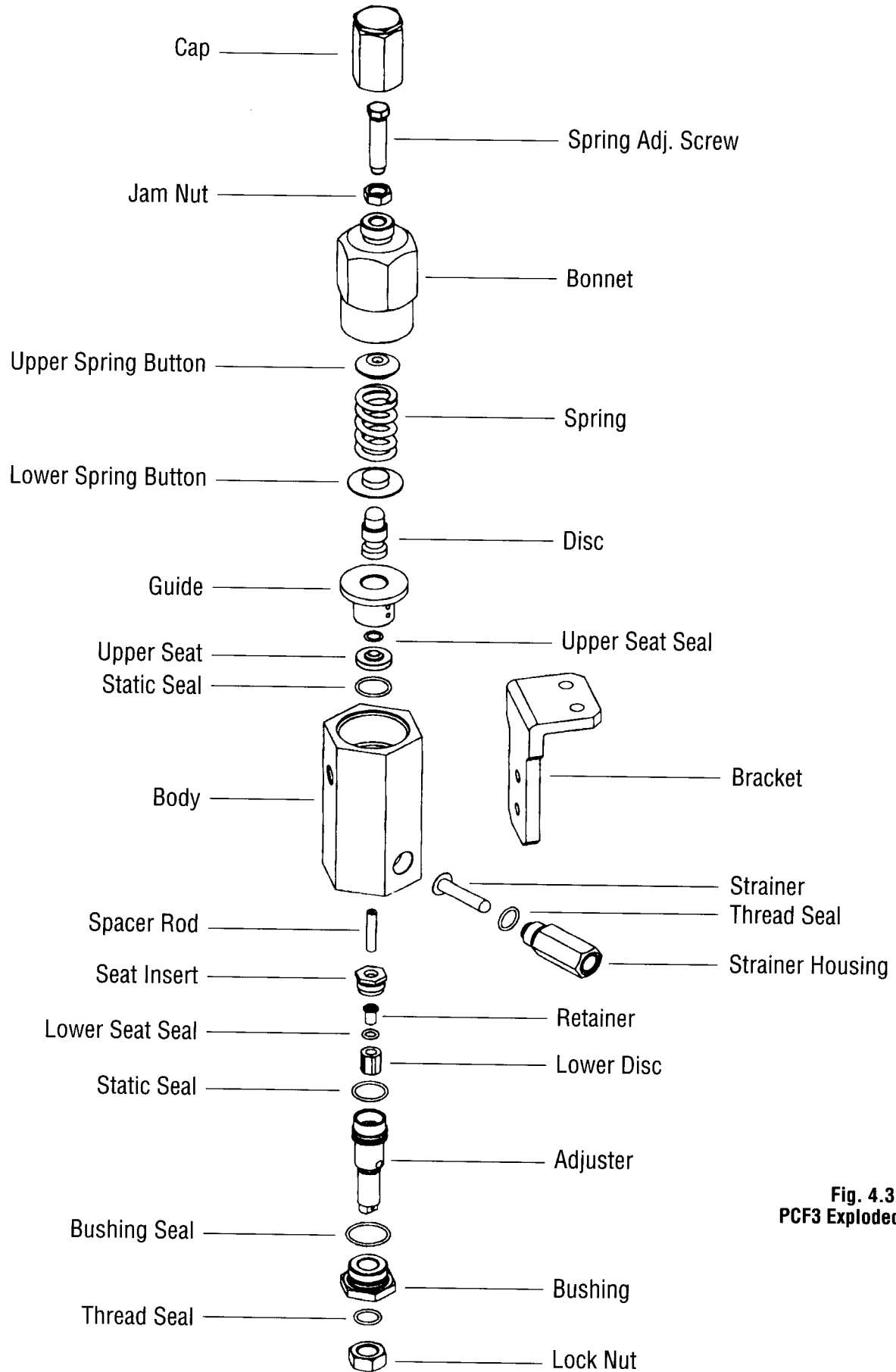


Fig. 4.3
PCF3 Exploded View

(iv) Setting and Testing

Testing of the PCF3 will be performed only after correct assembly has been accomplished. Read the entire test procedure. Test should be conducted only by qualified personnel.

Connect the PCF3 to the test rig (see test stand schematic, Figure 4.4).

A. Test Stand Schematic Description

V1 – Isolation valve, normally open when test is in progress.

V2 – Needle valve, regulates pressure into vessel.

V3 – Vent valve, normally closed when going up on the receiver pressure; also used to dump pressure from vessel.

V4 – Vent valve, normally closed when testing, used as an auxiliary pressure dump valve.

P1 – Pressure gage, to read dome pressure.

P2 – Pressure gage, to read vessel pressure.

Vessel Receiver – Test pressure receiver simulating a vessel.

Dome Receiver – Test pressure receiver simulating the dome/piston volume on the main valve.

In-Line Filter – Filters air going into the vessel.

B. Port Identification and its Connections

Port A: Where the pilot control senses the vessel pressure. Connect this to vessel receiver.

Port B: Where the pilot control is connected to the dome or piston of the main valve. Connect this to the dome receiver.

Port C: The exhaust port, normally vented to the atmosphere (i.e. piped to the outlet of the main valve, with bug screen).

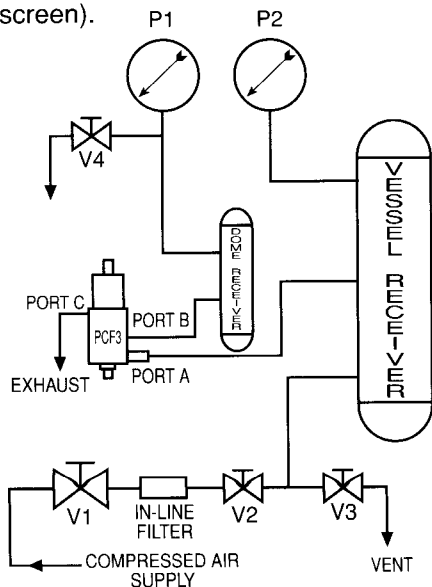


Fig. 4.4 Test Stand Schematic

C. Set Pressure Testing

Setting the pilot control is similar to setting a spring-loaded valve where the spring is being compressed to the desired set pressure. The set pressure is distinguished by the pop.

1. Refer to Table 4.2 for the nominal number of turns (on the spring adjusting screw) required to set the valve. Start counting the number of turns when the spring adjusting screw (approximately) touches the upper spring button (this can be done by feel).
2. Set the blow down adjuster at its lowest position.
3. Pressurize the vessel receiver by slowly opening V2. **Note:** both pressure gages P1 and P2 shall have the same pressure reading.
4. Record pop (set) pressure. **Note:** After pop, P1 should drop to zero. If it does not, carefully turn the blow down adjuster up to equalize P1 and P2. Pop again to confirm zero pressure on P1. Overpressurize the vessel receiver to 10% or 3 psig, whichever is greater.
5. Fine tune the set pressure and blow down to requirement (use Table 4.2 as a guide to the number of turns required).
6. When the set (pop) pressure on P2 is reached, P1 will read zero pressure (main valve is in the open or flowing mode).
7. Vent the vessel pressure slowly through V3 to determine the re-seat pressure of the valve. Proper re-seat (commonly there's a slurping sound) occurs when P1 and P2 read the same pressure.
8. When performance is satisfactory, tighten the lock nut, jam nut and cap.

D. Pilot Seat Tightness Testing

A 5/16" OD x 0.035" wall thickness copper tube or equivalent immersed no more than 1/2" deep in water shall be connected to the exhaust port. Raise the receiver pressure to the test pressure described below and observe for bubbles. No bubbles are allowed.

Test pressure:

- 95% of set pressure if set pressure is 100 psig or more OR**
- 5 psig below set pressure if set pressure is less than 100 psig**

Brush soap and water solution on joints internally exposed to pressure. Observe for leakage. No leakage at any joint is allowed.

E. Test Conclusion

Vent out pressure from the receiver tank. Unhook all test connections.

If only the pilot control requires maintenance, skip Section V and go on to Section VI for final assembly.

Pilot Control Spring Chart & Spring Adjusting Screw / Blow Down Adjustments

Set Pressure (psig)	Spring Number	Spr. Adj Scr. (turns)	Blow Down Adjustment +/- 1/8	95 % of Set (psig)	Set Pressure (psig)	Spring Number	Spr. Adj Scr. (turns)	Blow Down Adjustment +/- 1/8	95 % of Set (psig)	
15	B1106 SS	3 1/2	1/4	19	1800	B0536 SS	7	5/8	1710	
35		6	1/2	33	1900		7 1/2	5/8	1805	
50		8 1/2	5/8	48	2000		7 3/4	5/8	1900	
51	B0125 SS	3 1/2	1/4	48	2100		7 3/4	5/8	1900	
65		4 1/2	3/8	62	2200		8 1/2	3/4	2090	
80		5 1/2	3/8	76	2300		9	3/4	2185	
100		7	1/2	95	2301	B0403 SS	4 1/2	3/8	2185	
101	B0530 SS	3 1/2	1/4	96	2400		4 3/4	3/8	2280	
125		4 1/2	3/8	119	2500		5	3/8	2375	
175		6	1/2	166	2600		5	3/8	2470	
230		8 1/2	5/8	219	2700		5 1/4	3/8	2565	
231	B0531 SS	3	1/4	219	2800		5 1/2	1/2	2660	
280		3 1/2	1/4	266	2900	5 3/4	1/2	2755		
330		4	1/4	314	2901	B0404 SS	4	3/8	2755	
380		5	3/8	361	3000		4	3/8	2850	
430		5 1/2	3/8	409	3100		4 1/4	3/8	2945	
480		6	1/2	456	3200		4 1/4	3/8	3040	
530		7	1/2	504	3300		4 1/2	3/8	3135	
600		8	5/8	570	3301	B0210 SS	3 1/2	1/4	3135	
601		B0533 SS	5	3/8	571		3400	3 1/2	1/4	3230
650			5 1/2	3/8	618		3500	3 1/2	1/4	3325
700	6		3/8	665	3600		3 3/4	1/4	3420	
760	6 1/2		1/2	722	3700		3 3/4	3/8	3515	
820	7		1/2	779	3800		4	3/8	3610	
880	7 1/2		1/2	836	3900		4	3/8	3705	
940	8		5/8	893	4000		4 1/4	3/8	3800	
1000	8 1/2		5/8	950	4001	B0327 SS	3	1/4	3801	
1001	B0535 SS	5	3/8	951	4300		3 1/4	1/4	4085	
1080		5 1/2	3/8	1026	4500		3 1/2	1/4	4275	
1160		6	1/2	1102	4700		3 1/2	1/4	4465	
1240		6 1/2	1/2	1178	4900		3 3/4	1/4	4655	
1320		7	1/2	1254	5100		4	3/8	4845	
1400		7 1/2	1/2	1330	5300		4	3/8	5035	
1500		8	5/8	1425	5301		B0415 SS	3 1/4	1/4	5036
1501		B0536 SS	5 3/4	1/2	1425	5500		3 1/4	1/4	5225
1600	6 1/4		1/2	1520	5700	3 1/2		1/4	5415	
1700	6 3/4		1/2	1615	5900	3 1/2		1/4	5605	
					6100	3 3/4		1/4	5795	

Table 4.2

V. Main Valve

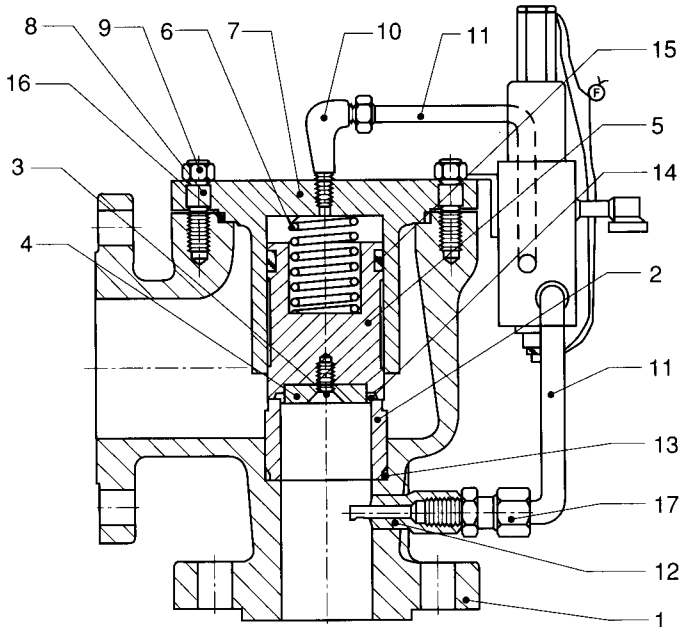


Fig. 5.1
Main Valve (1", 1 1/2", & 2" Inlet)

ITEM	PART NAME	MATERIAL
1	Body	SA-216, GR. WCB, CARB. ST.
2	Nozzle	316 ST. ST.
3	Retainer Screw	316 ST. ST.
4	Seat Retainer	316 ST. ST.
5	Piston	316 ST. ST.
6	Return Spring	316 ST. ST.
7	Guide/Cover	316 ST. ST.
8	Body Studs	ASTM A193 GR. B7
9	Body Hex Nut	ASTM A194 GR. 2H
10	Male Elbow	316 ST. ST.
11	Tubing	316 ST. ST.
12	Sensing Nipple	316 ST. ST.
13	Nozzle Seal	Viton®
14	Seat Seal	Viton®
15	Piston Seal	Viton®
16	Cover Seal	Viton®
17	NPT- Tub Connector	316 ST. ST.

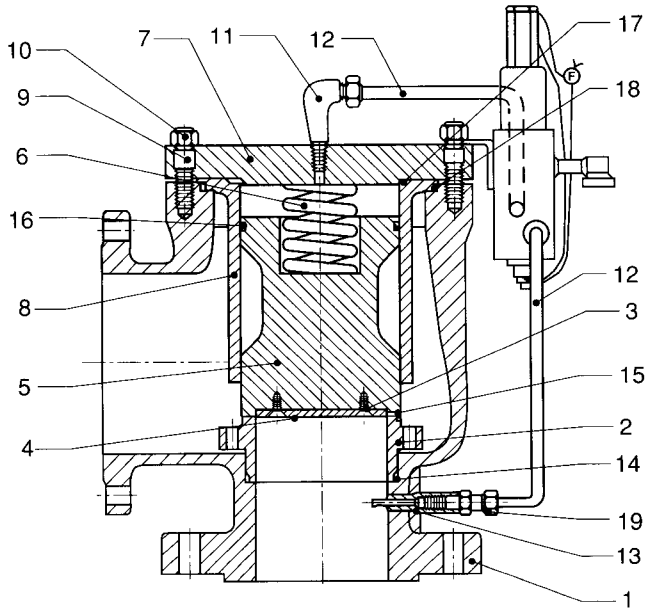


Fig. 5.2
Main Valve (3", 4", 6" & 8" Inlet)

ITEM	PART NAME	MATERIAL
1	Body	SA-216, GR. WCB, CARB. ST.
2	Nozzle	316 ST. ST.
3	Retainer Screw	316 ST. ST.
4	Seat Retainer	316 ST. ST.
5	Piston	316 ST. ST.
6	Return Spring	316 ST. ST.
7	Cover	316 ST. ST.
8	Guide	316 ST. ST.
9	Body Studs	ASTM A193 GR. B7
10	Body Hex Nut	ASTM A194 GR. 2H
11	Male Elbow	316 ST. ST.
12	Tubing	316 ST. ST.
13	Sensing Nipple	316 ST. ST.
14	Nozzle Seal	Viton®
15	Seat Seal	Viton®
16	Piston Seal	Viton®
17	Cover Seal	Viton®
18	Guide Seal	Viton®
19	NPT- Tub Connector	316 ST. ST.

Viton is a registered trademark of DuPont Dow Elastomers

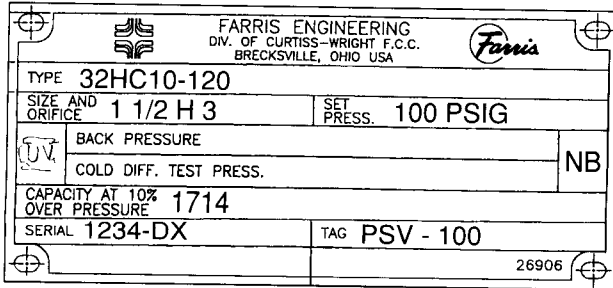


Fig. 5.3
Sample Nameplate for Main Valve

(i) Disassembly

ITEM	TOOL DESCRIPTION	SIZES
1	Wrenches	1/2", 5/8", 3/4", 7/8", 1-1/4"
2	O-Ring Pick	
3	1" Square Drive Socket Spanner	1-5/8", 2-7/16", 2-1/2", & 3-5/8"
4	1-1/2" Square Drive Socket Spanner	4-1/2"
5	Screw Driver	
6	Wire Cutter	
7	Extension Bar	9", 18"
8	C-Clamp	
9	Eye Bolt	

*Special tool for 6" & 8" inlet size valves (Part #s 25678 and 25677 respectively).

For 1", 1-1/2" and 2" inlet size: (Figure 5.1)

- Place valve on a clean and well-lit workbench.
- Remove wire seal.
- Remove pilot control, bracket and interconnecting tubing.
- Do not remove sensing nipple from body.
- Loosen body hex nuts and remove from cover.
- Using a nipple in the guide connection, carefully lift the guide-piston assembly straight up. Avoid tilting or dropping, which could damage nozzle face.
- Invert the guide-piston assembly and slide the piston and spring out.
- Remove cover seal.
- Remove seat retainer from piston by unscrewing the set screw.
- Remove seat seal and piston seal with o-ring pick.
- Unscrew nozzle from body with a socket spanner.
- Remove nozzle seal.

For 3", 4", 6" and 8" inlet size: (Figure 5.2)

- Place valve on a clean and well-lit workbench.
- Remove wire seal.
- Remove pilot control, bracket and interconnecting tubing.
- Do not remove sensing nipple from body.

- Loosen body hex nuts and remove from cover.
- Lift cover using eyebolts and lifting device.
- Remove spring.
- Remove cover seal from top of guide.
- Remove piston from guide using eyebolt and lifting device. Guide may also be lifted along due to piston seal friction. Hold the guide so that it will not be lifted with the piston.
- Remove guide and guide seal from body.
- Unscrew set screw to remove seat retainer from piston.
- Remove piston seal and seat seal.
- Unscrew nozzle from body with socket spanner or special tool. Remove nozzle from body.
- Remove nozzle seal from body.

(ii) Cleaning and Repairing

Clean all parts thoroughly. Replace all o-rings. Inspect all parts and replace any that are worn. **NO REMACHINING IS ALLOWED.** Polish guiding surfaces, if required. For o-ring purchasing, be sure to specify original compound. If in doubt, contact the Farris Factory.

(iii) Assembly

For 1", 1-1/2" and 2" inlet size:

- Refer to Figure 5.1 for construction details.
- Visually inspect all parts to be assembled. Replace any parts that are worn or damaged.
- Lubricate all threaded and mating surfaces with Bostik Never Seez or equivalent.
- Lubricate all seals with grease compound that is compatible to the elastomer.
- Insert nozzle seal into recess on bottom of nozzle.
- Screw nozzle into body using socket spanner.
- Position piston with the seat facing up. Place seat seal on piston, making sure it fits evenly and symmetrically.
- Place seat retainer on piston and tighten set screw, making sure that seat retainer sits evenly and symmetrically on piston. Use C-clamp to hold the piston and retainer in order to tighten the set screw fully.
- Insert piston seal into the groove around the circumference of the piston.
- Place cover seal onto the body.
- Invert piston so that the seat retainer faces down. Place spring on top of piston. Insert piston into guide with the spring in between. Check manually if there is interference between the guide and the piston. There may be some resistance due to the piston seal and the spring.
- Carefully place the guide-piston assembly into the body.

13. Thread body hex nuts onto body studs and tighten.
14. If sensing nipple is removed from the body, thread it to the body and make sure the hole orientation is correct and agrees with the arrows marked (Refer to Figure 5.4).
15. The main valve is now ready for final assembly (See Section VI).

For 3", 4", 6" and 8" inlet size:

1. Refer to Figure 5.2 for construction details.
2. Follow steps 2-5 of the assembly procedure for 1", 1-1/2" and 2" main valves.
3. Screw nozzle into body with socket spanner. Use the special tool to tighten nozzle for 6" and 8" inlet size valves.
4. Place the guide seal onto the body.
5. Place guide into the body carefully. Make sure that guide is seated on the body evenly.
6. Position piston with the seat facing up. Place seat seal on piston, making sure it fits evenly.
7. Place seat retainer on piston and align the holes of retainer to the threaded holes on piston. Tighten set screws. Use C-clamp to hold the piston and retainer if necessary.
8. Insert piston seal into the groove around the circumference of the piston.
9. Invert piston so that the retainer faces down. Lift piston with eyebolt and lifting device, and lower it into the guide carefully. Push the piston into the guide if needed. There should not be any interference between the guide and the piston, but there may be some frictional resistance caused by the piston seal.
10. Place spring on top of piston.
11. Place cover seal on guide.
12. Lift cover with eyebolts and lifting device. Align the holes of the cover with the body studs. Lower cover over guide.
13. Thread body hex nuts onto body studs and tighten.

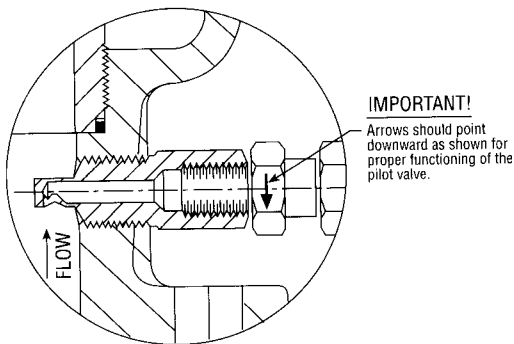


Fig. 5.4 Sensing Nipple Orientation

14. If sensing nipple is removed from the body, thread it to the body, making sure that hole orientation is correct and agrees with the arrow marked (Refer to Figure 5.4).
15. The main valve is now ready for final assembly (See Section VI).

VI. Final Assembly

The pilot control should have been tested and set prior to final assembly.

Assemble the pilot control to the main valve. Attach the mounting bracket securely to the pilot control. Bolt the mounting bracket to the main valve. Clear foreign matter in tubing by blowing compressed air through one end. The port connection and its orientation shall be exactly the same as the original configuration to guarantee valve operation. Refer to Figure 4.1 for port identification of the pilot control. Connect port A of the pilot control to the inlet of the main valve. Connect port B of the pilot control to the dome or piston of the main valve. Port C is the exhaust port, normally vented to the atmosphere.

Test the assembled pilot valve for proper setting.

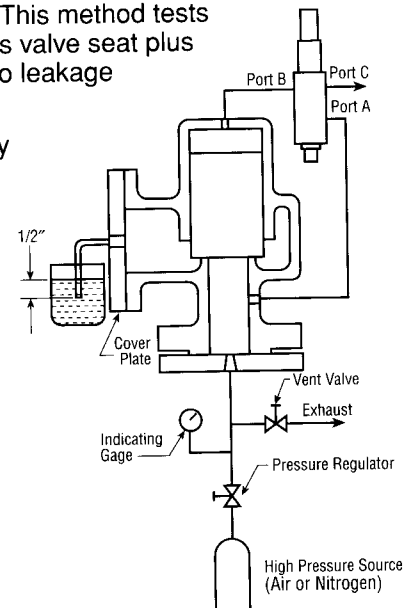
Next, perform leakage test on the pilot valve.

Main Seat Tightness Test (Refer to Figure 6.1)

Mount bubble test flange, tube, and cup on valve outlet. A tube of 5/16" OD X .035" wall submerged 1/2" below the water level shall be connected to the valve outlet. Apply nitrogen or air pressure to the valve inlet, equal to 95% of set pressure (if set pressure is 100 psig or more) or 5 psig below set pressure (if set pressure is less than 100 psig). This method tests for total leakage across valve seat plus piston seal leakage. No leakage is allowed.

The valve is now ready to be placed back in service.

Fig. 6.1 Main Seat Tightness Test



PRESSURE RELIEF VALVE INSTALLATION INSTRUCTIONS

1. Introduction

Pressure relief valves are precision instruments. Correct installation is essential for plant, property, personnel and public safety. Failure of a pressure relief valve can lead to catastrophic overpressure of equipment and/or the release of fluid under pressure. The fluids may be hazardous and all precautions should be taken to ensure safe disposal.

2. Storage & Handling

Cleanliness is essential to the satisfactory operation and tightness of a pressure relief valve. Every precaution should be taken to ensure that dirt or other foreign matter does not enter the valve.

- Valves that are not immediately installed in service should be stored indoors.
- Inlet and outlet covers should be left in place until the valve is to be installed.
- Valves should be moved and installed with the stem in the vertical position.
- Care should be taken to keep the inlet and outlet clean.

3. Receiving Inspection

A visual inspection of the valve should be made when it is first received. Any problems should be recorded and reported to the manufacturer or his local representative. Points that should be checked include:

- Looking for any shipping damage.
- Confirming the nameplate data against ordering documents.
- Verifying the factory wire seals are in place.
- Storing properly if the valve will not be installed immediately.

4. Confirmation of Set Pressure

Before the valve is installed, it is important to confirm the set pressure. This step should only be performed by trained personnel using proper test equipment. If trained personnel and/or proper test equipment are not available, this step should be skipped. Use of improper test procedures or equipment can damage the valve and will void any warranties.

5. Confirmation of Seat Tightness

After the set pressure has been verified, the valve's seat tightness should be checked using the procedures outlined in the appropriate maintenance manual. As a general rule, seat tightness testing is performed at 90% of the set pressure. This testing should only be performed by trained personnel using proper test equipment. If trained personnel and/or proper test equipment are not available, this step should be skipped. Use of improper test procedures or equipment can damage the valve and will void any warranties.

6. Inspection of Inlet and Outlet Piping

Before a pressure relief valve is installed in service, the upstream and downstream piping should be inspected for foreign matter such as welding beads, pipe scale, and other material that could damage the valve during relief. Wherever possible, the system should be thoroughly purged before the valve is installed.

7. Pressure Relief Valve Installation

Pressure relief valve performance can be adversely affected by improper installation. To ensure good performance, the following guidelines should be followed.

- Always install pressure relief valves upright with the stem in the vertical position and the inlet at the bottom.
- Avoid mounting valves close to equipment that can cause pressure fluctuations, such as compressor discharge lines.
- Avoid installing valves close to equipment that emits excessive heat.
- Install valves close to the pressure source so that the inlet pressure loss is no more than 3%.
- Mount valves away from equipment that may cause turbulence, such as reducing stations, orifice plates and nozzles, and other valves and fittings.
- Make sure all inlet and outlet piping is properly supported to avoid putting an excessive load on the valve. Provide drainage from the piping or from the valve body.
- Remove the inlet and outlet flange protectors. Any extraneous materials inside the valve body or nozzle should be removed.

- Make sure inlet piping is at least equal to or greater than the inlet size of the valve. Outlet piping should be equal to or greater than the valve's outlet size.
- On bellows valves remove the plastic shipping plug from the bonnet. Discharge vent in a safe direction.
- Tighten all inlet and outlet flange bolts evenly.
- Leave enough room to allow for in-line maintenance and adjustments.

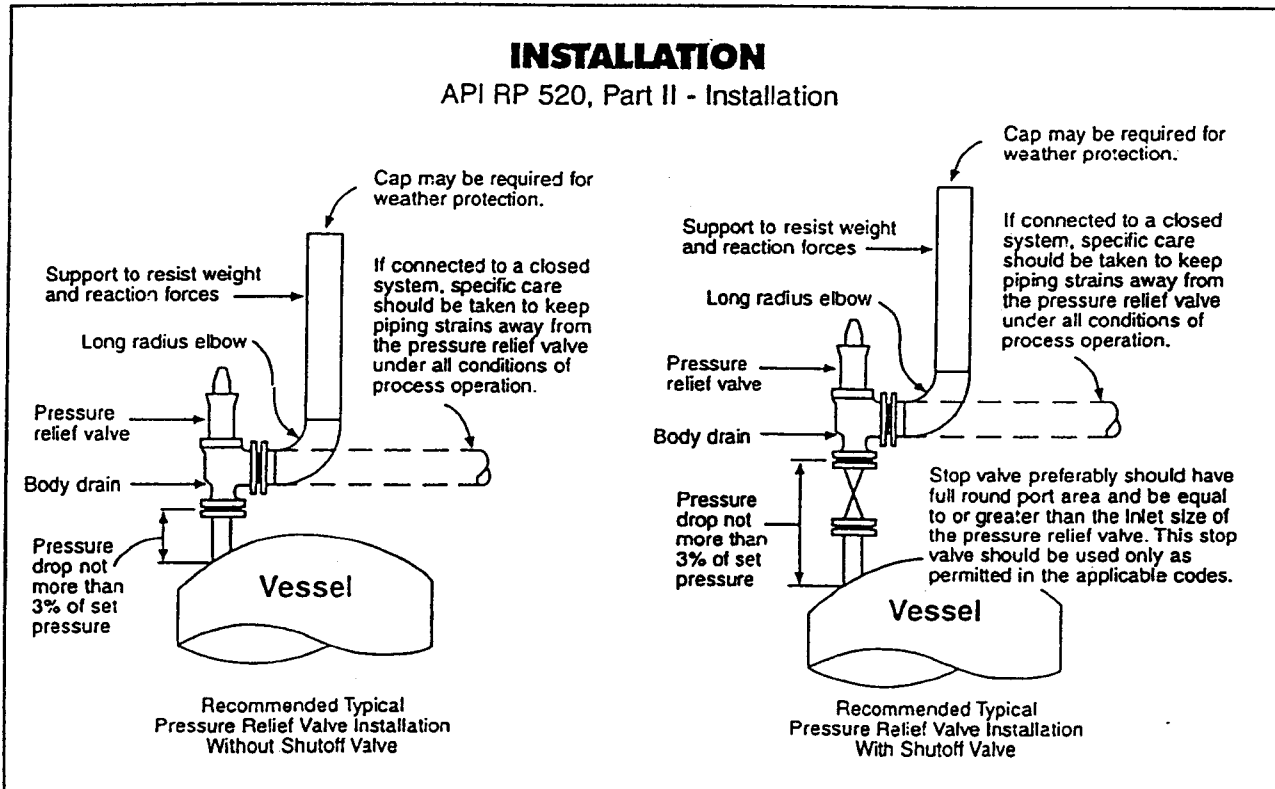
8. Lifting Levers

Lifting levers are provided on some valves to allow the user to manually verify that the valve trim is free to move when the operating pressure exceeds the set pressure.

To prevent stem damage, the valve should have a minimum of 75% of the set pressure under the disc before operating the test lever. In addition, the valve should never be carried by the lever as this can move the disc off the seat, resulting in damage to both parts.

9. System Start Up and Testing

It is recommended that the valve be isolated during pressure testing of the system, either by blanking or closing a stop valve. If gagging is used, extreme caution should be used to avoid damaging the valve stem or seat by overtightening the gag screw. Gag screws should be installed hand tight and should always be removed after system testing has been completed.



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RO 10/99 5M

Types 1051 and 1052 Styles F and G Size 40, 60, and 70 Rotary Actuators

Contents

Introduction	1
Scope of Manual	1
Description	3
Specifications	3
Installation	3
Actuator Mounting	4
Valve Flow Direction	6
Loading Connection	7
Turnbuckle Adjustment	7
Type 1052 Spring Adjustment	8
Initial Setting	8
Stroking Range	8
Principle of Operation	9
Maintenance	9
Disassembly	9
Assembly	11
Changing Actuator Mounting	13
Top-Mounted Handwheels and	
Adjustable Travel Stops	14
Principle of Operation for Handwheels	14
Handwheel Maintenance and Adjustable	
Travel Stop	15
Locking Mechanism	17
Installing the Locking Mechanism	17
Operating the Locking Mechanism	18
Pipe-Away Vent	20
Parts Ordering	21
Parts Reference	21



W8508-2

Figure 1. Vee-Ball Valve with Type 1052 Actuator and Type DVC6020 Positioner

Introduction

Scope of Manual

This instruction manual includes installation, adjustment, maintenance, and parts ordering information for the Type 1051 (size 40 and 60) and Type 1052 (Size 40, 60, and 70) pneumatic piston rotary actuator with F and G mounting adaptations (see figure 1).

The G mounting adaptation is for Type 7600 and 9500 valves, and the F mounting adaptation is for all

other ēdisc® or Vee-Ball® valves. Also, this instruction manual provides information for the optional top-mounted handwheel, up and down travel stops, locking mechanism, and pipe-away vent.

Instructions for the control valve, positioner, accessories, and other sizes of actuators are covered in separate instruction manuals.

Top-Mounted handwheels can be applied for infrequent service as a manual handwheel actuator. Also, an adjustable up travel stop can be added to the actuator to limit its stroke in the upward direction, or an adjustable down travel stop can be added to limit actuator stroke in the downward direction.

No person may install, operate, or maintain a Type 1051 or 1052 actuator without first • being fully trained and qualified in valve, actuator, and accessory installation, operation, and maintenance, and • carefully reading and understanding the contents of this manual. If you have any questions about these instructions, contact your Fisher® sales office before proceeding.



1051 & 1052 F & G Actuators

Table 1. Type 1051 and 1052 Actuator Specifications

<p>Operation</p> <p>Direct Acting: Increasing loading pressure extends the diaphragm rod out of the spring barrel</p> <p>Service: <i>Type 1051:</i> For on-off or throttling service with positioner <i>Type 1052:</i> For on-off or throttling service with or without a positioner</p> <p>Actuator Sizes</p> <p>Type 1051: ■ 40 and ■ 60 Type 1052: ■ 40, ■ 60, and ■ 70</p> <p>Maximum Diaphragm Sizing Pressure⁽¹⁾</p> <p>Size 40: 4.5 bar (65 psig) Size 60: 2.8 bar (40 psig) Size 70: 3.8 bar (55 psig)</p> <p>Maximum Diaphragm Casing Pressure⁽³⁾</p> <p>Size 40: 5.2 bar (75 psig) Size 60: 3.4 bar (50 psig) Size 70: 4.5 bar (65 psig)</p> <p>Maximum Valve Shaft Rotation</p> <p>90 degrees rotation (standard) travel stop, or 60 degrees (optional) travel stop for Type 1051 and 1052 actuators, or 75 degrees (optional) travel stop for Type 1052 actuators</p> <p>Valve Shaft Diameters, mm (Inches)</p> <p>Size 40: ■ 12.7 (1/2), ■ 15.9 (5/8), ■ 19.1 (3/4), ■ 22.2 (7/8), ■ 25.4 (1), or ■ 31.8, (1-1/4) Size 60: ■ 19.1 (3/4), ■ 22.2 (7/8), ■ 25.4 (1), ■ 31.8 (1-1/4), ■ 38.1 (1-1/2), ■ 44.5 (1-3/4), or ■ 50.8 (2)</p>	<p>Size 70: ■ 31.8 (1-1/4), ■ 38.1 (1-1/2), ■ 44.5 (1-3/4), or ■ 50.8 (2)</p> <p>Stroking Time</p> <p>Dependent on actuator size, rotation, spring rate, initial spring compression, and supply pressure. If stroking time is critical, consult your Fisher sales office</p> <p>Material Temperature Capabilities⁽²⁾</p> <p>Nitrile Diaphragm: -40 to 82°C (-40 to 180°F) Silicone Diaphragm: -40 to 149°C (-40 to 300°F) Nitrile O-Rings: -40 to 82°C (-40 to 180°F), Nitrile O-rings are used in optional top-mounted handwheel, adjustable down travel stop, and adjustable up travel stop assemblies</p> <p>Travel Indication</p> <p>Graduated disc and pointer combination located on actuator end of valve shaft</p> <p>Pressure Connections</p> <p>Standard: 1/4 inch NPT female thread Optional: ■ 1/2 or ■ 3/4 inch NPT female, and ■ 3/4 inch NPT female thread for pipe-away vent</p> <p>Mounting Positions</p> <p>See figure 3.</p> <p>Approximate Weights</p> <p>See table 2.</p> <p>Additional Specifications</p> <p>For casing pressure ranges and for material identification of the parts, see the Parts List</p>
---	---

1. Use this value to determine the maximum torque output allowed.

2. The pressure/temperature limits in this manual and any applicable standard or code limitation for valve should not be exceeded.

3. This maximum casing pressure is not to be used for normal operating pressure. Its purpose is to allow for typical regulator supply settings and/or relief valve tolerances.

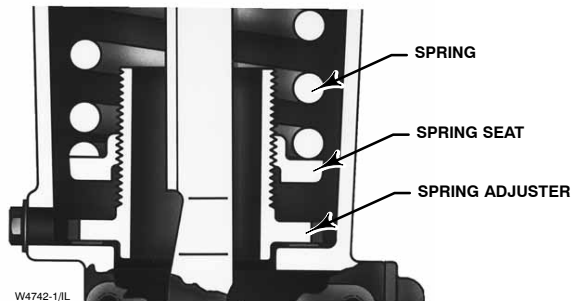


Figure 2. Typical Type 1052 Actuator Adjustable Spring Seat

Note

Neither Emerson®, Emerson Process Management, Fisher, nor any of their affiliated entities assumes responsibility for the selection, use and maintenance of any product. Responsibility for the selection, use, and maintenance of any product remains with the purchaser and end-user.

Description

The Type 1051 and 1052 diaphragm rotary actuators are pneumatic spring-return actuators for use with rotary-shaft control valves. The Type 1051 actuator can be used for on-off service, or it can be used for throttling service when equipped with a valve positioner. The Type 1052 actuator can be used for on-off service, or it can be used for throttling service when equipped with or without a valve positioner. The Type 1052 actuator spring is adjustable (see figure 2).

Table 2. Approximate Actuator Weights

SIZE	TYPE 1051		TYPE 1052		TOP-MOUNTED HANDWHEEL	
	Kg	Lb	Kg	Lb	Kg	Lb
40	43	94	45	99	7.3	16
60	89	197	92	203	11	24
70	---	---	123	272	21	47

Specifications

Specifications are shown in table 1. Specifications for actuator operation, as it originally comes from the factory, are stamped on the nameplate attached to the actuator.

Installation

When an actuator and valve body are shipped together, the actuator is normally mounted on the valve. Follow the valve body instructions when installing the control valve in the pipeline, and then perform the procedures presented in the Loading Connection section. If the actuator is shipped separately or if it is necessary to mount the actuator on the valve, perform the procedures presented in the Actuator Mounting section. And, if the actuator requires a pipe-away vent, or if a retrofit pipe-away kit needs to be installed, refer to the Pipe-Away Vent section.

WARNING

Always wear protective gloves, clothing, and eyewear when performing any installation operations. Be aware of pinching parts during installation operations.

Check with your process or safety engineer for any additional measures that must be taken to protect against process media.

If installing into an existing application, also refer to the WARNING at the beginning of the Maintenance section in this instruction manual.

1051 & 1052 F & G Actuators

Table 3. Recommended Bolting Torques

DESCRIPTION, KEY NUMBER	ACTUATOR SIZE								
	40			60			70		
	Size	N•m	lbf•ft	Size	N•m	lbf•ft	Size	N•m	lbf•ft
Diaphragm Casing, 5	3/8–24	27	20	3/8–24	27	20	3/8–24	27	20
Casing to spring barrel, 7	3/8–16	41	30	3/8–16	41	30	1/2–13	102	75
Diaphragm to rod, 9 (1051)	1/2–13	34	25	3/4–10	102	75	---	102	75
Diaphragm to rod, 9 (1052)	1/2–20	34	25	3/4–16	102	75	3/4–16	102	75
Rod end bearing, 16	1/2–20	34	25	5/8–18	61	45	3/4–16	102	75
Turnbuckle to lever, 18	1/2–13	81	60	5/8–11	163	120	3/4–10	271	200
Spring barrel to housing, 21	5/16–18	23	17	7/16–14	68	50	5/8–18	68	50
Housing to yoke, 23	3/8–16	34	25	1/2–13	81	60	1/2–13	81	60
Travel stop to lever, 28	1/2–13	81	60	5/8–11	163	120	3/4–10	271	200
Side of housing, 34 304/4200/PMV	3/8–16	34	25	1/2–13	81	60	1/2–13	81	60
Handwheel top, 54	1/2–20	34	25	5/8–18	34	25	---	34	25
Diaphragm head to rod/Adjustable down travel stop, 54 (1051)	1/2–13	27	20	3/4–10	66	49	---	69	51
Diaphragm head to rod/Adjustable down travel stop, 54 (1052)	1/2–20	27	20	3/4–16	66	49	3/4–16	69	51
Rod end to turnbuckle, 58	3/4–16–LH	102	75	7/8–14–LH	163	120	7/8–14–LH	163	120
Handwheel to actuator, 141	3/8–16	41	30	3/8–16	41	30	1/2–13	81	60

CAUTION

To avoid parts damage, do not use an operating pressure that exceeds the Maximum Diaphragm Casing Pressure (table 1) or produces a torque greater than the Maximum Allowable Valve Shaft Torque (see Catalog 14). Use pressure-limiting or pressure-relieving devices to prevent the diaphragm casing pressure from exceeding its limit.

To avoid parts damage, do not stroke the actuator while cover (key 33) is off.

Actuator Mounting

Use the following steps to connect a valve and an actuator. Key numbers are shown in figure 8 for Type 1051 actuators and in figure 9 for Type 1052 actuators.

WARNING

To avoid personal injury, perform the steps in the WARNING at the beginning of the Maintenance section to isolate the control valve and actuator.

1. Unscrew cap screws and washers (keys 34 and 63), and remove the cover (key 33).
2. Refer to figure 3 for available mounting styles and positions. When mounting on a Vee-Ball Design V150, V200 or V300 valve, check the valve manual to determine if it is Series B. The actuator is normally positioned vertically with the valve in a horizontal pipeline (see figure 3).

Instruction Manual

Form 5062
August 2005

1051 & 1052 F & G Actuators

MOUNTING	ACTION ⁽¹⁾	VALVE SERIES OR DESIGN				VALVE SERIES OR DESIGN		
		BALL/PLUG ROTATION TO CLOSE	V250	V150, V200 & V300	CV500 V500	DISC/BALL ROTATION TO CLOSE	V250	8510B, 8532, 8560 & 9500
Right-Hand	PDTC	CCW	A	A	A	CW	NA	B
	PDTO	CCW	B	B	B	CW	NA	A
Left-Hand	PDTC	CCW	NA	D	D	CW	C	C
	PDTO	CCW	NA	C	C	CW	D	D
Left-Hand (Optional) ⁽²⁾	PDTC	CW	NA	C	NA	NA	NA	NA
	PDTO	CW	NA	D	NA	NA	NA	NA

1. PDTC—Push-down-to-close, and PDTO—Push-down-to-open.
2. A left hand ball will be required for the 3- through 12-inch Series B and the 14- to 20-inch, with or without attenuator.

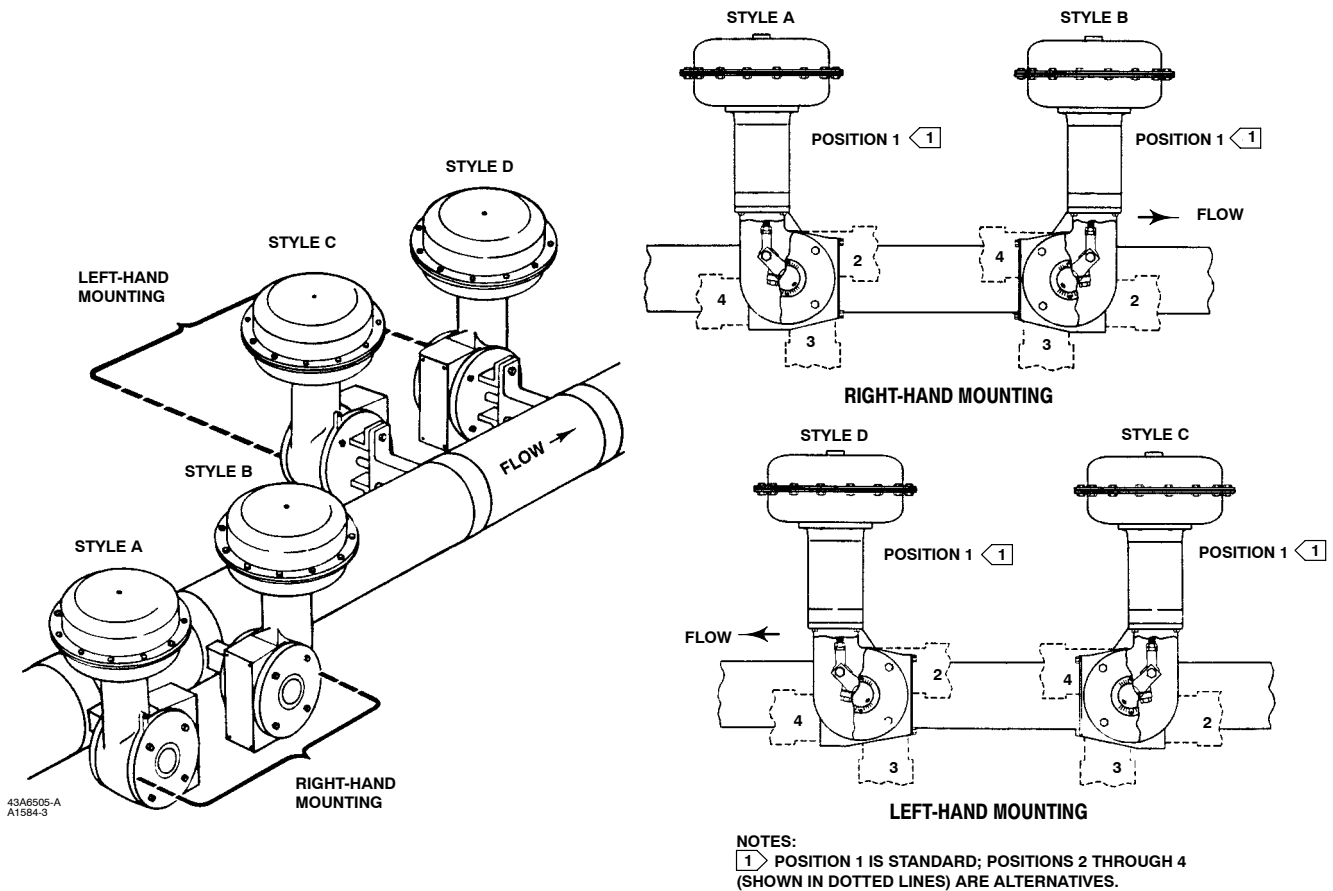


Figure 3. Mounting Styles and Positions for the Type 1051 and 1052 Actuator

WARNING

To avoid personal injury or property damage, the Type 1052 size 70 actuator, due to its weight, must be externally supported if mounted in the horizontal position.

3. When mounting the actuators, make sure that the bushing (key 67) and valve shaft are in-line so that the bushing will slide onto the valve shaft without damage.

4. Mount the actuator on the valve body and secure it with the valve mounting screws. The torque for 1/2 to 1-inch shafts is 88 N•m (65 lbf•ft); for 1-1/4 to

1051 & 1052 F & G Actuators

1-1/2 inch shafts is 136 N•m (100 lbf•ft); for 1-3/4 to 2-inch shafts is 183 N•m (135 lbf•ft).

CAUTION

Exceeding any torque requirement may impair the safe operation of this actuator by causing broken or damaged parts. Refer to table 3 for the bolting torque requirements.

5. Screw the left-hand threaded locknut (key 58) onto the diaphragm rod (key 10) as far as possible.
6. Screw the turnbuckle (key 57) as far as it will go onto the actuator rod.
7. Screw the locknut (key 16) as far as it will go onto the rod end bearing (key 17). Thread this assembly completely into the turnbuckle (key 57).
8. If the lever (key 27) is attached to the rod end bearing, remove the cap screw and hex nut (keys 18 and 19).
9. If the Type 1052 spring adjustment has been changed, complete the Initial Setting portion of the Type 1052 Spring Adjustment section before proceeding.
10. Consult the appropriate valve instruction manual's Installation section for lever/valve shaft orientation marks, and slide the lever into place (see figure 4). Clamp with the cap screw (key 28).
11. Rotate the lever (key 27) to align with the rod end bearing (key 17). This connection can be aided by moving the actuator off its up travel stop with a regulated air source and adjusting the turnbuckle (key 57) slightly.
12. Apply sealant (key 77) or equivalent thread-locking compound to the threads of the cap screw (key 18).
13. Connect the lever (key 27) and the rod end bearing (key 17) with the cap screw and hex nut (keys 18 and 19). Tighten the cap screw to the recommended bolt torque shown in table 3.
14. Note the valve position and direction of rotation. Position the travel indicator (key 37) accordingly.
 - a. If no handwheel actuator is to be used, position the travel indicator (key 37) according to

the valve position just noted. Replace the cover (key 33), and secure with washers and cap screws (keys 34 and 63). If holes in the cover and housing (key 20) do not align, temporarily loosen the cap screws (key 23), and shift the housing slightly.

CAUTION

To avoid parts damage, do not stroke the actuator while cover (key 33) is off.

- b. If a manual handwheel actuator is to be used, refer to the separate handwheel actuator instruction manual for mounting instructions.
15. Replace the cover (key 33), and secure with cap screws and washers (keys 34 and 63). If the holes in the cover and housing (key 20) do not align, use a regulated air source to move the actuator slightly off the up travel stop. If the hole alignment cannot be obtained in this manner, temporarily loosen the cap screws (key 23), and shift the housing slightly.

CAUTION

To avoid parts damage, do not stroke the actuator while cover (key 33) is off.

16. Follow the instructions given in the Turnbuckle Adjustment section before proceeding to the Loading Connection section.

Valve Flow Direction

Valve construction can change the flow direction for a control valve assembly. It is important to observe the flow direction in all valve applications **before** installing the valve in the pipeline (see figure 3). Refer to the appropriate valve bulletin or instruction manual.

Note

Observe all warnings and cautions provided in the appropriate valve instruction manual Installation section.

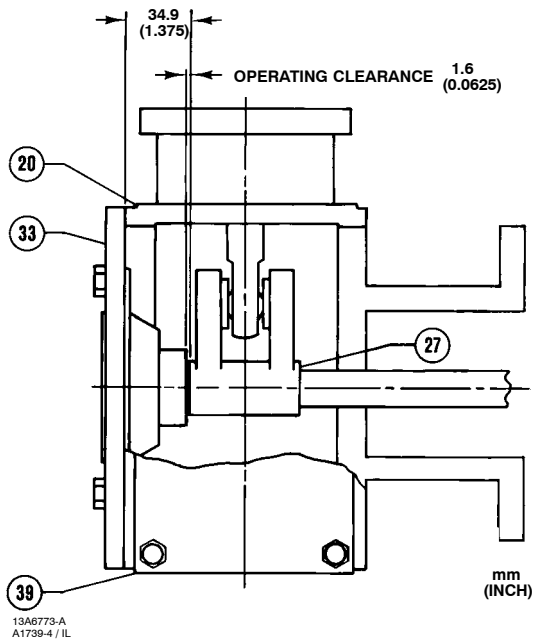


Figure 4. Lever Operating Clearance

Loading Connection

1. Connect the loading pressure piping to the pressure connection in the top of the diaphragm casing.
 - a. **For size 40 through 60 actuators:** Run either 1/4 inch pipe or 3/8 inch tubing between the 1/4 inch pressure connection and the instrument.
 - b. **For size 70 actuators:** Run either pipe or tubing between the pressure connection and the instrument. If necessary, remove the 1/4 inch bushing in the pressure connection to increase connection size.
2. Keep the length of pipe or tubing as short as possible to avoid transmission lag in the control signal. If an accessory (such as a volume booster or a valve positioner) is used, be sure that the accessory is properly connected to the actuator. If a valve positioner is part of the assembly, the pressure connection to the actuator will normally be made at the factory.

Table 4. Wrench Size Required for Turnbuckle Adjustment, Inches

ACTUATOR		TURN- BUCKLE (KEY 57)	LOWER LOCKNUT (KEY 16)	UPPER LOCKNUT (KEY 58)
Type	Size			
1051 & 1052	40	1-1/8	3/4	1-1/8
	60	1-5/16	15/16	1-5/16
	70	1-5/16	1-1/8	1-5/16

3. When the control valve is completely installed and connected to the instrument, check for correct action (air-to-open or air-to-close) to match the controlling instrument. For successful operation, the actuator stem and valve shaft must move freely in response to the loading pressure change on the diaphragm.

Adjustment

Turnbuckle Adjustment

Correct turnbuckle adjustment ensures that the valve is correctly closed when the actuator is against its travel stops. The turnbuckle adjustment is the only adjustment necessary on the Type 1051 actuator. Key numbers are shown in figure 8 for Type 1051 actuators and in figure 9 for Type 1052 actuators.

For accurate adjustment to the zero-degree valve disc or ball position, remove the valve from the pipeline. Refer to the valve instruction manual for instructions.

A regulated air supply will be required to stroke the actuator. Refer to table 4 for the sizes of the three open-end wrenches required for this procedure.

1. Remove the access plate (key 59). Also remove the machine screws (key 60), if present.

Note

For the most accurate adjustment of the actuator, do not remove the cover (key 33) during this procedure.

2. Loosen the lower locknut (key 16).
3. Make sure the actuator housing (key 20) is clear of any tools or other instruments that could obstruct the actuator stroke path. Pressure the diaphragm casing enough to stroke the actuator down so that the left-hand threaded upper locknut (key 58) is accessible through the access opening. Loosen the locknut.
4. Consult the appropriate valve instruction manual for determining the closed position of the valve. Then use one of the following:

1051 & 1052 F & G Actuators

a. **Push-down-to-close**—Slowly stroke the actuator to the down travel stop. Adjust the turnbuckle (key 57) until the valve is in the closed position. Lock this adjustment with the left-hand threaded locknut (key 58). Stroke the actuator to the mid-travel position, and tighten the locknut (key 16).

b. **Push-down-to-open**—Release all pressure from the diaphragm casing, making sure the diaphragm is against its up travel stop. Be sure that the optional handwheel is adjusted to its topmost position so that the zero position of the actuator and valve can be reached simultaneously. Check the valve position. Stroke the actuator so the turnbuckle (key 57) is accessible through the access opening. Adjust the linkage. Release pressure to the actuator, and check the new adjustment. Continue this procedure until the valve is in the closed position when the actuator is resting on its up travel stop. Stroke the actuator to the mid-travel position, and tighten the locknut (key 16). Stroke the actuator, and tighten the left-hand threaded locknut (key 58).

5. Replace the access plate (key 59).

6. Loosen the self-tapping screws (key 38), adjust the travel indicator (key 27), and re-tighten the self-tapping screws.

Type 1052 Spring Adjustment

Initial Setting

The Type 1052 nameplate specifies an initial spring setting, which is the initial setting adjusted into the actuator spring. Initial setting is the casing pressure at which the diaphragm and diaphragm rod begin to move away from the up travel stop **with the actuator disconnected from the valve**. (With the actuator connected to the valve and pressure applied to the valve, a higher pressure will be required to start actuator travel).

The initial setting was selected (based upon the service conditions specified when the actuator was ordered) so that, when the actuator and valve are in service, the valve will seat properly and full travel will be obtained within a diaphragm casing range of 0 to 1.2, 0 to 2.3, 0 to 2.8, or 0 to 3.8 bar (0 to 18, 0 to

33, 0 to 40, or 0 to 55 psig) depending on specific actuator size and construction.

If the actuator has been disassembled or if the spring adjustment was changed, and it is desired to match the initial setting stated on the nameplate, make sure the rod end bearing (key 17, figure 8 or 9) has been disconnected from the lever (key 27, figure 8 or 9). Adjust the spring so that the diaphragm rod just starts to travel at the spring set pressure specified on the nameplate.

Be sure the rod end bearing does not hit the lever as the diaphragm and diaphragm rod move away from the up travel stop. To adjust the spring, insert a round rod into one of the holes in the lower bearing seat (key 73, figure 9). Hole diameter is 9.5 mm (3/8 inch) for size 40 actuators, 15.9 mm (5/8 inch) for size 60 actuators, and 10.1 mm (3/4 inch) for size 70 actuators. Rotate the bearing seat to move it toward the casing to increase initial setting or away from the casing to decrease initial setting (keys 1 and 2, figure 9).

Stroking Range

The initial spring setting listed on the nameplate has been determined to be the optimum setting, and it is not recommended to make spring adjustments that will cause this value to change or be exceeded. For push-down-to-open valve action, the initial spring setting is the maximum allowable to provide the maximum spring closing force.

CAUTION

Any increase of this setting will over-stress the spring at full travel and may shorten the fatigue life of the spring.

For push-down-to-close valve action, the initial spring set has been determined to be the optimum balance between the air-to-close and the spring-to-open breakout torque.

If the Type 1052 actuator is to be changed from one valve action to another (i.e., push-down-to-close to push-down-to-open), first, refer to the table for key 11 in the Parts List section to determine the proper initial spring setting; then, adjust the unit according to the procedures in the Initial Settings portion of the Type 1052 Spring Adjustment section.

Principle of Operation

The diaphragm rod moves down as loading pressure is increased on top of the diaphragm. As the loading pressure is decreased, the spring forces the diaphragm rod upward.

The spring and diaphragm have been selected to meet the requirements of the application and, in service, the actuator should produce full travel of the valve with the diaphragm pressure as indicated on the nameplate.

Consult the separate positioner instruction manual for actuator principle of operation with positioner.

Maintenance

Actuator parts are subject to normal wear and must be inspected and replaced as necessary. The frequency of inspection and replacement depends upon the severity of service conditions. Key numbers are shown in figure 8 for Type 1051 actuators and in figure 9 for Type 1052 actuators.



WARNING

Avoid personal injury or property damage from sudden release of process pressure or uncontrolled movement of parts. Before performing any maintenance operations:

- Always wear protective gloves, clothing, and eyewear when performing any maintenance operations to avoid personal injury. Be aware of pinching parts during maintenance operations.
- Disconnect any operating lines providing air pressure, electric power, or a control signal to the actuator. Be sure the actuator cannot suddenly open or close the valve.
- Use bypass valves or completely shut off the process to isolate the valve from process pressure. Relieve process pressure from both sides of the valve. Drain the process media from both sides of the valve.
- Vent the power actuator loading pressure and relieve any actuator spring precompression.

- Use lock-out procedures to be sure that the above measures stay in effect while you work on the equipment.

- The valve packing box may contain process fluids that are pressurized, *even when the valve has been removed from the pipeline*. Process fluids may spray out under pressure when removing the packing hardware or packing rings, or when loosening the packing box pipe plug.

- Check with your process or safety engineer for any additional measures that must be taken to protect against process media.

CAUTION

To avoid parts damage, do not stroke the actuator while cover (key 33) is off.

Disassembly

The following procedure describes how to completely disassemble the actuator. When inspecting and replacing parts, perform only those steps necessary to accomplish the repair.

Do **not**, under ordinary circumstances, remove the cap screws (keys 7, 8, and 21) at this time.

CAUTION

Cap screw (key 18) must be disengaged from the lever (key 27) before removing the diaphragm casing (key 1). Failure to do so will allow the spring precompression to rotate the valve beyond its fully open or closed position. This could cause damage to the valve components and/or seal.

1. Perform the steps in the **WARNING** at the beginning of the Maintenance section to isolate the control valve and actuator.
2. Remove the tubing or piping from the top of the actuator.
3. Remove the positioner, if used. If necessary, refer to the positioner instruction manual for removal instructions.
4. Unscrew the cap screws and washers (keys 34 and 63), and remove the cover (key 33).

1051 & 1052 F & G Actuators

5. Remove the retaining ring (key 30), and slide the hub (key 29) from the cover. If necessary, remove the travel indicator (key 37) from the hub (key 29).
6. Inspect, and if necessary, replace the cover bushing (key 31). Remove the travel indicator scale (key 35) by removing the self-tapping screws (key 36). Press the bushing out of the cover (key 33).
7. Remove the cap screw and hex nut (keys 18 and 19).
8. Make note of the lever/valve shaft orientation, and then loosen the cap screw (key 28).

CAUTION

When removing the actuator from the valve, do not use a hammer or similar tool to drive the lever (key 27) off the valve shaft. Driving the lever could damage internal valve parts. On some valve types, driving the lever off the shaft could move the valve disc or ball and bearings away from the centered position, causing subsequent damage to valve parts as the valve is operated.

A wheel puller may be used to remove the lever. It is okay to tap the wheel puller screw lightly to loosen the lever, but hitting the screw with excessive force could also damage valve parts or disrupt the centered position of the valve disc and bearings.

9. Rotate the handwheel (if one is used) counterclockwise until the handwheel is not compressing the spring (key 11).

WARNING

To avoid personal injury from pre-compressed spring force suddenly thrusting the upper diaphragm casing (key 1) away from the actuator, relieve Type 1052 spring compression, or carefully remove Type 1051 casing cap screws before proceeding further.

10. To relieve spring compression:

a. *For Type 1051 actuators:*

- Loosen, but do not remove, all casing cap screws and hex nuts (keys 5 and 6). Make sure

there is no spring force to the upper diaphragm casing.

- Unscrew and remove the cap screws and hex nuts (keys 5 and 6), and then remove the upper diaphragm casing and the diaphragm (key 3).

b. *For Type 1052 actuators:*

- Insert a round rod into one of the holes in the lower bearing seat (key 73). Use the rod to rotate the lower bearing seat, and move it away from the actuator casings. Continue rotating the lower bearing seat until spring compression is completely removed. Rod hole diameter is 9.5 mm (3/8 inch) for size 40 actuators, 15.9 mm (5/8 inch) for size 60 actuators, and 19.1 mm (3/4 inch) for size 70 actuators.

- Unscrew and remove the cap screws and hex nuts (keys 5 and 6), and then remove the upper diaphragm casing and the diaphragm (key 3).

11. **Removing the diaphragm plate (key 4):**

a. *For Type 1051 actuators:*

- Pull the diaphragm plate (key 4) and attached parts out of the actuator. The spring (key 11), diaphragm rod (key 10), cap screw (key 9), spring seat (key 13), hex nut (key 58), turnbuckle (key 57), hex nut (key 16), and rod end bearing (key 17) will be attached to the diaphragm head assembly.

- The diaphragm plate (key 4) may be wedged against the diaphragm rod (key 10), thereby preventing the spring compression from being relieved as the cap screw (key 9) is loosened.

WARNING

Dislodge the diaphragm plate (key 4) from the diaphragm rod (key 10) before completely removing the cap screw (key 9). Failure to comply with this requirement could cause personal injury due to the sudden release of spring compression.

- Dislodge the diaphragm plate (key 4) from the diaphragm rod (key 10) by loosening the cap screw (key 9) one full turn and tapping the underside of the diaphragm plate until it follows the cap screw as it is being removed. Failure to check for this condition before completely removing the cap screw (key 9) could cause personal injury due to the sudden release of spring compression.

- Slowly remove the cap screw (key 9) while making sure that the diaphragm head assembly is following the cap screw disassembly. **Note—Make sure that spring load is zero before the cap screw is completely removed. See the WARNING on the preceding page.** If necessary, separate the remaining parts of the assembly.

b. *For Type 1052 actuators:*

(1.) Remove the rod end bearing (key 17), the hex nut (key 16), turnbuckle (key 57), and the hex nut (key 58) from the diaphragm rod (key 10).

(2.) Pull the diaphragm plate (key 4) and attached parts out of the actuator. Then remove the cap screw (key 9) to separate the diaphragm plate and the diaphragm rod.

(3.) Proceed as appropriate:

- *For Size 40 and 60 actuators:* Remove the actuator spring (key 11) from the actuator. If it is necessary to remove the adjusting screw (key 74) from the spring barrel during this procedure, heat the base of the adjusting screw to 177°C (350°F) long enough for the thread-locking compound (key 77) to lose its holding strength. Then, unscrew the adjusting screw from the spring barrel. If the spring seat and the lower bearing seat (keys 13 and 73) are to be replaced, unscrew the lower bearing seat from the adjusting screw, and then remove the thrust bearing and the bearing races (keys 71 and 72) from the lower bearing seat.

- *For Size 70 actuators:* Remove the actuator spring (key 11) from the actuator. Remove the cap screws (key 21), then remove the spring barrel (key 12) from the actuator housing. If it is necessary to remove the spring adjustment parts, loosen the set screw (key 75), and unscrew the spring adjusting screw (key 74) from the spring barrel (key 12).

12. Unscrew the cap screws (key 23), and remove the actuator housing assembly (key 20).

13. Unbolt the mounting yoke (key 22) from the valve.

14. Check the bushing (key 67) in the mounting yoke. Press out and replace the bushing if necessary.

Assembly

This procedure assumes that the actuator was completely disassembled. If the actuator was not completely disassembled, start these instructions at the appropriate step. This procedure also assumes that the valve is removed from the pipeline for ease in actuator assembly and adjustment.

Key numbers are shown in figure 8 for Type 1051 actuators and in figure 9 for Type 1052 actuators.

1. Installing the spring barrel (key 12):

a. *For Type 1051 actuators:* Place the spring barrel onto the housing (key 2). Secure the spring barrel with cap screws (key 21). Tighten the cap screws to the torque value shown in table 3.

b. *For Type 1052 actuators:* If the spring barrel (key 12) was removed from the housing (key 20), align the spring barrel to the housing as described below to ensure that the offset hole in the base of the spring barrel will be located properly.

- *For Size 40 and 60 actuators:* Note that one of the accessory mounting bosses on the spring barrel is closer to the diaphragm end of the spring barrel. Place the spring barrel onto the housing with the upper boss (the one closer to the diaphragm end) on the same side as the boss located on the housing (see figures 8 and 9). This ensures proper positioning of the offset hole. Secure the spring barrel with cap screws (key 21). On final assembly, tighten the screws to the torque value shown in table 3.

- *For Size 70 actuators:* The spring barrel need not be aligned in any particular position when placing it on the housing.

2. If the bushing (key 67) was removed, press in the new bushing. The end of the bushing should be flush with the bottom of the recess in the mounting yoke (key 22).

3. Slide the mounting yoke over the valve shaft, and secure it to the valve with the valve mounting cap screws.

4. Tighten the valve mounting cap screws to the bolting torque listed in step 6 of the Installation procedures.



WARNING

Exceeding any torque requirement may impair the safe operation of the

1051 & 1052 F & G Actuators

actuator and lead to possible personal injury or property damage.

5. Refer to figure 4 for the desired orientation of the housing (key 20). Secure the housing to the mounting yoke with cap screws (key 23).

6. Coat with lithium grease (key 93) lubricant or equivalent on the cap screw threads (key 9), and the tapered end of the diaphragm rod (key 10).

7. Proceed as appropriate:

a. For Type 1051 actuators (see figure 8)

- Assemble the diaphragm rod, spring seat (key 13), spring (key 11), and diaphragm plate (key 4), and secure with the cap screw (key 9). Tightening the cap screw will compress the spring. Be certain the tapered end of the diaphragm rod is seated in the corresponding hole in the diaphragm plate, that the spring is seated in the spring seat, and that the cap screw is tightened to the torque specified in table 3.

- Install the hex nut (key 58), turnbuckle (key 57), hex nut (key 16), and rod end bearing (key 17) onto the diaphragm rod.

- Be certain the travel stops (key 8) are located as shown in figure 5.

- Install the diaphragm plate and attached parts into the actuator.

- Be sure the warning nameplate (key 56) is in place. Install the diaphragm (key 3) and the upper diaphragm casing (key 1). Install the cap screws and hex nuts (keys 5 and 6). Tighten the cap screws evenly in a crisscross pattern to compress the spring and secure the upper diaphragm casing. Refer to table 3 for torque values.

b. For Type 1052 actuators (see figure 9):

- *For actuator designs without a set screw (key 75) in the spring barrel (key 12):* if the adjusting screw and attached parts were removed, first clean and then lubricate the upper threads of the adjusting screw (key 74) with a lubricant (key 76) or equivalent as shown in figure 9. Install the lower bearing seat (key 73), the thrust bearing (key 71), the thrust bearing races (key 72), and the spring seat (key 13) onto the adjusting screw.

- First, clean and then coat the lower end of the adjusting screw with sealant (key 77) or equivalent

thread-locking compound as shown in figure 9, and install the entire assembly into the spring barrel (key 12). Let the adjusting screw stand undisturbed for at least two hours after installation to allow the thread-locking compound to cure.

CAUTION

Apply lubricant to the upper threads and thread-locking compound to the lower threads of the adjusting screw. Do not overlap the coat of lubricant with the coat of thread-locking compound since this will adversely affect the performance quality of both substances.

- *For actuator designs with a set screw (key 75),* if the adjusting screw (key 74) and attached parts were removed, lubricate the threads of the adjusting screw with the lubricant (key 76) or equivalent. Install the lower bearing seat (key 73), the thrust bearing (key 71), the thrust bearing races (key 72), and the spring seat (key 13) onto the adjusting screw. Install this assembly into the spring barrel (key 12). Secure the adjusting screw with the set screw (key 75).

8. Coat the tapered end of the diaphragm rod (key 10) and the threads of the cap screw (key 9) with the lubricant (key 76) or equivalent. Bolt the diaphragm plate to the diaphragm rod.

9. Be certain the travel stops (key 8) are located as shown in figure 5.

10. Install the spring (key 11) into the spring barrel. Install the diaphragm plate and diaphragm rod into the actuator. Attach the hex nut (key 58), turnbuckle (key 57), hex nut (key 16), and rod end bearing (key 17) to the diaphragm rod.

11. Installing the diaphragm:

- Place the upper diaphragm casing (key 1) onto the lower diaphragm casing (key 2). If necessary, rotate the lower bearing seat (key 73) so that the upper diaphragm casing travel stop will not contact the diaphragm when the casing cap screws and nuts (key 5 and 6) are tightened.

- Secure the upper diaphragm casing with the cap screws and hex nuts (keys 5 and 6). Be sure the warning nameplate is in place on the casing. Tighten the nuts on the cap screws to the torque value shown in table 3.

12. **For Type 1052 actuators,** complete the Initial Setting portion of the 1052 Spring Adjustment section before proceeding.

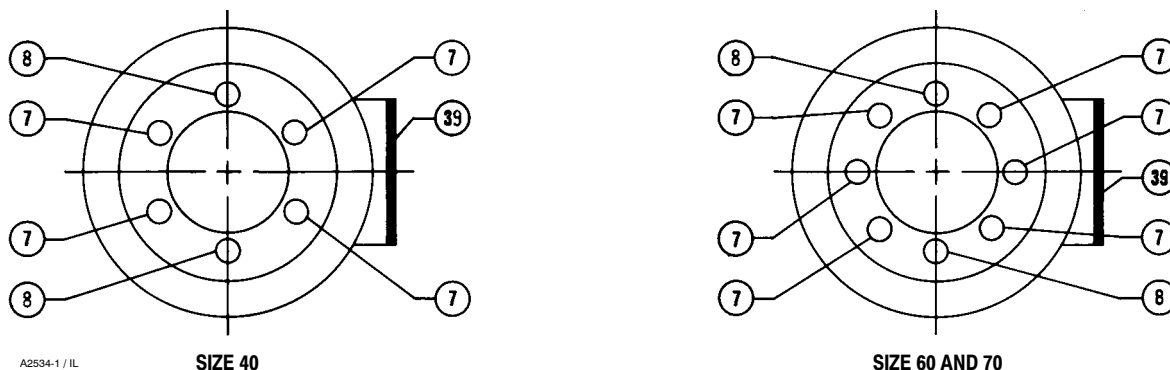


Figure 5. Travel Stop Orientation

13. Refer to the appropriate valve instruction manual for lever/valve shaft orientation marks, and slide the lever (key 27) into place; see figure 4 for correct lever operating clearance. Clamp with the cap screw (key 28, figure 9).
14. Rotate the lever (key 27) to align with the rod end bearing (key 17). This connection can be aided by carefully stroking the actuator off its up travel stop with a regulated air source.
15. Apply sealant (key 77) or equivalent thread-locking compound to the threads of the cap screw (key 18).
16. Connect the lever (key 27) and the rod end bearing (key 17) with the cap screw and hex nut (keys 18 and 19). Tighten the nut on the cap screw (see table 3).
17. Coat the bearing surfaces of the hub (key 29), and cover (key 33) with lubricant (key 76) or equivalent. Install the bushing (key 31) and hub into the cover. Secure with the retaining ring (key 30).
18. Install the travel indicator scale (key 35), and secure it with the self-tapping screws (key 36). Then install the travel indicator (key 37), and secure it with the self-tapping screws (key 38).
19. Note the valve disc or ball position, and direction of rotation. Position the travel indicator (key 37) accordingly.
20. Replace the cover (key 33), and secure with cap screws and washers (keys 34 and 63). If the holes in the cover and housing (key 20) do not align, use a regulated air source to move the actuator slightly off the up travel stop. If hole alignment cannot be obtained in this manner, temporarily loosen cap screws (key 23), and shift the housing slightly.

CAUTION

To avoid parts damage, do not stroke the actuator while cover (key 33) is off.

21. If a valve positioner is to be used, consult the separate valve positioner instruction manual for proper positioner installation.
22. Follow the instructions in the Turnbuckle Adjustment section.

Changing Actuator Mounting

The actuator is normally positioned vertically in a horizontal pipeline. However, four mounting styles and four positions for each style are possible (see figure 3).

Note

Due to its weight, the Type 1052, size 70 actuator must be externally supported if mounted in the horizontal position.

Correct lever/valve shaft positioning is important to ensure proper valve action. Consult the appropriate valve instruction manual.

Style A is right-hand mounted, while style D is left-hand mounted. In all other ways, the styles A and D are identical.

Style B is right-hand mounted, while style C is left-hand mounted. In all other ways, the styles B and C are identical.

Use the following procedure along with figures 8 and 9, for key number references, to convert from

1051 & 1052 F & G Actuators

styles A and D to styles B and C or visa versa or to change the mounting position.

WARNING

To avoid personal injury, perform the steps in the WARNING at the beginning of the Maintenance section to isolate the control valve and actuator.

1. Remove the tubing or piping from the top of the actuator.
2. Remove the cover (key 33) by unscrewing and removing the cap screws and washers (keys 34 and 63).
3. Unscrew cap screw (key 18). Loosen cap screw (key 28).

CAUTION

When removing the actuator from the valve body, do not use a hammer or similar tool to drive the lever (key 27) or actuator off the valve shaft. Driving the lever or actuator could damage internal valve parts. On some valve types, driving the lever (key 27) could move the valve disc and bearings away from the centered position causing subsequent damage to valve parts.

A wheel puller may be used to remove the lever. It is okay to tap the wheel puller screw lightly to loosen the lever, but hitting the screw with excessive force could also damage valve parts or disrupt the centered position of the valve disc and bearings.

4. If changing styles,
 - Unscrew cap screws (key 23), and remove the actuator housing (key 20) from the mounting yoke (key 22).
 - Rotate the housing 180 degrees, maintaining the appropriate position (1, 2, 3, or 4), and place the actuator onto the mounting yoke (key 22).
5. If changing positions, unscrew cap screws (key 23), and rotate the actuator housing to the desired position.

6. Secure actuator housing (key 20) to the mounting yoke (key 22) with cap screws (key 23). Consult table 3 for appropriate bolt torques.

7. Consult the appropriate valve instruction manual for lever/valve shaft orientation marks, and slide the lever (key 27) into place; see figure 4 for correct lever operating clearance. Clamp with the cap screw (key 28).

8. Rotate the lever (key 27) to align with the rod end bearing (key 17). This connection can be aided by stroking the actuator off its up travel stop with a regulated air source.

9. Apply sealant (key 77) or equivalent thread-locking compound to the threads of the cap screw (key 18).

10. Connect the lever (key 27) and the rod end bearing (key 17) with the cap screw and hex nut (keys 18 and 19). Tighten cap screw to the recommended bolt torque shown in table 3. This connection can be aided by stroking the actuator from its up travel stop with a regulated air source.

11. Note the valve position and direction of rotation. Position the travel indicator (key 37) accordingly. Replace the cover (key 33), and secure it with cap screws and washers (keys 34 and 63).

- If the holes in the cover and housing (key 20) do **not** align, use a regulated air source to move the actuator slightly off the up travel stop.
- If hole alignment **cannot** be obtained in this manner, temporarily loosen cap screws (key 23) and shift the housing slightly.

CAUTION

To avoid parts damage, do not stroke the actuator while cover (key 33) is off.

12. Follow the instructions given in the Turnbuckle Adjustment section.

Top-Mounted Handwheels and Adjustable Travel Stops

Principle of Operation for Handwheels

Note

If repeated or daily manual operation is expected or desired, the unit should

be equipped with a manual handwheel actuator. Refer to the separate manual handwheel actuator instruction manual for mounting instructions.

Top-Mounted Handwheel Assembly is attached to a special upper diaphragm casing (key 1, figures 8 and 9) with cap screws (key 141, figure 10). A hex nut (key 137, figure 11) locks the handwheel in position. Turning the handwheel (key 51, figure 10) clockwise into the upper diaphragm casing forces the pusher (key 135, figure 10) against the diaphragm and diaphragm plate (keys 3 and 4, figures 8 and 9) to compress the spring (key 11, figures 8 and 9) and move the diaphragm rod downward.

Turning the handwheel counterclockwise allows the actuator spring to move the diaphragm rod upward.

- If the valve is push-down-to-close, full opening can be restricted by positioning the handwheel at the desired position.
- If the valve is push-down-to-open, full closing of the valve can be restricted by use of the handwheel.

Adjustable Up Travel Stop (figure 11) limits the actuator stroke in the upward direction. To make adjustments, first relieve actuator loading pressure before removing the closing cap (key 187) as it is a pressure retaining part. Remove the closing cap (key 187). Also, for size 70 actuators, the hex nut (key 137) must be loosened. Then turn the stem (key 133) clockwise into the diaphragm case to move the actuator stem downward or counterclockwise to allow the spring to move the actuator stem upward.

- If the valve has push-down-to-close action, full opening can be restricted by the position of the adjustable travel stop. Or,
- If the valve has push-down-to-open action, full closing can be restricted by the position of the adjustable travel stop.

For size 70, tighten the hex nut and replace the closing cap after adjustment.

Adjustable Down Travel Stop (figure 12) limits the actuator stroke in the downward direction. To make adjustments, first relieve actuator loading pressure before removing the closing cap (key 187) as it is a pressure retaining part. Remove the closing cap (key 187). Loosen the hex jam nut (key 189) and either turn the hex nut (key 63 for size 40 and 70 actuators; or key 54 for size 60 actuators) down on the stem (key 133) to limit travel, or up on the stem

to allow more travel. Lock the jam nut against the hex nut, and replace the closing cap after the adjustment has been made.

Handwheel Maintenance and Adjustable Travel Stop

If loading pressure seems to be leaking from either the handwheel or adjustable up stop, the O-rings (key 138 and 139, figures 10 and 11) may need replacement. If the adjustable down stop leaks, the O-ring (key 139, figure 12) may need replacement or possibly the closing cap (key 187, figure 11) is not tight. To tighten the closing cap, apply a good grade of thread sealant to the closing cap threads.

For ease of operation, the stem threads (key 133, figures 10, 11, and 12) may need an occasional application of lubricant (key 241) or equivalent. A grease fitting (key 169, figures 10 and 11) is provided for this purpose in the size 70. The size 70 may also need to have the thrust bearing (key 175, figures 10 and 11) packed with lubricant (key 241) or equivalent. Travel stops for the smaller casings can be lubricated between the stem and pusher (key 135, figures 10 and 11) with the lubricant (key 241) or equivalent.

The following disassembly procedures are separated where appropriate between the top-mounted handwheel and adjustable up travel stop assemblies (figures 10 and 11) and the adjustable down travel stop assembly (figure 12).

WARNING

To avoid personal injury, perform the steps in the WARNING at the beginning of the Maintenance section to isolate the control valve and actuator.

1. Remove the tubing or pipe from the handwheel body (key 142, figures 10, 11, and 12).

WARNING

To avoid personal injury from the pre-compressed spring force thrusting the upper diaphragm casing (key 1, figures 8 and 9) away from the actuator, either relieve Type 1052 spring compression, or carefully remove Type 1051 casing cap screws by following the instructions that are referenced in the steps below before removing the casing.

1051 & 1052 F & G Actuators

2. Relieve all actuator spring compression by following the procedures presented in the Disassembly portion of the Maintenance section. Then, rotate either the handwheel (key 51, figure 10) or the travel stop stem (key 133, figures 11 and 12) counterclockwise until the handwheel or travel stop assembly is no longer compressing the spring.

CAUTION

For Type 1051 actuators with ēdisc valves and push-down-to-open action, the cap screw (key 18, figure 8) should be disengaged from the lever (key 27, figure 9) before removing the diaphragm casing (key 1, figure 8) as specified in the following steps. Failure to do so will allow the spring precompression to rotate the valve beyond its closed position. This could cause damage to the valve seal, seat, or other valve components.

3. Proceed as appropriate:

For Adjustable Up Travel Stops:

- a. Remove the upper diaphragm casing (key 1, figures 8 and 9) by following steps 1, 3, 7, 9, 10, and 11 of the Disassembly portion of the Maintenance section.
- b. Remove the cap screws (key 141, figures 10 and 11), and separate the assembly from the upper casing.
- c. Loosen the locknut (key 137, figure 10), or remove the closing cap (key 187, figure 11).
- d. Turn the stem (key 133, figures 10 and 11) clockwise out of the valve body. On handwheel assemblies, the cotter pin and hex nut (keys 247 and 54, figure 10) will have to be removed so that the handwheel (key 51, figure 10) and locknut can be taken off the stem first.
- e. Remove and inspect the O-rings (keys 138 and 139, figures 10 and 11); replace them if necessary.
- f. To complete disassembly:

For sizes 40 and 60: Drive out the groove pin (key 140, figures 10 and 11), and slide the pusher (key 135, figures 10 and 11) off the stem.

For size 70: The pusher unit is held to the stem by a retaining screw (key 174, figures 10, 11 or 12). Removing the retaining screw and pusher exposes the thrust bearing (key 175, figures 10 and 11) for inspection.

For Adjustable Down Travel Stops:

Key numbers are shown in figure 12 unless otherwise noted. For ease of operation, the stem (key 133) threads may need an occasional application of lubricant.

- a. Remove the closing cap (key 187), and unscrew the jam nut and hex nut (keys 189 and 63 for size 40 and 70 actuators; or keys 189 and 43 for size 60 actuators) off the stem (key 133).
- b. Remove the upper diaphragm casing (key 1, figures 8 and 9) and travel stop body (key 142) by following steps 1, 3, 7, 9, 10, and 11 of the Disassembly portion of the Actuator Maintenance section.
- c. Unscrew cap screws (key 141), and remove the body from the diaphragm case.
- d. Check the condition of the O-ring (key 139), and replace it if necessary.
- e. Loosen the hex nut (key 54), and then unscrew the travel stop stem (key 133) out of the actuator stem. The lower diaphragm plate (key 82) can now be removed and the rest of the actuator disassembled.

4. Reassemble by reversing the order of the disassembly steps, being sure to apply lubricant as previously mentioned and as shown by the lubrication boxes (key 241) in figures 10 and 11. For size 70 handwheels or up travel stop assemblies, coat the threads of the retaining screws (key 174, figures 10 and 11) with sealant (key 242) or equivalent thread-locking compound.

5. Readjust the spring to obtain the appropriate travel stop restriction by following the steps in the Top Mounted Handwheel Assembly section, and then return the unit to operation.

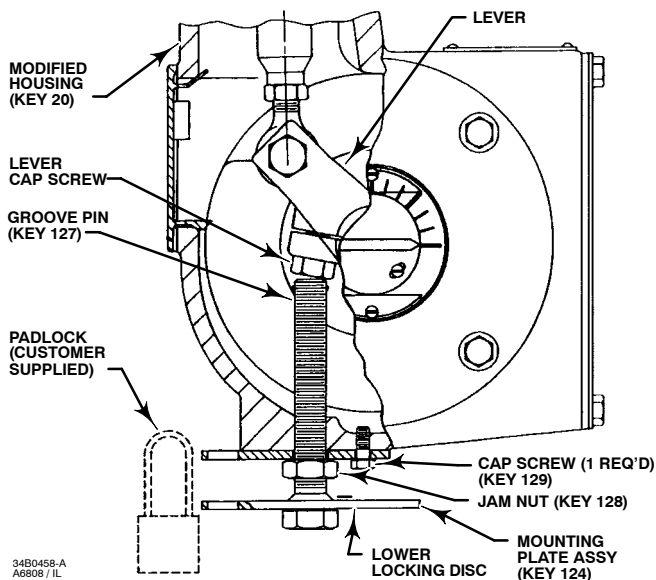


Figure 6. Actuator Locking Mechanism

Locking Mechanism

Refer to figure 6 when installing, operating, and locking the mechanism. Key numbers are shown in figure 6 unless otherwise noted.

Installing the Locking Mechanism

WARNING

To avoid personal injury, perform the steps in the WARNING at the beginning of the Maintenance section to isolate the control valve and actuator.

1. To add the locking mechanism to an existing actuator, contact your Fisher sales office to purchase the required parts. The required parts are the locking mechanism and a modified actuator housing.
2. To remove the old housing, use the Disassembly procedures in the Maintenance section.
3. Attach the mounting plate (key 123) to the modified housing (key 20) as shown in figure 6.

Attach it with the cap screw (key 129). Make sure the hole in the center of the mounting plate lines up with the large tapped hole in the housing.

4. Make sure the jam nut (key 128) is threaded onto the threaded bolt before threading it into the housing.

5. After the bolt is threaded into the housing, install the groove pin (key 127) into the end of the bolt. (Note: The groove pin will prevent the threaded bolt from being totally unthreaded from the actuator housing.)

6. Make sure that the bolt is not threaded in so far that it will interfere with reassembly of the actuator.

7. Reassemble actuator using the Assembly procedure in the Maintenance section.

8. Make sure the actuator diaphragm rod is retracted fully. This will be the locked position of the valve. For a push-down-to-close valve and actuator, the valve will be fully open when locked. For a push-down-to-open valve and actuator, the valve will be fully closed when locked.

9. Screw the threaded bolt into the housing until it contacts the head on the lever cap screw (see figure 6).

10. Insert the padlock (customer supplied) to connect the mounting plate (key 123) with the lower locking disc on the mounting plate assembly (key 124). You might have to back off the lower locking disc a slight amount to line up the holes for the padlock.

CAUTION

In the larger sized actuators, the layers of the mounting plate assembly may be far enough apart that you will need to purchase a padlock with a longer loop. Do not attempt to force the layers closer to fit a small looped padlock, as property damage may result.

11. Tighten the jam nut (key 128) against the mounting plate.

1051 & 1052 F & G Actuators

Operating the Locking Mechanism

To Unlock the Actuator

1. Remove the padlock. Loosen the jam nut (key 128), and unscrew the threaded bolt until it is stopped by the groove pin (key 127) in the threaded bolt.

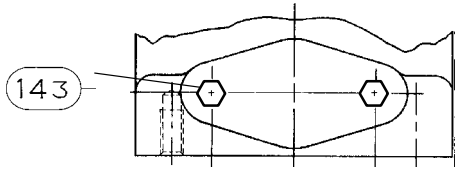
CAUTION

For normal operation of the actuator, the threaded bolt must be unscrewed far enough so that the actuator lever will not contact the bolt, which could lead to property damage.

2. If you are going to leave the bolt threaded into the housing, lock it by tightening the jam nut (key 128) against the mounting plate so that it cannot be screwed into the housing and interfere with normal actuator operation.

To Lock the Actuator

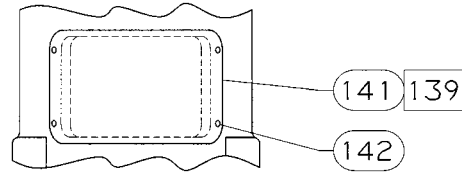
1. Make sure the actuator diaphragm rod is retracted fully. This will be the locked position of the valve. For a push-down-to-close valve and actuator, the valve will be fully open when locked. For a push-down-to-open valve and actuator, the valve will be fully closed when locked.
2. Make sure the jam nut (key 128) is loose. Screw the threaded bolt into the housing until it contacts the head on the lever cap screw (see figure 6).
3. Rotate the threaded bolt until one of the holes in the lower locking disc (which is welded to the bolt) is in line with the hole in the mounting plate (key 123). Tighten the jam nut against the mounting plate.
4. Lock the plate and disc together with a padlock. (The padlock is customer supplied.)



32A9325-F / IL

NOTE:
IF ACCESSORIES ARE NOT INSTALLED ON THE MOUNTING BOSS, INSTALL CAP SCREWS (KEY 143) TO PLUG OPENINGS. A MOUNTING BOSS IS LOCATED ON BOTH SIDES OF THE SPRING BARREL.

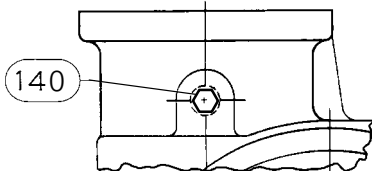
ACCESSORIES MOUNTING BOSS



34B4646-B / IL

NOTE:
FOR FIELD CONVERSION OF TYPE 1052 ACTUATORS, ATTACH COVER (KEY 141) OVER THE SPRING BARREL ADJUSTMENT OPENING WITH SELF-TAPPING SCREWS (KEY 142). USE KEY 141 AS A DRILLING TEMPLATE. USE DRILL SIZE 2.6 mm (A #37 DRILL) (0.104-INCH) BY 9.6 mm (0.38-INCH) DEEP.
 APPLY SEALANT

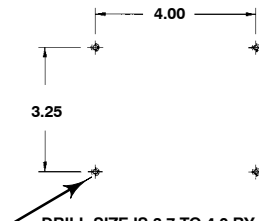
TYPE 1052 SPRING BARREL ACCESS COVER



40B3945-B / IL

NOTE:
INSTALL THE HEX HEAD PLUG (KEY 140) INTO THE VENT OPENING LOCATED IN THE ACTUATOR HOUSING.

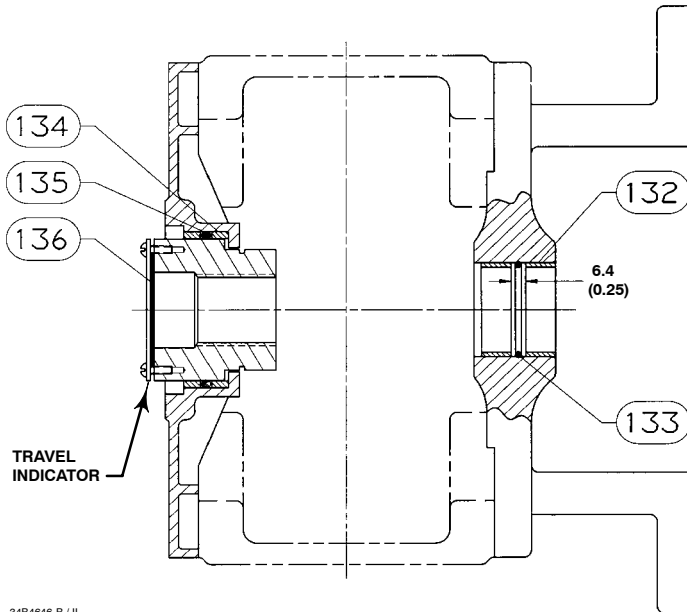
HOUSING VENT PLUG LOCATION



DRILL SIZE IS 3.7 TO 4.0 BY 14.2 mm DEEP (0.145 TO 0.158 BY 0.56-INCH). TAP SIZE IS 10-24 UNC-2B BY 9.6 mm (0.38-INCH) DEEP, 4 HOLES

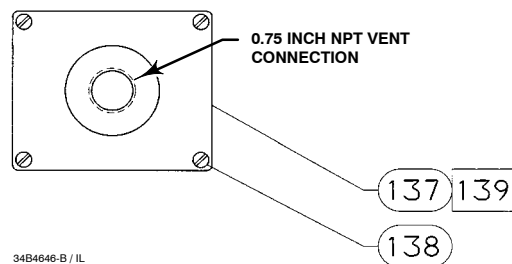
34B4646-B

DRILLING AND TAPPING PATTERN ACCESS PLATE ASSEMBLY



34B4646-B / IL

MOUNTING YOKE AND COVER ASSEMBLY



34B4646-B / IL

NOTE:
FOR FIELD CONVERSION, DRILL AND TAP HOLE PATTERN IF HOUSING HAS A NON-METALLIC ACCESS PLATE. USE KEY 137 AS A DRILLING TEMPLATE IF DESIRED. OR, USE THE DIMENSIONS PROVIDED IN THIS FIGURE FOR DRILLING AND TAPPING.
 APPLY SEALANT

ACCESS PLATE ASSEMBLY

mm
(INCH)

Figure 7. Pipe Away Vent Assembly

1051 & 1052 F & G Actuators

Pipe-Away Vent

**WARNING**

If a flammable or hazardous gas is being used as a supply medium, personal injury, or property damage could result from fire or explosion of accumulated gas. A remote vent pipe cannot be relied upon to vent all gases from the installed location. Provide adequate ventilation for the actuator/positioner assembly. Comply with local and regional codes, and keep the vent pipeline as short as possible with few bends.

Some applications require venting of gas from the rotary actuator housing. The 3610 Series positioners vent into the actuator housing, and from there, the gas has numerous avenues of escape.

Note

This modification is NOT intended to be a leak-proof or pressure-tight design. It is intended to aid in containing the gas that vents from the positioner and allow for connection of piping to carry it away.

Take care that an adequate vent pipe size is used. This is particularly important with the larger size actuators that have fast stroking speed requirements. In these situations, large quantities of gas can be vented very quickly through the positioner, and adequate pipe-away capability must be obtained. Keep the vent piping as short as possible with few bends.

Refer to the Disassembly and Assembly steps in the Maintenance section to gain access to the following parts. Key numbers are shown in figure 7 unless otherwise noted.

Bushings—Remove the mounting yoke bushing (key 67), and the end plate cover bushing (key 31, figures 8 and 9). Replace them with the pipe-away vent parts, as shown in figure 7. The mounting yoke bushing (key 132) is a two-piece bushing with an O-ring (key 133). The end plate cover completes the assembly with a two-piece bushing (key 134) with an O-ring (key 135).

Travel Indicator—A gasket (key 136) is placed under the travel indicator plate. Remove the indicator plate (key 37, figures 8 and 9), install the gasket (key 136) as shown in figure 7.

Access Plate Assembly—A modified metal access plate assembly (key 137) is provided with a 3/4 inch NPT vent connection as shown in figure 7. If the actuator had a plastic access plate, it will be necessary to drill and tap the actuator housing to install the machine screws (key 138) as shown in figure 7. Use the drilling and tapping pattern shown in figure 7, or use the holes in the access plate as a template to mark holes.

When finished with all maintenance procedures requiring the access plate assembly (key 137) to be removed, use the sealant (key 139, or equivalent) provided with the kit to seal the plate in place.

Housing Vent Plug—A vent is provided in the housing design. To plug this opening, the pipe-away vent kit provides a hex pipe plug (key 140) for this opening, as shown in figure 7. Install the hex plug (key 140) into this opening and tighten it.

Accessories Mounting Boss—If accessories are not installed on the mounting boss, install cap screws (key 143) to plug openings. The location to install the cap screws (key 143) is shown in figure 7. A mounting boss is located on both sides of the spring barrel (key 12, figures 8 and 9).

Type 1052 Spring Barrel Access Cover—For field conversion of Type 1052 actuators, attach the cover (key 141) over the spring barrel adjustment opening with self-tapping screws (key 142). Use key 141 as a drilling template. Drill size is 2.6 mm (A #37 drill) (0.104-inches) by 9.6 mm (0.38-inches) deep.

Parts Ordering

When corresponding with your Fisher sales office about this equipment, refer to the serial number found on the actuator nameplate (key 41, figures 8 and 10). Also, specify the complete 11-character part number from the following parts list when ordering replacement parts. The Size 70 actuator is available only in Type 1052 actuators.

Note

Use only genuine Fisher replacement parts. Components that are not supplied by Fisher should not, under any circumstances, be used in any Fisher valve, because they will void your warranty, might adversely affect the performance of the valve, and might jeopardize worker and workplace safety.

Note

Neither Emerson, Emerson Process Management, Fisher, nor any of their affiliated entities assumes responsibility for the selection, use and maintenance of any product. Responsibility for the selection, use, and maintenance of any product remains with the purchaser and end-user.

Parts Kits

Top-Mounted Handwheel Retrofit Kits

Kit provides parts to add a top-mounted handwheel. Kit Number 1 includes the handwheel assembly only. Kit Number 2 includes Kit Number 1 and a new upper case (key 1) that is required to mount the handwheel assembly.

Kit Number 1

Key	Description	Part Number
	Size 40	38A1213X032
	Size 60	38A1213X062
	Size 70 Type 1052 only	CV8010X0052

Kit Number 2

Key	Description	Part Number
	Size 40	38A1213X072
	Size 60,	38A1213X022
	Size 70 Type 1052 only	CV8010X0062

Pipe-Away Vent Retrofit Kit

Vent-away kits include: access plate, two-piece bushing, two O-rings, gasket, and the application of a sealant (sealant supplied with retrofit kit). For Type 1052, an additional cover plate and screws are required for the spring adjustment access.

See figure 7.

Pipe-Away Vent Retrofit Kit Numbers

SHAFT DIAMETER		TYPE 1051 SIZE	KIT PART NUMBER	TYPE 1052 SIZE	KIT PART NUMBER
mm	Inches				
12.7	1/2	40	34B4646X022	30	34B4646X152
				40	34B4646X162
15.9	5/8	40	34B4646X032	30	34B4646X172
				40	34B4646X182
19.1	3/4	40	34B4646X042	30	34B4646X192
				40	34B4646X202
22.2	7/8	60	34B4646X052	60	34B4646X212
		40	34B4646X062	40	34B4646X222
25.4	1	60	34B4646X072	60	34B4646X232
		40	34B4646X082	40	34B4646X242
31.8	1-1/4	60	34B4646X092	60	34B4646X252
		40	34B4646X102	40	34B4646X262
38.1	1-1/2	60	34B4646X112	60	34B4646X272
				70	34B4646X282
44.5	1-3/4	60	34B4646X122	60	34B4646X292
				70	34B4646X302
50.8	2	60	34B4646X132	60	34B4646X312
				70	34B4647X322
				60	34B4646X332
				70	34B4647X342

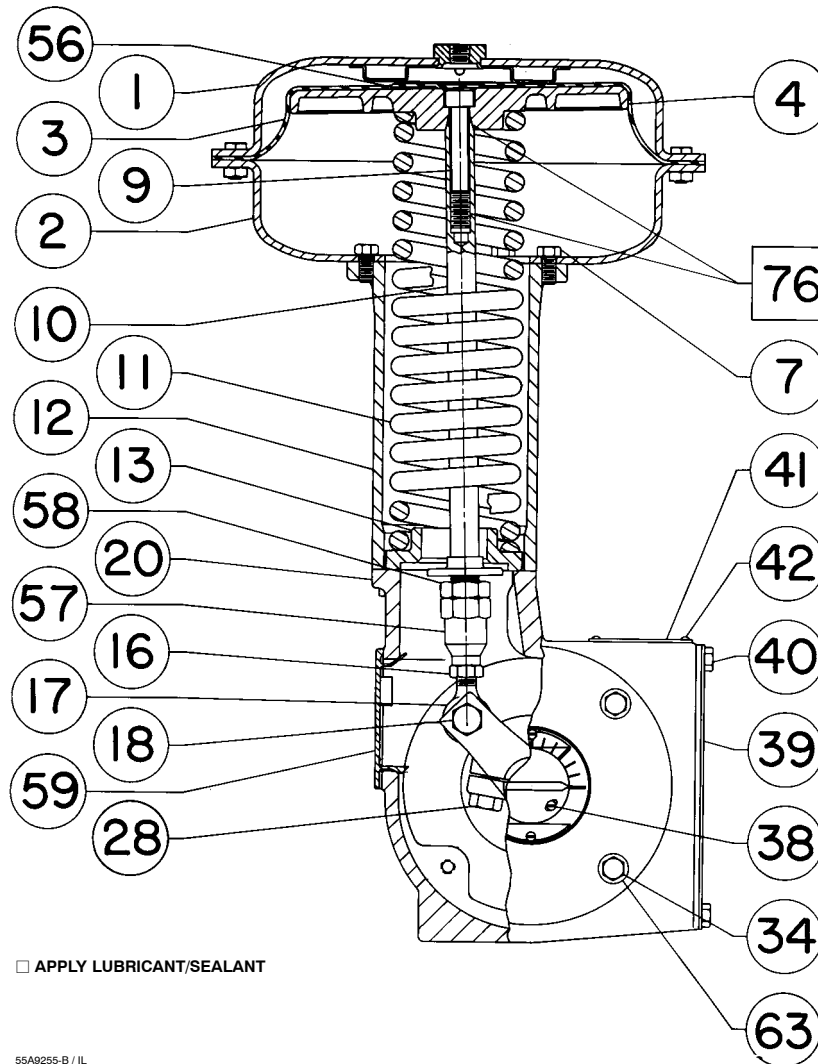


Figure 8. Typical Type 1051 Actuator Assembly

Parts List

Common Parts (Figures 8 and 9)

Note

Part numbers shown are for recommended spares only. For part numbers not shown, contact your Fisher sales office.

Key	Description	Part Number	Key	Description	Part Number
1	Casing, upper		3*	Diaphragm, molded (continued)	
2	Diaphragm Casing, lower (steel zn pl)			Size 60	2E859702202
3*	Diaphragm, molded (nitrile/nylon)			Size 70	2N126902202
	Standard			w/adj down stop	
	w/handwheel, or w/adj up stop			Size 40	2E669902202
	Size 40	2E670002202		Size 60	2E859802202
				Size 70	2N130902202
				Silicone/polyester	
				Standard	
				w/handwheel, or w/adj up stop	
				Size 40	2E6700X0012
				Size 60	2E8597X0032
				Size 70	2N1269X0012
			4	Diaphragm Head	

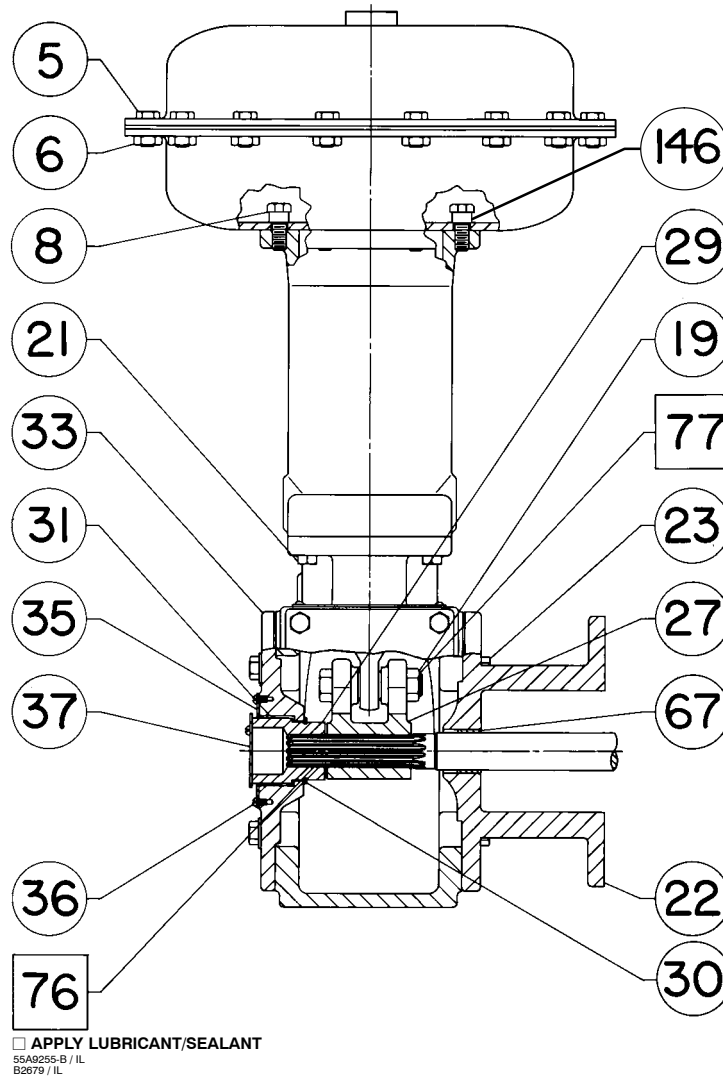


Figure 8. Typical Type 1051 Actuator Assembly (Continued)

Key	Description	Part Number	Key	Description	Part Number
5	Screw, Cap, Hex Hd, Size 40 (12 req'd) Size 60 (16 req'd) Size 70 (24 req'd)		16	Nut, Hex	
6	Nut, Hex Size 40 (16 req'd) Size 60 (24 req'd) Size 70 (28 req'd)		17	Bearing Rod End	
7	Screw, Cap, Hex Hd Size 40 (4 req'd) Size 60 (6 req'd) Size 70 (10 req'd)		18	Screw, Cap, Hex Hd	
8	Stop, Travel (2 req'd)		19	Nut, Hex, Jam	
9	Screw, Cap, Hex Socket		20	Housing	
10	Diaphragm Rod		20	Modified Housing	
11	Spring	See following table	21	Screw, Cap, Hex Hd (4 req'd)	
12	Spring Barrel		22	Yoke, Mounting	
13	Spring Seat	See following table	23	Screw, Cap, Hex Hd (4 req'd)	
			27	Lever	
			28	Screw, Cap, Hex Hd	
			29	Hub	
			30	Ring, Retaining, Ext	
			31*	Bushing Size 40 Sizes 60 & 70	12A9373X012 12A9374X012
			33	Cover	

1051 & 1052 F & G Actuators

Key	Description	Part Number	Key	Description	Part Number
34	Screw, Cap, Hex Hd w/o switches, w/Type 304, Type 4200, w/BZE6-2RN or DTE6-2RN SW, w/micro switch w/90 deg, or w/ Type 3710 positioner (4 req'd) w/NAMCO or LSA/LSX switches, w/1 or 2 GO switches, w/ LSA/LSX sw, or w/NAMCO or LSA/LSX switch (2 req'd)		140*	Pin, Groove Carbon Steel-Plated Size 40 S31600 (316 SST) Size 60	1F118028992 1B627035072
35	Scale, Indicator		141	Screw, Cap, Hex Hd Size 40 (6 req'd) Size 60 (8 req'd) Size 70 (12 req'd)	
36	Screw, Self Tapping (2 req'd)		142	Body	
37	Travel Indicator		164	Body Extension	
38	Self-Tapping Screw (2 req'd)		169	Grease Fitting	
38	Machine Screw (2 req'd)		171	Washer, plain	
39	Plate, Cover		174	Retaining Screw	
40	Screw, Cap, Hex Hd (4 req'd)		175	Bearing, Thrust	
41	Nameplate		176	Bearing Race, Thrust, Type 1052 Size 70 only (2 req'd)	
42	Screw, Drive (4 req'd)		241	Lithium grease lubricant or equivalent	
56	Warning Label		242	Thread locking sealant or equivalent	
57	Turnbuckle		244	Anti-seize lubricant or equivalent	
58	Nut, Hex, Jam		246	Spacer	
59	Plate, Access		247	Pin, Cotter	
63	Washer, Plain Size 40 (4 req'd) Size 60 & 70 (2 req'd)				
67*	Bushing	See following table			
71	Bearing, Thrust		133	Stem	
72	Bearing Race (2 req'd)		135	Plate, Pusher	
73	Bearing Seat		137	Nut, travel stop	
74	Screw, Adjusting		138*	O-Ring, (nitrile) Size 40 Size 60 Size 70	1D237506992 1B885506992 1C415706992
75	Set Screw, Hex Socket		139*	O-Ring, (nitrile) Size 40 Size 60 Size 70	1D267306992 1D547106992 1D269106992
76	Lithium grease lubricant or equivalent		140*	Pin, Groove carbon steel-plated Size 40 S31600 (316 SST) Size 60	1F118028992 1B627035072
77	Thread locking sealant or equivalent		141	Screw, Cap, Hex Hd Size 40 (6 req'd) Size 60 (8 req'd) Size 70 (12 req'd)	
78	Screw, Cap 9.5 & 12.7 mm (3/8 & 1/2 inch) Shafts (2 req'd) 15.9 thru 50.4 mm (5/8 thru 2-inch) Shafts (4 req'd)		142	Body	
82	Diaphragm Head, lower		164	Body Extension	
83	Plug, Protective		169	Grease Fitting	
- - -	Pipe Bushing (not shown)		171	Spacer	
144	Warning Nameplate		174	Retaining Screw	
146	Spacer		175	Bearing, Thrust	
			176	Bearing Race, Thrust, Type 1052 Size 70 only (2 req'd)	
			187	Travel Stop Cap	
			241	Lithium grease lubricant or equivalent	
			242	Thread locking sealant or equivalent	

Adjustable Up Travel Stop (Figure 11)

Top-Mounted Handwheel (Figure 10)

51	Handwheel	
54	Nut, Hex, Slotted	
133	Stem	
135	Plate, Pusher	
137	Nut, Hex, Jam	
138*	O-Ring, (nitrile) Size 40 Size 60 Size 70	1D237506992 1B885506992 1C415706992
139*	O-ring, (nitrile) Size 40 Size 60 Size 70	1D267306992 1D547106992 1D269106992

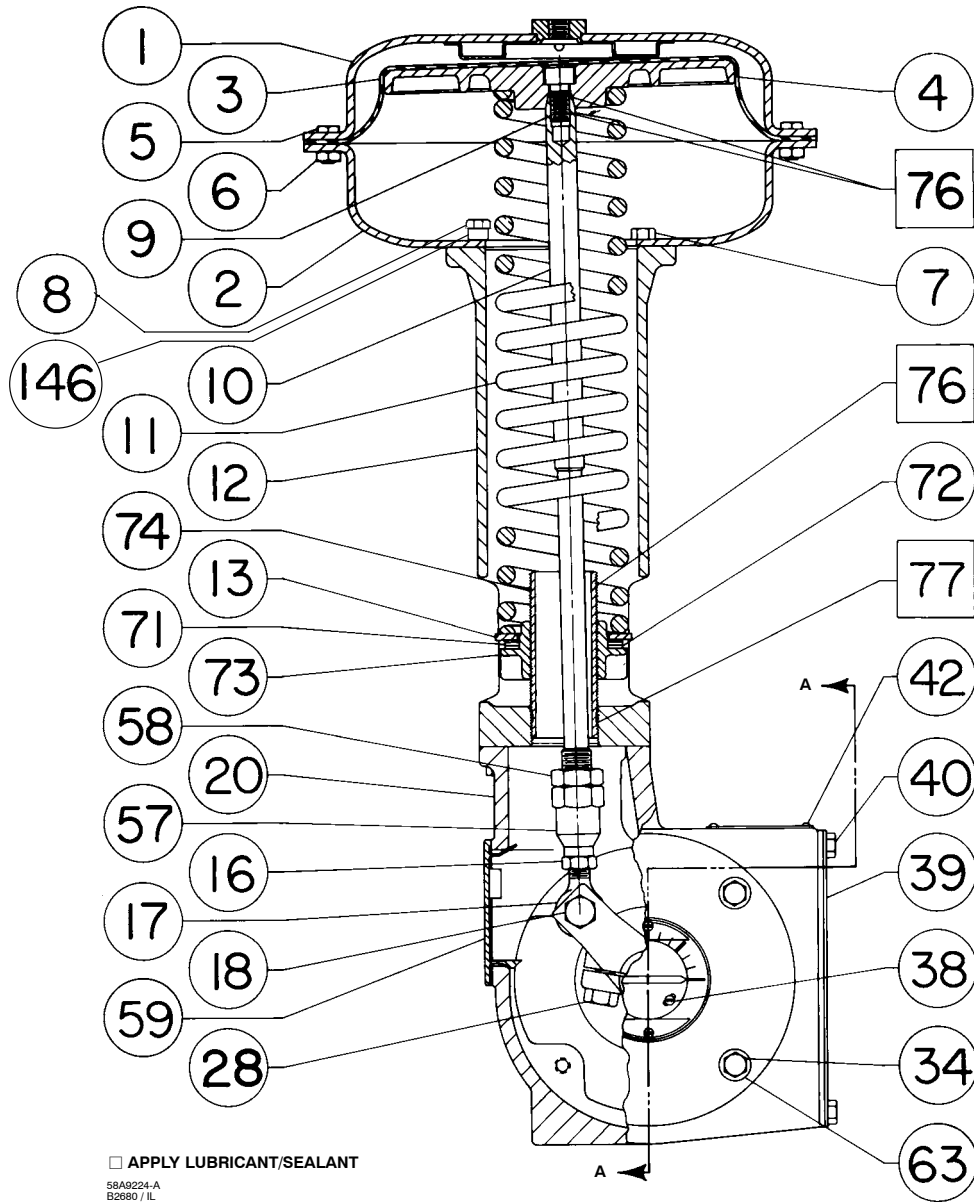


Figure 9. Typical Type 1052 Assembly

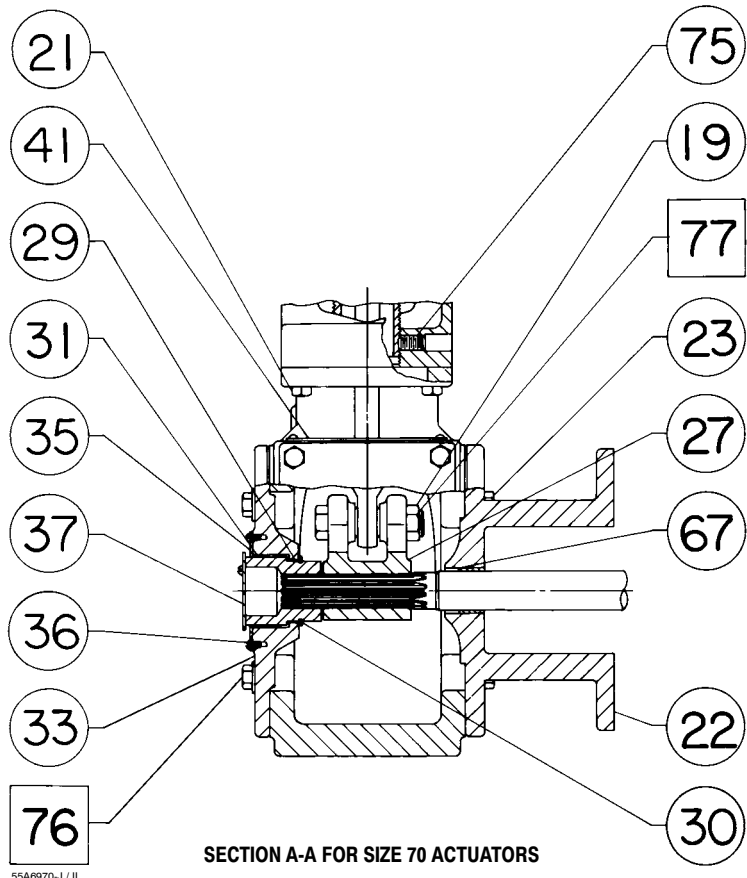
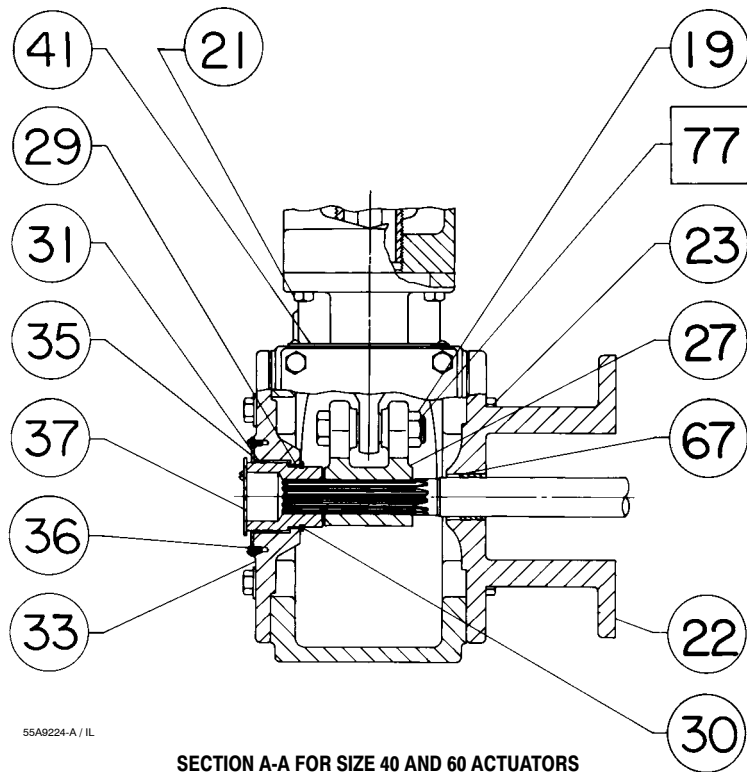
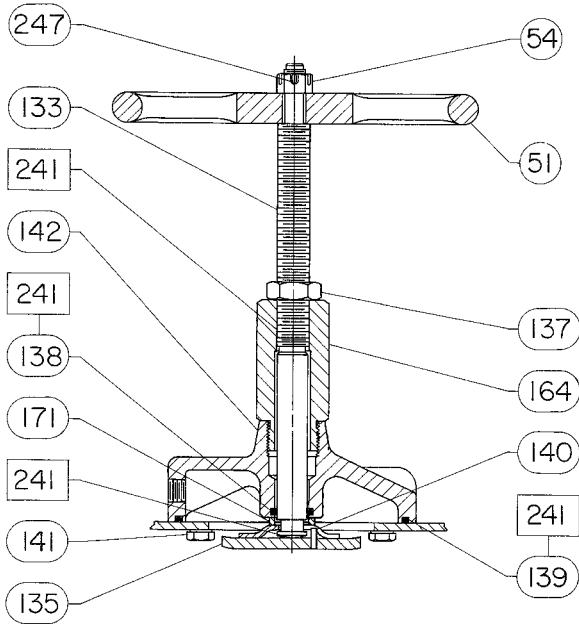


Figure 9. Typical Type 1052 Assembly (continued)

Instruction Manual

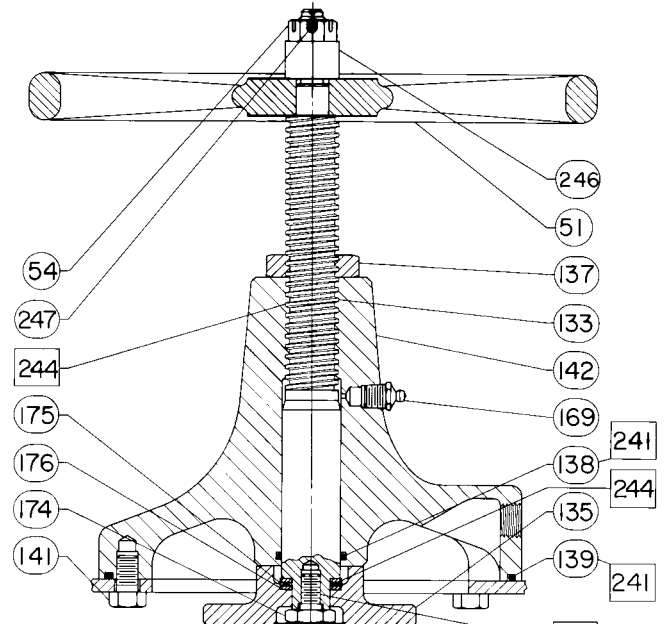
Form 5062
August 2005

1051 & 1052 F & G Actuators



APPLY LUBRICANT
38A1213-B / IL

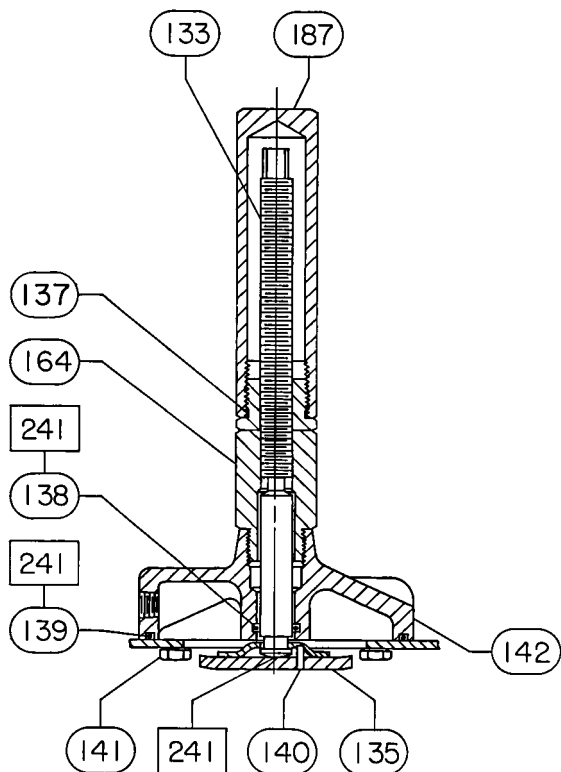
**TOP-MOUNTED HANDWHEEL ASSEMBLY FOR
SIZE 30, 40, AND 60 ACTUATORS**



APPLY LUBRICANT/SEALANT
CV8010-G / IL

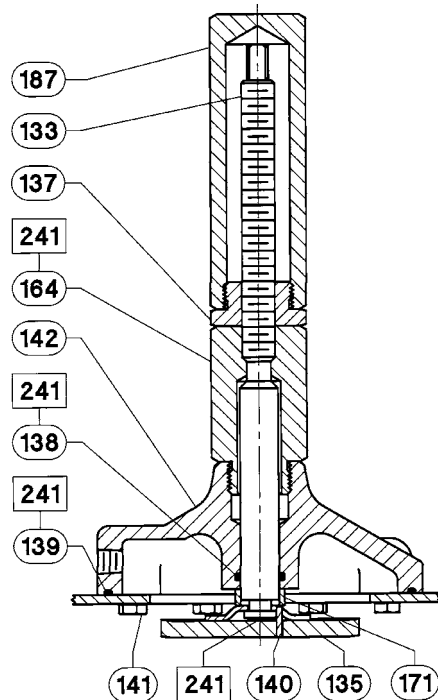
**TOP-MOUNTED HANDWHEEL ASSEMBLY FOR
SIZE 70 ACTUATOR**

Figure 10. Handwheel Assemblies



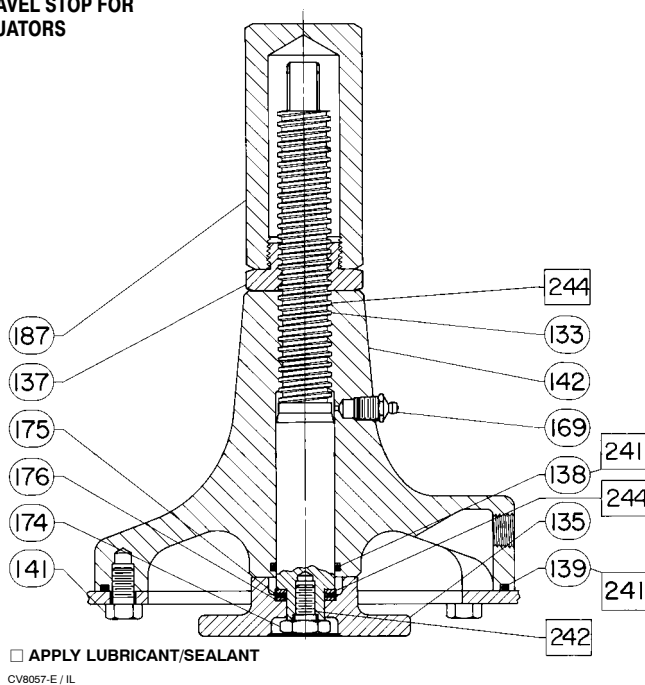
□ APPLY LUBRICANT
28A1207-B / IL

**ADJUSTABLE UP TRAVEL STOP FOR
SIZE 40 ACTUATORS**



□ APPLY LUBRICANT
28A1214-A / IL

**ADJUSTABLE UP TRAVEL STOP FOR
SIZE 60 ACTUATORS**



□ APPLY LUBRICANT/SEALANT
CV8057-E / IL

**ADJUSTABLE UP TRAVEL STOP FOR SIZE 70
TYPE 1052 ACTUATORS**

Figure 11. Adjustable Up Travel Stops

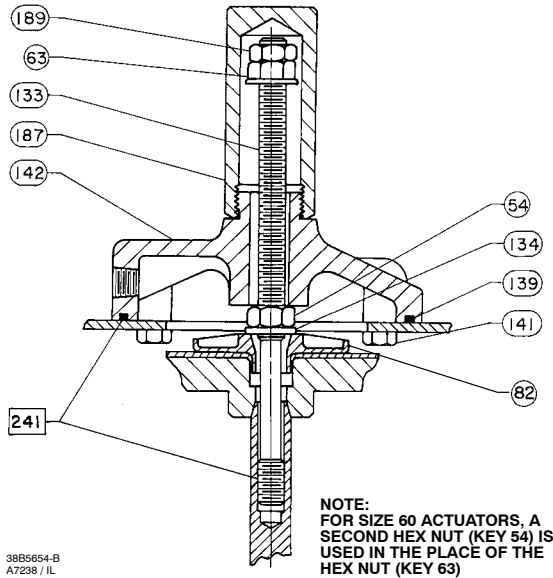


Figure 12. Adjustable Down Travel Stop

Adjustable Down Travel Stop (Figure 12)

Key	Description	Part Number
54	Nut, Hex Size 40 (1 req'd) Size 60 & 70 (2 req'd)	
63	Flange Nut	
133	Travel Stop Stem	
134	Washer (plain carbon steel)	
139*	O-Ring (nitrile) Size 40 Size 60 Size 70	1D267306992 1D547106992 1D269106992
141	Screw, Cap, Hex Hd (steel zn pl) Size 40 (6 req'd) Size 60 (8 req'd) Size 70 (12 req'd)	
142	Travel Stop Body	
187	Travel Stop Cap	
189	Nut, Hex, Jam Size 40 & 60 (1 req'd) Size 70 (2 req'd)	
241	Lithium grease lubricant or equivalent	

**Locking Assembly (Figure 6)
(Size 40, 60, and 70 Actuators)**

123	Mounting Plate
124	Mounting Plate Assembly
127	Groove Pin
128	Jam Nut
129	Cap Screw

Pipe-Away Vent (Figure 7)

Key	Description	Part Number
132*	Lined Bushing (steel/PTFE) yoke side 12.7 mm (1/2 inch) dia. shaft (2 req'd) 15.9 mm (5/8 inch) dia. shaft (2 req'd) 19.1 mm (3/4 inch) dia. shaft (2 req'd) 22.2 mm (7/8 inch) dia. shaft (2 req'd) 25.4 mm (1-inch) dia. shaft (2 req'd) 31.8 mm (1-1/4 inch) dia. shaft (2 req'd) 38.1 mm (1-1/2 inch) dia. shaft (2 req'd) 44.5 mm (1-3/4 inch) dia. shaft (2 req'd) 50.8 mm (2-inch) dia. shaft (2 req'd)	1U902599402 14B4642X012 F1918348112 14B4631X012 14B4632X012 14B4633X012 14B4634X012 14B4635X012 G1668548112
133*	O-Ring (nitrile) 12.7 mm (1/2 inch) dia. shaft 15.9 mm (5/8 inch) dia. shaft 19.1 mm (3/4 inch) dia. shaft 22.2 mm (7/8 inch) dia. shaft 25.4 mm (1-inch) dia. shaft 31.8 mm (1-1/4 inch) dia. shaft 38.1 mm (1-1/2 inch) dia. shaft 44.5 mm (1-3/4 inch) dia. shaft 50.8 mm (2-inch) dia. shaft	1J4888X0052 11A8741X052 1F4636X0032 10A3805X012 10A8217X042 14A6981X012 1F1153X0012 1P1676X0012 10A3800X012
134*	Bushing (steel/PTFE) hub side Size 30/40 12.7 to 22.2 mm (1/2 to 7/8 inch) dia. shaft (2 req'd) Size 40 25.4 to 31.8 mm (1- to 1-1/4 inch) dia. shaft (2 req'd) Size 60 19.1 to 50.8 mm (3/4 to 2-inch) dia. shaft (2 req'd)	14B3503X012 14B3503X012 14B4310X012
135*	O-Ring, hub side Size 30/40 12.7 to 22.2 mm (1/2 to 7/8 inch) dia. shaft Size 40 25.4 to 31.8 mm (1- to 1-1/4 inch) dia. shaft Size 60 19.1 to 50.8 mm (3/4 to 2-inch) dia. shaft	1K594906562 1K594906562 1U2504X0042
136	Travel Indicator Gasket	
137	Access Plate assembly	
138	Machine screw (4 req'd)	
139	Blue RTV or equivalent	
140	Plug	
141	Spring Barrel Cover, Type 1052 only (2 req'd)	
142	Self-tapping Screw Size 30 & 40 (4 req'd) Size 60 (5 req'd) Size 70 (8 req'd)	
143	Cap Screw Size 30 (8 req'd) Size 40 & 70 (4 req'd) Size 60 (2 req'd)	

1051 & 1052 F & G Actuators

Key 11. Spring⁽¹⁾ for Type 1052 Actuator Only (Steel)

Key 13. Spring Seat⁽¹⁾ for Type 1052 Actuator Only (Steel)

CASING PRESSURE		ACTUATOR SIZE	KEY 11 SPRING PART NUMBER	KEY 13 SPRING SEAT PART NO.
Bar	Psig			
0 to 1.2	0 to 18	40	1L217427042	12A9447X012
		60	1K162727082 1N937327082 1N937327082	12A9450X012 12A9448X012 12A9449X012
0 to 2.3	0 to 33	40	1L217327042 1P637127082	12A9446X012 12A9447X012
		60	1K162827082 1K162827082 1N937327082 1N937327082	12A9448X012 12A9449X012 12A9448X012 12A9449X012
0 to 2.8	0 to 40	40	1L217327042	12A9446X012
0 to 3.8	0 to 55	60	1K162827082 1K162829082	12A9448X012 12A9449X012
		40	1L217327042	12A9446X012
0.2 to 1.0	3 to 15	60	1K162727082	12A9450X012
0.2 to 2.1	3 to 30	40	1L217327042 1P637127082	12A9446X012 12A9447X012
		60	1K162827082 1N937327082	12A9449X012 12A9449X012

Key 11. Spring⁽¹⁾ for Type 1052 Actuators Only (Steel)

CASING PRESSURE		ACTUATOR SIZE	INITIAL SPRING COMPRESSION				KEY 11 SPRING PART NUMBER
Bar	Psig		Push-down-to-open		Push-down-to-close		
			Bar	Psig	Bar	Psig	
0 to 1.2	0 to 18	40	0.2	3.0	0.2	3.0	1L217427042
	0 to 18		60	0.3	4.3	0.2	3.0
0 to 2.3	0 to 33	40	0.3	4.3	0.3	4.3	1P637127082
			60	0.4	6.0	0.2	3.0
0 to 2.3	0 to 33	60	0.3	4.4	0.2	3.0	1N844027082
			70	0.2	3.5	0.2	3.5
0 to 2.8	0 to 40	60	0.5	7.0	0.2	3.0	1K162827082
			70	0.5	6.8	0.2	3.0
0 to 2.8	0 to 40	40	0.7	10.1	0.2	3.0	1R676027082
			60	0.3	4.4	0.2	3.0
0 to 2.8	0 to 40	60	0.4	6.0	0.2	3.0	1L217327042
			70	0.5	6.8	0.2	3.0
0 to 3.8	0 to 55	40	0.5	7.0	0.2	3.1	1K162827082
			70	0.7	10.1	0.2	3.3
0 to 3.8	0 to 55	40	0.3	4.4	0.2	3.5	1N844027082
			70	0.7	10.1	0.7	10.1
0.2 to 1.0	3 to 15	40	---	---	0.2	3.0	1L217427042
			60	0.3	3.7	0.2	3.0
0.2 to 2.1	3 to 30	40	0.3	4.3	0.3	4.3	1P637127082
			60	0.4	6.0	0.2	3.0
0.2 to 2.1	3 to 30	60	---	---	0.2	3.0	1N844027082
			70	0.2	3.5	0.2	3.5
0.2 to 2.1	3 to 30	60	0.5	7.0	0.2	3.0	1K162827082
			70	---	---	0.2	3.0
0.2 to 2.1	3 to 30	70	0.7	10.1	0.2	3.0	1R676027082

1. For more detailed ordering information concerning spring selection to obtain the torque required by the valve, consult your Fisher sales office.

Instruction Manual

Form 5062
August 2005

1051 & 1052 F & G Actuators

Keys 22 and 67^{(1)*}: Mounting Yoke Assembly

VALVE DESIGN	ACTUATOR SIZE	VALVE SHAFT DIAMETER	VALVE SHAFT DIAMETER	KEY 22 YOKE CAST IRON		KEY 67 BUSHING, PTFE
		mm	Inches			
CV500, V100, V150, V200, V250, V300, 8510, 8532, and 8560	40	12.7	1/2	12A9799X0A2	---	1U902599402
		15.9	5/8	12A9799X0B2	---	12A9555X012
		19.1	3/4	12A9799X0C2	---	12A9556X012
	40	22.2	7/8	12A9799X0E2	---	12A9557X012
		25.4	1	12A9799X0G2	---	12A9775X012
		31.8	1-1/4	12A9799X112	---	12A9558X012
	60	19.1	3/4	12A9799X0D2	---	12A9556X012
		22.2	7/8	12A9799X0F2	---	12A9557X012
		25.4	1	12A9799X0H2	---	12A9775X012
	60 and 70	31.8	1-1/4	12A9799X0J2	---	12A9558X012
		38.1	1-1/2	12A9799X0K2	---	12A9559X012
		44.5	1-3/4	12A9799X0L2	---	10A3848X012
50.8		2	12A9799X0M2	---	12A9715X012	
9500 for G Mounting	40	12.7	1/2	---	32A9755X012	1U902599402
		15.9	5/8	---	32A9742X012	12A9555X012
		19.1	3/4	---	32A9743X012	12A9556X012
	40	25.4	1	---	32A9757X012	12A9575X012
		31.8	1-1/4	---	32A9746X012	12A9558X012
	60	19.1	3/4	---	32A9750X012	12A9556X012
		25.4	1	---	32A9778X012	12A9775X012
	60 and 70	31.8	1-1/4	---	32A9753X012	12A9558X012
		38.1	1-1/2	---	32A9754X012	12A9559X012
		44.5	1-3/4	---	35A9704X012	12A9560X012
		50.8	2	---	35A9705X012	12A9561X012

1. The yokes in this column are available as yoke-bushing assemblies. However, the bushings are available as replacement parts.

1051 & 1052 F & G Actuators

Instruction Manual

Form 5062
August 2005

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627 Series Pressure Reducing Regulators

Introduction

Scope of Manual

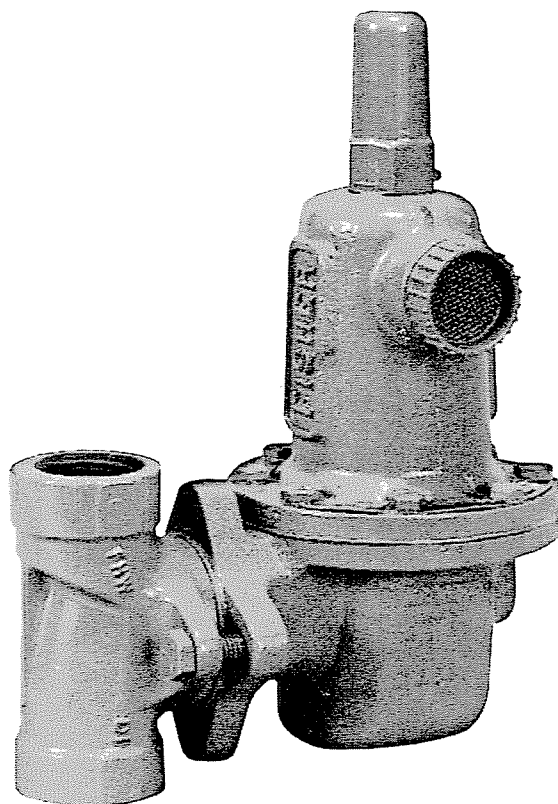
This manual provides instructions for the installation, adjustment, maintenance, and parts ordering for the 627 Series regulators. These regulators usually are shipped separate for line installation, although sometimes they are shipped installed on other equipment. Refer to the instruction manual for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

Description

The 627 Series self-operated pressure reducing regulators (figure 1) are for high and low pressure systems. These regulators can be used with natural gas, air, or a variety of other gases. Performance characteristics vary according to construction (see the AVAILABLE CONFIGURATIONS specification in table 1).

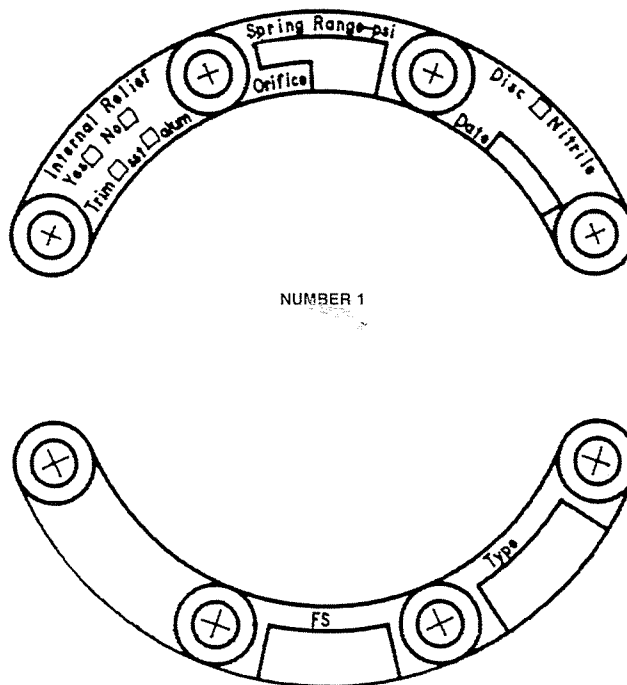
Specifications

Table 1 gives some general specifications for the 627 Series regulators. The nameplates (figure 2) gives detailed information for a particular regulator as it comes from the factory.



W4793

Figure 1. Typical 627 Series Self-Operated Pressure Reducing Regulator



10B3679-D

NUMBER 2

Figure 2. Nameplates

627 Series

Table 1. Specifications

Available Constructions

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

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

Type 627M: Type 627 with a stem seal between the body outlet pressure and diaphragm case. Pressure is measured under the diaphragm through the 1/4-inch NPT downstream control line connection (figure 9)

Type 627MR: Type 627M with internal relief (figure 10)

Type 627H: Type 627 with a diaphragm limiter to deliver a higher outlet pressure (figure 11)

Type 627HM: Type 627H with a stem seal between the body outlet pressure and diaphragm case. Pressure is measured under the diaphragm through two 1/4-inch NPT downstream control line connections (figure 12)

Body Sizes

3/4, 1, or 2-inch

End Connection Styles

3/4, 1, or 2-inch body sizes: NPT

1 or 2-inch body sizes: ANSI Class 300 or 600 RF flanged

Maximum Inlet Pressure⁽¹⁾ (Body Rating)

2000 psig (138 bar) for NPT steel, 1480 psig (102 bar) for RF flanged steel, or 1000 psig (69 bar) for ductile iron

Maximum Valve Disk Inlet Pressure Rating⁽¹⁾

2000 psig (138 bar) for nylon disk or 1000 psig (69 bar) for nitrile disk

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

See table 2 for pressures by port and spring range

Maximum Spring and Diaphragm Casing Pressure⁽¹⁾

See table 3

Maximum Body Outlet Pressure⁽¹⁾ (Type 627M, 627MR, and 627HM Only)

2000 psig (138 bar) for screwed steel, 1480 psig (102 bar) for RF flanged steel, or 1000 psig (69 bar) for ductile iron. (Type 627 and 627R are limited by maximum diaphragm casing pressure)

Port Diameters

See table 2

Internal Relief Performance

Type 627R: See table 4

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

Temperature Capabilities⁽¹⁾

-20 to 180°F (-29 to 82°C)

Pressure Registration

Type 627, 627H or 627R: Internal

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

De-Icer System

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

Relief Indicator

For 627R and 627MR (see figures 8 and 9)

Spring Case Vent Connection

3/4-inch NPT female with removable screened vent assembly

Control Line Connection (Type 627M, 627HM or 627MR Only)

1/4-inch NPT female

Approximate Weight

Ductile Iron or Steel Casings: 10 pounds (4,5 kg)

Aluminum Casings: 6.3 pounds (2.8 kg)

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

Table 2. Maximum Inlet Pressures, Differential Pressures, and Outlet Pressure Ranges

TYPE NUMBER	OUTLET PRESSURE RANGE, SPRING PART NUMBER, AND COLOR	ORIFICE SIZE, INCHES (mm)	MAXIMUM INLET PRESSURE, PSIG (bar)	MAXIMUM DIFFERENTIAL PRESSURE, PSID (bar)
627 and 627M ⁽³⁾	5 ⁽²⁾ to 20 psig (0,34 to 1,4 bar) 10B3076X012 Yellow	3/32 (2,4)	2000 (138) ⁽¹⁾	2000 (138) ⁽¹⁾
		1/8 (3,2)	1000 (69) ⁽¹⁾	1000 (69) ⁽¹⁾
		3/16 (4,8)	750 (51,7)	750 (51,7)
		1/4 (6,4)	500 (34,5)	500 (34,5)
		3/8 (9,5)	300 (20,7)	300 (20,7)
		1/2 (12,7)	250 (17,2)	250 (17,2)
	15 to 40 psig (1,0 to 2,8 bar) 10B3077X012 Green	3/32 (2,4)	2000 (138) ⁽¹⁾	2000 (138) ⁽¹⁾
		1/8 (3,2)	1500 (103) ⁽¹⁾	1500 (103) ⁽¹⁾
		3/16 (4,8)	1000 (69) ⁽¹⁾	1000 (69) ⁽¹⁾
		1/4 (6,4)	750 (51,7)	750 (51,7)
		3/8 (9,5)	500 (34,5)	500 (34,5)
		1/2 (12,7)	300 (20,7)	300 (20,7)
	35 to 80 psig (2,4 to 5,5 bar) 10B3078X012 Blue	3/32 (2,4)	2000 (138) ⁽¹⁾	2000 (138) ⁽¹⁾
		1/8 (3,2)	2000 (138) ⁽¹⁾	2000 (138) ⁽¹⁾
		3/16 (4,8)	1750 (121) ⁽¹⁾	1750 (121) ⁽¹⁾
		1/4 (6,4)	1500 (103) ⁽¹⁾	1500 (103) ⁽¹⁾
3/8 (9,5)		1000 (69) ⁽¹⁾	1000 (69) ⁽¹⁾	
1/2 (12,7)		750 (51,7)	750 (51,7)	
70 to 150 psig (4,8 to 10,3 bar) 10B3079X012 Red	3/32 (2,4)	2000 (138) ⁽¹⁾	2000 (138) ⁽¹⁾	
	1/8 (3,2)	2000 (138) ⁽¹⁾	2000 (138) ⁽¹⁾	
	3/16 (4,8)	2000 (138) ⁽¹⁾	2000 (138) ⁽¹⁾	
	1/4 (6,4)	1750 (121) ⁽¹⁾	1750 (121) ⁽¹⁾	
	3/8 (9,5)	1250 (86,2) ⁽¹⁾	1250 (86,2) ⁽¹⁾	
	1/2 (12,7)	750 (51,7)	750 (51,7)	
627R and 627MR	5 ⁽²⁾ to 20 psig (0,34 to 1,4 bar) 10B3076X012 Yellow	3/32 (2,4)	2000 (138) ⁽¹⁾	2000 (138) ⁽¹⁾
		1/8 (3,2)	1000 (69) ⁽¹⁾	1000 (69) ⁽¹⁾
		3/16 (4,8)	750 (51,7)	750 (51,7)
		1/4 (6,4)	500 (34,5)	500 (34,5)
		3/8 (9,5)	300 (20,7)	300 (20,7)
		1/2 (12,7)	200 (13,8)	200 (13,8)
	15 to 40 psig (1,0 to 2,8 bar) 10B3077X012 Green	3/32 (2,4)	2000 (138) ⁽¹⁾	2000 (138) ⁽¹⁾
		1/8 (3,2)	1500 (103) ⁽¹⁾	1500 (103) ⁽¹⁾
		3/16 (4,8)	1000 (69) ⁽¹⁾	1000 (69) ⁽¹⁾
		1/4 (6,4)	750 (51,7)	750 (51,7)
		3/8 (9,5)	300 (20,7)	300 (20,7)
		1/2 (12,7)	200 (13,8)	200 (13,8)
	35 to 80 psig (2,4 to 5,5 bar) 10B3078X012 Blue	3/32 (2,4)	2000 (138) ⁽¹⁾	2000 (138) ⁽¹⁾
		1/8 (3,2)	1750 (121) ⁽¹⁾	1750 (121) ⁽¹⁾
		3/16 (4,8)	1000 (69) ⁽¹⁾	1000 (69) ⁽¹⁾
		1/4 (6,4)	750 (51,7)	750 (51,7)
3/8 (9,5)		300 (20,7)	300 (20,7)	
1/2 (12,7)		200 (13,8)	200 (13,8)	
70 to 150 psig (4,8 to 10,3 bar) 10B3079X012 Red	3/32 (2,4)	2000 (138) ⁽¹⁾	2000 (138) ⁽¹⁾	
	1/8 (3,2)	1000 (69) ⁽¹⁾	1000 (69) ⁽¹⁾	
	3/16 (4,8)	500 (34,5)	500 (34,5)	
	1/4 (6,4)	300 (20,7)	300 (20,7)	
	3/8 (9,5)	200 (13,8)	200 (13,8)	
	1/2 (12,7)	200 (13,8)	200 (13,8)	
627H and 627MH ⁽³⁾	140 to 250 psig (9,7 to 17,2 bar) 10B3078X012 Blue	3/32 (2,4)	2000 (138) ⁽¹⁾	2000 (138) ⁽¹⁾
		1/8 (3,2)	2000 (138) ⁽¹⁾	2000 (138) ⁽¹⁾
		3/16 (4,8)	1750 (121) ⁽¹⁾	1750 (121) ⁽¹⁾
		1/4 (6,4)	1500 (103) ⁽¹⁾	1000 (69) ⁽¹⁾
		3/8 (9,5)	1000 (69) ⁽¹⁾	500 (34,5)
	240 to 500 psig (16,5 to 34,5 bar) 10B3079X012 Red	1/2 (12,7)	750 (51,7)	250 (17,2)
		3/32 (2,4)	2000 (138) ⁽¹⁾	2000 (138) ⁽¹⁾
		1/8 (3,2)	2000 (138) ⁽¹⁾	2000 (138) ⁽¹⁾
		3/16 (4,8)	1750 (121) ⁽¹⁾	1750 (121) ⁽¹⁾
		1/4 (6,4)	1500 (103) ⁽¹⁾	1000 (69) ⁽¹⁾

1. For inlet pressure in excess of 1000 psig (69 bar), refer to the maximum body and disk pressure ratings in the specification table.
2. For pressure settings under 10 psig (0,69 bar), inlet pressure should be limited to approximately 100 psig (6,9 bar) so the setpoint adjustment can be obtained.
3. The unbalance forces change from the wide-open monitor mode to an active regulator mode such that the Type 627M or 627MH should have a 3/8-inch (9,5 mm) or larger orifice when used as a wide-open monitor.

627 Series

Table 3. Maximum Spring and Diaphragm Casing Pressure(1)

MAXIMUM PRESSURE DESCRIPTION	SPRING AND DIAPHRAGM CASING STYLE	TYPE 627, PSIG (bar)	TYPE 627R, PSIG (bar)	TYPE 627M, PSIG (bar)	TYPE 627MR, PSIG (bar)	TYPE 627H AND 627HM, PSIG (bar)
Maximum pressure to spring and diaphragm casings to prevent leak to atmosphere other than relief action (internal parts damage may occur)	Die cast aluminum	250 (17,2)	250 (17,2)	Not Available	Not Available	Not Available
	Die cast aluminum	250 (17,2)	250 (17,2)	250 (17,2)	Not Available	Not Available
	Steel	250 (17,2)	250 (17,2)	250 (17,2)	250 (17,2)	800 (55,2)
Maximum pressure to spring and diaphragm casings to prevent burst of casings during abnormal operation (leak to atmosphere and internal parts damage may occur)	Die cast aluminum	375 (25,9)	375 (25,9)	Not Available	Not Available	Not Available
	Ductile iron	465 (32)	465 (32)	465 (32)	465 (32)	Not Available
	Steel	1500 (103)	1500 (103)	1500 (103)	1500 (103)	1500 (103)
Maximum diaphragm casing overpressure (above setpoint) to prevent damage to internal parts	All styles	60 (4,1)	120 (8,3)	60 (4,1)	120 (8,3)	120 (8,3)

1. If the spring case is pressurized, a metal adjusting screw cap is required. Contact your Fisher Sales Representative.



WARNING

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

To avoid such injury or damage, provide pressure-relieving or pressure-limiting devices (as required by the appropriate code, regulation, or standard) to prevent service conditions from exceeding those limits. The Type 627R or 627MR regulator with internal relief will provide downstream overpressure protection within the limits given in tables 1, 2, 3 and 4. If these limits are exceeded additional downstream overpressure protection must be provided by the user.

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

Installation

Regulator operation within ratings does not preclude the possibility of damage from debris in the lines or from external sources. A regulator should be inspected for damage periodically and after any overpressure condition. Key numbers referenced in this section are shown in figures 7 through 12. Ensure that the operating temperature capabilities listed in table 1 are not exceeded.

Like most regulators, 627 Series regulators have outlet pressure ratings that are lower than their inlet pressure ratings. A pressure relieving or pressure limiting device must be provided by the user for the Type 627, 627H, 627M, and 627HM regulators if the inlet pressure can exceed the outlet pressure rating, since these regulators do not have internal relief.

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

Note

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

Perform steps 1 through 6 for all types of regulators:

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

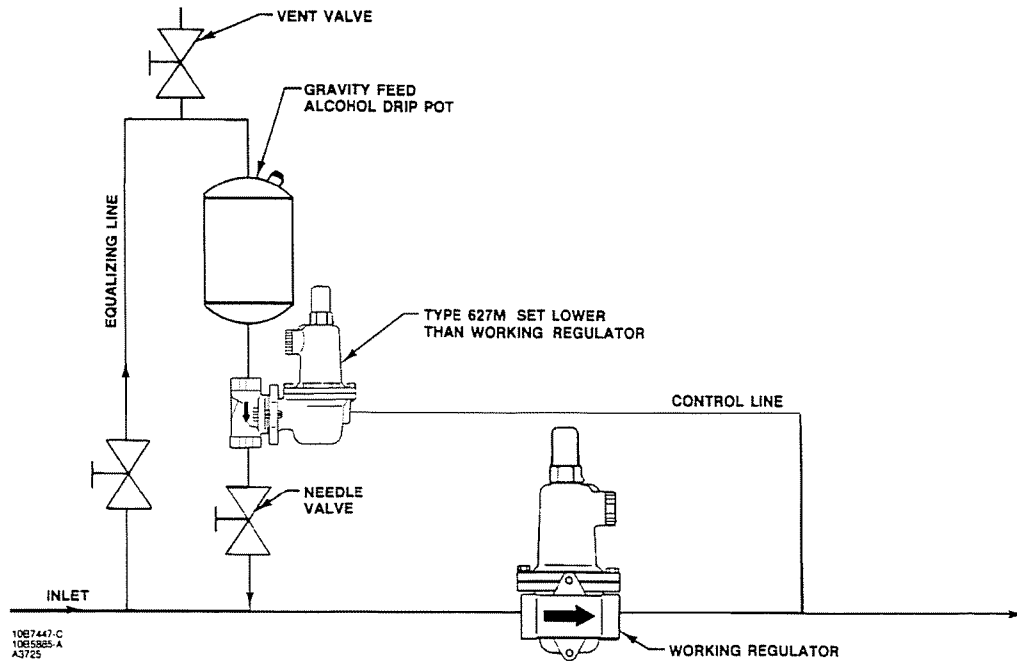


Figure 3. Schematic of De-Icer System



WARNING

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

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

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

7. A Type 627M, 627HM, or 627MR regulator requires a downstream control line. Install the control line before putting the regulator into operation.

8. Ensure that the downstream control line piping is at least 3/8-inch or larger outside diameter tubing and

connected to a straight section of outlet piping 10 diameters downstream of the regulator.

9. A hand valve should be installed in the control line. This hand valve can be used to throttle down and dampen outlet pulsations in control pressure which may cause instability or cycling of the regulator.

Remote Vent Line Installation

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

Protect the remote vent opening against entrance of rain, snow, or any other foreign material that may plug the vent or vent line and prevent proper operation of the regulator. Periodically check the vent opening to be sure it is not plugged with foreign debris.

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

For the Type 627M or 627HM regulator de-icer system, refer to the application shown in figure 3. With a large pressure drop across the working regulator, ice can

627 Series

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

OUTLET PRESSURE RANGE, SPRING PART NUMBER, AND COLOR	OUTLET PRESSURE SETTING, PSIG (bar)	MAXIMUM ALLOWABLE DOWNSTREAM SYSTEM PRESSURE, PSIG (bar)	MAXIMUM INLET PRESSURE TO KEEP MAXIMUM ALLOWABLE DOWNSTREAM SYSTEM PRESSURE FROM BEING EXCEEDED, PSIG (bar) ⁽²⁾					
			Orifice Size, Inches (mm)					
			3/32 (2,4)	1/8 (3,2)	3/16 (4,8)	1/4 (6,4)	3/8 (9,5)	1/2 (12,7)
5 ⁽³⁾ to 20 psig (0,34 to 1,4 bar) 10B3076X012 Yellow	10 (0,69)	60 (4,1)	1250 (86,2)	740 (51,1)	320 (22,1)	190 (13,1)	95 (6,56)	75 (5,18)
		100 (6,9)	2000 (138)	1500 (103)	620 (42,7)	390 (26,9)	180 (12,4)	130 (8,97)
		125 (8,6)	2000 (138)	1900 (131)	830 (57,2)	480 (33,1)	220 (15,2)	160 (11,0)
		175 (12,1)	2000 (138)	2000 (138)	1100 (75,8)	670 (46,2)	320 (22,1)	220 (15,2)
		200 (13,8)	2000 (138)	2000 (138)	1300 (89,6)	770 (53,1)	360 (24,8)	260 (17,9)
	250 (17,2)	2000 (138)	2000 (138)	1600 (110)	960 (66,2)	450 (31,0)	320 (22,1)	
	15 (1,0)	60 (4,1)	1000 (69,0)	620 (42,7)	260 (17,9)	170 (11,7)	90 (6,2)	70 (4,8)
		100 (6,9)	2000 (138)	1400 (96,5)	610 (42,1)	370 (25,5)	170 (11,7)	130 (8,97)
		125 (8,6)	2000 (138)	1900 (131)	810 (55,8)	480 (33,1)	220 (15,2)	160 (11,0)
		175 (12,1)	2000 (138)	2000 (138)	1100 (75,8)	670 (46,2)	320 (22,1)	220 (15,2)
		200 (13,8)	2000 (138)	2000 (138)	1300 (89,6)	770 (53,1)	360 (24,8)	260 (17,9)
	250 (17,2)	2000 (138)	2000 (138)	1600 (110)	960 (66,2)	450 (31,0)	320 (22,1)	
	20 (1,4)	60 (4,1)	850 (58,6)	490 (33,8)	210 (14,5)	130 (9,0)	80 (5,52)	65 (4,49)
		100 (6,9)	2000 (138)	1300 (89,6)	600 (41,4)	360 (24,8)	170 (11,7)	120 (8,28)
		125 (8,6)	2000 (138)	1800 (124)	800 (55,2)	480 (33,1)	220 (15,2)	160 (11,0)
175 (12,1)		2000 (138)	2000 (138)	1100 (75,8)	670 (46,2)	320 (22,1)	220 (15,2)	
200 (13,8)		2000 (138)	2000 (138)	1300 (89,6)	770 (53,1)	360 (24,8)	260 (17,9)	
250 (17,2)	2000 (138)	2000 (138)	1600 (110)	960 (66,2)	450 (31,0)	320 (22,1)		
15 to 40 psig (1,0 to 2,8 bar) 10B3077X012 Green	15 (1,0)	60 (4,1)	1000 (69,0)	380 (26,2)	210 (14,5)	130 (8,97)	80 (5,5)	65 (4,49)
		100 (6,9)	2000 (138)	1300 (89,6)	590 (40,7)	350 (24,1)	170 (11,7)	120 (8,28)
		125 (8,6)	2000 (138)	1800 (124)	800 (55,2)	470 (32,4)	220 (15,2)	160 (11,0)
		175 (12,1)	2000 (138)	2000 (138)	1100 (75,8)	640 (44,1)	320 (22,1)	220 (15,2)
		200 (13,8)	2000 (138)	2000 (138)	1300 (89,6)	780 (53,8)	370 (25,5)	260 (17,9)
	250 (17,2)	2000 (138)	2000 (138)	1600 (66,2)	960 (66,2)	450 (31,0)	320 (22,1)	
	20 (1,4)	60 (4,1)	630 (43,4)	200 (13,8)	150 (10,3)	100 (6,9)	70 (4,83)	65 (4,49)
		100 (6,9)	2000 (138)	1200 (82,7)	550 (37,9)	330 (22,8)	160 (11,0)	120 (8,28)
		125 (8,6)	2000 (138)	1700 (117)	760 (52,4)	450 (31,1)	210 (14,5)	160 (11,0)
		175 (12,1)	2000 (138)	2000 (138)	1100 (75,8)	630 (43,4)	320 (22,1)	220 (15,2)
		200 (13,8)	2000 (138)	2000 (138)	1300 (89,6)	770 (53,1)	360 (24,8)	260 (17,9)
	250 (17,2)	2000 (138)	2000 (138)	1600 (66,2)	960 (66,2)	460 (31,7)	320 (22,1)	
	30 (2,1)	100 (6,9)	2000 (138)	950 (65,5)	450 (31,1)	260 (17,9)	140 (9,66)	110 (7,59)
		125 (8,6)	2000 (138)	1500 (103)	670 (46,2)	400 (27,6)	190 (13,1)	150 (10,3)
		175 (12,1)	2000 (138)	2000 (138)	1000 (69,0)	610 (42,1)	300 (20,7)	220 (15,2)
		200 (13,8)	2000 (138)	2000 (138)	1200 (82,7)	760 (52,4)	360 (24,8)	260 (17,9)
		250 (17,2)	2000 (138)	2000 (138)	1600 (110)	970 (66,9)	460 (31,7)	320 (22,1)
	40 (2,8)	100 (6,9)	1500 (103)	700 (48,3)	330 (22,8)	200 (13,8)	120 (8,28)	108 (7,45)
		125 (8,6)	2000 (138)	1300 (89,6)	560 (38,6)	340 (23,4)	180 (12,4)	140 (9,66)
		175 (12,1)	2000 (138)	1800 (124)	1000 (69,0)	550 (37,9)	290 (20,0)	220 (15,2)
200 (13,8)		2000 (138)	2000 (138)	1200 (82,7)	730 (50,3)	350 (24,1)	250 (17,2)	
250 (17,2)		2000 (138)	2000 (138)	1600 (110)	970 (66,9)	460 (31,7)	320 (22,1)	

form with in this regulator. The formation of ice decreases the size of the port opening, so the regulator is unable to supply enough flow to satisfy the downstream demand. When the downstream pressure falls below the outlet pressure setting of the Type 627M or 627HM regulator, the disk assembly of the Type 627Mor 627HMregulator moves off its seat ring, permitting alcohol to flow into the main gas line. The alcohol carried to the main regulator by the flow stream prevents additional ice from forming on the seat ring. When normal flow resumes, and as pressure in the downstream system is restored, the Type 627M or 627HM regulator shuts off.

Startup and Adjustment

Startup



WARNING

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

Table 4. Type 627R Internal Relief Performance⁽¹⁾ (continued)

OUTLET PRESSURE RANGE, SPRING PART NUMBER, AND COLOR	OUTLET PRESSURE SETTING, PSIG (bar)	MAXIMUM ALLOWABLE DOWNSTREAM SYSTEM PRESSURE, PSIG (bar)	MAXIMUM INLET PRESSURE TO KEEP MAXIMUM ALLOWABLE DOWNSTREAM SYSTEM PRESSURE FROM BEING EXCEEDED, PSIG (bar) ⁽²⁾					
			Orifice Size, Inches (mm)					
			3/32 (2,4)	1/8 (3,2)	3/16 (4,8)	1/4 (6,4)	3/8 (9,5)	1/2 (12,7)
35 to 80 psig (2,4 to 5,5 bar) 10B3078X012 Blue	40 (2,8)	125 (8,6)	2000 (138)	1100 (75,8)	500 (34,5)	300 (20,7)	170 (11,7)	140 (9,66)
		150 (10,3)	2000 (138)	1600 (110)	750 (51,7)	440 (30,3)	230 (15,9)	180 (12,4)
		175 (12,1)	2000 (138)	2000 (138)	980 (67,6)	580 (40,0)	290 (20,0)	220 (15,2)
		200 (13,8)	2000 (138)	2000 (138)	1200 (82,7)	720 (49,6)	340 (23,4)	250 (17,2)
		250 (17,2)	2000 (138)	2000 (138)	1600 (110)	940 (64,8)	450 (31,0)	320 (22,1)
	50 (3,4)	125 (8,6)	1400 (96,5)	820 (56,5)	400 (27,6)	230 (15,9)	150 (10,3)	140 (9,66)
		150 (10,3)	2000 (138)	1400 (96,5)	650 (44,8)	370 (25,5)	210 (14,5)	170 (11,7)
		175 (12,1)	2000 (138)	1900 (131)	700 (48,3)	530 (36,5)	270 (18,6)	210 (14,5)
		200 (13,8)	2000 (138)	2000 (138)	1100 (75,8)	670 (46,2)	330 (22,8)	240 (16,5)
		250 (17,2)	2000 (138)	2000 (138)	1500 (103)	920 (63,4)	430 (29,6)	320 (22,1)
	60 (4,1)	125 (8,6)	900 (62,1)	450 (31,1)	270 (18,6)	190 (13,1)	140 (9,66)	130 (8,97)
		150 (10,3)	1700 (117)	1100 (75,8)	540 (37,2)	300 (20,7)	190 (13,1)	160 (11,0)
		175 (12,1)	2000 (138)	1700 (117)	780 (53,8)	470 (32,4)	250 (17,2)	200 (13,8)
		200 (13,8)	2000 (138)	2000 (138)	1000 (69,0)	610 (42,1)	310 (21,4)	230 (15,9)
		250 (17,2)	2000 (138)	2000 (138)	1400 (96,5)	880 (60,7)	420 (29,0)	310 (21,4)
	70 (4,8)	150 (10,3)	1200 (82,7)	850 (58,6)	430 (29,6)	250 (17,2)	170 (11,7)	160 (11,0)
		175 (12,1)	2000 (138)	1400 (96,5)	670 (46,2)	400 (27,6)	230 (15,9)	190 (13,1)
		200 (13,8)	2000 (138)	2000 (138)	920 (63,4)	550 (37,9)	280 (19,3)	230 (15,9)
		250 (17,2)	2000 (138)	2000 (138)	1300 (89,6)	830 (57,2)	400 (27,6)	310 (21,4)
		150 (10,3)	800 (55,2)	500 (34,5)	300 (20,7)	200 (13,8)	160 (11,0)	150 (10,3)
80 (5,5)	175 (12,1)	1500 (103)	1200 (82,7)	550 (37,9)	330 (22,8)	210 (14,5)	190 (13,1)	
	200 (13,8)	2000 (138)	1700 (117)	800 (55,2)	480 (33,1)	270 (18,6)	220 (15,2)	
	250 (17,2)	2000 (138)	2000 (138)	1200 (82,7)	770 (53,1)	390 (26,9)	300 (20,7)	
	175 (12,1)	1900 (131)	600 (41,4)	400 (27,6)	260 (17,9)	200 (13,8)	175 (12,1)	
	200 (13,8)	2000 (138)	1200 (82,7)	630 (43,4)	380 (26,2)	250 (17,2)	210 (14,5)	
70 to 150 psig (4,8 to 10,3 bar) 10B3079X012 Red	250 (17,2)	2000 (138)	2000 (138)	1100 (75,8)	680 (46,9)	360 (24,8)	290 (20,0)	
	175 (12,1)	1400 (96,5)	250 (17,2)	240 (16,5)	200 (13,8)	190 (13,1)	175 (12,1)	
	200 (13,8)	2000 (138)	960 (66,2)	520 (35,9)	330 (22,8)	240 (16,5)	210 (14,5)	
	250 (17,2)	2000 (138)	2000 (138)	1000 (69,0)	620 (42,7)	350 (24,1)	280 (19,3)	
	200 (13,8)	1500 (103)	250 (17,2)	240 (16,5)	230 (15,9)	210 (14,5)	210 (14,5)	
100 (6,9)	250 (17,2)	2000 (138)	1600 (110)	770 (53,1)	520 (35,9)	320 (22,1)	270 (18,6)	
	250 (17,2)	2000 (138)	1000 (69,0)	500 (34,5)	390 (26,9)	290 (20,0)	260 (17,9)	
	250 (17,2)	2000 (138)	1000 (69,0)	500 (34,5)	390 (26,9)	290 (20,0)	260 (17,9)	
125 (8,6)	250 (17,2)	2000 (138)	1000 (69,0)	500 (34,5)	390 (26,9)	290 (20,0)	260 (17,9)	
	250 (17,2)	2000 (138)	1000 (69,0)	500 (34,5)	390 (26,9)	290 (20,0)	260 (17,9)	
150 (10,3)	250 (17,2)	2000 (138)	1000 (69,0)	500 (34,5)	390 (26,9)	290 (20,0)	260 (17,9)	
	250 (17,2)	2000 (138)	1000 (69,0)	500 (34,5)	390 (26,9)	290 (20,0)	260 (17,9)	

1. The internal relief performance values are obtained by removing the disk assembly.
2. For inlet pressures in excess of 1000 psig (69 bar), refer to the maximum body and disk pressure ratings in the specifications table.
3. For pressure settings under 10 psig (0,69 bar), inlet pressure should be limited to approximately 100 psig (6,9 bar) so the setpoint adjustment can be obtained.
- Shaded areas indicate maximum inlet pressures allowed during system malfunction only. Table 6 gives the maximum inlet pressure for normal regulator operation.

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

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

Adjustment

The range of allowable pressure settings is marked on the nameplate (figure 2). If a pressure setting beyond this range is necessary, substitute the appropriate regulator control spring. Change the nameplate to indicate the new pressure range.

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

627 Series

Table 5. Maximum Torque Values

KEY NUMBER ⁽¹⁾	DESCRIPTION	MAXIMUM TORQUE, FOOT-POUNDS (N•m)
2	Seat ring	25 (34)
3	Cap screw (w/ aluminum diaphragm casing)	16 (22)
	Cap screw (w/ ductile iron or steel diaphragm casing)	25 (34)
18	Lever cap screw	7 (9)
22	Diaphragm connector nut	17 (23)
26	Guide retainer (for Type 627R and 627MR only)	3 (4)
37	Spring case cap screw (w/ aluminum or ductile iron diaphragm casing)	7 (9)
	Spring case cap screw (w/ steel diaphragm casing)	35 (47)
46	Diaphragm cap screw (w/Type 627 or 627M)	7 (9)
	Diaphragm cap screw (w/Type 627H or 627MH)	14 (19)

1. Refer to figures 7 through 10 for key number locations.

Note

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

Refer to figures 7 through 12 for key number locations.

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

Shutdown



WARNING

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

1. Close the nearest upstream shutoff valve.
2. Close the nearest downstream shutoff valve.

3. Open the vent valve between the regulator and the downstream shutoff valve nearest to it.

4. For a Type 627, 627H, or 627R regulator, the regulator will open to release pressure between the upstream shutoff valve and the regulator.

5. A Type 627M, 627HM, or 627MR regulator requires venting the control line and downstream pressure from the regulator before maintenance. The pressure between these shutoff valves is released through the open regulator because the disk assembly remains open in response to the decrease in control line pressure.

Maintenance

Unless otherwise specified, the following maintenance procedures apply to all types of regulators. For a summary of maximum torque values required for all types of regulators, refer to table 5.

Due to normal wear, damage from external sources, or debris in the air or gas line, regulator parts such as the disk assembly, seat ring, and diaphragm must be inspected periodically and replaced as necessary to ensure correct performance. The frequency of inspection and replacement depends upon the severity of conditions and the requirements of state and federal laws. Normal wear of the seat ring and disk assembly is accelerated with high pressure drops and with large amounts of impurities in the flow stream. Instructions are given below for replacing the disk assembly, seat ring, diaphragm, and O-rings. These procedures may also be used for disassembly required for inspection and replacement of other parts.

Problem Indication for Type 627R and 627MR Regulators



WARNING

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

The vent assembly is equipped with a relief indicator (key 49, figure 4). The cap for the relief indicator snaps over the vent assembly opening. If the relief valve opens wide, exhaust gas pops the cap off the screen vent assembly opening indicating a problem with the regulator. If the cap pops off, refer to the shutdown and to the body area maintenance procedures to inspect the disk assembly and seat ring.

If the disk assembly and seat ring are not damaged, refer to the diaphragm and spring case area maintenance procedures in this section.

The disk assembly and seat ring can be inspected, removed, and replaced without removing the regulator body from the line connections. Refer to the body area maintenance procedures.

Body Area Maintenance Procedures

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

While using the following procedures, refer to figures 7 through 12 for key number locations.

Replacing the Disk Assembly or Seat Ring

1. To inspect and replace the disk assembly (key 9) or seat ring (key 2), remove the cap screws (key 3, figure 5), and separate the diaphragm casing (key 5) from the body (key 1).
2. Inspect and, if necessary, remove the seat ring (key 2). If removed, coat the threads of the replacement seat ring with lubricant (key 38) and torque to 25 foot-pounds (34 N•m).
3. Inspect the disk assembly and, if necessary, remove the hair pin clip (key 13) that holds the disk assembly (key 9) in place. If replacing the disk assembly is the only maintenance required, skip to step 16.

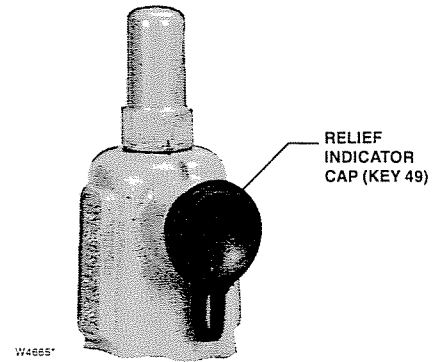


Figure 4. Relief Indicator

Replacing the Stem Assembly

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

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

4. For Type 627, 627H, and 627R regulators (figure 5), use steps 5 through 8 to remove and replace the stem assembly.
5. Remove the boost body (key 6), stabilizer (key 7), and stem guide (key 8) from the diaphragm casing (key 5). Unhook and remove the stem (key 10) from the diaphragm casing (key 5).
6. Remove and inspect the diaphragm casing O-ring (key 4, figure 7, 8, or 11) and replace it if necessary.
7. Apply lubricant (key 42) to a replacement diaphragm casing O-ring (key 4, figure 7, 8, or 11) and install it onto the boost body (key 6). Skip to step 14.
8. For the Type 627 or 627H regulators, be sure to insert the pitot tube (tab) into the outlet side of the body (see figure 7 or 11). Skip to step 14.

Perform steps 9 through 19 for Type 627M, 627HM, and 627MR Regulators only:

9. For Type 627M, 627HM, and 627MR regulators (figure 5), use steps 10 through 14 to remove and replace the stem assembly.
10. To remove the blocked throat (key 43), insert a screw driver blade into the groove provided in the throat and pry it out of the diaphragm casing (key 5). Inspect and replace parts as necessary.

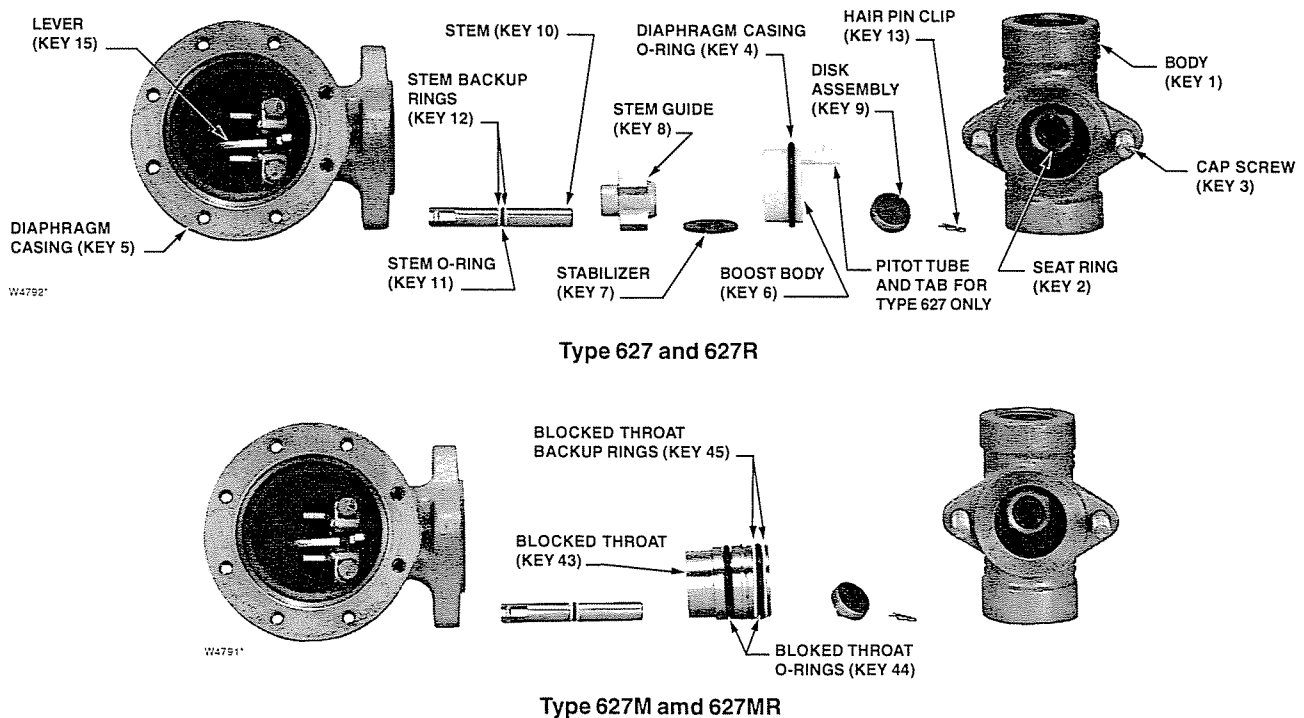


Figure 5. Stem Assemblies

11. Inspect and, if necessary, replace the blocked throat O-rings (key 44, figure 5) and backup rings (key 45, figure 5).

12. Apply lubricant (key 42) to replacement blocked throat O-rings (key 44) and backup rings (key 45).

13. Apply lubricant (key 42) to the replacement stem O-ring (key 11) and stem backup rings (key 12) and install them on the stem (key 10).

14. For assembly, insert the stem (key 10) into the diaphragm casing (key 5) and hook it on the lever (key 15).

15. Insert parts into the diaphragm casing (key 5) that were removed in steps 5 and 6 or step 10 (see figure 5).

16. Install the the disk assembly (key 9), line up the hole in the disk assembly and stem (key 10) and insert the hair pin clip (key 13).

17. Position the diaphragm casing plus attached parts in relation to the body (key 1) so that they are correct for the application.

18. Secure the diaphragm casing to the body with the cap screws (key 3, figure 5). For an aluminum diaphragm casing (key 5), torque the cap screws (key 3) to 16 foot-pounds (22 N•m). For ductile iron or steel diaphragm casings, torque the cap screws (key 3) to 25 foot-pounds (34 N•m).

19. It may be necessary to reposition the diaphragm spring case to prevent rain, ice, and foreign debris from entering the spring case. Refer to the diaphragm and spring case area maintenance procedures, steps 1, 2, and 21 through 25.

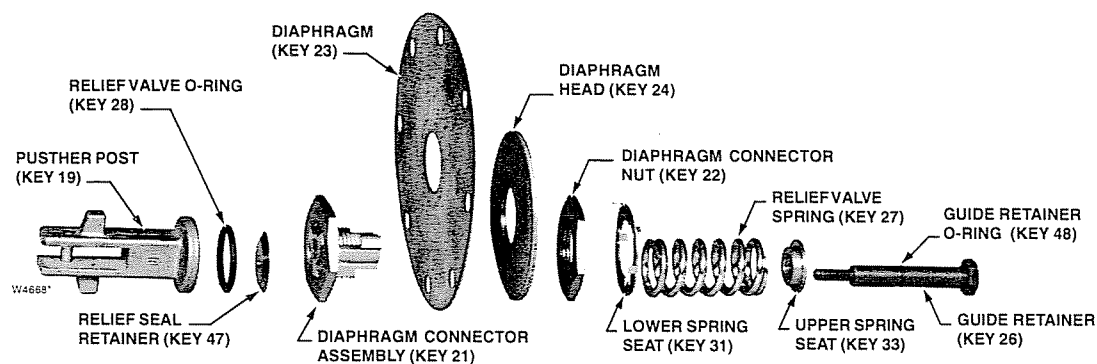
Diaphragm and Spring Case Area Maintenance Procedures

These procedures are for gaining access to the control spring, diaphragm assembly, and lever assembly. All spring pressure must be released from the diaphragm casing before these steps can be performed.

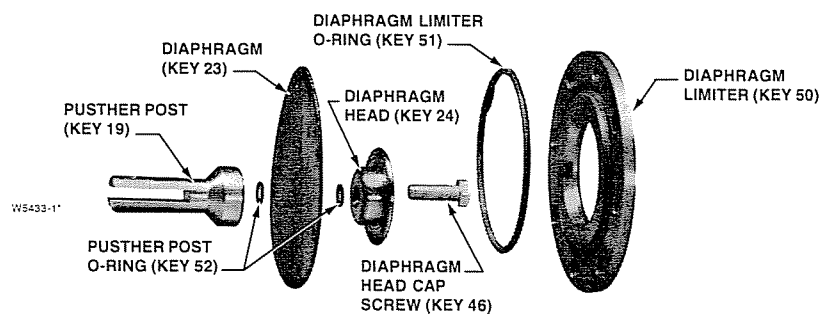
While using the following procedures, refer to figures 7 through 12 for key number locations.

1. Remove the adjusting screw cap (key 36), loosen the lock nut, and turn the adjusting screw (key 35) counterclockwise until all compression is removed from the control spring (key 32).

2. Remove the spring case cap screws (key 37), the nameplates, and lift off the spring case (key 29). If changing the control spring (key 32) or repositioning the spring case (key 29) is the only maintenance required, install the replacement control spring or rotate the spring case so it is correct for the application. Skip to step 21. For diaphragm area maintenance, continue with step 3.



Type 627, 627R, 627M, or 627MR



Type 627H and 627HM

Figure 6. Diaphragm Assemblies

3. Remove the diaphragm limiter and O-ring (keys 50 and 51, on the Type 627H or 627HM only). Remove the diaphragm assembly by tilting it so that the pusher post (key 19) slips off the lever (key 15).

4. If it is necessary to replace the lever assembly, remove the lever cap screws (key 18).

5. Install the replacement lever (key 15) into the lever retainer (key 16) by inserting the lever pin (key 17). Secure the lever assembly into the diaphragm casing with the cap screws (key 18) and torque the cap screws to 7 foot-pounds (9 N•m).

If it is necessary to perform maintenance on the diaphragm assembly, continue with steps 6 through 11 and step 20 for Type 627, 627H, 627M, and 627HM regulators, or steps 12 through 19 for Type 627R and 627MR regulators.

Perform steps 6 through 11 for Type 627, 627H, 627M, and 627HM Regulators only:

6. For Type 627, 627H, 627M, and 627HM regulators (figures 5 & 6), use steps 7 through 11 to disassemble and reassemble the diaphragm assembly.

7. Remove the diaphragm head cap screw (key 46), lower spring seat (key 31, Type 627 or 627M only), and diaphragm head (key 24). On the Type 627H or 627HM, remove the diaphragm cap screw O-rings (key 52). Separate the diaphragm (key 23) from the pusher post (key 19).

8. Install the diaphragm (key 23), in reverse order in step 7, on the pusher post (key 19), insert and finger tighten the diaphragm head cap screw (key 46).

9. Hook the pusher post on the lever (key 15), then turn the diaphragm (key 23) to match the holes in the diaphragm with the holes in the spring casing.

10. Unhook the pusher post from the lever and torque the diaphragm head cap screw (key 46) to 7 foot-pounds (9 N•m) for the Type 627 or 627M. On the Type 627H or 627HM torque the diaphragm head cap screw to 14 foot-pounds (18 N•m).

11. Hook the pusher post on the lever (key 15) and check the hole alignment. If necessary, loosen the cap screw (key 46) and reposition the diaphragm (key 23) on the pusher post (key 19). Retorque the screw (see step 10). Skip to step 20.

627 Series

Perform steps 12 through 19 for Type 627R and 627MR Regulators only:

12. For Type 627R and 627MR regulators (figure 6), use steps 13 through 19 to disassemble and reassemble the diaphragm assembly:

13. Remove the guide retainer (key 26) and separate the diaphragm parts. Refer to figure 6 for the sequence of parts.

14. To remove the diaphragm (key 23), remove the diaphragm connector nut (key 22) and lift off the diaphragm head (key 24) and diaphragm (key 23) from the connector assembly (key 21). Do not attempt to disassemble the connector assembly (key 21).

15. Position the replacement diaphragm (key 23) on the connector assembly (key 21), install the diaphragm head (key 24) and connector nut (key 22), then torque to 17 foot-pounds (32 N•m).

16. If necessary, replace the guide retainer O-ring (key 48) and, set the guide retainer (key 26) aside, ready for assembly.

17. On the pusher post (key 19) install the relief seal O-ring (key 28) and lubricate (key 42). Also, install the relief seal retainer (key 47), diaphragm connector assembly (key 21, with attached parts) relief spring (key 27), upper relief spring seat (key 33), and guide retainer (key 26). Torque the guide retainer (key 26) to 3 foot-pounds (4 N•m).

18. Hook the pusher post (with attached parts) on the lever (key 15) to check the alignment of the holes in the diaphragm with the holes in the spring casing. If the holes do not line up, unhook the pusher post from the lever, hold the pusher post, and rotate the diaphragm to the correct position.

19. Install the lower spring seat (key 31) over the relief spring so it rests flat on the connector nut (key 22).

20. Insert the diaphragm assembly into the diaphragm casing (key 5) and hook the pusher post on the lever (key 15).

21. Install the control spring (key 32) and upper spring seat (key 33), and apply lubricant (key 38) to the upper spring seat (key 33).

22. Install the spring case (key 29) so that the screened vent assembly (key 30) is in the correct position for the application. Place the nameplates (key 39) over the screw holes, insert the spring case cap screws (key 37), and finger tighten.

23. Screw in the adjustment screw to put slack into the diaphragm (key 23).

24. Using a crisscross pattern, finish tightening the spring case cap screws (key 37) to 7 foot-pounds (9 N•m) of torque.

25. If necessary, refer to the installation and/or the startup and adjustment procedures.

26. Install the adjusting screw cap (key 34) after regulator adjustment.

Parts Ordering

When corresponding with your Fisher sales office or sales representative about this regulator, always reference the type number which is found on the nameplate (key 39, figures 7 through 12).

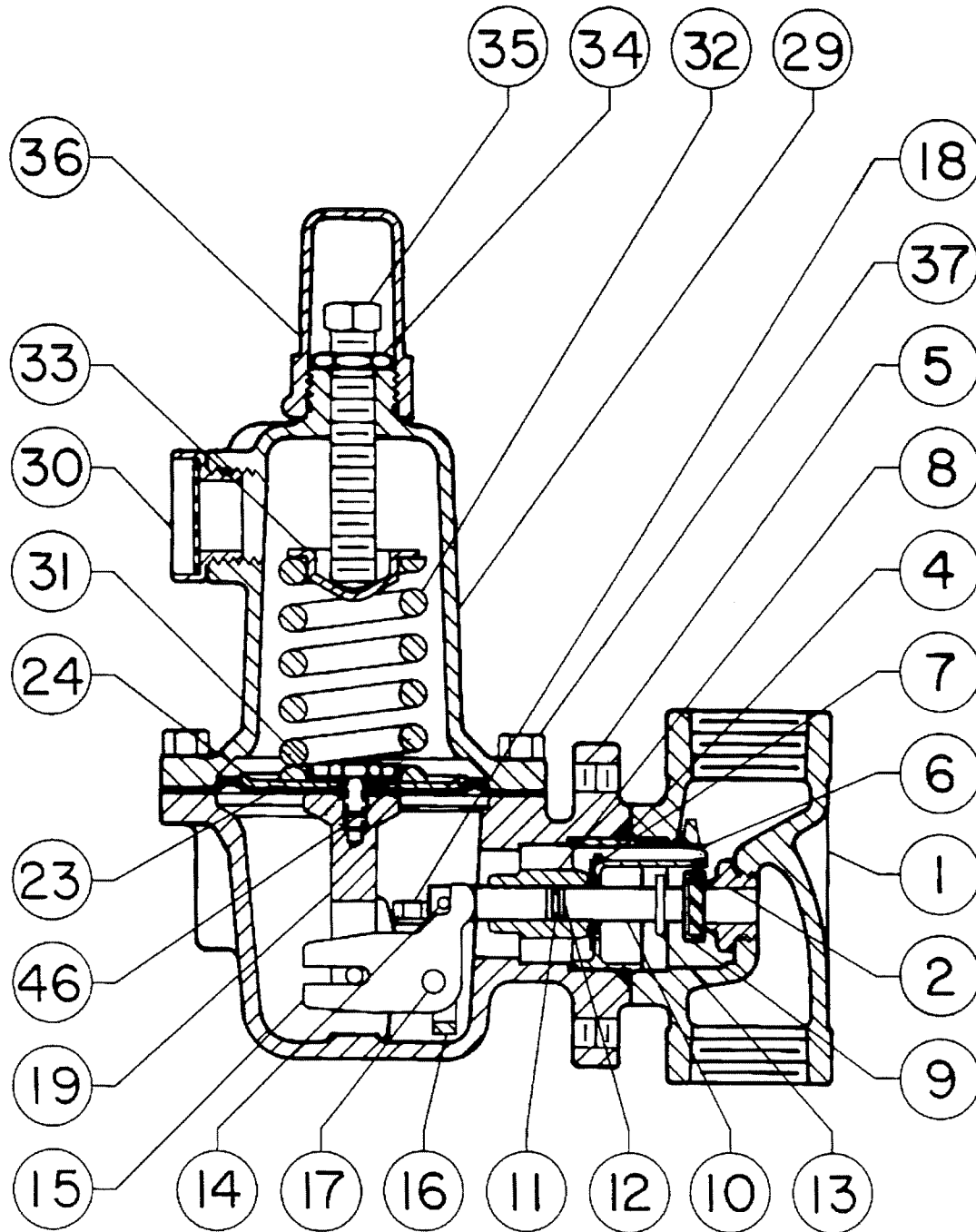
When ordering replacement parts, reference the key number of each needed part as found in the following parts list.

Parts List

Key	Description	Part Number
	Type 627 Parts Kit with aluminum/nitrile trim (includes keys 4, 9, 11, 12, and 23)	R627X000A12
	Type 627 Parts Kit with stainless steel/nitrile trim (includes keys 4, 9, 11, 12, and 23)	R627X000S12
	Type 627R Parts Kit with aluminum/nitrile trim (includes keys 4, 9, 11, 12, 23, 28, and 48)	R627RX00A12
	Type 627R Parts Kit with stainless steel/nitrile trim (includes keys 4, 9, 11, 12, 23, 28, and 48)	R627RX00S12
1	Body	
	Ductile iron	
	1000 psig (69 bar) max inlet pressure	
	3/4-inch NPT size	30B3046X012
	1-inch NPT size	30B3048X012
	2-inch NPT size	30B3096X012
	Steel	
	2000 psig (138 bar) max inlet pressure	
	3/4-inch NPT size	30B3050X012
	1-inch NPT size	30B3051X012
	2-inch NPT size	30B7452X012
	Steel, ANSI Class 600 RF flanged	
	1480 psig (102 bar) max inlet pressure	
	1-inch size	40B6754X012
	2-inch size	40B6756X012
2*	Seat ring	
	Aluminum	
	3/32-inch (2.4 mm) port diameter	0R044109022
	1/8-inch (3.2 mm) port diameter	1A936709012
	3/16-inch (4.8 mm) port diameter	00991209012
	1/4-inch (6.4 mm) port diameter	0B042009012
	3/8-inch (9.5 mm) port diameter	0B042209012
	1/2-inch (12.7 mm) port diameter	1A928809012
	303 Stainless steel	
	3/32-inch (2.4 mm) port diameter	0R044135032
	1/8-inch (3.2 mm) port diameter	1A936735032
	3/16-inch (4.8 mm) port diameter	00991235032
	1/4-inch (6.4 mm) port diameter	0B042035032
	3/8-inch (9.5 mm) port diameter	0B042235032
	1/2-inch (12.7 mm) port diameter	1A928835032

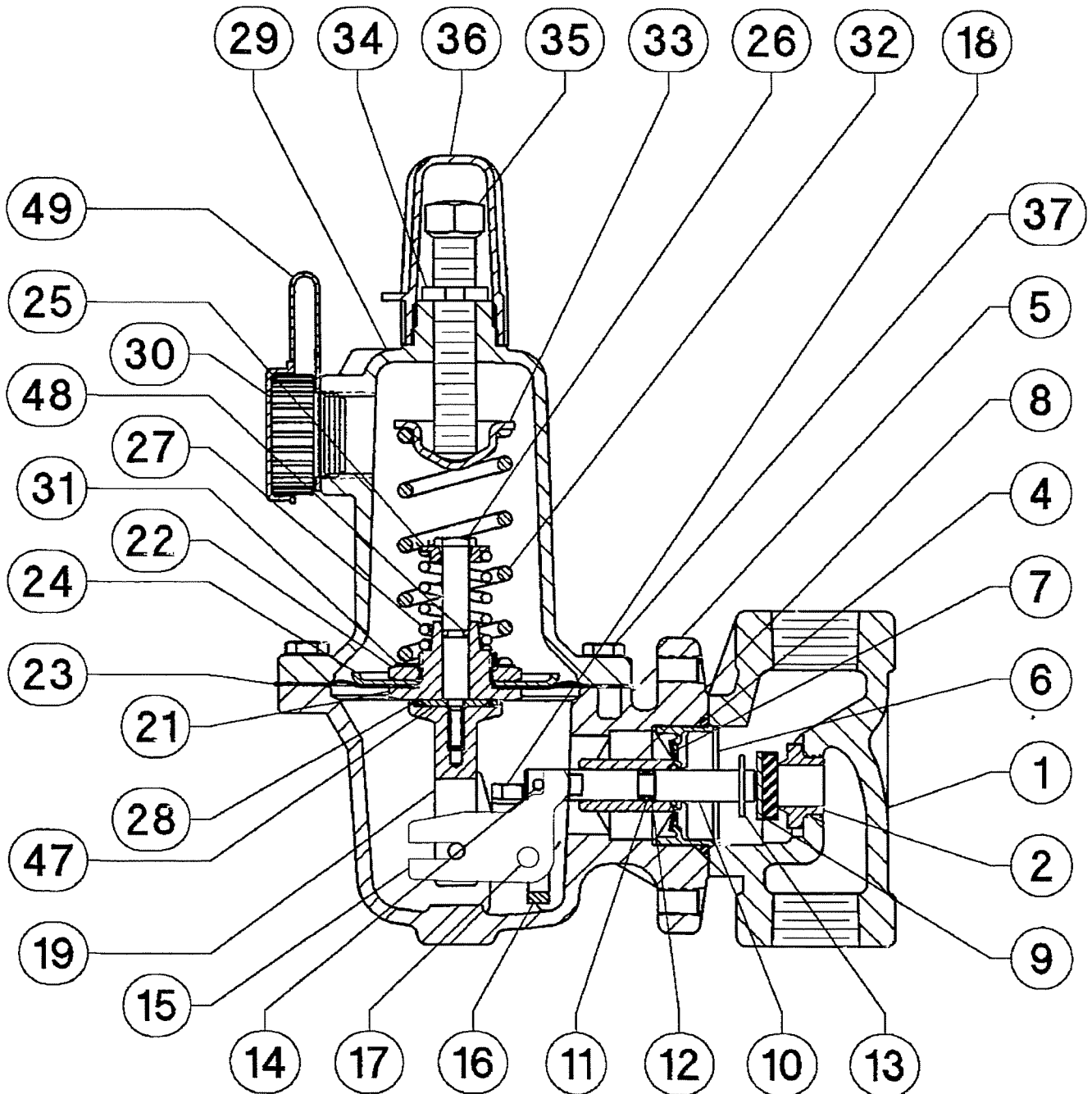
*Recommended spare part.

Key	Description	Part Number	Key	Description	Part Number
2*	Seat ring (continued)		23*	Diaphragm, nitrile (continued)	
	316 Stainless steel, NACE ⁽¹⁾ construction only			For Type 627 or 627M w/steel diaphragm case	10B8735X012
	3/32-inch (2.4 mm) port diameter	0R0441X0012		For Type 627R or 627MR w/aluminum or ductile iron diaphragm case	10B3068X012
	1/8-inch (3.2 mm) port diameter	1A9367X0022		For Type 627R or 627MR w/steel diaphragm case	10B8736X012
	3/16-inch (4.8 mm) port diameter	009912X0012		For Type 627H or 627HM w/steel diaphragm case (diaphragm is neoprene with nylon fabric)	12B0178X012
	1/4-inch (6.4 mm) port diameter	0B0420X0012	24	Diaphragm Head, plated steel	
	3/8-inch (9.5 mm) port diameter	0B0422X0012		For Type 627 or 627M, plated steel	1D666428982
	1/2-inch (12.7 mm) port diameter	1A9288X0012		For Type 627R or 627MR, plated steel	10B3071X012
3	Cap Screw (not shown), (2 req'd)			For Type 627H or 627HM, 416 stainless steel	12B0175X012
	Type 627 and 627R w/aluminum diaphragm case, pl steel	18A1087X012	25	Relief Spring Seat (for Type 627R or 627MR only), steel	10B7446X012
	All Types w/ductile iron diaphragm case, pl steel	1C403824052	26	Guide Retainer (for Type 627R or 627MR only), stainless steel	10B7450X012
	or steel diaphragm case, pl steel	1C403024052	27	Relief Spring (for Type 627R or 627MR only), plated steel	10B6757X012
4*	Diaphragm Case O-Ring (Type 627, 627H, or 627R only), nitrile	17A2325X022	28*	Relief Seal O-Ring (for Type 627R or 627MR only), nitrile	1J108506992
5	Diaphragm Case		29	Spring Case	
	For Type 627 or 627R			For Type 627 or 627R	
	Aluminum w/o 1/8-inch gauge tap	40B3084X012		Aluminum	40B3086X012
	Aluminum with 1/8-inch gauge tap for Type 627 only	11B5380X012		Ductile iron	30B3055X012
	Ductile iron w/o 1/8-inch gauge tap	30B3053X012		Steel	30B3102X012
	Ductile iron with 1/8-inch gauge tap for Type 627 only	31B0641X012		For Type 627M or 627MR	
	Steel	30B3104X012		Ductile iron	30B3055X012
	For Type 627M or 627MR			Steel	30B3102X012
	Ductile iron	39A5987X012		For Type 627M or 627MR	
	Steel	30B8734X012		Ductile iron	30B3055X012
	For Type 627H, steel	30B3104X012		Steel	30B3102X012
	For Type 627HM, steel	30B8734X012		For Type 627H or 627HM	
6	Boost Body (not for Type 627M, 627HM, or 627MR), Delrin ⁽²⁾		30	Screened Vent Assembly, plastic	30B3102X012
	For Type 627 or 627H	30B3056X012	31	Lower Spring Seat, plated steel	10B3093X012
	For Type 627R	30B3057X012		For Type 627 or 627M	1D666625072
7	Stabilizer (for Type 627, 627H, and 627R only), nitrile	10B3060X012		For Type 627R or 627MR	20B3073X012
8	Stem Guide (for Type 627, 627H, and 627R only), powdered metal	20B3061X012	32	Control Spring, pl steel	
9*	Disk Assembly (for all port diameters)			5 to 20 psig (0.34 to 1.4 bar), yellow	10B3076X012
	Aluminum holder and nitrile disk	1C4248X0212		15 to 40 psig (1.0 to 2.8 bar), green	10B3077X012
	303 Stainless steel holder and nitrile disk	1C4248X0202		35 to 80 psig (2.4 to 5.5 bar), blue	10B3078X012
	Aluminum holder and nylon disk	1C4248X00A2		70 to 150 psig (4.8 to 10.3 bar), red	10B3079X012
	303 Stainless steel holder and nylon disk	1C4248X0062		140 to 250 psig range (9.6 to 17.2 bar), blue, used in a Type 627H or 627HM	10B3078X012
	NACE construction only			240 to 500 psig range (16.5 to 34.5 bar), red, used in a Type 627H or 627HM	10B3079X012
	Aluminum holder and nitrile disk	1C4248X0212	33	Upper Spring Seat, plated steel	1D667125072
	316 Stainless steel holder and nitrile disk	1C4248X0252	34	Locknut, plated steel	1D667728982
	Aluminum holder and nylon disk	1C4248X00A2	35	Adjusting Screw, pl steel	
	316 Stainless steel holder and nylon disk	1C4248X0262		For Type 627 or 627M	10B3081X012
10	Stem			For Type 627H or 627HM	10B3081X012
	303 stainless steel	10B3059X012		For Type 627R or 627MR	10B3080X012
	316 stainless steel (NACE)	10B3059X022	36	Adjusting Screw Cap, plastic	20B3082X012
11*	Stem O-Ring, nitrile	1D687506992	37	Spring Case Cap Screw, pl steel (8 required)	
12	Stem Backup Ring, TFE (2 required)	1K786806992		For aluminum or ductile iron diaphragm case	1A391724052
13	Hair Pin Clip, stainless steel	10B3058X012		For steel diaphragm case	10B8737X012
14	Drive Pin, plated steel	1A953228982		For Type 627H/HM, steel diaphragm case	1A346424052
15	Lever, plated steel	20B3063X012	39	Nameplate	-----
16	Lever Retainer, plated steel	30B3097X012	43	Blocked Throat (for Type 627M, 627HM or 627MR only), stainless steel	10B3085X012
17	Lever Pin		44	Blocked Throat O-Ring (for Type 627M, 627HM, or 627MR only), nitrile (2 required)	1E264306992
	Stainless steel	10B3083X012	45	Blocked Throat Backup Ring (for Type 627M, 627HM, or 627MR only), TFE (2 required)	10B3106X012
	316 stainless steel (NACE)	10B3083X022	46	Diaphragm Head Cap Screw, steel	
18	Lever Cap Screw (2 required)			For Type 627 or 627M	1K920724052
	Plated steel	10B7454X012		For Type 627H or 627HM	1C379124052
	316 stainless steel (NACE)	10B7454X022	47	Relief Seal Retainer (for Type 627R or 627MR only), stainless steel	10B7445X012
19	Pusher Post, aluminum		48*	Guide Retainer O-Ring (for Type 627R or 627MR only), nitrile	1D682506992
	For Type 627 or 627M	10B3098 X012	49	Relief Indicator (for Type 627R or 627MR only), rubber (not shown)	
	For Type 627R or 627MR	10B3098 X022	50	Diaphragm Limiter	30B3100X012
	For Type 627H or 627HM, 416 stainless steel	10B3098 X032	51*	Diaphragm Limiter O-Ring	1K877606992
21	Diaphragm Connector (for Type 627R or 627MR only), stainless steel	10B6758X012	52*	Pusher Post O-Ring (2 required)	1C853806992
22	Diaphragm Connector Nut (for Type 627R or 627MR only), stainless steel	10B7449X012			
23*	Diaphragm, nitrile				
	For Type 627 or 627M w/aluminum or ductile iron diaphragm case	10B3069X012			



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Figure 7. Type 627 Regulator Components



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Figure 8. Type 627R Regulator Components

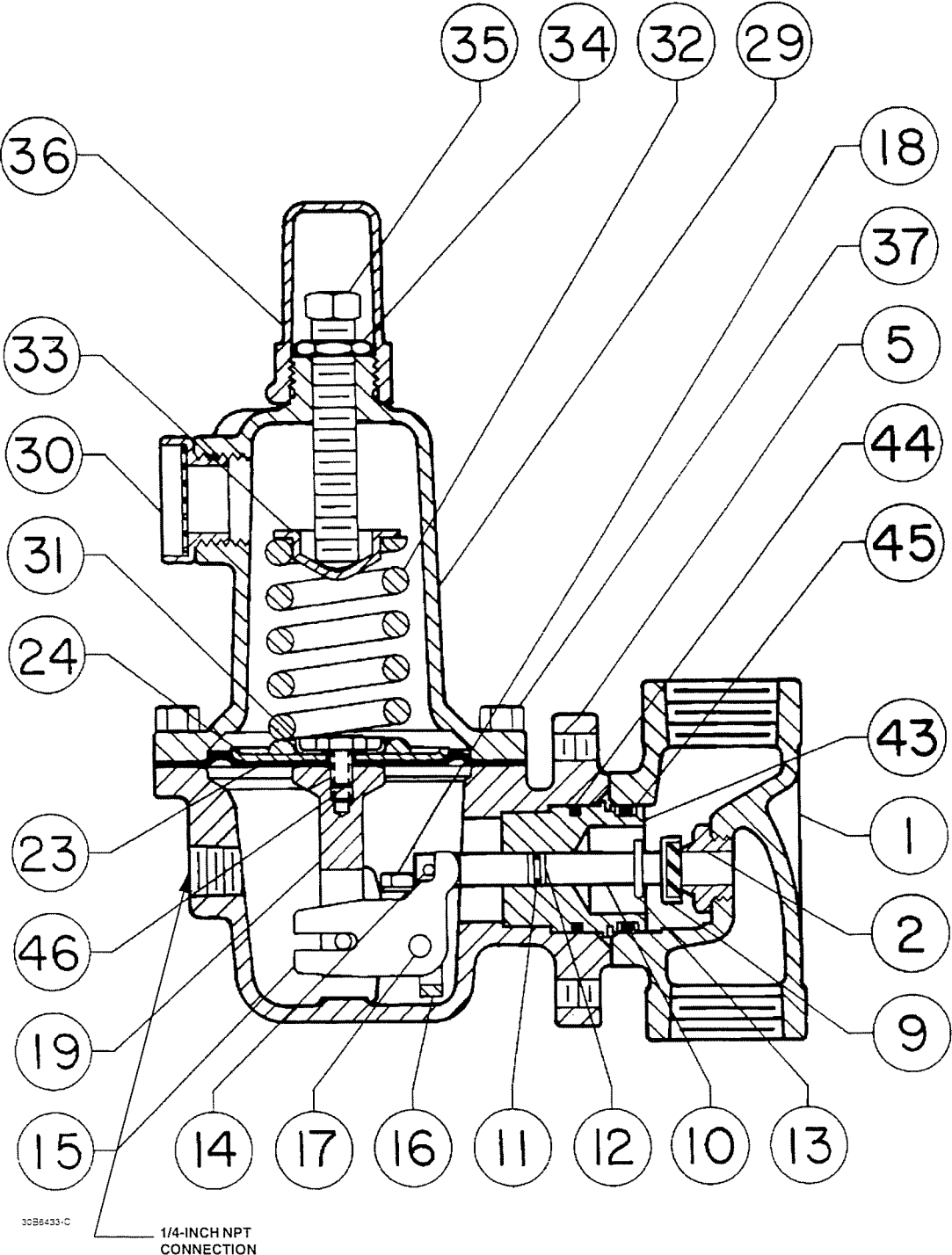


Figure 9. Type 627M Regulator Components

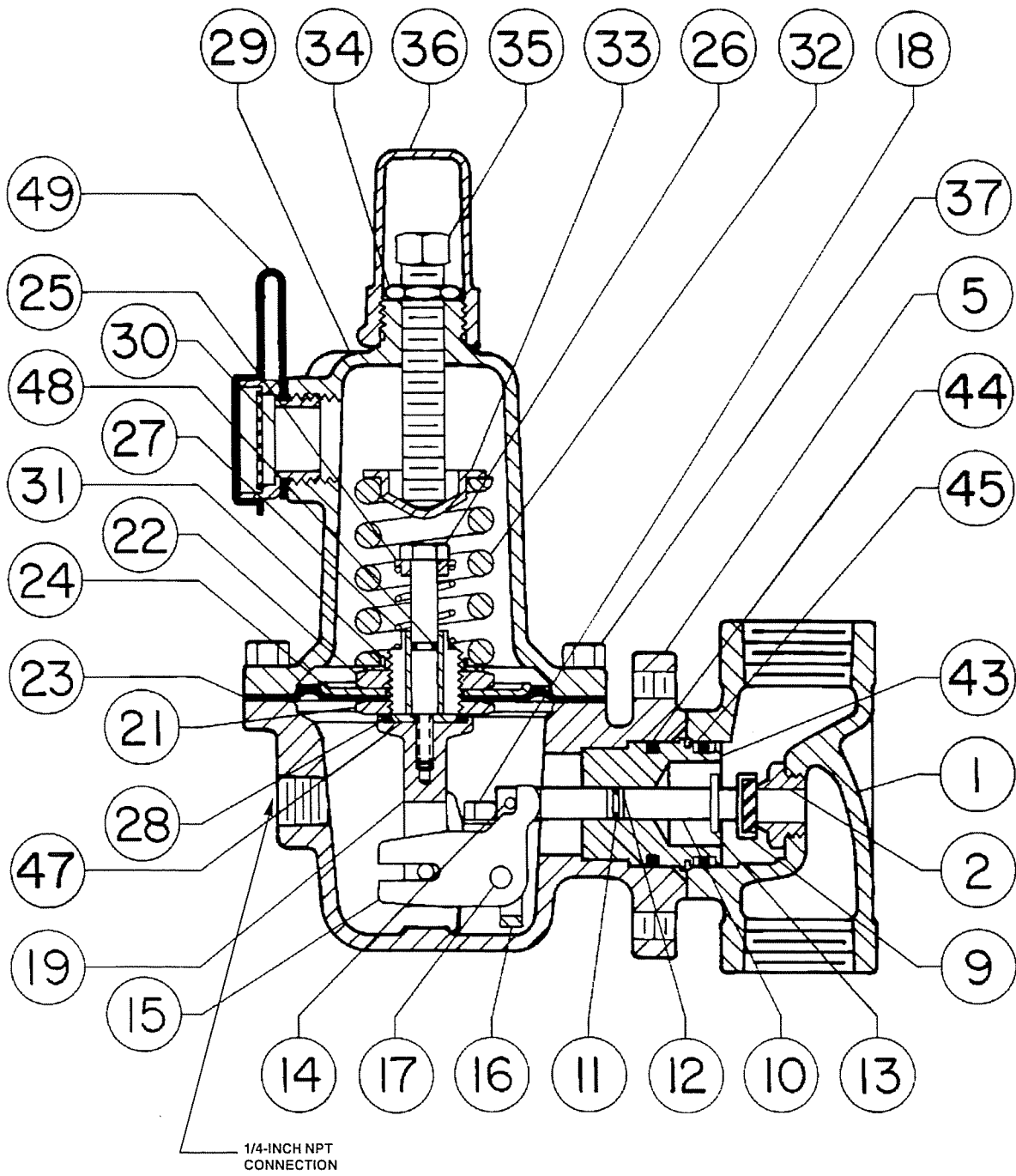
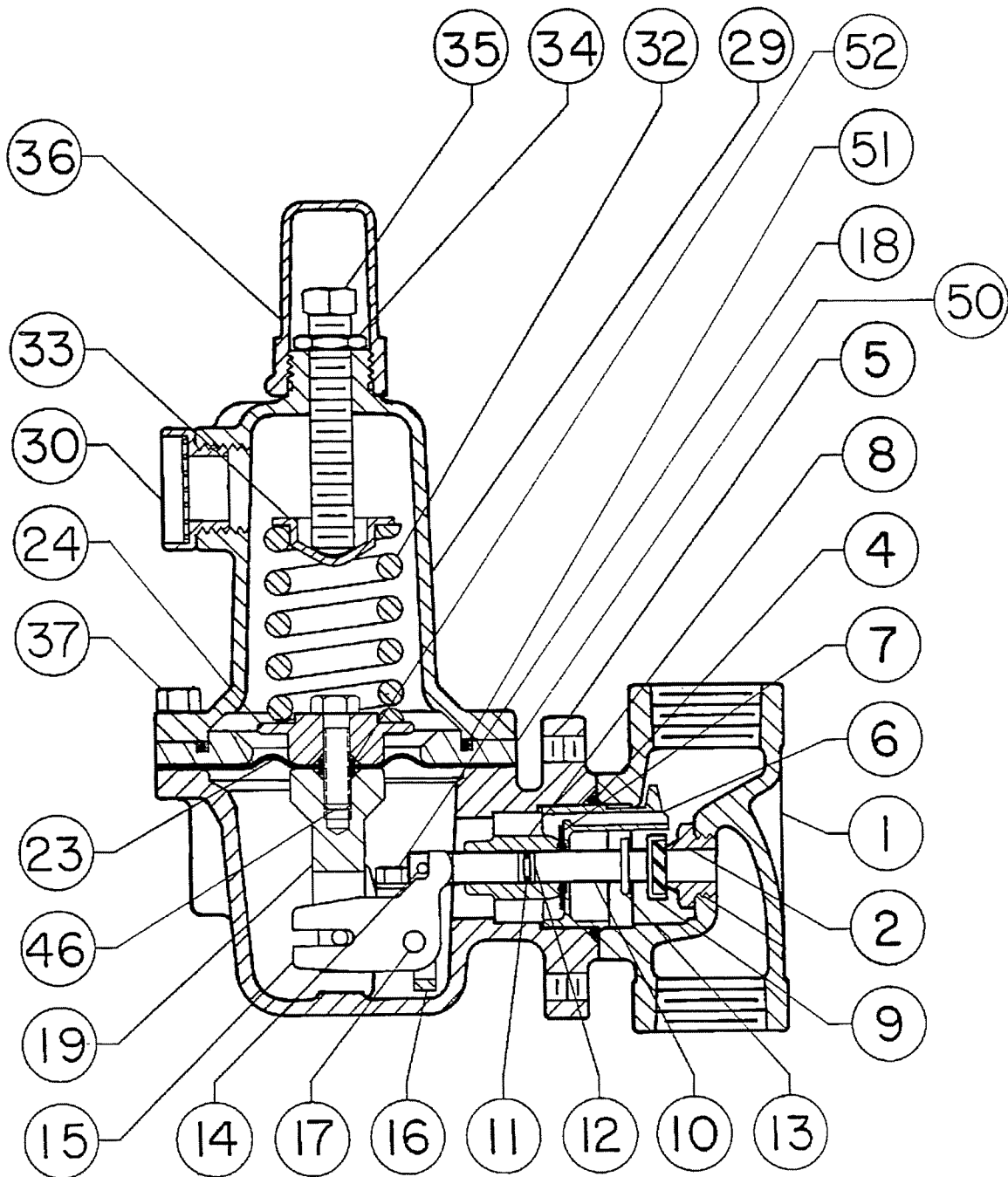
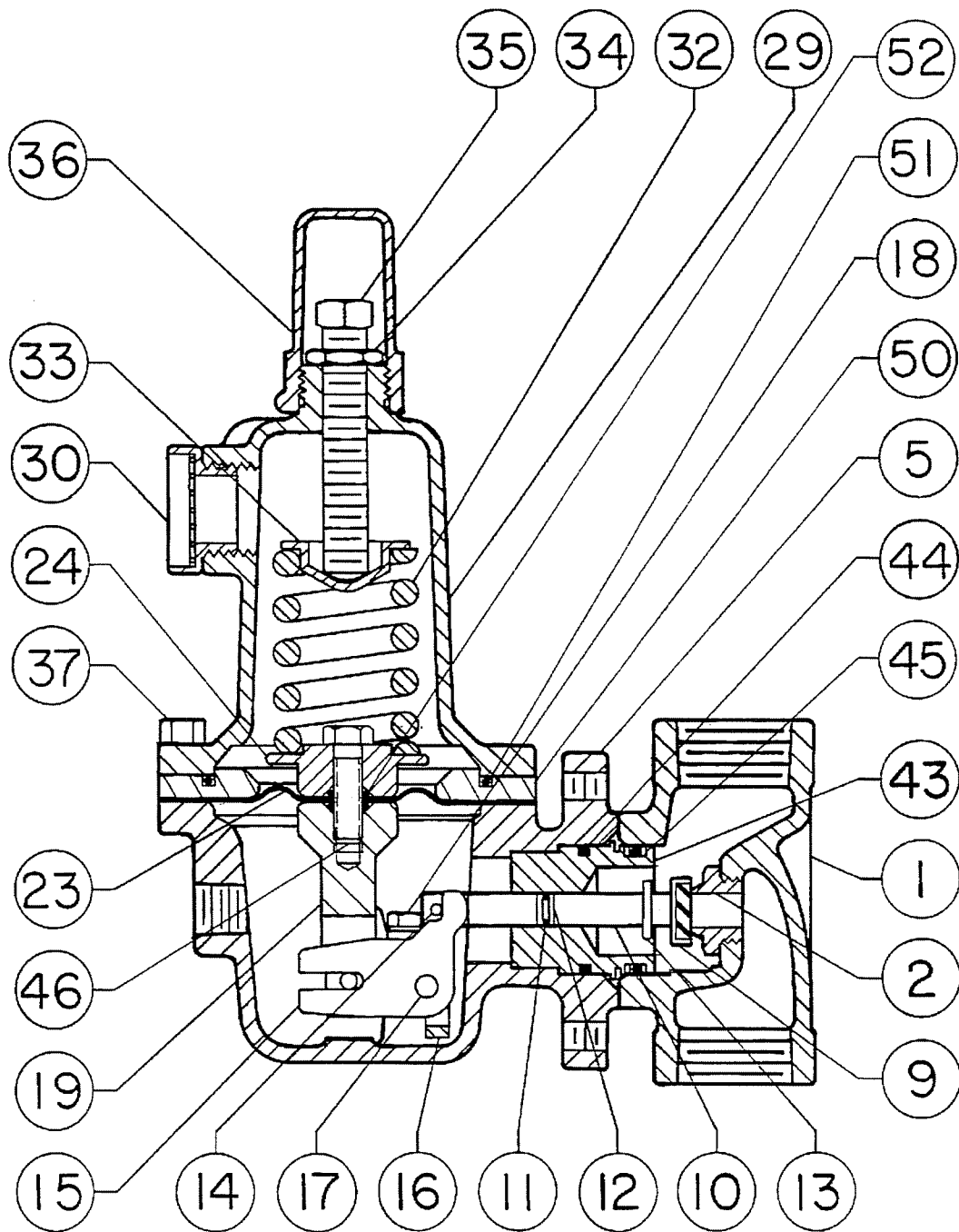


Figure 10. Type 627MR Regulator Components



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Figure 11. Type 627H Regulator Components



3159372-B

Figure 12. Type 627HM Regulator Components

**Errata Sheet
for
627 Series
Form 5252, July 1989**

This errata sheet includes information covering the Type 627LB extended body regulator. This new body style is available on all 627 Series configurations and will be an addition to key 1 in the Parts List. The pressure ratings on the Type 627LB bodies will be identical to the existing specifications stated in the current 627 Series Instruction Manual. Each bullet on this errata sheet refers to a section of the 627 Series Instruction Manual (form 5252) where this information needs to be added.

- Add the following to the Available Constructions section of Table 1. Specifications on page 2.
- Add the following figure to the end of page 18.

Type 627LB: A 627 Series construction with an extended NPT screwed body. Note: The pressure ratings and capacities for a Type 627LB depend on the 627 Series construction. See the above listed constructions for ratings and specifications.

- Add the following to the Parts List on page 12.

Key	Description	Part Number
1	Body	
	Type 627LB - Ductile iron	
	1000 psig (69 bar) max inlet pressure	
	3/4-inch NPT screwed body	39B2450X012
	1-inch NPT screwed body	39B2451X012
	2-inch NPT screwed body	39B0414X012
	Type 627LB - Steel	
	2000 psig (138 bar) max inlet pressure	
	3/4-inch NPT screwed body	39B0411X012
	1-inch NPT screwed body	39B0412X012
	2-inch NPT screwed body	39B0415X012

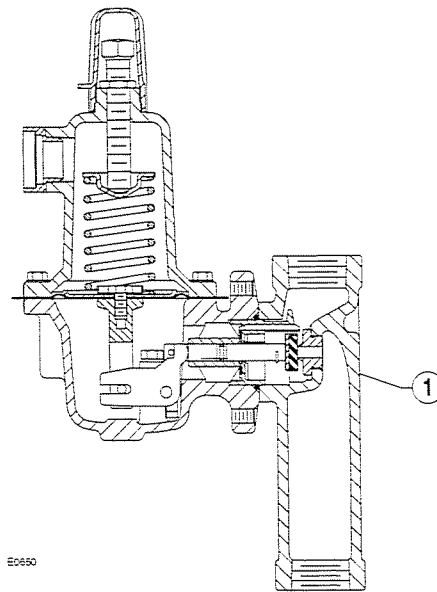


Figure 13. Type 627LB Regulator Body

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Regulators

The 67 Series small-volume regulators (figure 1) are typically used to provide constantly controlled reduced pressures to pneumatic and electropneumatic controllers and other instruments. These self-operated regulators are suitable for most air or gas applications and may even be used for liquid service where material compatibility exists. Other applications include providing reduced pressures to air chucks, air jets, spray guns, and liquified petroleum gas (LPG) torches and burners.

Features

- **Compactness**—The small size of the 67 Series regulators makes them particularly useful in installations with space limitations.

- **Ease of Maintenance**—No special tools are required to service these regulators, and they need not be removed from lines when servicing and repair are necessary.

- **Filtering Action**—A Type 67AF, 67AFR, 67AFS, or 67AFSR regulator (figure 2) has an internal filter to help clean impurities from the process fluid, removing particles that might damage the regulator or downstream equipment. The filter has a free area of 12 times the pipe area and can be obtained in glass, resin-impregnated cellulose, or stainless steel.

- **Internal Relief**—Although not designed to provide full overpressure protection, a token-capacity internal relief valve (indicated by an R in the type number as shown in table 1) allows partial reduction of downstream pressure without the necessity of an external relief valve being opened. The internal relief valve seat (figure 2 or 3) has a soft molded diaphragm insert.

- **Panel Mounting**—Some 67 Series regulators are available with either 1-hole or 3-hole panel mounting (figure 3).

- **Tamper Resistant**—To detect tampering with the outlet pressure setting, a Type 67AF or 67AFR regulator may be obtained with the adjusting screw wired to a machine screw or other body part after the outlet pressure is set.

- **Sour Gas Service Capability**—For sour gas, the body, spring case, and trim are available in materials that comply with National Association of Corrosion Engineers (NACE) Standard MR-01-75.

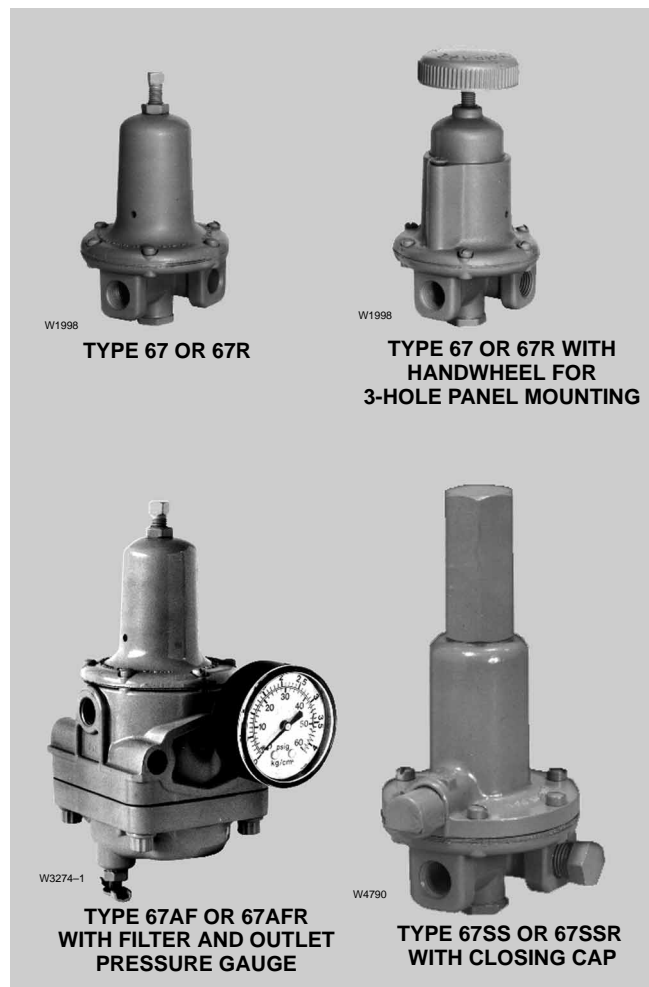


Figure 1. Typical 67 Series Regulators

- **High-Pressure Inlet Capability**—Type 67H/67HR brass or Type 67SS/67SSR stainless steel construction allows inlet pressures of up to 400 psig (27.6 bar).

- **Smooth, Close Regulation and High Stability**—Regulator design (figure 2 or 3) isolates the diaphragm and pressure response chamber from the main flow stream.

- **Second Outlet Pressure Tapping**—Body side outlet connection is standard with the Type 67AFS, 67AFSR, 67SS, and 67SSR regulators and is available with all other types. A pipe plug or pressure gauge may be installed in the side outlet connection, and a Type 67 or 67R regulator additionally may have a tire valve installed in this connection.

Specifications

AVAILABLE CONFIGURATIONS	See table 1	CONSTRUCTION MATERIALS	For Type 67AF or 67AFR Filter Regulator: See table 4 For Type 67AFS or 67AFSR Filter Regulator: See table 5 For Type 67 or 67R Regulator Without Filter: See table 6 For Type 67H or 67HR Regulator Without Filter: See table 7 For Type 67SS or 67SSR Regulator Without Filter: See table 8
INLET AND END OUTLET SIZE AND CONNECTION STYLE	1/4-inch NPT screwed ⁽¹⁾	MATERIAL TEMPERATURE CAPABILITIES⁽²⁾	With Nitrile Diaphragm and Plug: -20 TO 180°F (-29 to 82°C) With Fluoroelastomer Diaphragm and Plug: 0 to 300°F (-18 to 149°C)
SIDE OUTLET SIZE AND CONNECTION STYLE (WHEN USED)	1/4-inch NPT screwed ⁽¹⁾	PRESSURE SETTING ADJUSTMENT	Adjustable throughout each Spring range by turning adjusting screw or handwheel
MAXIMUM INLET PRESSURE (BODY RATING)⁽²⁾	Type 67H, 67HR, 67SS, or 67SSR Regulator: 400 psig (27.6 bar) All Other Types: 250 psig (17.2 bar)	PRESSURE REGISTRATION	Internal
OUTLET PRESSURE RANGES	See table 2	STANDARD SPRING CASE VENT LOCATION	Over inlet
MAXIMUM DIAPHRAGM PRESSURE⁽²⁾	50 psi (3.4 bar) over outlet pressure setting, or 110 psig (7.6 bar), whichever is greater	SPRING CASE VENT CONNECTION	<ul style="list-style-type: none"> ■ 1/8 inch (3.2 mm) drilled hole or ■ 1/4 inch 18 NPT tapping depending on configuration
INTERNAL RELIEF PERFORMANCE (TYPE 67AFR, 67AFSR, 67HR, 67R, or 67SSR REGULATOR ONLY)	Low capacity for seat leakage only; external relief valve must be provided if inlet pressure can exceed maximum emergency outlet pressure	FILTER CAPABILITIES	Free Area: 12 times pipe area Rating <i>Cellulose or Stainless Steel Element:</i> 40 microns <i>Glass Element:</i> 10 microns
REGULATOR CAPACITIES	See table 3	DIMENSIONS	See figure 5 or 6
REGULATOR PERFORMANCE CURVES	See figure 4	APPROXIMATE WEIGHT	Up to 1-1/2 pounds (0.7 kg) depending on configuration
PORT DIAMETER	1/8 inch (3.2 mm)	OPTIONS	See table 1
FLOW COEFFICIENTS	Wide-Open C_g for External Relief Sizing: 8.5 Maximum C_v: 0.28 Representative C_1: 30.4		

1. End connection for other than ANSI standards can usually be provided; consult the Fisher sales office or sales representative.

2. The pressure/temperature limits in this bulletin and any applicable standard limitation should not be exceeded.

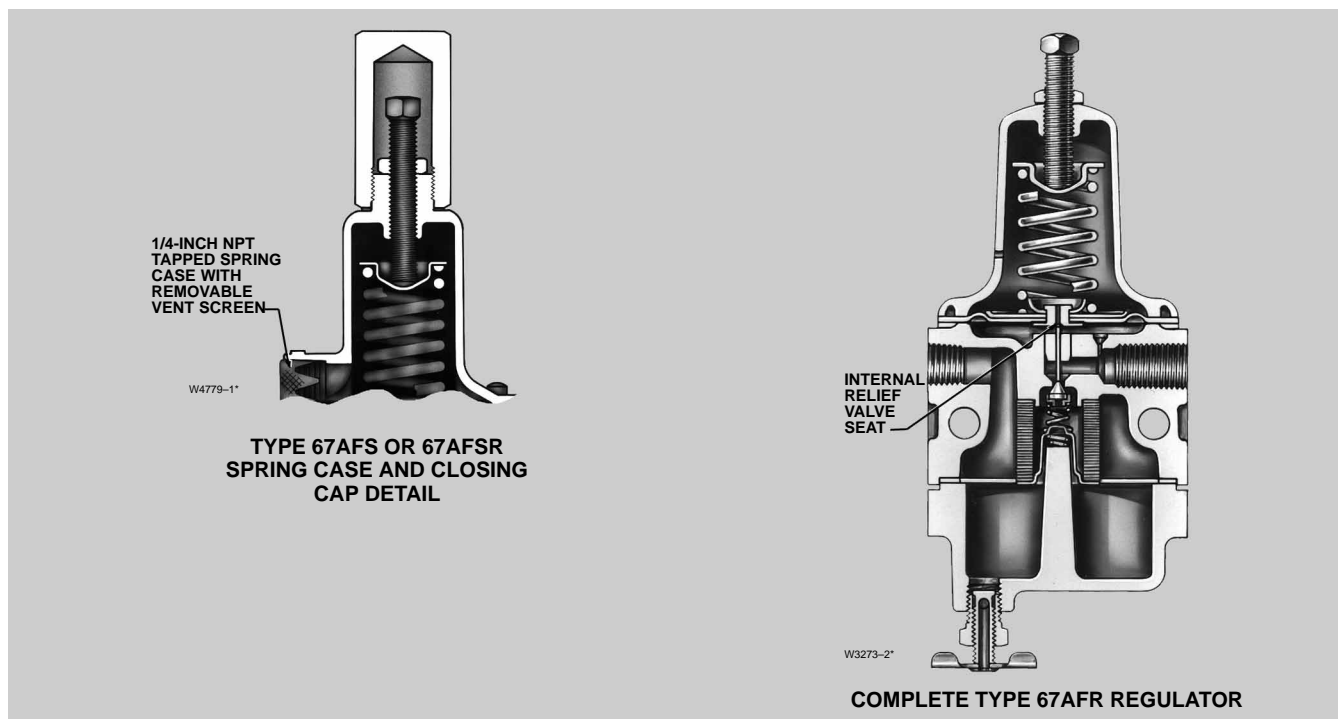


Figure 2. Filter Regulator Construction Features

Table 1. Available Configurations

CONSTRUCTION FEATURE		TYPE NUMBER									
		67	67AF	67AFR	67AFS	67AFSR	67H	67HR	67R	67SS	67SSR
Standard	Aluminum body & spring case	X	X	X					X		
	Brass body & spring case						X	X			
	Stainless steel body & spring case				X	X				X	X
	Filter		X	X	X	X					
	Internal relief			X		X		X	X		X
	NACE-qualified materials	X	X	X	X	X			X		
Optional	Aluminum/alloy 400 (UNS N04400) inlet screen	X	X	X			X	X	X		
	Steel/stainless steel inlet screen				X	X				X	X
	Pressure gauge ⁽¹⁾ in side outlet	X	X	X	X	X	X	X	X	X	X
	Tire valve in side outlet	X							X		
	Type H800 relief valve ⁽¹⁾ in end outlet connection for outlet pressure settings of 35 psig (2.4 bar) or less	X	X	X	X	X	X	X	X	X	X
	■ Plain or ■ chrome-plated handwheel adjusting screw	X	X	X			X	X	X		
	Spring case with handwheel adjusting screw	X	X	X			X	X	X		
	TFE diaphragm protector for liquid ammonia service	X									
	Extra-thick diaphragm						X				
	Adjusting screw safety wiring		X	X							
Spring case for mounting Type 661 remote control drive unit (can't be ordered with handwheel or 1/4-inch 18 NPT vent tapping)	X	X	X					X			

1. Construction covered more fully in separate bulletin.

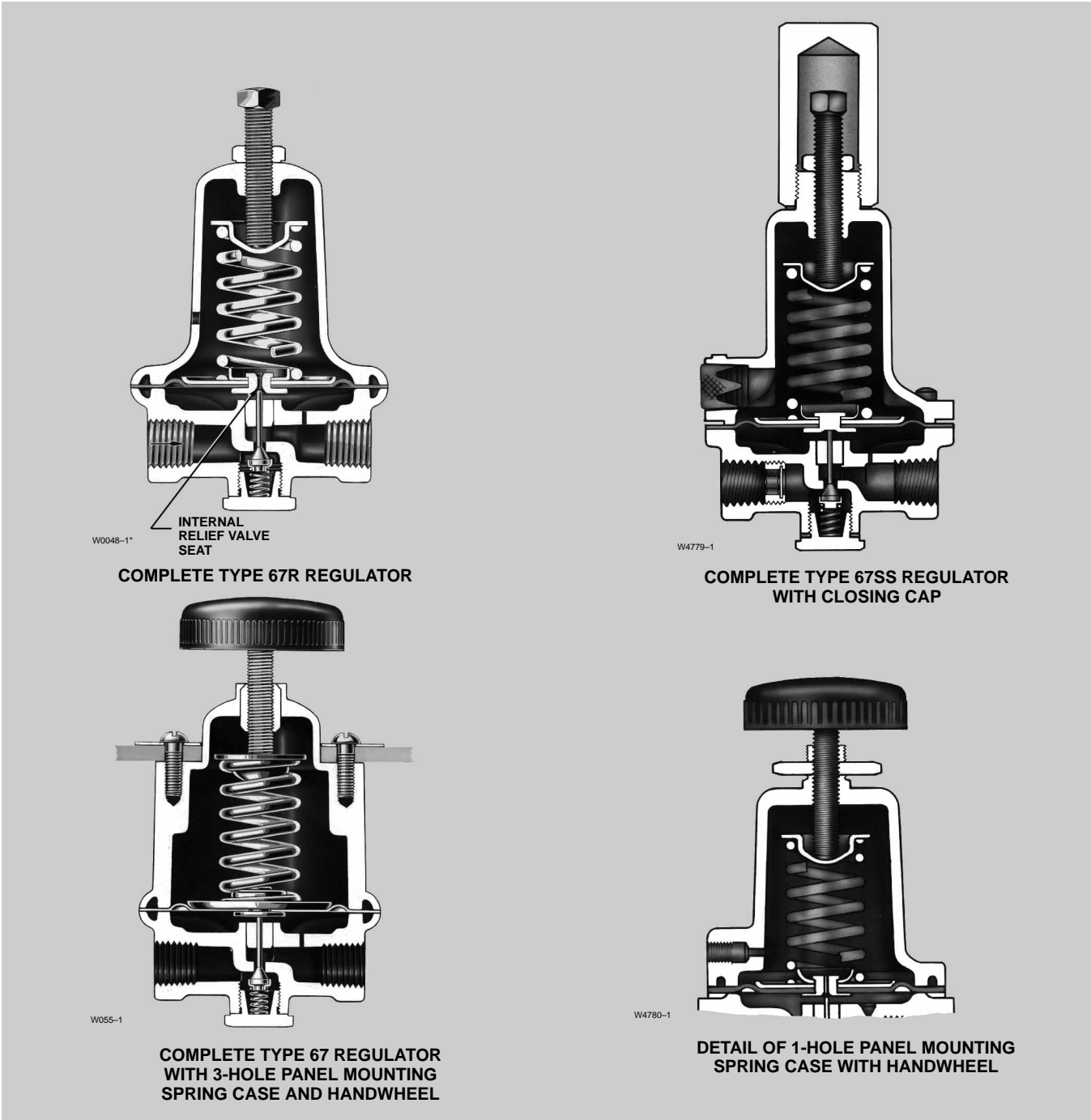


Figure 3. Construction Features of Regulators Without Filters

Table 2. Outlet Pressure Ranges

OUTLET PRESSURE RANGE				CONTROL SPRING DATA		
U.S. Units, Psig		Metric Units, Bar		Part Number	Color Code	Material
With 1-Hole Panel-Mounting Spring Case	With All Other Spring Cases	With 1-Hole Panel-Mounting Spring Case	With All Other Spring Cases			
—	5 to 35	—	0.34 to 2.4	19A2852 X012	Cad plated	Inconel ⁽¹⁾ for sour gas service
—	30 to 60	—	2.1 to 4.1	19A2854 X012	Blue	
3 to 18	3 to 20	0.21 to 1.2	0.21 to 1.4	1B9860 27212	Green	Plated steel for other service
5 to 30	5 to 35	0.34 to 2.1	0.34 to 2.4	1B7883 27022	Cad plated	
30 to 50	30 to 60	2.1 to 3.4	2.1 to 4.1	1B7884 27022	Blue	
35 to 80	35 to 100	2.4 to 5.5	2.4 to 6.9	1K7485 27202	Red	

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Air Capacity Information

Regulating capacities at selected inlet pressures and outlet pressure settings are given in table 3, and typical performance curves are shown in figure 4. Flows are in scfh (60°F and 14.7 psia) of air at 60°F. To determine the equivalent capacities for other gases, multiply the table capacity by the following appropriate conversion factor: 1.29 for 0.6 specific gravity natural gas, 0.810 for propane, 0.707 for butane, or 1.018 for nitrogen. For gases of other specific gravities, multiply the given capacity by 0.775, and divide by the square root of the appropriate specific gravity.

Then, if capacity is desired in normal cubic meters per hour at 0°C and 1.01325 bar, multiply scfh by 0.0168.

To determine wide-open flow capacities for relief sizing, use the following formula:

$$Q = \sqrt{\frac{520}{GT}} C_g P_1 \text{ SIN} \left(\frac{3417}{C_1} \sqrt{\frac{\Delta P}{P_1}} \right) \text{ DEG}$$

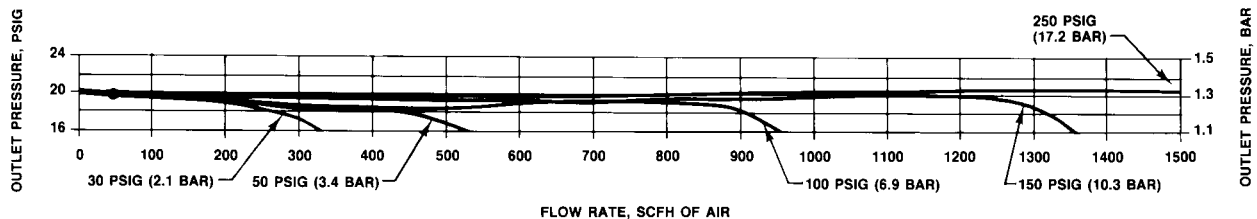
where,

- C_g = gas sizing coefficient, or 8.5 from Specifications table
- C_1 = C_g/C_v , or 30.4 from Specifications table
- G = gas specific gravity (air = 1.0)
- P_{1abs} = inlet pressure, psia (add 14.7 psi to gauge inlet pressure to obtain absolute inlet pressure)
- Q = flow rate, scfh
- T = absolute temperature in °R of air at inlet

Table 3. 67 Series Regulator Capacities at 10 Percent Droop

OUTLET PRESSURE	SPRING PART NUMBER (SEE TABLE 2 FOR RANGE)	INLET PRESSURE		CAPACITY SCFH OF AIR ⁽¹⁾
		Psig	Bar	
15 psig (1.0 bar)	1B9860 27212	50	3.4	400
		75	5.2	600
		100	6.9	750
		150	10.3	1000
		250	17.2	1400
25 psig (1.7 bar)	19A2852 X012 or 1B7883 27022	50	3.4	400
		75	5.2	550
		100	6.9	750
		150	10.3	1000
		250	17.2	1400
40 psig (2.8 bar)	19A2854 X012 or 1B7884 27022	50	3.4	150
		75	5.2	500
		100	6.9	500
		150	10.3	700
		250	17.2	1400
80 psig (5.5 bar)	1K7485 27202	100	6.9	400
		150	10.3	650
		250	17.2	1000

1. See Gas Capacity Information section for conversion to equivalent capacities of other gases and/or normal m³/hr.



NOTE: SEE CAPACITY INFORMATION SECTION FOR CONVERSION TO EQUIVALENT CAPACITIES OF OTHER GASES AND/OR CUBIC METERS PER HOUR. EACH CURVE REPRESENTS A DIFFERENT INLET PRESSURE AS

MARKED. CURVES ARE NOT PLOTTED FOR DROOPS GREATER THAN 20% OR 4 PSIG (0.28 BAR) BELOW THE OUTLET PRESSURE SETTING OF 20 PSIG (1.4 BAR) AS INDICATED BY ●

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Figure 4. 67 Series Regulator Performance Curves for Cadmium Plated Spring 1B7883 27022

Overpressure Protection

Like most pressure-reducing regulators, 67 Series regulators have outlet pressure ratings that are different from their inlet pressure ratings. A pressure relieving or pressure limiting device — such as a Type H800 relief valve for an outlet pressure setting of 35 psig (2.4 bar) or less — is needed if inlet pressure can exceed the outlet pressure rating. A Type 67AFR, 67AFSR, 67HR, 67R, or 67SSR regulator, because of its low-capacity internal relief, does provide very limited downstream overpressure protection, but this internal relief should not be considered complete protection against overpressure.

Overpressuring any portion of a regulator or associated equipment may cause personal injury, leakage, or property damage due to bursting of pressure-containing parts or explosion of accumulated gas. Regulator operation within ratings does not prevent the possibility of damage from external sources or from debris in the pipeline.

Refer to the Capacity Information section and the relief sizing coefficient in the specifications table to determine the required relief valve capacity.

Table 4. Construction Materials for Type 67AF and 67 AFR Filter Regulators

Part	Material
Body, filter, cap, and drain valve	Aluminum
Body bushing	■ Brass or ■ 303 stainless steel, except ■ 316 stainless steel for sour gas service
Filter element	■ Cellulose (standard), ■ glass, or ■ 18-8 stainless steel
Filter cap gasket	Neoprene
Spring case, closing cap if used, and plug spring seat	■ Aluminum, except ■ zinc for 3-hole panel mounting spring case
Control spring	■ Plated steel spring wire, except ■ alloy X750 (UNS N07750) for sour gas service
Control spring seat	■ Zinc-plated steel, except ■ heat-treated steel for sour gas service
Plug spring and filter element retractor spring	■ 302 stainless steel, except ■ alloy X750 (UNS N07750) for sour gas service
Plug and diaphragm	■ Nitrile or ■ fluoroelastomer
Stem	■ Brass or ■ 304 stainless steel, except ■ 316 stainless steel for sour gas service
Diaphragm plate	■ Plated steel, except ■ heat-treated steel for sour gas service
Pusher post (Type 67AF only)	■ Aluminum, except ■ 316 stainless steel for sour gas service
Relief valve seat (Type 67AFR only)	■ Brass or ■ 303 stainless steel, except ■ 316 stainless steel for sour gas service
Bolting and other metal parts	Steel and stainless steel

Table 5. Construction Materials for Type 67AFS and 67 AFSR Filter Regulators

Part	Material
Body, body bushing, filter cap, and drain valve	316 stainless steel
Filter element	■ Cellulose (standard) , ■ glass, or ■ 18-8 stainless steel
Filter cap gasket	Neoprene
Spring case and closing cap	316 stainless steel
Control spring, plug spring, and filter element retainer spring	Alloy X750 (UNS N07750)
Plug and diaphragm	■ Nitrile or ■ fluoroelastomer
Stem, plug spring seat, diaphragm plate, and pusher post (Type 67AFS) or relief valve seat (Type 67AFSR)	316 stainless steel
Bolting and other metal parts	Steel and stainless steel

Table 6. Construction Materials for Type 67 and 67R Regulators Without Filter

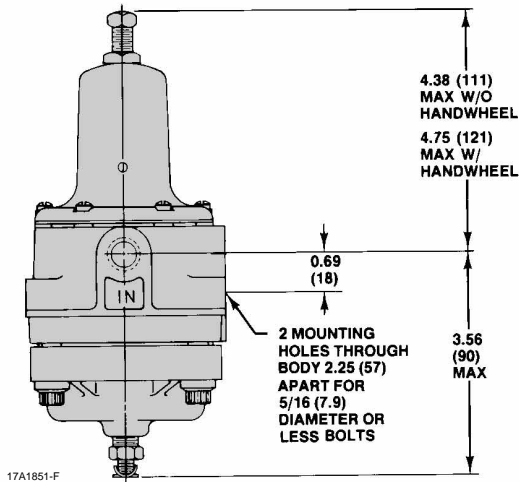
Part	Material
Body and body plug	Aluminum
Body bushing	■ Brass or ■ 303 stainless steel, except ■ 316 stainless steel for sour gas service
Body plug gasket	Composition
Spring case, closing cap if used, and plug spring seat	■ Aluminum, except ■ zinc for 3-hole panel mounting spring case
Control spring	■ Plated steel spring wire, except ■ alloy X750 (UNS N07750) for sour gas service
Control spring seat	■ Zinc-plated steel, except ■ heat-treated steel for sour gas service
Plug spring	■ 302 stainless steel, except ■ alloy X750 (UNS N07750) for sour gas service
Plug and diaphragm	■ Nitrile or ■ fluoroelastomer
Stem	■ Brass or ■ 304 stainless steel, except ■ 316 stainless steel for sour gas service
Diaphragm plate	■ Plated steel, except ■ heat-treated steel for sour gas service
Pusher post (Type 67 only)	■ Aluminum, except ■ 316 stainless steel for sour gas service
Relief valve seat (Type 67R only)	■ Brass or ■ 303 stainless steel, except ■ 316 stainless steel for sour gas service
Bolting and other metal parts	Steel and stainless steel

Table 7. Construction Materials for Type 67H and 67HR Regulators Without Filter

Part	Material
Body, body plug, and body bushing	Brass
Body plug gasket	Composition
Spring case, and closing cap if used	■ Brass, except ■ aluminum for 1-hole panel mounting spring case or ■ zinc for 3-hole panel mounting spring case
Control spring	Plated steel spring wire
Control spring seat	Zinc-plated steel
Plug spring	302 stainless steel
Plug and diaphragm	■ Nitrile or ■ fluoroelastomer
Stem and plug spring seat	Brass
Diaphragm plate	Plated steel
Pusher post (Type 67H) or relief valve seat (Type 67HR)	Brass
Bolting and other metal parts	Steel and stainless steel

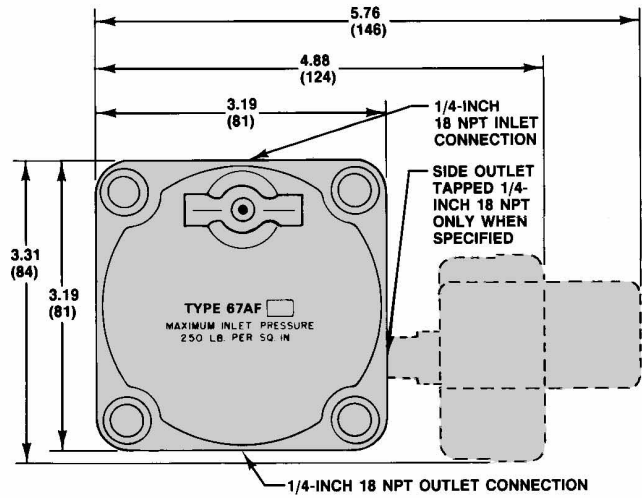
Table 8. Construction Materials for Type 67SS and 67SSR Regulators Without Filter

Part	Material
Body, body plug, and body bushing	316 stainless steel
Spring case, closing cap if used, and plug spring seat	316 stainless steel
Closing cap gasket if used	Composition
Control spring	Plated steel spring wire
Control spring seat	Zinc-plated steel
Plug, diaphragm, and body plug O-ring	■ Nitrile (except composition for body plug O-ring) or ■ fluoroelastomer
Plug spring	302 stainless steel
Stem	304 stainless steel
Diaphragm plate	Plated steel
Pusher post (Type 67SS) or relief valve seat (Type 67SSR)	303 stainless steel
Bolting and other metal parts	Steel and stainless steel



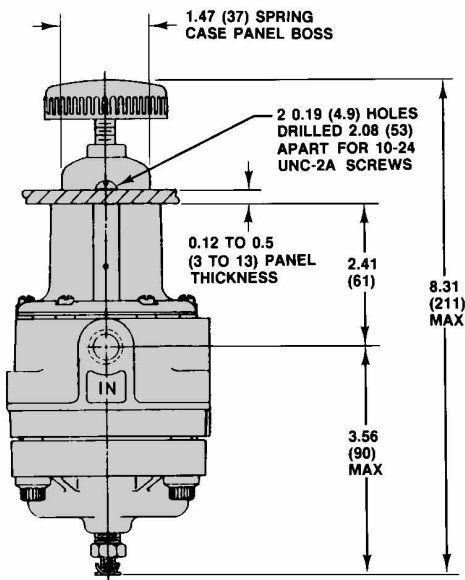
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TYPE 67AF OR 67AFR END VIEW



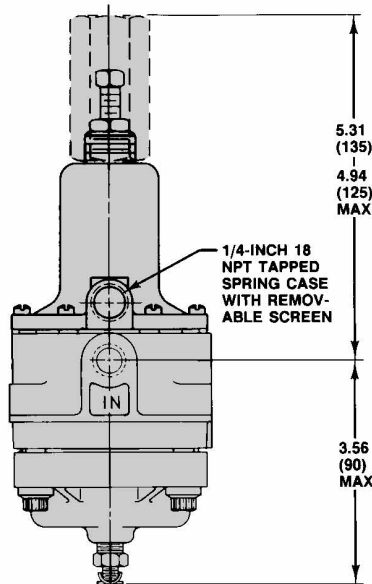
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BOTTOM DIMENSIONS



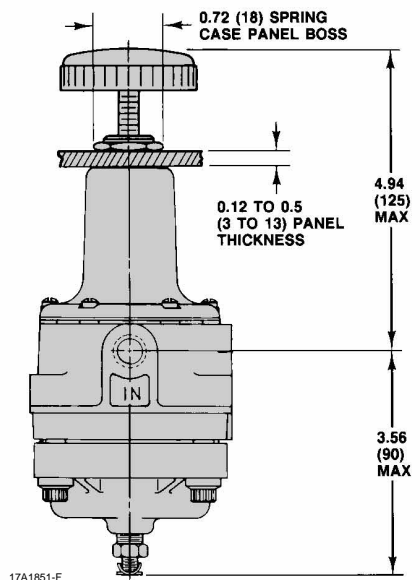
17A1850-A

END VIEW WITH 3-HOLE PANEL MOUNTING SPRING CASE



10B8036-A
B2085

TYPE 67AFS OR 67AFSR END VIEW (ALSO TYPICAL OF TYPE 67AF OR 67AFR WITH CLOSING CAP)

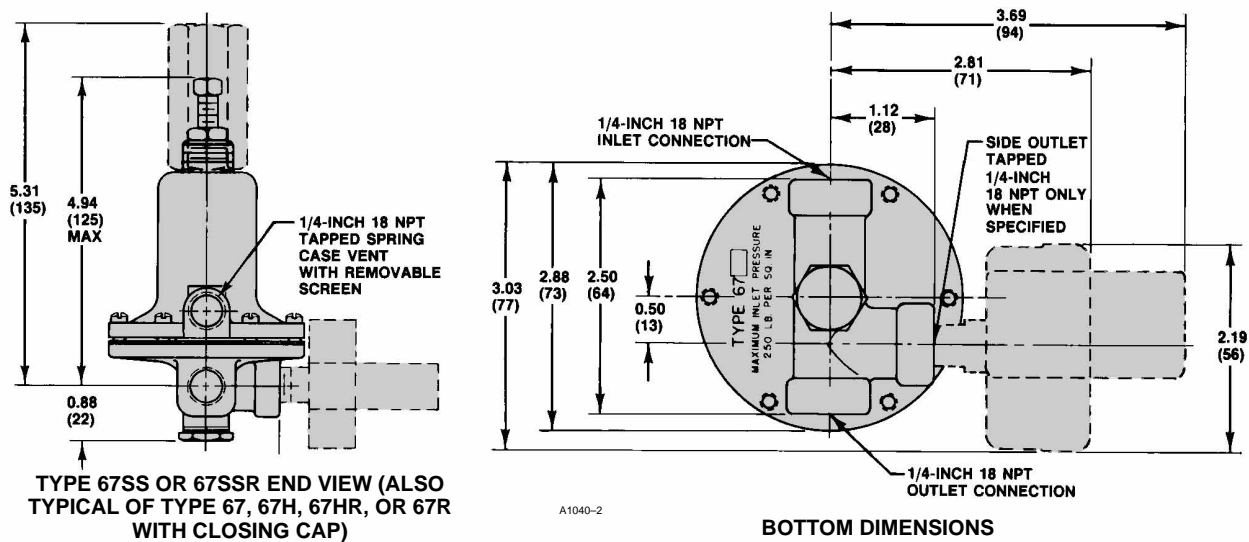


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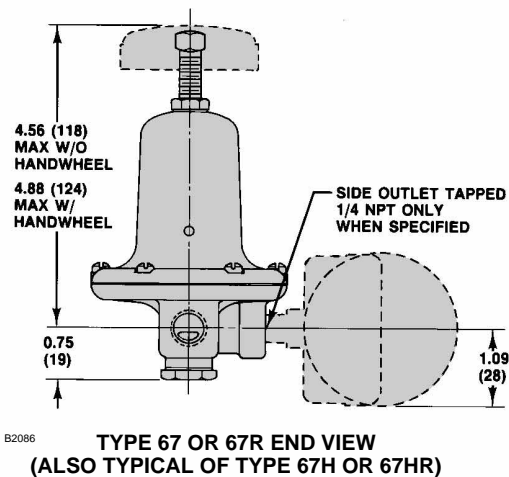
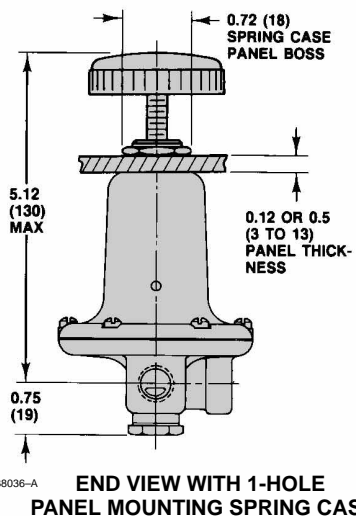
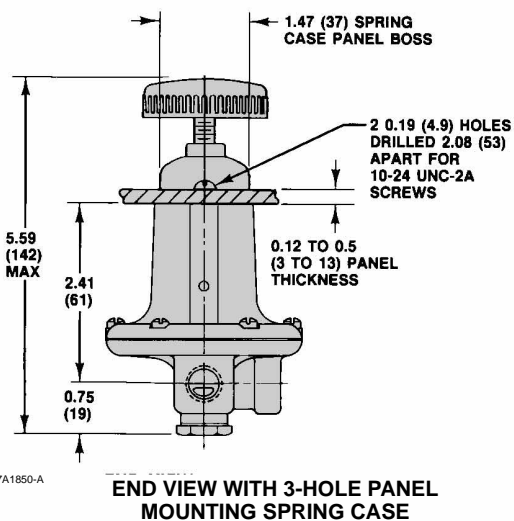
END VIEW WITH 1-HOLE PANEL MOUNTING SPRING CASE

INCH
(mm)

Figure 5. Dimensions for Regulator with Filter



10B8036-A



INCH
(mm)

Figure 6. Dimensions for Regulator Without Filter

Ordering Information

When ordering, specify:

Application Information

1. Type of regulator
2. Body, spring case, and trim materials
3. Control spring range in psig (bar)

Regulator Information

Refer to the Specifications table on page 2. Review the description to the right of each specification and the information in each referenced table or figure. Specify your choice whenever a selection is offered. Always specify the regulator type number as identified in table 1, as well as the type number(s) of an associated gauge or relief valve.

While this information is presented in good faith and believed to be accurate, Fisher Controls does not guarantee satisfactory results from reliance upon such information. *Nothing contained herein is to be construed as a warranty or guarantee, express or implied, regarding the performance, merchantability, fitness*

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Design D4 Control Valve Assembly

Contents

Introduction	1
Scope of Manual	1
Description	1
Specifications	1
Installation	3
Spring Adjustment	5
Maintenance	5
Valve Plug and Seat Ring	6
Valve Packing	7
Actuator	8
Parts Ordering	10
Repair Kits	10
Parts List	11

Introduction

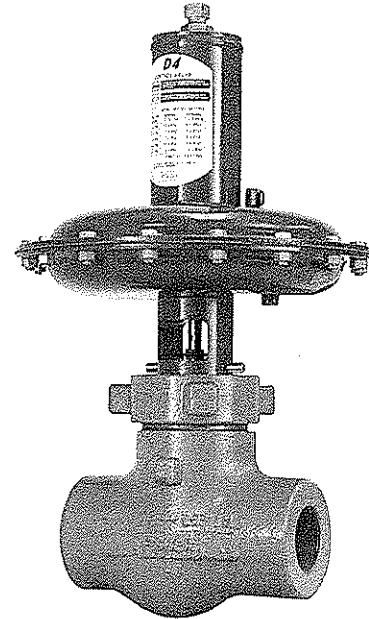
Scope of Manual

This instruction manual provides installation, maintenance, and parts information for the Design D4 control valve.

No person may install, operate, or maintain a Design D4 control valve without first • being fully trained and qualified in valve, actuator, and accessory installation, operation, and maintenance, and • carefully reading and understanding the contents of this manual. If you have any questions about these instructions, contact your Fisher® sales office before proceeding.

Note

Neither Emerson®, Emerson Process Management, Fisher, nor any of their affiliated entities assumes responsibility for the selection, use and maintenance of any product. Responsibility for the selection, use, and maintenance of any product remains with the purchaser and end-user.



W8331/L

Figure 1. Design D4 Control Valve

Description

The Design D4 control valve is a compact, rugged valve designed primarily for high-pressure throttling applications. This valve is ideal for use on pressure and flow control applications within the oil and gas production industry. The Design D4 valve also makes an excellent dump valve for high-pressure separators and scrubbers.

Specifications

Table 1 lists specifications for the Design D4 control valve. Some of the specifications for a given control valve as it originally comes from the factory are stamped on a nameplate located on the actuator spring barrel.



Table 1. Specifications

<p>Available Configurations</p> <p>Spring-to-Close Spring-to-Open</p> <p>Valve Body Sizes and End Connection Styles⁽¹⁾</p> <p>See table 2</p> <p>Maximum Inlet Pressures and Temperatures⁽¹⁾</p> <p>If the valve nameplate shows an ASME pressure-temperature class, maximum inlet pressure and temperature is consistent with the applicable class per ASME B16.34. If the nameplate does not show an ASME class, it will show a maximum cold working pressure at 38°C (100°F) (for example, 248 bar [3600 psi])</p> <p>Maximum Pressure Drops⁽¹⁾</p> <p>See tables 3, 4, 5, and 6</p> <p>Input Signal to Actuator</p> <p>See tables 3, 4, 5, and 6</p> <p>Actuator Maximum Casing Pressure⁽¹⁾</p> <p>3.4 bar (50 psig)</p> <p>Shutoff Classification per ANSI/FCI 70-2 and IEC 60534-4</p> <p>Class IV</p>	<p>Material Temperature Capabilities⁽¹⁾</p> <p>Actuator Assembly: -40 to 93°C (-40 to 200°F)</p> <p>Valve Body Assembly: <i>Standard Bonnet O-Ring:</i> -46 to 149°C (-50 to 300°F) <i>Optional Fluoroelastomer Bonnet O-Ring:</i> -23 to 204°C (-10 to 400°F)</p> <p>Flow Characteristic</p> <p>Equal percentage</p> <p>Flow Direction</p> <p>Flow up only</p> <p>Port Diameters</p> <p>See table 2</p> <p>Valve Plug Travel</p> <p>19 mm (0.75 inch)</p> <p>Valve Plug Style</p> <p>Micro-Form™ valve plug</p> <p>Actuator Diaphragm Effective Area</p> <p>452 cm² (69 inches²)</p> <p>Actuator Pressure Connection Size</p> <p>1/4 inch NPT female</p>
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1. The pressure or temperature limits in the referenced tables and any applicable ASME code limitations should not be exceeded.

Table 2. Valve Sizes and Connection Styles

VALVE SIZE, INCHES	PORT DIAMETER, (INCHES)	SCREWED	RAISED FACE (RF) FLANGED				RING TYPE JOINT (RTJ) FLANGED	
		3600 psi	Class 150	Class 300	Class 600	Class 900 and 1500	Class 600	Class 900 and 1500
1	0.25, 0.375, 0.5, 0.75	X	X	X	X	X	X	X
2	0.25, 0.375, 0.5, 0.75, 1, 1.25	X	X	X	X	X	X	X

X = Available construction.

*Table 3. Maximum Shutoff Pressure Drops⁽¹⁾ for Design D4 Control Valves (Spring-to-Close)
When Used with Typical Control Instrumentation⁽²⁾*

INPUT SIGNAL TO ACTUATOR		0 to 1.2 Bar (0 to 18 Psig)		0 to 1.4 Bar (0 to 20 Psig)		0 to 2.0 Bar (0 to 30 Psig)		0 to 2.3 Bar (0 to 33 Psig)		0 to 2.4 Bar (0 to 35 Psig)		0 to 3.4 Bar (0 to 50 Psig)	
SPRING		Light Rate						Heavy Rate					
INITIAL SPRING SETTING		0.77 Bar (11.2 Psig)		0.77 Bar (11.2 Psig)		0.85 Bar (12.4 Psig)		1.05 Bar (15.3 Psig)		1.18 Bar (17.1 Psig)		1.18 Bar (17.1 Psig)	
PORT DIAMETER		Maximum Pressure Drop											
mm	Inches	Bar	Psi	Bar	Psi	Bar	Psi	Bar	Psi	Bar	Psi	Bar	Psi
6.4	0.25	259 ⁽³⁾	3750 ⁽³⁾	259 ⁽³⁾	3750 ⁽³⁾	259	3750	259	3750	259	3750	259	3750
9.5	0.375	259 ⁽³⁾	3750 ⁽³⁾	259 ⁽³⁾	3750 ⁽³⁾	259	3750	259	3750	259	3750	259	3750
12.7	0.5	191	2765	191	2765	219	3180	259	3750	259	3750	259	3750
19.1	0.75	80	1160	80	1160	92	1340	123	1785	143	2080	143	2080
25.4	1	42	610	42	610	49	715	67	965	78	1130	78	1130
31.8	1.25	25	365	25	365	30	430	41	590	48	700	48	700

1. The pressure or temperature limits in the referenced tables and any applicable ASME code limitations should not be exceeded.
2. For example, use the column marked 0-1.4 bar (0-20 psig) for a 0.21-1.0 bar (3-15 psig) pneumatic controller with 1.4 bar (20 psig) supply pressure.
3. For applications with downstream pressure in excess of 196 bar (2845 psig), use 196 bar (2845 psig) for Maximum Shutoff Pressure.

*Table 4. Maximum Shutoff Pressure Drops⁽¹⁾ for Design D4 Control Valves (Spring-to-Close)
When Used with Instrumentation with Restricted Output Range⁽²⁾*

INPUT SIGNAL TO ACTUATOR		0.2 to 1.0 Bar (3 to 15 Psig)				0.4 to 2.0 Bar (6 to 30 Psig)			
SPRING		Light Rate				Heavy Rate			
INITIAL SPRING SETTING		0.67 Bar (9.7 Psig)				0.97 Bar (14.0 Psig)			
PORT DIAMETER		Maximum Pressure Drop							
mm	Inches	Bar		Psi		Bar		Psi	
6.4	0.25	259 ⁽³⁾		3750 ⁽³⁾		259 ⁽⁴⁾		3750 ⁽⁴⁾	
9.5	0.375	152 ⁽³⁾		2205 ⁽³⁾		210 ⁽⁴⁾		3045 ⁽⁴⁾	
12.7	0.5	80		1160		113		1635	
19.1	0.75	31		445		45		655	
25.4	1	14		210		23		330	
31.8	1.25	7.6		110		13		185	

1. The pressure or temperature limits in the referenced tables and any applicable ASME code limitations should not be exceeded.
2. For example, an Electro-Pneumatic Transducer calibrated for 0.21-1.0 bar (3-15 psig) output pressure.
3. For applications with downstream pressure in excess of 85 bar (1240 psig), use 85 bar (1240 psig) for Maximum Shutoff Pressure.
4. For applications with downstream pressure in excess of 118 bar (1715 psig), use 118 bar (1715 psig) for Maximum Shutoff Pressure.

Installation



Always wear protective gloves, clothing, and eyewear when performing any installation operations to avoid personal injury.

To avoid personal injury or property damage caused by bursting of pressure-retaining parts or by uncontrolled process fluid, be certain the service conditions do not exceed

the limits shown on the valve nameplate and in tables 1, 3, 4, 5, and 6. Use pressure-relieving devices required by government or accepted industry codes and good engineering practices.

Check with your process or safety engineer for any additional measures that must be taken to protect against process media.

If installing into an existing application, also refer to the WARNING at the beginning of the Maintenance section in this instruction manual.

Table 5. Maximum Shutoff Pressure Drops⁽¹⁾ for Design D4 Control Valves (Spring-to-Open) When Used with Typical Control Instrumentation⁽²⁾

INPUT SIGNAL TO ACTUATOR		0 to 1.2 Bar (0 to 18 Psig)		0 to 1.4 Bar (0 to 20 Psig)		0 to 2.0 Bar (0 to 30 Psig)		0 to 2.3 Bar (0 to 33 Psig)		0 to 2.4 Bar (0 to 35 Psig)		0 to 3.4 Bar (0 to 50 Psig)	
SPRING		Light Rate						Heavy Rate					
INITIAL SPRING SETTING		0.23 Bar (3.4 Psig)		0.23 Bar (3.4 Psig)		0.28 Bar (4.0 Psig)		0.28 Bar (4.0 Psig)		0.28 Bar (4.0 Psig)		0.28 Bar (4.0 Psig)	
PORT DIAMETER		Maximum Pressure Drop											
mm	Inches	Bar	Psi	Bar	Psi	Bar	Psi	Bar	Psi	Bar	Psi	Bar	Psi
6.4	0.25	259 ⁽³⁾	3750 ⁽³⁾	259 ⁽³⁾	3750 ⁽³⁾	259	3750	259	3750	259	3750	259	3750
9.5	0.375	259 ⁽³⁾	3750 ⁽³⁾	259 ⁽³⁾	3750 ⁽³⁾	259	3750	259	3750	259	3750	259	3750
12.7	0.5	187	2715	233	3380	259	3750	259	3750	259	3750	259	3750
19.1	0.75	78	1135	99	1430	147	2130	178	2575	198	2875	259	3750
25.4	1	41	600	53	765	80	1160	97	1410	109	1575	195	2830
31.8	1.25	24	355	32	465	49	715	60	875	68	985	123	1785

1. The pressure or temperature limits in the referenced tables and any applicable ASME code limitations should not be exceeded.
 2. For example, use the column marked 0-1.4 bar (0-20 psig) for a 0.21-1.0 bar (3-15 psig) pneumatic controller with 1.4 bar (20 psig) supply pressure.
 3. For applications with downstream pressure in excess of 190 bar (2760 psig), use 190 bar (2760 psig) for Maximum Shutoff Pressure.

Table 6. Maximum Shutoff Pressure Drops⁽¹⁾ for Design D4 Control Valves (Spring-to-Open) When Used with Instrumentation with Restricted Output Range⁽²⁾

INPUT SIGNAL TO ACTUATOR		0.2 to 1.0 Bar (3 to 15 Psig)				0.4 to 2.0 Bar (6 to 30 Psig)			
SPRING		Light Rate				Heavy Rate			
INITIAL SPRING SETTING		0.43 Bar (6.2 Psig)				0.69 Bar (10.0 Psig)			
PORT DIAMETER		Maximum Pressure Drop							
mm	Inches	Bar		Psi		Bar		Psi	
6.4	0.25	226 ⁽³⁾		3275 ⁽³⁾		259 ⁽⁴⁾		3750 ⁽⁴⁾	
9.5	0.375	91 ⁽³⁾		1315 ⁽³⁾		259 ⁽⁴⁾		3750 ⁽⁴⁾	
12.7	0.5	46		660		196		2845	
19.1	0.75	15		220		82		1195	
25.4	1	---		---		43		630	
31.8	1.25	---		---		26		380	

1. The pressure or temperature limits in the referenced tables and any applicable ASME code limitations should not be exceeded.
 2. For example, an Electro-Pneumatic Transducer calibrated for 0.21-1.0 bar (3-15 psig) output pressure.
 3. For applications with downstream pressure in excess of 51 bar (740 psig), use 51 bar (740 psig) for Maximum Shutoff Pressure.
 4. For applications with downstream pressure in excess of 202 bar (2925 psig), use 202 bar (2925 psig) for Maximum Shutoff Pressure.

CAUTION

When ordered, the valve configuration and construction materials were selected to meet particular pressure, temperature, pressure drop, and controlled fluid conditions. Responsibility for the safety of process media and compatibility of valve materials with process media rests solely with the purchaser and end-user. Since some body/trim material combinations are limited in their pressure drop and temperature ranges, do not apply any other conditions to the valve without first contacting your Fisher sales office.

To avoid product damage, inspect the valve before installation for any

damage or any foreign material that may have collected in the valve body. Also remove any pipe scale, welding slag, or other foreign material from the pipeline.

1. Before installing the control valve assembly, inspect it for any damage and for any foreign material that may have collected in the valve body.
2. Remove any pipe scale, welding slag, and other foreign material from the pipeline.
3. The control valve can be installed in any position, but normally the actuator is vertical above the valve. Install the valve so the flow direction arrow on the side of the valve indicates the direction of the process flow.
4. Install the valve following local and national piping codes when they apply to the application. For screwed connections, treat the male pipe threads with a good grade pipe compound. For flanged

valves, use suitable gaskets between valve and pipeline flanges.

5. If continuous operation is required during maintenance and inspection, install a conventional three-valve bypass around the valve.
6. Connect loading pressure for the Spring-to-Open configuration to the 1/4-18 NPT connection in the upper casing assembly (key 23) as shown in figure 4. The Spring-to-Close configuration loading pressure connection is in the lower casing assembly (key 39) as shown in figure 3.

Spring Adjustment

The spring has a fixed pressure span over which loading pressure will stroke the valve. Adjustment of the spring compression shifts the span so that more or less loading pressure is required to start travel. Since the span does not change, there will be a corresponding increase or decrease in the pressure requirements at the end of the valve stroke.

In order to maximize shutoff pressure drop values, the actuator spring must be accurately adjusted for each Input Signal Pressure Range. If the actuator has been disassembled or pressure conditions have changed, the spring may require adjustment. Refer to tables 2 and 3 to determine the Initial Spring Set values based on the Input Signal range that is available to the actuator. These values include packing friction.

Spring-to-Close

Refer to figure 3.

1. Loosen the adjusting screw nut (key 44).
2. Turn the adjusting screw (key 31) clockwise to compress the spring or counterclockwise to decrease spring compression.
3. After adjustment, tighten the adjusting screw nut (key 44).

Spring-to-Open

Refer to figure 4.

1. Unscrew the spring case assembly (key 27).
2. Turn the adjusting stem nut (key 44) clockwise to compress the spring or counterclockwise to decrease spring compression.

3. After adjustment, replace the spring case assembly (key 27).

Maintenance

Refer to figure 3.

Valve parts are subject to normal wear and must be inspected and replaced as necessary. The frequency of inspection and maintenance depends on the severity of the service conditions.

WARNING

Avoid personal injury from sudden release of process pressure or bursting of parts. Before performing any maintenance operations:

- Always wear protective gloves, clothing, and eyewear when performing any maintenance operations to avoid personal injury.
- Disconnect any operating lines providing air pressure, electric power, or a control signal to the actuator. Be sure the actuator cannot suddenly open or close the valve.
- Use bypass valves or completely shut off the process to isolate the valve from process pressure. Relieve process pressure on both sides of the valve. Drain the process media from both sides of the valve.
- Vent the power actuator loading pressure and relieve any actuator spring precompression.
- Use lock-out procedures to be sure that the above measures stay in effect while you work on the equipment.
- The valve packing box may contain process fluids that are pressurized, *even when the valve has been removed from the pipeline.* Process fluids may spray out under pressure when removing the packing hardware or packing rings.
- Check with your process or safety engineer for any additional measures that must be taken to protect against process media.

Valve Plug and Seat Ring

The Design D4 control valve is designed to allow easy access to the valve plug and seat ring without disturbing the packing. Refer to other sections of this instruction manual if additional maintenance is required.

Disassembly

1. Remove the loading pressure tubing and any accessories that may hamper disassembly.
2. Break the hammer nut (key 6) loose with a hammer. Continue turning the hammer nut by using a hammer or a large adjustable wrench, tightened around one ear of the hammer nut. If the bonnet is stuck on the valve, continue to unscrew the hammer nut. The hammer nut will contact the spring pins (key 7) and will force the bonnet out of the valve. Carefully lift the actuator, bonnet, and valve plug assembly from the valve body.

Note

The spring pins must always be in place during valve operation. They provide a safeguard against injury when the unit is being disassembled.

3. Use a socket wrench to loosen the seat ring (key 3).
4. Remove the seat ring (key 3) and seat ring gasket (key 9) from the valve body.
5. Inspect parts for wear or damage that would prevent proper operation of the valve body. Carefully clean the seat ring gasket surfaces and seat ring threads.

CAUTION

Be careful to avoid damaging the seating surface on the valve plug or seat ring as damage in these areas will allow excessive leakage at shutoff. Avoid damaging the highly polished valve stem surface. A damaged valve stem could cut the packing and allow process fluid to leak to the atmosphere.

6. **For spring-to-close only:** To remove the valve plug (key 2), drive out the groove pin (key 4) and unscrew the valve plug from the stem (key 47). If the groove pin (key 4) is not exposed, verify that

downward movement of the stem is not restricted by instrument linkages attached to the stem (key 47).

Table 7. Torque for Seat Ring (Key 3)

VALVE SIZE		RECOMMENDED TORQUE	
mm	Inches	N•m	Lbf•ft
25.4	1	407	300
50.8	2	698	515

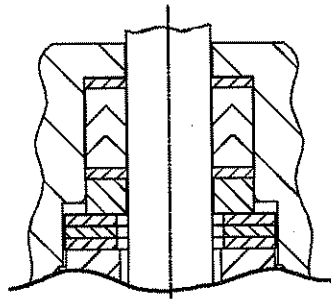
If the valve plug cannot be easily unscrewed from the stem, use a punch to keep the stem from turning as the plug is removed.

7. **For spring-to-open only:** To remove the valve plug (key 2), first remove the spring case assembly (key 27). Remove the adjustment screw nut (key 44), the upper spring seat (key 29), and the spring (key 30). Push the adjustment stem (key 31) fully downward until the diaphragm plate (key 40) contacts the cap screws (key 38), exposing the groove pin (key 4) in the plug. If the groove pin (key 4) is not exposed, verify that downward movement of the stem is not restricted by instrument linkages attached to the stem (key 47). Drive out the groove pin (key 4) and unscrew the valve plug from the stem (key 47).

If the valve plug cannot be easily unscrewed from the stem, use a punch to keep the stem from turning as the plug is removed.

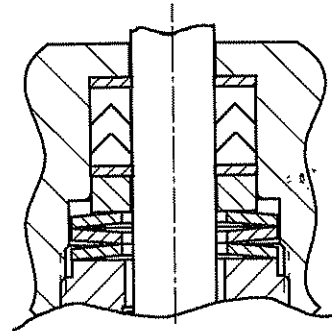
Assembly

1. Make sure the bonnet O-ring (key 8) is on the bonnet and lubricated with lithium grease or equivalent (key 49).
2. Install the plug (key 2) on the stem (key 47) and insert a new groove pin (key 4).
3. Thoroughly clean the seat ring and bonnet threads in the valve body (key 1). Also clean the valve body seat ring gasket surfaces.
4. Apply anti-seize lubricant or equivalent (key 54) to the threads of the seat ring (key 3), and its mating threads in the valve body.
5. Apply anti-seize lubricant or equivalent (key 54) to the seat ring gasket (key 9) and install into the valve body.
6. Screw the seat ring into the valve body. Use a socket wrench to tighten the seat ring to the torque values shown in table 7. Remove all excess lubricant after tightening.
7. Lubricate (key 54) the threads on the valve body and hammer nut and the contact surfaces of the bonnet and hammer nut flange. Install the bonnet and actuator assembly with pinned valve plug onto the valve body. Tighten the hammer nut using an



BELLEVILLE SPRINGS REASONABLY TIGHT TO SEAT THE PACKING

E0862



BELLEVILLE SPRINGS FINGER TIGHT, THEN TIGHTEN 5/8 TURN (5 FLATS ON THE RETAINER)

Figure 2. Design D4 Belleville Spring Procedure

adjustable wrench until the nut stops turning. A few hammer blows will be required to ensure that the assembly is tight.

8. See the actuator assembly and spring adjustment sections of this manual.

Valve Packing

WARNING

Observe the warning at the start of the Maintenance section.

The valve stem packing can only be accessed from within the valve body. If packing maintenance is required, first disassemble per steps 1, 2, and 6 or 7 in the Valve Plug and Seat Ring Disassembly section of this document.

Disassembly

1. Loosen the packing retainer locknut (key 22) with a spanner wrench or with a punch and hammer.
2. Unscrew the packing retainer (key 10) from the bonnet (key 5).
3. Remove the three Belleville springs (key 11), packing spacer (key 14), packing (key 13), and two anti-extrusion rings (key 12) from the bonnet, using a formed wire hook.
4. Clean and inspect the packing box wall to ensure that the packing surfaces are not damaged. If the

surface condition is damaged, and cannot be improved by light sanding, replace the bonnet by contacting your Fisher sales office.

5. Inspect the valve stem for scratches or wear, and valve plug for wear or damage. Replace if necessary.

Assembly

Refer to figures 2 and 3.

1. Install new packing and Belleville springs according to the packing arrangement shown in figure 2.
2. Apply a light film of lubricant (key 54) to the threads of the packing retainer (key 10).
3. Install the packing retainer into the bonnet and tighten until the Belleville springs (key 11) are reasonably tight to fully seat the packing and anti-extrusion rings.
4. Completely loosen the packing retainer to relieve all Belleville spring compression.
5. Retighten the packing retainer by hand until the packing retainer firmly contacts the Belleville springs.
6. Tighten the packing retainer clockwise 5/8 turn (5 flats on the retainer).
7. Lock the packing retainer (key 10) solidly in place by tightening the packing retainer locknut (key 22) using a spanner wrench, or a hammer with a punch or chisel.

D4 Valve

Actuator (Spring-to-Close)

WARNING

Observe the warning at the start of the Maintenance section.

Refer to figure 3.

Before disassembling the actuator, disassemble the valve plug, seat ring, and packing according to instructions in this manual.

Disassembly

1. Loosen the adjusting screw nut (key 44) and turn the adjusting screw (key 31) counterclockwise to remove all spring compression.
2. Unscrew the casing cap screws and hex nuts (keys 45 and 46), and remove the upper casing assembly (key 23) from the lower casing (key 39).
3. Remove the spring seat (key 29) and actuator spring (key 30).
4. Lift out the diaphragm, diaphragm plate, and stem assembly. Remove the travel indicator (key 32) when the bottom of the stem enters the yoke window.
5. To replace the diaphragm (key 15), separate the diaphragm assembly by using a wrench on the hex nuts (key 42) to unscrew the assembly.
6. Separate the parts—diaphragm washer, actuator O-ring (keys 41 and 25), diaphragm, and diaphragm plate, (keys 15 and 40).
7. Inspect the diaphragm and the actuator O-ring for damage or deterioration, and replace if necessary. If the diaphragm is replaced, a new O-ring should also be installed.
8. Inspect the stem O-ring (key 19) and bonnet bushing (key 20); replace if necessary. To inspect the casing O-ring (key 18), remove the cap screws (key 38) and lift off the lower casing (key 39). Replace the O-ring if necessary.
9. If the hammer nut needs to be removed from the bonnet, the spring pins (key 7) can be removed with locking pliers.

Assembly

1. Before starting assembly, make sure all parts are clean and in good condition. There should be no

burrs or sharp edges on any threads or surfaces that might cut or damage an O-ring, bushing, the packing, or the diaphragm. When replacing O-rings and bushings, be sure the O-ring or bushing groove is clean and undamaged. Using a general purpose lubricant (key 49), lubricate all bushings and O-rings and the threads of parts that have to pass through the bushings and O-rings.

CAUTION

The threads on factory-produced valve stems have been specially machined to avoid O-ring, bushing, or packing damage during trim maintenance. Use of other than a factory-produced valve stem may result in early stem O-ring, bushing, and packing failure.

Note

Do not lubricate cap screws (key 38) before inserting them in the following procedure.

2. Place the hammer nut and spring pins on the bonnet, if removed. Install the casing O-ring (key 18), the stem O-ring (key 19), and the bonnet bushing (key 20). Position the lower casing (key 39) on the bonnet. Insert the nonlubricated cap screws (key 38), and torque to 49 N•m (36 lbf•ft).

Note

Spring pins must always be in place during valve operation, acting as a safeguard against injury when the unit is being disassembled.

3. Assemble the diaphragm plate assembly. Place the patterned side of the diaphragm (key 15) against the diaphragm plate (key 40). Be sure to turn the diaphragm washer (key 41) so that the side that is beveled on the inside diameter is against the O-ring (key 25). Also, make sure that it is assembled for installation with the diaphragm on the loading pressure side and the lockwasher (key 43) and lower spring seat (key 28) are on the spring side.
4. Fasten the diaphragm and diaphragm plate assembly on the stem with hex nuts (key 42). Place the diaphragm and diaphragm plate, and stem assembly into the lower casing and bonnet. Install the travel indicator (key 32) on the stem as the bottom of the stem enters the yoke window.

CAUTION

Over-tightening the diaphragm casing cap screws and nuts (keys 45 and 46) can damage the diaphragm. Do not exceed 27 N•m (20 lbf•ft) torque.

5. Replace the spring (key 30) on the diaphragm plate (key 40). Replace the upper spring seat (key 29). Position the upper casing (key 23) on the lower casing (key 39). Insert the cap screws (key 45) and tighten the hex nuts (key 46). Torque the casing cap screws evenly to 27 N•m (20 lbf•ft) using a crisscross pattern.
6. Adjust the initial spring set per the Spring Adjustment section in this manual.

Actuator (Spring-to-Open)

⚠ WARNING

Observe the warning at the start of the Maintenance section.

Refer to figure 4.

Before disassembling the actuator, disassemble the valve plug, seat ring, and packing according to instructions in this manual.

Disassembly

1. Unscrew the spring case assembly (key 27). Turn the adjusting screw nut (key 44) counterclockwise to remove all spring compression. Remove the adjusting screw nut, upper spring seat, and spring (keys 44, 29, and 30)
2. Unscrew the casing cap screws and hex nuts (keys 45 and 46), and remove the upper casing assembly (key 23) from the lower casing (key 39). Remove the cotter pin (key 36) and unscrew the adjusting stem (key 31).
3. Lift out the diaphragm (key 15), diaphragm plate (key 40), and stem assembly. Remove the travel indicator (key 32) when the bottom of the stem enters the yoke window.
4. To replace the diaphragm (key 15), separate the diaphragm assembly by using a wrench on the hex nuts (key 42) to unscrew the assembly.
5. Separate the parts—diaphragm washer, actuator O-ring (keys 41 and 25), diaphragm, and diaphragm plate, (keys 15 and 40).

6. Inspect the diaphragm and the actuator O-ring for damage or deterioration, and replace if necessary. If the diaphragm is replaced, a new O-ring should also be installed.

7. Inspect the stem O-ring (key 19) and bonnet bushing (key 20); replace if necessary. To inspect the casing O-ring (key 18), remove the cap screws (key 38) and lift off the lower casing (key 39). Replace the O-ring if necessary. Inspect the adjusting stem bushing (key 26) and actuator stem O-ring (key 53). Replace if necessary.

8. If the hammer nut needs to be removed from the bonnet, the spring pins (key 7) can be removed with locking pliers.

Assembly

1. Before starting assembly, make sure all parts are clean and in good condition. There should be no burrs or sharp edges on any threads or surfaces that might cut or damage an O-ring, bushing, the packing, or the diaphragm. When replacing O-rings and bushings, be sure the O-ring or bushing groove is clean and undamaged. Using a general purpose lubricant (key 49), lubricate all bushings and O-rings and the threads of parts that have to pass through the bushings and O-rings.

CAUTION

The threads on factory-produced valve stems have been specially machined to avoid O-ring, bushing, or packing damage during trim maintenance. Use of other than a factory-produced valve stem may result in early stem O-ring, bushing, and packing failure.

Note

Do not lubricate cap screws (key 38) before inserting them in the following procedure.

2. Place the hammer nut and spring pins on the bonnet, if removed. Install the casing O-ring (key 18), the stem O-ring (key 19), and the bonnet bushing (key 20). Position the lower casing (key 39) on the bonnet. Insert the nonlubricated cap screws (key 38), and torque to 49 N•m (36 lbf•ft).
3. Assemble the diaphragm plate assembly. Place the patterned side of the diaphragm (key 15) against the diaphragm plate (key 40). Be sure to turn the diaphragm washer (key 41) so that the side that is beveled on the inside diameter is against the O-ring

D4 Valve

(key 25). Also, make sure that it is assembled for installation with the diaphragm on the loading pressure side and the lockwasher (key 43) and diaphragm washer (key 41) are on the upper side.

Note

Spring pins must always be in place during valve operation, acting as a safeguard against injury when the unit is being disassembled.

4. Fasten the diaphragm and diaphragm plate assembly on the stem with hex nuts (key 42). Place the diaphragm and diaphragm plate, and stem assembly into the lower casing and bonnet. Install the travel indicator (key 32) on the stem as the bottom of the stem enters the yoke window.

5. Screw the adjusting stem (key 31) onto the stem (key 47) and secure the cotter pin (key 36). Make sure the bushing and O-ring are in place in the upper casing.

CAUTION

Over-tightening the diaphragm casing cap screws and nuts (keys 45 and 46) can damage the diaphragm. Do not exceed 27 N•m (20 lbf•ft) torque.

6. Position the upper casing (key 23) on the lower casing (key 39). Insert the cap screws (key 45) and tighten the hex nuts (key 46). Torque the casing cap screws evenly to 27 N•m (20 lbf•ft) using a crisscross pattern.

7. Replace the spring (key 30), spring seat (key 29), and adjusting stem nut (key 44) over the adjusting stem. Replace the spring case assembly (key 27).

8. Adjust the initial spring set per the Spring Adjustment section in this manual.

Parts Ordering

Each Design D4 control valve is assigned a serial number, which can be found on the nameplate. Refer to the number when contacting your Fisher representative for assistance or when ordering replacement parts.

Note

Use only genuine Fisher replacement parts. Components that are not supplied by Fisher should not, under any circumstances, be used in any Fisher valve, because they will void your warranty, might adversely affect the performance of the valve, and might jeopardize worker and workplace safety.

Note

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Repair Kits

Note

All repair kits are supplied with hydrogenated nitrile bonnet O-ring. Viton bonnet O-ring must be ordered separately when required.

Description	Part Number
* Packing Repair Kit Includes key numbers 4, 8, 12 (2 req'd), and 13	RD4X0000012
* Actuator Repair Kit Includes key numbers 4, 8, 12 (2 req'd), 13, 15, 18, 19, 20, 25, 26, 36, and 53	RD4X0000022

Instruction Manual

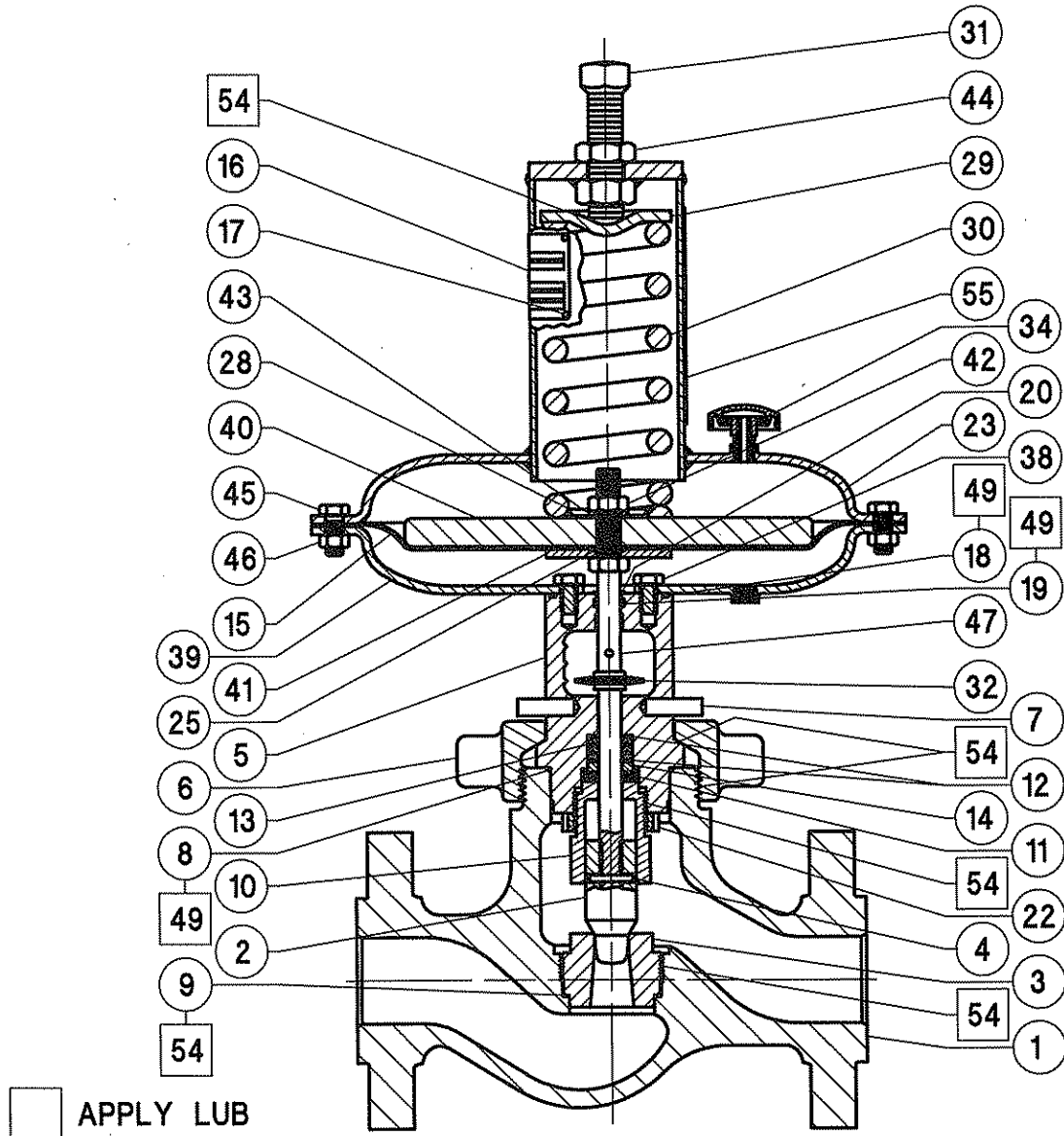
Form 5755
September 2005

D4 Valve

Parts List

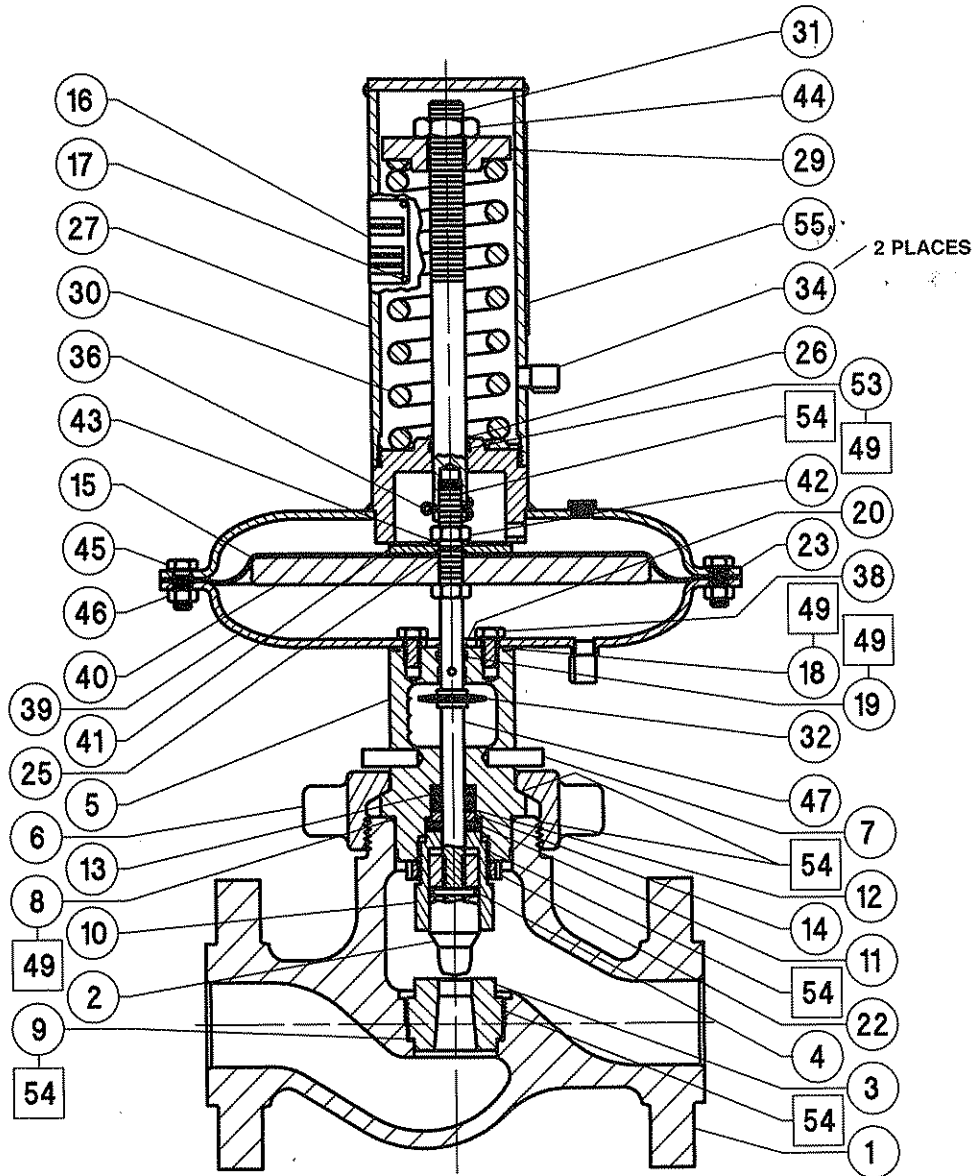
Key	Description	Part Number	Key	Description	Part Number
1	Valve Body			2-inch valve	
2*	Valve Plug			0.25 inch port diameter	GE07389X012
	S41000 / S41600 HT			0.375 inch port diameter	GE07394X012
	1-inch valve			0.5 inch port diameter	GE07397X012
	0.25 inch port diameter	20C3692X012	4*	Groove Pin	
	0.375 inch port diameter	20C3693X012	5	Bonnet	
	0.5 inch port diameter	20C3694X012	6	Hammer Nut	
	0.75 inch port diameter	GE01557X012	7	Spring Pin	
	2-inch valve		8*	Bonnet O-ring	
	0.25 inch port diameter	GE00992X012		Hydrogenated Nitrile	
	0.375 inch port diameter	GE00993X012		-46 to 149°C (-50 to 300°F)	10C3680X012
	0.5 inch port diameter	GE00994X012		Viton, -23 to 204°C (-10 to 400°F)	10C3680X022
	0.75 inch port diameter	GE01558X012	9*	Seat Ring Gasket	
	1-inch port diameter	GE01561X012		For 1-inch valve	1B198836042
	1.25 inch port diameter	GE01555X012		For 2-inch valve	1B198836042
	S17400 H1150 Dbl		10	Packing Retainer	
	1-inch valve		11	Belleville Springs	
	0.25 inch port diameter	20C3692X032	12*	Anti-Extrusion Washer, 2 req'd	12B6335X022
	0.375 inch port diameter	20C3693X032	13*	Packing Set	12B6667X012
	0.5 inch port diameter	20C3694X032	14	Packing Spacer	
	0.75 inch port diameter	GE01557X032	15*	Diaphragm	22B3521X012
	2-inch valve		16	Nameplate	
	0.25 inch port diameter	GE00992X032	17	Drive Screw	
	0.375 inch port diameter	GE00993X032	18*	Casing O-ring	1F9141X0142
	0.5 inch port diameter	GE00994X032	19*	Stem O-ring	1K7561X0072
	0.75 inch port diameter	GE01558X032	20*	Bonnet Bushing	17A7112X012
	1-inch port diameter	GE01561X032	22	Locknut	
	1.25 inch port diameter	GE01555X032	23	Upper Casing Assembly	
	Tungsten Carbide		25*	Actuator O-ring	1K7561X0072
	1-inch valve		26*	Adjusting Stem Bushing (spring-to-open only)	17A4059X012
	0.25 inch port diameter	20C3696X012	27	Spring Case Assembly	
	0.375 inch port diameter	20C3697X012	28	Lower Spring Seat	
	0.5 inch port diameter	20C3698X012	29	Upper Spring Seat	
	0.75 inch port diameter	20C3699X012	30	Spring	
	2-inch valve			Spring-to-Close, Light Rate	1F176827092
	0.25 inch port diameter	20C3682X012		Spring-to-Close, Heavy Rate	1E792427082
	0.375 inch port diameter	20C3683X012		Spring-to-Open, Light Rate	1F176727032
	0.5 inch port diameter	20C3685X012		Spring-to-Open, Heavy Rate	1F714327092
	0.75 inch port diameter	20C3686X012	31	Adjustment Screw or Stem	
	1-inch port diameter	20C3687X012	32	Travel Indicator	
	1.25 inch port diameter	20C3688X012	34	Vent Assembly	
3*	Seat Ring		36*	Cotter Pin (spring-to-open only)	1C608035022
	S17400 H1150 Dbl		37	Pipe Plug	
	1-inch valve		38	Cap Screw	
	0.25 inch port diameter	GE00982X032	39	Lower Casing	
	0.375 inch port diameter	GE00983X032	40	Diaphragm Plate	
	0.5 inch port diameter	GE00984X032	41	Diaphragm Washer	
	0.75 inch port diameter	GE00985X032	42	Hex Nut	
	2-inch valve		43	Lockwasher	
	0.25 inch port diameter	GE00986X032	44	Adjustment Screw Nut	
	0.375 inch port diameter	GE00987X032	45	Cap Screw	
	0.5 inch port diameter	GE00988X032	46	Hex Nut	
	0.75 inch port diameter	GE00989X032	47*	Valve Stem	
	1-inch port diameter	GE00990X032		Nitronic 50, Reverse Acting	20C3681X022
	1.25 inch port diameter	GE00991X032		Nitronic 50, Direct Acting	20C3716X022
	Tungsten Carbide		49	Lubricant (lithium grease or equivalent)	
	1-inch valve		50	NACE Tag (not shown)	
	0.25 inch port diameter	GE07347X012	51	Drive Screw	
	0.375 inch port diameter	GE07363X012	53*	Actuator Stem O-ring (spring-to-open only)	1C7821X0182
	0.5 inch port diameter	GE07364X012	54	Lubricant (anti-seize or equivalent)	
	0.75 inch port diameter	GE07365X012	55	Spring Setting Label (not shown)	

D4 Valve



GE02332-A

Figure 3. Design D4 Valve Assembly (Spring-to-Close)



GE02334-B

□ APPLY LUB

Figure 4. Design D4 Valve Assembly (Spring-to-Open)

D4 Valve

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EMERSON™
Process Management

Type D2 FloPro™ Control Valve

Contents

Introduction	1
Scope of Manual	1
Description	3
Specifications	3
Installation	3
Setting Valve FloPro Flow Adjuster	4
Changing Actuator Action from (Air-to-Open) to (Air-to-Close)	4
Maintenance	5
Valve Trim Maintenance	6
Packing and Valve Trim Maintenance	7
Parts Kits	15
Parts List	15

Introduction

Scope of Manual

This instruction manual provides installation, maintenance, and parts information for the 1-inch Type D2 FloPro™ control valve and actuator.

No person may install, operate, or maintain a Type D2 FloPro control valve without first • being fully trained and qualified in valve, actuator, and accessory installation, operation, and maintenance, and • carefully reading and understanding the contents of this manual. If you have any questions about these instructions, contact your Fisher sales office before proceeding.

Note

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W8527-1

GLOBE STYLE



W9040_1a

ANGLE STYLE

Figure 1. Type D2 FloPro™ Control Valve



Table 1. Specifications

<p>Valve Assembly Pressure Class</p> <p>ASME B16.34 Class 900</p> <p>Maximum Inlet Pressure and Temperature⁽¹⁾</p> <p>155 bar from –46 to 93°C, and 150 bar at 149°C. (2250 psig from –50 to 200°F, and 2185 psig at 300°F)</p> <p>Maximum Allowable Pressure Drop⁽¹⁾</p> <p>Flow Down⁽²⁾ <i>Maximum Inlet Pressure:</i> 155 bar (2250 psig) <i>Maximum Outlet Pressure:</i> 103 bar (1500 psig)</p> <p>Flow Up <i>Maximum Inlet Pressure:</i> 103 bar (1500 psig) <i>Maximum Outlet Pressure:</i> 103 bar (1500 psig)</p> <p>Shutoff Classification</p> <p>ANSI Class IV ANSI/FCI 70-2 and IEC 60534-4</p> <p>Construction Materials</p> <p>Valve Body and Bonnet: ASME SA 352 LCC Stress relieved</p> <p>Valve Plug and Seat: (R0006) Alloy 6</p> <p>Valve Stem: (S31600) 316 SST</p> <p>O-Rings: (HNBR) Hydrogenated Nitrile</p> <p>Packing: PTFE/Carbon PTFE</p> <p>Packing Springs: (N07718) Inconel 718</p> <p>Stem Bushing: (Ryton) PPS</p> <p>Actuator Diaphragm: Nitrile/Polyester</p> <p>Actuator Springs: Zinc-plated steel</p> <p>Flow Characteristic</p> <p><i>FloPro</i> Characterized</p>	<p>Port Diameter</p> <p>13 mm (0.5 inch)</p> <p>Maximum Travel</p> <p>13 mm (0.5 inch)</p> <p>Approximate Weight</p> <p>Globe Valve Body: 7.7 kg (17 lb) Angle Valve Body: 8.2 kg (18 lb)</p> <p>Material Temperature Capabilities</p> <p>Valve Body Assembly: –46 to 149°C (–50 to 300°F)</p> <p>Actuator Assembly: –46 to 93°C (–50 to 200°F)</p> <p>Bonnet/Body Connection</p> <p>Threaded with leakoff bleed</p> <p>Standard Actuator Configuration</p> <p>The <i>D2 FloPro</i> actuator is an on-off spring-and-diaphragm.</p> <p>Globe Valve Body: Supplied as either Air-to-Open or Air-to-Close.</p> <p>Angle Valve Body: Supplied as Air-to-Open only</p> <p>Maximum Actuator Casing Pressure</p> <p>2.8 bar (40 psig)</p> <p>Minimum Required Actuator Casing Pressure</p> <p>2.1 to 2.4 bar (30 to 35 psig)</p> <p>Actuator Diaphragm Effective Area</p> <p>194 cm² (30 square inches)</p> <p>Actuator Pressure Connections</p> <p>1/4 inch NPT female</p>
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1. The pressure or temperature limits in the referenced tables and any applicable ASME code limitations should not be exceeded.
 2. Standard flow direction.

Description

The Type D2 FloPro control valve (figure 1) is a compact, rugged valve designed for on-off control of a variety of fluids at pressures up to 155 bar (2250 psig). This valve is ideal for use as a dump valve on gas separators and scrubbers. It is also well suited for other high pressure applications in natural gas production, compression, and processing. The Type D2 FloPro valve has threaded end connections and is available in either a 1-inch globe style or angle style body.

Specifications

Table 1 lists specifications for the Type D2 FloPro control valve. Some of the specifications for a given control valve as it originally comes from the factory are stamped on a nameplate located on the upper diaphragm casing flange.

Installation



WARNING

Always wear protective gloves, clothing, and eyewear when performing any installation operations to avoid personal injury.

Personal injury or equipment damage caused by sudden release of pressure may result if the valve assembly is installed where service conditions could exceed the limits given in table 1 or on the appropriate nameplates. To avoid such injury or damage, provide a relief valve for overpressure protection as required by accepted industry or local, state, and Federal codes and good engineering practices.

Check with your process or safety engineer for any additional measures that must be taken to protect against process media.

If installing into an existing application, also refer to the WARNING at the beginning of the Maintenance section in this instruction manual.

CAUTION

This valve is intended for a specific range of pressures, temperatures, and other service conditions (see table 1). Applying different pressure, temperature, and other conditions to the valve could result in parts damage, malfunction of the valve, or loss of control of the process. Do not expose this valve to service conditions or variables other than those for which this valve is intended. If you are not sure what these conditions are, you should contact your Fisher sales office for more complete specifications.

1. Before installing the valve, inspect it to be certain that the valve body cavity is free of foreign material. Clean out all pipelines to remove scale, welding slag, and other foreign materials.

2. The control valve assembly may be installed in any orientation unless limited by seismic criteria.

The standard flow direction is indicated by the arrow on the valve body.

3. Use accepted piping practices when installing the valve in the pipeline.

4. If continuous operation is required during inspection or maintenance, install a three-valve bypass around the control valve assembly.

Note

The 1-inch Type D2 FloPro valve is equipped with ENVIRO-SEAL® D2 packing.

The actuator, on the globe style valve, is available from the factory as either air-to-open or air-to-close. The actuator, on the angle style valve, is available from the factory only as air-to-open.

Additionally, the actuator as shipped from the factory, has the FloPro flow adjuster set at a 0.375 inch port flow rate position. If some other flow rate is desired, see the Setting Valve FloPro Flow Adjuster section in this manual.

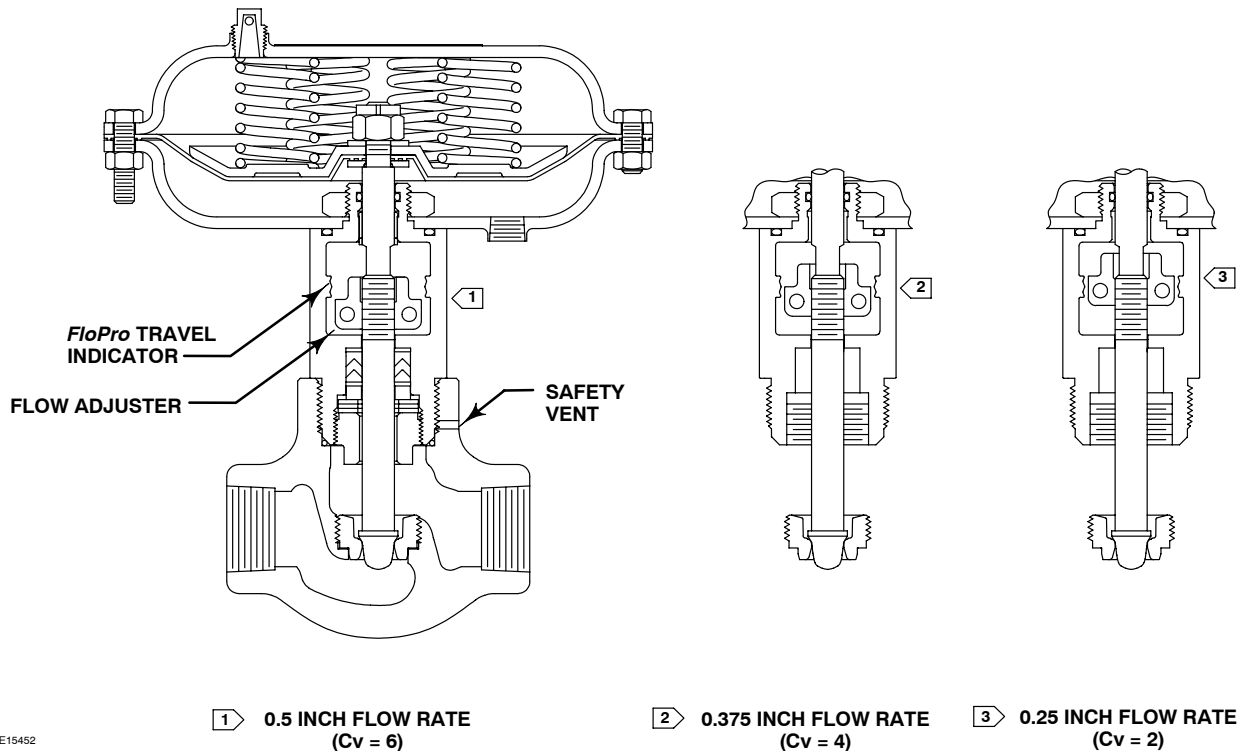


Figure 2. Flow Rate Adjustments

Setting Valve FloPro™ Flow Adjuster

Air-to-Open Actuator Action

1. To change the valve flow rate, loosen the flow adjuster socket head cap screws (key 29), and reposition the flow adjuster halves (key 14 and 15) to the desired flow rate position. See figure 2 for flow rate settings.

Air-to-Close Actuator Action

1. Attach a pressure line to the actuator. Supply pressure to the actuator to seat the plug in the seat ring.
2. To change the valve flow rate, loosen the flow adjuster socket head cap screws (key 29), and reposition the flow adjuster halves (key 14 and 15) to the desired flow rate position. See figure 2 for flow rate settings.

Changing Actuator Action from (Air-to-Open) to (Air-to-Close)

Key numbers are referenced in figures 6 and 7.

WARNING

To prevent possible personal injury or property damage from removing the casing cap screws in the wrong sequence, follow the procedure as outlined below for removing the upper casing.

1. Remove the six **short** actuator casing cap screws (key 22) first. Once these have been removed from the actuator assembly, remove the two **long** actuator cap screws (key 30) by alternating between them as you loosen them, to keep the upper casing (key 21) level during this procedure.

Note

Be aware as you loosen and remove the actuator cap screws that the actuator springs are under compression.

2. Remove the upper casing (key 21) and the springs (key 27).
3. Do not turn the valve stem (key 4) while removing the diaphragm hex nut (key 26). Keep the stem from

turning by using an open end wrench on the machined flats located on the valve stem above the flow adjuster for this procedure. Continue the actuator disassembly by removing the washer (key 24) diaphragm plate (key 25), diaphragm (key 19), washer (key 36), and O-ring (key 37). Inspect the diaphragm for any wear or damage. Replace with a new one if necessary.

4. Unscrew the socket head cap screws (key 29), and remove the flow adjuster halves (key 14 and 15). Position the stem (key 4) to its most upward position.
5. Place 2 of the springs (key 27) from the actuator into the bottom casing (key 20), equally spaced, 180 degrees apart. Place the washer (key 36) over the valve stem, as shown in view A of figure 7. Then place the O-ring (key 37) over the valve stem. Next install the diaphragm plate (key 25) and, using the diaphragm plate, correctly position the actuator springs.
6. Place the diaphragm (key 19) over the stem, along with washer (key 24). Position the diaphragm so the holes in the diaphragm align with the holes in the bottom casing.
7. Insert a 1/8 inch diameter drift punch, or other suitable device through the 5/32 inch diameter hole in the valve stem located below the bottom of the previously removed flow adjuster. Install hex nut (key 26) and tighten to 10 N•m (90 lbf•in). Use the 1/8 inch drift punch or other holding device to turn the stem to align the holes of the diaphragm (key 19) to the lower casing (key 20).
8. Position the upper casing and install the two **long** cap screws (key 30) opposite one another. Install the six shorter cap screws (key 22) and the hex nuts, tightening the actuator casing cap screws evenly using a cross-tightening procedure. Torque to 10 N•m (8 lbf•ft).
9. Connect a pressure line to the top actuator pressure connection, and apply pressure to the actuator. Stroke the actuator until the valve plug is seated on the seat ring. Install the flow adjuster, positioning it to the desired travel. Tighten the flow adjuster socket head cap screws to 3 N•m (26 lbf•in).
10. Release the actuator pressure, and install the vent plug (key 28) into the bottom casing pressure connection.

Maintenance

Valve parts are subject to normal wear and must be inspected and replaced as necessary. Inspection and maintenance frequency depends on the severity of service conditions. This section includes instructions for packing and trim maintenance, and replacing actuator parts.

All maintenance operations can be performed with the valve in the line.

Note

Whenever a gasket seal or O-ring is disturbed by removing or shifting gasketed parts, a new gasket should be installed upon reassembly. This is necessary to ensure a good gasket seal, since the used gasket or O-ring will not seal properly.

WARNING

Avoid personal injury from sudden release of process pressure. Before performing any maintenance operations:

- **Always wear protective gloves, clothing, and eyewear when performing any maintenance operations to avoid personal injury.**
- **Disconnect any operating lines providing air pressure or a control signal to the actuator. Be sure the actuator cannot suddenly open or close the valve.**
- **Use bypass valves or completely shut off the process to isolate the valve from process pressure. Relieve process pressure on both sides of the valve. Drain the process media from both sides of the valve.**
- **Use lock-out procedures to be sure that the above measures stay in effect while you work on the equipment.**
- **The valve packing box may contain process fluids that are pressurized, even when the valve has been removed from the pipeline. Process fluids may spray out under**

D2 FloPro™ Valve

pressure when removing the packing hardware or packing rings.

- Check with your process or safety engineer for any additional measures that must be taken to protect against process media.

Valve Trim Maintenance

Note

The following maintenance procedures apply to both air-to-open and air-to-close actuator configurations, except for steps 2 and 8 as noted.

Key numbers are referenced in figures 6, 7, and 8.

1. Isolate the control valve from the line pressure, release pressure from both sides of the valve body, and drain the process media from both sides of the valve.
2. **For air-to-open actuator action only**, apply pressure to the actuator to fully stroke it open. This will raise the plug off its seat so that the valve stem serrations are visible inside the flow adjuster window (see figures 4 and 5). Loosen the socket head screws (key 29) and lower the flow adjuster (key 14 and 15) to its lowest position on the valve stem. Retighten the socket head screws (key 29) to 3 N•m (26 lbf•in). Relieve pressure to the actuator, shut off all pressure lines to the actuator, and disconnect. Use lockout procedures to be sure that the above measures stay in effect while you work on the equipment.

CAUTION

The preceding step is intended to prevent damage to the valve plug (key 3) and seat ring (key 5) during the removal of the bonnet and actuator.

3. Unscrew the bonnet from the valve body.

WARNING

Avoid personal injury from sudden release of process pressure. If the process media starts to escape from the safety vent (see figure 2) located in the bonnet neck of the valve body,

STOP DISASSEMBLY IMMEDIATELY!

The escape of process media indicates that the valve has NOT been isolated from the process media, or process pressure is trapped in the valve body.

Check with your process or safety engineer for any additional measures that must be taken to protect against process media.

4. Once the bonnet has been removed from the valve body, inspect the seat ring (key 5) for wear or damage. If the seating surface has been damaged, remove it from the valve body. Also remove the seat ring gasket (key 6). Clean and inspect the valve body gasket surface for damage. Visually inspect the valve body interior below the seat ring for erosion. Replace the valve body if necessary.

To replace the seat ring, first install a new seat ring gasket. Install the new seat ring and tighten to 230 N•m (170 lbf•ft).

Cover the opening in the valve body to prevent foreign material from getting into the valve body cavity.

5. Inspect the valve stem for scratches or wear, and valve plug for wear or damage. Replace if necessary.
6. If the valve plug requires replacement, use an open end wrench on the machined flats located on the valve stem above the flow adjuster and unscrew the valve plug from the valve stem. Replace it with a new valve plug. Screw the valve plug into the valve stem, being careful not to damage the plug seat or plug contour. Tighten to 18 N•m (13 lbf•ft).

WARNING

Upon reassembly, ensure that no foreign material blocks the safety vent hole as shown in figure 2. If the safety vent hole is blocked or plugged, possible personal injury from the sudden release of process pressure during maintenance disassembly may occur.

7. Lubricate a new O-ring (key 13) with Lubriplate MAG-1 or equivalent and place it into the valve body as shown in figure 6 or 7. Ensure that no foreign material blocks the safety vent hole. Screw the bonnet into the valve body, and torque to a range of 542 to 678 N•m (400 to 500 lbf•ft).

- 8. **For air-to-open actuator action only**, attach the pressure line to the actuator, and supply pressure to the actuator. Loosen the socket head screws (key 29) and remove the flow adjuster (keys 14 and 15). Release the pressure to the actuator. This allows the plug to find its seated position.
- 9. Set the flow adjuster to the desired travel position (see figure 2), and tighten the flow adjuster socket head cap screws to 3 N•m (26 lbf•in).

Packing and Valve Trim Maintenance

Note

The following maintenance procedures apply to both air-to-open and air-to-close actuator configurations, except as noted.

Key numbers are referenced in figures 6, 7, and 8.

- 1. Isolate the control valve from the line pressure, release pressure from both sides of the valve body, and drain the process media from both sides of the valve.
- 2. **For air-to-open actuator action only**, apply pressure to the actuator to fully stroke it open. This will raise the plug off its seat so that the valve stem serrations are visible inside the flow adjuster window (see figures 4 and 5). Loosen the socket head screws (key 29) and lower the flow adjuster (key 14 and 15) to its lowest position on the valve stem. Retighten the socket head screws (key 29) to 3 N•m (26 lbf•in). Relieve pressure to the actuator, shut off all pressure lines to actuator, and disconnect. Use lockout procedures to be sure that the above measures stay in effect while you work on the equipment.

CAUTION

The preceding step is intended to prevent damage to the valve plug (key 3) and seat ring (key 5) during the removal of the bonnet and actuator.

- 3. Unscrew the bonnet from the valve body.

WARNING

Avoid personal injury from sudden release of process pressure. If the

process media starts to escape from the safety vent (see figure 2) located in the bonnet neck of the valve body,

STOP DISASSEMBLY IMMEDIATELY!

The escape of process media indicates that the valve has NOT been isolated from the process media, or process pressure is trapped in the valve body.

Check with your process or safety engineer for any additional measures that must be taken to protect against process media.

- 4. Once the bonnet has been removed from the valve body, inspect the valve seat (key 5) for wear or damage. If the seating surface has been damaged, remove it from the valve body. Also remove the seat ring gasket (key 6). Clean and inspect the valve body gasket surface for damage. Visually inspect the valve body interior below the seat ring for erosion. Replace the valve body if necessary.

To replace the seat ring, first install a new seat ring gasket. Install the new seat ring and tighten to 230 N•m (170 lbf•ft).

Cover the opening in the valve body to prevent foreign material from getting into the valve body cavity.

WARNING

To prevent possible personal injury or property damage from removing the casing cap screws in the wrong sequence, follow the procedure as outlined below for removing the upper casing.

- 5. Remove the six **short** actuator casing cap screws (key 22) first. Once these have been removed from the actuator assembly, remove the two **long** actuator cap screws (key 30) by alternating between them as you loosen them, to keep the upper casing (key 21) level during this procedure..

Note

Be aware as you loosen and remove the actuator cap screws that the actuator springs are under compression for the air-to-open configuration.

6. Remove the upper casing (key 21) and the springs (key 27).
7. Do not turn the valve stem (key 4) while removing the diaphragm hex nut (key 26). Keep the stem from turning by using an open end wrench on the machined flats located on the valve stem above the flow adjuster for this procedure. Continue the actuator disassembly by removing these parts: washer (key 24) diaphragm plate (key 25), diaphragm (key 19), washer (key 36), and O-ring (key 37). Inspect the diaphragm for any wear or damage. Replace with a new one if necessary.

If you wish to inspect/replace the bonnet to actuator casing O-ring (key 16), mark the orientation of the actuator pressure connection to the bonnet for later reference (see figures 4 and 5). Unscrew the hex nut (key 18) from the bonnet. Remove the bottom casing (key 20).

8. Unscrew the flow adjuster socket head cap screws (key 29), and remove the flow adjuster halves.
9. Unscrew the packing retainer (key 7) from the bonnet (key 2). After the packing retainer has been unscrewed from the bonnet, pull the valve stem and plug out of the bonnet.
10. Remove the three Belleville springs (key 9), packing spacer (key 10), packing (key 11), and two anti-extrusion rings (key 12) from the bonnet. See figure 3.
11. Clean and inspect the packing box wall to ensure that the packing surfaces are not damaged. If the surface condition is damaged, and cannot be improved by light sanding, replace the bonnet by contacting your Fisher sales office.
12. Inspect the valve stem for scratches or wear, and valve plug for wear or damage. Replace if necessary.
13. If the valve plug requires replacement, use an appropriate tool on the machined flats located on the valve stem above the flow adjuster and unscrew the valve plug from the valve stem. Replace it with a new valve plug. Screw the valve plug into the valve stem, being careful not to damage the plug seat or plug contour. Tighten to 18 N•m (13 lbf•ft).
14. Inspect the valve stem bushing (key 8) located in the upper end of the bonnet. If damaged, remove and replace it with new bushing (key 8). Replace the valve stem bushing by inserting the bushing, flange end first, into the bore located at the top of the bonnet flow adjuster window. Insert until the flange snaps into the groove provided for it.

15. Remove the O-ring (key 17) from the upper end of the bonnet. Replace it with a new one, and lubricate it with Lubriplate MAG-1 or equivalent.
16. Install new packing according to the packing arrangement shown in figure 3, Apply a light film of Lubriplate Mag-1 lubricant or equivalent to the threads of the packing retainer (key 7). Install the Belleville springs and packing retainer, as shown in figure 3, but do not tighten.
17. Apply a light film of Lubriplate Mag-1 lubricant or equivalent to the valve stem. Carefully slide the valve stem through the packing retainer and packing to a point where the serration extends completely into the flow adjuster window of the bonnet (see figures 4 and 5).

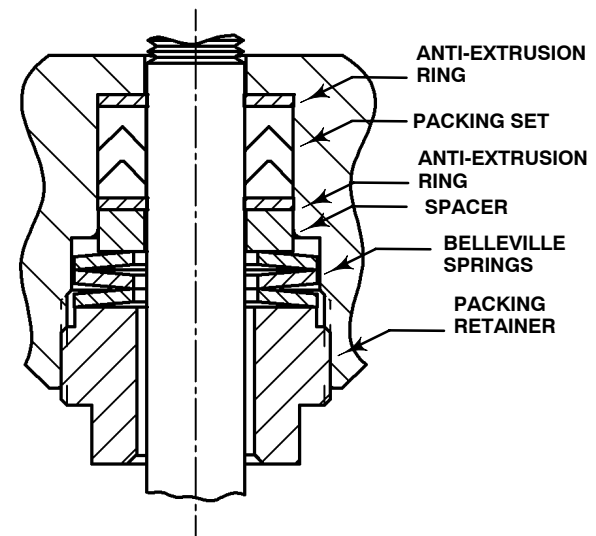


Figure 3. Packing and Belleville Spring Stacking Order

18. **Tighten the packing retainer to a range of 81 to 95 N•m (60 to 70 lbf•ft). Then loosen the packing retainer 30 degrees counter-clockwise. See figure 3.**
19. If the bottom casing (key 20) has been removed, place O-ring (key 16) into the groove provided in the top of the bonnet. Place the bottom casing on the bonnet, oriented in the same position as marked in step 7 on page 8. Screw the hex nut (key 18) onto the bonnet, and tighten to 203 N•m (150 lbf•ft).
20. **For air-to-open actuator action only (see figures 6 or 8),** assemble the actuator by first placing the O-ring (key 37) over the valve stem. Then place the washer (key 36) over the valve stem. Place the diaphragm (key 19) over the valve stem, and position it so the holes in the diaphragm match the holes in the casing. Place the diaphragm plate

(key 25) over the valve stem. Install the washer (key 24), diaphragm hex nut (key 26). Tighten the diaphragm hex nut to 10 N•m (90 lbf•in), while holding the stem by the flats. Install six springs (key 27) and attach the upper casing (key 21) by first installing the two **long** cap screws (key 30) opposite one another.

21. **For air-to-close actuator action only (see figure 7)**, assemble the actuator by first placing 2 of the springs (key 27) from the actuator into the bottom casing (key 20), equally spaced, 180 degrees apart. Place the washer (key 36) over the valve stem, as shown in view A of figure 7. Then place the O-ring (key 37) over the valve stem. Next install the diaphragm plate (key 25) and, using the diaphragm plate, correctly position the actuator springs.

a. Place the diaphragm (key 19) over the stem, along with washer (key 24). Position the diaphragm so the holes in the diaphragm align with the holes in the bottom casing.

b. Insert a 1/8 inch diameter drift punch, or other suitable device through the 5/32 inch diameter hole in the valve stem located below the bottom of the previously removed flow adjuster. Install hex nut (key 26) and tighten to 10 N•m (90 lbf•in). Use the 1/8 inch drift punch or other holding device to turn the stem to align the holes of the diaphragm (key 19) to the lower casing (key 20).

22. Position the upper casing and install the two **long** cap screws (key 30) opposite one another. Install the six shorter cap screws (key 22) and the hex nuts, tightening the actuator casing cap screws

evenly using a cross-tightening procedure. Torque to 10 N•m (8 lbf•ft).

WARNING

Upon reassembly, ensure that no foreign material blocks the safety vent hole as shown in figure 2. If the safety vent hole is blocked or plugged, possible personal injury from the sudden release of process pressure during maintenance disassembly may occur.

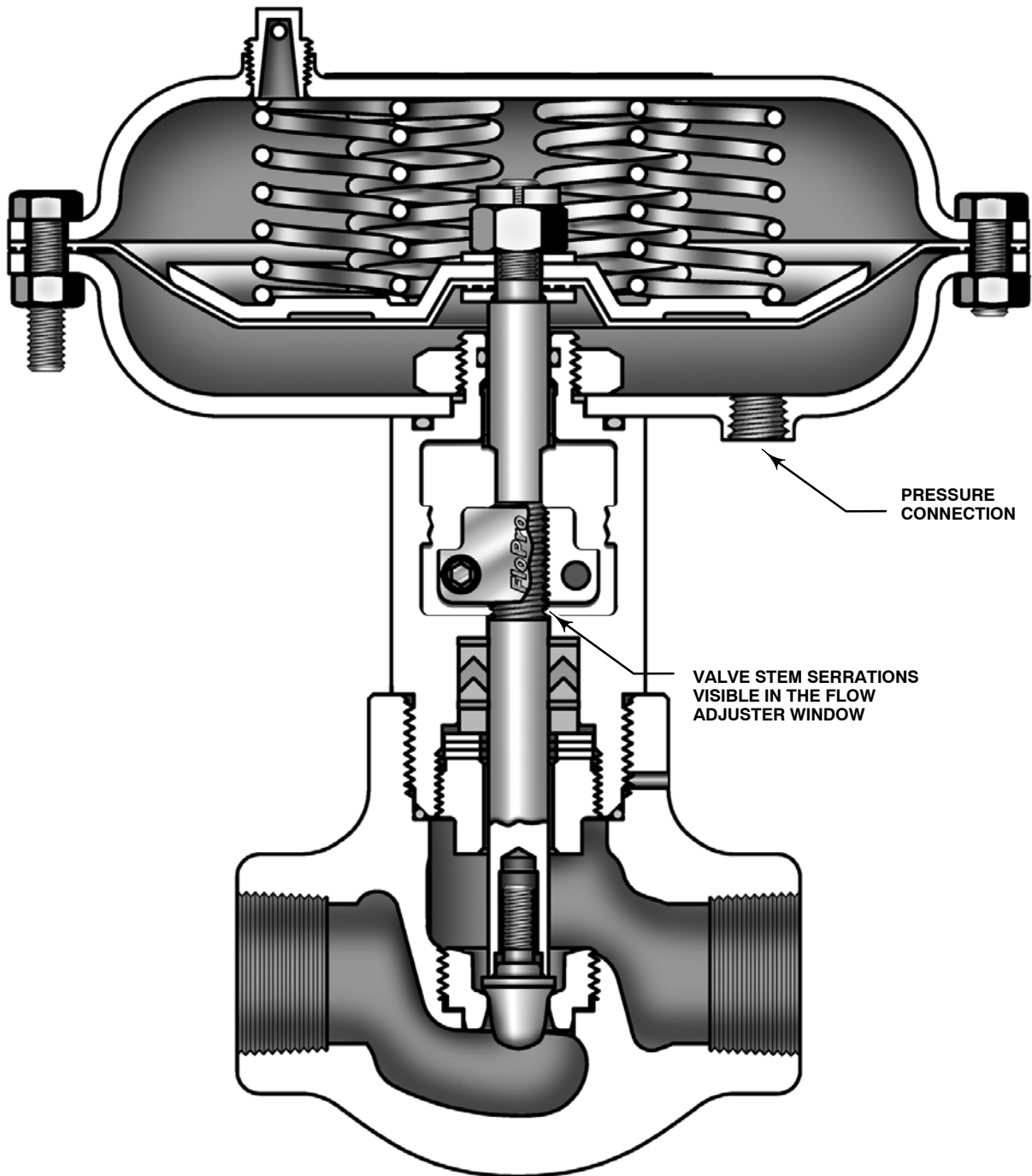
23. Lubricate a new O-ring (key 13) with Lubriplate MAG-1 or equivalent and place it into the valve body as shown in figure 6 or 7. Ensure that no foreign material blocks the safety vent hole. Screw the bonnet into the valve body, and torque to a range of 542 to 678 N•m (400 to 500 lbf•ft).

24. **For air-to-open actuator action only**, attach the pressure line to the actuator, and supply pressure to the actuator. Loosen the socket head screws (key 29) and remove the flow adjuster (keys 14 and 15). Release the pressure to the actuator. This allows the plug to find its seated position.

25. Set the flow adjuster to the desired travel position (see figure 2), and tighten the flow adjuster socket head cap screws to 3 N•m (26 lbf•in).

26. **For air-to-close actuator action only**, attach a pressure line to the actuator. Supply pressure to the actuator to seat the plug in the seat ring.

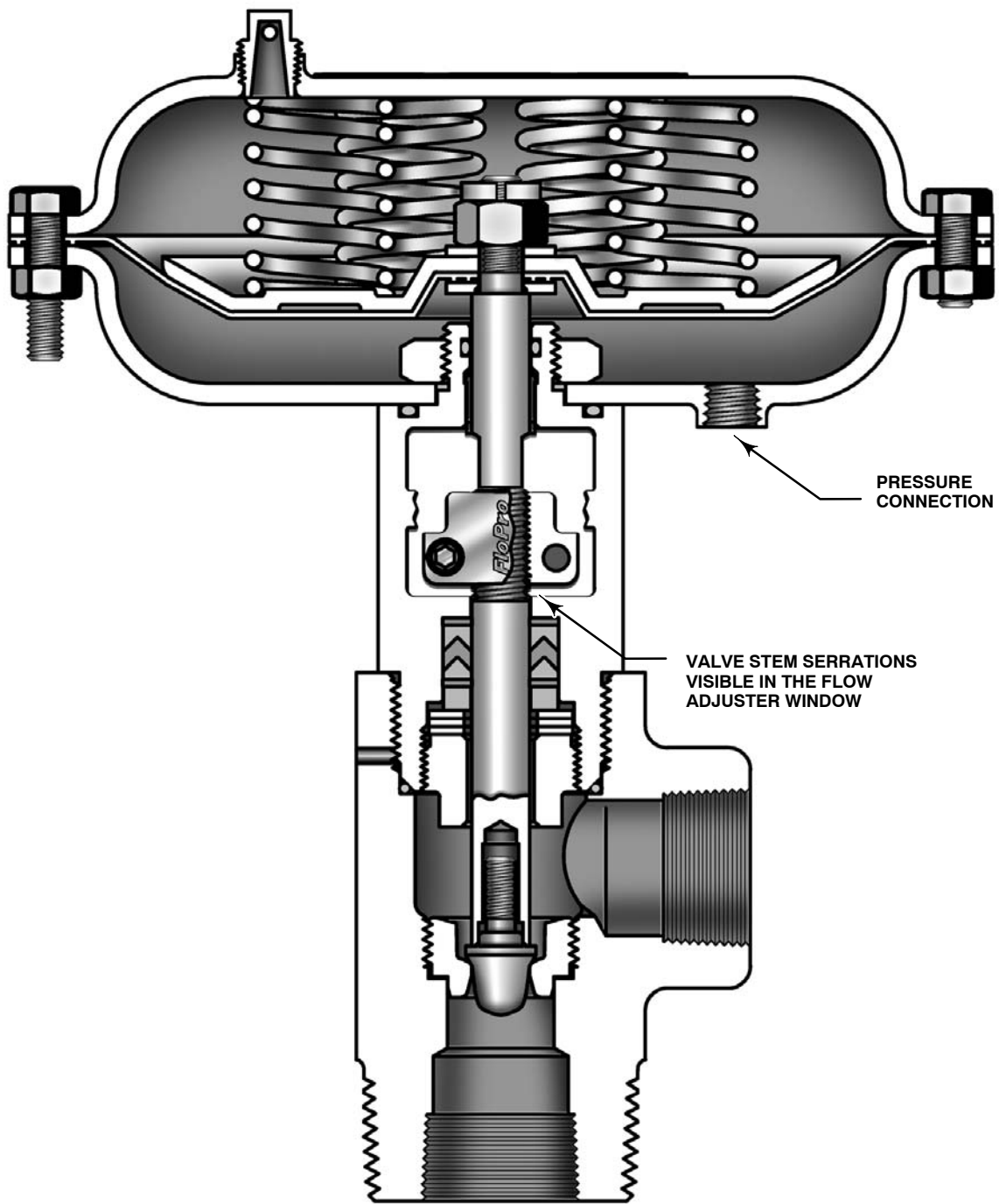
27. Set the flow adjuster to the desired travel position (see figure 2), and tighten the flow adjuster socket head cap screws to 3 N•m (26 lbf•in).



GLOBE STYLE AIR-TO-OPEN

W9005-1

Figure 4. Type D2 FloPro™ Globe Style Construction



W9006-1

ANGLE STYLE AIR-TO-OPEN

Figure 5. Type D2 FloPro™ Angle Style Construction

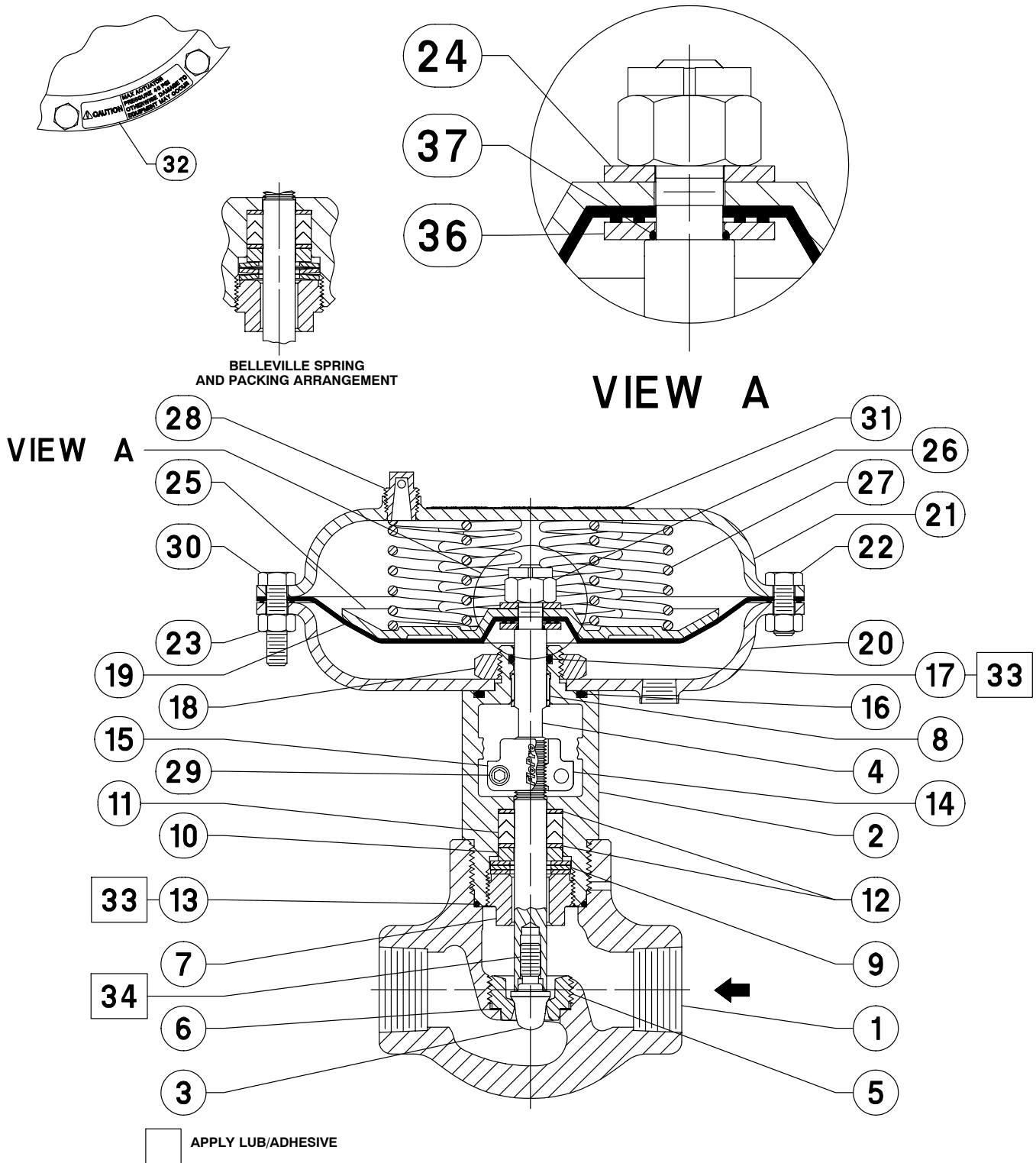


Figure 6. Type D2 FloPro™ Assembly—Air-to-Open

Instruction Manual

Form 5738
April 2005

D2 FloPro™ Valve

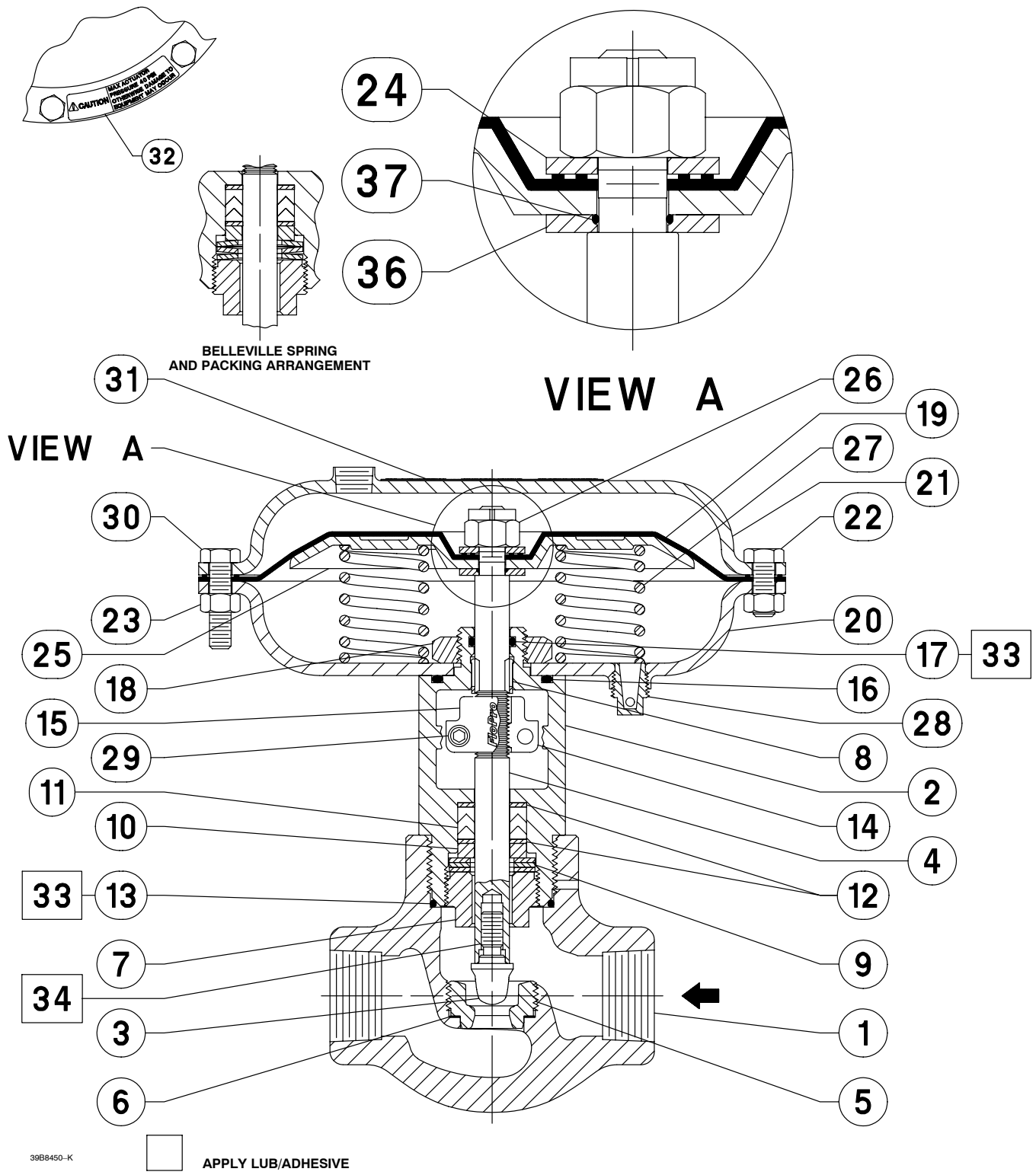


Figure 7. Type D2 FloPro™ Assembly—Air-to-Close

39B8460-K

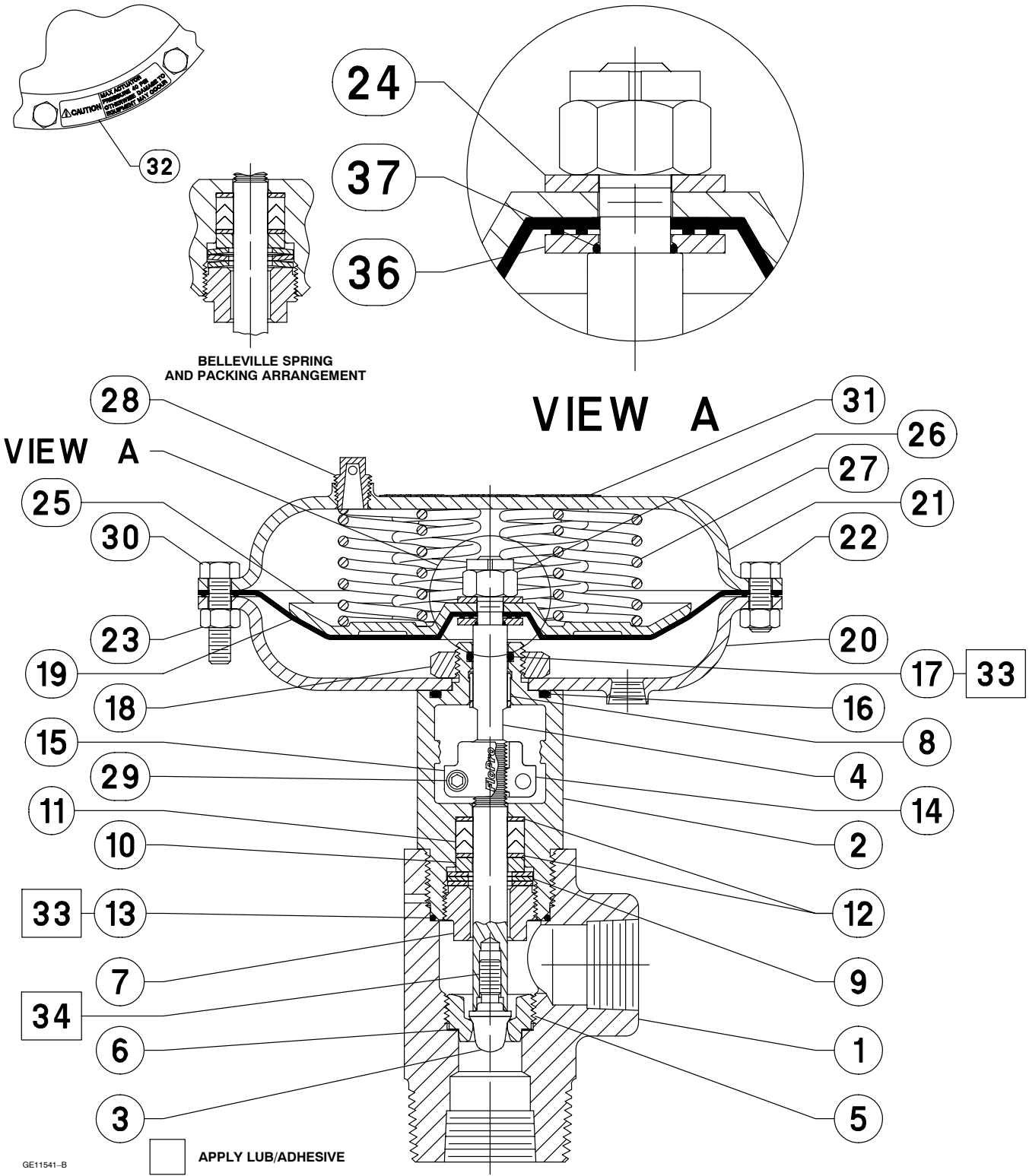


Figure 8. Type D2 FloPro™ Angle Valve Assembly—Air-to-Open

Parts Ordering

Note

Use only genuine Fisher replacement parts. Components that are not supplied by Fisher should not, under any circumstances, be used in any Fisher valve, because they will void your warranty, might adversely affect the performance of the valve, and might jeopardize worker and workplace safety.

Note

Neither Emerson, Emerson Process Management, nor Fisher assume responsibility for the selection, use, or maintenance of any product. Responsibility for proper selection, use, and maintenance of any Fisher product remains solely with the purchaser and end-user.

Parts Kits

	Description	Part Number
*	Valve Trim Kit Includes key numbers 3, 5, 6, and 13	19B8485X012
*	Valve Packing Kit Includes key numbers 8, 11, 12 (2 req'd), 13, 16, and 17	19B8486X012

Parts List

Note

Part numbers are shown for recommended spares only. For part numbers not shown, contact your Fisher sales office.

Key	Description	Part Number
1	Valve Body	
2	Bonnet	
3	Valve Plug	
4*	Valve Stem	39B5914X012
5	Seat Ring	
6*	Seat Ring Gasket	19B5887X012
7	Packing Retainer	
8	Valve Stem Bushing	
9	Belleville Springs (3 req'd)	
10	Packing Spacer	
11	ENVIRO-SEAL D2 Packing Set	
12	Anti-Extrusion Ring (2 req'd)	
13	Valve Body O-ring	
14	Flow Adjuster Half	
15	Flow Adjuster Half	
16	Casing O-ring	
17	Valve Stem O-ring	
18	Hex Nut	
19*	Diaphragm	39B3849X012
20	Bottom Casing	
21	Upper Casing	
22	Short Actuator Casing Cap Screws (6 req'd)	
23	Nut	
24	Washer	
25	Diaphragm Plate	
26	Diaphragm Hex Nut	
27	Springs Air-to-Open (use 6 springs) Air-to-Close (use 2 springs)	
28	Vent Plug	
29	Flow Adjuster Socket Head Cap Screws (2 req'd)	
30	Long Actuator Casing Cap Screws (2 req'd)	
31	Nameplate	
32	Caution Label	
33	Lubricant, Lubriplate MAG-1 or equivalent	
36	Washer	
37	O-ring	

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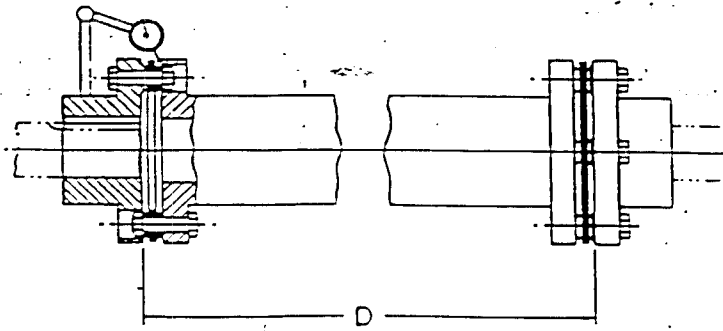
Formflex[®]

8 BOLT DOUBLE FLEX COUPLING
 Installation and Maintenance Instructions
 TYPE HSH, FSH, HFTH ALL SIZES

Form 1180

(H-FT-H)

Fig. 1

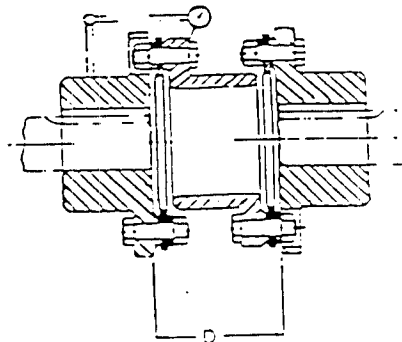


PARTS LIST

1. Bolt (16)
2. Hub (2)
3. Double Concave Washer (16)
4. Nut (16)
5. Spacer (1)
6. Flex Element (2)
7. Single Concave Washer (8)

(HSH)

Fig. 2

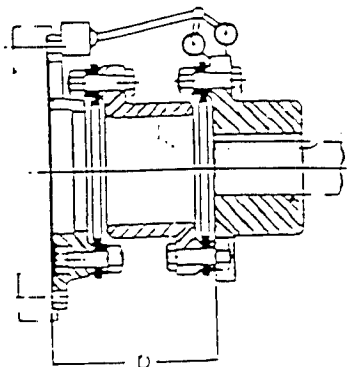


PARTS LIST

1. Bolt (16)
2. Hub (2)
3. Washer (16)
4. Nut (16)
5. Spacer (1)
6. Flex Element (2)

(FSH)

Fig. 3



PARTS LIST

1. Bolt (16)
2. Hub (1)
3. Washer (16)
4. Nut (16)
5. Spacer (1)
6. Flex Element (2)
7. Adapter Plate (1)

Proper care in installing and aligning will permit couplings to operate to full capacity, compensate for mis-alignment, and provide very good service life.

1. Inspect shafts and hub(s) bores and make sure they are free from burrs. Check for the proper fit of the keys to the shafts and hubs.
2. Fit the couplings hub(s) so that the shaft end(s) is/are flush with the machined face of the flange. If the hub is bored for an interference fit, the hubs should be heated then quickly positioned on the shaft. *Do Not* spot heat or heat above 300°F as it may cause distortion.
3. Move the equipment to be connected into position. Set the gap to the required distance between shaft ends, D dimension. See Fig. 1, 2 or 3.

ASSEMBLY & ALIGNMENT

4. Type FSH

- a. Install bolts (1) in Flywheel Adaptor (7).
- b. Install Flywheel Adaptor (7).
- c. Attach a dial indicator to the Flywheel Adaptor (7), indicate a point on the hub (2) flange outside diameter.
- d. Rotate the Flywheel Adaptor (7) with the hub (2) stationary. The driver and driven equipment will have allowable parallel misalignment when the Total Maximum Indicator Reading (TIR) is within limits as shown in table II.
- e. Reposition the dial indicator to indicate a point on hub (2) flange face near the outside diameter.
- f. With the dial indicator attached to the Flywheel Adaptor (7) and held stationary rotate the hub (2). The driver and driven equipment will have allowable angular misalignment when the maximum indicator reading is within limits as shown in table II.
- g. With equipment aligned and using Fig. 3 as a guide attach the flex elements (6) to the Flywheel Adaptor bolts (1), position the element washers (3) over the bolts (1) and install the nuts (4).
- h. Bring the spacer (5) into position install the bolts (1) thru the spacer and flex elements, place the element washers (3) over the bolts and install the nuts (4).
(The spacer must be supported at this time as not to damage the connected flex elements.)
- i. Position the flex elements between the hub (2) and spacer (5). Install the bolts (1) thru the spacer and flex elements place the element washers (3) over the bolts and install the nuts (4).
- j. Install the bolts (1) thru the hub (2) and flex elements (6) place the element washers (3) over the bolts and install the nuts (4).

- k. With equipment aligned and coupling assembled inspect all components for correct orientation. Tighten all nuts (4) to their proper torque value as shown in table I.

5. Type HSH & H-FT-H

- a. Bring the equipment into approximate good alignment by attaching one end of spacer (5) to a hub (2). Use Fig. 1 or 2 as a guide.
Note: Type H-FT-H has two style element washers (3) & (7) on bolt (1) either side of flex element (6) attached to the spacer (5). Element washer (7) must be positioned with the flat side adjacent to the spacer (5).
- b. With one end of the coupling assembled align the equipment well enough to assemble the opposite end of the spacer to the hub.
- c. Assemble the spacer to the hub using fig. 1 or 2 as a guide.
- d. Tighten all nuts (4) to their proper torque value as shown in table I with lightly oiled threads
- e. Attach a dial indicator to each hub. Indicate a point on the nearest spacer flange. See fig. 1 or 2.
- f. Rotate the assembled coupling, the equipment will be aligned when the Total Indicator Reading (T.I.R.) is within the allowable limits as shown in table II for both ends.

6. Inspection

IMPORTANT: To ensure unlimited life recheck alignment and retorquing nuts after one or two hours of actual operation. If the equipment is portable this should be done each time the equipment is moved.

TABLE I (Lightly oiled threads)

SIZE	31	35	42	45	50	55	60	70	75	80	85	92
FT-LB $\pm 10\%$	40	70	125	150	210	320	450	575	830	1000	1400	1400

TABLE II. Total indicator reading-inches.

SIZE	31	35	42	45	50	55	60	70	75	80	85	92
TIR	.004	.004	.005	.006	.006	.007	.008	.009	.010	.011	.012	.013

REPLACEMENT PARTS

To order replacement parts it is necessary to furnish the complete assemble number of the Dura-Flex Couplings and the required parts.

Example: Please send (8) nuts and (8) bolts for a type HSH-45

Order must be placed with the local Formflex distributor in your area or with the Original Equipment Manufacturer.

WARNING



ROTATING EQUIPMENT IS POTENTIALLY DANGEROUS AND MUST BE PROPERLY GUARDED. THE USER SHOULD COMPLY WITH APPLICABLE SAFETY CODES IN ACCORDANCE TO OSHA STANDARDS.



TB Wood's Incorporated
Chambersburg, PA.

FOR TECHNICAL ASSISTANCE, CONTACT

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OPEN END V-BELTING



Part No: B-Open End
 B 0.66" Top Width – Classical Profile
 Available Roll Lengths

APPLICATIONS

Ideal solution for temporary replacement in emergency situations or for long center drives; can be used on all types of industrial applications.

KEY FEATURES & BENEFITS

- Universal classical profile.
- Wingprene-impregnated Wingflex® envelope.
- Goodyear's Plioflex® cushion and insulation.
- Multiple-ply, square-woven fabric tension members.
- Oil, heat, ozone, and abrasion resistant.
- Easy installation with spliced ends.
- Static conductive.

THE IDEAL SOLUTION FOR PROBLEM APPLICATIONS AND EMERGENCY REPLACEMENTS

Goodyear Open End V-belting is the perfect answer for applications where endless V-belts are difficult or impossible to install. It also serves as an ideal emergency replacement when the exact length of endless belt is not readily available.

Open End V-belting will operate in any drive as long as RMA standard sheave dimensions are observed and the recommended maximum speed of 3,500 feet per minute is not exceeded. It is not recommended as a permanent substitute for endless V-belts except on drives where standard belts cannot be installed.

HORSEPOWER RATINGS

The horsepower ratings for fastened Open End V-belts are approximately 30% of published horsepower ratings for Goodyear's standard multiple V-belts as shown in Goodyear's Multiple V-belt Engineering Manual (20044896).

Note: Because of differences in the stretch characteristics and variations in cross section dimensions, Open End V-belts and Endless V-belts should not be used together on multiple drives.

V-BELT

Regular Construction	Cut Lengths
A Section	A Section
B Section	B Section
C Section	C Section
D Section	

Roll Lot: Either 250' (max. 2 pcs.) or 500' (max. 3 pcs.) approx. rolls. "D" section available only in 250' (max. 2 pcs.) approx. rolls.

WATER FILLER CAP ASSEMBLY



MODEL 390 WITH 1" MNPT

The Model 390 has an automotive type radiator cap. It is supplied with a 3/16" hole in the filler neck. Two choices of radiator caps are available.

Model Number	Radiator Cap Pressure Rating
390-7	7 lb.
390-1K	15 lb.



MODEL 29508 WITH 1" MNPT

The Model 29508 has an automotive type radiator cap. It is supplied with a 1/4" OD vent tube in the filler neck. Two choices of radiator caps are available.

Model Number	Radiator Cap Pressure Rating
29508-7	7 lb.
29508-15	15 lb.

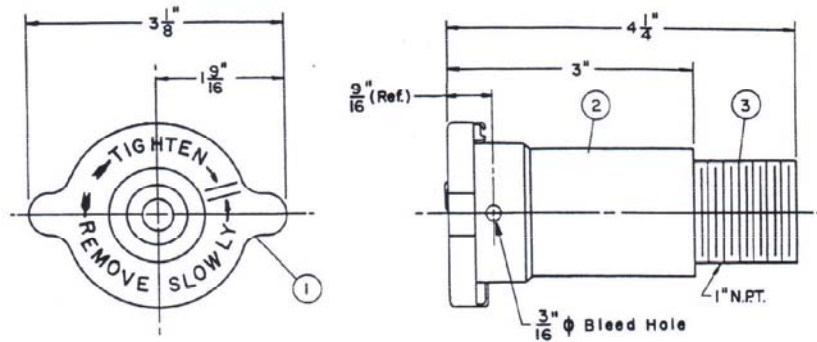


MODEL 1794 WITH 2" MNPT

The Model 1794 has a truck radiator cap. It is supplied with a 5/16" OD vent tube in the filler neck. Two choices of radiator caps are available.

Model Number	Radiator Cap Pressure Rating
1794-7	7 lb.
1794-15	15 lb.

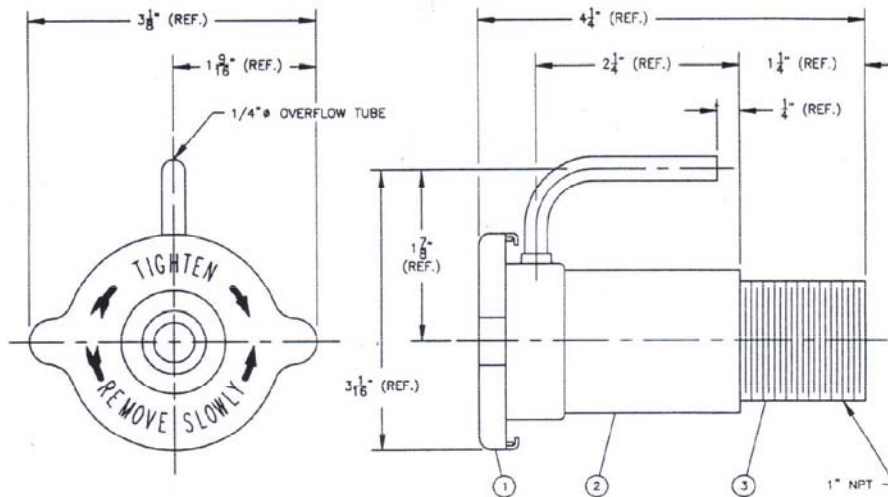
MODEL 390 FILLER CAP ASSEMBLY



REPLACEMENT RADIATOR CAP

	P/N
7#	A-3352
15#	A-733

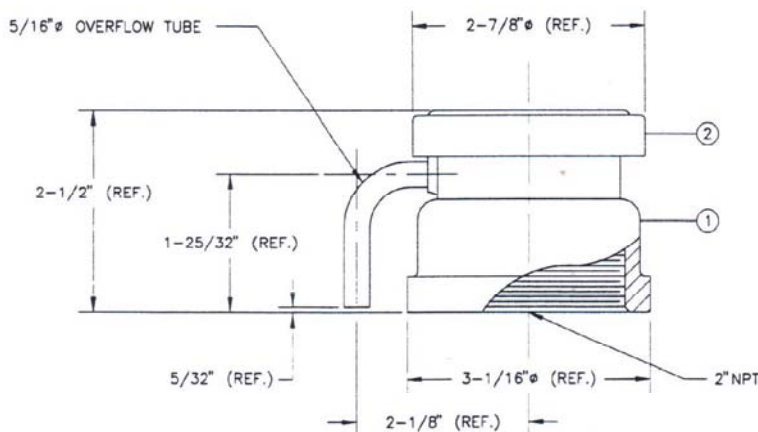
MODEL 29508 FILLER CAP ASSEMBLY



REPLACEMENT RADIATOR CAP

	P/N
7#	A-3352
15#	A-733

MODEL 1794 FILLER CAP ASSEMBLY



REPLACEMENT RADIATOR CAP

P/N

Represented by:

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 fax 504.755.1913
<http://www.kenco-eng.com>

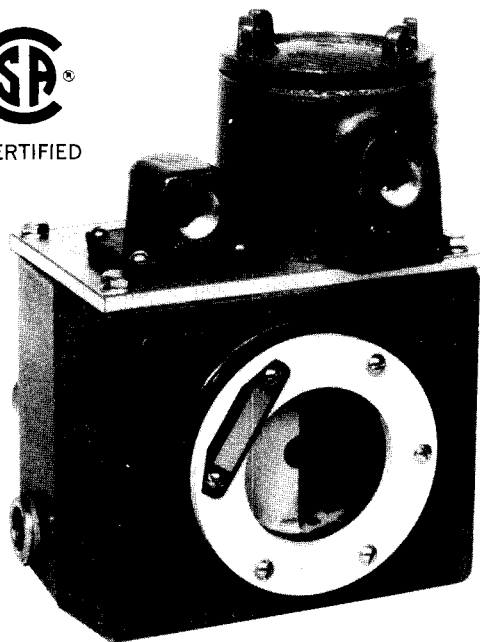


LCE OIL LEVEL CONTROLLERS WITH EXPLOSION-PROOF ELECTRIC LOW-LEVEL SAFETY SWITCHES

BULLETIN LCE
102694



CERTIFIED



MODEL LCE

DESIGN CHARACTERISTICS

Canadian Standards certified for Class 1, Division 1, Group C and D Hazardous Locations.

- 15 amp, 125 / 250 / 480V ac; 0.5 amp, 125V dc; 0.25 amp, 250V dc; 1/8 hp, 125V ac; 1/4 hp, 250V ac.
- SPDT standard.
DPDT available: NOT CSA Approved.
- High / Low Switch available.

OIL CONTROL VALVE

- Operates at inlet oil static head pressure of 1 to 15 feet.
- High Pressure Model available for 5 to 70 psi.
- Oil Inlet Housing can be rotated 360°.
- Mechanism fully removeable without draining oil.
- 1/2" NPT Inlet, 3/4" NPT Outlet.
- Visua! 1/4" thick Pyrex Sight Glass

EQUIPMENT SPECIFICATIONS

MODEL NO.	ENGINE	MODEL NO.	ENGINE
LCE	OIL CONTROLLER less MGT. BRKT.	LCE-11	OIL CONTROLLER with ADAPTER for LUBRICATOR.
LCE-1	OIL CONTROLLER with ADAPTER for CLARK MA & CFA.	LCE-14	OIL CONTROLLER with ADAPTER for WHITE COMPRESSOR.
LCE-2	OIL CONTROLLER with ADAPTER for CLARK HMB & TMP.	LCE-15	OIL CONTROLLER with ADAPTER for INGERSOLL RAND XVG & PVG.
LCE-3	OIL CONTROLLER with ADAPTER for CLARK RA, HRA, HBA, HCA, HLA, & TLA.	LCE-16	OIL CONTROLLER with ADAPTER for COOPER-BESSEMER GMV 275.
LCE-4	OIL CONTROLLER with ADAPTER for INGERSOLL-RAND SVG.	LCE-17	OIL CONTROLLER with ADAPTER for WAUKESHA VHP 6 and 12 CYLINDER GAS OR DIESEL SERVICE ENGINES.
LCE-5	OIL CONTROLLER with ADAPTER for INGERSOLL-RAND KVG & KVS.	LCE-18	OIL CONTROLLER with ADAPTER for WAUKESHA VHP "L" SERIES GAS ENGINES WITH SLOW FLOW METER MOUNTED BESIDE THE OIL CONTROLLER.
LCE-6	OIL CONTROLLER with ADAPTER for COOPER-BESSEMER GMW.	LCE-19	OIL CONTROLLER with ADAPTER for INGERSOLL-RAND ROTARY.
LCE-7	OIL CONTROLLER with ADAPTER for COOPER-BESSEMER GMV.	LCE-37	OIL CONTROLLER with ADAPTER for WAUKESHA VHP 16 CYLINDER GAS or DIESEL SERVICE ENGINES.
LCE-8	OIL CONTROLLER with ADAPTER for COOPER-BESSEMER GMX.		
LCE-9	OIL CONTROLLER with UNIVERSAL ADAPTER.		

OPTIONS

FIRE SAFE — Add FS to model number.
HIGH/LOW SWITCH — Add HL to model number.
HOSE KIT — Add K to model number

HIGH PRESSURE — 5 to 35 PSI — Add HP-A to model number.
36 to 70 PSI — Add HP-B to model number.
DOUBLE POLE, DOUBLE THROW — Add DPDT to model number.
EXAMPLE: LCE-3-FS-HP-A



INSTALLATION INSTRUCTIONS FOR LCE MODEL OIL CONTROLLERS

1. Set controller so that bullseye of sight glass corresponds to desired oil level with equipment running.
2. Connect hose or pipe from controller outlet (located on either side of controller) to crankcase.
HOSE MUST BE STRAIGHT WITHOUT KINKS OR LOOPS.
HOSE MUST HAVE DOWNWARD PITCH FROM CONTROLLER OUTLET TO ENGINE CRANKCASE.
FLOW IS BY GRAVITY.
3. Oil supply must be at least 1 foot above controller inlet.
4. Engines that operate with a vacuum in the crankcase **MUST HAVE** a pressure-equalizing line between the controller and the engine. This line must be at least $\frac{3}{8}$ " I.D. tubing. It must be installed so it is **SELF DRAINING** and **TRAP FREE**. Keep it as short as possible.
5. **CAUTION** Clean slag and metal chips from oil reservoir before connecting hose to controller.
6. The electrical connection on the LCE series is a micro switch, which is located in the conduit housing. The micro switch is single-pole, double-throw. The electrical rating is 15 amp, 125/250/480V ac; 0.5 amp, 125V dc; 0.25 amp, 250V dc; $\frac{1}{8}$ hp, 125V ac; $\frac{1}{4}$ hp, 250V ac.

OPERATING AND MAINTENANCE INSTRUCTIONS FOR LCE OIL LEVEL CONTROLLERS

1. OIL VALVE:

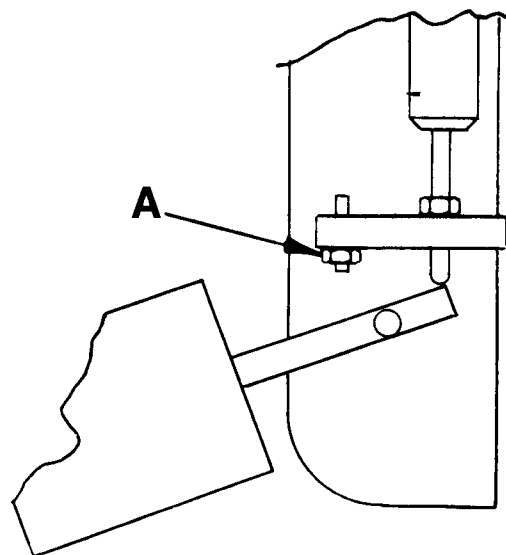
The oil valve is designed to hold the oil level near the center of the gauge glass. Failure of the oil valve to hold correct level can be caused by:

- A) Excessive inlet oil pressure, which will cause the unit to overfill.
- B) Improper equalizing lines between the controller and the crankcase.

2. ELECTRIC SWITCH ADJUSTMENT:

The operating position of the micro switch can be changed by backing out or turning in the adjustment screw located under the conduit cover as shown on the replacement parts diagram.

On High-Low Model: Adjust Screw #A to change high-level action. The standard setting of the switch action is $\frac{3}{4}$ " to $\frac{7}{8}$ " increase or decrease in level.



**OWNER'S (OPERATOR'S) MANUAL
AND SAFETY INSTRUCTIONS
FOR CF SERIES CHAIN HOIST (MODEL CF4)**

BEFORE USING THIS PRODUCT :

ALWAYS SAVE THIS BOOK FOR FUTURE REFERENCE

ALWAYS READ OWNER'S (OPERATOR'S) MANUAL AND SAFETY INSTRUCTIONS

- ⚠ WARNING** : **IMPROPER** chain hoist use could result in death or serious injury. To avoid these hazards:
- : **NEVER** hoist loads over or near people.
 - : **NEVER** work under or near hoisted loads.
 - : **ALWAYS** operate, inspect and maintain this hoist in accordance with applicable safety codes and regulations.

These safety instructions contain important information to help you use the chain hoist in a safe manner. Please refer to this Owner's (Operator's) Manual for additional safety information.

CONTENTS

DEFINITION	1
1. BEFORE USE	1
1.1 Safety Summary	1
1.2 Safety Instructions	2
2. MAIN SPECIFICATIONS	5
3. OPERATION	6
3.1 Safety Consideration	6
3.2 Operation	6
3.3 Hoist Storage	6
4. INSPECTION	7
4.1 Outline	7
4.2 Daily Inspection	7
4.3 Periodic Inspection	8
5. MAINTENANCE	13
5.1 Lubrication	13
5.2 Overhaul, Assembly and Adjustment	14
6. WARRANTY	21
7. PARTS LIST	22

DEFINITION

⚠ WARNING : indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

1. BEFORE USE

1.1 Safety Summary

Danger exists when heavy loads are transported, particularly when the equipment is not being used properly or is poorly maintained. Because accidents and serious injury could result, special safety precautions apply to the operation, maintenance and inspection of the Manual Chain Hoist.

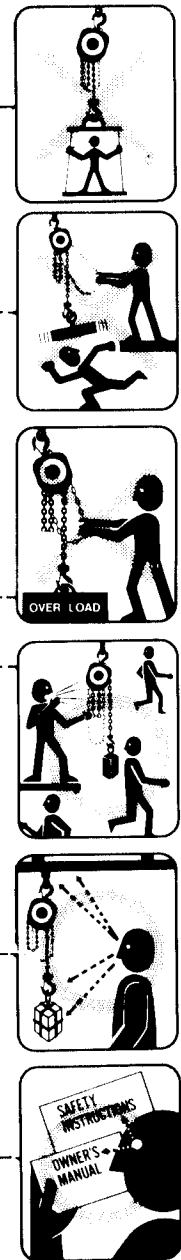
Following these simple rules can help to avoid hoisting accidents;

⚠ WARNING : **IMPROPER chain hoist use could result in death or serious injury. To avoid these hazards:**

- NEVER** use a hoist for lifting, supporting or transporting people.
- NEVER** lift or transport loads over or near people.
- NEVER** work near or under hoisted loads.
- NEVER** lift more than rated load.
- ALWAYS** let people around you know when a lift is about to begin.
- ALWAYS** make sure that the supporting structures and load-attaching device are strong enough to hold the weight of the load and hoist.
- ALWAYS** read Owner's (Operator's) manual and safety instructions.

Remember, proper rigging and lifting techniques are the responsibility of the operator. Be sure to read and understand the instructions contained in this manual before using your hoist. Check all applicable safety codes, regulations and other applicable laws for further information about the safe use of your hoist.

More detailed safety information is contained in the following pages. For additional information, please contact Kito Corporation or your authorized Kito dealer.



1.2 Safety Instructions

Serious injury could result if the following safety instructions are not followed.

⚠ WARNING : **IMPROPER chain hoist use could result in death or serious injury. To avoid these hazards:**

“ALWAYSs”

- ALWAYS** make sure that you and others are clear of the load before lifting begins.
- ALWAYS** allow only qualified (trained in safety and operation) people to operate the hoist.
- ALWAYS** operate a hoist only if you are physically fit.
- ALWAYS** check the hoist before daily use according to the Recommended Daily Inspection (Refer to Sec. 4.2).
- ALWAYS** let the authorized personnel inspect the hoist periodically (Refer to Sec. 4.3).
- ALWAYS** make sure that the chain length is long enough for the intended job.
- ALWAYS** check that the hook latches are in proper working order before use (Refer to Sec. 4.3).
- ALWAYS** replace all missing or broken hook latches.
- ALWAYS** be sure that the hoist's rated capacity, which is found on the hoist's label, is well in excess of the weight of the load.
- ALWAYS** be sure that the load is properly seated in the saddle of the hook.
- ALWAYS** keep the load from hitting the chain.
- ALWAYS** use two hoists which have rated capacities equal to or more than the load to be lifted whenever you must use two hoists to lift a load. This will provide adequate protection in the event that a sudden load shift or failure of one hoist occurs.
- ALWAYS** check the brake before use (Refer to Sec. 4.3).
- ALWAYS** check for loose or missing parts before use.
- ALWAYS** lubricate the hoist regularly (Refer to Sec. 5.1).
- ALWAYS** pay attention to the load at all times when operating the hoist.
- ALWAYS** ease the slack out of the chain and sling when starting a lift to prevent a sudden loading.

ALWAYS secure a hoist and loads properly after use.

ALWAYS consult the manufacturer or your dealer if you plan to use a hoist in a dusty, moist or greasy environment.

ALWAYS consult the manufacturer or your dealer if you plan to use a hoist in an excessively corrosive environment.

ALWAYS operate the hoist with manual power.

⚠ WARNING : **IMPROPER chain hoist use could result in death or serious injury. To avoid these hazards:**

“NEVERs”

NEVER use the hoist to transport people.

NEVER lift a load over people.

NEVER work near or under hoisted loads.

NEVER operate a hoist if damaged or malfunctioning.

NEVER use a hoist which has been taken out of service until the hoist has been properly repaired or replaced.

NEVER use a hoist if the hook latch is missing or broken.

NEVER lift a load unless it is directly under the hook.

NEVER splice a hoist chain.

NEVER use non-authentic KITO chains on the hoist.

NEVER use the hoist chain as a sling.

NEVER force a chain or hook into place by hammering.

NEVER jerk a load to prevent a sudden loading.

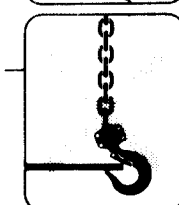
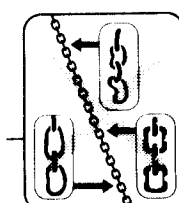
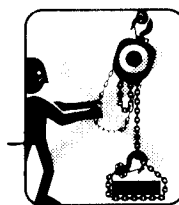
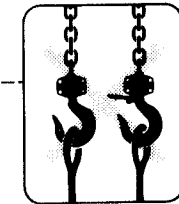
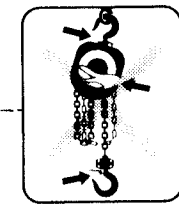
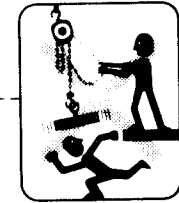
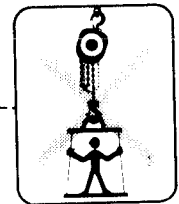
NEVER use a twisted, kinked, damaged or stretched load chain.

NEVER swing a suspended load.

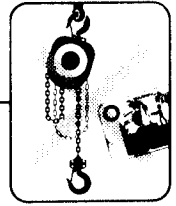
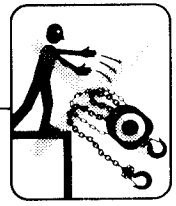
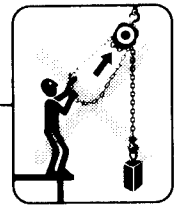
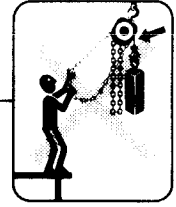
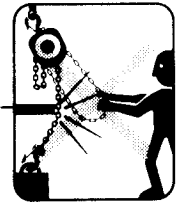
NEVER support a load on the tip of the hook.

NEVER suspend a load for an extended period of time.

NEVER leave a suspended load unattended.



- NEVER** run the load chain over a sharp edge. -----
- NEVER** weld or cut a load suspended by a hoist.
- NEVER** use the hoist chain as a welding electrode.
- NEVER** use the hoist with rusty chain.
- NEVER** wind so far that the hook touches the block.-----
- NEVER** unwind so far that no unloaded chain is left.-----
- NEVER** operate a hoist if chain jumping, excessive noise, jamming, overloading or binding occurs.
- NEVER** use a hoist without chain stopper (or tail pin) at the end of no load side chain.
- NEVER** throw a hoist.-----
- NEVER** use a hoist without a name plate or warning tag and label or with illegible name plate, warning tag and label.
- NEVER** remove or obscure the warning tag. -----
- NEVER** use modified or deformed hooks.
- NEVER** use a motor to operate a manual hoist.
- NEVER** use a hoist near fire or where hot objects may touch it.
- NEVER** use the hoist in temperature below -20°C (-4°F) or above $+60^{\circ}\text{C}$ ($+140^{\circ}\text{F}$).

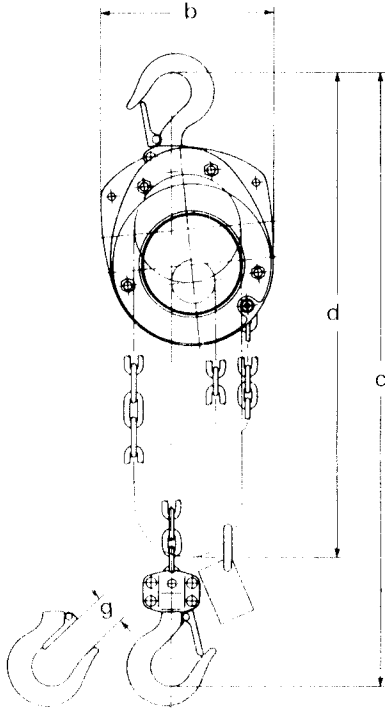


WARNING TAG is installed on a hand chain.

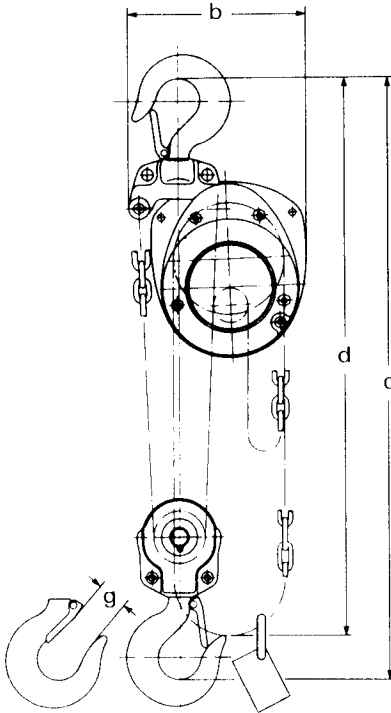
2. MAIN SPECIFICATIONS

Unit system is the metric one (SI unit system) in the following table.

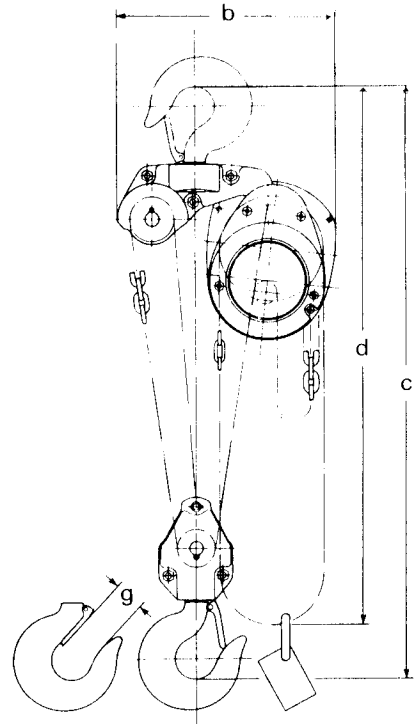
1/2 to 1 1/2 t



2 to 3 t



5 t



Model	Code	Nominal Capacity (t)	Std. Lift (mm)	Min. Distance between Hooks; C (mm)	Chain Pull to Lift Full Load (kg)	Chain O'hauled to Lift Load One Meter (m)	Test Load (kg)	Net Weight (kg)	Shipping Weight (Approx) (kg)	Load chain Dia (mm) × Fall(lines)	Weight in kg for Additional One Meter of Lift (kg)	b (mm)	d (mm)	g (mm)
CF1	CF005	1/2	250	325	30	19	750	10	11	5.0 × 1	1.5	150	2.5	27
CF1	CF010	1	250	370	36	31	1500	12	13	6.3 × 1	1.8	174	2.5	29
CF1	CF015	1 1/2	250	440	42	41	2360	17	18	7.1 × 1	2.1	203	2.5	34
CF1	CF020	2	300	510	40	63	3000	21	22	6.3 × 2	2.7	204	3.0	36
CF1	CF030	3	300	590	46	81	4750	28	30	7.1 × 2	3.2	240	3.0	42.5
CF1	CF050	5	300	620	46	134	6300	37	39	7.1 × 3	4.3	342	3.0	46.5

- Any lift of chain is available on request. Because KITO chains are specially heat-treated, only authentic KITO chains should be used on your hoist. **Never** attempt to lengthen your chain by attaching additional chain links with any other means. KITO can supply almost any length of chain desired. Simply specify the length of chain desired when ordering.

3. OPERATION

3.1 Safety Consideration

⚠ WARNING : **IMPROPER operation could result in death or serious injury. To avoid these hazards, only operate the chain hoist by hand. Power operation may result in structural damage or premature wear. This damage or wear may cause a part to break and cause the load to fall.**

3.2 Operation

1. Face the hand chain wheel side of the hoist.
2. To raise the load, pull hand chain clockwise.
3. To lower the load, pull hand chain counterclockwise.

NOTE: The clicking sound of the pawl when a load is being raised indicates normal operation.

3.3 Hoist Storage

⚠ WARNING : **IMPROPER chain hoist use could result in death or serious injury. To avoid these hazards:**

ALWAYS store the hoist in no load condition.

ALWAYS wipe off all dirt and water.

ALWAYS oil the chain, top pin, chain pin and hook latches.

ALWAYS hang in a dry place.

ALWAYS check the hoist for abnormalities when using the hoist after a period of non-use according to the regular inspection procedures (Refer to Sec.4.3).

4. INSPECTION

4.1 Outline

There are two types of inspection, the daily inspection performed by the operator while using the hoist, and the more thorough periodic inspections performed by qualified personnel who have the authority to remove the unit from service.

4.2 Daily Inspection

Before each work shift, check the following points:

- (1) Check that the name plate showing the hoist capacity is attached and clearly legible.
- (2) Check that the warning tag and label are attached and clearly legible.
- (3) Check for visual defects or abnormal noises which could indicate a defect.
- (4) Check that the upper and lower hook latches are in place and in proper condition.
- (5) Make sure the openings of the top and bottom hooks are not too wide, that the swivel rotates freely and that the hook latch is in position and works normally.
- (6) Check for wear or damage, increased throat width, bent shank or bending of hook.
- (7) Check that the chain does not have excessive rust or corrosion and that it is not dry due to lack of lubricant.
- (8) When facing the hand chain side of the hoist with no load : The brake is operating normally if the pawl “clicks” when the hand chain is wound in a clockwise direction and does not “click” when operated in the counterclockwise direction.
- (9) Check lubrication and lubricate if necessary (Refer to Sec.5.1).
- (10) Check that the chain is assembled normally and that there is no twisting.
- (11) Check for loose or missing nuts and for missing split pins.

4.3 Periodic Inspection

Periodic inspections should be made at the interval shown below and should follow the given procedures.

NORMAL (Normal use): Semiannual inspection
 HEAVY (Frequent use): Quarterly inspection
 SEVERE (Excessively frequent use): Monthly inspection

<Regular Inspection Procedure>

Figures in parentheses are Figure Nos. in Parts List.

Item	Inspection Method	Discard Limit/Criteria	Measures
Indications	Check visually.	○ Capacity indication is clear.	Attach the name plate.
HOOK [1,4,44,56,66,75] (Top and Bottom)			
1. Deformation/ twist of hook opening	Measure dimension “e” between two embossed marks at time of purchase with calipers. Check visually.	○ No deformation from original shape (at time of purchase). ○ Twist shall not be large enough to detect visually.	Replace the hook. Replace the hook.
2. Wear	Measure “c” and “d” with slide cali- pers.	○ Never use the hook if dimension “c” or “d” becomes less than 90% of normal.	Replace the hook.

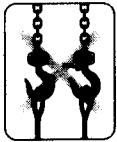
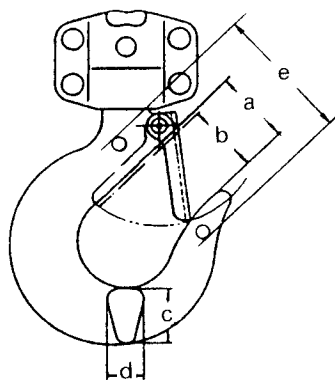
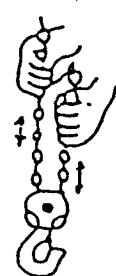
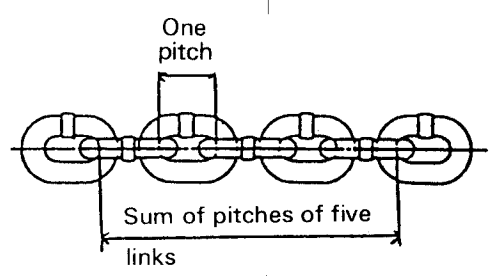


Table 1
(Reference dimensions)



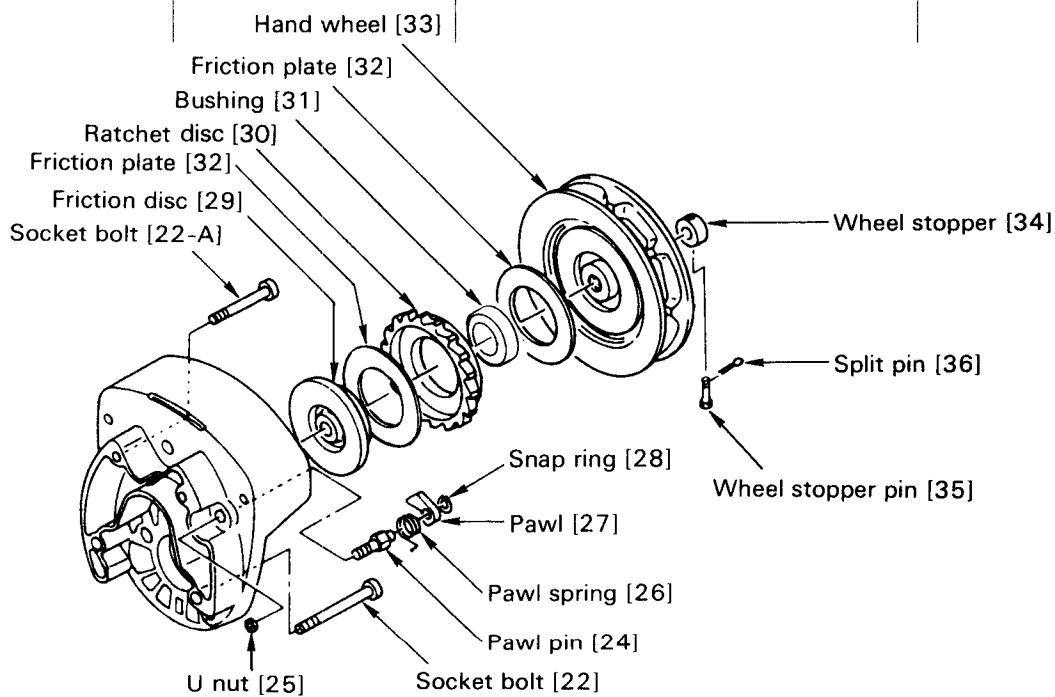
Type (t)	a (mm)		b (mm)		c (mm)		d (mm)	
	Normal	Normal	Normal	Discard	Normal	Discard	Normal	Discard
½	31.0	27.0	17.0	15.3	12.1	10.9		
1	34.0	29.0	21.8	19.6	16.0	14.4		
1½	37.5	34.0	26.5	23.9	19.5	17.6		
2	40.0	36.0	30.0	27.0	21.8	19.6		
3	46.0	42.5	37.5	33.8	27.2	24.5		
5	50.0	46.5	47.5	42.8	34.5	31.1		

Item	Inspection Method	Discard Limit/Criteria	Measures												
3. Hook flaws	Check visually.	○ No great damage permitted.	Replace the hook.												
4. Hook movement	Turn hook.	○ Shall turn smoothly.	Replace the hook.												
5. Upper/lower fixture damage [Fittings of 1,4,44,56,66,75]	Check visually.	○ No slack or missing rivets, nuts or bolts.	Replace the hook.												
6. Idle sheave rotation [55,61,70]	Hold the load chain with both hands and turn the idle sheave by moving the chain up and down.	○ Smooth rotation.	Overhaul.												
7. Hook latch [2,6,45,57,67,76]	Check visually.	○ Proper positioning and smooth working.	Replace the latch or hook.												
															
LOAD CHAIN [42] 1. Wear	Measure with slide calipers.	○ Measure the sum of pitches of five chain links and check that the maximum length does not exceed value shown in table 2.	Replace the chain.												
															
Table 2															
<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th>Type (t)</th> <th>Sum of pitches of five links (mm)</th> <th>Discard limit (mm)</th> </tr> </thead> <tbody> <tr> <td>½</td> <td>75.5</td> <td>77.7</td> </tr> <tr> <td>1, 2</td> <td>95.5</td> <td>98.3</td> </tr> <tr> <td>1½, 3, 5</td> <td>106.0</td> <td>109.1</td> </tr> </tbody> </table>				Type (t)	Sum of pitches of five links (mm)	Discard limit (mm)	½	75.5	77.7	1, 2	95.5	98.3	1½, 3, 5	106.0	109.1
Type (t)	Sum of pitches of five links (mm)	Discard limit (mm)													
½	75.5	77.7													
1, 2	95.5	98.3													
1½, 3, 5	106.0	109.1													
2. Rust, flaws, deformation	Check visually.	○ No obvious rust (Apply oil as necessary.) ○ No twists or harmful flaws.	Remove rust. Replace the load chain.												
HOOK YOKE (Top set [1,44,66] Bottom set [4,56,75]) Joint of upper/lower fixtures with top pin [3] and chain pin [7,46]	Measure hole diameter of joint area in two directions at right angle.	○ Deformation not permitted (if each measured value differs more than 0.5mm, it is not a circle).	Replace the part.												

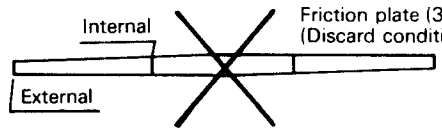
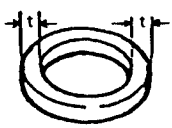
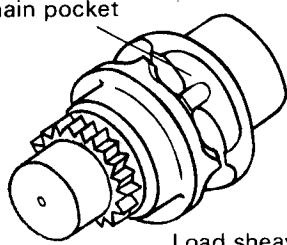
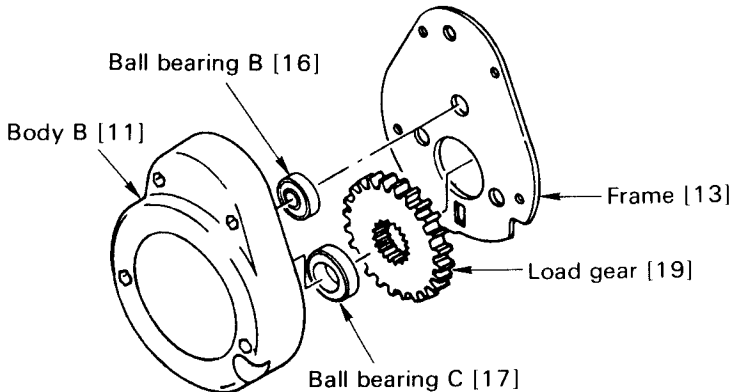
Item	Inspection Method	Discard Limit/Criteria	Measures
FUNCTION 1. Lifting and lowering 2. Brake	Lift and lower a light load.	<ul style="list-style-type: none"> ○ No abnormal difficulty in lifting or lowering. ○ Confirm that none of the problems listed below occur during lifting and lowering: <ul style="list-style-type: none"> • Lifting impossible. • Load falls when the operator removes his hands. • Load fall during unwinding. • Load slips down slowly. 	Overhaul and service. Overhaul and service.

BRAKE
(Inside mechanism)

Overhaul and check.



1. Flaws on brake surface [31,31-A,32]	Check visually.	○ No flaws due to scratching or gouging by foreign matter.	Replace the part.
2. Flaws on friction disc [29]	Check visually.	○ No flaws due to scratching or gouging by foreign matter.	Replace the part.
3. Wear on friction plate [32]	Measure with slide calipers.	○ Retain uniform thickness and friction plate shall not be worn more than 0.5mm. For all types; Normal thickness: 3 mm Discard limit: 2.5 mm	Replace the part.

Item	Inspection Method	Discard Limit/Criteria	Measures									
4. Flatness of friction plate [32]	Check clearance with straight gauge.	<ul style="list-style-type: none"> ○ Clearance shall be uniform. Internal part shall not be thicker than external part. 	Replace the part.									
5. Bushing [31]; wear and oil	Check radial thickness (t) with caliper and oil existence.  Bushing [31] t: Radial thickness	<ul style="list-style-type: none"> ○ Radial thickness (t) shall be uniform. Oil shall be contained. Refer to table 3. <p style="text-align: center;">Table 3</p> <table border="1"> <thead> <tr> <th>Type (t)</th> <th>Normal thickness (t) (mm)</th> <th>Discard limit (mm)</th> </tr> </thead> <tbody> <tr> <td>½</td> <td>3</td> <td>2</td> </tr> <tr> <td>1, 1½, 2, 3, 5</td> <td>4</td> <td>3</td> </tr> </tbody> </table>	Type (t)	Normal thickness (t) (mm)	Discard limit (mm)	½	3	2	1, 1½, 2, 3, 5	4	3	Replace the part.
Type (t)	Normal thickness (t) (mm)	Discard limit (mm)										
½	3	2										
1, 1½, 2, 3, 5	4	3										
6. Ratchet disc [30]; wear and rust	Check visually.	<ul style="list-style-type: none"> ○ The tooth wear shall not be more than 1.5 mm. ○ No rust. 	Replace the part.									
LIFTING SYSTEM												
1. Load sheave [18]; wear and deformation	Check visually.  Load sheave [18]	<ul style="list-style-type: none"> ○ No large wear, no deformation, or no burr due to load chain contact is permitted on the surface of load chain pocket. 	Replace the part.									
2. Gear [19]; wear and flaw	Check visually. 	<ul style="list-style-type: none"> ○ Teeth shall be free from large wear or flaws. 	Replace the part.									

Item	Inspection Method	Discard Limit/Criteria	Measures
3. Hand wheel [33]; wear and deformation	Check visually.	<ul style="list-style-type: none"> ○ No large wear or no deformation on the surface of hand chain pocket. ○ Turn and check if it touches the cover. 	<p>Replace the part.</p> <p>Replace the part.</p>
FRAME [13] 1. Flaw on frame	Check visually.	<ul style="list-style-type: none"> ○ No flaws or cracks. 	Replace the frame.
MISCELLANEOUS 1. Wear on chain guide [20] 2. Flaw on guide roller [20-A] 3. Deformation of stripper [21]	<p>Check visually.</p> <p>Check visually.</p> <p>Check visually.</p>	<ul style="list-style-type: none"> ○ No excessive wear or press mark is permitted. ○ Shall turn lightly. ○ No large crush or damage on stripper tip is permitted. 	<p>Replace the part.</p> <p>Replace the part.</p> <p>Replace the part.</p>

5. MAINTENANCE

⚠ WARNING : **IMPROPER chain hoist use could result in death or serious injury. To avoid these hazards:**

- : **NEVER perform maintenance on the hoist while it is supporting a load.**
- : **Before performing maintenance, attach the tag:
[“DANGER”: DO NOT OPERATE EQUIPMENT BEING REPAIRED.]**
- : **Only allow qualified service personnel to perform maintenance.**
- : **After performing any maintenance on the hoist, always test to its rated capacity before returning to service.**

5.1 Lubrication

5.1.1 Applying Grease to Gears

Remove body B (11), in the way of '5.2 Overhaul'.

Remove old grease and replace with new grease (standard grease*), at annual inspection.

Temperature range of standard grease is -20°C (-4°F) to $+60^{\circ}\text{C}$ (140°F). If the hoist is used at temperature below -20°C (-4°F) or above $+60^{\circ}\text{C}$ (140°F), consult the manufacturer or dealer since some parts shall be changed.

*Calcium soap grease equivalent of NLGI (National Lubricating Grease Institute)/#2

5.1.2. Load Chain

⚠ WARNING : **IMPROPER chain hoist use could result in death or serious injury. To avoid these hazards:**

- : **Failure to maintain clean and well lubricated load chain will void the manufacturer's warranty.**

ALWAYS lubricate load chain weekly, or more frequently, depending on severity of service.

ALWAYS lubricate more frequently than normal in a corrosive environment.*

ALWAYS use machine oil equivalent to ISO VG46 or 68.

ALWAYS clean chain with an acid free solvent only to remove rust or abrasive dust build-up. After cleaning, lubricate the chain.

ALWAYS lubricate each link of the chain and apply new lubricant over existing layer.

*KITO has a corrosion-resistant chain as an option. For information on the capabilities and limitations of KITO's regular and corrosion-resistant chain, please ask your dealer.

5.2 Overhaul, Assembly and Adjustment

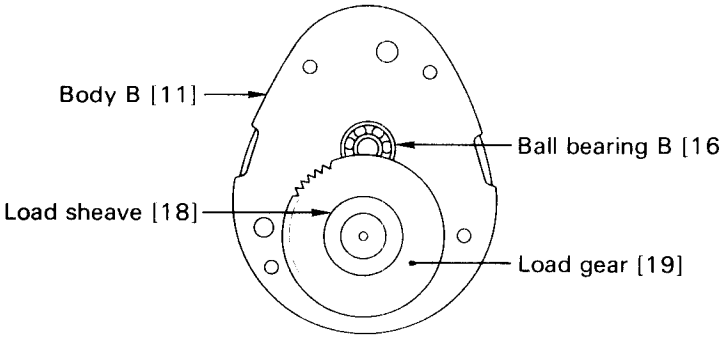
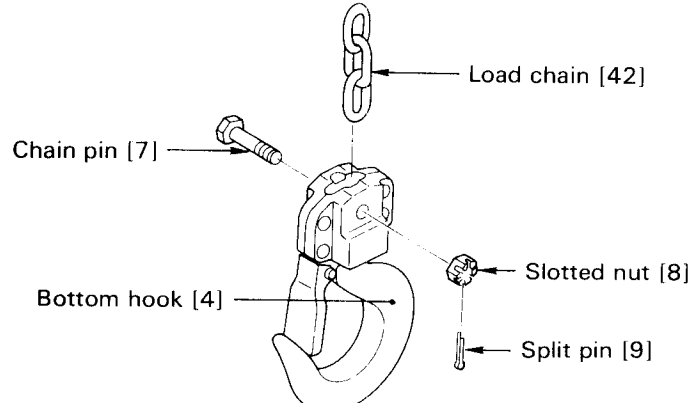
5.2.1 Overhaul

Figures in parentheses are Figure Nos. in Parts List.

Overhaul Procedures	Remarks
1. Put a hoist with wheel cover side up.	
2. Unscrew three screws [38] (with spring washers [39]) fixing the wheel cover [37].	
3. Remove the wheel cover [37] from the body A [10].	
4. Insert the vertical link of the hand chain [43] into the notch of the hand wheel [33] and remove the hand chain by turning the hand wheel counterclockwise.	Bring the notch of the hand wheel to the right hand.
5. Pull out split pin [36] from the wheel stopper pin [35] and remove the wheel stopper pin and wheel stopper [34] from the pinion [14].	
6. Remove hand wheel [33] from the pinion [14] by turning the hand wheel counterclockwise.	If the hand wheel is too tight to turn by hand, put hand chain on the hand wheel back again and pull it down hard. It will release the brake.
7. Remove two friction plates [32], ratchet disc [30] and bushing [31] from the friction disc [29].	
8. Remove the friction disc [29] from the pinion [14] by turning counterclockwise holding the end of the pinion with fingers.	
9. Remove snap ring [28] from the pawl pin [24] (on the body A [10]) and then remove pawl [27] and pawl spring [26].	
10. Unscrew the pawl pin [24].	The pawl pin is fixed with the U nut [25].
11. Unscrew four socket bolts [22, 22-A] connecting body A [10] and B [11].	Four socket bolts are fixed with U nuts [23] on the body B side.

Overhaul Procedures	Remarks
<p>12. Separate the body A [10] and B [11].</p> <p>13. Take ball bearing A [15] and C [17-A] out of the body A [10].</p> <p>14. Remove top hook [1] and top pin [3] from the body B [11].</p> <p>15. Remove pinion [14], chain guide [20] (or guide rollers [20-A]), stripper [21], tail pin [40], and load chain [42].</p> <p>16. Remove the frame [13].</p> <p>17. Take load sheave [18] out of the load gear [19].</p> <p>18. Remove the load gear [19].</p> <p>19. Unscrew tap socket bolt [41] from the body B [11].</p> <p>20. Pull split pin [9] out of the slotted nut [8] and remove the slotted nut and chain pin [7] from the bottom hook [4].</p>	<p>Remove the bearing by tapping the ball bearing A and C with a wooden hammer from the brake side.</p>

5.2.2 Assembly and Adjustment

Assembly Procedures	Remarks
<ol style="list-style-type: none"> 1. Wipe off old grease from the body B [11] and frame [13]. 2. Apply new grease to the ball bearing B [16] and C [17] on the body B [11]. 3. Insert load sheave [18] into the load gear [19] and put them together on the ball bearing C [17]. 	
	
<ol style="list-style-type: none"> 4. Apply new grease to the load gear [19]. 5. Put frame [13] on the body B [11] according to pattern. 6. Insert the end of the load chain [42] to the bottom hook [4] and fix them with the chain pin [7], slotted nut [8] and split pin [9]. 	<p>⚠ WARNING Always bend surely the split pin.</p>
	

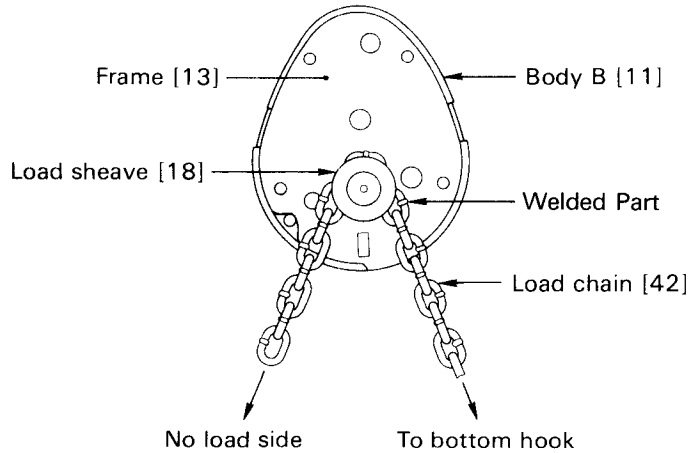
Assembly Procedures

Remarks

7. Wind load chain [42] round the load sheave [18] so that the bottom hook side comes to right hand and the end link of the other side becomes vertical to the load sheave pocket.

⚠ WARNING

Put the welded part of the vertical chain link outward.

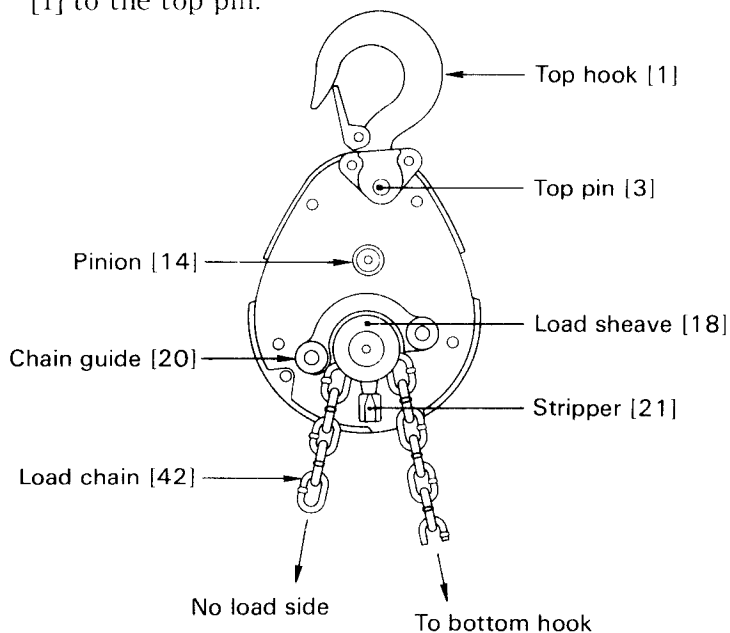


8. Put chain guide [20] (or guide rollers for ½ t type [20-A]) on the frame [13].

⚠ WARNING

Fit the larger boss of chain guide [20] into holes on frame [13].

9. Put stripper [21] on the frame [13].
10. Insert pinion [14] shaft from its gear side into the frame [13].
11. Insert top pin [3] into the frame [13] and put top hook [1] to the top pin.



Assembly Procedures

Remarks

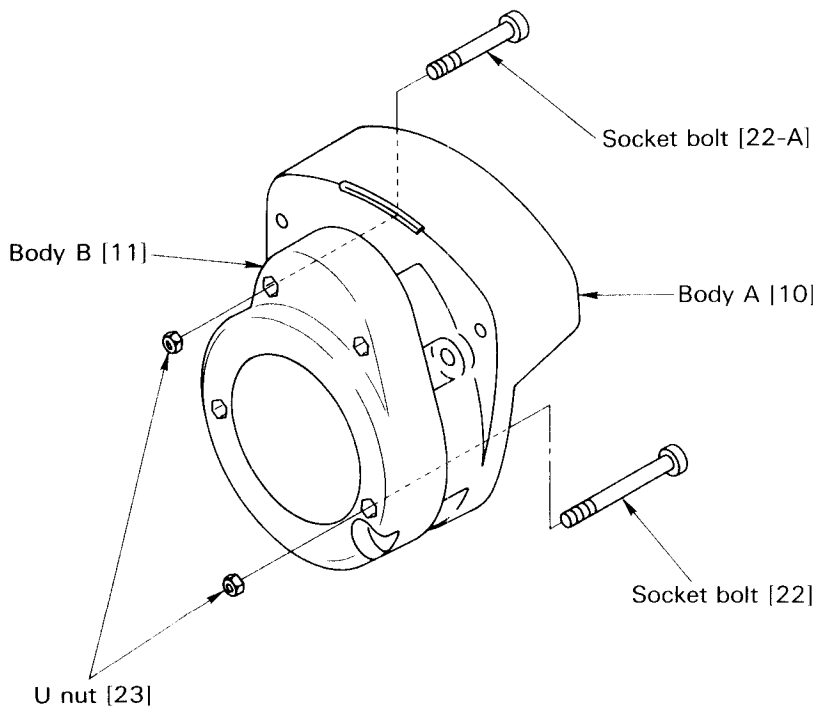
12. Grease ball bearing A [15] and insert it into the body A [10].
13. Put the body A [10] with the ball bearings [15,17-A] side down on the body B [11].
14. Insert four socket bolts [22,22-A] into the body A [10] and turn the whole body sideways. Then fix the bolts with the U nuts [23] holding the U nuts with fingers.

⚠ WARNING

Make sure each part is completely set between body A [10] and frame [13].

⚠ WARNING

Insert short socket bolts [22-A] to the upper holes and long socket bolts [22] to the lower holes.



15. Insert pawl pin [24] into the body A [10] and fix it with the U nut [25].
16. Apply machine oil to the pawl pin [24] and join pawl spring [26] and the pawl [27] respectively to it. Fix the pawl with snap ring [28].

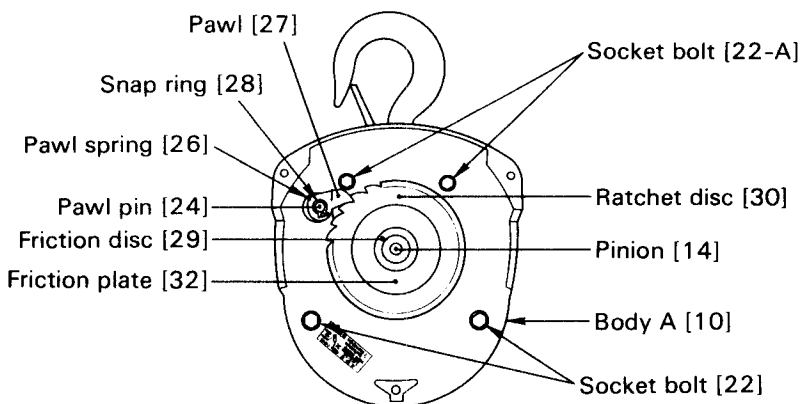
⚠ WARNING

Make sure the pawl spring is fixed to the pawl and the snap ring is securely set at the groove of the pawl pin.

Assembly Procedures

Remarks

17. Put friction disc [29] to the pinion [14].
18. Wipe out any dirt on the friction disc [29], friction plates [32] and both sides of the ratchet disc [30] and check that bushing [31] contains oil soaked inside. Then place the friction plate, bushing, ratchet disc (while turning the pawl [27] counterclockwise) and friction plate respectively on the friction disc. (Make sure that the pawl meshes with the ratchet disc properly.)



19. Wipe out the dirt of the hand wheel [33] and apply machine oil to the threaded part of it. Screw it in the pinion [14] shaft all the way down.
20. Place wheel stopper [34] to the head of the pinion [14], insert wheel stopper pin [35] and fix it with a split pin [36].

⚠ WARNING

Never apply oil since the brake is “dry system”. Wipe out thoroughly any oil and dirt on the brake. The gear of the ratchet disc shall point at the pawl. Otherwise, the hand wheel cannot be assembled later.

In case the bushing does not have oil inside, soak it in tarbin oil for a day. Install it in without wiping the oil. Make sure that the pawl meshes with the ratchet disc properly.

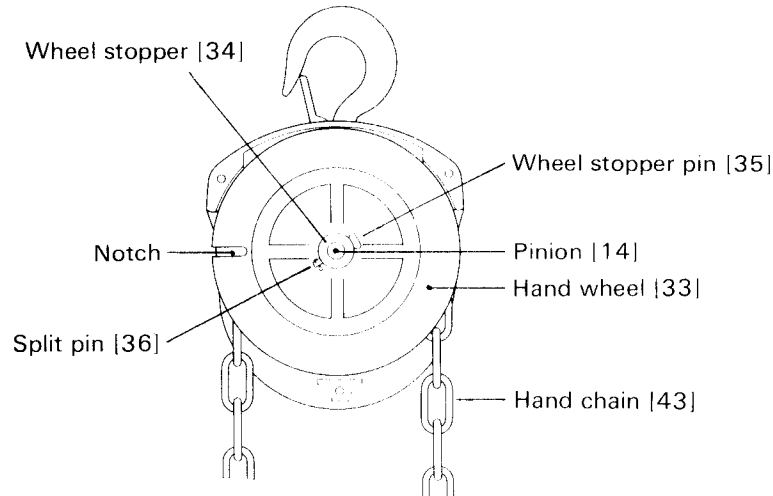
⚠ WARNING

Never forget to bend the split pin after inserting into the wheel stopper pin.

Assembly Procedures

Remarks

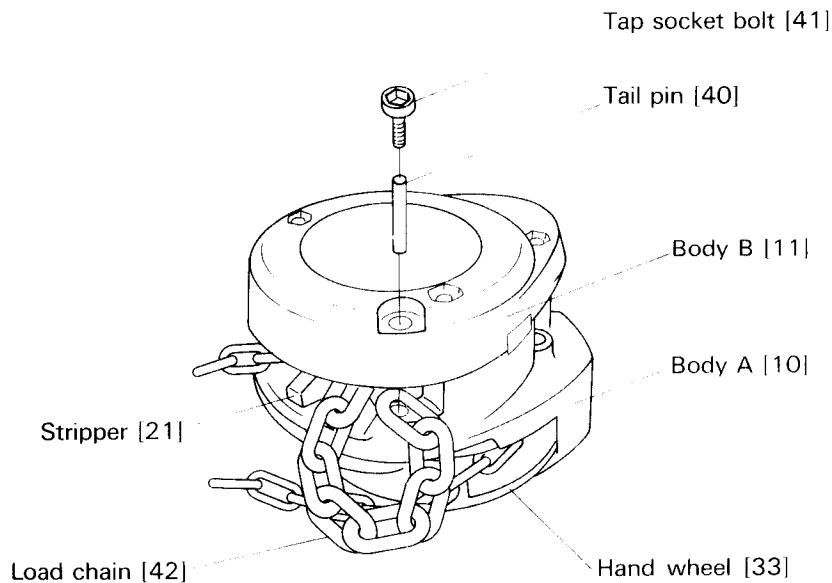
21. Set the notch of the hand wheel to the left hand. Insert the vertical link of the hand chain [43] into the notch of the hand wheel [33] and reeve the hand chain by turning the hand wheel clockwise.



22. Put wheel cover [37] on the body A [10] and fix them with the spring washers [39] and screws [38].
23. Put a hoist with body B [11] side up. Place the slack end of the load chain between body A [10] and body B [11]. Then insert tail pin [40], and screw tap socket bolt [41] into the body B.

⚠ WARNING

Make sure the load chain is not twisted.



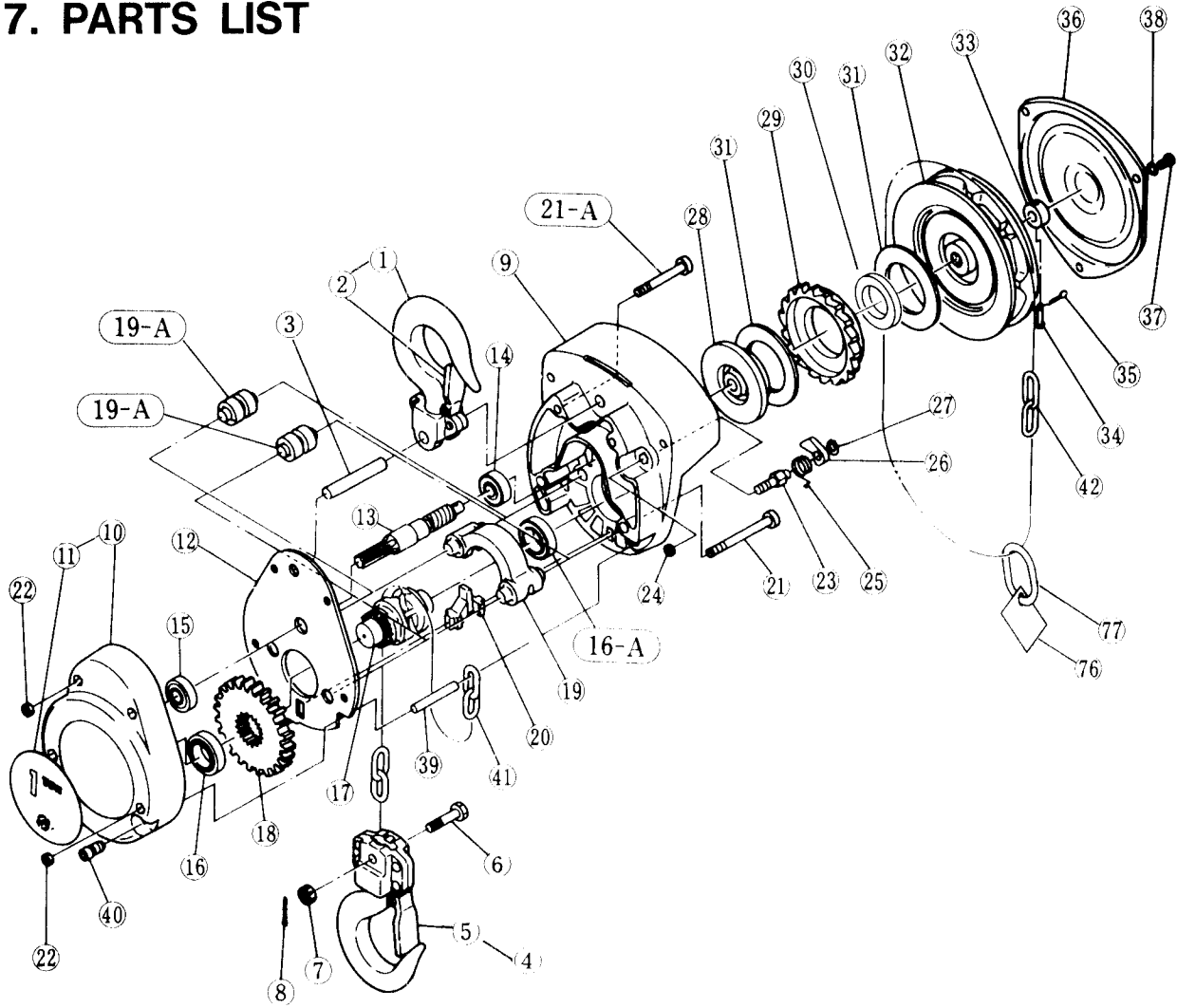
6. WARRANTY

Kito Corporation (“Kito”) extends the following warranty to the original purchaser (“Purchaser”) of new products manufactured by “Kito” (Kito’s Products).

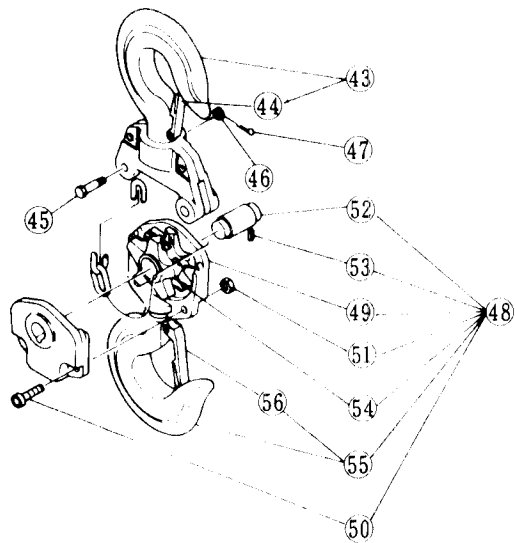
- (1) “Kito” warrants that Kito’s Products, when shipped, shall be free from defects in workmanship and/or materials under normal use and service and “Kito” shall, at the election of “Kito”, repair or replace free of charge any parts or items which are proven to have said defects, provided that all claims for defects under this warranty shall be made in writing immediately upon discovery and, in any event, within one (1) year from the date of purchase of Kito’s Products by “Purchaser” and provided, further, that defective parts or items shall be kept for examination by “Kito” or its authorized agents or returned to Kito’s factory or authorized service center upon request by “Kito”.
- (2) “Kito” does not warrant components of Products provided by other manufacturers. However to the extent possible, “Kito” will assign to “Purchaser” applicable warranties of such other manufacturers.
- (3) Except for the repair or replacement mentioned in (1) above which is “Kito”’s sole liability and purchaser’s exclusive remedy under this warranty. “Kito” shall not be responsible for any other claims arising out of the purchase and use of Kito’s Products, regardless of whether “Purchaser”’s claims are based on breach of contract, tort or other theories, including claims for any damages whether direct, indirect, incidental or consequential.
- (4) This warranty is conditional upon the installation, maintenance and use of Kito’s Products pursuant to the product manuals prepared in accordance with content instructions by “Kito”. This warranty shall not apply to Kito’s Products which have been subject to negligence, misuse, abuse, misapplication or any improper use or combination or improper fittings, alignment or maintenance.
- (5) “Kito” shall not be responsible for any loss damage caused by transportation, prolonged or improper storage or normal wear and tear of Kito’s Products or for loss of operating time.
- (6) This warranty shall not apply to Kito’s Products which have been fitted with or repaired with parts, components or items not supplied or approved by “Kito” or which have been modified or altered.

THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY WARRANTY OF MERCHANTABILITY OR OF FITNESS FOR A PARTICULAR PURPOSE.

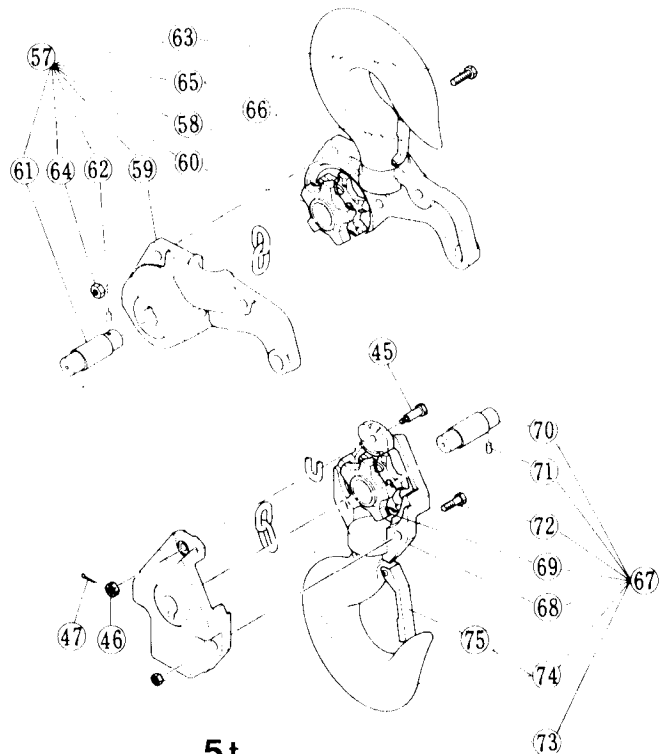
7. PARTS LIST



ADDITIONAL PARTS FOR 2, 3 AND 5 TON CAPACITY



2t, 3t



5t

Fig. No.	Part No.	Part Name	Nos. Per Hoist	Capacity Code					
				005	010	020	015	030	050
①	CF-001	Top Hook Assembly	1						
2	CF-071	Hook Latch Assembly	1						
③	CF-163	Top Pin	1						
④	CF-021A	Bottom Hook Complete Set	1						
5	CF-071	Hook Latch Assembly	1						
⑥	CF-041	Chain Pin	1						
⑦	CF-049	Slotted Nut	1						
⑧	CF-096	Split Pin	1						
⑨	CF-101	Body A	1						
⑩	CF-102	Body B with Name Plate	1						
11	CF-801	Name Plate	1						
⑫	CF-105	Frame	1						
⑬	CF-111AF	Pinion	1						
⑭	CF-120	Ball Bearing A	1						
⑮	CF-130	Ball Bearing B	1						
⑯	CF-140	Ball Bearing C	1						
16-A	CF-141	Ball Bearing D	1						
*⑰	CF-116	Load Sheave	1						
⑱	CF-114	Load Gear	1						
⑲	CF-178	Chain Guide (for 1t & over cap.)	1						
19-A	CF-161	Guide Roller (for 1/2t cap.)	2						
20	CF-162	Stripper	1						
21	CF-185	Socket Bolt for Body	2						
21-A	CF-186	Socket Bolt for Body	2						
22	CF-184	U Nut for Body	4						
23	CF-156	Pawl Pin	1						
24	CF-160	U Nut	1						
25	CF-158	Pawl Spring	1						
26	CF-155	Pawl	1						
27	CF-157	Snap Ring	1						
28	CF-153AF	Friction Disc	1						
29	CF-152AF	Ratchet Disc	1						
30	CF-154AF	Bushing	1						
31	CF-150AF	Friction Plate	2						
32	CF-115AF	Hand Wheel	1						
33	CF-159	Wheel Stopper	1						
34	CF-167	Wheel Stopper Pin	1						
35	CF-182	Split Pin	1						
36	CF-171	Wheel Cover	1						
37	CF-187	Screw	3						
38	CF-188	Spring Washer	3						

Fig. No.	Part No.	Part Name	Nos. Per Hoist	Capacity Code					
				005	010	020	015	030	050
⑳	CF-164	Tail Pin	1						
㉑	CF-181	Tap Socket Bolt	1						
㉒	CF-841	Load Chain	1						
㉓	CF-842	Hand Chain	1						
㉔	CF-931	Warning Tag	1						
㉕	CF-045	Chain Stopper Link	1						
ADDITIONAL PARTS FOR 2 & 3 t CAPACITY									
㉖	CF-001	Top Hook Assembly	1						
44	CF-071	Hook Latch Assembly	1						
㉗	CF-041	Chain Pin	1						
㉘	CF-049	Slotted Nut	1						
㉙	CF-085	Split Pin	1						
㉚	CF-021A	Bottom Hook Complete Set	1						
49	CF-031	Bottom Yoke	2						
50	CF-081	Bolt	2						
51	CF-082	Lever Nut	2						
52	CF-053	Shaft	1						
53	CF-083	Spring Pin	1						
54	CF-051	Idle Sheave	1						
55	CF-021	Bottom Hook Assembly	1						
56	CF-071	Hook Latch Assembly	1						
ADDITIONAL PARTS FOR 5 t CAPACITY									
㉛	CF-001A	Top Hook Complete Set	1						
58	CF-011	Top Yoke A	1						
59	CF-012	Top Yoke B	1						
60	CF-051	Idle Sheave	1						
61	CF-053	Shaft	1						
62	CF-083	Spring Pin	1						
63	CF-081	Bolt	3						
64	CF-082	Lever Nut	3						
65	CF-001	Top Hook Assembly	1						
66	CF-071	Hook Latch Assembly	1						
㉜	CF-021A	Bottom Hook Complete Set	1						
68	CF-031	Bottom Yoke	2						
69	CF-051	Idle Sheave	1						
70	CF-053	Shaft	1						
71	CF-083	Spring Pin	1						
72	CF-081	Bolt	2						
73	CF-082	Lever Nut	2						
74	CF-021	Bottom Hook Assembly	1						
75	CF-071	Hook Latch Assembly	1						

Note:

1. *Load Sheave for 5 t cap. is delivered complete with Load Gear.
2. The letter "AF" in parts list means exclusive use for Model CF4. When ordering parts for Model CF3, use same part name and parts number without AF.
3. CF-154AF Bushing is exclusive for CF4.

NOTES

OWNER'S (OPERATOR'S) MANUAL AND SAFETY INSTRUCTIONS FOR TS SERIES (MODEL TS2) PLAIN AND GEARED TROLLEY

BEFORE USING THIS PRODUCT :

ALWAYS SAVE THIS BOOK FOR FUTURE REFERENCE

ALWAYS READ OWNER'S (OPERATOR'S) MANUAL AND SAFETY INSTRUCTIONS

- ⚠ WARNING** : IMPROPER trolley use could result in death or serious injury. To avoid these hazards:
- : NEVER transport loads over or near people.
 - : NEVER work under or near lifted loads.
 - : ALWAYS operate, inspect and maintain this trolley in accordance with applicable safety codes and regulations.
 - : ALWAYS follow the installation procedure on this manual when using the hoist with this TS2 trolley.

These safety instructions contain important information to help you use the TS2 Trolley in a safe manner. Please refer to this Owner's (Operator's) Manual for additional safety information.



YAMANASHI HEAD OFFICE : Tsujijarai 2000, Showa-cho, Nakakoma-gun,
Yamanashi-ken, 409-38 Japan.

Phone:0552-75-7736 Fax:0552-75-6165

TOKYO OFFICE : 3-37-4, Yoyogi, Shibuya-ku, Tokyo, 151 Japan.

Phone:03-5371-7341 Fax:03-5371-7349

CONTENTS

DEFINITIONS	
1. SAFETY	1
1-1 Safety summary	1
1-2 Safety instructions	2
2. TROLLEY SPECIFICATIONS	4
2-1 For manual chain hoist	4
2-2 For electric chain hoist	5
3. TROLLEY INSTALLATION	6
3-1 Coupling with manual chain hoists	6
3-2 Coupling with electric chain hoists	7
3-3 Adjusting trolley width before installation	8
3-4 Installation of trolley onto beam	8
3-5 Installation of stopper onto traversing beam	10
3-6 Installation of power supply cable	10
3-7 Check points after installation	11
4. OPERATION	11
4-1 Safety considerations	11
4-2 Operation	11
4-3 Trolley Storage	11
4-4 Precaution in handling	12
5. INSPECTION	12
5-1 Outline	12
5-2 Daily inspection	12
5-3 Periodic inspection	13
5-4 Inspection method and criteria	13
6. MAINTENANCE	16
6-1 Conditioning	16
6-2 Lubrication	16
6-3 Overhaul and assembly	17
7. BUFFER AND T-TYPE HANGER	19
7-1 Buffer	19
7-2 T-type hanger	19
8. WARRANTY	22
9. PARTS LIST	23

! WARNING

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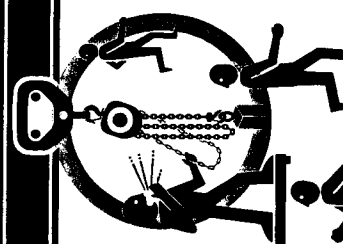
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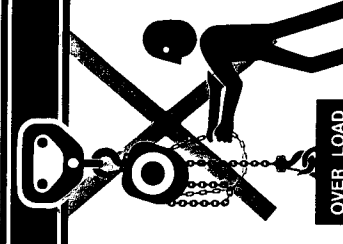
IMPROPER trolley and chain hoist use could result in death or serious injury. To avoid these hazards:



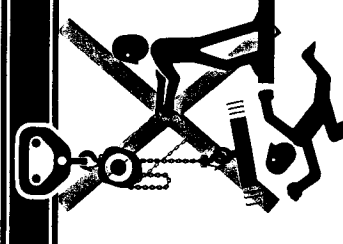
ALWAYS read owner's (operator's) manual and safety instructions before operating.



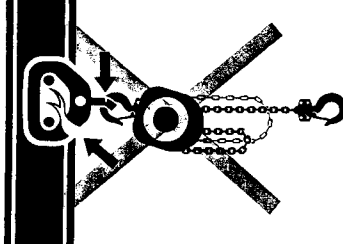
ALWAYS notify others when a transport is about to begin.



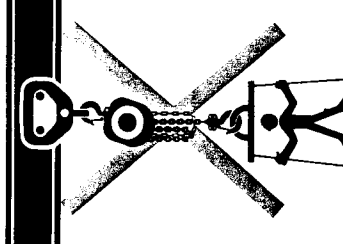
NEVER transport more than the trolley's rated capacity.



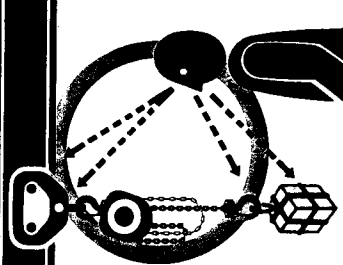
NEVER lift or transport loads over or near people.



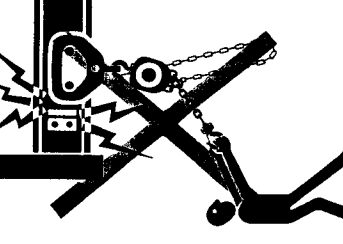
NEVER operate a trolley if damaged or malfunctioning.



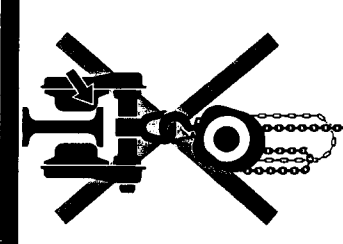
NEVER use a trolley for supporting, or transporting people.



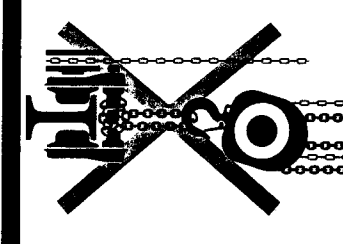
ALWAYS make sure that the supporting structures are strong enough to support the weight of the load and hoist.



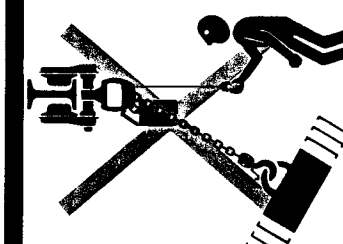
NEVER allow trolley to collide with stopper on the beam.



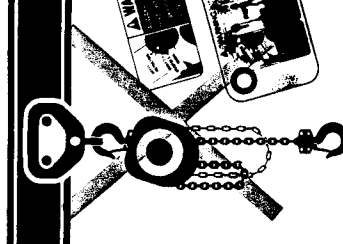
NEVER use a trolley if the width does not fit the rail.



NEVER connect the hoist to the trolley with improper fittings.



NEVER operate unless load is centered under hoist.



NEVER remove or obscure the warning tags and labels.

DEFINITIONS

⚠ WARNING : Death or serious injury could result in potentially hazardous situation.

1. SAFETY

1-1 Safety summary

Danger exists when heavy loads are transported, particularly if the equipment is not being used properly or is poorly maintained. Because accidents and serious injury could result, special safety precautions apply to the operation, maintenance and inspection of trolleys.

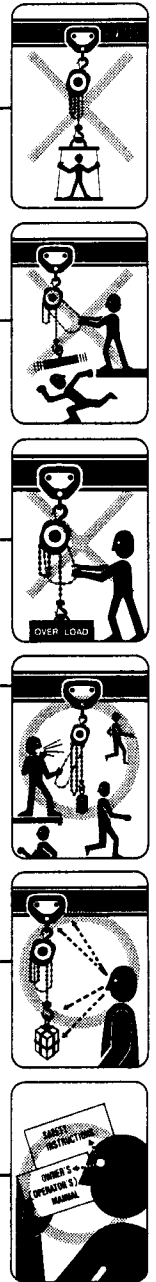
Following these simple rules can help to avoid transporting accidents;

⚠ WARNING : Death or serious injury could result in improper trolley use.
To avoid these hazards :

- NEVER** use a trolley for transporting people. -----
- NEVER** lift or transport loads over or near people.-----
- NEVER** work near or under suspended loads.-----
- NEVER** transport more than the trolley's rated capacity.-----
- ALWAYS** notify others when a transport is about to begin.-----
- ALWAYS** make sure that the supporting structures are strong enough to support the weight of the load and hoist.-----
- ALWAYS** read owner's (operator's) manual and safety instructions before operating.-----

REMEMBER : proper rigging and lifting techniques are the responsibility of the operator. Be sure you read and understand the instructions contained in this manual before using your trolley. Check all applicable safety codes, regulations and other applicable laws for further information about the safe use of your trolley.

More detailed safety information is contained in the following pages. For additional information, please contact Kito Corporation or your authorized Kito dealer.



1-2 Safety instructions

Serious injury could result if the following safety instructions are not followed.*

(If this trolley is used in conjunction with a hoist, also refer to the hoist manual for additional precautions and instructions.)

⚠ WARNING : Death or serious injury could result in improper trolley use. To avoid these hazards :

NEVER allow an unqualified (not trained in safety and operation) person to operate the trolley.

NEVER apply loads which exceed the rated capacity of the trolley.

NEVER attach the hoist that has a rated capacity which exceeds the rated capacity of the trolley.

NEVER operate the trolley when a "DO NOT OPERATE" sign is placed on the trolley.

NEVER use a trolley if the width does not fit the rail.-----

NEVER use the hand chain to support a load.

NEVER transport a load over people.

NEVER use the trolley for transporting people.

NEVER allow anyone to stand on a suspended load.

NEVER swing a suspended load.

NEVER leave a suspended load unattended.

NEVER weld or cut a load suspended by the trolley.

NEVER connect the hoist to the trolley with improper fittings.-----

NEVER operate the trolley hand chain if excessive noise, jamming, overloading or binding occurs.

NEVER work near or under suspended loads.

NEVER operate a trolley if damaged or malfunctioning.-----

NEVER use a trolley which has been taken out of service until the trolley has been properly repaired or replaced.

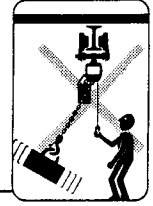
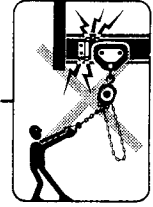
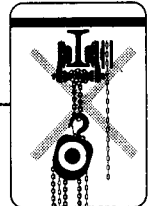
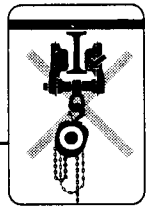
NEVER use a trolley without a nameplate or warning labels or with illegible nameplate or labels.-----

NEVER remove or obscure the warning tags.-----

NEVER operate a trolley unless you are physically capable of doing so.

NEVER allow a trolley to collide with another trolley or stopper on the beam.-----

NEVER operate trolley unless load is centered under trolley.-----



⚠ WARNING : IMPROPER trolley use could result in death or serious injury. To avoid these hazards :

- ALWAYS** make sure that you and others are clear of the load path.
- ALWAYS** inspect the trolley for wear or damage before each shift.
- ALWAYS** inspect the trolley thoroughly and replace worn or damaged parts.
- ALWAYS** lubricate the trolley regularly.
- ALWAYS** pay attention to the load at all times when operating the trolley.
- ALWAYS** rig the load properly and carefully.
- ALWAYS** check the trolley before daily use according to the Recommended Daily Inspection.
- ALWAYS** let the authorized personnel inspect the trolley periodically.
- ALWAYS** consult the manufacturer or your dealer if you plan to use a trolley in an excessively corrosive environment.
- ALWAYS** use the trolley within rail slope of 1/50.

2. TROLLEY SPECIFICATIONS

2-1 For manual chain hoist

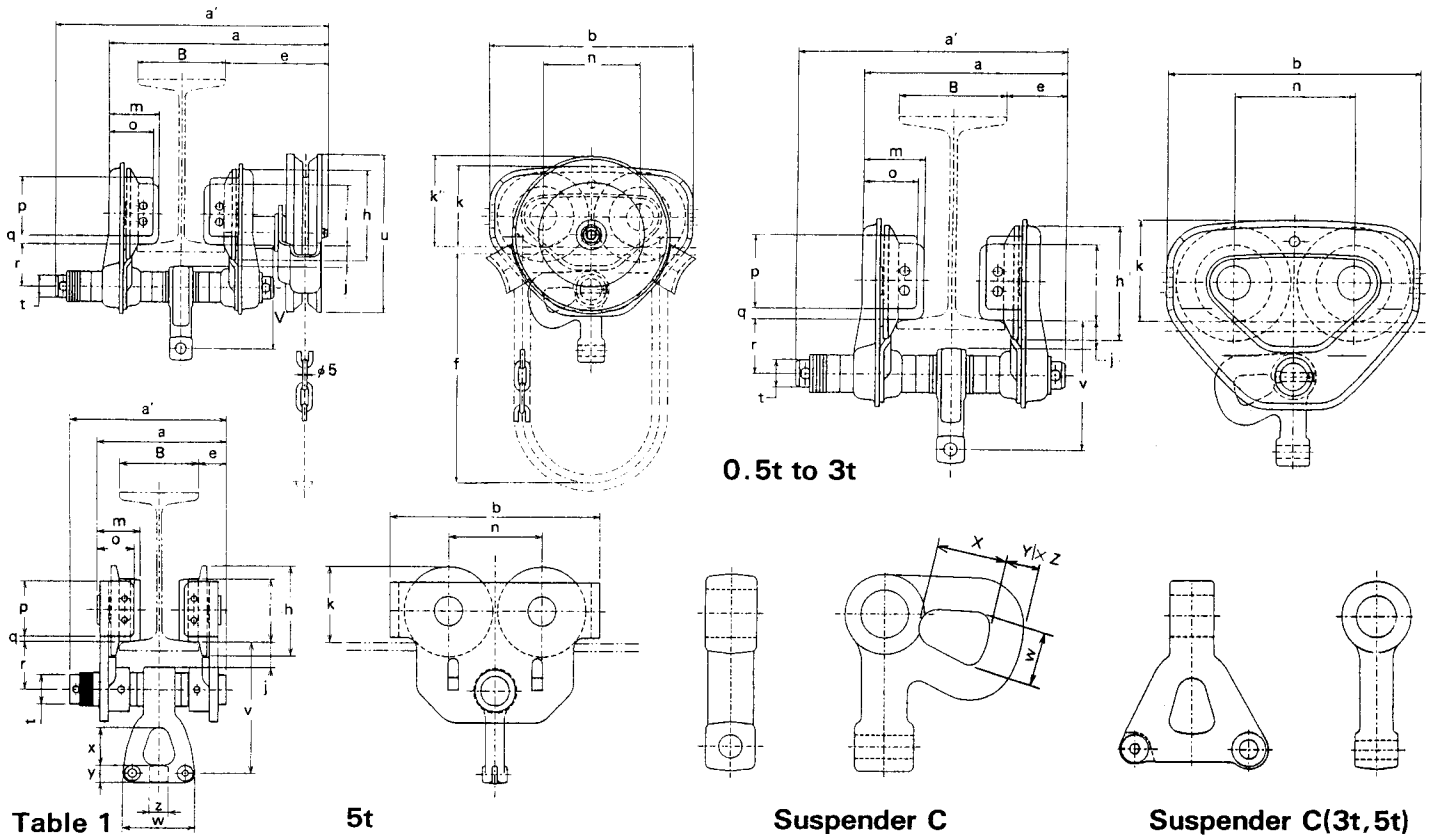


Table 1

Model	Code		Capacity (t)	Rail Width Adjustability			Min. Radius for Curve (mm)	Net Weight (kg)		Hand Chain Folded Length (m)	V (mm)	W (mm)	X (mm)	Y (mm)	Z (mm)	a [Max.] (mm)	a' (mm)	b (mm)
	Plain Trolley	Geared Trolley		Standard	Option			TSP	TSG									
					W20	W30												
TS2	TSP005C	—	0.5	50 to 102	103 to 203	204 to 305	1100*	4.5	—	—	93	26	33	14	14	173	204	182
TS2	TSP010C	TSG010C	1	58 to 127	128 to 203	204 to 305	1300*	8.0	12	2.5	106	28	37	18	18	275 (215)	309 (249)	236
TS2	TSP015C	TSG015C	1.5	82 to 153	—	154 to 305	1500	14	18	2.5	129	32	40	22	22	349 (264)	385 (300)	280
TS2	TSP020C	TSG020C	2	82 to 153	—	154 to 305	1500	14	19	3.0	129	32	40	22	22	349 (264)	385 (300)	280
TS2	TSP025C	TSG025C	2.5	82 to 153	—	154 to 305	1700	23	27	3.0	144	36	44	27	25	359 (280)	398 (320)	324
TS2	TSP030C	TSG030C	3	82 to 153	—	154 to 305	1700	23	27	3.0	169	40	48	24	30	359 (280)	398 (320)	324
TS2	TSP050C	TSG050C	5	100 to 178	—	179 to 305	2300	50	56	3.5	228	60	70	33	36	376 (273)	400 (297)	400

Capacity (t)	e (mm)	f (mm)	h (mm)	i (mm)	j (mm)	k (mm)	k' (mm)	m (mm)	n (mm)	o (mm)	p (mm)	q (mm)	r (mm)	t (mm)	u (mm)
0.5	46	—	82	60	19	76	—	45	84	42	54	10	38	22	—
1	116 (56)	2.2	106	71	28	95	106	56	112	50	69	10	50	25	183
1.5	154 (69)	2.2	127	85	34	112	109	71	131	63	83	10	62	32	183
2	154 (69)	2.7	127	85	34	112	109	71	131	63	83	10	62	32	183
2.5	157 (79)	2.7	148	100	36	134	114	80	152	74	102	10	68	36	183
3	157 (79)	2.7	148	100	36	134	114	80	152	74	102	10	68	36	183
5	156 (53)	3.2	169	118	47	144	131	81	178	70	104	10	88	54	183

* Figures in parentheses show the data for plain trolley type.

• The maximum 200mm and 300mm rail width are available as option.

※ Minimum flange width for curved rail : 0.5 ton trolley 57mm.
 : 1 ton trolley 73mm.
 : 2.5 and 3ton trolley 89mm.

• Net weight is when flange width is in standard range.

• Dimension "a" is when flange width is in standard range.

• Dimension "a'" is when flange width is adjusted to the maximum of the standard range.

2-2 For electric chain hoist

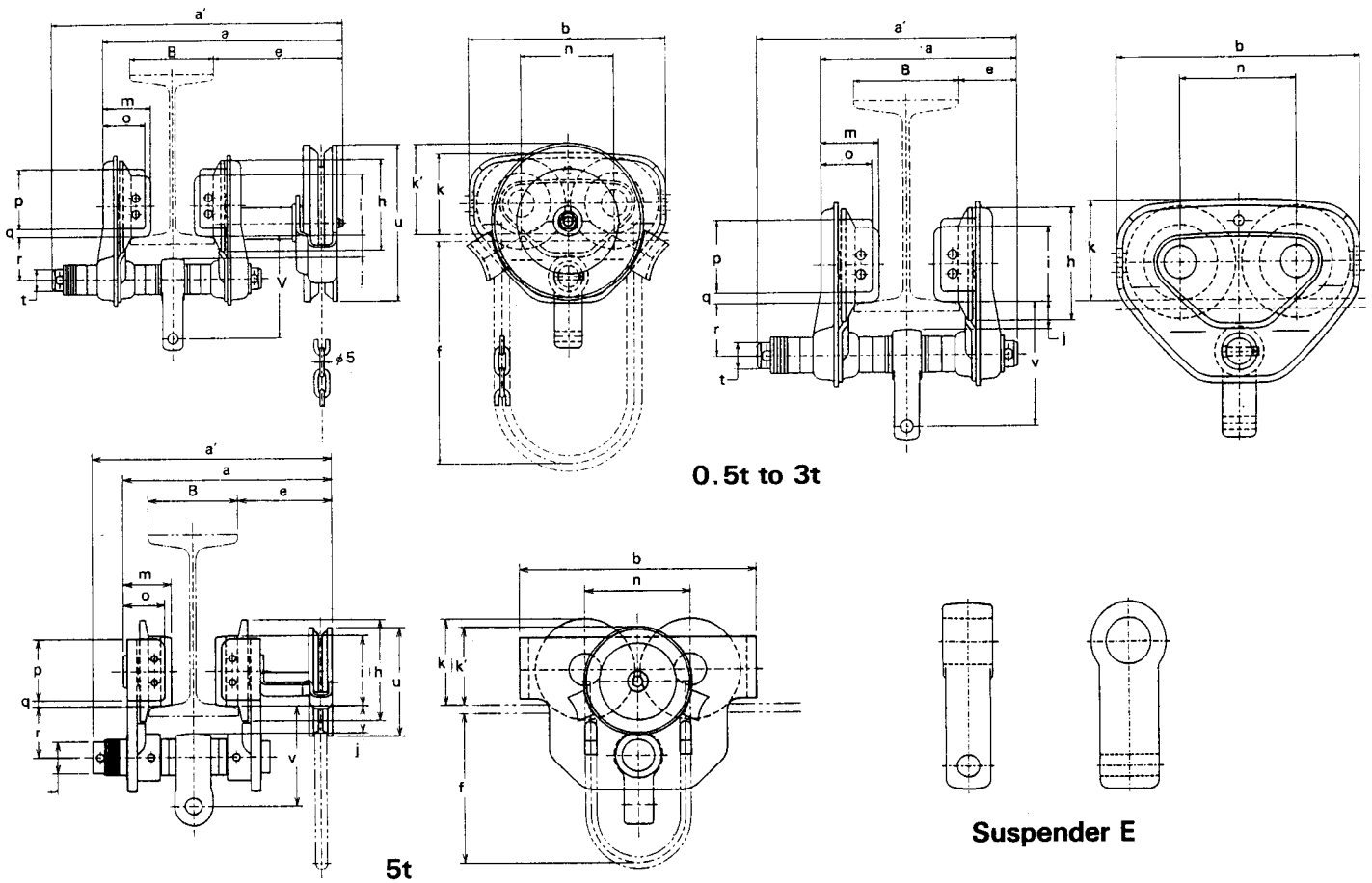


Table 2

Model	Code		Capacity (t)	Rail Width Adjustability			Min. Radius for Curve (mm)	Net Weight (kg)		Hand Chain Folded Length (m)	V (mm)	a [Max.] (mm)	a' (mm)	b (mm)
	Plain Trolley	Geared Trolley		Standard	Option			TSP	TSG					
					W20	W30								
TS2	TSP005E	—	0.5	50 to 102	103 to 203	204 to 305	1100*	4.5	—	3.0	98	173	204	182
TS2	TSP010E	TSG010E	1	58 to 127	128 to 203	204 to 305	1300*	8.0	12	3.0	119	311 (215)	345 (249)	236
TS2	TSP020E	TSG020E	2	82 to 127		204 to 305	1500	14	19	3.0	138	349 (264)	385 (300)	280
TS2	TSP025E	TSG025E	2.5	82 to 153		154 to 305	1700	23	27	3.0	153	359 (280)	398 (320)	324
TS2	TSP030E	TSG030E	3	82 to 153		154 to 305	1700	23	27	3.0	153	359 (280)	398 (320)	324
TS2	TSP050E	TSG050E	5	100 to 178		179 to 305	2300	50	56	3.5	171	376 (273)	400 (297)	400

Capacity (t)	e (mm)	f (mm)	h (mm)	i (mm)	j (mm)	k (mm)	k' (mm)	m (mm)	n (mm)	o (mm)	p (mm)	q (mm)	r (mm)	t (mm)	u (mm)
0.5	46	—	82	60	19	76	—	45	84	42	54	10	38	22	—
1	152 (56)	2.7	106	71	28	95	106	56	112	50	69	10	50	25	183
2	154 (69)	2.7	127	85	34	112	109	71	131	63	83	10	62	32	183
2.5	157 (79)	2.7	148	100	36	134	114	80	152	74	102	10	68	36	183
3	157 (79)	2.7	148	100	36	134	114	80	152	74	102	10	68	36	183
5	156 (53)	3.2	169	118	46.5	144	131	81	178	70	104	10	88	54	183

- Figures in parentheses show the data for plain trolley type.
- Minimum flange width for curved rail : 0.5 ton trolley 57mm.
: 1 ton trolley 73mm.
: 3ton trolley 89mm.
- The maximum 200mm and 300mm rail width are available as option.

- Net weight is when flange width is in standard range.
- Dimension "a" is when flange width is in standard range.
- Dimension "a'" is when flange width is adjusted to the maximum of the standard range.

3. TROLLEY INSTALLATION

3-1 Coupling with manual chain hoists

(1) The CB series hoists can be suspended either in the hook suspension method (the top hook is hung from the suspender C as shown in Fig.A), or in the direct-coupling method (the hoist body, with the top hook removed, is directly coupled to the suspender C as shown in Fig.B). However, the 7.5 ton and larger capacity CB series hoist can only be suspended by the hook suspension method and the top hook must be hung directly from the suspension shaft of the trolley.

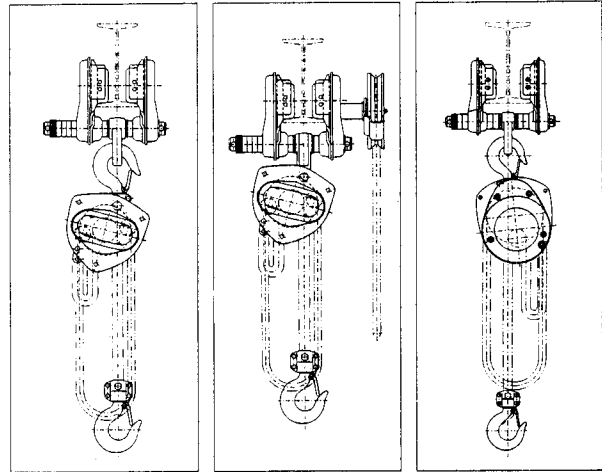


Fig. A

Fig. B

Fig. C

The CF and CL series hoists can be suspended by suspender C like Fig. A and C.

(2) The direct-coupling method is best for circumstances which require as much effective hoisting length as possible, but where the height of the ceiling is low. The hook suspension method type is best for circumstances when the chain hoist is transferred frequently.

(3) Direct Coupling method of CB series chain hoist.

1) For 0.5 to 2.5 ton capacity (Refer to Fig. 1)

- a) Remove the wheel cover nuts and spring washers, then remove the wheel cover itself.
- b) Straighten and remove the bent split pin in the top pin, pull out the top pin and remove the top hook.
- c) Mount the suspender to the hoist body using the top pin and the split pin which have been removed as above.
- d) Firmly bend the pointed end of the split pin as shown in Fig. 2.
- e) Install the wheel cover, as it was before, with the nuts and spring washers.

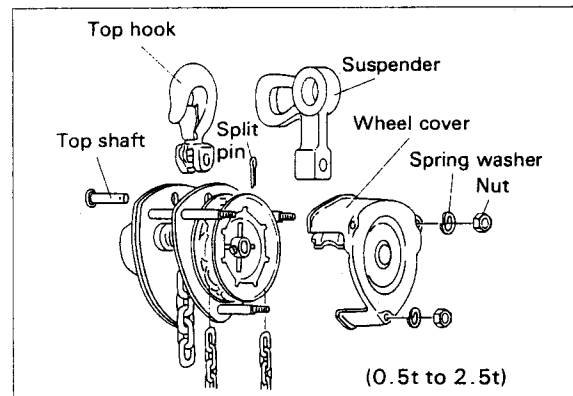


Fig. 1

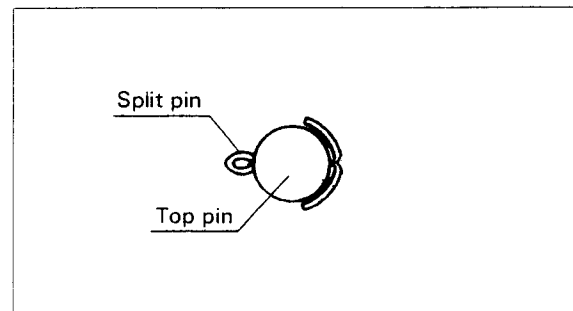


Fig. 2

2) For 3 or 5 ton capacity. (Refer to Fig. 3.)

In addition to the procedure stated above, the following steps are also required.

- a) Straighten the bent split pin, remove the slotted nuts, pull out the chain pins, and then remove the load chain from the top hook, in Fig. 3.
- b) Connect the end of load chain and the suspender with chain pins, slotted nuts and the split pin.
- c) Firmly bend the pointed end of the split pin.
- d) Make sure that no twisting and no capsizing of load chain occurs.

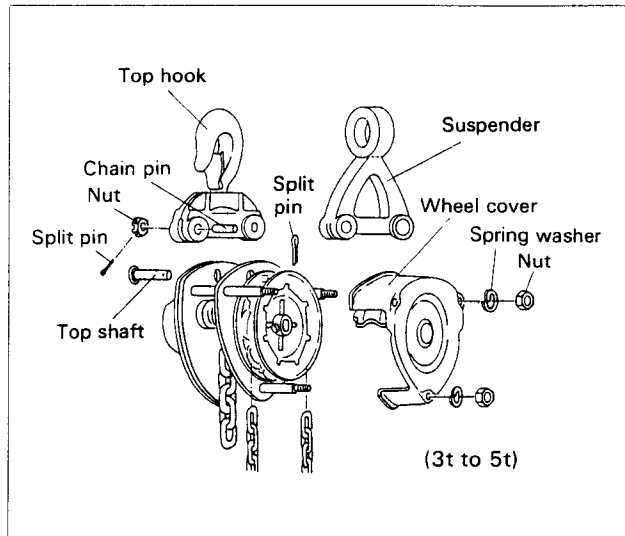


Fig. 3

3-2 Coupling with electric chain hoists

• ES, EF series

The direct coupling method shown in Fig. D should be applied.

(1) Remove the top hook from the hoist body. (Refer to Fig. 4-1)

Straighten the bent split pin, remove the slotted nut, and the top pin (in the case of double falls of chain, the top bolt), and then remove the top hook.

(2) Installation of suspender

Mount the suspender E to the hoist body using the top pin (or top bolt), and a nut which has been removed as above, and a new split pin. Firmly bend the pointed end of the split pin as shown in Fig. 2.

(3) The EF series electric chain hoist can be suspended by the suspender E like Fig. E.

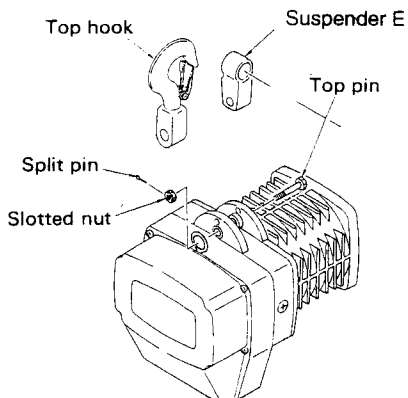


Fig. 4-1

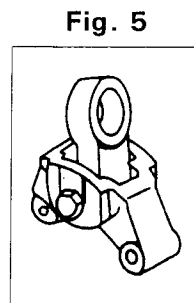


Fig. 5
Suspender E for double falls of chain

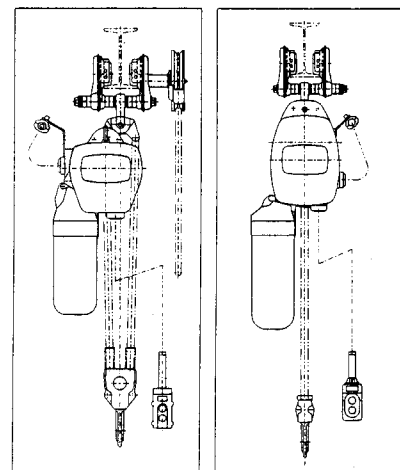


Fig. D

Fig. E

• ER series

The direct coupling method is shown in Fig. F.

Installation of suspender (Refer to Fig. 4-2)

Mount the suspender G to the connection yoke with the connection yoke rubber, the yoke bolt and the slotted nut. Then insert a new split pin and bend it securely as shown in Fig. 2.

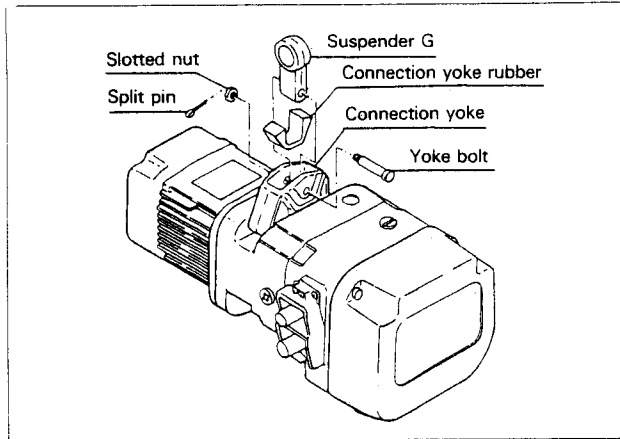


Fig. 4-2

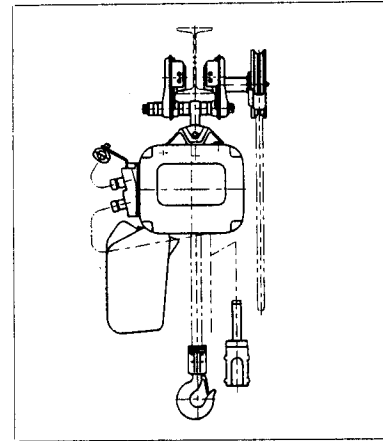


Fig. F

3-3 Adjusting trolley width before installation

When the trolley and the chain hoist are combined, the following procedures must be followed to adjust the trolley width by using the inner and outer adjusting spacers (Refer to Table 3 on page 9).

- (1) Make sure that the direction is as shown in Fig. A to E.
- (2) The right and left side plates should be as far apart as possible, and the difference between A and B should be approximately 4mm (Refer to Fig. 6).
- (3) Bend the split pin of the shaft stopper pin as shown in Fig. 7.

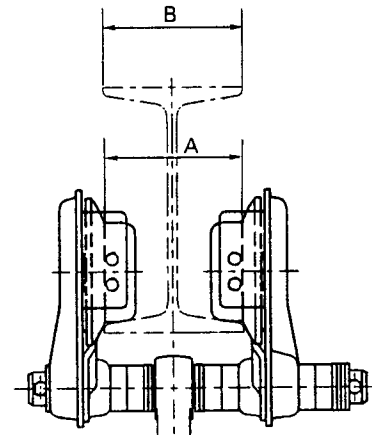


Fig. 6

3-4 Installation of trolley onto beam

- (a) It is preferable to install the trolley from the end of the beam, with the chain hoist and the trolley coupled. After installation, make sure to re-install the stopper as it was.
- (b) When there is no space between the end of beam and building, first remove the side plate S from the suspension shaft. After placing the side plate G on the other side of the flange, reassemble and re-install side plate S as it was before. Also, bend the split pin of shaft stopper pin correctly as shown in Fig. 7.

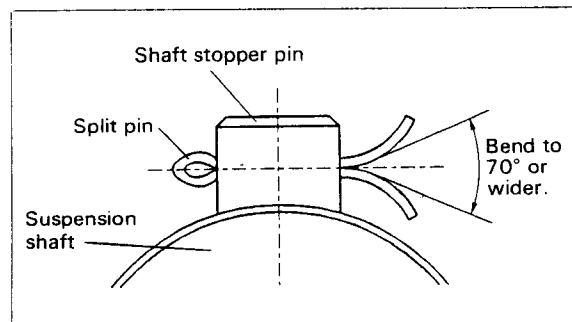


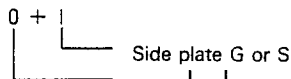
Fig. 7

Table 3

Beam flange width		(in)	2	2 ⁵ / ₁₆	2 ¹ / ₂ 2 ⁵ / ₈	0 ¹ / ₈	10 ¹ / ₄	10 ³ / ₈	10 ¹ / ₂	11	11 ¹ / ₈	11 ¹ / ₄	11 ³ / ₈	11 ⁵ / ₈	11 ³ / ₄	11 ¹³ / ₁₆	11 ⁷ / ₈	12		
Capacity	Parts	(mm)	50	58	64 66	157	260	264	267	279	283	286	289	295	298	300	302	305		
		0.5	Thin spacer	Inner	2+3	3+4	0+1	+1	1+2	2+2	2+3	4+5	1+1	1+2	2+2	3+3	3+4	4+4	4+5	1+5
Outer	4			2	8	7	6	5	4	0	7	6	5	3	2	1	0	3		
Thick spacer	Inner		0+0	0+0	1+1	+2	2+2	2+2	2+2	2+2	3+3	3+3	3+3	3+3	3+3	3+3	3+3	3+3	4+3	
	Outer		4	4	2	3	3	3	3	3	1	1	1	1	1	1	1	1	0	
Fixing spacer	Inner		-	-	-	+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	
	Outer																			
1	Thin spacer		Inner		3+3	0+0	+1	1+2	2+2	2+3	4+5	1+1	1+2	2+2	3+3	3+4	4+4	4+5	1+5	
			Outer		2	8	7	6	5	4	0	7	6	5	3	2	1	0	3	
	Thick spacer		Inner		0+0	1+1	+2	2+2	2+2	2+2	2+2	3+3	3+3	3+3	3+3	3+3	3+3	3+3	3+3	4+3
			Outer		6	4	3	3	3	3	3	1	1	1	1	1	1	1	1	0
Fixing spacer	Inner			-	-	+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	
	Outer																			
2	Thin spacer	Inner				+1	1+2	2+2	2+3	4+5	1+1	1+2	2+2	3+3	3+4	4+4	4+5	1+5		
		Outer				7	6	5	4	0	7	6	5	3	2	1	0	3		
	Thick spacer	Inner				+4	4+4	4+4	4+4	4+4	5+5	5+5	5+5	5+5	5+5	5+5	5+5	6+5		
		Outer				3	3	3	3	3	1	1	1	1	1	1	1	1	0	
Fixing spacer	Inner				+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1		
	Outer																			
3	Thin spacer	Inner				+1	1+2	2+2	2+3	4+5	1+1	1+2	2+2	3+3	3+4	4+4	4+5	1+5		
		Outer				7	6	5	4	0	7	6	5	3	2	1	0	3		
	Thick spacer	Inner				+4	4+4	4+4	4+4	4+4	5+5	5+5	5+5	5+5	5+5	5+5	5+5	6+5		
		Outer				3	3	3	3	3	1	1	1	1	1	1	1	1	0	
Fixing spacer	Inner				+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1		
	Outer																			
5	Thin spacer	Inner				+1	1+2	2+2	2+3	0+1	1+1	1+2	2+2	3+3	3+4	4+4	1+4	1+5		
		Outer				6	5	4	3	7	6	5	4	2	1	0	3	2		
	Thick spacer	Inner				+3	3+3	3+3	3+3	4+4	4+4	4+4	4+4	4+4	4+4	4+4	5+4	5+4		
		Outer				3	3	3	3	1	1	1	1	1	1	1	0	0		
Fixing spacer	Inner				+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1		
	Outer																			

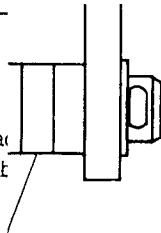
Note : 1) Take note the numbers on :

Example



2) Adjustment of trolley width
See clause 3-3.

Adjust the dimensions by number of inner or outer at the number in the above table



3-7 Check points after installation

When the entire installation is completed, check the followings.

- (1) Check whether the relative position of the trolley and the chain hoist is correct (See Fig. A to E).
- (2) Check that the beam stoppers are securely fastened on the rail to prevent trolley run away.
- (3) Make sure that no bolt, nut, split pin or snap pin are missing, and that those are all adequately fastened.

4. OPERATION

4-1 Safety considerations

The three most important aspects of trolley operation are:

- (1) Follow all safety instructions when operating trolley,
- (2) Allow only qualified people to operate a trolley and
- (3) Subject each trolley to a regular inspection and a maintenance procedure.

4-2 Operation

(1) Plain trolley

For plain trolley, movement is controlled by pushing on the load or the hook of the attached hoist.

(2) Geared trolley

For geared trolley, when facing the trolley hand wheel :

Pull down on right side of hand chain (Clockwise rotation) to move left.

Pull down on left side of hand chain (Counterclockwise rotation) to move right.

4-3 Trolley storage

NEVER expose the trolley to rain or dew.

NEVER leave the trolley in a damp place.

ALWAYS be sure to house the trolley under the eaves or under some cover after use, in the case of outdoor installation.

ALWAYS wipe off all dirt and water.

ALWAYS install in a dry place.

ALWAYS lubricate gear side of the pinion and track wheel G.

4-4 Precaution in handling

(1) Avoid slant loading

It is dangerous to pull the load slant, with the trolley connected to the hoist, as the trolley is inclined and gives too much strain to the trolley.

(2) Avoid collision

The trolley will be damaged if it is bumped against stopper or against another trolley.

(3) Never allow articles to become caught or hooked onto the hand chain.

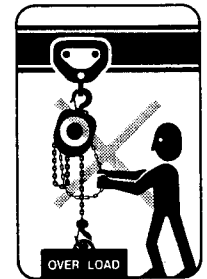
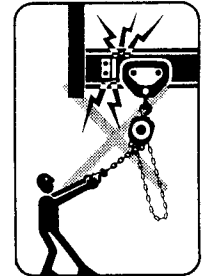
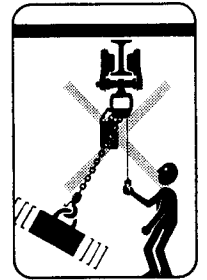
When articles are hooked or caught on the hand chain and the hand chain is strongly pulled, severe damage will be caused not only to the hand chain but also to the trolley itself.

(4) Never overload

The nameplate on the trolley shows the maximum lifting capacity. If the capacity of the trolley is different from the capacity of the chain hoist with which it is combined, operates them within the capacity of whichever smaller.

(5) Never throw

Never throw or drag the trolley.
Always handle trolleys with care.



5. INSPECTION

5-1 Outline

There are two types of inspection, the daily inspection performed by the operator while using the trolley, and the more thorough periodic inspection performed by qualified personnel who have the authority to remove the unit from service.

5-2 Daily inspection

ALWAYS check the following points before each work shift.

- (1) Check for visual signs or abnormal noises which could indicate a potential malfunction.
- (2) Check hand chain movement around the hand wheel.
- (3) Clean the chain, if chain binds, jumps, "clicks" or is excessively noisy.
- (4) Replace the chain, if problem persists.
- (5) Check for smooth operation.

5-3 Periodic inspection

Periodic inspection should be made at the interval shown below and should follow the given procedures.

NORMAL (Normal use) :	Semiannual inspection
HEAVY (Frequent use) :	Quarterly inspection
SEVERE (Excessively frequent use) :	Monthly inspection

Inspect all the items in "Periodic Inspection". Also inspect the following.

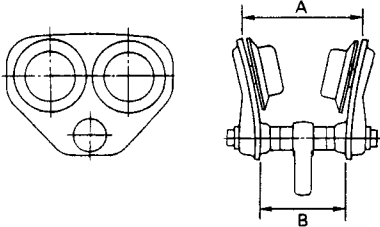
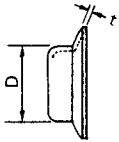
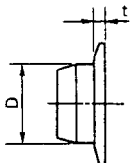
- (1) Check rivets, split pins, cap screws and nuts. Replace if missing and tighten if loose.
- (2) Inspect for wear, damage, distortion, deformation and cleanliness. If external evidence indicates the need, disassemble.
- (3) Check gears, shafts, bearings and chain guides. Replace worn or damaged parts. Clean, lubricate and reassemble.
- (4) Check for damage or excessive wear. Replace if necessary.
- (5) Check for distortion, wear and continued ability to support load.
- (6) Check that the trolley wheels track the beam properly and total clearance between wheels and flange equals to approximately 4mm. (Refer to 3-3 on page 8.) Adjust the clearance if necessary.
- (7) Check side plates for spreading due to bending. Repair as necessary.
- (8) Check name plates for presence and legibility. Replace if necessary.

5-4 Inspection method and judgment criteria

5-4-1 Daily inspection procedure

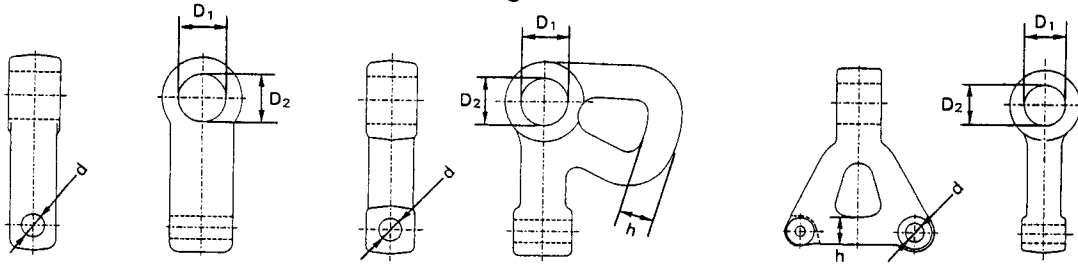
Inspection Item	Inspection Method	Discard Limits / Judgment Criteria	Countermeasures/ Others
1. Function	• Run under no load condition.	• Trolley should run smoothly and is not tilt when a light load is applied.	• If the movement is not smooth, try to determine its cause and replace the trolley with a new one if necessary.
2. Deformations and damages of each part	• Check visually.	• There should be no deformation or damage.	• Replace the part with new one if deformed or damaged.
3. Part loosening	• Check visually.	• Parts should not be loosened.	• Fasten tightly.
4. Name plate	• Check visually.	• Every description should be clear and visible.	• Replace the name plate with new one.

5-4-2 Periodic inspection procedure

Inspection Item	Inspection Method	Discard Limits / Judgment Criteria	Countermeasures/ Others																																		
1. Traversing function	<ul style="list-style-type: none"> Move trolley with light load suspended. 	<ul style="list-style-type: none"> Trolley should run smoothly, and not tilt when a light load is applied. Overall movement should be smooth. 	<ul style="list-style-type: none"> If not smooth, adjust beam, readjust balance or lubricate pinion holder, pinion and gear of track wheel G. 																																		
2. Side plate deformation	<ul style="list-style-type: none"> Check with calipers. 	<ul style="list-style-type: none"> Dimension A and B should not exceed 2mm. <p>Fig. 11</p> 	<ul style="list-style-type: none"> If the difference exceeds 2mm, replace it with a new one. 																																		
3. Track wheel abrasion	<ul style="list-style-type: none"> Check visually or with calipers as needed. <p>Fig. 12 0.5 to 3t</p>  <p>Fig. 13 5t</p> 	<ul style="list-style-type: none"> Abrasion of tread or flange should not exceed the limits on the table below. <p style="text-align: center;">Table 5</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th rowspan="2">Capacity (t)</th> <th colspan="2">Tread outside diameter : D</th> <th colspan="2">Flange thickness : t</th> </tr> <tr> <th>Standard</th> <th>Limit</th> <th>Standard</th> <th>Limit</th> </tr> </thead> <tbody> <tr> <td>0.5</td> <td>60</td> <td>58.5</td> <td>3.2</td> <td>2.5</td> </tr> <tr> <td>1</td> <td>71</td> <td>69.5</td> <td>4</td> <td>3.3</td> </tr> <tr> <td>2</td> <td>85</td> <td>83.5</td> <td>4.5</td> <td>3.8</td> </tr> <tr> <td>3</td> <td>100</td> <td>98.5</td> <td>5</td> <td>4.3</td> </tr> <tr> <td>5</td> <td>118</td> <td>112</td> <td>9.6</td> <td>6.7</td> </tr> </tbody> </table>	Capacity (t)	Tread outside diameter : D		Flange thickness : t		Standard	Limit	Standard	Limit	0.5	60	58.5	3.2	2.5	1	71	69.5	4	3.3	2	85	83.5	4.5	3.8	3	100	98.5	5	4.3	5	118	112	9.6	6.7	<ul style="list-style-type: none"> Replace it with a new one if it exceeds the limit.
Capacity (t)	Tread outside diameter : D			Flange thickness : t																																	
	Standard	Limit	Standard	Limit																																	
0.5	60	58.5	3.2	2.5																																	
1	71	69.5	4	3.3																																	
2	85	83.5	4.5	3.8																																	
3	100	98.5	5	4.3																																	
5	118	112	9.6	6.7																																	
4. Missing or damaged nameplate	<ul style="list-style-type: none"> Check visually. 	<ul style="list-style-type: none"> Never use the one which is not legible. 	<ul style="list-style-type: none"> Replace it with new one. 																																		
5. Damage of hand wheel	<ul style="list-style-type: none"> Check visually. 	<ul style="list-style-type: none"> Never use the damaged one. 	<ul style="list-style-type: none"> Replace it with new one. 																																		
6. Deformation and abrasion of gear (track wheel G, pinion)	<ul style="list-style-type: none"> Check visually or use calipers as needed. 	<ul style="list-style-type: none"> Never use the deformed or abraded one. 	<ul style="list-style-type: none"> Replace it with new one. 																																		
7. Deformation and abrasion of suspension shaft	<ul style="list-style-type: none"> Check visually or use calipers as needed. 	<ul style="list-style-type: none"> Never use the suspension shaft if its diameter is worn by 10% or more. 	<ul style="list-style-type: none"> Replace it with new one. 																																		

Inspection Item	Inspection Method	Discard Limits / Judgment Criteria	Countermeasures/ Others
8. Deformation and abrasion of suspender	<ul style="list-style-type: none"> Check visually or use calipers as needed. 	<ul style="list-style-type: none"> Never use the suspender if its dimensions of $D_2 - D_1$, d or h exceed the limit in the Table 6 below. 	<ul style="list-style-type: none"> Replace if it exceeds the limit below.

Fig. 14



Suspender E, G

Suspender C

Suspender C

Table 6

(mm)

Hoist Type	Trolley capacity (t)	Hoist applied capacity (t)	$D_2 - D_1$ limit	d		h	
				Standard	Limit	Standard	Limit
CB (Susp. C)	0.5	0.5	1	12.2	13	14	12.5
	1	0.5 · 1	1	12.2	13	18	16
	2	1.5 · 1	1	16.2	17	22	20
	3	2.5	1.5	16.2	17	27	24
		3	1.5	16.4	17	24	21.5
5	5	1.5	16.4	17	33	30	
ES or EF (Susp. E) ER (Susp. G)	0.5	0.25 · 0.5-S, 0.5-L	1	12.2	13	—	—
	1	1-S · 1-L	1	12.2	13	—	—
	2	1.5 · 2-S · 2-L	1	20.2	21	—	—
	3	2.5 · 3	1.5	20.2	21	—	—
5	5	1.5	28.2	30	—	—	

9. Rail deformation	<ul style="list-style-type: none"> Check visually or use a calipers as needed. 	<ul style="list-style-type: none"> The flange should not be deformed. 	<ul style="list-style-type: none"> Replace or repair.
10. Condition of welded part	<ul style="list-style-type: none"> Check visually. 	<ul style="list-style-type: none"> There should be no crack. There should be no rust. 	<ul style="list-style-type: none"> Repair or strengthen.
11. Rail abrasion	<ul style="list-style-type: none"> Check visually or use a calipers as needed. 	<ul style="list-style-type: none"> The tread should not be abraded. Replace it if the dimension B becomes 95% t becomes 90% of new one. 	<ul style="list-style-type: none"> Replace.

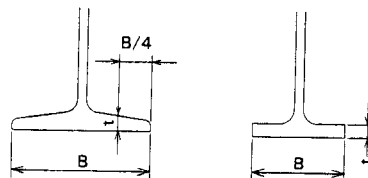


Fig. 15

12. Loosening of fixing bolt	<ul style="list-style-type: none"> Try to turn it with a spanner. 	<ul style="list-style-type: none"> The bolt should be tightened firmly. 	<ul style="list-style-type: none"> Tighten the bolt.
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6. MAINTENANCE

ALWAYS maintain, inspect and test the trolley in accordance with applicable safety codes and regulations.

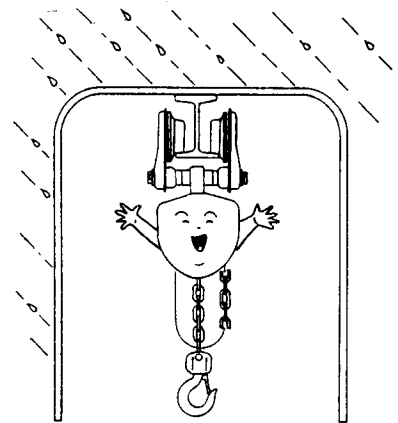
Safety regulations for hoists and cranes regulates implementations and maintenances of daily inspection, monthly inspection, annual inspection and testings. All inspection and maintenance records should be kept for at least 3 years.

- ⚠ WARNING** : **IMPROPER trolley use could result serious injury or death.**
- To avoid these hazards :**
- : NEVER perform maintenance on the trolley while it is suspending a load.**
 - : Before performing maintenance, attach the tag :**
["DANGER": DO NOT OPERATE EQUIPMENT BEING REPAIRED.]
 - : Only allow qualified service personnel to perform maintenance.**
 - : After performing maintenance, test trolley to 100% of its rated capacity before returning to service.**

6-1 Conditioning

6-1-1 Storing

- (1) In the event that the trolley or hoist becomes wet, dry the trolley or hoist with a dry cloth.
- (2) In the case of outdoor installation, make sure to house a trolley or hoist under the eaves or under some cover after operation.



6-2 Lubrication

6-2-1 Geared wheels (geared trolley only)

Lubricate exposed trolley drive pinion and wheel teeth. Brush with grease as often as necessary to keep teeth liberally covered. If the grease becomes contaminated with sand, dirt or other abrasive materials, remove old grease and replace with new grease (standard grease*) during monthly or annual inspection.

Temperature range of standard grease is -20°C (-4°F) to $+60^{\circ}\text{C}$ (140°F). If the hoist is used at temperatures below -20°C (-4°F) or above $+60^{\circ}\text{C}$ ($+140^{\circ}\text{F}$), consult the manufacturer or dealer since some parts should be changed.

* Calcium soap grease equivalent of NLGI (National Lubricating Grease Institute) / 2, or EP 2.

6-2-2 Trolley wheels and hand chain

Trolley wheel bearings do not need to be lubricated and must be replaced if worn or damaged. Hand chain, used on geared trolley, does not normally require lubrication.

6-3 Overhaul and assembly

Overhaul and assemble should be performed with reference to the following figures.

- Fig. 23 : for 0.5t to 3t plain trolley
- Fig. 24 : for 5t plain trolley
- Fig. 25 : for 0.5t to 3t geared trolley
- Fig. 26 : for 5t geared trolley

6-3-1 Precaution in overhaul and assembly

- (1) Parts names are described in parts list on page 23 to 28.
- (2) For overhauling a geared trolley, remove the track wheel first, then take off the pinion.
- (3) Adjusting spacers and fixing spacers can be classified by colour.
Adjusting spacers : yellow Fixing spacers : white
- (4) When connecting with geared trolley, install it as the trolley's hand chain should be on right side from the hoist's name plate side.
- (5) Bend the split pin firmly as shown in Fig. 16-1 or 16-2. When removing the frame for installing the trolley onto rail, tighten the split pin firmly after the installation is completed.
- (6) Place the shaft stopper pin as shown in Fig. 16-1 or 16-2 and the flat surface should be touched on adjusting spacers.

Fig. 16-1

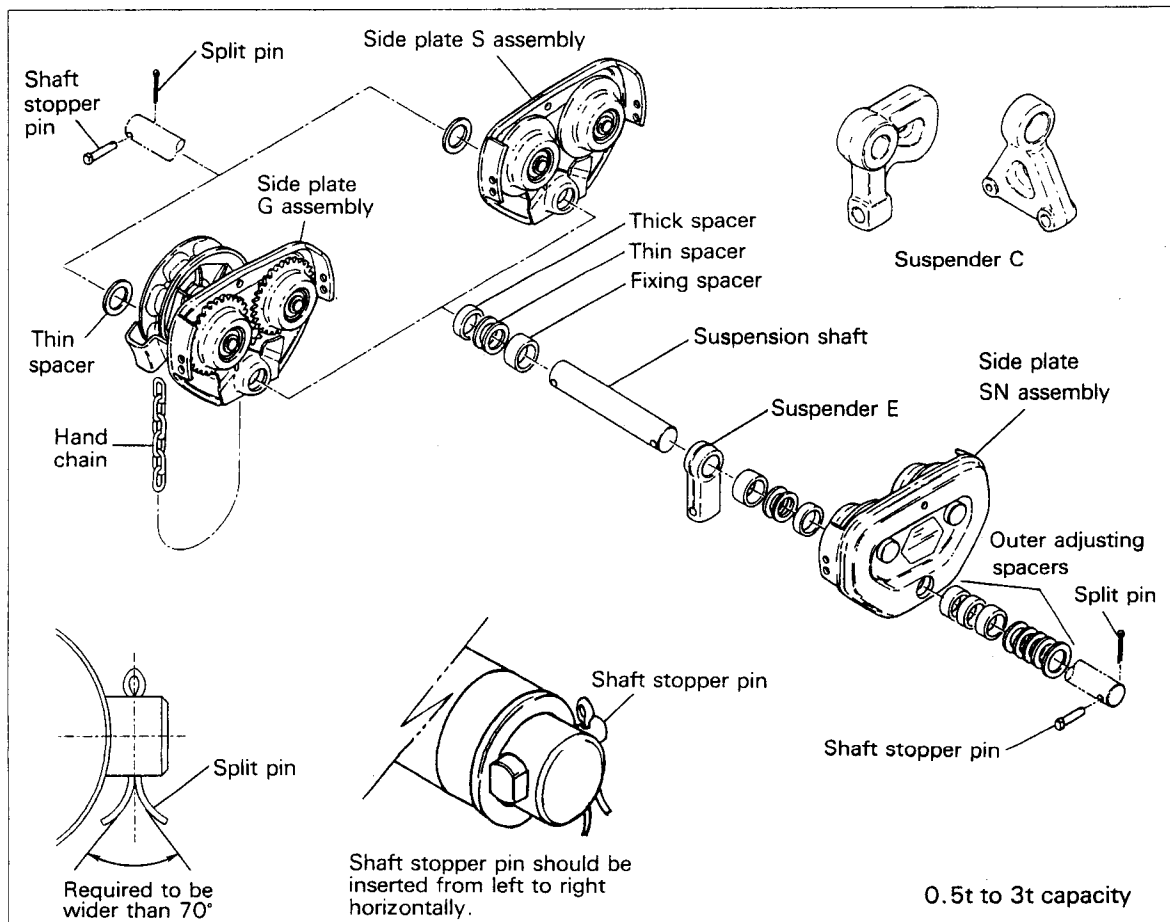
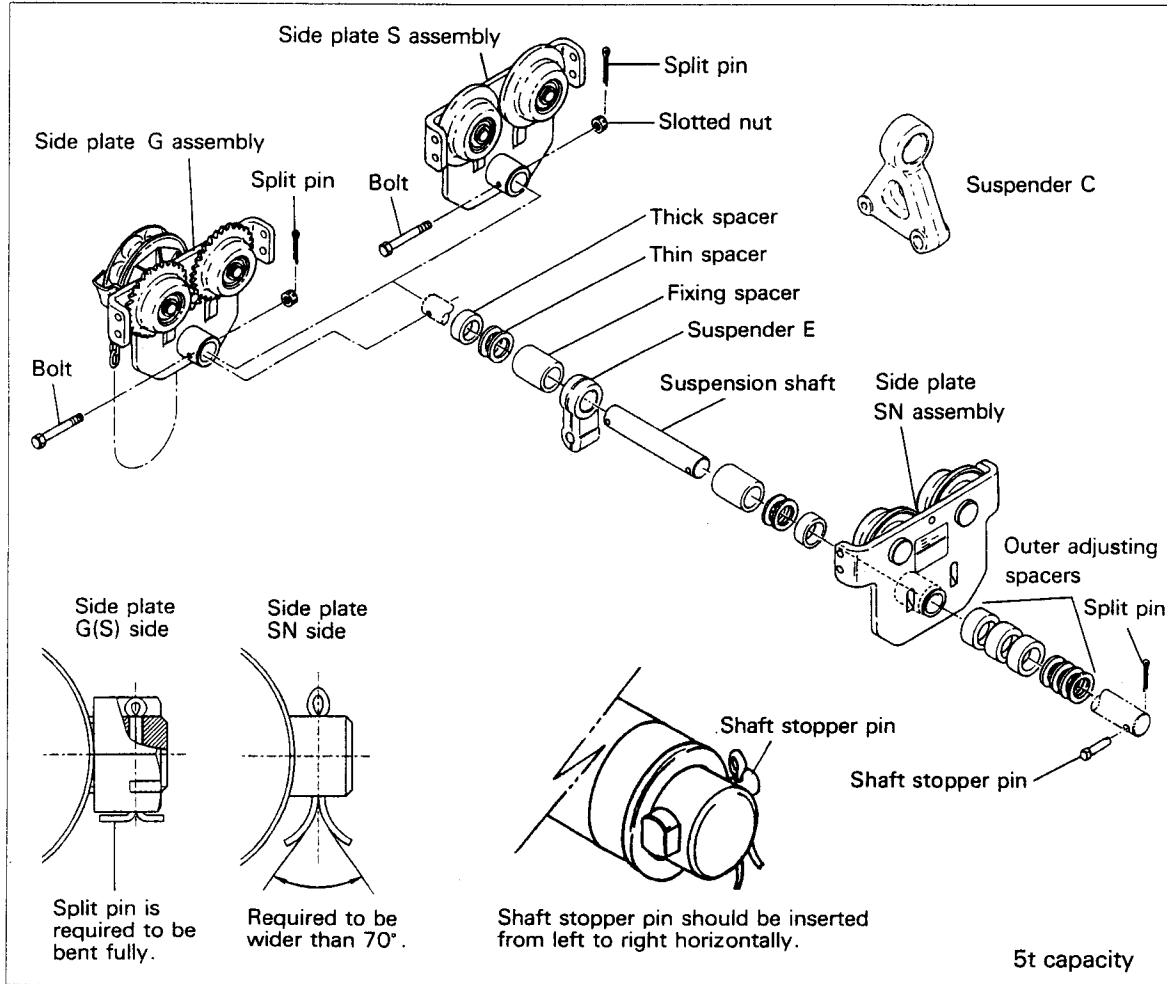


Fig. 16-2



7. BUFFER AND T-TYPE HANGER

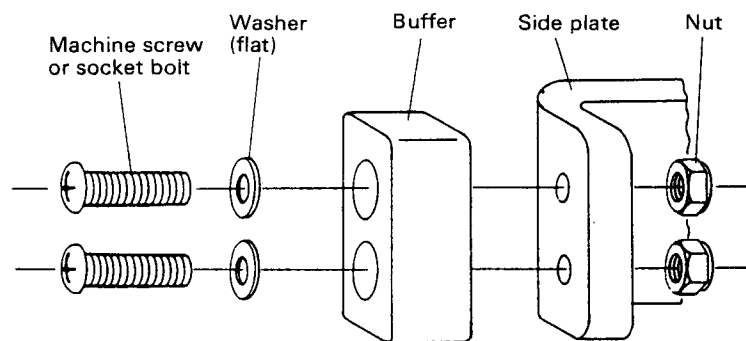
7-1 Buffer

The side plates "S" and "G" have bumpers (lug) which prevent damage to the wheel and to the trolley. Buffers are available as option.

7-1-1 Installation of buffer

Assemble as described below. Tighten the screw tightly, so the buffer can not be moved by hand.

Fig. 17



7-2 T-type hanger

A T-type hanger is used for moving the power supply cable while running together with the trolley on the same rail. When employing a T-type hanger, an additional fitting (cable pusher) is needed.

7-2-1 Installation of cable pusher

(1) Up to 3 t capacity

Fix the cable pusher by the M5 socket bolt with a spring washer from outside the side plate. When the power supply is on right as shown in Fig. 18, place the cable pusher on right side of the side plate.

When the power supply is on left, turn the cable arm fitting 180° (upside down direction) and re-install it. Then re-install the cable pusher on the left side of the side plate.

(2) 5 t capacity

Fix the cable arm by the bolt and spring washer into the $\phi 8\text{mm}$ hole of the side plate from inside. The method of installation depends on the direction of the power supply cable.

* When there is no taps or holes for installation of the cable pusher on the side plate, make them referring to Fig. 20 and Table 7.

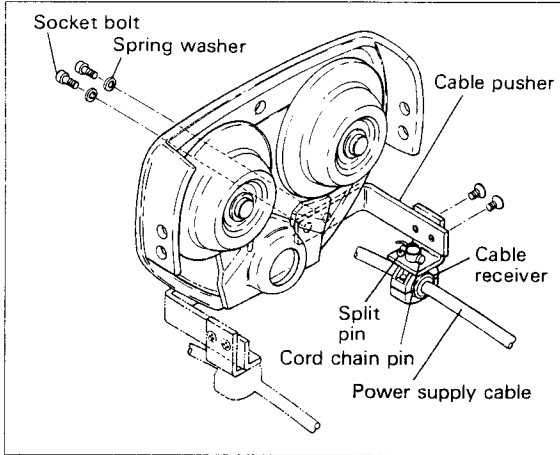


Fig. 18

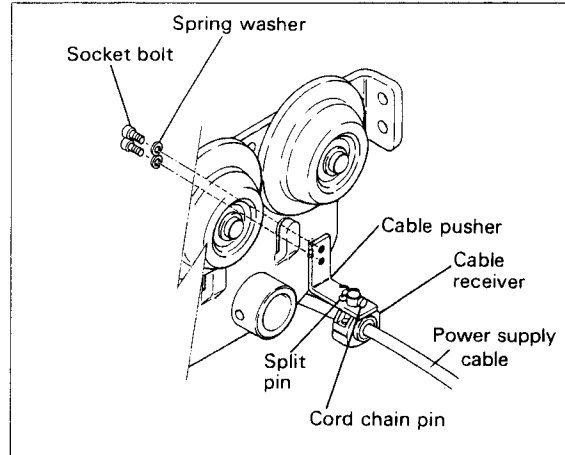


Fig. 19

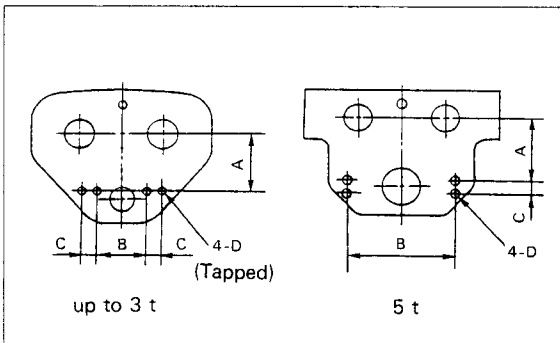


Fig. 20

	A	B	C	D
1/2t	62	50	15	M5
1t	75	80	15	M5
2t	86	80	22	M5
3t	93.5	124	22	M5
5t	142	242	19	$\phi 8.5$

Table 7

7-2-2 Installation of cable receiver

Install the cable receiver onto the hole ($\phi 14\text{mm}$) from the bottom side of the cable pusher (cable arm) with a cord chain pin and a split pin. (Bend the split pin firmly). (Refer to Fig. 18 or 19.)

7-2-3 Installation of T-type hanger

(1) Type

There are 3 types. After adjusting the rail width as refer to the table below, install the T-type hanger from the rail end. (See Fig. 21)

(2) Installation of T-type hanger

After adjusting beam width as refer to the table 8, install the required number of the T-type hanger as shown in Fig. 22.

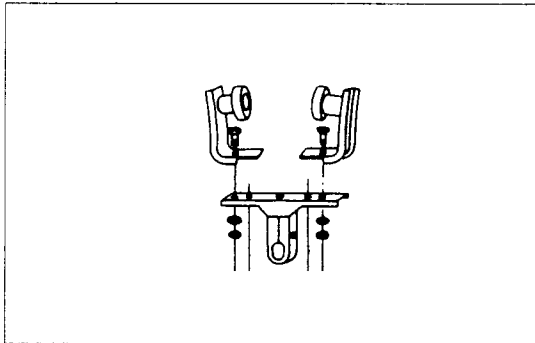


Fig. 21

Type	Beam Width (mm)
T-type hanger 200	76 to 102 (3" to 4")
T-type hanger 250	102 to 152 (4" to 6")
T-type hanger 275	127 to 178 (5" to 7")

Table 8

Note : Ask your authorized Kito dealer if the beam width exceeds 178mm.

*The intervals between adjacent hangers.

In case of the straight beam or the larger radius curved beam, 2m interval between hangers is adequate. In case of smaller radius curved beam, closer interval gives smooth operation. For example, if the curve radius is about 1.5m, about 1m interval is adequate.

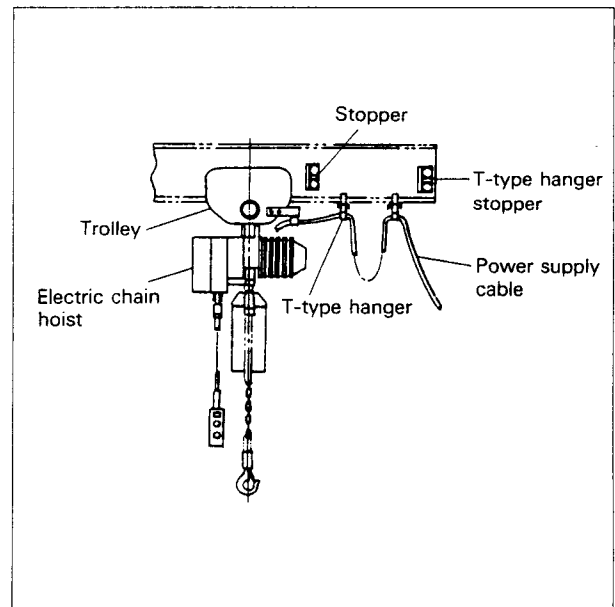


Fig. 22

8. WARRANTY

Kito Corporation ("Kito") extends the following warranty to the original purchaser ("Purchaser") of new products manufactured by "Kito"(Kito's Products).

- (1) "Kito" warrants that Kito's Products, when shipped, shall be free from defects in workmanship and/or materials under normal use and service and "Kito" shall, at the election of "Kito", repair or replace free of charge any parts or items which are proven to have said defects, provided that all claims for defects under this warranty shall be made in writing immediately upon discovery and, in any event, within one (1) year from the date of purchase of Kito's Products by "Purchaser" and provided, further, that defective parts or items shall be kept for examination by "Kito" or its authorized agents or returned to Kito's factory or authorized service center upon request by "Kito".
- (2) "Kito" does not warrant components of products provided by other manufacturers. However, to the extent possible, "Kito" will assign to "Purchaser" applicable warranties of such other manufacturers.
- (3) Except for the repair or replacement mentioned in (1) above which is "Kito"'s sole liability and purchaser's exclusive remedy under this warranty, "Kito" shall not be responsible for any other claims arising out of the purchase and use of Kito's Products, regardless of whether "Purchaser"'s claims are based on breach of contract, tort or other theories, including claims for any damages whether direct, indirect, incidental or consequential.
- (4) This warranty is conditional upon the installation, maintenance and use of Kito's Products pursuant to the product manuals prepared in accordance with content instructions by "Kito". This warranty shall not apply to Kito's Products which have been subject to negligence, misuse, abuse, misapplication or any improper use or combination or improper fittings, alignment or maintenance.
- (5) "Kito" shall not be responsible for any loss or damage caused by transportation, prolonged or improper storage or normal wear and tear of Kito's Products or for loss of operating time.
- (6) This warranty shall not apply to Kito's Products which have been fitted with or repaired with parts, components or items not supplied or approved by "Kito" or which have been modified or altered.

THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY WARRANTY OF MERCHANTABILITY OR OF FITNESS FOR A PARTICULAR PURPOSE.

9. PARTS LIST

*When ordering replacement parts, please specify the following points.

1. Part name and trolley capacity.
2. Correct figure number.

Plain trolley (Rail width-standard)

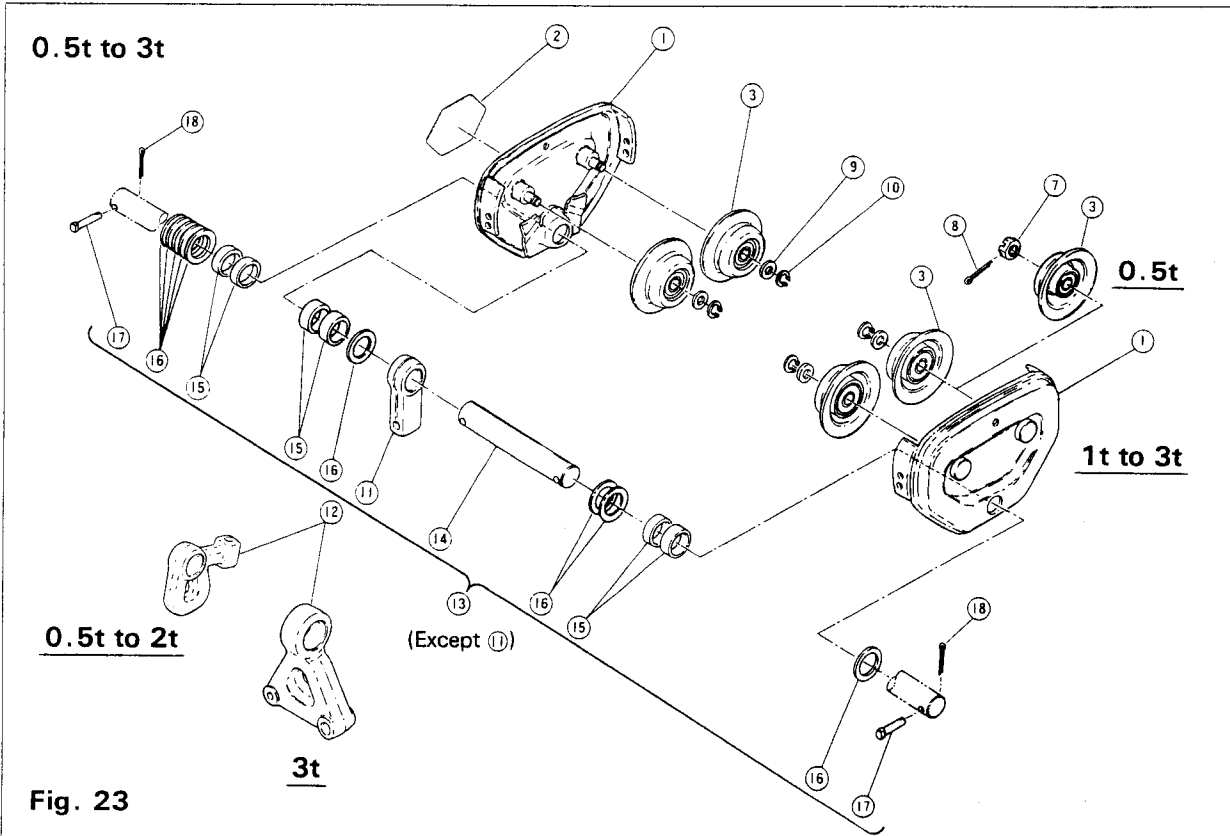


Fig. 23

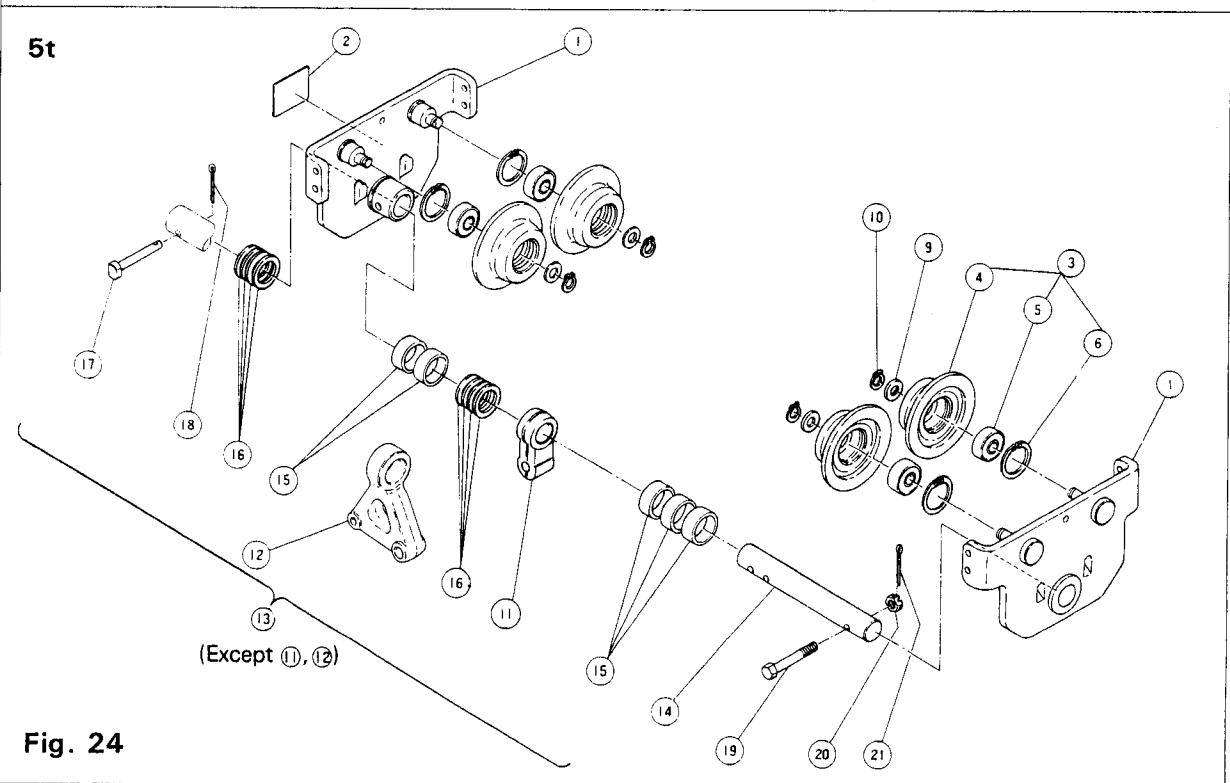
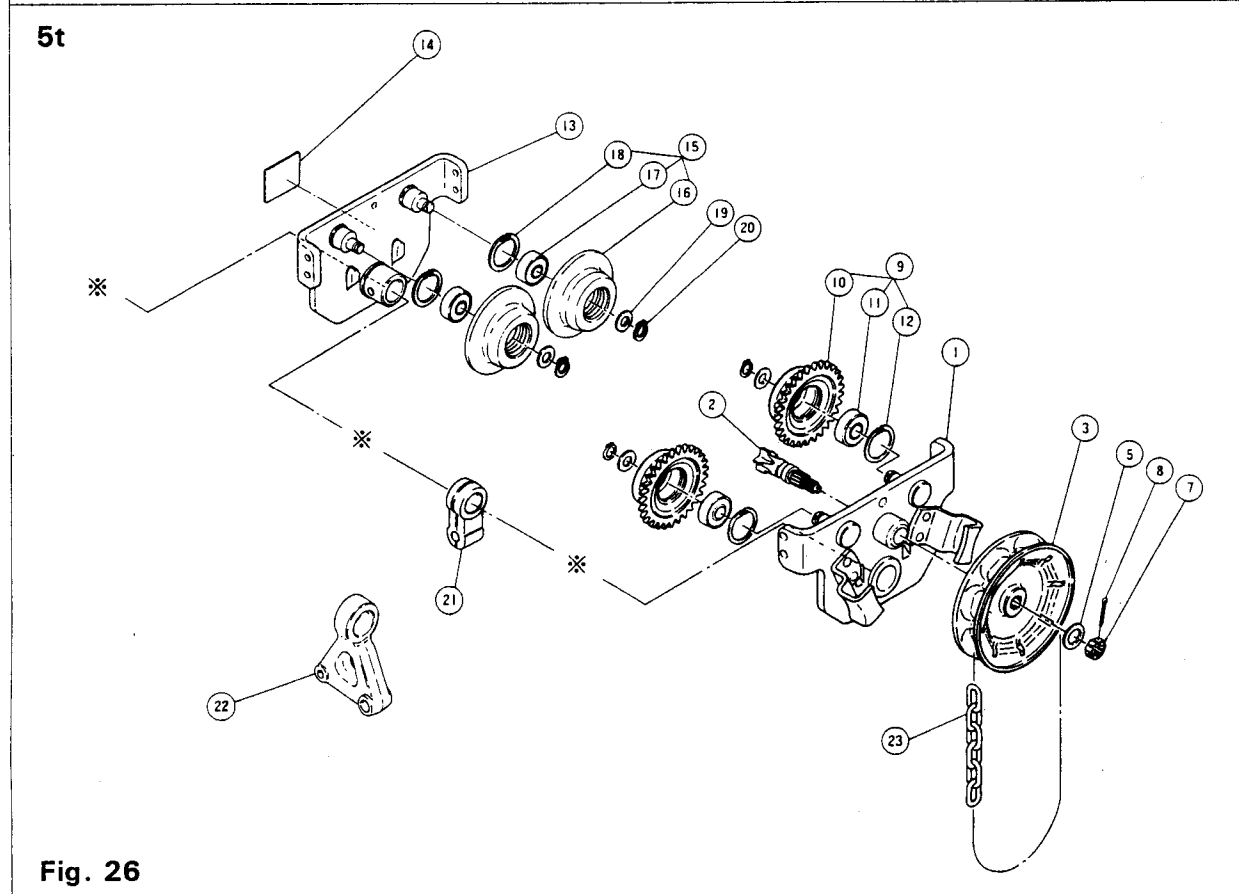
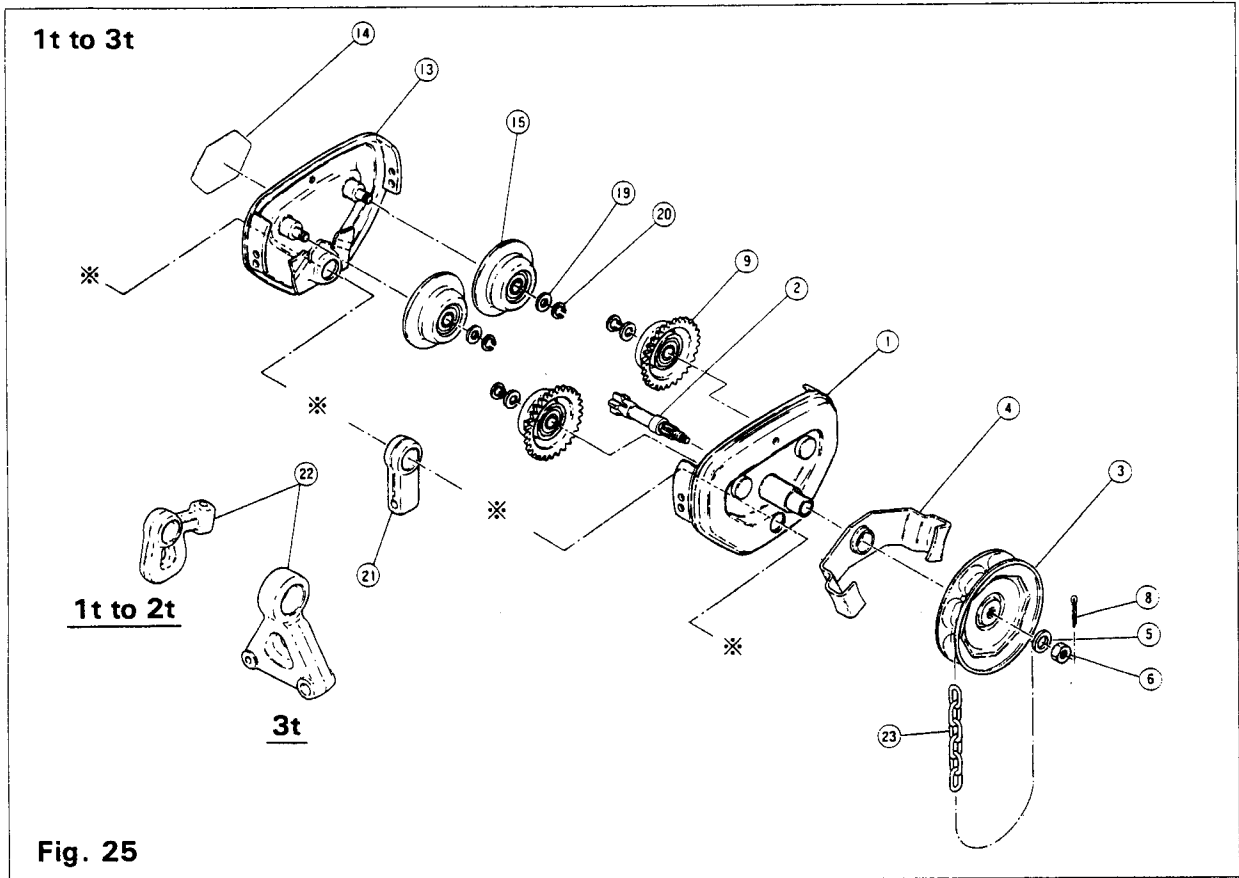


Fig. 24

Fig. No.	Part No.	Part Name	Nos. per Trolley	Capacity					Remarks
				0.5t	1t	2t	3t	5t	
1		Side plate S Assembly	2					—	
		Side plate S Assembly	2	—	—	—	—		
2	T7G-800	Name plate B	1						
3	T6G-5102	Track wheel S Assembly	4					—	
	T3G-1102	Track wheel S Assembly	4	—	—	—	—		
4		Track wheel S	4	—	—	—	—		
5		Ball bearing	4	—	—	—	—	(6307ZZ)	
6		Snap ring	4	—	—	—	—	(R-80)	
7	T6P-158	Slotted nut	4	(L-M10)	—	—	—	—	
8	T6P-159	Split pin	4	(2×16)	—	—	—	—	
9	T6-104	Track wheel washer	4	—		(T1G-2')	(T1G-3')	(MS3-5')	
10	T6G-106	Snap ring	4	—	(S-15)	(S-20)	(S-25)	(S-35)	
11	T7GB-004	Suspender E	1					(MS3-5')	for Electric chain hoist
12	T7GC-004	Suspender C	1					(T5G-5')	for Manual chain hoist
13	T7G-1115	Suspension shaft (standard) Assembly	1						
14	T7G-115	Suspension shaft (standard)	1						
15	T7G-116	Thick spacer	*					(T1G-5')	
16	T6G-117	Thin spacer	**					—	
	T7G-120		8	—	—	—	—		
17	T6G-156	Shaft stopper pin	2 (1)					(MS3-5')	(1) for 5t
18	T6G-157	Split pin	2 (1)	(3.2×20)		(4×20)		(4×22)	(1) for 5t
19	T4G-154	Suspension shaft bolt	1	—	—	—	—	(MS3-5')	
20	T4G-155	Slotted nut	1	—	—	—	—	(L-M12)	
21	T4G-156	Split pin	1	—	—	—	—	(3×22)	

Note : * 4p/cs for 0.5t, 6p/cs for 1t*2t, 9p/cs for 3t, 5p/cs for 5t.
** 10p/cs for 0.5t, 9p/cs for 1t, 8p/cs for 2t, 11p/cs for 3t.

Geared trolley (Rail width-standard)



Note : * Refer to the parts list of plain trolley for suspender assembly.

Fig. No.	Part No.	Part Name	Nos. per Trolley	Capacity				Remarks
				1t	2t	3t	5t	
1		Side plate G Assembly	1				_____	
		Side plate G Assembly	1	_____	_____	_____		
2	T7GB-121	Pinion	1	_____			(T4GB-1')	
			1		_____	_____	_____	for Electric chain hoist
	T7GC-127	Pinion	1		_____	_____	_____	for Manual chain hoist
3	T6G-123	Hand wheel	1				_____	
	T7G-123			_____	_____	_____		
4	T6G-5125	Hand chain guide Assembly	1				_____	
5	T7G-152	Washer	1		(L-M12)			
6	T7G-151	Lever nut	1		(M2-40')			_____
7	T4G-151	Slotted nut	1	_____	_____	_____	(L-M12)	
8	T7G-160	Split pin	1		(3 × 18)			(3 × 22)
9	T6G-5101	Track wheel G Assembly	2				_____	
	T3G-1102	Track wheel G Assembly	2	_____	_____	_____		
10		Track wheel G	2	_____	_____	_____		
11		Ball bearing	2	_____	_____	_____	(6307ZZ)	
12		Snap ring	2	_____	_____	_____	(R-80)	
13		Side plate S Assembly	1				_____	
		Side plate S Assembly	1	_____	_____	_____		
14	T7G-800	Name plate B	1					
15	T6G-5102	Track wheel Assembly	2				_____	
	T3G-1102	Track wheel S Assembly	2	_____	_____	_____		
16		Track wheel S	2	_____	_____	_____		
17		Ball bearing	2	_____	_____	_____	(6307ZZ)	
18		Snap ring	2	_____	_____	_____	(R-80)	
19	T6G-104	Track wheel washer	4		(T1G-2')	(T1G-3')	(MS3-5')	
20	T6G-106	Snap ring	4	(S-15)	(S-20)	(S-25)	(S-35)	
21	T7GB-004	Suspender E	1				(MS3-5')	for Electric chain hoist
22	T7GC-004	Suspender C	1				(TS1-5')	for Manual chain hoist
23	T7G-842	Hand chain	1	(2.5m)	*2.5m for 1.5t (3m)		(3.5m)	for Manual chain hoist

Rail width-option

Suspension shaft W20 Assembly. (0.5t, 1t)

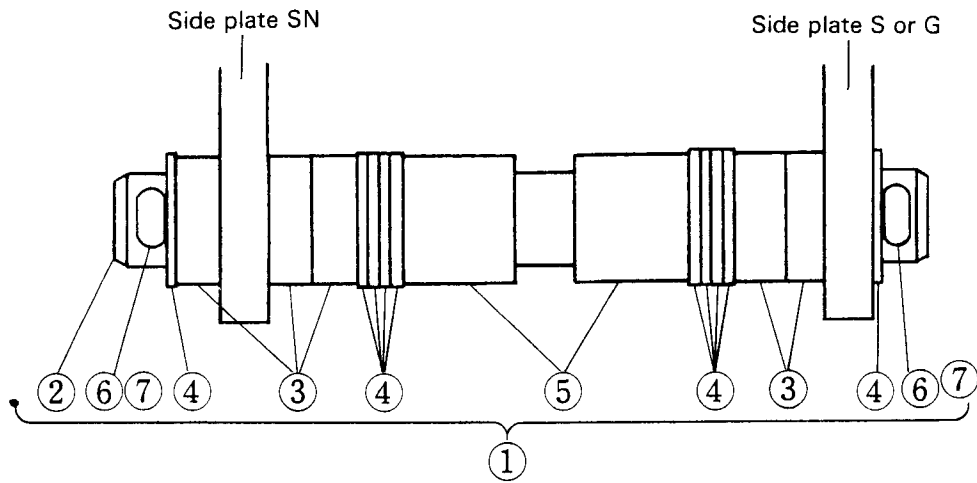


Fig. 27

Suspension shaft W30 Assembly. (0.5t to 3t)

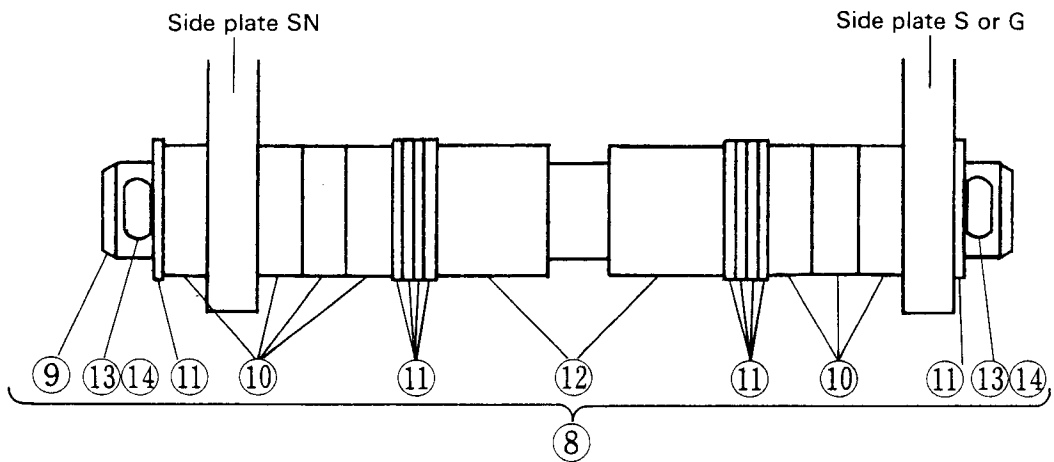


Fig. 28

Suspension shaft W30 Assembly. (5t)

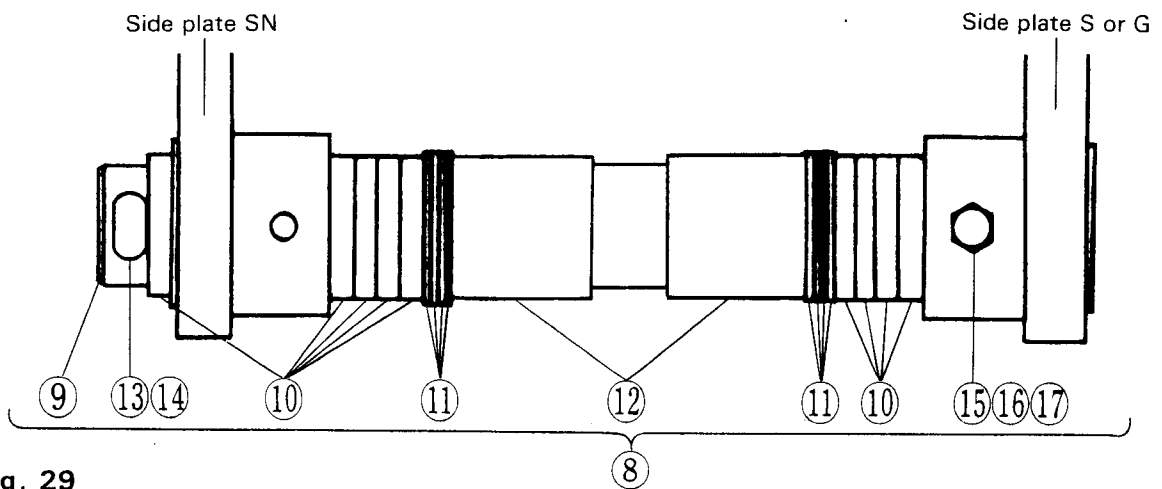


Fig. 29

Fig. No.	Part No.	Part Name	Nos. per Trolley	Capacity					Remarks
				0.5t	1t	2t	3t	5t	
1	T7G-136	Suspension shaft W20 Assembly	1			—	—	—	
2	T7G-136	Suspension shaft W20	1			—	—	—	
3	T7G-116	Thick spacer	*			—	—	—	
4	T6G-117	Thin spacer	10			—	—	—	
5	T7G-137	Fixing spacer W20	2			—	—	—	
6	T6G-156	shaft stopper pin	2			—	—	—	
7	T6G-157	Split pin	2	(3.2 × 20)					
8	T7G-1181	Suspension shaft W30 Assembly	1						
9	T7G-181	Suspension shaft W30	1						
10	T7G-116	Thick spacer	**					(T1G5')	
11	T6G-117	Thin spacer	10					—	
	T7G-120		8	—	—	—	—		
12	T7G-182	Fixing spacer W30	2						
13	T6G-156	Shaft stopper pin	2 (1)				(MF2-2')	(MS3-5')	(1) for 5t
14	T6G-157	Split pin	2 (1)	(3.2 × 20)		(4 × 20)		(4 × 22)	(1) for 5t
15	T4G-154	Shaft stopper pin	1	—	—	—	—	(MS3-5')	
16	T4G-155	Slotted nut	1	—	—	—	—	(L-M12)	
17	T4G-156	Split pin	1	—	—	—	—	(3 × 22)	

Note : *7p'cs for 0.5t, 5p'cs for 1t.

**7p'cs for 0.5t+1t, 11p'cs for 2t+3t, 9p'cs for 5t.

NOTES



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INSTRUCTION MANUAL

ELECTRIC LEVEL CONTROLS

LINC-L471 • LINC-L471SC • LINC-LV471 • LINC-L971

*Recognized as a
world-class leader in
level control
switches,
diaphragm operated
motor valves,
flow indicators,
chemical metering
pumps, and
allied products.*

LINC
MANUFACTURING

ELECTRIC LEVEL CONTROLS

PRODUCT DESCRIPTION

Scope Of This Manual:

This manual describes and provides instructions and parts lists for the LINC-L471, LINC-L471SC, LINC-LV471 and LINC-L971 Series Electric Level Controls.

Product Description:

Used as a high & low level control, the L471 & L471SC can activate alarms, provide a switch input for control systems, or perform a variety of desired electrical switch operations actuated by a liquid or liquid interface.

Operation:

As the float is moved by varying liquid height, a magnet is moved closer to or further away from a switch enclosure. As the magnet moves closer, a reed switch in the enclosure closes. As the magnet moves further away, the switch opens. The arm containing the magnet also acts as a counterweight for the float.

The float is small and will operate in liquids with a specific gravity as low as 0.4. The interface type float will operate with a specific gravity differential as low as 0.1. The small float permits an economical installation in locations where other controls would be cost prohibitive. With the optional relay mounted in an explosion-proof case, the control of larger electrical loads can be obtained. The manual override option allows the operator to manually move the float arm to the test switch position.

The SC Series is designed to eliminate the threaded control connection in mounting with the use of a bolted ring per API recommended practice RP14E. The external cage allows for installation of the control at any elevation.

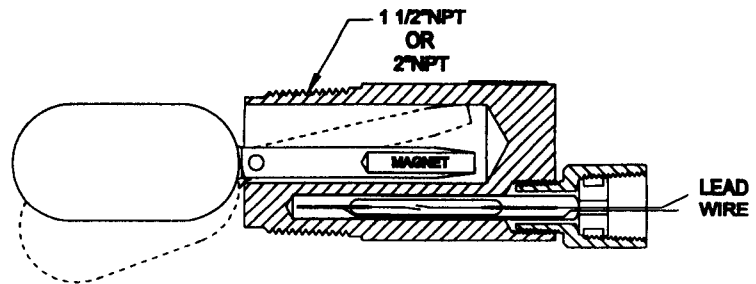


Figure 1

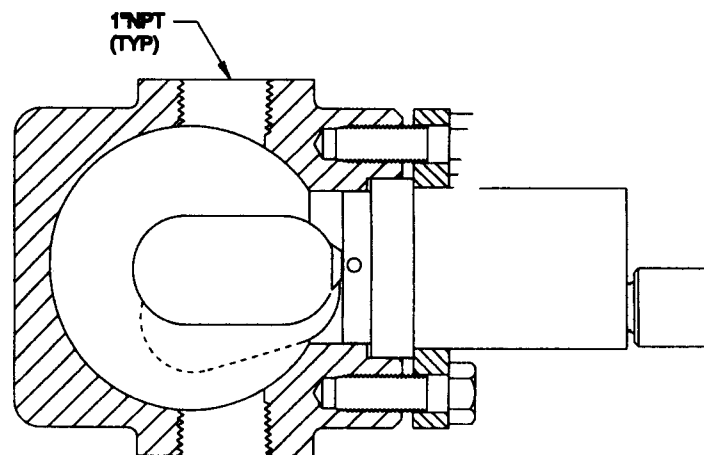


Figure 2

Features:

- All wetted parts isolated from the environment. These level controls are safe even in the event of fire.
- *Certified as explosion proof for Hazardous Locations: Class I, Div. 1, Groups A, B, C, D; Class II, Div. 1, Groups E, F, G; & Class III, Div. 1.
- All 316 stainless steel wetted parts provide corrosion resistance. Also available in Monel, Kynar and other plastics.
- Our sealed switch assembly prevents dust, dirt, or moisture from affecting the level control's operation. Classified "Factory Sealed" by CSA/NRTL/C.
- Cartridge switch assembly provides easy field replacement and servicing.
- High or low alarm, normally open or normally closed operation simply by inverting the level control.

*When a relay assembly is used, Class I, Div. 1, is limited to groups C and D.

ELECTRIC LEVEL CONTROLS

I N S T A L L A T I O N

Installation

Before installing the level control, inspect the unit for any damage. The float arm must pivot freely. Thread the level control into the desired connection. See Figure 3 for suggested installations. The float requires a minimum clearance of 1 1/4" from the center line of the unit for proper operation. For operation as a high level alarm, the conduit connection must be positioned to the lowest possible location. For operation as a low level alarm, the conduit connection must be positioned to the highest possible location. Wiring connections may now be made. Do not allow the wiring connections to pull on the switch assembly.

Caution: Do not exceed switch ratings.

LINC-L471, LINC-L471SC:
SPST, 100 VA AC with 3
AMP inrush capability,
maximum 250 volts.

Breakdown voltage is 300 volts. Electrical ratings are given for resistive loads. For inductive loads, de-rate the switch rating by 50% and do not exceed the VA ratings on the inrush current. If the applied load is inductive, such as a relay or coil, then a protective device should be used to prevent "inductive

kick," which may burn the switch contacts. The protective device recommended is dependent on the voltage used. For DC operation, a diode similar to an IN34A should be wired in parallel with the switch. See Figure 4, wiring schematic. For AC operation, a Varistor should be wired in parallel with the switch. Recommended Varistor for

110 VAC is a G.E. #V150-LA1 and for 220 VAC a G.E. #V300-LA2. See Figure 4, Wiring Schematic.

For SPDT Switch Cartridge Wiring:

White - Common
Black - Normally Closed
Red - Normally Open

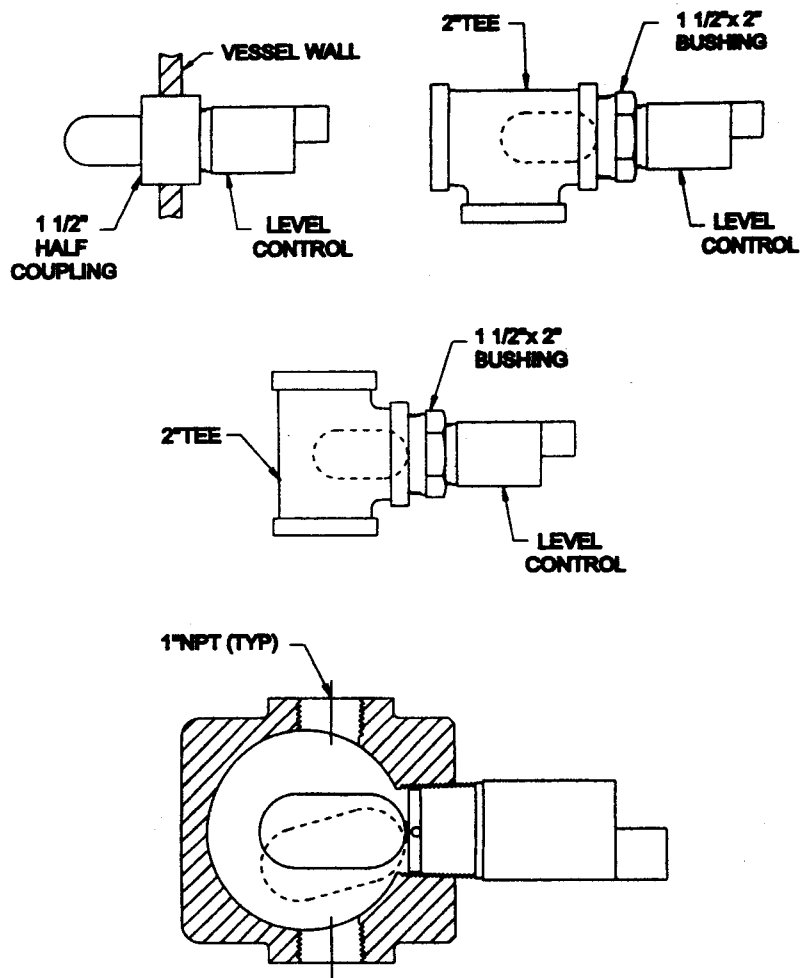


Figure 3

ELECTRIC LEVEL CONTROLS

M A I N T E N A N C E

Maintenance:

The LINC-L471 and LINC-L471SC Series electric level controls have been designed to be as maintenance free as possible. However, the component parts are subject to normal wear and must be inspected and replaced as necessary. Inspection and maintenance frequency depend upon the severity of service conditions. Instructions are provided in this section for maintaining the controls as units, i.e., float and float arm, relay and switch cartridge.

All the maintenance procedures below assume that the control has been removed from service. The switch and relay can be serviced with the control installed. The power must be disconnected before removing the relay enclosure cover or opening the conduit fitting.

Float & Float Arm:

Check the physical clearance for float operation. The float must swing freely. Solvent cleaning of the float arm chamber may be required if used in viscous or dirty liquids. If the float has collapsed or is perforated, unscrew the float from the float arm and replace with a new float. Use Loctite® to secure the float to the float arm. To remove the float arm,

drive out the pivot pin using a 1/8" punch. When installing the float arm, make certain that the threaded offset of the float arm is against the thick wall of the body.

Relay:

To test for proper relay function, disconnect the switch leads from the relay socket. Apply appropriate voltage to the coil terminals and observe the relay contact closure with an ohmmeter connected across the common and normally closed contacts. Interrupt the coil power supply several times while observing the ohmmeter. No movement indicates a defective relay, coil or contacts. This procedure should be repeated for each set of contacts in service.

To remove a defective relay, simply pull the relay from the socket and replace with a new relay.

When ordering a replacement relay, be certain to specify coil voltage. After installing a new relay, reconnect the switch leads.

Switch:

To test for switch malfunction, connect an ohmmeter across the electrical leads and observe the meter as the float assembly is mechanically operated. No meter move-

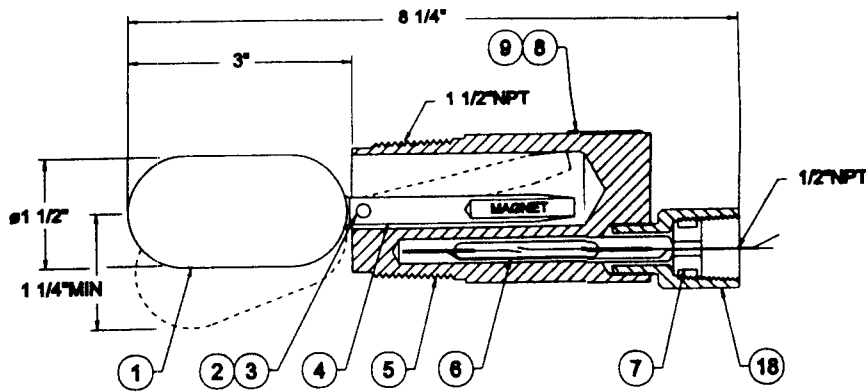
ment indicates a switch failure.

To replace a switch on the LINC-L471 or LINC-L471SC Series, pull out the switch cartridge along with the grommet through the conduit adapter. Slide the new switch cartridge into the body. Route the switch wired through the grommet and seat the grommet in the conduit adapter.

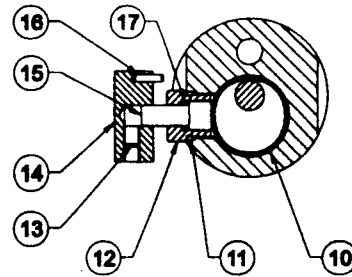
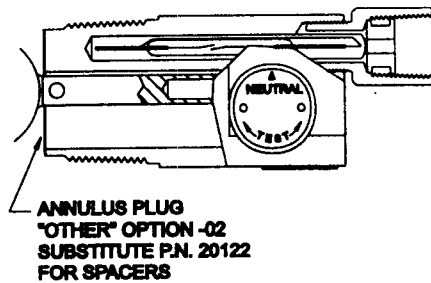
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ELECTRIC LEVEL CONTROLS

L I N C - L 4 7 1 - 0 1



Model LINC-L471-01



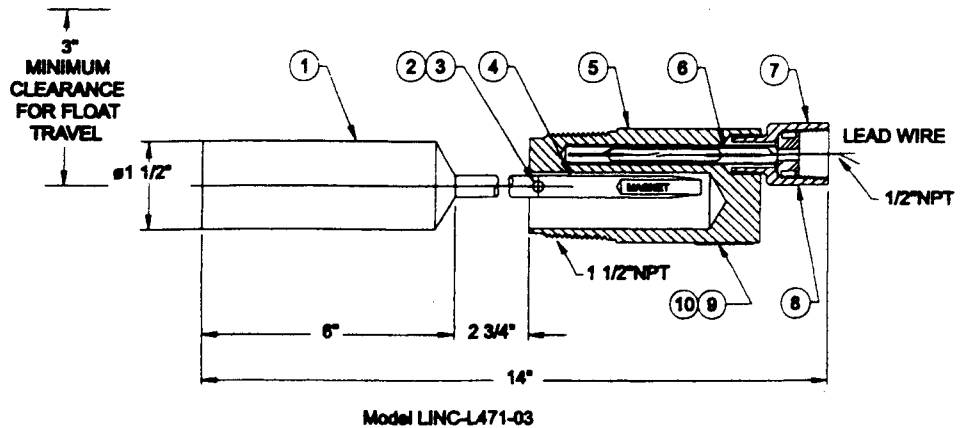
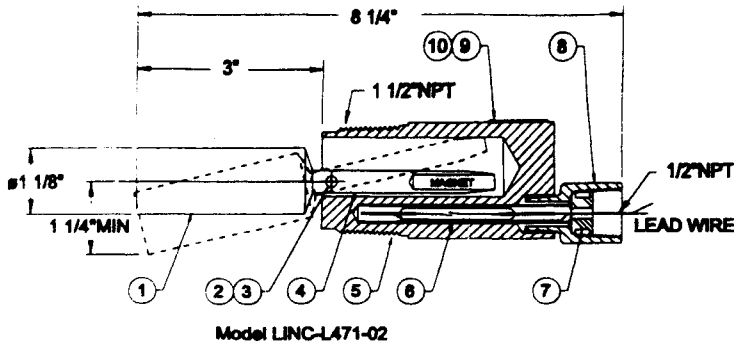
MANUAL OVERRIDE, STANDARD BODY
Body Style -2, -4

Model	L471-01	L471-21	Description	Material	Qty
1	10245	10245	Float	316 ss	1
2	20120	20120	Pin	316 ss	1
3	20121	20121	Spacer	316 ss	2
4	20853	24883	Float Arm Assembly	316 ss	1
5	30313	30715	Body	316 ss	1
6*	20495	20495	Switch Cartridge	304 ss	1
7	10087	10087	Grommet	Nitrile	1
8	10012	10012	Name Plate	316 ss	1
9	10324	10324	Drive Screw (not shown)	18-8 ss	4
10		24885	Ring Weldment	316 ss	1
11		10996	O-Ring	Fluorocarbon	1
12		22271	Packing Gland	316 ss	1
13		10621	Set Screw	18-8 ss	1
14		22577	Knob	303 ss	1
15		24875	Stem	316 ss	1
16		11192	Roll Pin	18-8 ss	3
17		10108	O-Ring	Fluorocarbon	1
18	20119	20119	Conduit Adapter	303 ss	1
19		11193	Name Plate (not shown)	Sealed	1
20	24834	24834	Switch Cartridge SPST 500°F (Optional)	Sealed	1
21	24835	24835	Switch Cartridge SPDT 500°F (Optional)	Sealed	1
22	24836	24836	Switch Cartridge SPDT 400°F (Optional)	Sealed	1

*Recommended spare

ELECTRIC LEVEL CONTROLS

LINC-L471-02 & LINC-L471-03

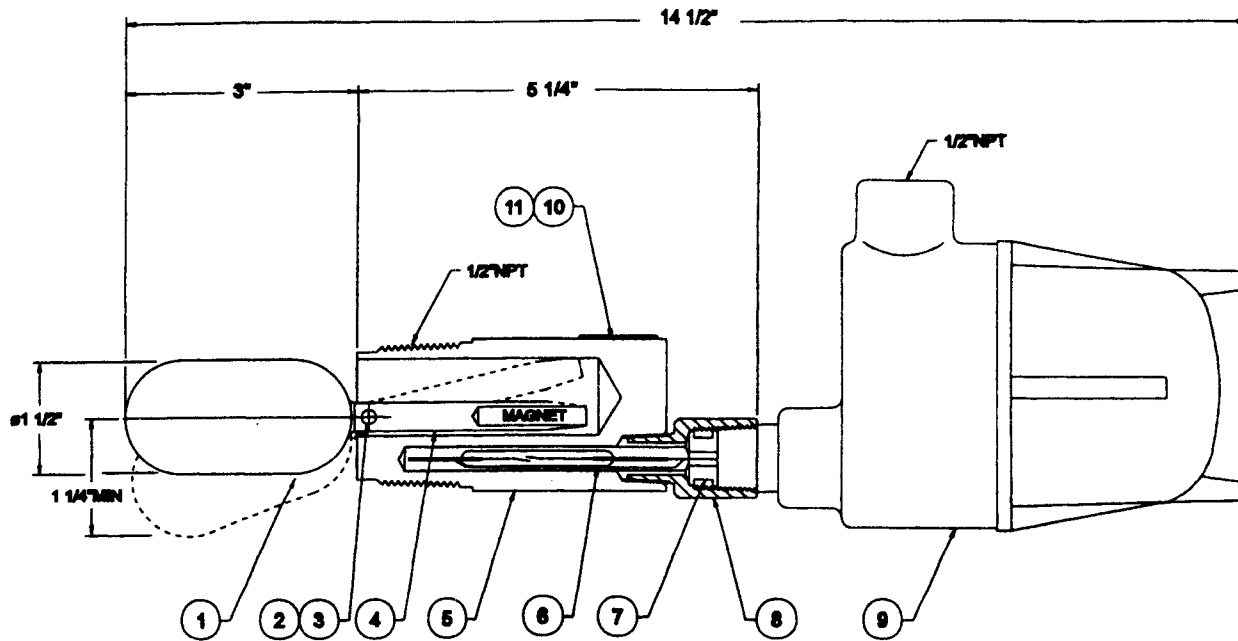


Model	L471-02	L471-03	Description	Material	Qty
1	20149	20136	Float	Polypropylene	1
2	20120	20120	Pin	316 ss	1
3	20121	20121	Spacer	316 ss	2
4	20853	21671	Float Arm Assembly	316 ss	1
5	30313	30313	Body	316 ss	1
6	20495	20495	Switch Cartridge	Sealed	1
7	10087	10087	Grommet	Nitrile	1
8	20119	20119	Conduit Adapter	303 ss	1
9	10012	10012	Name Plate	316 ss	1
10	10324	10324	Drive Screw (not shown)	18-8 ss	2
11	24834	24834	Switch Cartridge SPST 500°F (Optional)	Sealed	1
12	24835	24835	Switch Cartridge SPDT 500°F (Optional)	Sealed	1
13	24836	24836	Switch Cartridge SPDT 400°F (Optional)	Sealed	1

*Recommended spare

ELECTRIC LEVEL CONTROLS

L I N C - L 4 7 1 - 0 1 - 0 4

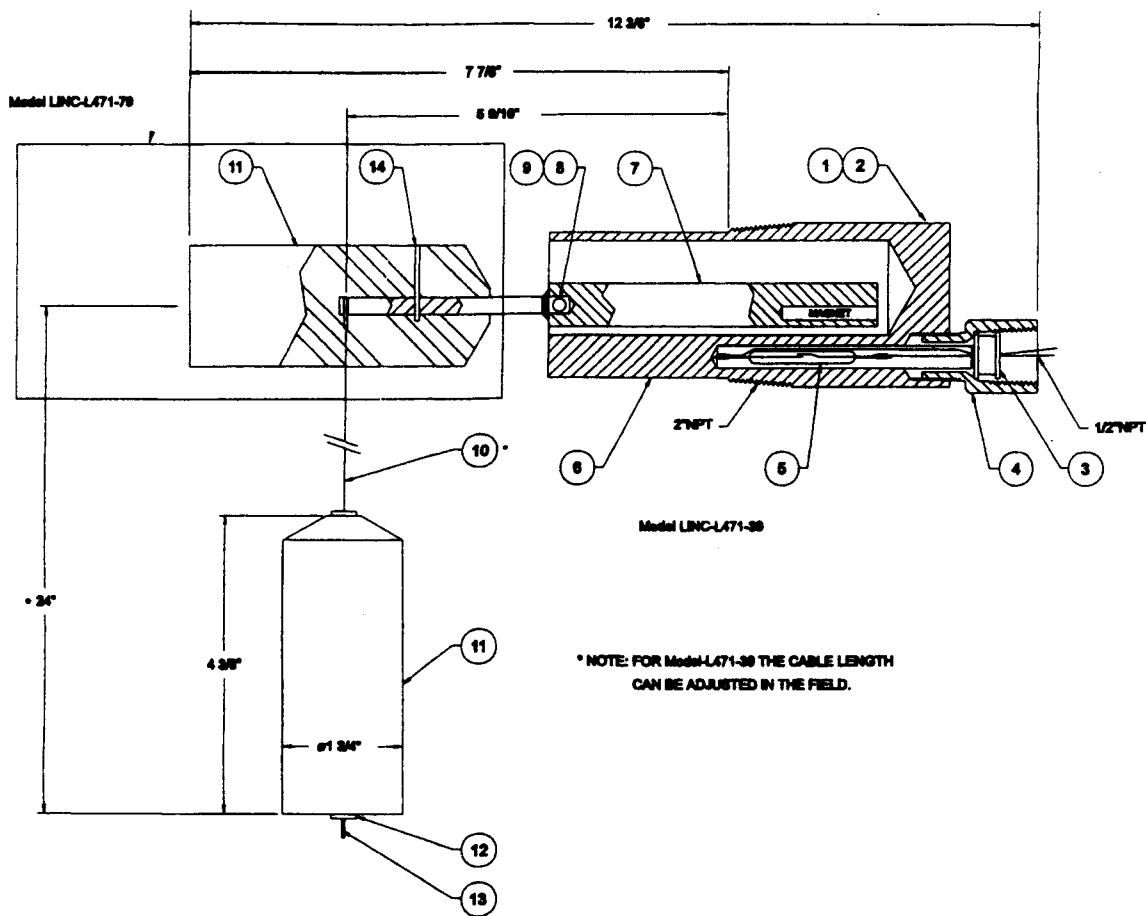


Model	LINC-L471-01-04			
Item	Part #	Description	Material	Qty
1	10245	Float	316 ss	1
2	20120	Pin	316 ss	1
3	20121	Spacer	316 ss	2
4	20853	Float Arm Assembly	316 ss	1
5	30313	Body	316 ss	1
6*	20495	Switch Cartridge	Sealed	1
7	10087	Grommet	Nitrile	1
8	20119	Conduit Adapter	303 ss	1
9	21593	Relay Assembly (110 VAC see relays)		1
10	10419	Name Plate	316 ss	1
11	10324	Drive Screw (not shown)	18-8 ss	2
12	24834	Switch Cartridge SPST 500°F (Optional)	Sealed	1
13	24835	Switch Cartridge SPDT 500°F (Optional)	Sealed	1
14	24836	Switch Cartridge SPDT 400°F (Optional)	Sealed	1

*Recommended spare

ELECTRIC LEVEL CONTROLS

L I N C - L 4 7 1 - 3 9 & 7 9

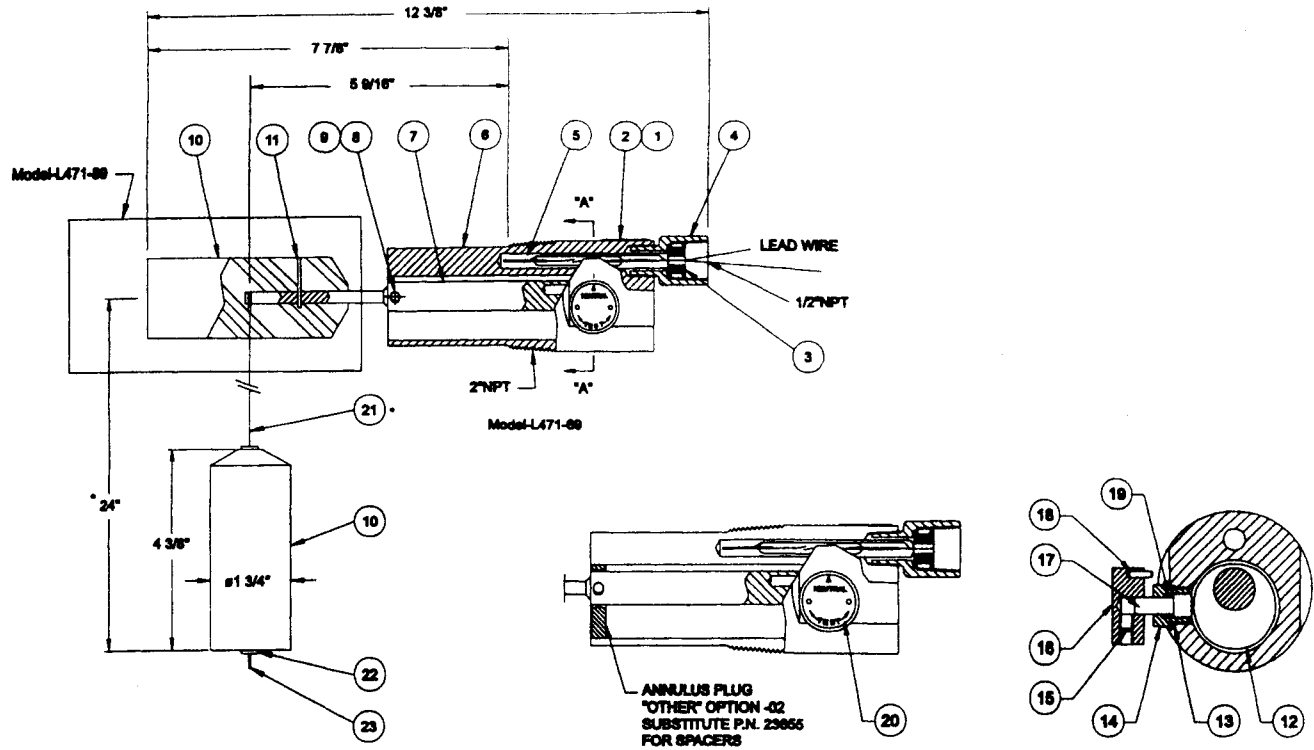


Item	Part #	Part #	Description	Material	Qty
1	10012	10012	Name Plate	316 ss	1
2	10324	10324	Drive Screw	18-8 ss	2
3	10087	10087	Grommet	Nitrile	1
4	20119	20119	Conduit Adapter	303 ss	1
5**	20495	20495	Switch Cartridge	Sealed	1
6	31079	31079	Body	316 ss	1
7	23540	23540	Float/Magnet Arm	316 ss	1
8	20334	20334	Pin	316 ss	1
9	23604	23604	Spacer	316 ss	2
10	11566		Wire Cable	304 ss	24"
11	23503	23503	Displacer	Polypropylene	1
12	23500		Stop Ring	316 ss	1
13	11565		Crimp	18-8 ss	3
14		11571	Pin	316 ss	1
15	24834	24834	Switch Cartridge SPST 500°F (Optional)	Sealed	1
16	24835	24835	Switch Cartridge SPDT 500°F (Optional)	Sealed	1
17	24836	24836	Switch Cartridge SPDT 400°F (Optional)	Sealed	1

**Recommended spare

ELECTRIC LEVEL CONTROLS

L I N C - L 4 7 1 - 6 9 & 8 9



NOTE: FOR Model-L471-89, THE CABLE LENGTH CAN BE ADJUSTED IN THE FIELD.

MANUAL OVERRIDE, EXTENDED BODY
Body Style -6, -8

Model	L471-69	L471-89	Description	Material	Qty
1	10012	10012	Name Plate	302 ss	1
2	10324	10324	Drive Screw	18-8 ss	4
3	10087	10087	Grommet	Nitrile	1
4	20119	20119	Conduit Adapter	303 ss	1
5*	20495	20495	Switch Cartridge	Sealed	1
6	31079	31265	Body	316 ss	1
7	24083	24083	Float/Magnet Arm	316 ss	1
8	20334	20334	Pin	316 ss	1
9	23604	23604	Spacer	316 ss	1
10	23503	23503	Displacer	Polypropylene	1
11		11571	Pin	316 ss	1
12	24887	24887	Ring Weldment	316 ss	1
13	10996	10996	O-Ring	Fluorocarbon	1
14	22271	22271	Packing Gland	316 ss	1
15	10621	10621	Set Screw	18-8 ss	1
16	22577	22577	Knob	303 ss	1
17	24875	24875	Stem	316 ss	1
18	11192	11192	Roll Pin	15-7 PH ss	3
19	10108	10108	O-Ring	Fluorocarbon	1
20	11193	11193	Name Plate Manual Check	304 ss	1
21	11566		Wire Cable	304 ss	
22	23500		Stop Ring	316 ss	2
23	11565		Crimp	18-8 ss	3
24	24834	24834	Switch Cartridge SPST 500°F (Optional)	Sealed	1
25	24835	24835	Switch Cartridge SPDT 500°F (Optional)	Sealed	1
26	24836	24836	Switch Cartridge SPDT 400°F (Optional)	Sealed	1

*Recommended spare

LINC

ELECTRIC LEVEL CONTROLS

ELECTRIC RELAYS

Installation & Maintenance:

- AC Voltage DPDT Plug-In Type Relay Or DC Voltage DPDT Plug-In Type Relay:

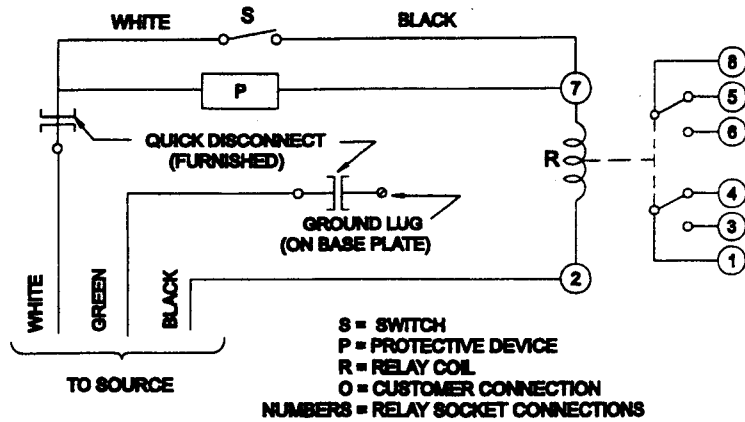
1. Check the relay coil to assure it is rated for your source voltage.
2. Connect one side of the source to the white wire within the enclosure using accepted electrical practices. Connect the other side of the source (black wire) terminal #2.
3. The load may now be wired to terminals #1, #3, #4 and #8, #5 and #6.
4. Secure the enclosure cover prior to applying source voltage.
5. Apply source voltage.

For use in an SPDT function, follow the above instructions, except omit connections for the load to terminals #8, #5, and #6.

Caution: On DC applications, the protective device is directional. If polarity is reversed, the switch could be damaged.

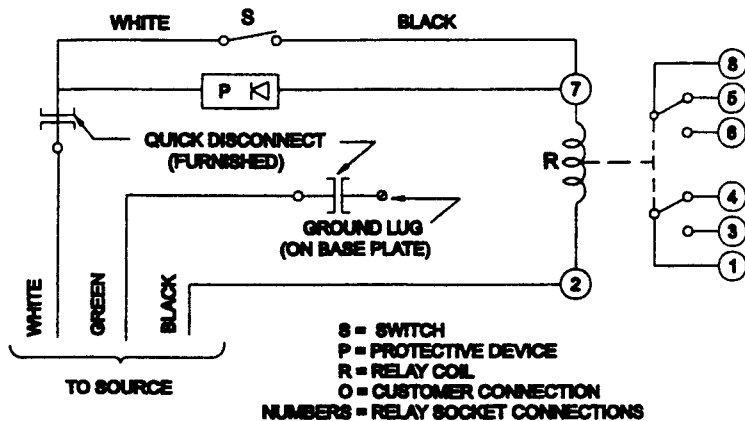
WIRING SCHEMATIC

FOR AC VOLTAGE DPDT, PLUG-IN TYPE RELAY

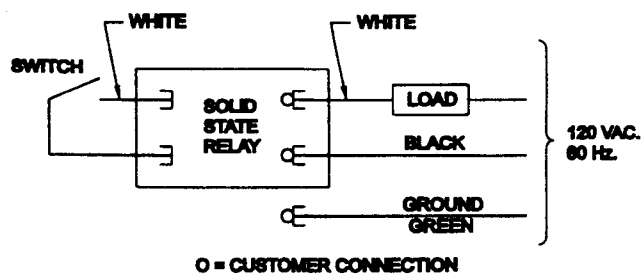


WIRING SCHEMATIC

FOR DC VOLTAGE DPDT, PLUG-IN TYPE RELAY

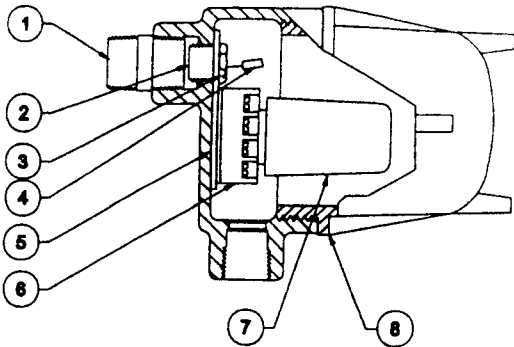


SOLID STATE RELAY WIRING SCHEMATIC

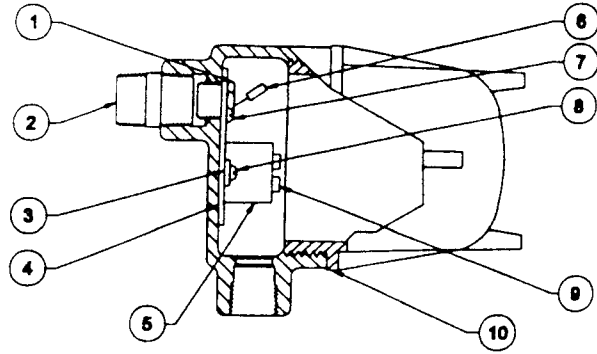


ELECTRIC LEVEL CONTROLS

ELECTRIC RELAYS



Model LINC - 21593



Model LINC - 21537

Model	LINC-21593	115 VAC Plug-In Relay		
Item	Part #	Description	Material	Qty
1	10236	Nipple	Plated	1
2	10376	Bushing	Brass	1
3	10189	Round Head Screw	Plated	1
4	12001	Terminal ring	Insulated	1
5	20948	Mounting Plate	Aluminum	1
6	10472	Relay Base	Plastic	1
7*	10688	Relay (110 VAC)		1
8	21501	Relay Enclosure with Lid	Plated	1
9	10623	Quick Disconnect, 1/4" F (not shown)	Insulated	1
10*	10239	Protective Device (not shown)		1
11	10420	Insulating Tubing (not shown)	PVC	**
12	10423	Wire Lug (not shown)	Insulated	1
13	10436	Round Head Screw (not shown)	18-8 ss	1
14	10925	Quick Disconnect, M (not shown)	Insulated	1

*Recommended spare
**As required

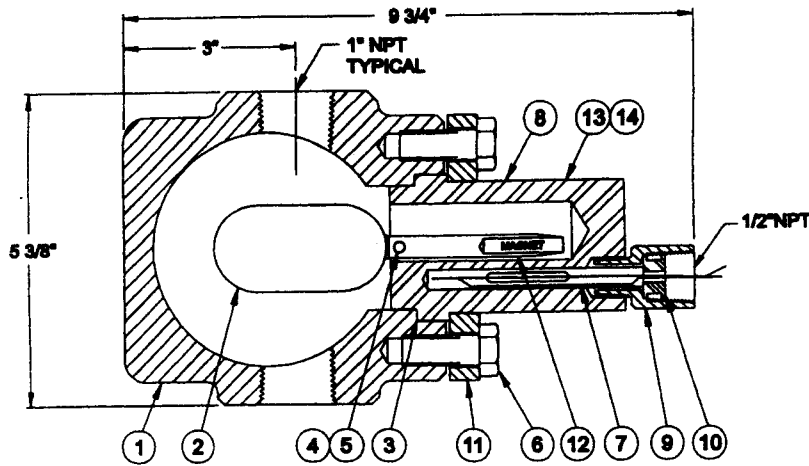
For Other Variations				
Relay Assembly	Coil Voltage	Item 7	Item 10	
21593	115 VAC	10688	10239	
21594	240 VAC	10729	10426	
21589	6 VDC	10725	10425	
21590	12 VDC	10726	10425	
21591	24 VDC	10727	10425	
20286	110 VDC	10587	10425	

Model	LINC-21537	Solid State Relay		
Item	Part #	Description	Material	Qty
1	10376	Bushing	Brass	1
2	10236	Nipple	Plated	1
3	10698	Washer	Plated	2
4	20948	Mounting Plate	Aluminum	1
5*	10233	Relay (110/220 VAC)		1
6	12001	Terminal Ring	Insulated	1
7	10189	Round Head Screw	Plated	1
8	10190	Round Head Screw	18-8 ss	2
9	10623	Wire Lug	Insulated	4
10	21501	Relay Enclosure with Lid	Plated	1

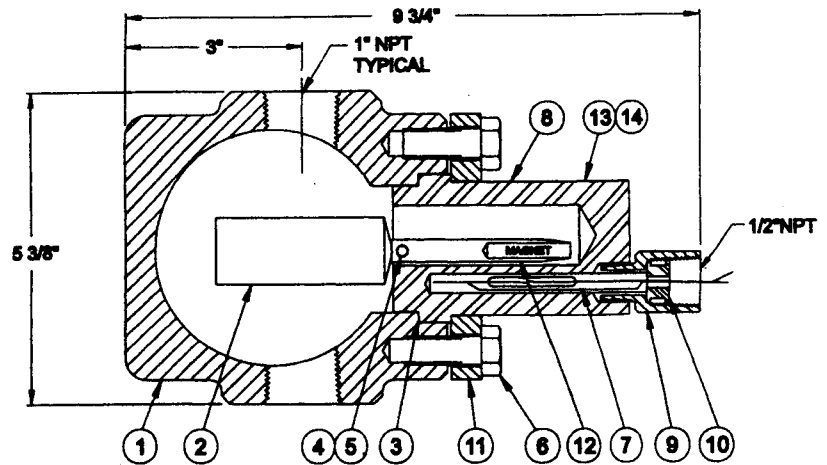
*Recommended spare

ELECTRIC LEVEL CONTROLS

LINC-L471SC-01 & LINC-L471SC-02



Model LINC-L471SC-01



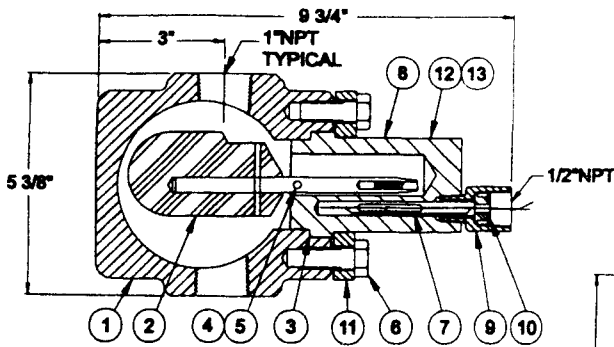
Model LINC-L471SC-02

Model	L471SC-01	L471SC-02	Description	Material	Qty
1	40256	40256	Cage	Cast Steel	1
2	10245		Float	316 ss	1
		20149	Float	Polypropylene	1
3*	11257	11257	Gasket	TFE	1
4	20334	20334	Pin	316 ss	1
5	20121	20121	Spacer	316 ss	2
6	10211	10211	Cap Screw	Plated	6
7*	20495	20495	Switch Cartridge	Sealed	1
8	30282	30282	Body	316 ss	1
9	20119	20119	Conduit Adapter	303 ss	1
10	10087	10087	Grommet	Nitrile	1
11	30258	30258	Ring Flange	Steel	1
12	20853	20853	Float Arm Assembly	316 ss	1
13	10013	10013	Name Plate	316 ss	1
14	10324	10324	Drive Screw (not shown)	18-8 ss	2
15	24834	24834	Switch Cart. SPST 500°F (Optional)	Sealed	1
16	24835	24835	Switch Cart. SPDT 500°F (Optional)	Sealed	1
17	24836	24836	Switch Cart. SPDT 400°F (Optional)	Sealed	1

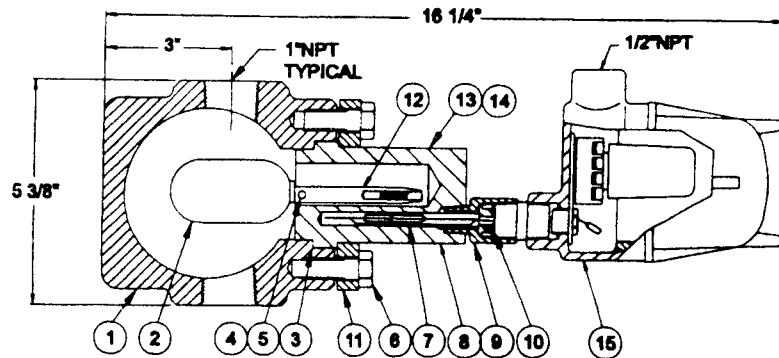
*Recommended spare

ELECTRIC LEVEL CONTROLS

LINC-L471SC-03 & LINC-L471SC-04



Model LINC-L471SC-03



Model LINC-L471SC-01-04

Model	L471SC-03	L471SC-01-04	Description	Material	Qty
1	40256	40256	Cage	Cast Steel	1
2	10245	10245	Float	316 ss	1
3*	11257	11257	Gasket	TFE	1
4	20334	20334	Pin	316 ss	1
5	20121	20121	Spacer	316 ss	2
6	10211	10211	Cap Screw	Plated	6
7*	20495	20495	Switch Cartridge	Sealed	1
8	30282	30282	Body	316 ss	1
9	20119	20119	Conduit Adapter	303 ss	1
10	10087	10087	Grommet	Nitrile	1
11	30258	30258	Ring Flange	Steel	1
12	10013	See below	Name Plate	316 ss	1
13	10324	See below	Drive Screw (not shown)	18-8 ss	2
14	24834	See below	Switch Cart. SPST 500°F (Optional)	Sealed	1
15	24835	See below	Switch Cart. SPDT 500°F (Optional)	Sealed	1
16	24836	See below	Switch Cart. SPDT 400°F (Optional)	Sealed	1

*Recommended spare

Model	L471SC-01-04	Description	Material	Qty
12	20853	Float Arm Assembly	316 ss	1
13	10013	Name Plate	316 ss	1
14	10324	Drive Screw (not shown)	18-8 ss	2
15	21593	Relay Assembly (110 VAC see relays)		1
16	24834	Switch Cart. SPST 500°F (Optional)	Sealed	1
17	24835	Switch Cart. SPDT 500°F (Optional)	Sealed	1
18	24836	Switch Cart. SPDT 400°F (Optional)	Sealed	1

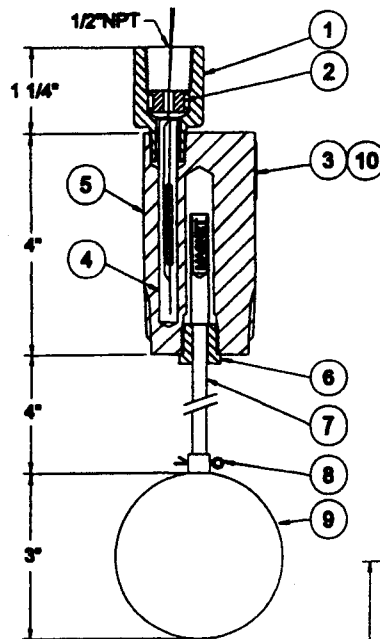
*Recommended spare

ELECTRIC LEVEL CONTROLS

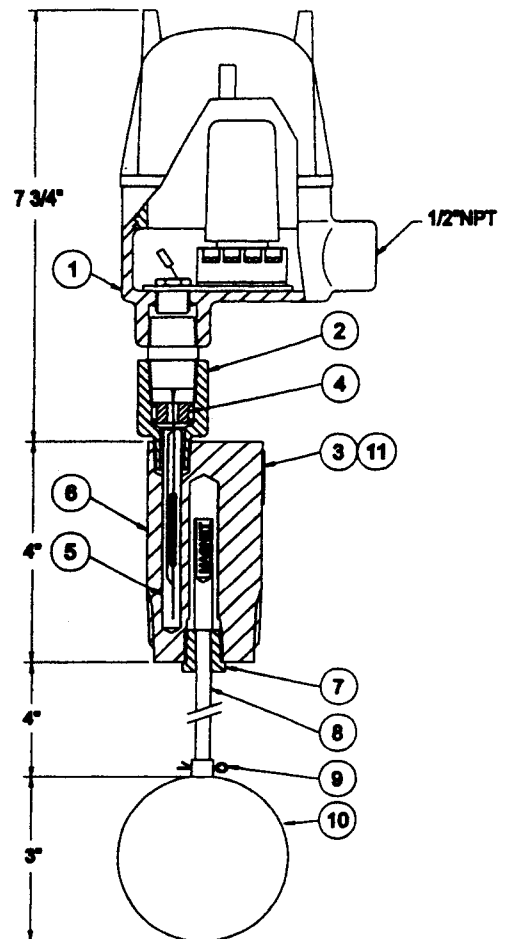
L I N C - L V 4 7 1 : V E R T I C A L

Product Description:

The LV-471 is used as a high or low level control to sound alarms, operate control equipment or perform a variety of desired electrical functions. These controls will operate in any specific gravity of 0.7 or higher. The standard unit has a 3" O.D. spherical float and is rated at 250 psi. The standard float arm is 4" long. Various floats and float arm lengths are available to fit your application. These controls are available with a normally closed or normally open switch arrangement. This unit is installed through a 1-1/2" NPT fitting and the float is attached with a cotter key after the body is screwed into place. Various flanged models are also available to meet your specifications.



Model LINC-LV471-04
Normally Closed



Model LINC-LV471-04-04
Normally Closed

ELECTRIC LEVEL CONTROLS

L I N C - L V 4 7 1 : V E R T I C A L

Model		LINC-LV471-04 Normally Closed		
Item	Part #	Description	Material	Qty
1	20119	Conduit Adapter	303 ss	1
2	10087	Grommet	Nitrile	1
3	10012	Name Plate	316 ss	1
4*	20495	Switch Cartridge	Sealed	1
5	30316	Body	316 ss	1
6	20152	Float Arm Retainer	316 ss	1
7	20444	Float Arm Assembly	316 ss	1
8	10237	Cotter Pin	18-8 ss	1
9	10250	Float	316 ss	1
10	10324	Drive Screw (not shown)	18-8 ss	2
11	24834	Switch Cartridge SPST 500°F (Optional)	Sealed	1
12	24835	Switch Cartridge SPDT 500°F (Optional)	Sealed	1
13	24836	Switch Cartridge SPDT 400°F (Optional)	Sealed	1

Note: For models below, use the same parts as listed above with the following exceptions:

Model		LINC-LV471-03 Normally Open		
Item	Part #	Description	Material	Qty
7	20446	Float Arm Assembly	316 ss	1

*Recommended spare

Model		LINC-LV471-04-04 Normally Closed		
Item	Part #	Description	Material	Qty
1	21593	Relay Assembly (110 VAC see relays)		1
2	20119	Conduit Adapter	303 ss	1
3	10419	Name Plate	316 ss	1
4	10087	Grommet	Nitrile	1
5*	20495	Switch Cartridge	Sealed	1
6	30316	Body	316 ss	1
7	20152	Float Arm Retainer	316 ss	1
8	20444	Float Arm Assembly	316 ss	1
9	10237	Cotter Pin	18-8 ss	1
10	10250	Float	316 ss	1
11	10324	Drive Screw (not shown)	18-8 ss	2
12	24834	Switch Cartridge SPST 500° F (Optional)	Sealed	1
13	24835	Switch Cartridge SPDT 500°F (Optional)	Sealed	1
14	24836	Switch Cartridge SPDT 400°F (Optional)	Sealed	1

Note: For models below, use the same parts as listed above with the following exceptions:

Model		LINC-LV471-03-04 Normally Open		
Item	Part #	Description	Material	Qty
8	20446	Float Arm Assembly	316 ss	1

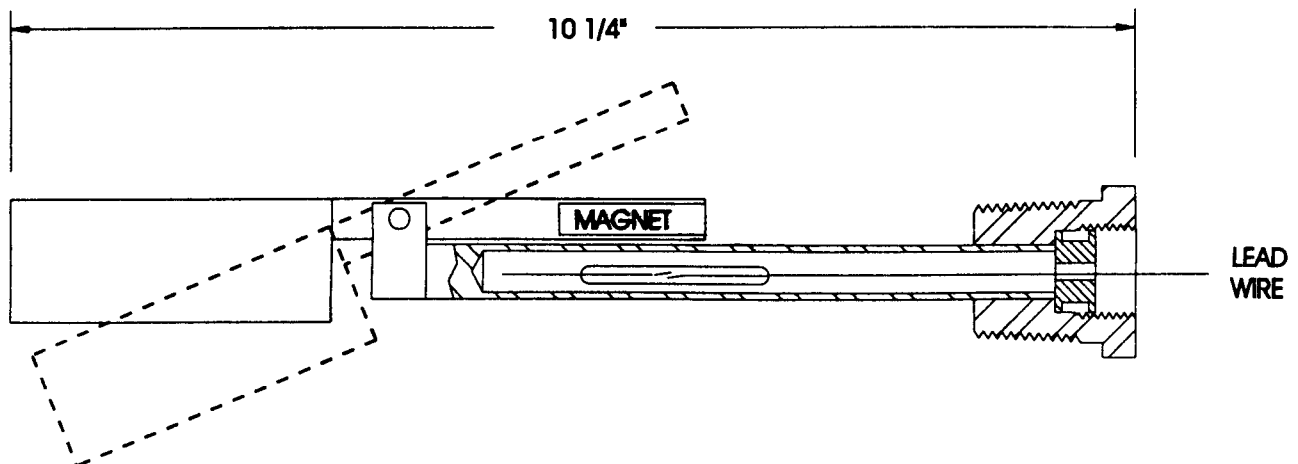
*Recommended spare

ELECTRIC LEVEL CONTROLS

LINC-L971 SERIES: EXTENDED BODY

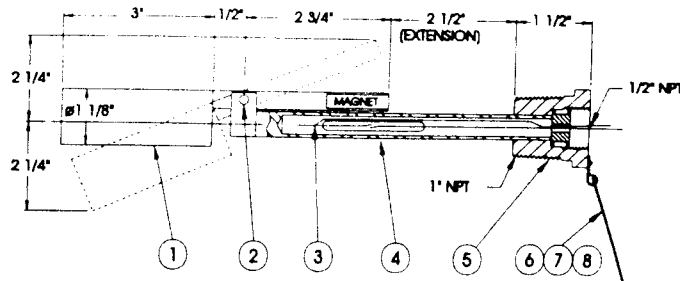
Product Description:

The L971 is used as a high or low level control. The electrical switch closure may be used to sound alarms, operate control equipment or perform any desired electrical function. These standard units are installed through a 1" NPT fitting. The standard float is a solid, high-density polypropylene material and will operate in specific gravities of 0.6 or higher. Due to the length of the float, these controls must have 3" of vertical clearance for the unit to operate. This control is available in a wide variety of designs to meet any specific requirements.

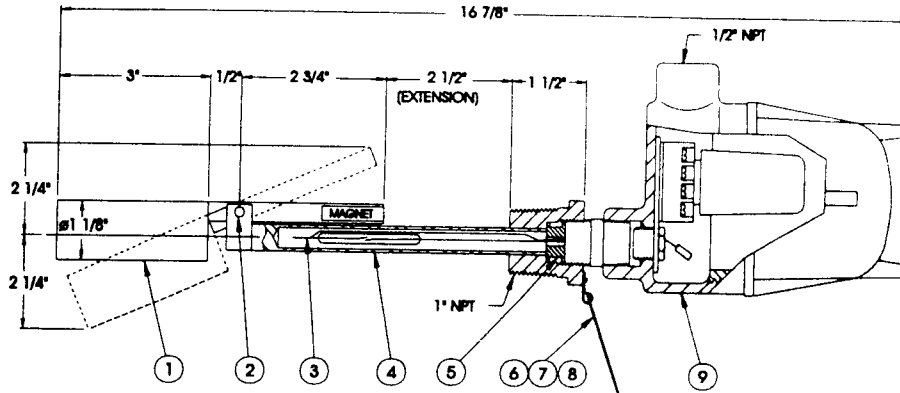


ELECTRIC LEVEL CONTROLS

LINC-L971 SERIES: EXTENDED BODY



Model LINC-L971-01



Model LINC-L971-01-04

Model	L971-01			
Item	Part #	Description	Material	Qty
1	21161	Float Arm Assembly	Polypropylene	1
2	21001	Pivot Pin	316 ss	1
3*	20416	Switch Cartridge	Sealed	1
4	30117	Body Assembly	316 ss	1
5	10087	Grommet	Nitrile	1
6	12972	Name Plate	316 ss	1
7	13060	Drive Screw	18-8 ss	1
8	13061	Clamp	18-8 ss	1
9	24852	Switch Cartridge H.T. 500°F	Sealed	1

*Recommended spare

Model	L971-01-04			
Item	Part #	Description	Material	Qty
1	21161	Float Arm Assembly	Polypropylene	1
2	21001	Pivot Pin	316 ss	1
3*	20416	Switch Cartridge	Sealed	1
4	30117	Body Assembly	316 ss	1
5	10087	Grommet	Nitrile	1
6	10867	Name Plate	316 ss	1
7	13060	Drive Screw	18-8 ss	1
8	13061	Clamp	18-8 ss	1
9	21593	Relay Assembly (110 VAC, see relays)		1
10	24852	Switch Cartridge H.T. 500°F	Sealed	1

*Recommended spare

LINC

MANUFACTURING

P.O. Drawer 788

Porter, Texas 77365

800-455-LINC

281-354-2163

Fax: 281-354-8668

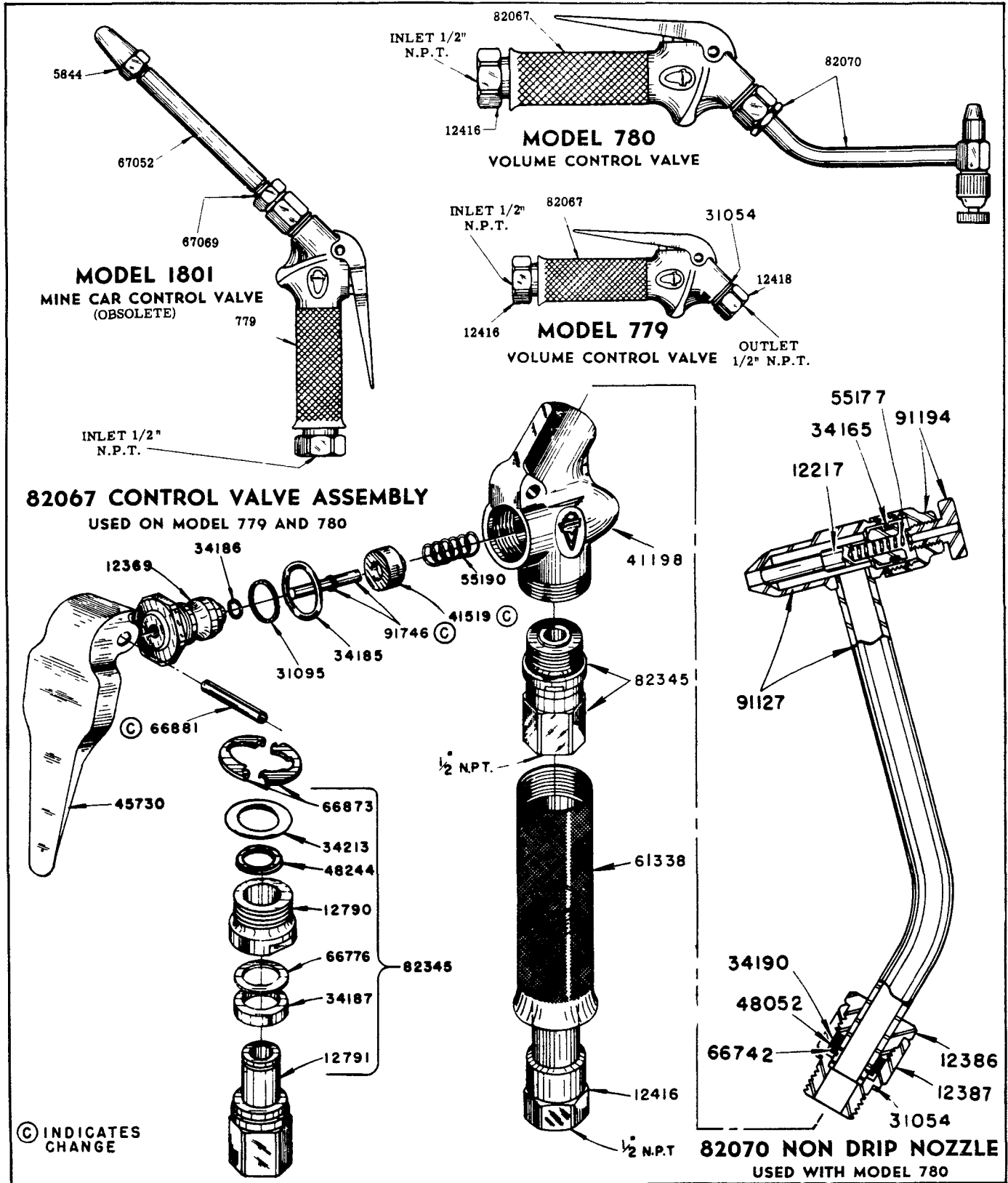
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Models 779, 780, 1801

CONTROL VALVE ASSEMBLIES

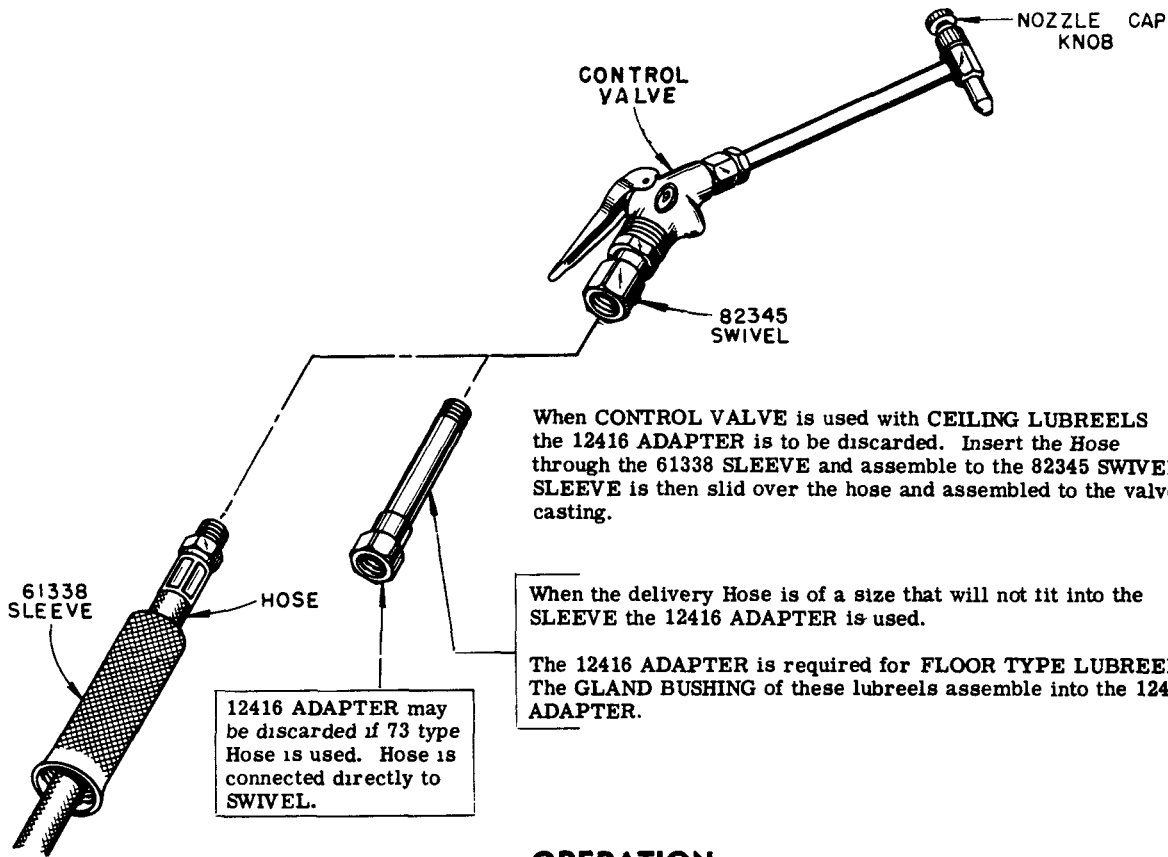
OPERATING INSTRUCTIONS PARTS AND SERVICE



LINCOLN ST. LOUIS
4010 GOODFELLOW BLVD - ST LOUIS, MO 63120 • (314) 383 5900

A DIVISION OF
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CORPORATION

SECTION - **F21**
PAGE - **IID**

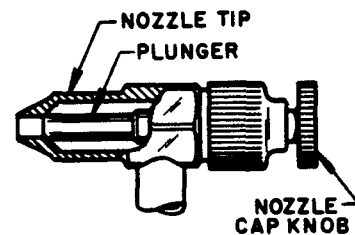


OPERATION

The CONTROL VALVE is designed to allow the operator complete control of the volume of lubricant being dispensed. First unscrew the NOZZLE CAP KNOB three or four full revolutions. A slight compression of the VALVE HANDLE will allow a small volume of lubricant to pass through the CONTROL VALVE, and NOZZLE. As the HANDLE is further compressed the lubricant volume will increase. When the VALVE HANDLE is released a PLUNGER in the NOZZLE TIP prevents the lubricant from draining out of the hose extension. The NOZZLE should always be closed when the CONTROL VALVE is not being used. To close NOZZLE turn the NOZZLE CAP KNOB clock-wise and tighten by hand.

If lubricant continues to flow from NOZZLE TIP after the VALVE HANDLE is released:

1. Lubricant is by-passing the 41519 CHECK SEAT. If sealing surface is cut or otherwise damaged, replace the 41519 CHECK SEAT. To remove the VALVE HANDLE use a slender punch to drive the 66881 ROLL PIN out of the HANDLE and VALVE CASTING.
2. PLUNGER in NOZZLE TIP or seat for PLUNGER in NOZZLE TIP is worn, pitted or otherwise damaged. Tighten and retighten NOZZLE CAP KNOB two or three times with pliers to reseal plunger. IMPORTANT: After reseating PLUNGER remove and inspect 41519 CHECK SEAT. Replace if damaged. CHECK SEAT should hold the lubricant pressure back from NOZZLE as purpose of NOZZLE is not to stop flow of lubricant when under pressure.



REPAIR PARTS LIST

PART NO.	DESCRIPTION	PART NO.	DESCRIPTION	PART NO.	DESCRIPTION
5844	Nozzle	34185	"O" Ring Packing	66742	Retaining Ring
12217	Plunger	34186	"O" Ring Packing	66776	Spring Washer
12369	Gland Nut	34187	Packing	66873	Truarc Retaining Ring
12386	Swivel Nut	34190	Swivel Packing	66881	Roll Pin
12387	Str. Swivel Body	34213	"O" Ring Packing	67052	Nipple
12416	Adapter	41198	Valve Body	67069	Bushing
12418	Adapter	41519	Check	82067	Low Pressure Control Valve
12790	Swivel Adapter	45730	Handle	82070	Non Drip Nozzle Assembly
12791	Swivel Stud	48052	Plunger Packing Washer	82345	Swivel Assembly
31054	Gasket	48244	Washer	91127	Nozzle Body Assembly
31095	Gasket	55177	Spring	91194	Cap Assembly
34165	"O" Ring	55190	Spring	91746	Plunger Assembly
		61338	Valve Sleeve		

PARTS - LOANER PUMPS - REPAIRS BY FACTORY TRAINED SERVICEMEN AVAILABLE IN AUTHORIZED SERVICE DEPARTMENTS. LIST FURNISHED UPON REQUEST.

LINCOLN ST. LOUIS
4010 GOODFELLOW BLVD. • ST. LOUIS, MO 63120 • (314) 383 5900

A DIVISION OF
McNEIL
CORPORATION

FRONT MOUNTING LIQUID LEVEL GAGES - WITH AND WITHOUT THERMOMETER

A patented dual purpose closed circuit style liquid level gage that provides both instant and positive visual check of fluid levels and temperature in either hydraulic or oil reservoirs. Maximum sight protection is provided by the heavy precision machined bar stock body. Thermometer series gages have a protected sensing element that extends well into the tank - unaffected by unrelated ambient temperature. Gages are furnished complete including O-ring seals and hex nuts for mounting. A .06 (1.52mm) alignment adjustment at each stud facilitates mounting. This gage can be installed from the outside on 1/2-20UNF tapped holes when reservoirs do not have access to the interior and tank wall thickness permits tapping. For installations where gage is bolted to cylindrical tank wall, conical sleeves are available. **Please specify** when ordering. Front mounting gages can be made to order with mounting centers up to 142.00 (3606.80mm) in 1.00 (25.40mm) increments. Stainless steel dial thermometer: 1.38 (35.05mm) dia. dual scale Fahrenheit (50° to 300°), Centigrade (10° to 150°). For back mount gages see our SERIES G610 and G620 on Bulletin F327-10/-20.

STANDARD MATERIALS:

- Aluminum construction
- Buna N seals
- Borosilicate glass with redline on white background for distinct level reading and maximum fluid compatibility

OPERATING CONDITIONS:

- See ENG. STD. 109

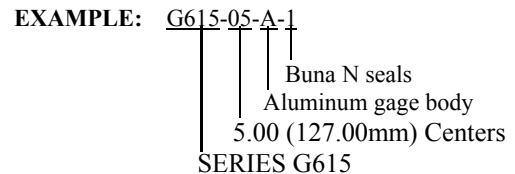
HOW TO ORDER:

Use code letters for body material: Use code number for seal material:

- | | |
|--|-------------------------------|
| A - Aluminum gage body (standard) | 1 - Buna N seals (standard) |
| B - Brass gage body (optional) | 2 - Butyl seals (optional) |
| S - Steel gage body (optional) | 3 - Viton A® seals (optional) |
| Y - Stainless Steel gage body (optional) | 4 - Ethylene propylene seals |
| | 10- Neoprene seals (optional) |

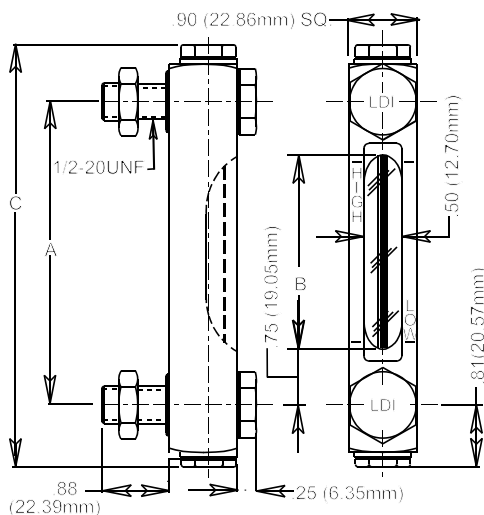
First, specify series number, then mounting centers, then kind of metal, and finally seal material, separating each with a dash (-):

SERIES G605 WITHOUT THERM.	SERIES G615 WITH THERM.	A - CENTERS INCHES (mm)	B - SIGHT INCHES (mm)	C - LENGTH INCHES (mm)
G605	G615	03 (76.20)	1.50 (38.10)	4.62 (117.35)
G605	G615	04 (101.60)	2.50 (63.50)	5.62 (142.75)
G605	G615	05 (127.00)	3.50 (88.90)	6.62 (168.15)
G605	G615	06 (152.40)	4.50 (114.30)	7.62 (193.55)
G605	G615	07 (177.80)	5.50 (139.70)	8.62 (218.95)
G605	G615	08 (203.20)	6.50 (165.10)	9.62 (244.35)
G605	G615	09 (228.60)	7.50 (190.50)	10.62 (269.75)
G605	G615	10 (254.00)	8.50 (215.90)	11.62 (295.15)
G605	G615	11 (279.40)	9.50 (241.30)	12.62 (320.55)
G605	G615	12 (304.80)	10.50 (266.70)	13.62 (345.95)

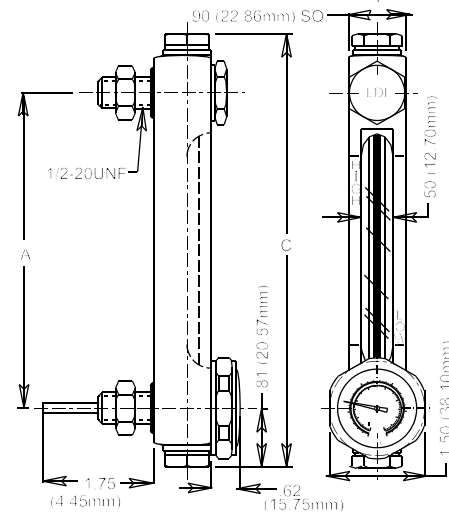


NOTE: The sight opening in all cases is 1.50 (38.10mm) less than mounting centers and overall length is 1.62 (41.15mm) greater than mounting centers. Gages with 13.00 (330.20mm) and greater mounting centers are furnished with spacer sleeves to space gage from tank allowing for bowing of the tank wall in larger reservoirs. Center mounting kits are furnished with gages 48.00 (1219.20mm) and greater mounting centers.

SERIES G605 - SIGHT ONLY



SERIES G615 WITH DIAL THERMOMETER



LUBE DEVICES, INC.

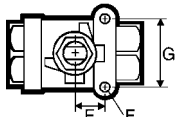
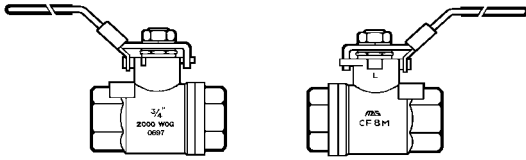
1864 NAGLE AVE., P.O. BOX 1810, MANITOWOC, WI 54221-1810
 PHONE: (920) 682-6877 FAX: (920) 684-7210
 E-MAIL: sales@lubedevices.com WEBSITE: www.lubedevices.com

FRONT MOUNTING LIQUID LEVEL GAGES - WITH AND WITHOUT THERMOMETER

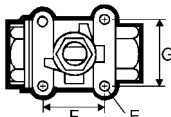
3/04 **BULLETIN F327-5 / -15**

G Series Investment Cast Stainless Steel Ball Valves

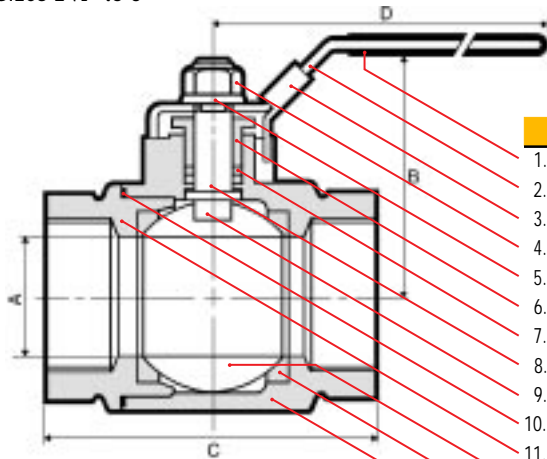
G2



Sizes 1/4" to 2"



Sizes 2 1/2" to 3"



- Markings to MSS-SP25
- Available with Oval handle for size range: 1/4"-2"
- Material test results & inspection certificates available upon request
- CRN numbers available upon request
- 1/2" to 2" mounting pads are tapped, 1/4" and 3/8" have reserve holes cast in, 2 1/2" and 3" are dimpled. Recommended tapping sizes are listed for reference only.

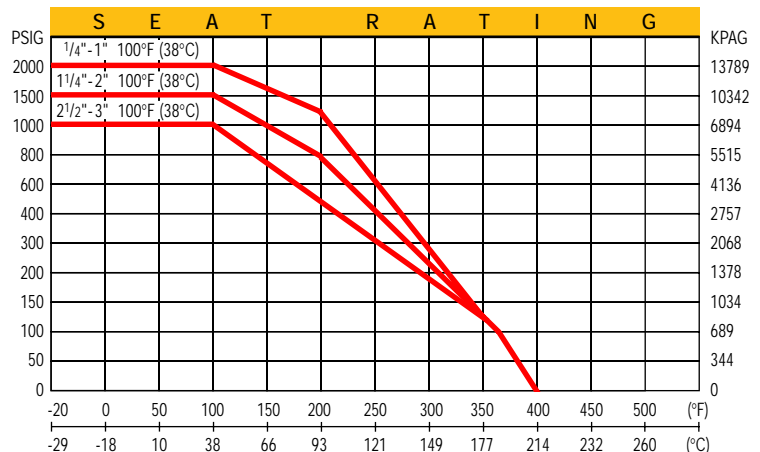
- Full port
- NPT ends to ANSI B1.20.1
- Two piece body
- Blowout-proof stem
- Adjustable packing gland
- Locking lever handle
- Actuator mounting pad
- 2000 PSI, W.O.G. 1/4" to 1"
- 1500 PSI, W.O.G. 1 1/4" to 2"
- 1000 PSI, W.O.G. 2 1/2" to 3"



NAME / MATERIAL

1. Handle Grip / Vinyl
2. Handle / Stainless Steel 304 - A276
3. Locking Device / Stainless Steel 304 - A276
4. Handle Nut / Stainless Steel 304 - A 276
5. Stem Washer / Stainless Steel 304 - A276
6. Gland Nut / Stainless Steel 304 - A276
7. Packing / PTFE
8. Thrust Washer / Reinforced Teflon 15% GFT
9. Stem / Stainless Steel 316 / A276
10. Gasket / PTFE
11. Cap / Stainless Steel 316 - CF8M
12. Ball / SS 316 - A 276
13. Seat / Reinforced Teflon 15% GFT
14. Body / Stainless Steel 316 - CF8M

D I M E N S I O N S										
size	8	10	15	20	25	32	40	50	65	80
mm/in	1/4	3/8	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3
A	9.60	9.60	12.70	20.00	25.00	32.00	38.00	50.80	65.00	78.00
mm/in	0.374	0.374	0.500	0.787	0.984	1.260	1.496	2.000	2.559	3.071
B	54.00	54.00	57.00	65.50	69.50	82.50	88.00	105.00	138.00	148.00
mm/in	2.130	2.130	2.240	2.580	2.740	3.250	3.460	4.130	5.430	5.830
C	57.60	57.60	62.00	72.50	86.00	94.00	116.00	134.00	164.00	180.00
mm/in	2.264	2.264	2.441	2.854	3.386	3.700	4.567	5.276	6.457	7.086
D	103.50	103.50	103.50	125.00	125.00	158.00	158.00	181.00	252.00	252.00
mm/in	4.075	4.075	4.075	4.921	4.921	6.220	6.220	7.126	9.921	9.921
E	M6	M6	M6	M6	M6	M8	M8	M8	M8	M8
F	12.70	12.70	12.70	22.10	22.10	23.62	23.62	23.62	70.00	70.00
mm/in	0.500	0.500	0.500	0.870	0.870	0.930	0.930	0.930	2.750	2.750
G	28.45	28.45	28.45	34.80	34.80	50.00	54.00	60.30	73.00	73.00
mm/in	1.120	1.120	1.120	1.370	1.370	1.969	2.126	2.375	2.875	2.875
CV	7.0	7.0	15.0	45.0	65.0	125.0	175.0	380.0	500.0	900.0
weights	0.260	0.250	0.313	0.555	0.795	1.330	2.013	3.550	6.250	9.370
kg/lb	0.572	0.550	0.689	1.221	1.749	2.926	4.429	7.810	13.750	20.614

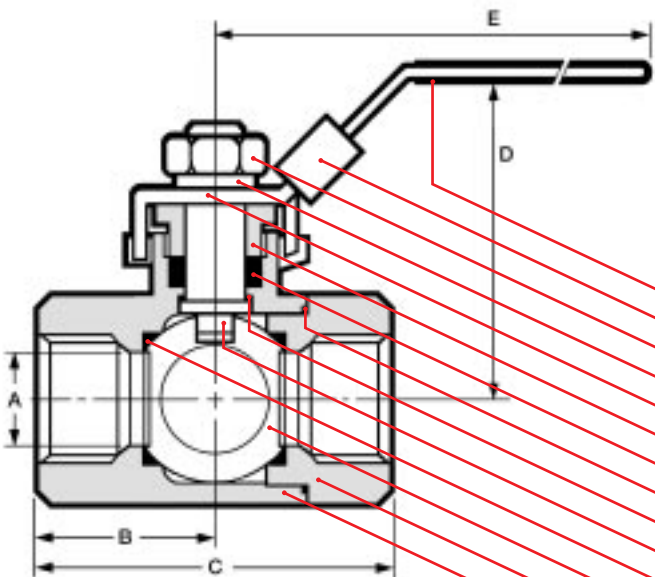
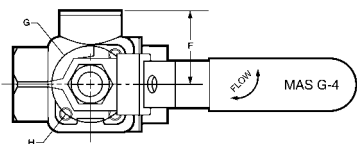


G Series Investment Cast Stainless Steel Ball Valves

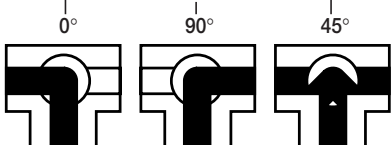
G4



- Three way L-port
- Reduced port
- NPT ends to ANSI B1.20.1
- Two piece body
- Blowout-proof stem
- Adjustable packing gland
- Locking lever handle
- ISO 5211 mounting pad
- 1000 PSI, W.O.G. 1/4" to 2"



Flow Pattern From Top View
Rotation

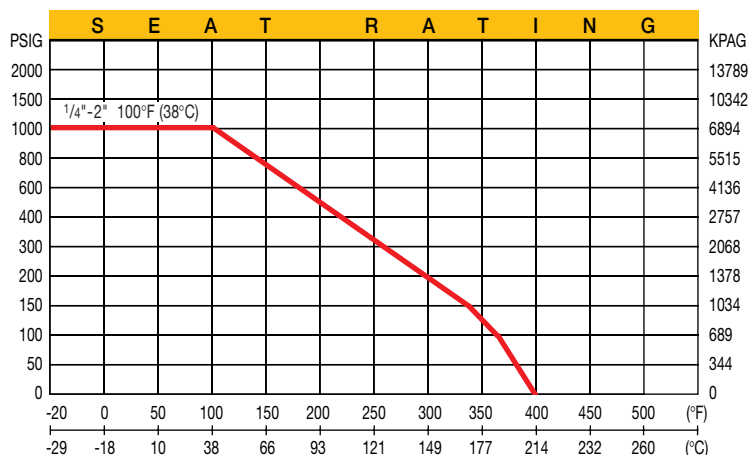


NAME / MATERIAL

1. Handle Grip / Vinyl
2. Locking Device / Stainless Steel 304 - A276
3. Handle Nut / Stainless Steel 304 - A276
4. Stem Washer / Stainless Steel 304 - A276
5. Handle / Stainless Steel 304 - A276
6. Gland Nut / Stainless Steel 304 - A276
7. Stem Packing / PTFE
8. Gasket / PTFE
9. Thrust Washer / Reinforced Teflon 15% GFT
10. Stem / Stainless Steel 316 - A276
11. Seat / Reinforced Teflon 15% GFT
12. Ball / Stainless Steel 316 - A276
13. Cap / Stainless Steel 316 - CF8M
14. Body / Stainless Steel 316 - CF8M

- Open port pressure must exceed closed port pressure, diverter service
- Material test results & inspection certificates available upon request.
- CRN numbers available upon request
- Markings to MSS-SP-25

D I M E N S I O N S								
size	8	10	15	20	25	32	40	50
mm/in	1/4	3/8	1/2	3/4	1	1 1/4	1 1/2	2
A	11.10	12.70	12.70	17.30	20.60	25.40	31.80	38.10
mm/in	0.44	0.50	0.50	0.68	0.81	1.00	1.25	1.50
B	29.35	29.35	29.35	38.10	40.75	51.00	55.50	68.50
mm/in	1.16	1.16	1.16	1.50	1.60	2.01	2.19	2.70
C	58.70	58.70	58.70	76.20	82.00	102.00	111.00	137.00
mm/in	2.31	2.31	2.31	3.00	3.23	4.02	4.37	5.39
D	50.80	50.80	50.80	58.50	62.35	74.15	78.85	94.20
mm/in	2.00	2.00	2.00	2.29	2.46	2.92	3.10	3.71
E	100.00	100.00	100.00	130.00	130.00	155.00	155.00	175.00
mm/in	3.94	3.94	3.94	5.12	5.12	6.10	6.10	6.89
F	30.00	30.00	30.00	38.10	42.67	51.00	61.00	71.37
mm/in	1.18	1.18	1.18	1.50	1.68	2.01	2.40	2.81
G	36.00	36.00	36.00	36.00	42.00	50.00	50.00	50.00
mm/in	1.42	1.42	1.42	1.42	1.65	1.97	1.97	1.97
H	M6	M6	M6	M6	M6	M8	M8	M8
CV	4	5.4	5.4	12	15	21	34	47
weights	0.390	0.360	0.330	0.660	0.850	1.490	2.040	2.160
kg/lb	0.858	0.792	0.726	1.452	1.870	3.278	4.488	6.952



Mercer 8100 Series INTRODUCTION



Mercer Valve 8100 Series Safety Relief Valves are the "State of the Art" in soft seat, high flow rate, pressure relieving devices. The field-proven soft seat is coupled with a new, unique disk type PATENTED DESIGN. Expected seat life is hundreds of "pops". Full length guiding of "low rate" set pressure springs insures accurate, repeatable relief action.

The Valve is well suited for all industrial air, gas, and liquid relief applications, including compressors, separators, refinery applications, transmission and gathering lines, gas production units, heater treaters, scrubbers, and other production processes.

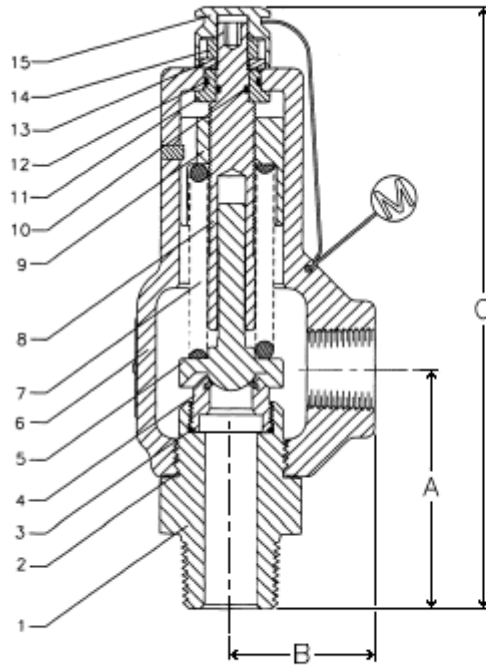
All 8100 Series Valves are built in accordance with the requirements of the ASME Boiler and Pressure Vessel Code. Capacity ratings were established by testing performed at the National Board of Boiler and Pressure Vessel Inspectors, Columbus, Ohio.

Mercer 8100 Series SPECIFICATIONS

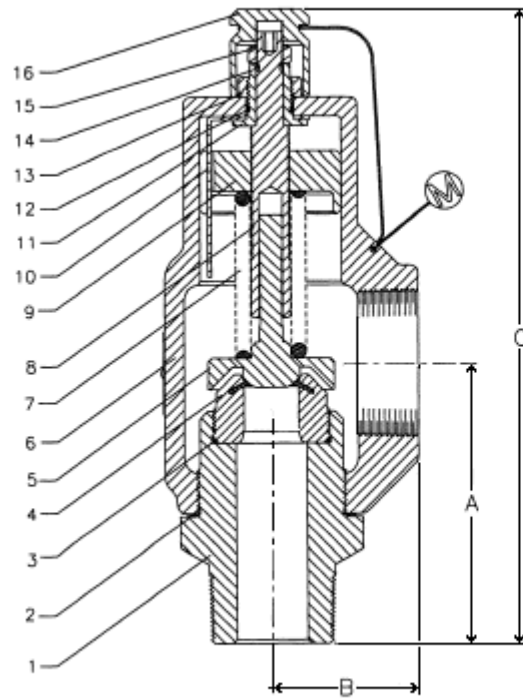


Valve Size	1"	2"
Orifice Diameter (in.)	0.520	0.775
API Orifice Area (sq. in.)	0.196	0.503
ASME Actual Orifice Area (sq. in.)	0.212	0.472
Inlet Sizes Offered	3/4", 1"	1 1/2", 2"
Pressure Ranges (psig)	15-2400	15-2000
ASME Gas "Slope" (90%)	3.100	7.210
Flow Coefficient "K" (90%) Gas	0.800	0.830
ASME Flow Factor "CV" (90%) Liquid	5.150	12.770

Mercer 8100 Series BILL OF MATERIALS



8100 SERIES 1/2" ORIFICE		
ITEM NO.	PART NAME	STANDARD MATERIALS
1	Inlet Base	Carbon Steel
2	Base Seal	Soft Steel
3	O'Ring	Viton
4	Nozzle Subassy	Stainless Steel / Soft Seat
5	Disk Subassy	Stainless Steel
6	Body	Carbon Steel
7	Spring	Stainless Steel
8	Adjustment Screw	Stainless Steel
9	Adjustment Bushing	Carbon Steel
10	O'Ring	Buna N
11	Center Bushing	Carbon Steel
12	O'Ring	Buna N
13	Washer	Carbon Steel
14	Lock Nut	Carbon Steel
15	Cap	Anodized Aluminum



8100 SERIES 1/4" ORIFICE		
ITEM NO.	PART NAME	STANDARD MATERIALS
1	Inlet Base	Carbon Steel
2	Base Seal	Soft Steel
3	O'Ring	Viton
4	Nozzle Subassy	Stainless Steel / Soft Seat
5	Disk Subassy	Stainless Steel
6	Body	Carbon Steel
7	Spring	Stainless Steel
8	Adjustment Screw	Stainless Steel
9	Adjustment Bushing	Carbon Steel
10	Index Bracket	Carbon Steel
11	Center Bushing	Carbon Steel
12	O'Ring	Buna N
13	Center Nut	Carbon Steel
14	O'Ring	Buna N
15	Lock Nut	Carbon Steel
16	Cap	Anodized Aluminum

Mercer 8100 Series SELECTION TABLE



Valve Size Inlet and Outlet	Available Orifice Size	Inlet/Outlet P/N: Code	Maximum Pressure Limit (psig) 1	Dimensions (in) 1/16 A x B x C	Approximate Weight (lb)
3/4" MNPT x 1" FNPT	1/2" Orifice	12	2400	3-1/4 x 1-7/8 x 8	4.5
1" MNPT x 1" FNPT	1/2" Orifice	17	2400	3-1/4 x 1-7/8 x 8	4.5
1-1/2" MNPT x 24" FNPT	3/4" Orifice	34	2000	4-1/2 x 2-3/8 x 10-1/8	10
2" MNPT x 2" FNPT	3/4" Orifice	43	2000	4-1/2 x 2-3/8 x 10-1/8	10
Notes:					
1) System Conditions and Temperatures can limit the maximum pressure of the valve					



2-WIRE SEISMIC VIBRATION TRANSMITTER
MODEL ST5484E-XXX-XXX-XX
INSTALLATION INSTRUCTIONS

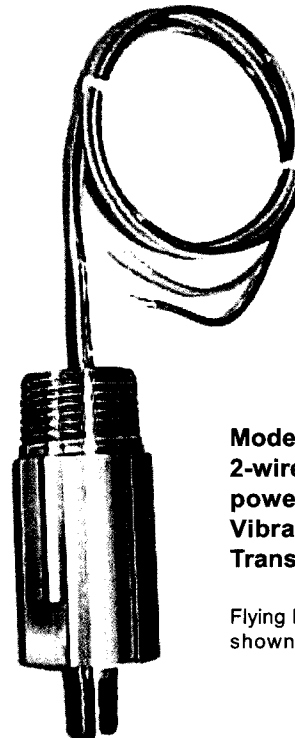
- Provides 4-20 mA signal proportional to velocity vibration
- Direct connection to PLC, DCS or other recording monitor
- Two wire, loop powered, simplifies field wiring, IPT® reversible power
- Different top wiring configurations and mounting stud types, see table

The Model ST5484E Seismic Vibration Transmitter is a new version of an established series of transmitters from Metrix. It incorporates state-of-the-art electronic components and circuits. It also offers several new options in terms of features and configurations. Be sure to study the configuration of the transmitter before putting it in service.

The transmitter combines a vibration sensor and signal conditioner in a single package. They provide the ideal solution for sensing machinery vibration level and transmitting a proportional 4-20 mA signal directly to a PLC, DCS, monitor, or computer. Typical applications include low and medium speed machines, such as fans, blowers, pumps, motors, and centrifuges. The transmitter can be supplied with optional screw cover elbow fittings for connecting flexible conduit.

The transmitter is all solid state, has no moving parts, and is encapsulated in a stainless steel housing. Each transmitter is factory calibrated to the sensitivity marked on the label.

An optional dynamic signal output can be specified. This signal is an acceleration signal with 100 mV/g sensitivity. This signal can be used for vibration analysis with portable instruments. It cannot drive long lines without a buffer amplifier. This is due to the low operating power typical in loop powered devices. Be aware that low impedance portable instruments will load this output.



Model ST5484E
2-wire, Loop-
powered
Vibration
Transmitter

Flying lead version shown

Verify Transmitter Configuration

Be sure to determine the transmitter configuration before installing it. See inside for configuration details.

ST5484E-XXX-XXX-XX

1st XXX denotes measurement range
2nd XXX denotes mounting type, area use rating, and top connection (including signal output option)
3rd XX denotes optional filtering

IPT® (Independent Polarity) is a registered trademark of Metrix Instrument Co.

ST5484E CONFIGURATION

ST5484E - **A** - **B C D** - **E F**

A - Full Scale

1	2	1	= 1.0 ips (25 mm/s), pk
1	2	2	= 0.5 ips (12.7 mm/s), pk
1	2	3	= 2.0 ips (50 mm/s), pk
1	2	4	= 5.0 ips (125 mm/s), pk
1	3	2	= 3.0 ips (75 mm/s), pk
1	5	1	= 1.0 ips (25 mm/s), rms
1	5	2	= 0.5 ips (12.7 mm/s), rms
1	5	3	= 2.0 ips (50 mm/s), rms
1	5	4	= 5.0 ips (125 mm/s), rms
1	6	2	= 3.0 ips (75 mm/s), rms

B - Mounting

0	= Integral 1/4" NPT
1	= Integral 1/2" NPT
2	= 3/8-24 UNF X 1/2"
3	= 1/2-20 UNF X 1/2"
4	= M8 X 1-12
5	= M10 X 1.25-12

C - Hazardous Area Rating

1	= Non-hazardous & CSA/NRTL/C (for all connections) Class I, Div 2, Grps A,B,C & D
2	= Class I, Div 1, Grps B,C & D & Class II, Div 1, Grps E,F & G (only available with flying leads configuration)
3	= CENELEC EEx ia IIC T4 Intrinsically Safe (only available with terminal block or 2-pin MS connector configurations)

D - Connection

0	= 4-20 mA; Flying leads (C = 1 or 2)
1	= 4-20 mA & Dynamic Signal; Flying leads (C = 1 or 2)
2	= 4-20 mA; 2-pin terminal block (C = 1 or 3)
3	= 4-20 mA & Dynamic Signal; 4-pin terminal block (C = 1 or 3)
4	= 4-20 mA; 2-pin MS connector (C = 1 or 3)

E - HP Filter

0	= No Filter (2 Hz)
1	= 5 Hz
2	= 10 Hz
3	= 20 Hz
4	= 50 Hz
5	= 100 Hz
6	= 200 Hz

F - LP Filter

0	= No Filter (1500 Hz)
1	= 500 Hz
2	= 1000 Hz
3	= 2000 Hz

Standard Configuration:

ST5484E-121-020-00

- A - 1.0 ips Full scale range
- B - 1/4 in. NPT (pipe thread) mounting
- C - Class I, Div 1 Area rating
- D - 4-20 mA Flying leads connection
- E - No High pass filter
- F - No Low pass filter

The complete Model Number, showing the configuration and serial number, is etched onto the body of the Transmitter.

INSTALLATION

1. MOUNTING It is important the transmitter body be solidly mounted to the machine surface. See the section on transducer placement. Different machine preparations are required for the two basic transmitter mounting styles; NPT (National Pipe Thread) and machine thread (UNF and Metric). Transmitters with the NPT type mounting stud are secured by the thread engagement and the base of the transmitter does not come in contact with the machine surface. On the other hand, transmitters with the machine thread studs must make contact with the machine surface. The base of the transmitter must make square and direct contact. This requires preparing the surface of the machine with a 1 1/2 inch counterbore (surfacing tool). This tool can be used with a portable drill equipped with a magnetic base but care must be taken so that the tapped and threaded hole is perpendicular to the machined surface. The transmitter must make contact all the way around its base surface. Contact Metrix for more detailed instructions for using a counterbore.

If installing a transmitter with a standard 1/4 inch NPT stud, drill a hole using a 7/16 inch bit, 5/8-7/8 inch deep. Then tap using a 1/4 - 18 NPT (tapered pipe tap). Hand tighten the transmitter and then turn an additional 1 to 2 turns using a wrench on the wrench flats. Do not use a pipe wrench. A pipe wrench can apply extreme forces to the body and potentially damage electronic components. A minimum of three (3) threads of engagement should be made. A 1/4 inch to 1/2 inch NPT bushing is available for mounting the transmitter in existing 1/2 inch NPT holes. Also, a Model 7084 Flange Adapter can be used between the transmitter and the machine surface when there is not enough surface thickness to drill and tap a hole. The flange adaptor mounts with three small screws. See accessories.

INSTALLATION (Continued)

If installing a transmitter with one of the straight machined thread sizes, follow standard drill and tap procedures. Be sure to not drill a hole larger than the counterbore pilot diameter before using the counterbore to prepare the machine surface. Drill out the hole with the correct tap drill size after preparing the surface.

The sensitive axis of the transmitter is in line with the mounting stud. The transmitter can be oriented in any (0 to 360 degree) position.

2. WIRING The ST5484E is connected like any other loop powered transmitter. The following is a summary based on area designations.


2.A SAFE AREA INSTALLATION Connect the field wiring in accordance with the appropriate diagram on page 4. The ST5484E transmitter requires a minimum of 11 VDC for proper operation. The minimum loop power supply voltage required is 11 VDC plus 1 volt for each 50 ohms of loop resistance.

ST5484E Example: Signal wire resistance = 10 ohms
 Resistance of receiver = 250 ohms
 Total loop resistance = 260 ohms

Minimum supply voltage = 260 (1V/50 ohms) + 11V = 16.2 VDC

The maximum loop power supply voltage that may be applied is 30 VDC. The maximum loop resistance (RL) is calculated by the equation:


$RL = 50 (VS - 11) \text{ ohms}$
Example: $RL = 50 (24 - 11) = 650 \text{ ohms}$ for 24 VDC loop supply.


2.B INTRINSICALLY SAFE INSTALLATION IN HAZARDOUS LOCATIONS  **EEx ia IIC T4** Connect the field wiring in accordance with the appropriate Metrix drawing. The leads must be terminated inside an enclosure that affords a degree of protection of at least IP20, as defined on Metrix drawings. The transmitter requires a minimum of 11 VDC for proper operation. The voltage drop across the specified non-isolated barriers with a 20 mA loop current is 8.1 VDC.

The minimum loop power supply voltage required is 19.1 VDC plus 1 volt for each 50 ohms of loop resistance. The maximum loop power supply voltage that may be applied to the safety barrier is 26 VDC. Therefore, the maximum loop resistance with a 26 VDC supply is 345 ohms.

Example: Signal wire resistance = 5 ohms
 Resistance of receiver = 100 ohms
 Total loop resistance = 105 ohms

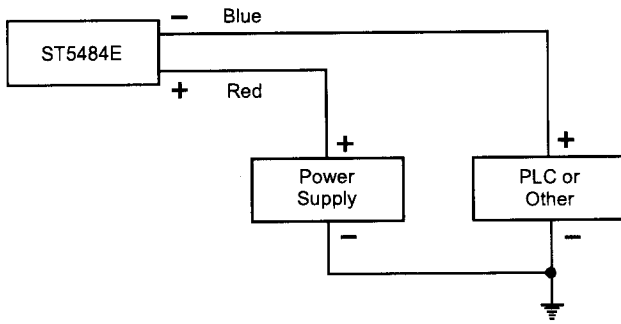
Minimum supply voltage = 105 (1V/50 ohms) + 19.1 V = 21.2 VDC

2.C EXPLOSION-PROOF INSTALLATION IN HAZARDOUS LOCATIONS  ST5484E transmitters are CSA certified explosion-proof, Class I (B, C & D); Class II (E, F & G). Connect the field wiring in accordance with the appropriate diagram on page 4. Refer to paragraph 2.A for loop voltage and resistance requirements. All conduit and junction boxes used must be certified explosion-proof for the class, division and group required by the application. Installation of the transmitter must meet all of the explosion-proof installation requirements of the local governing agency and facility safety procedures.

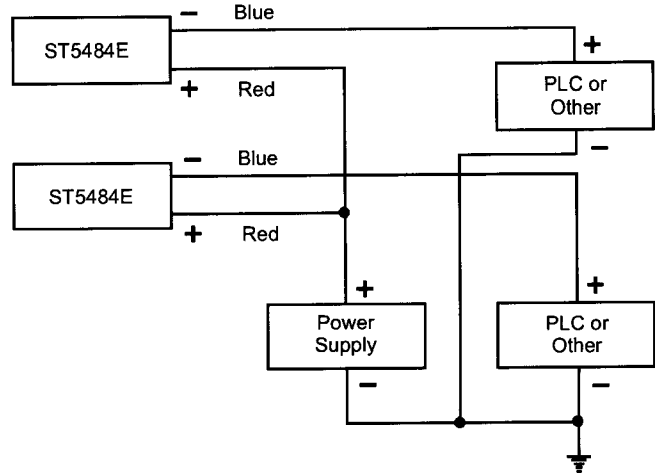
3. ELECTROMAGNETIC COMPATIBILITY In order to meet the requirements of  electromagnetic compatibility in areas of high electromagnetic interference, the field wiring must be:

1. shielded twisted pair cable enclosed in grounded metallic conduit, or
2. double shielded twisted pair cable with a metallic body cable gland fitting and with the outer shield grounded to earth.

WIRING DIAGRAMS



Single Transmitter



Multiple Transmitters

Use standard two-conductor, twisted pair, shielded wiring for the long run to the instrumentation enclosure. The transmitter is connected like any other loop powered end device.

CONNECTION TO PLC OR OTHER INDICATING INSTRUMENT

The first step in configuring the PLC, DCS, or other recording instrument is to determine the source of power. The ST5484E requires loop power be supplied to it. Some Analog Input channels, on a PLC or DCS, for example, provide this power from within. If they do not provide power, an external power supply must be provided. Connect the transmitter field wiring using standard instrumentation practices.

Scaling of the display is on the basis of the range of the transmitter. The measurement parameter name is "vibration" and the units are "ips" (inches per second) or "mm/s" (millimeters per second). The example below is based on a standard 1.0 ips transmitter.

Vibration Level	Transmitter Output	PLC (or other) Scale
None	4 mA +/- 0.1 mA	0.00 ips
1.0 ips	20 mA +/- 0.4 mA	1.00 ips

In order to prevent nuisance alarms, due to transient operating conditions, program a time delay into the alarm. Momentary "jolts" that can occur at start-up or during some operating condition changes, do not reflect a machines steady state operating condition. The indicated vibration level must cross the threshold level and stay above it for a preset time before any alarm action is taken. A 2 to 3 second delay is normally applied to most machinery. Consult Metrix if you have a question about your machines operating characteristics.

Some rough starting machinery may also need a start-up time lockout for alarms. A start-up lockout is different than a time delay! A start-up lockout functions the same as a time delay, but is usually set to a much longer time. Both may be needed.

TYPICAL TRANSMITTER PLACEMENT

The ST5484E measures seismic vibration at the attachment point on the machine. Its sensitive direction is through its cylindrical body. It will not measure side to side motion. It measures velocity vibration in ips (inches per second). Velocity vibration is a common measurement for a large variety of machinery.

Typical transmitter mounting for casing vibration measurements is in the horizontal direction at the bearing housings. Usually the horizontal direction is more sensitive because of the way machinery is typically mounted. Figure 2 shows the flying leads being spliced in the conduit elbow. Please be aware the splice can not be made at this point if in a hazardous area. In this case, make the splice in a second conduit hub (meeting splicing requirements) at the end of the flexible

conduit. The standard lead length is 24 inches. We recommend using the “Y” conduit elbow because it prevents the conduit from extending too far away from the transmitter, limiting the likelihood of getting snagged while working near the machinery. If a 1 inch to 3/4 inch reducer is used at the elbow, a smaller diameter flexible conduit can be used. It is always a good idea to limit the mass that “hangs” on the transmitter. The flexible conduit should make a bend in order to be sure any rigid conduit motion can not feed into the transmitter body.

Typical Application and Mounting Arrangement

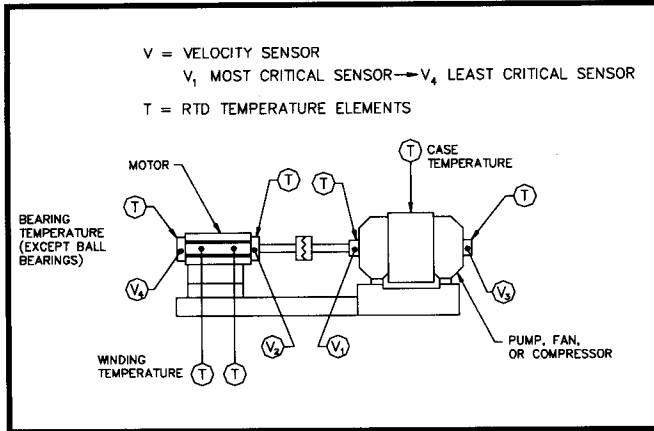


Figure 1

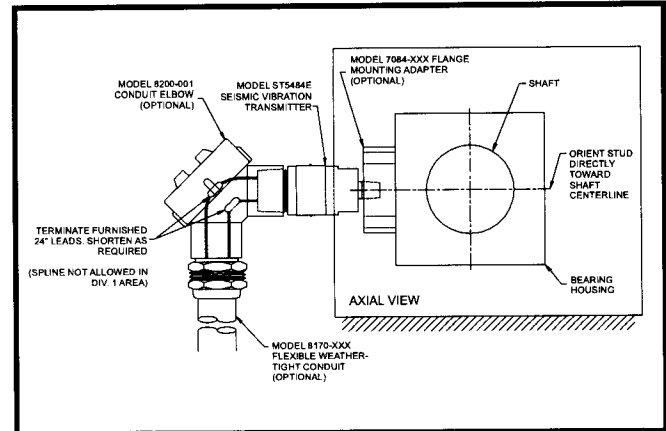


Figure 2

CALIBRATION

The ST5484E transmitter has been factory calibrated for the full scale vibration level marked on the label. If the calibration is in doubt the unit can be verified in the field by following the procedures outlined below. Note that there are no Zero and Span adjustments on the transmitter.

1. Zero Verification In the absence of vibration the output current should be $4 \text{ mA} \pm 0.1 \text{ mA}$. If the ambient vibration is more than 2% of full scale, the transmitter should be removed from the machine and placed on a vibration free surface for this measurement. Often a piece of foam can be used to isolate the transmitter from external motion.

2. Span Verification Subject the transmitter to a known vibration within the full scale range marked on the label. If using a portable vibration shaker where it can be tested at full scale, the output should be $20 \text{ mA} \pm 0.4 \text{ mA}$. If using another reference, like a similar machine, calculate the current value on a proportional basis.

The output level can also be compared to a vibration level read on a portable vibration meter. This reading should be taken as close to the transmitter location as possible. Note that the frequency range of the portable meter must be similar to the frequency range of the ST5484E. Otherwise, significant differences between the two readings could be encountered.

If you shake the transmitter by hand you can produce a high output as long as there are no high pass filters. Check the configuration for filters. There is no way of knowing the expected output when shaking it by hand.

OPTIONAL DYNAMIC OUTPUT

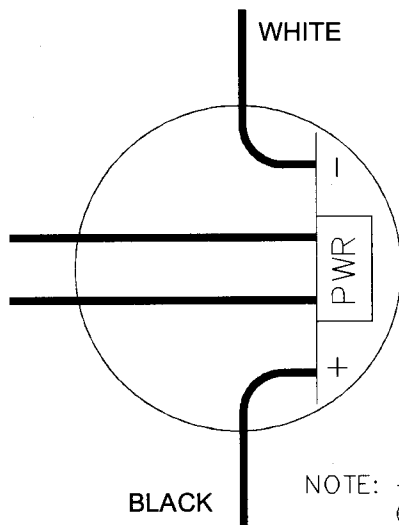
The transmitter can be configured with an optional dynamic output. This output is an acceleration signal with a sensitivity of 100 mV/g , the connections are shown in Figure 3. An electrically isolated or battery powered portable vibration analyzer can only be used to analyze this signal. Since this a loop powered device an external ground will affect the loop output and could cause a false alarm. When using a portable vibration analyzer, or data collector, be sure to turn the instrument sensor power off. Be aware, most portable vibration analyzers have a low input impedance and they will load this signal resulting in attenuation of as much as 20 to 30%, refer to Table 1. This shows the nominal attenuation to be expected with a given input impedance.

NOTE: In all cases for all locations, the use of this signal is for temporary use only. Permanent connection could violate hazard location installations. Care should be exercised to avoid introducing electrical noise or mechanical vibrations when using this output. When output is not in use, be sure leads cannot touch conduit or each other. This will affect the 4-20 mA current output. This output can not be accessed using leads longer than 10 or 12 feet.

Table 1.

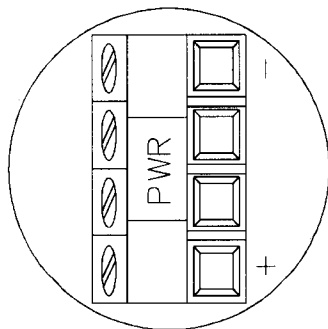
Inout Impedance of Analyzer	dB Attenuation
10MEG	0.01
5MEG	0.02
2MEG	0.04
1MEG	0.09
500K	0.18
200K	0.43
100K	0.84
50K	1.61
20K	3.57
10K	6.10

Figure 3.



NOTE: + AND - SYMBOLS ARE NOT ON LABEL

TOP VIEW OF FLYING LEADS WIRED VERSION

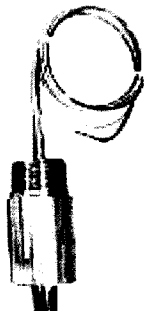


NOTE: + AND - SYMBOLS ARE NOT ON LABEL

TOP VIEW OF TERMINAL BLOCK VERSION

OPTIONAL MOUNTING & CONNECTION

The ST5484E is available with different mounting options as well as different field wiring options. Some of these are illustrated here. The performance of the transmitter does not change (except for the dynamic output option, discussed earlier).



ST5484E-XXX-X20-XX
With 2-24" flying leads.

ST5484E-XXX-X21-XX
With 4-24" flying leads. The dynamic signal leads (black & white) provide a buffered 100 mV/g connection for analysis.



ST5484E-XXX-X32-XX
With two slot terminal block.

ST5484E-XXX-X33-XX
Four slot terminal block top connection. The dynamic signal terminals (two outside ones) provide a buffered 100 mV/g connection for analysis.



ST5484E-XXX-X14-XX
With 2-pin MS style connector.

OPTIONAL MOUNTING ACCESSORIES



8200-001, Conduit Elbow & Reducer
Provides access and physical protection for field wiring. Suitable for Class I, Div. 1 (Grps C & D) and Class II, Div. 1 (Grps E, F & G), hazardous areas. 1" to 3/4" NPT reducer for customer connection included. NEMA 4 IP 65. Material: copper free aluminum.

8200-002, Conduit Elbow & Reducer
Conduit Elbow with terminal block



8200-005, Stainless Steel Conduit Elbow & Reducer
Provides access and physical protection for field wiring. 1/2" NPT suitable for Class I, Div. 1 (Grps B, C & D)*, Class II, Div. 1 (Grps E, F & G)*. Material: stainless steel

8200-006, Conduit Elbow & Reducer
Stainless Steel Conduit Elbow with terminal block

* Certification Pending



8201-001, Conduit Union
Fits between transmitter and 8200-001 conduit elbow to facilitate installation and wiring where there is not enough room to rotate the elbow. Suitable for Class I, Div. 1 (Grps A, B, C & D) and Class II, Div. 1 (Grps E, F & G), hazardous areas. Material: zinc plated steel.



7084-001, Stainless Steel Flange Mount Adaptor
Provides a means to surface mount transmitters rather than NPT stud (1/2" NPT center hole). Three equally spaced 6.6 mm (0.26") diameter mounting holes on 38 mm (1.50") diameter circle.

7084-002, Flange Mount Adaptor
Same as 7084-001, except center hole is 1/4" NPT. Material: stainless steel

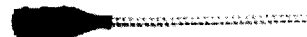


8253-002, Bushing
Bushing for 1/2" NPT mount when screwed onto standard 1/4" NPT base. Material: stainless steel.

OPTIONAL CONNECTION ACCESSORIES



8978-111-XXXX, Splashproof Cable Assembly
Two (2) pin socket connector with integral, molded splash proof boot with 6.4 mm (0.25") diameter polyurethane jacketed cable with twisted shielded pair wires. xxx.x = Cable length in meters.



9334-111-YYYY-XXXX, Splashproof Cable Assembly w/Stainless Steel Armor
Two (2) pin socket connector with integral, molded splash proof boot with 7.1 mm (0.28") diameter, SST armored jacket with cable, twisted shielded pair wires. xxx.x = Cable length in meters. yyy.y = Armor length in meters.



8978-211-XXXX, Cable Assembly
Two (2) pin socket connector with cable strain relief with 6.4 mm (0.25") diameter polyurethane jacketed cable with twisted shielded pair wires. xxx.x = Cable length in meters.

Note: All 8978 connector/cable assemblies rated to 121°C (250°F) max.



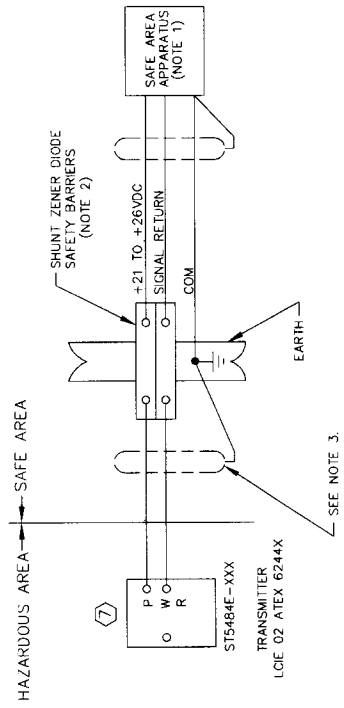
9334-211-YYYY-XXXX, Cable Assembly, w/Stainless Steel Armor
Two (2) pin socket connector with 7.1 mm (0.28") diameter, SST armored jacket with cable, twisted shielded pair wires. xxx.x = Cable length in meters. yyy.y = Armor length in meters.



8169-75-002-XXX, Two-wire, Cable Assembly
2 conductor (20 AWG) twisted, shielded PVC jacketed cable, with plated steel grip for cable strain relief, male 3/4" NPT end. Specify -XXX for length in feet. Example: 8169-75-002-010 =10 ft (3.1M). Material: zinc plated steel.

REV	DATE	BY	DESCRIPTION
A	06-22-06	AW	REVISED
B	06-22-06	AW	REVISED
C	06-22-06	AW	REVISED

INSTALLATION - VIBRATION TRANSMITTER IN HAZARDOUS LOCATION CENELEC



Entity Parameters	
Vmax,	Vi = 30V
Imax,	Ii = 100mA
Pi	= 0.75W
Ci	= 29nF
Li	= 0mH

AGENCY APPROVED PRODUCT
DO NOT DEVIATE FROM
DOCUMENTED CONSTRUCTION
OR LISTED PARTS

Verifie' et Certifie'
conforme d' l'execution

- NOTES: (UNLESS OTHERWISE SPECIFIED)
- SAFE AREA APPARATUS IS NOT SPECIFIED EXCEPT THAT IT MUST NOT BE SUPPLIED FROM NOR CONTAIN IN NORMAL OR ABNORMAL CONDITIONS A SOURCE OF POTENTIAL WITH RESPECT TO EARTH IN EXCESS OF 250 VRMS OR 250 VDC.
 - THE SAFETY BARRIER MUST CONFORM TO THE FOLLOWING:
 $V_{oc}, V_o \leq V_{max}, V_i$
 $I_{sc}, I_i \leq I_{max}, I_i$
 $P_o \leq P_i$
 - CIRCUIT IN HAZARDOUS AREA MUST BE CAPABLE OF WITHSTANDING A VOLTAGE TEST OF 500 VRMS TO EARTH OR TO THE FRAME OF THE APPARATUS FOR ONE MINUTE.
 - THE CAPACITANCE AND EITHER THE INDUCTANCE OR INDUCTANCE TO RESISTANCE (L/R) RATIO OF THE INTERCONNECTING CABLE MUST NOT EXCEED THE FOLLOWING:
 $C \text{ cable} \leq C_o - C_i$
 $L \text{ cable} \leq L_o - L_i$
 - THE HAZARDOUS AREA CABLE IS TO BE INSTALLED AS EITHER A SEPARATE CABLE OR A SEPARATE CIRCUIT WITHIN A "TYPE A" CABLE OR WITHIN A "TYPE B" CABLE AS DEFINED IN EN 50039 (1980). THE PEAK VOLTAGE OF ANY CIRCUIT IN THE "TYPE B" CABLE MUST NOT EXCEED 60V.
 - THE INSTALLATION MUST COMPLY WITH THE APPROPRIATE NATIONAL INSTALLATION REQUIREMENTS. EXAMPLE: UK: BS5345 PART 4 (1977).
- ⑦ REFER TO SPECIFICATION DRAWING 9163 FOR ADDITIONAL INSTALLATION AND WIRING DETAILS. MODEL 8200-001 CONDUIT ELBOW OR OTHER IP 20 RATED FITTING MUST BE EMPLOYED TO PROTECT THE ELECTRICAL CONNECTION. MATERIAL OF FITTING MUST CONTAIN LESS THAN 6% MAGNESIUM.

MATERIAL	ST5484E-XXX TRANSMITTER LCE 02 ATEX 6244X
FRACCTIONS: DECIMALS	1/100, 1/10, 1/1000, 1/10000
ANGLES: DEGREES	30, 45, 60, 90, 120, 150, 180
SURFACE FINISH	SMOOTH
DO NOT SCALE DRAWING	
U.S.A.	
INSTALLATION	ST5484E-XXX TRANSMITTER
9278	



MP Filtri Tank Accessories

Level Indicators

✱ Level Indicators

These indicators are available in the following styles: Vertical Indicators with standard bolt centers in three different materials. Vertical Indicators with variable bolt centers in two different materials. Large circular indicators with 6 bolt mounting pattern with optional probe style thermometer. Small circular indicators with threaded or clearance hole mounting. Common values for all level indicators are: Maximum Pressure is 30 PSI; Working Temperature is -22°F to +212°F; Compatible with Mineral Oils, Synthetic Fluids, Water-based Emulsions and Phosphate Esters except as noted. Not Compatible with alcohol or alcohol-based liquid except as noted.

- ◆ **LVA** series is a molded plastic with anodized aluminum shell. Mounted with two nuts or threaded tank wall on 3", 5" or double 5" centers. Standard seal is Buna N; Viton seal is optional. Thermometer is optional.
- ◆ **LVP** series is a low cost one piece molded plastic. Mounted with two nuts or threaded tank wall on 3" or 5" centers. Standard seal is Buna N; Viton seal is optional. Thermometer is optional.
- ◆ **LVE** series is a molded plastic with reinforced plastic protective shell. Mounted with two nuts or threaded tank wall on 5" or 9-1/4" centers. Standard seal is Buna N; Viton seal is optional. Thermometer is optional.
- ◆ **LVM** series of six lengths up to 16-1/2 inches with optional one or two bolt mounting. Length is 5.24", 6.42", 9.17", 11.14", 13.11" and 16.65". Slightly less for two hole mounting. Seal is Buna N.
- ◆ **LVU** series of 4 lengths with optional min/max indicators and shut off valve. Connectors are 2 3/8" BSP connectors except where optional shutoff is ordered. Sizes are 19.60", 39.37", 59.06" and 78.74". Protective shell is optional. Pyrex glass with protective shell is optional. Seals are Buna N.
- ◆ **LCO** Series are large circular indicators with 6 bolt mounting pattern in 6 and 8 inch diameters with optional probe style thermometer. Seals are Buna N.

◆ **LCP** series are small circular indicators with threaded or clearance hole mounting.

- LCP***M series are made of aluminum with glass window in sizes to fit 1/2", 1" and 1-1/2" BSP. Seals are inorganic fiber. Screen is optional.
- LCP***N series are made of black nylon with plastic window in sizes to fit 1/4", 3/8", 1/2", 3/4", 7/8", 1", 1-1/4", 1-1/2" and 2" BSP. Seals are inorganic fiber unless expansion stile is specified; then seals are Buna N. Screen is optional.
- LCP***T series are made of Trogamid clear plastic with plastic window in sizes to fit 1/4", 3/8", 1/2", 3/4", 7/8", 1", 1-1/4" BSP, M14x1.5, M16x1.5, M18x1.5, M20x1.5 and M22x1.5. Seals are Buna N. Screen is optional on 3/4", 1" and 1-1/4" BSP sizes.

◆ **LCC** series are small circular indicators with threaded or clearance hole mounting.

- LCC***N series are made of black nylon with plastic dome window in sizes to fit 1/2", 3/4", 7/8", 1", 1-1/4", 1-1/2" and 2" BSP. Seals are inorganic fiber unless expansion stile is specified; then seals are Buna N.
- LCC***T series are made of Trogamid clear plastic with plastic dome window in sizes to fit 1/4", 3/8", 1/2", 3/4", 1" BSP, M14x1.5, M16x1.5, M18x1.5, M20x1.5 and M22x1.5. Seals are Buna N.

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[[Lenz Level Indicators](#) ]

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Installation for L1100, L1200, L1200N Series Liquid Level Switches and DV850, DV875, and DV2100 Series Dump Valves

DV models are Patent pending.

Please read the following instructions before installing. A visual inspection for damage during shipping is recommended before mounting.

GENERAL INFORMATION

WARNING

BEFORE BEGINNING INSTALLATION OF THIS MURPHY PRODUCT

- ✓ Disconnect all electrical power to the machine.
- ✓ Make sure the machine cannot operate during installation.
- ✓ Follow all safety warnings of the machine manufacturer.
- ✓ Read and follow all installation instructions.
- ✓ OBSERVE all pressure and electrical ratings and requirements for the devices and the operating environment.
- ✓ BE SURE all pressure HAS BEEN REMOVED from the vessel before opening any pressure connections.

Description



Series L1100 and L1200 Liquid Level Switches are float activated to operate an electrical SPDT snap switch (optional DPDT on some models) for alarm or shutdown of an engine or electric motor. They screw directly into the wall of the vessel. Series L1200 can also be used with a weld collar or external float chamber.

Series L1200N is a float-activated, pneumatic-vent level device used to operate dump valves or similar devices. This model screws directly into the vessel or can be mounted via an external float chamber. It **cannot** be used with weld collar 15050375. Model variations include a dump valve operator with or without a filter/pressure regulator and indicating pressure gauge.

NOTE: All stainless steel versions of L1100, L1200, L1200N, L1200NDVO, and L1200NDVOR series carry Canadian Registration Number OF1476.2.

Series DV850, DV875 & DV2100 Dump Valves receive a pneumatic input signal to cause an orifice to open or close allowing liquid condensate to be drained from a pressure vessel. A pop up button indicates valve open/closed. Stainless steel versions available. *NOTE: All stainless steel versions of DV850, DV875, and DV2100 series carry Canadian Registration Number OC1476.2.*

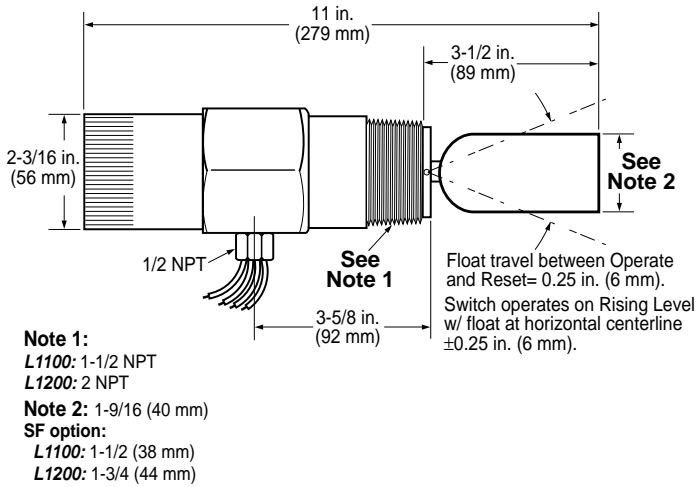
Specifications	L1100	L1111	L1150	L1200	L1250	L1200N	L1200NDVO	L1200NDVOR
Body								
• Standard: Electroless Nickel plated steel	X ^A	X ^A	X ^A	X ^B	X ^B	X ^B	X ^B	X ^B
• Optional: 316 Stainless Steel†	X ^A	X ^A	X ^A	X ^B	X ^B	X ^B	X ^B	X ^B
Pressure Rating								
• 15 psi (103 kPa) [1.03 bar] Polyethylene Float			X		X			
• 1500 psi (10.3 MPa) [103.42 bar] Stainless Float	X	X		X		X	X	X
• 2000 psi (13.8 MPa) [138 bar] BUOYGLAS™ Float	X	X		X		X	X	X
Temperature Rating								
• Standard: -20/175°F (-29/79°C)			X		X			
• Standard: -20/300°F (-29/149°C)	X	X		X		X	X	X
• Optional: -20/400°F (-29/204°C)*	X	X		X		X	X	X
Specific Gravity								
• Standard: 0.5 with BUOYGLAS™ float	X	X		X		X	X	X
• Optional: 0.65 with 304 Stainless Steel†	X	X		X		X	X	X
• Standard 0.73 Polyethylene Float			X		X			
Electrical								
• Standard SPDT: 5 A @ 125/480 VAC (see p. 3 for full ratings)	X	X	X	X	X			
• Optional DPDT: 10 A @ 250 VAC (see p. 3 for full ratings)	X	X	X	X	X			
Wire: 18 AWG x 36 in. (1.0 mm ² x 914 mm)	X	X	X	X	X			
O-Rings: Viton	X	X	X	X	X	X	X	X
Valve: Two-way snap-action vent type • 1/8 in. (3 mm) orifice w/Viton "A" seat • 1/8 NPT inlet; 1/4 NPT outlet • 30-70 psi (207-483 kPa) [2.07-4.83 bar] operating pressure						X	X	X
Dump Valve Operator: Operates Murphy DV Series dump valves or similar.							X	X
Pressure Regulator/Filter and Murphy 20BPG: 0-75 psi (0-517 kPa) [0-5.17 bar] pressure gauge. Maximum input 300 psi (2.07 MPa) [20.68 bar].								X
Operation: H=For high level, L=For low level	H	L	H	H	H	H	H	H

^A=1-1/2 NPT ^B=2 NPT †Meets NACE standard MR-01-75 for direct exposure to H₂S service. *Not available with DPDT snap-switch.

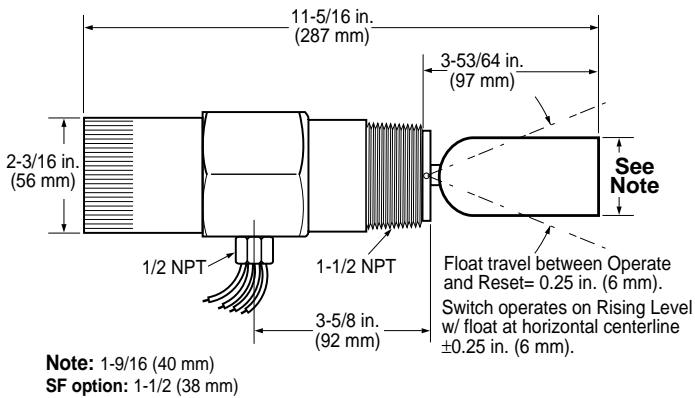
**Products covered by this literature comply with EMC Council directive 89/336/EEC regarding electromagnetic compatibility.

DIMENSIONS

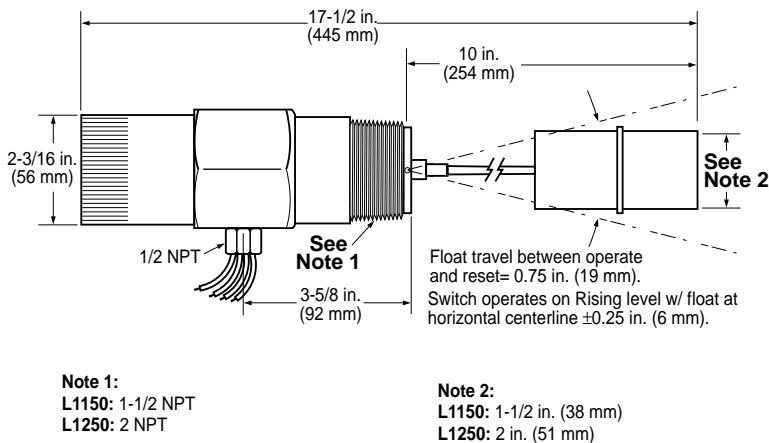
L1100 and L1200



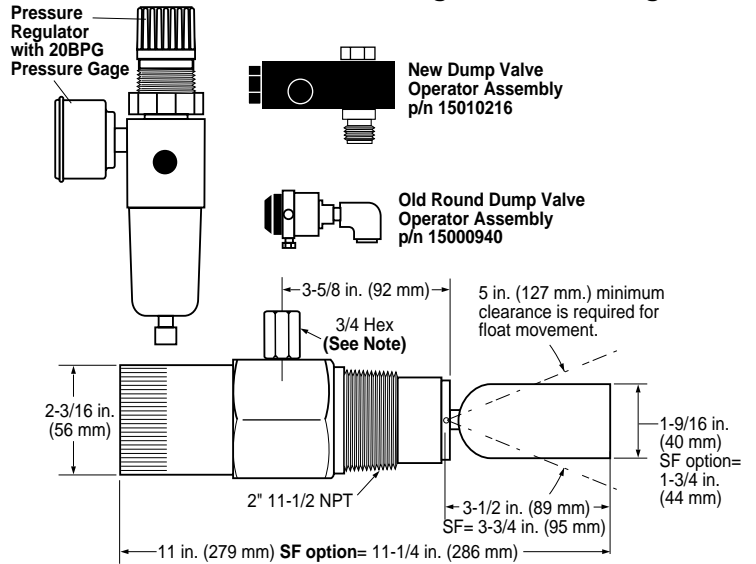
L1111



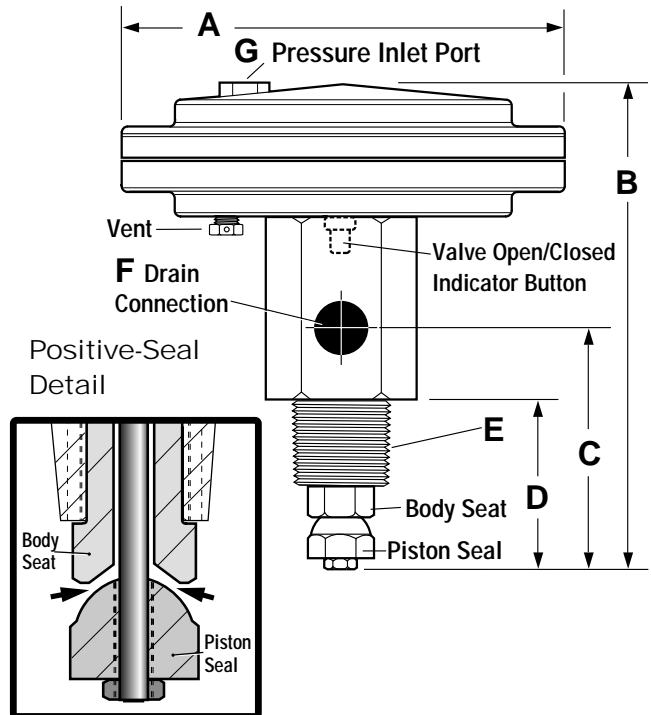
L1150 and L1250



L1200N, L1200NDVO and L1200NDVOR with Dump Valve Operator, Pressure Regulator and Gage



DV850, DV875, and DV2100 Series Dump Valves



	DV850/SS	DV875/SS	DV2100/SS
A	6-3/4 (171)	6-3/4 (171)	6-3/4 (171)
B	7-9/64 (181)	7-9/64 (181)	7-59/64 (201)
C	3-9/32 (83)	3-9/32 (83)	3-63/64 (101)
D	2-19/64 (58)	2-19/64 (58)	2-5/32 (55)
E	1 NPT	1 NPT	2 NPT
F	1/2 NPT	3/4 NPT	1 NPT
G	1/8 NPT	1/8 NPT	1/8 NPT

NOTE: Dimensions are in inches and (millimeters)

REPLACING AND INSTALLING THE DVOA ASSEMBLY

When replacing/installing the old style DVO assembly with the new style (DVOA), tubing and fitting modifications are required. We suggest removing the L1200NDVO/DVOR from the vessel. Relieve pressure from the vessel or use block valves before removing the L1200NDVO/DVOR.

Replacing and Installing the DVOA Assembly For Models L1200NDVO & L1200NDVOR

Tools Needed: Strap or pipe wrench; 3/4" Hex wrench; 9/16" hex wrench; needle nose pliers; tubing cutters and benders and the appropriate tools for the fittings.

1. Block off and bleed the instrument gas pressure supply to the L1200NDVO.
2. Remove the tubing between the L1200NDVO and the separator dump valve, and remove the supply gas tubing (regulator [-R] if used).
3. Remove the L1200NDVO from the vessel (optional).
4. If the L1200N was removed from the vessel, mount it in a suitable vise on a work bench (if possible).
5. Using the proper tools, disconnect the Inlet, Outlet and Exhaust fittings from the existing DVO (see fig. 1). You will re-connect these to the new DVOA in a later step.

NOTE: The following steps must be done with the DVO in the upright position (on top of the L1200N).

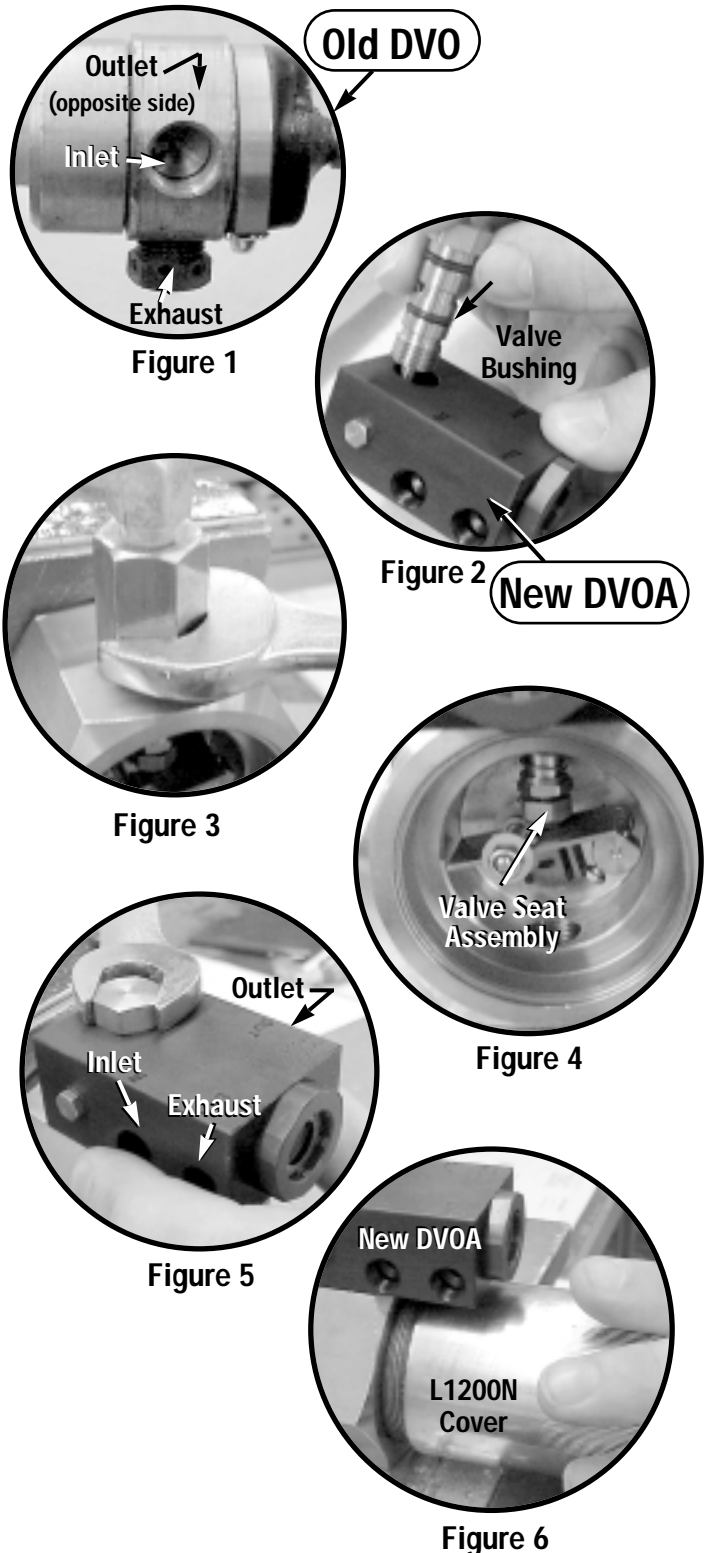
6. Remove the L1200N cover (this will aid with the alignment of the new DVOA Valve Bushing). The use of a strap wrench or a pipe wrench may be needed.
7. Insert the new Valve Bushing through the new DVOA (see fig. 2). The markings on top of the DVOA must be facing up. This will be needed in step 9.
8. With a 3/4" hex wrench loosen the existing DVO, valve stem, and static seal (see fig. 3). Once the assembly is loosened, **VERY CAREFULLY** use needle nose pliers to hold the Valve Seat Assembly in place. Remove the existing DVO making sure the Valve Seat Assembly inside the L1200NDVO is aligned and straight (see fig. 4).



CAUTION: MAKE SURE the Valve Seat Assembly inside the L1200N remains in place after removing the DVO.

9. Holding the Seat Assembly up with the needle nose pliers inside the L1200NDVO body, place the tip of the new DVOA valve bushing through the spring and into the hole in the center of the valve seat, and tighten the valve bushing. The Valve Seat Assembly should be able to move freely up and down after the bushing has been tightened. The DVO red button must face away from the vessel.
10. With the new DVOA aligned over the hex on the L1200NDVO body, tighten the Valve Bushing using the 9/16" hex wrench. You may need to hold the DVOA while tightening the Valve Bushing to keep it from rotating (see fig. 5).
11. If the L1200N is in the vise, operate the float and inspect for smooth and proper operation of the Valve Seat Assembly.
12. Replace the L1200NDVO cover (see fig. 6).
13. Using the appropriate tools re-install the Inlet, the Outlet and the Exhaust fittings to the new DVOA (see fig. 5).
14. If the L1200N was removed from the vessel re-install it at this time.
15. Modify existing or install new tubing to connect the Inlet, the Outlet and Exhaust fittings.

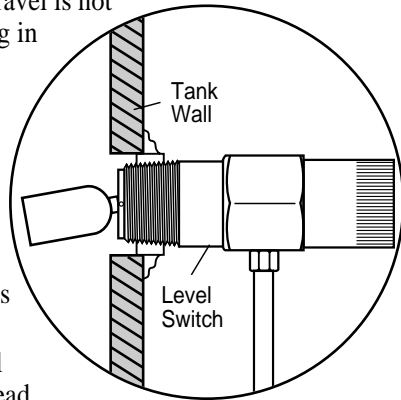
NOTE: Clean, dry instrument quality gas should be used. Use of filters will improve service life and reliability.



PRESSURE VESSEL INSTALLATION: L1100, L1200, and L1200N

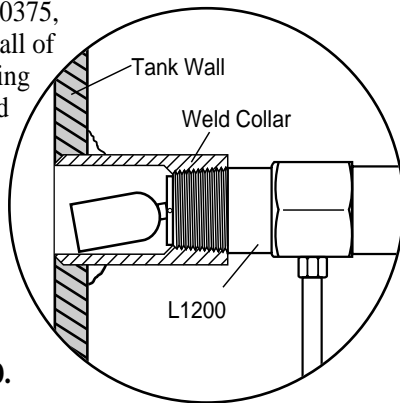
Direct Installation into the Wall of the Pressure Vessel

1. Determine that the float travel is not obstructed by the coupling in the vessel wall, internal baffles, etc. Do NOT use more than one arm extension P/N 15050395.
2. BE SURE that the float and extension are tight and that the lock washer is in place.
3. Before installing the level switch a suitable pipe thread sealant is recommended. Screw the unit directly into the threaded connection in the wall of the pressure vessel.
4. Be sure that the electrical connection is positioned at the bottom. For L1200N the 1/8 NPT pneumatic connection should be on top (the 1/4 NPT vent connection should be on the bottom). See "Pneumatic models" section for further instructions for the L1200N.
5. Make the electrical wiring connections according to appropriate wiring diagrams for the alarm or shutdown system to be used. The electrical connection is 1/2-14 NPT.
6. BE SURE all electrical connections are insulated and the cover is fully installed before reconnecting electrical power.
7. BE SURE all pressure connections are tight before pressurizing the system.



Installation with a Weld Collar

1. The weld collar, P/N 15050375, must be welded into the wall of the pressure vessel according to code standards and good welding practices.
2. Follow above instructions for installation directly into the wall of the pressure vessel.
3. **NOTE: Weld collar 15050375 can be used ONLY with model L1200.**



Installation Using External Float Chamber 15050697

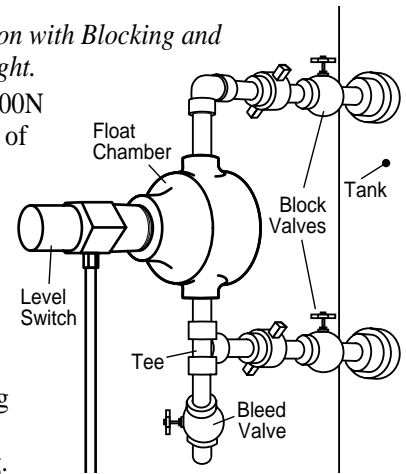
CAUTION: USE "NON SPARKING TOOLING".

1. Install the float chamber 15050697 on the outside wall of the pressure vessel using 1 NPT piping. Position the 2 NPT threaded connection at the height where you want the level switch to operate. The 2 NPT threaded connection must be positioned away from the tank wall.

2. A tee is typically installed at the bottom of the lower 1 inch pipe riser to allow draining of the float chamber for servicing or replacement.

NOTE: A typical installation with Blocking and Bleed valves is shown at right.

3. Install the L1200 or L1200N in the 2 NPT connection of the float chamber. BE SURE float travel is not restricted and that the float is tight onto the float shaft.
4. To complete installation and wiring, follow the instructions for mounting directly into wall of the vessel and for wiring.



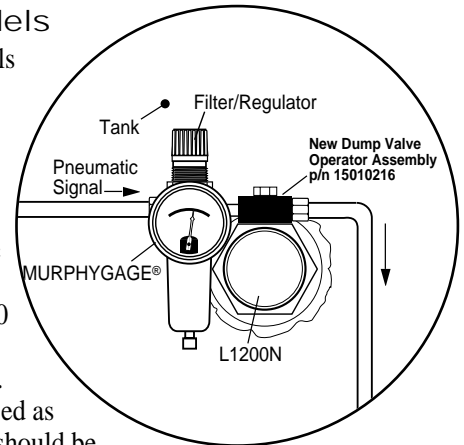
Pneumatic Models

1. All pneumatic models operate on the vent principle. The pneumatic signal source MUST BE CLEAN AND DRY. The input pneumatic signal must be regulated between 30 and 70 psi (207-483 kPa) [2.07-4.83 bar].

If produced gas is used as the signal source, it should be taken after gas passes through the final scrubber. A suitable filter must be positioned before the L1200NDVO to prevent liquids and/or particulates from entering the dump valve operator.

NOTE: Check filter periodically for wear and tear and elements that hamper the flow of the pneumatic signal.

2. All pressure connections must be tight and maintained tight so as not to leak air/gas.
3. Valve seat adjustment can be made if air/gas begins to leak. Care should be taken when adjusting as only slight movement is necessary to stop the leakage; excessive force will bind the seating mechanism.



-
- Hex Socket Set Screw**
 - loosen for adjustment
 - tighten after adjustment
 - Hex Adjustment Nut**
 - turn left until air seepage stops
 - **Caution:** only slight adjustment is needed—too much will lock up mechanism
 - Trip Cam (float down)**
 - should be in this position
 - non-adjustable

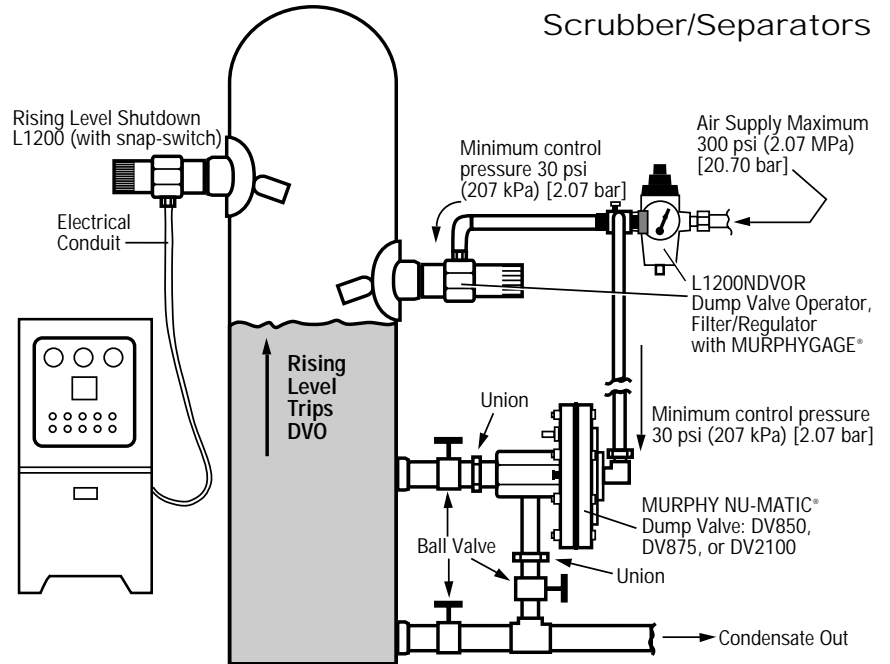
TYPICAL INSTALLATION ON GAS COMPRESSORS

Basic Operation

As condensate rises in the scrubber, the float on the L1200NDVOR rises and trips its pneumatic valve. The valve opens allowing pressure to enter the dump valve pilot chamber. Once the pressure enters the pilot chamber it forces the diaphragm and valve stem forward thus opening the valve seat (valve open/closed indicator button pops out) and releasing condensate through the valve stem and out the drain. As the condensate level drops, the L1200NDVOR pneumatic valve closes to shut off the pressure to the dump valve causing it to close.

If for any reason the condensate continues to rise beyond normal dump levels, model L1200 operates the alarm and/or shuts down the equipment.

The L1200NDVOR Filter/Regulator and the MURPHYGAGE® help keep the control pressure clean and dry. They also allow the operator to adjust pressure to recommended levels.



DUMP VALVE INSTALLATION

DV850 - DV875 - DV2100



CAUTION: USE "NON SPARKING TOOLING".

The following steps describe the "Block and Bleed" method for installing the dump valve. The "Direct Mounting" method to the tank wall is also accepted.

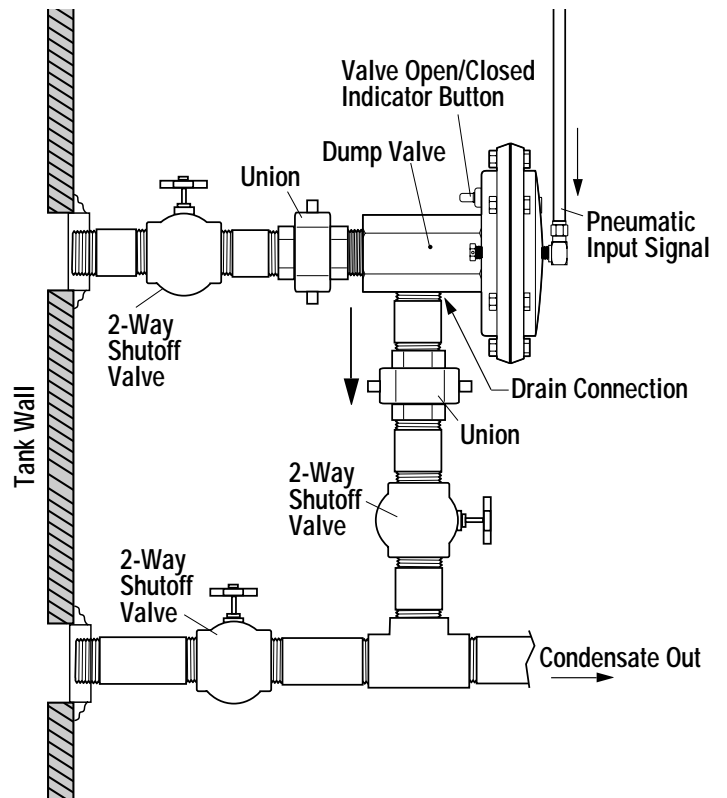
1. Install a manual shutoff (2-way) valve and a union between the DV valve and the vessel to facilitate valve repair or replacement.
2. Position the DV valve drain connection so it is on the bottom.
3. Install a 2-way valve to the drain line between the lower vessel entry and the condensate out line.
4. Be sure the unit is screwed tight and does not leak liquid.
5. Install the piping for the pneumatic input signal into the 1/8 NPT threaded connection of the pressure inlet port (on top of the DV valve).
6. Install a 2-way valve and union between the DV drain connection and the condensate out line.

NOTE: The typical procedure to remove the valve should be:

1. Close the shutoff valve between the scrubber and the DV valve.
2. Operate the dump valve to equalize pressure to the drain (condensate out)line.
3. Close the shutoff valve downstream of the drain.

Be Careful, pressure will still be in the system at the drain pressure when the unions are loosened.

Typical Dump Valve installation



REPLACING THE DUMP VALVE SEAT KIT

Replacing the Seat Kit on the Dump Valves

Tools needed: 7/8" hex wrench, 7/16" hex wrench, 1-1/8" hex wrench, and thread sealer; optional pressure source.

NOTE: Relieve pressure from scrubber or use the block valves before removing the DV dump valve.

1. Remove the valve from the Scrubber.



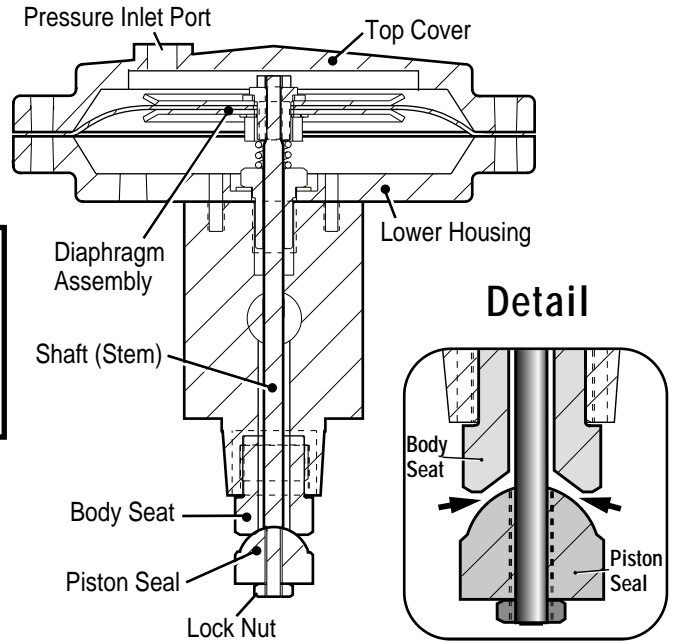
CAUTION: THE BODY SEAT AND PISTON SEAL WILL BE DAMAGED IF ALLOWED TO TURN AGAINST EACH OTHER. THE PREFERRED METHOD IS TO USE AIR TO KEEP THE VALVE OPEN. IF AIR IS NOT AVAILABLE, CAREFULLY FOLLOW THE ALTERNATE INSTRUCTIONS (STEPS 2A & 8A). ALSO, DO NOT GRIP THE OPERATING STEM WITH ANY TOOLS. IF STEM NEEDS TO BE HELD, USE THE NUT ON THE BACK OF THE DIAPHRAGM.

2. Apply 30 psi to the pressure inlet port (top of valve). The Shaft and Piston Seal will extend.

2A. IF AIR IS NOT AVAILABLE DO THE FOLLOWING: Remove the valve Top Cover (bolts/nuts). Note the orientation of the Top Cover to the bottom. Mark both sides of the Diaphragm Housing before dis-assembly. Once the Top Cover is removed, carefully turn the valve upside down with the Piston Seal pointing up. Clamp the bottom housing down, or secure it against a flat surface to compress the spring and open the Piston Seal and Body Seat. Be careful not to damage the diaphragm. The valve must be kept in this fashion, with this much clearance throughout the following operations.

3. Hold the Piston Seal with the 7/8" hex wrench, and remove the Locknut with 7/16" hex wrench.

4. Unscrew the Piston Seal with the 7/8" hex wrench. Now, unscrew the Body Seat (use 7/8" hex wrench for DV850 and DV875 models). Use the 1-1/8" hex wrench for the DV2100 Series models.



5. Apply thread sealer to new Body Seat, and screw it in place tightening with the wrench until it stops. **NOTE:** Clean the female threads in the body before inserting the new Body Seat to facilitate threading.
6. Apply thread sealer to the shaft (stem), and screw the new Piston Seal on to the shaft (stem).
7. Hold the Piston Seal with the 7/8" hex wrench and screw the Locknut in place.
8. Remove the 30 psi pressure to the pressure inlet port, and re-install the valve into the scrubber.
- 8A.** Re-install the Top Cover, paying attention to the alignment marks made in step 2A. Re-install the DV into the scrubber.

REPLACING THE DUMP VALVE DIAPHRAGM ASSEMBLY

Replacing the Diaphragm Assembly for all DV models (Refer to the Illustration above)

Tools needed: 7/8" hex wrench, 7/16" hex wrench, 5/8" hex wrench or socket, and thread sealer.

NOTE: Relieve pressure from scrubber or use the block valves before removing the DV dump valve.

1. Remove the valve from the Scrubber.

2. Remove the valve Top Cover (bolts/nuts). Note the orientation of the Top Cover to the bottom. Mark both sides of the Diaphragm Housing before dis-assembly.



CAUTION: MAKE SURE TO USE A 7/8" HEX WRENCH TO HOLD THE PISTON SEAL WHILE REMOVING THE DIAPHRAGM ASSEMBLY. DO NOT GRIP THE DIAPHRAGM (BLACK RUBBER) WITH ANY TOOLS.

3. Hold the Piston Seal with a 7/8" hex wrench making sure to keep the shaft (stem) from turning, and remove the nut on the back of the diaphragm assembly with the 7/16" wrench.

4. While holding the piston seal with the 7/8" wrench, proceed to remove the diaphragm assembly by hand.

NOTE: You will be turning the assembly against the spring when unscrewing the diaphragm assembly.

5. To re-assemble the assembly, apply thread sealer to the shaft/stem threads and hold the Piston Seal with a 7/8" hex wrench.
6. Keep holding the Piston Seal with 7/8" hex wrench. Make sure the 3/4" nut side of the new diaphragm assembly is toward the shaft. Press the diaphragm assembly into the shaft threads and tighten it on to the shaft threads by hand.
7. Keep holding the Piston Seal with 7/8" hex wrench. Apply thread sealer to 7/16" nut, and screw it on to the shaft threads to lock the diaphragm assembly in place, tighten the nut with the 7/16" wrench.
8. Press down the diaphragm assembly with your hands to open the valve, and *very carefully* turn to align the diaphragm holes with the lower housing bolt holes.

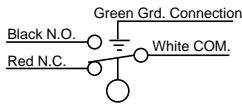


CAUTION: THE BODY SEAT AND PISTON SEAL WILL BE DAMAGED IF ALLOWED TO TURN AGAINST EACH OTHER.

9. Re-install the Top Cover, paying attention to the alignment marks made in step 2. Be sure to tighten the bolts and nuts evenly. Re-install the DV into the scrubber.

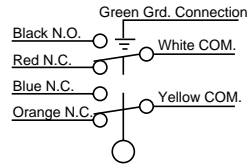
ELECTRICAL INFORMATION

SPDT (Snap Switch)



Switch Rating: 5 A @ 125-250- 480 VAC
 1/2 A @ 125 VDC
 1/4 A @ 250 VDC
 2A @ 6-30 VDC Resistive
 1A @ 6-30 VDC Inductive

DPDT (Snap Switch)



Switch Rating: 10 A @ 125-250 VAC
 1/2 A @ 125 VDC
 1/4 A @ 250 VDC
 10 A @ 6-24 VDC Inductive/Resistive

REPLACEMENT PARTS

Order by part number designation.

L1100/L1200*

- 15000893: BUOYGLAS™ float
- 15000894: Stainless Steel float for L1200
- 15000937: Stainless Steel float for L1100
- 15000124: SPDT snap switch assembly
- 15010213: L1100 counter balance assembly
- 15010214: L1200 counter balance assembly

L1200N

- 15050420: Cam spring return
- 15050421: Cam
- 15000893: BUOYGLAS™ float
- 15000894: Stainless Steel float for L1200N
- 15050453: Valve stem
- 15010189: Counter balance assembly

L1200NDVO and L1200NDVOR

- 55050621: Regulator only
- 05706499: 20BPG-D-75 Pressure MURPHYGAGE®
0-75 psi (517 kPa) [5.17 bar]
- 15010216: DVOA assembly (New rectangular style)
- 15000940: DVO assembly (Old round style)
- 00003341: Filter for regulator
- 00003340: Regulator Diaphragm Kit

DV850, DV850SS, DV875, DV875SS, DV2100 and DV2100SS

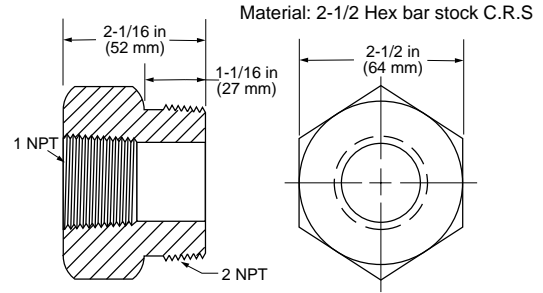
- 55000219: Diaphragm Assembly (all models)
- 55000224: Seat Kit (DV850, DV850SS, DV875 and DV875SS)
- 55000225: Seat Kit (DV2100 and DV2100SS)
- 55050617: Optional Adapter Bushing 2 NPT to 1 NPT

*To maintain hazardous location listings, all other repairs must be made by the factory.

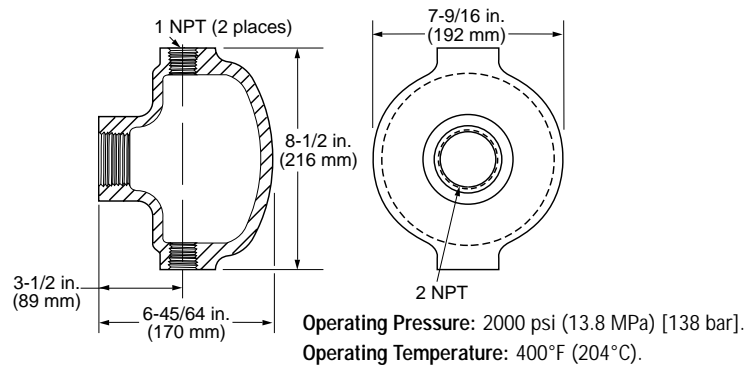
ACCESSORIES

Order by part number designation.

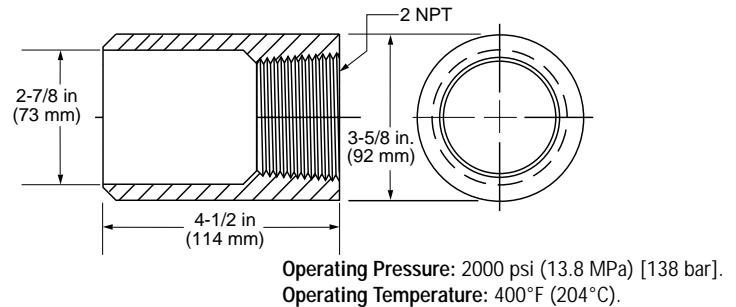
55050617: DV850/DV875 Adapter Bushing



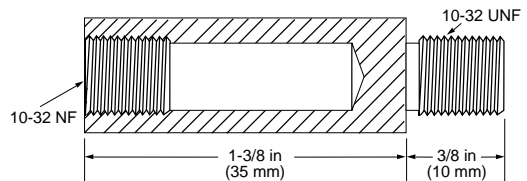
15050697: External Float Chamber



15050375: Weld Collar



15000892: Float Shaft Extension



Warranty

A two-year limited warranty on materials and workmanship is given with this Murphy product.
Details are available on request and are packed with each unit.

In order to consistently bring you the highest quality, full featured products, we reserve the right to change our specifications and designs at any time.



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Shock/Vibration Control Switches Installation Instructions

Models: VS2, VS2C, VS2EX, VS2EXR, VS2EXRB and VS94



Please read the following instructions before installing. A visual inspection of this product for damage during shipping is recommended before mounting. It is your responsibility to have a qualified person install the unit, and make sure installation conforms with NEC and local codes.

GENERAL INFORMATION

WARNING

BEFORE BEGINNING INSTALLATION OF THIS MURPHY PRODUCT

- ✓ Disconnect all electrical power to the machine.
- ✓ Make sure the machine cannot operate during installation.
- ✓ Follow all safety warnings of the machine manufacturer.
- ✓ Read and follow all installation instructions.



Model VS2EX

Description

The Murphy shock and vibration switches are available in a variety of models for applications on machinery or equipment where excessive vibration or shock can damage the equipment or otherwise poses a threat to safe operation. A set of contacts is held in a latched position through a mechanical latch and magnet mechanism. As the level of vibration or shock increases an inertia mass exerts force against the latch arm and forces it away from the magnetic latch causing the latch arm to operate the contacts. Sensitivity is obtained by adjusting the amount of the air gap between the magnet and the latch arm plate.

Applications include all types of rotating or reciprocating machinery such as cooling fans, engines, pumps, compressors, pump jacks, etc.

Models

VS2: Base mount; non hazardous locations.

VS2C: C-clamp mount; non hazardous locations.

VS2EX: Explosion-proof; Class I, Div. 1, Groups C and D*.

VS2EXR: Explosion-proof with remote reset.

VS2EXRB: Explosion-proof; Class I, Div. 1, Group B* ; with remote reset.

VS94: Base mount; non hazardous locations, NEMA 4.

Remote Reset Option (VS2EXR, VS2EXRB and VS94 only)

Includes built-in electric solenoid which allows reset of tripped unit from a remote location. Standard on VS2EXR and VS2EXRB. Optional on VS94 (options listed below).

-R15: Remote reset for 115 VAC

-R24: Remote reset for 24 VDC

Time Delay Option (VS94 only)

Overrides trip operation on start-up. For VS94 series models, the delay time is field-adjustable from 5 seconds up to 6-1/2 minutes with a 20-turn potentiometer (15 seconds per turn approximately). Options listed below:

-T15: Time delay for 115 VAC

-T24: Time delay for 24 VDC

Space Heater Options (VS94 only)

This optional space heater board prevents moisture from condensing inside the VS94 Series case. Options listed below:

-H15: Space heater for 115 VAC

-H23: Space heater for 230 VAC

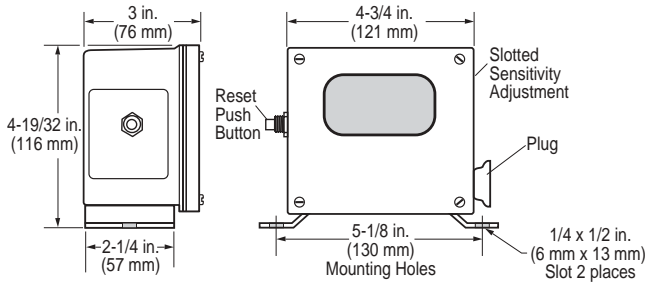
-H24: Space heater for 24 VDC

Warranty

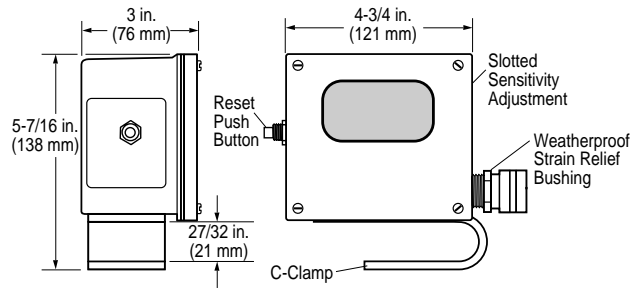
A two-year limited warranty on materials and workmanship is provided with this Murphy product. Details are available on request and are packed with each unit.

DIMENSIONS

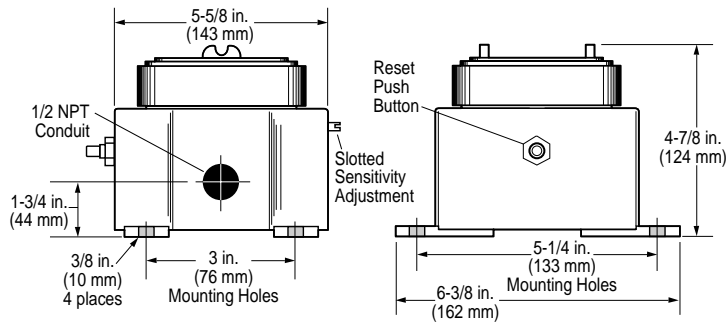
VS2



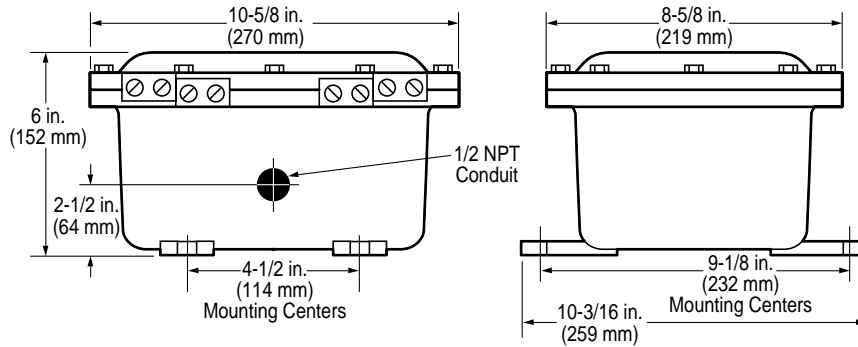
VS2C



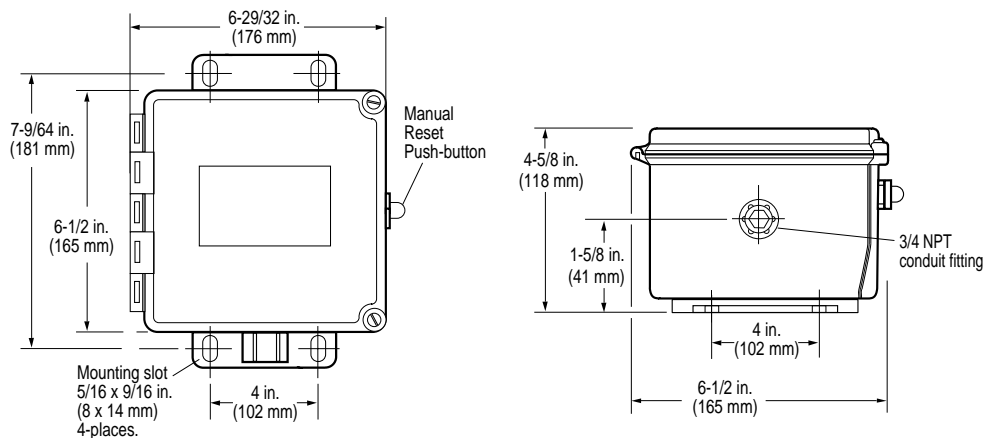
VS2EX and VS2EXR



VS2EXRB



VS94



SPECIFICATIONS

VS2 and VS2C

- **Case:** Weatherproof (equal to NEMA 3R) suitable for non-hazardous areas.
VS2: *Base mount*
VS2C: *C-clamp mount. Includes 45 feet (13.7 meters), 2-conductor 16 AWG, 30 strands/0.25 mm strand dia. (1.5 mm²) cable, and five cable hold down clamps.*
- **Contacts:** SPDT double make leaf contacts, 5A @ 480 VAC.
- **Range adjustment:** 0 - 7 G's; 0 - 100 Hz /0.100 in. displacement.

VS2EX

- **Case:** Explosion-proof and weatherproof aluminum alloy housing; meets NEMA 7 specifications; Class I, Division 1, Groups C & D; UL and CSA listed*
VS2EX: *base mount.*
- **Snap-switches:** 2-SPDT snap-switches; 5A @ 480 VAC;* 2A resistive, 1A inductive, up to 30 VDC.
- **Range adjustment:** 0 - 7 G's; 0 - 100 Hz /0.100 in. displacement.

VS2EXR

- **Case:** Same as VS2EX.
- **Snap-switch:** 1-SPDT snap-switch and reset coil; 5A @ 480 VAC;* 2A resistive, 1A inductive, up to 30 VDC.
- **Remote Reset (optional):**

<i>Option</i>	<i>Operating Current</i>
-R15:	350 mA @ 115 VAC
-R24:	350 mA @ 24 VDC
- **Range adjustment:** 0 - 7 G's; 0 - 100 Hz /0.100 in. displacement.

VS2EXRB

- **Case:** Explosion-proof aluminum alloy housing; rated Class I, Division 1, Group B hazardous areas.
- **Snap-switch:** 1-SPDT snap-switch with reset coil (option available for additional SPDT switch); 5A @ 480 VAC; 2A resistive, 1A inductive, up to 30 VDC.

Remote Reset:(optional):

<i>Option</i>	<i>Operating Current</i>
-R15:	350 mA @ 115 VAC
-R24:	350 mA @ 24 VDC

- **Range adjustment:** 0 - 7 G's; 0 - 100 Hz /0.100 in. displacement.

VS94

- **Case:** Polyester fiberglass reinforced; NEMA type 4 and 4X; IP66; CSA types 4 and 12.
- **Conduit Fitting:** 3/4 NPT conduit fitting connection.
- **Normal Operating Ambient Temperature:** 0 to 140°F (-18 to 60°C).
- **Snap-switches:** 2-SPDT snap acting switches; 5A @ 480 VAC; 2A resistive, 1A inductive, up to 30 VDC.
- **Range adjustment:** 0 - 7 G's; 0 - 100 Hz /0.100 in. displacement.

Heater (optional):

<i>Option</i>	<i>Operating Current</i>
H15	.023 A @ 115 VAC
H23	.011 A @ 230 VAC
H24	.12 A @ 24 VDC

Remote Reset (optional):

<i>Option</i>	<i>Operating Current</i>
R15	.17 A @ 115 VAC
R24	.36 A @ 24 VDC

Time Delay (optional):

<i>Option</i>	<i>Operating Current</i>	<i>Standby Current</i>
T15	.360 A @ 115 VAC	.01 A @ 115 VAC
T24	1.15 A @ 24 VDC	.01 A @ 24 VDC

- **Time Delay/Remote Reset:** Adjustable 20-turn potentiometer from 5 seconds to 6-1/2 minutes (15 seconds per turn approximately).

*CSA and UL listed with 480 VAC rating.

INSTALLATION



WARNING: STOP THE MACHINE AND DISCONNECT ALL ELECTRICAL POWER BEFORE BEGINNING INSTALLATION.

The VS2 and VS94 series shock switches are sensitive to shock and vibration in all three planes of motion - up/down, front/back and side/side. Front/back is the most sensitive (The reset pushbutton is located on the "front" of the unit). For maximum sensitivity mount the unit so that the front faces into the direction of rotation of the machine. (See Dimensions on page 2 for sensitivity adjustment location).

The VS2 and VS94 Series must be firmly attached/mounted to the machine so that all mounting surfaces are in rigid contact with the mounting surface of the machine. For best results, mount the instrument in-line with the direction of rotating shafts and/or near bearings. In other words, the reset push button should be mounted pointing into the direction of shaft rotation (see page 5). It may be necessary to provide a mounting plate or bracket to attach the VS2 and VS94 Series to the machine. The mounting bracket should be thick enough to prevent induced acceleration/vibration upon the VS2 or VS94 Series. Typically 1/2 in. (13mm) thick plate is sufficient. See illustrations on page 5 for typical mounting locations.



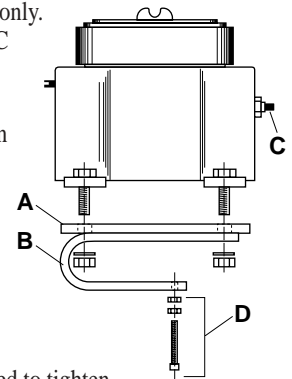
CAUTION: A dust boot is provided on the reset pushbutton for all series to prevent moisture or dust intrusion. The sensitivity adjustment for model VS2EX is not sealed; therefore, mounting

orientation should be on a horizontal plane or with the sensitivity adjustment pointing down. Sensitivity adjustment for model VS2 is covered by a plug. The plug must be in place and tight to prevent moisture or dust intrusion.

C-Clamp Installation (VS2C model only)

A C-Clamp is supplied with the VS2C model only. The C-Clamp is shipped installed on the VS2C but must be installed on the VS2EX and VS2EXR switches.

1. The C-Clamp (B) will already be installed on a 1/4 in. (6 mm) thick steel mounting plate (A). Bolt the VS2 switch to the mounting plate as illustrated — with four 5/16 in. bolts, nuts, and washers.
2. The mounting location should provide convenient access to the TATTLETALE® push button (C).
3. The hardened set screw and nuts (D) are used to tighten the switch to an I-Beam or cross member such as a Sampson post of an oilwell pumpjack.



Continued on next page.

All Models



WARNING: STOP THE MACHINE AND DISCONNECT ALL ELECTRICAL POWER BEFORE BEGINNING INSTALLATION.

1. Firmly secure the unit to the equipment using the base foot mount or C-Clamp if applicable. See *C-Clamp Installation* page 3.
For oilwell pumpjacks attach the VS2 and VS94 Series to the Sampson post or walking beam. See *Typical Mounting Locations* page 5.
2. Make the necessary electrical connections to the vibration switch. See *Internal Switches*, page 6 for electrical terminal locations and page 7 for typical wiring diagrams. **DO NOT EXCEED VOLTAGE OR CURRENT RATINGS OF THE CONTACTS.** Follow appropriate electrical codes/methods when making electrical connections. Be sure that the run of electrical cable is secured to the machine and is well insulated from electrical shorting. Use of conduit is recommended.

NOTE: If the electrical cable crosses a pivot point such as at the pivot of the walking beam, be sure to allow enough slack in the cable so that no stress is placed on the cable when the beam moves.

If conduit is not used for the entire length of wiring, conduit should be used from the electrical supply box to a height above ground level that prevents damage to the exposed cable from the elements, rodents, etc. or as otherwise required by applicable electrical codes. If conduit is not attached directly to the VS2 and VS94 Series switch, use a strain relief bushing and a weatherproof cap on the exposed end of the conduit. A “drip loop” should be provided in the cable to prevent moisture from draining down the cable into the conduit should the weathercap fail.

Sensitivity Adjustment

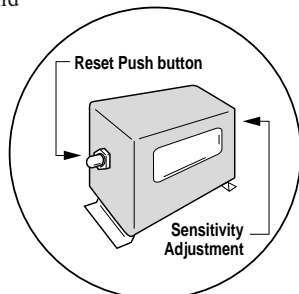


WARNING: REMOVE ALL POWER BEFORE OPENING THE ENCLOSURE. IT IS YOUR RESPONSIBILITY TO HAVE A QUALIFIED PERSON PERFORM ADJUSTMENTS, AND MAKE SURE IT CONFORMS WITH NEC AND LOCAL CODES. DO NOT ADJUST SENSITIVITY WHILE THE MACHINE IS RUNNING. STAND CLEAR OF THE MACHINE AT ALL TIMES WHEN IT IS OPERATING.

All models of the VS2 and VS94 Series cover a wide range of sensitivity. Each model is adjusted to the specific piece of machinery on which it is installed. After the switch has been installed in a satisfactory location (see page 5) the sensitivity adjustment will be increased or decreased so that the switch does not trip during start-up or under normal operating conditions. This is typically done as follows:

1. REPLACE ALL COVERS, LIDS, AND ELECTRICAL ENCLOSURES.
2. Press the reset push button to engage the magnetic latch. To be sure the magnetic latch has engaged, observe latch through the window on the VS2 and VS2C (see DETAIL “A”). On the VS2EX, VS94 series the reset button will remain depressed meaning the magnetic latch has engaged.
3. Start the machine.
4. If the instrument trips on start-up,

DETAIL “A”



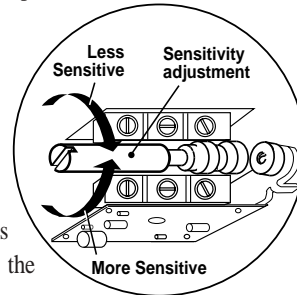
allow the machine to stop. Turn the sensitivity adjustment 1/4 turn clockwise, (adjustment for VS94 and VS2EXRB models is located within the box, see DETAIL “B”).



WARNING: MAKE THE AREA NON-HAZARDOUS BEFORE OPENING THE EXPLOSION-PROOF (-EX) ENCLOSURES.

Depress the reset button and restart the machine. Repeat this process until the unit does not trip on start-up.

DETAIL “B”



5. If the instrument does NOT trip on start-up, stop the machine. Turn the sensitivity adjustment 1/4 turn counter-clockwise. Repeat the start-up/stop process until the instrument trips on start-up. Turn the sensitivity adjustment 1/4 turn clockwise (less sensitive). Restart the machine to verify that the instrument will not trip on start-up.
6. Verify that the unit will trip when abnormal shock/vibration exists.

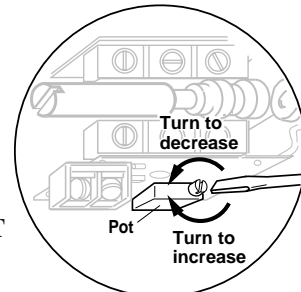
VS94 Time Delay Adjustment



WARNING: REMOVE ALL POWER BEFORE OPENING ACCESS DOOR. IT IS YOUR RESPONSIBILITY TO HAVE A QUALIFIED PERSON ADJUST THE UNIT, AND MAKE SURE IT CONFORMS WITH NEC AND LOCAL CODES.

1. Apply power to the time delay circuit. (see page 7 for time delay circuit). The time delay function will be initiated.
2. Time the length of the delay with a watch. Let time delay expire. After it expires, the override circuit will de-energize the solenoid, allowing the latch arm to trip. A clicking noise is heard.
3. TURN THE POWER OFF TO RESET THE TIME DELAY CIRCUIT.

DETAIL “C”



NOTE: Allow 30 seconds bleed-time between turning the power “OFF” and “ON”

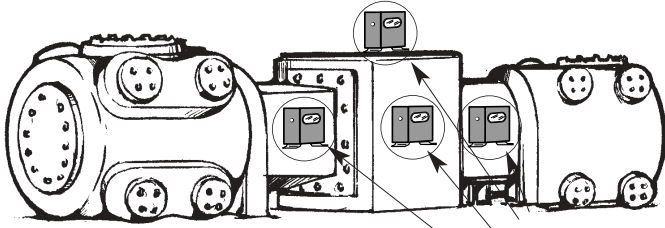
4. Locate the time adjustment pot (DETAIL “C”). The time is factory-set at the lowest setting (5 seconds approximately). To increase time, rotate the 20-turn pot clockwise as needed (15 seconds per turn approximately).
5. Repeat the above steps as necessary to obtain desired time delay.

NOTE: An external time delay can be used with the remote reset feature of the VS2EXR series to provide a remote reset and override of the trip operation on start-up. Time delay must automatically disconnect after

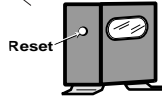
TYPICAL MOUNTING LOCATIONS

NOTE: These are typical mounting locations for best operation. Other mountings are possible. See *Installation* section on page 3.

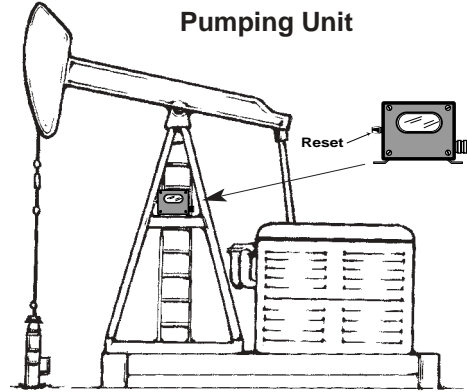
2-Throw Balance-Opposed Compressor



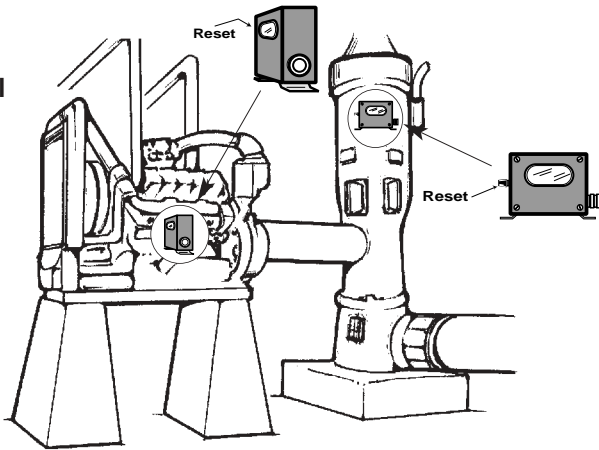
NOTE: If installing on cylinders, 2 vibration/shock switches are recommended- 1 for each cylinder.



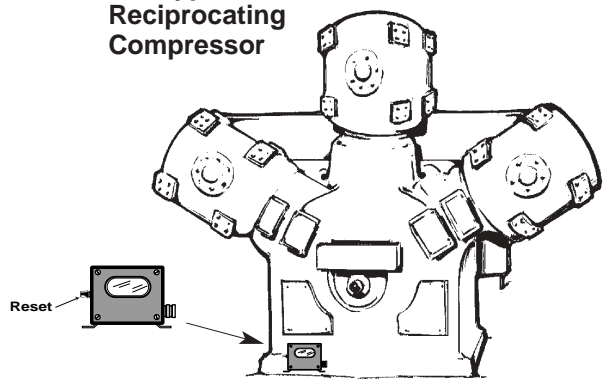
Pumping Unit



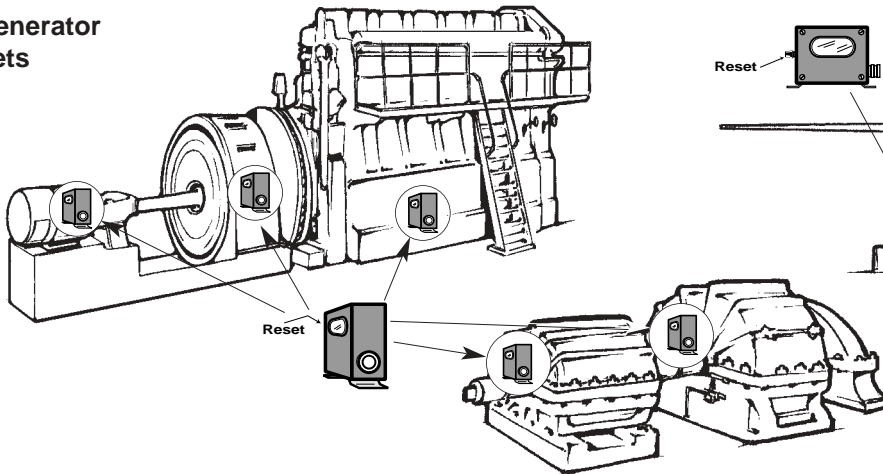
Engine and Vertical Shaft Pump



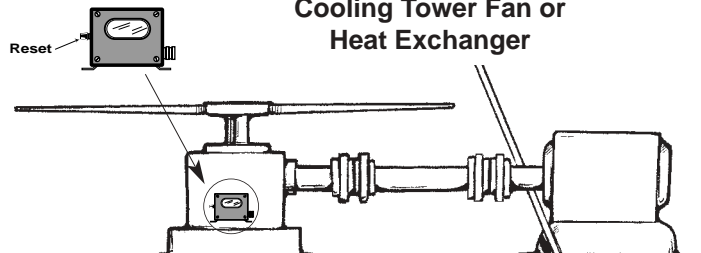
"Y" Type Reciprocating Compressor



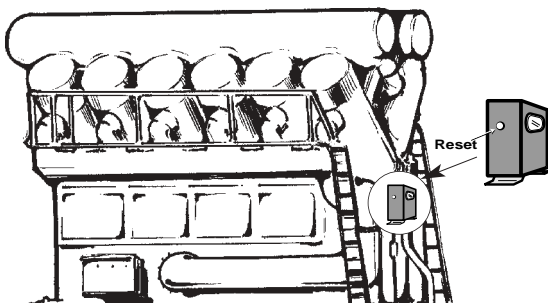
Generator Sets



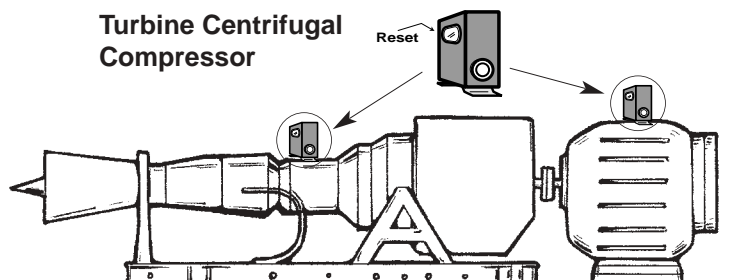
Cooling Tower Fan or Heat Exchanger



Engine Compressor

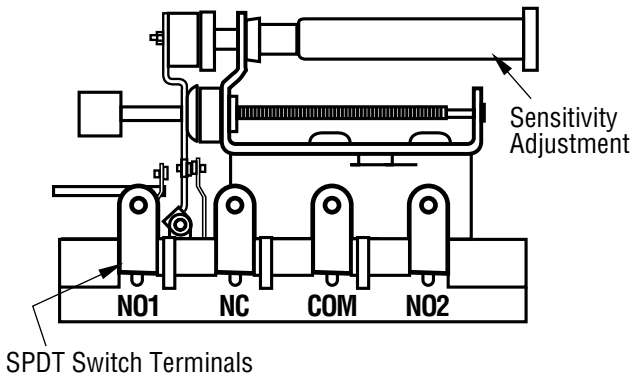


Turbine Centrifugal Compressor

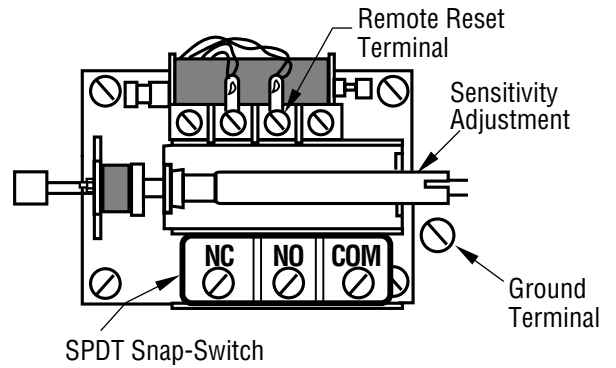


INTERNAL SWITCHES

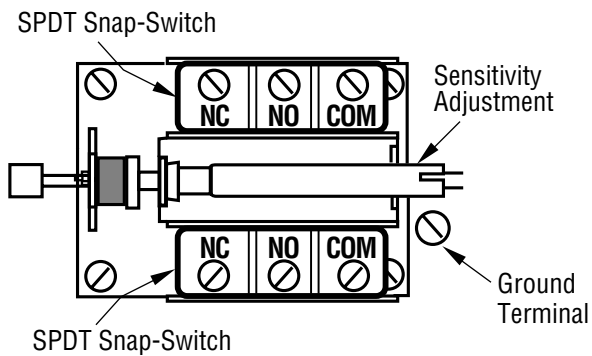
VS2 and VS2C



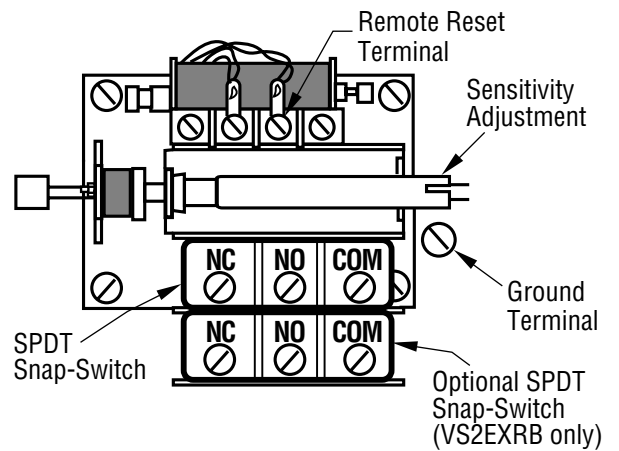
VS2EXR



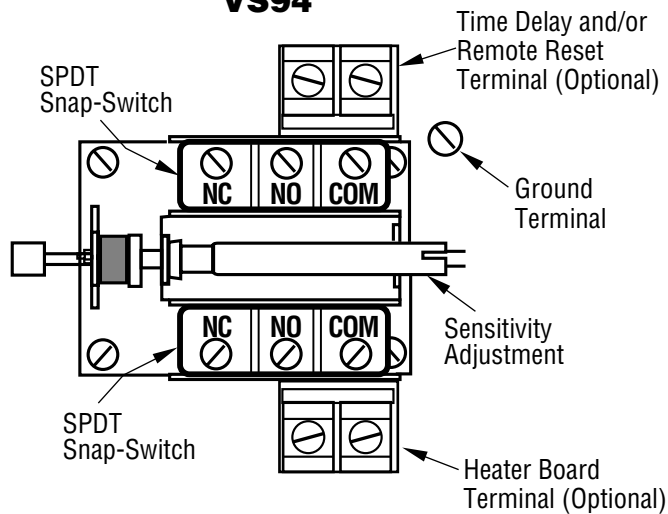
VS2EX



VS2EXB and VS2EXRB



VS94

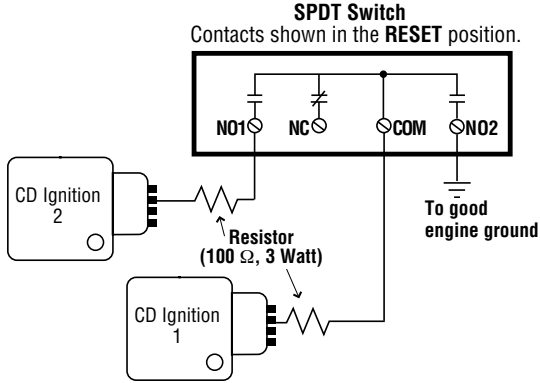


ELECTRICAL

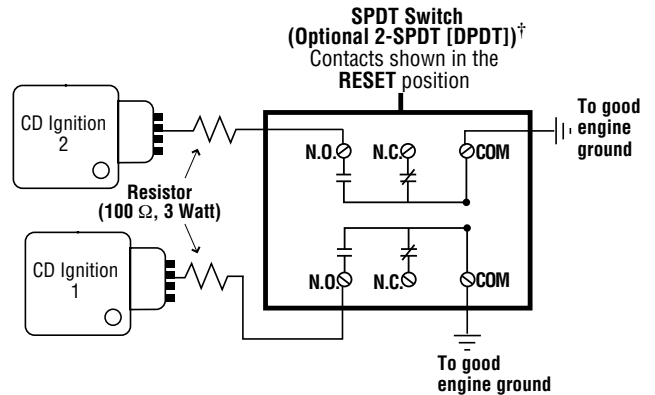


WARNING: REMOVE POWER BEFORE OPENING THE UNIT (ACCESS DOOR). STOP THE MACHINE AND DISCONNECT ALL ELECTRICAL POWER BEFORE BEGINNING THE WIRING OPERATION. IT IS YOUR RESPONSIBILITY TO HAVE A QUALIFIED PERSON INSTALL AND WIRE THE UNIT, AND MAKE SURE IT CONFORMS WITH NEC AND APPLICABLE CODES.

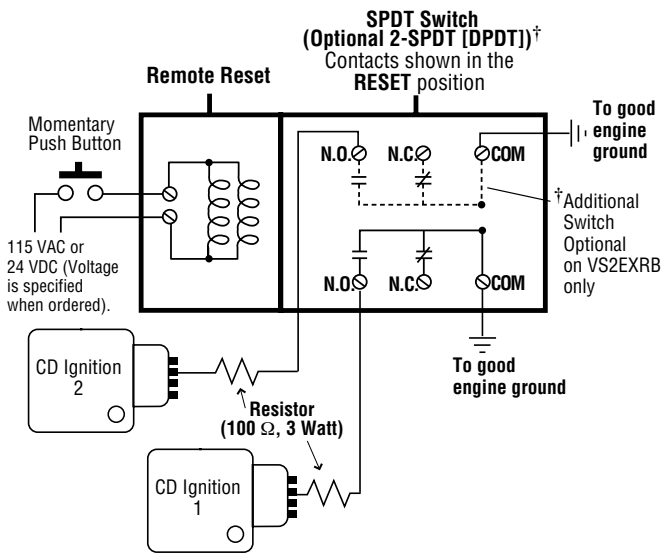
VS2 and VS2C Typical Wiring Diagram for Single or Dual CD Ignition



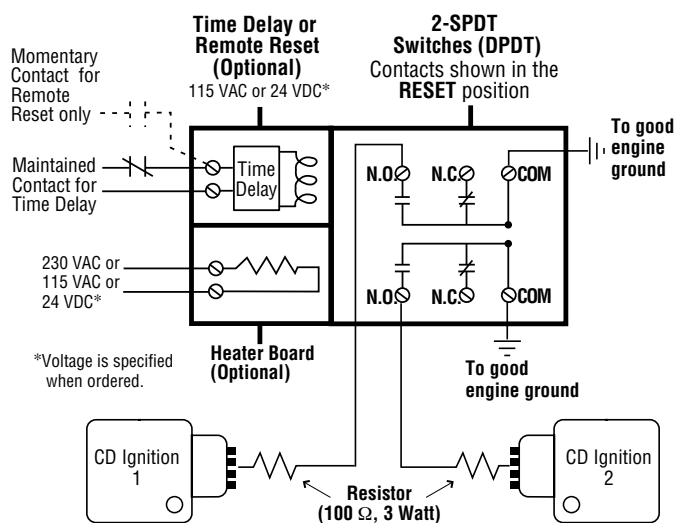
VS2EX Typical Wiring Diagram for Single or Dual CD Ignitions



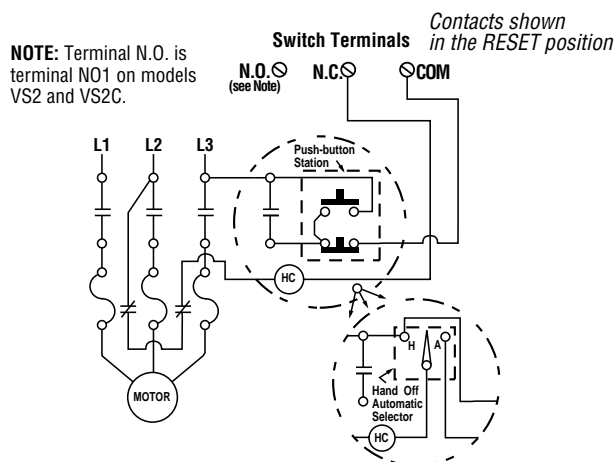
VS2EXR and VS2EXRB Typical Wiring Diagram for Single or Dual CD Ignitions



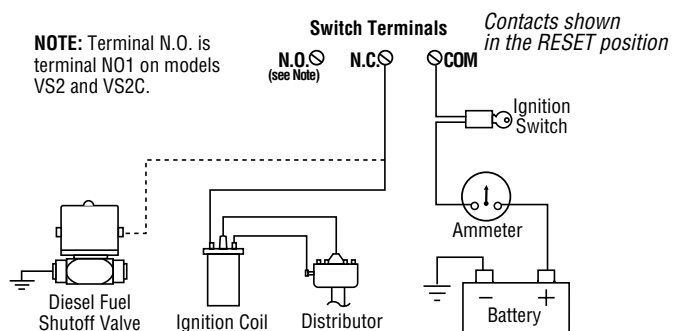
VS94 Typical Wiring Diagram for Single or Dual CD Ignitions



VS2, VS2C, VS2EX, VS2EXR, VS2EXRB and VS94 Typical Wiring Diagram for Electric Motors



VS2, VS2C, VS2EX, VS2EXR, VS2EXRB and VS94 Typical Wiring Diagram for Distributor Ignition or Diesel



SERVICE PARTS

PART NO. DESCRIPTION

VS2

20000030 Movement assembly
 20000031 Glass and gasket assembly
 20000032 Reset push button assembly

VS2C

20000030 Movement assembly
 20000031 Glass and gasket assembly
 20000032 Reset push button assembly
 20050021 Mounting clamp
 20000185 VS2C 5-clamp hardware package assembly.
 20050465 2-Conductor electrical cable, 45 feet (13.7 meters)

VS2EX

20010091 Movement assembly
 20050087 Cover
 00000309 Cover gasket
 20010090 Snap-switch and insulator kit (1 switch per kit)
prior to September 1, 1995.*
20000288 Snap-switch and insulator kit (1 switch per kit) for models manufactured on September 1, 1995 or later.*
 20000289 C-clamp conversion mounting kit

VS2EXR

20000262 Movement assembly
 20050087 Cover
 00000309 Cover gasket
 20010090 Snap-switch and insulator kit (1 switch per kit)
prior to September 1, 1995.*
20000288 Snap-switch and insulator kit (1 switch per kit) for models manufactured on September 1, 1995 or later.*
 20000049 Reset solenoid assembly (115 VAC)
 20000234 Reset solenoid assembly (24 VDC)
 20000289 C-clamp conversion mounting kit

PART NO. DESCRIPTION

VS2EXRB

20010090 Snap-switch and insulator kit (1 switch per kit)
prior to September 1, 1995.*
20000288 Snap-switch and insulator kit (1 switch per kit) for models manufactured on September 1, 1995 or later.*
 20000057 *Inside* snap-switch and insulator kit (1 switch per kit) for model VS2EXRB-D **prior to September 1, 1995.***
 20000058 *Outside* snap-switch and insulator kit (1 switch per kit) for model VS2EXRB-D **prior to September 1, 1995.***
20000287 Inside snap-switch and insulator kit (1 switch per kit) for model VS2EXRB-D manufactured on September 1, 1995 or later.*
20000290 Outside snap-switch and insulator kit (1 switch per kit) for model VS2EXRB-D manufactured on September 1, 1995 or later.*
 20050077 Adjustment shaft
 20000262 Movement assembly
 20000049 Reset solenoid assembly (115 VAC)
 20000234 Reset solenoid assembly (24 VDC)

VS94 Series

25050506 Dust boot
 00000232 Conduit fitting
 20010090 Snap-switch and insulator kit (1 switch per assembly)
prior to September 1, 1995.**
20000288 Snap-switch and insulator kit (1 switch per assembly) for models manufactured on September 1, 1995 or later.***

* If no date code is found, refer to the old switch. Models with date 0895 and before use old switch. Dated 0995 after, use straight snap-switch arm, no rollers.
 ** Models dated Q1 thru Q8 (formed snap-switch arm and rollers).
 ***Models date coded Q9 thru Q12 and R1 thru R12 (straight snap-switch arm, no rollers).



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In order to consistently bring you the highest quality, full featured products, we reserve the right to change our specifications and designs at any time.

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NORTH AMERICAN VALVE COMPANY LTD.

1-PC. INVESTMENT CAST BALL VALVE
REDUCED BORE MODEL C1
1/4" to 2"

Available in:

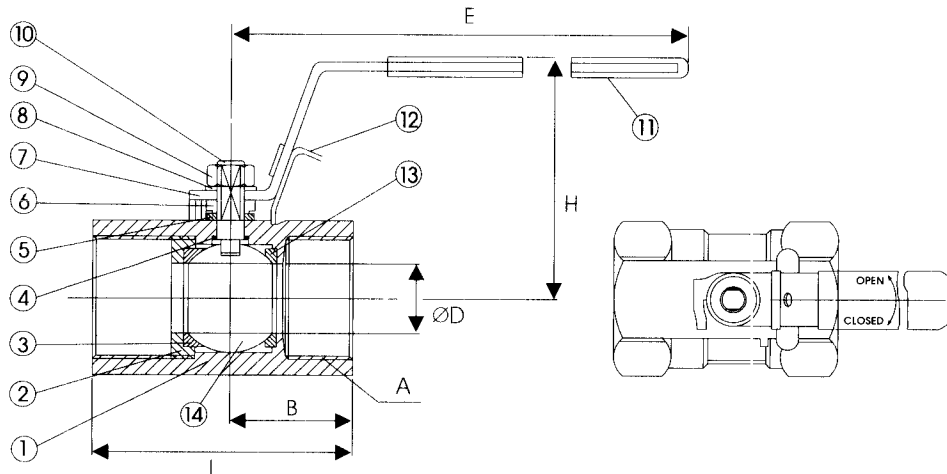
- Carbon Steel
- Stainless Steel
- Carbon Steel Low Temp



FEATURES:

- Pipe thread in accordance with ANSI B2.1, BS 21, DIN 259/2999
- Blowout-proof stem
- Investment cast body
- 2000 W.O.G. (1/4" to 2")
- Locking device, Lug body
- Material: ASTM A351-CF8M, A216-WCB & A352-LCC
- Screwed end
- Mounting pad
- NACE MR-01-75 as a standard

TECHNICAL DATA - 1-PC. REDUCED BORE MODEL C1



SIZE	D (mm / in.)	B (mm / in.)	L (mm / in.)	E (mm / in.)	H (mm / in.)	A (mm / in.)
1/2"	9.2 / .36	31.5 / 1.24	65 / 2.56	90 / 3.54	49 / 1.93	1/2" NPT
3/4"	12.5 / .49	34.55 / 1.36	70 / 2.76	90 / 3.54	52 / 2.05	3/4" NPT
1"	15 / .59	38.65 / 1.52	80 / 3.15	110 / 4.33	54 / 2.13	1" NPT
1 1/4"	20 / .79	40.5 / 1.59	95 / 3.74	110 / 4.33	64 / 2.52	1 1/4" NPT
1 1/2"	25 / .98	42.6 / 1.68	100 / 3.94	140 / 5.51	68 / 2.68	1 1/2" NPT
2"	32 / 1.26	47.9 / 1.89	114 / 4.49	140 / 5.51	75 / 2.95	2" NPT

ITEM	PARTS	STYLE		
		NACE	NACE & LowTemp	Stainless Steel
1	BODY	A216-WCB	A352-LCC	A351-CF8M
2	END PLUG	A216-WCB	A352-LCC	A351-CF8M
3	BIG SEAT	RTFE	RTFE	RTFE
4	THRUST WASHER	PTFE	PTFE	PTFE
5	STEM PACKING	PTFE	PTFE	PTFE
6	PACKING FOLLOWER	Carbon Steel	Carbon Steel	304 SS
7	HANDLE	304 SS	304 SS	304 SS
8	WASHER	304 SS	304 SS	304 SS
9	STEM NUT	304 SS	304 SS	304 SS
10	STEM	316 SS	316 SS	316 SS
11	HANDLE COVER	Plastic	Plastic	Plastic
12	LOCKING DEVICE	304 SS	304 SS	304 SS
13	SEAT	RTFE	RTFE	RTFE
14	BALL	316 SS or CF8M	316 SS or CF8M	316 SS or CF8M

For additional technical information, please consult North American-Nutron Company[®]
We reserve the right to change dimensions or substitute materials.

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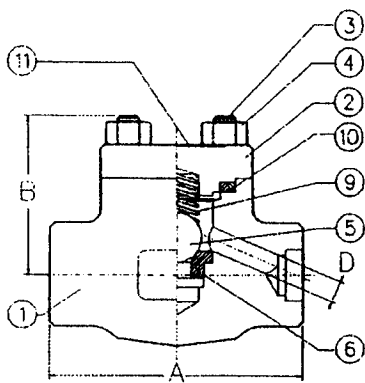
CHECK VALVE

SW/NPT - 800/1500

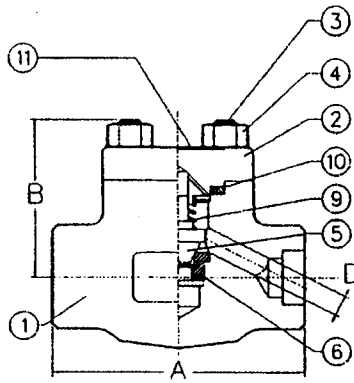
#	Ball	Piston	Swing	Standard Service	NACE Sour	NACE (-50°F) Low Temp
1	Body	Body	Body	A105N	A105N	A350 LF2
2	Cap	Cap	Cap	A105N	A105N	A350 LF2
3	Body Studs	Body Studs	Body Studs	A193 B7	A193 B7M	A320 L7M
4	Body Nuts	Body Nuts	Body Nuts	A194 2H	A194 2HM	A194 7M
5	Ball	Piston	Disc	A182 F6	A182 F316	A182 F316
6	Seat	Seat	Seat	F6 HF	F316 HF	F316 HF
7			Swing Arm	A182 F6	A182 F316	A182 F316
8			Disc Nut	A194 2H	A194 2HM	A194 7M
9	Spring	Spring		Stainless Steel		
10	Gasket	Gasket	Gasket	S.S Spiral Wound Graphite		
11	Nameplate	Nameplate	Nameplate	Aluminum		

**Pressure Ratings
(ASTM A105/A350 Gr. LF2)**

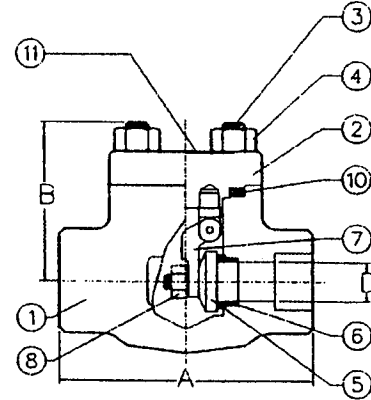
Class	Pressure
800	1975 psi @ 100°F
1500	3705 psi @ 100°F



BALL



PISTON



SWING

		1/4		3/8		1/2		3/4		1		1 1/4		1 1/2		2		
Class 800	A	in/mm	3.11	79	3.11	79	3.15	80	3.54	90	4.33	110	5.00	127	6.10	155	6.69	170
	B	in/mm	2.40	61	2.40	61	1.97	50	2.20	56	2.91	74	3.11	79	3.94	100	4.29	109
	D	in/mm	0.28	7	0.28	7	0.35	9	0.49	12.5	0.69	17.5	0.89	22.5	1.10	28	1.26	32
	Wt	lb/kg	3.31	1.5	3.09	1.4	2.4	1.1	4.0	1.8	5.7	2.6	7.9	3.6	12.1	5.5	18.5	8.4

		1/4		3/8		1/2		3/4		1		1 1/4		1 1/2		2		
Class 1500	A	in/mm	3.54	90	3.54	90	3.54	90	4.33	110	5.00	127	6.10	155	6.69	170	8.27	210
	B	in/mm	2.20	56	2.20	56	2.20	56	2.91	74	3.11	79	3.94	100	4.29	109	5.31	135
	D	in/mm	0.26	6.5	0.35	9	0.39	10	0.51	13	0.71	18	0.91	23	1.10	28	1.34	34
	Wt	lb/kg	4.9	2.2	4.9	2.2	4.9	2.2	6.6	3	9.0	4.1	13.7	6.2	20.7	9.4	29.3	13.3

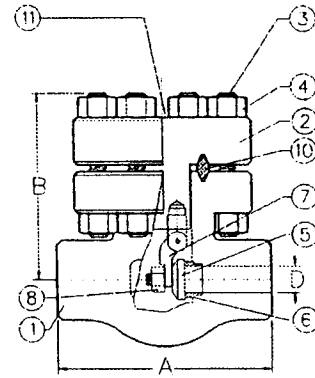
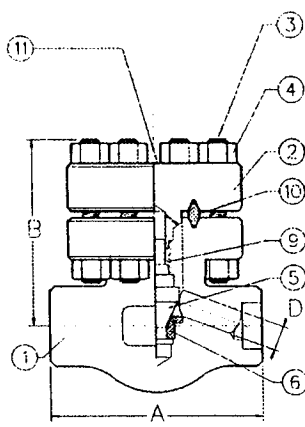
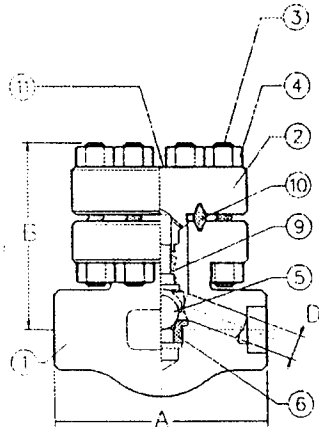
NAVCO®

CHECK VALVE

SW/NPT – 1500/2500 (RTJ Bonnet)

#	Ball	Piston	Swing	Standard Service	NACE Sour	NACE (-50°F) Low Temp
1	Body	Body	Body	A105N	A105N	A350 LF2
2	Cap	Cap	Cap	A105N	A105N	A350 LF2
3	Body Studs	Body Studs	Body Studs	A193 B7	A193 B7M	A320 L7M
4	Body Nuts	Body Nuts	Body Nuts	A194 2H	A194 2HM	A194 7M
5	Ball	Piston	Disc	A182 F6	A182 F316	A182 F316
6	Seat	Seat	Seat	F6 HF	F316 HF	F316 HF
7			Swing Arm	A182 F6	A182 F316	A182 F316
8			Disc Nut	A194 2H	A194 2HM	A194 7M
9	Spring	Spring		Stainless Steel		
10	Gasket	Gasket	Gasket	S.S Ring Gasket		
11	Nameplate	Nameplate	Nameplate	Aluminum		

Pressure Ratings (ASTM A105/A350 Gr. LF2)	
Class	Pressure
1500	3705 psi @ 100°F
2500	6170 psi @ 100°F



Class 1500			1/4	3/8	1/2	3/4	1	1 1/4	1 1/2	2						
	A	in/mm	-	-	4.33	110	4.72	120	5.12	130	-	-	8.27	210	9.45	240
	B	in/mm	-	-	3.66	93	4.29	109	4.80	122	-	-	6.22	158	6.73	171
	D	in/mm	-	-	0.43	11	0.57	14.5	0.75	19	-	-	1.22	31	1.48	37.5
	Wt	lb/kg	-	-	8.4	3.8	13.0	5.9	15.0	6.8	-	-	41.4	18.8	52.2	23.7

Class 2500			1/4	3/8	1/2	3/4	1	1 1/4	1 1/2	2						
	A	in/mm	-	-	4.33	110	4.72	120	5.12	130	-	-	8.27	210	9.45	240
	B	in/mm	-	-	3.78	96	4.06	103	4.96	126	-	-	6.46	164	7.13	181
	D	in/mm	-	-	0.39	10	0.51	13	0.71	18	-	-	1.10	28	1.34	34
	Wt	lb/kg	-	-	3.1	1.4	13.9	6.3	16.1	7.3	-	-	43.2	19.6	54.7	24.8

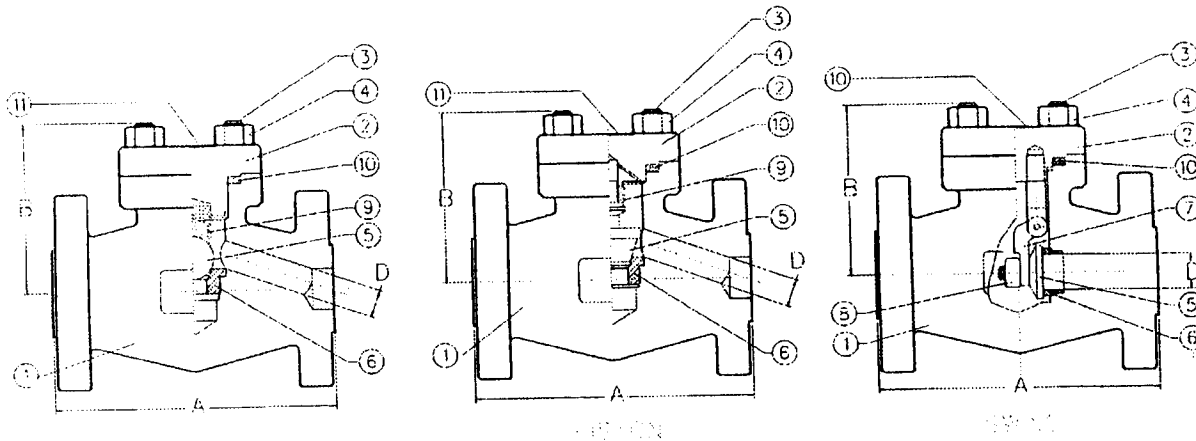
NAVCO®

CHECK VALVE

Flanged – ANSI 150/300/600/1500

#	Ball	Piston	Swing	Standard Service	NACE Sour	NACE (-50°F) Low Temp
1	Body	Body	Body	A105N	A105N	A350 LF2
2	Cap	Cap	Cap	A105N	A105N	A350 LF2
3	Body Studs	Body Studs	Body Studs	A193 B7	A193 B7M	A320 L7M
4	Body Nuts	Body Nuts	Body Nuts	A194 2H	A194 2HM	A194 7M
5	Ball	Piston	Disc	A182 F6	A182 F316	A182 F316
6	Seat	Seat	Seat	F6 HF	F316 HF	F316 HF
7			Swing Arm	A182 F6	A182 F316	A182 F316
8			Disc Nut	A194 2H	A194 2HM	A194 7M
9	Spring	Spring		Stainless Steel		
10	Gasket	Gasket	Gasket	S.S Spiral Wound Graphite		
11	Nameplate	Nameplate	Nameplate	Aluminum		

Pressure Ratings (ASTM A105/A350 Gr. LF2)	
Class	Pressure
150	285 psi @ 100°F
300	740 psi @ 100°F
600	1480 psi @ 100°F
1500	3705 psi @ 100°F



Class 150		in/mm	1/4		3/8		1/2		3/4		1		1 1/4		1 1/2		2	
			-	-	-	-	4.25	107.9	4.63	117.5	5.00	127	-	-	6.50	165.1	8.00	203.2
	B	in/mm	-	-	-	-	3.27	83	3.35	85	3.66	93	-	-	3.82	97	4.84	123
	D	in/mm	-	-	-	-	0.35	9	0.49	12.5	0.69	17.5	-	-	1.10	28	1.26	32
	Wt	lb/kg	-	-	-	-	5.7	2.6	8.4	3.8	11.2	5.1	-	-	18.5	8.4	31.3	14.2

Class 300		in/mm	1/4		3/8		1/2		3/4		1		1 1/4		1 1/2		2	
			-	-	-	-	6.00	152.4	7.00	177.8	8.00	203.2	-	-	11.36	288.6	10.50	266.7
	B	in/mm	-	-	-	-	1.97	50	2.20	56	2.91	74	-	-	3.94	100	4.29	109
	D	in/mm	-	-	-	-	0.35	9	0.49	12.5	0.69	17.5	-	-	1.10	28	1.26	32
	Wt	lb/kg	-	-	-	-	6.2	2.8	10.4	4.7	12.6	5.7	-	-	26.2	11.9	36.2	16.4

Class 600		in/mm	1/4		3/8		1/2		3/4		1		1 1/4		1 1/2		2	
			-	-	-	-	6.50	165.1	7.50	190.5	8.50	215.9	-	-	9.50	241.3	11.50	292.1
	B	in/mm	-	-	-	-	1.97	50	2.20	56	2.91	74	-	-	3.94	100	4.29	109
	D	in/mm	-	-	-	-	0.35	9	0.49	12.5	0.69	17.5	-	-	1.10	28	1.26	32
	Wt	lb/kg	-	-	-	-	6.8	3.1	11.0	5	16.1	7.3	-	-	26.5	12	36.6	16.6

Class 1500		in/mm	1/4		3/8		1/2		3/4		1		1 1/4		1 1/2		2	
			-	-	-	-	8.50	215.9	9.00	228.6	10.00	254.0	-	-	12.00	304.8	14.50	368.3
	B	in/mm	-	-	-	-	2.20	56	2.91	74	3.11	79	-	-	4.29	109	5.31	135
	D	in/mm	-	-	-	-	0.39	10	0.51	13	0.71	18	-	-	0.94	24	1.10	28
	Wt	lb/kg	-	-	-	-	18.04	8.2	19.8	9.0	28.4	12.9	-	-	53.7	24.4	88.2	40.1

* A = Raised face dimensions, RTJ dimension see page TI2

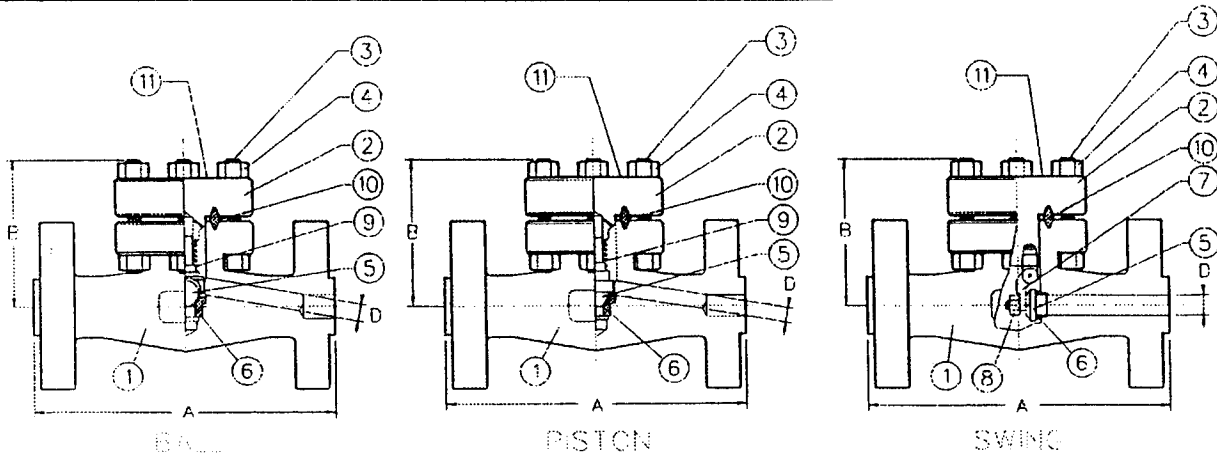
NAVCO®

CHECK VALVE

Flanged – ANSI 1500/2500 (RTJ Bonnet)

#	Ball	Piston	Swing	Standard Service	NACE Sour	NACE (-50°F) Low Temp
1	Body	Body	Body	A105N	A105N	A350 LF2
2	Cap	Cap	Cap	A105N	A105N	A350 LF2
3	Body Studs	Body Studs	Body Studs	A193 B7	A193 B7M	A320 L7M
4	Body Nuts	Body Nuts	Body Nuts	A194 2H	A194 2HM	A194 7M
5	Ball	Piston	Disc	A182 F6	A182 F316	A182 F316
6	Seat	Seat	Seat	F6 HF	F316 HF	F316 HF
7			Swing Arm	A182 F6	A182 F316	A182 F316
8			Disc Nut	A194 2H	A194 2HM	A194 7M
9	Spring	Spring		Stainless Steel		
10	Gasket	Gasket	Gasket	S.S Ring Gasket		
11	Nameplate	Nameplate	Nameplate	Aluminum		

Pressure Ratings (ASTM A105/A350 Gr. LF2)	
Class	Pressure
1500	3705 psi @ 100°F
2500	6170 psi @ 100°F



Class 1500		1/4	3/8	1/2	3/4	1	1 1/4	1 1/2	2	
	A	in/mm	-	-	-	-	8.50 / 215.9	9.00 / 228.6	10.00 / 254	12.00 / 304.8
B	in/mm	-	-	-	-	3.66 / 93	4.29 / 109	4.80 / 122	6.22 / 158	6.73 / 171
D	in/mm	-	-	-	-	0.43 / 11	0.57 / 14.5	0.75 / 19	1.22 / 31	1.48 / 37.5
Wt	lb/kg	-	-	-	-	16.5 / 7.5	24.0 / 10.9	31.7 / 14.4	66.8 / 30.3	97.0 / 44

Class 2500		1/4	3/8	1/2	3/4	1	1 1/4	1 1/2	2	
	A	in/mm	-	-	-	-	10.37 / 263.5	10.75 / 273	12.13 / 308	15.13 / 384.2
B	in/mm	-	-	-	-	3.78 / 96	4.06 / 103	4.96 / 126	6.46 / 164	7.13 / 181
D	in/mm	-	-	-	-	0.39 / 10	0.51 / 13	0.71 / 18	1.10 / 28	1.34 / 34
Wt	lb/kg	-	-	-	-	22.7 / 10.3	32.2 / 14.6	23.8 / 10.8	93.0 / 42.2	133.8 / 60.7

* A = Raised face dimensions, RTJ dimension see page TI2

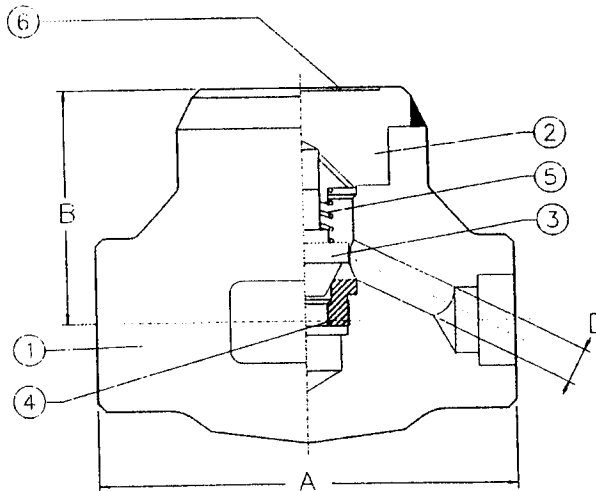
NAVCO®

CHECK VALVE

Welded Bonnet SW/NPT/BW – 800/1500/2500

#	Piston	Standard Service	NACE Sour	NACE (-50°F) Low Temp
1	Body	A105N	A105N	A350 LF2
2	Cap	A105N	A105N	A350 LF2
3	Piston	A182 F6	A182 F316	A182 F316
4	Seat	F6 HF	F316 HF	F316 HF
5	Spring	Stainless Steel		
6	Nameplate	Aluminum		

Pressure Ratings (ASTM A105/A350 Gr. LF2)	
Class	Pressure
800	1975 psi @ 100°F
1500	3705 psi @ 100°F
2500	6170 psi @ 100°F



		1/4		3/8		1/2		3/4		1		1 1/4		1 1/2		2	
Class 800	A	in/mm	3.11 / 79	3.11 / 79	3.15 / 80	3.54 / 90	4.33 / 110	5.00 / 127	6.10 / 155	6.69 / 170	7.31 / 187	8.27 / 210	9.45 / 240	10.8 / 274	12.4 / 315	14.3 / 363	16.4 / 416
	B	in/mm	2.40 / 61	2.40 / 61	1.89 / 48	2.01 / 51	2.48 / 63	2.80 / 71	3.39 / 86	3.90 / 99	4.59 / 117	5.37 / 137	6.36 / 163	7.59 / 193	9.09 / 231	10.9 / 277	13.1 / 336
	D	in/mm	0.28 / 7	0.28 / 7	0.35 / 9	0.49 / 12.5	0.69 / 17.5	0.89 / 22.5	1.10 / 28	1.26 / 32	1.51 / 38	1.77 / 45	2.14 / 54	2.63 / 67	3.25 / 83	4.01 / 102	4.97 / 126
	Wt	lb/kg	3.53 / 1.6	3.31 / 1.5	1.8 / 0.8	2.4 / 1.1	4.4 / 2	7.3 / 3.3	10.8 / 4.9	16.1 / 7.3	21.7 / 9.8	28.6 / 12.9	37.1 / 16.8	47.5 / 21.5	60.1 / 27.2	75.1 / 34.0	92.8 / 42.1

		1/4		3/8		1/2		3/4		1		1 1/4		1 1/2		2	
Class 1500	A	in/mm	3.54 / 90	3.54 / 90	3.54 / 90	4.33 / 110	5.00 / 127	6.10 / 155	6.69 / 170	8.27 / 210	9.45 / 240	10.8 / 274	12.4 / 315	14.3 / 363	16.4 / 416	18.8 / 474	21.5 / 546
	B	in/mm	1.97 / 50	1.97 / 50	1.97 / 50	2.20 / 56	2.64 / 67	3.23 / 82	3.90 / 99	4.76 / 121	5.69 / 143	6.79 / 173	8.16 / 208	9.84 / 251	11.8 / 300	14.2 / 361	17.1 / 432
	D	in/mm	0.26 / 6.5	0.35 / 9	0.39 / 10	0.51 / 13	0.71 / 18	0.91 / 23	1.10 / 28	1.34 / 34	1.63 / 41	1.97 / 50	2.37 / 60	2.93 / 74	3.66 / 93	4.58 / 116	5.71 / 145
	Wt	lb/kg	3.1 / 1.4	3.1 / 1.4	3.1 / 1.4	5.1 / 2.3	8.4 / 3.8	12.3 / 5.6	18.3 / 8.3	29.5 / 13.4	41.8 / 18.9	56.1 / 25.4	73.6 / 33.4	95.4 / 43.2	121.8 / 55.2	153.1 / 69.4	190.4 / 86.3

		1/4		3/8		1/2		3/4		1		1 1/4		1 1/2		2	
Class 2500	A	in/mm	- / -	- / -	- / -	4.33 / 110	5.00 / 127	6.10 / 155	6.69 / 170	8.27 / 210	9.45 / 240	10.8 / 274	12.4 / 315	14.3 / 363	16.4 / 416	18.8 / 474	21.5 / 546
	B	in/mm	- / -	- / -	- / -	2.20 / 56	2.64 / 67	3.90 / 99	4.76 / 121	5.69 / 143	6.79 / 173	8.16 / 208	9.84 / 251	11.8 / 300	14.2 / 361	17.1 / 432	20.1 / 511
	D	in/mm	- / -	- / -	- / -	0.39 / 10	0.51 / 13	0.71 / 18	0.91 / 23	1.10 / 28	1.34 / 34	1.63 / 41	1.97 / 50	2.37 / 60	2.93 / 74	3.66 / 93	4.58 / 116
	Wt	lb/kg	- / -	- / -	- / -	4.0 / 1.8	6.6 / 3	10.1 / 4.6	14.3 / 6.5	20.3 / 9.2	28.6 / 12.9	39.1 / 17.7	51.8 / 23.5	67.9 / 30.8	87.7 / 39.6	112.4 / 51.0	143.1 / 64.9

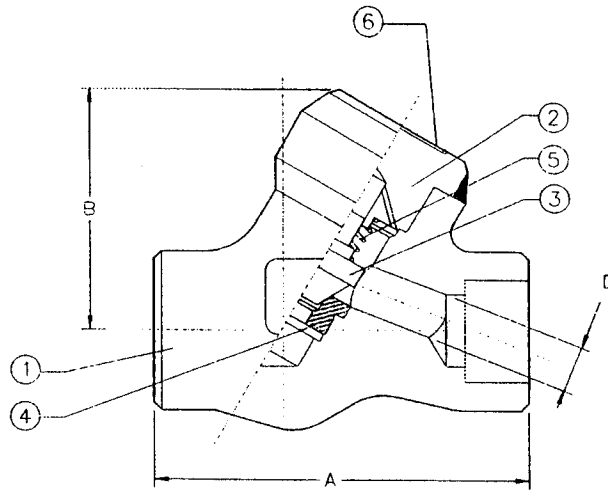
NAVCO®

CHECK VALVE

Welded Angle Pattern SW/NPT – 800/1500/2500

#	Piston	Standard Service	NACE Sour	NACE (-50°F) Low Temp
1	Body	A105N	A105N	A350 LF2
2	Cap	A105N	A105N	A350 LF2
3	Piston	A182 F6	A182 F316	A182 F316
4	Seat	F6 HF	F316 HF	F316 HF
5	Spring	Stainless Steel		
6	Nameplate	Aluminum		

Pressure Ratings (ASTM A105/A350 Gr. LF2)	
Class	Pressure
800	1975 psi @ 100°F
1500	3705 psi @ 100°F
2500	6170 psi @ 100°F



		1/4		3/8		1/2		3/4		1		1 1/4		1 1/2		2	
Class 800	A	in/mm	3.15 / 80	3.15 / 80	3.15 / 80	3.94 / 100	4.33 / 110	4.92 / 125	6.30 / 160	7.48 / 190							
	B	in/mm	2.36 / 60	2.36 / 60	2.36 / 60	2.95 / 75	3.35 / 85	3.94 / 100	4.53 / 115	5.51 / 140							
	D	in/mm	0.31 / 8	0.35 / 9	0.49 / 12.5	0.71 / 18	0.89 / 22.5	1.16 / 29.5	1.38 / 35	1.79 / 45.5							
	Wt	lb/kg	3.3 / 1.5	3.3 / 1.5	3.3 / 1.5	5.5 / 2.5	6.6 / 3	12.1 / 5.5	13.2 / 6	19.8 / 9							

		1/4		3/8		1/2		3/4		1		1 1/4		1 1/2		2	
Class 1500	A	in/mm	- / -	- / -	- / -	3.94 / 100	4.33 / 110	4.92 / 125	5.91 / 150	6.30 / 160	7.48 / 190						
	B	in/mm	- / -	- / -	- / -	2.95 / 75	3.35 / 85	3.35 / 85	4.53 / 115	4.53 / 115	5.51 / 140						
	D	in/mm	- / -	- / -	- / -	0.43 / 11	0.57 / 14.5	0.75 / 19	1.06 / 27	1.22 / 31	1.48 / 37.5						
	Wt	lb/kg	- / -	- / -	- / -	5.5 / 2.5	6.6 / 3	9.9 / 4.5	12.1 / 5.5	14.3 / 6.5	20.9 / 9.5						

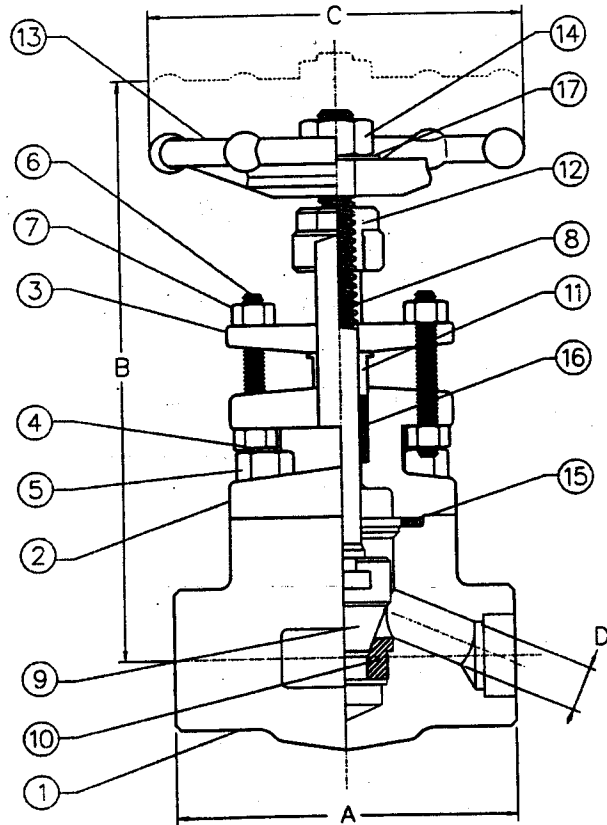
		1/4		3/8		1/2		3/4		1		1 1/4		1 1/2		2	
Class 2500	A	in/mm	- / -	- / -	- / -	4.33 / 110	4.92 / 125	6.30 / 160	6.30 / 160	7.48 / 190	8.27 / 210						
	B	in/mm	- / -	- / -	- / -	3.35 / 85	3.35 / 85	4.53 / 115	4.53 / 115	5.51 / 140	5.91 / 150						
	D	in/mm	- / -	- / -	- / -	0.39 / 10	0.47 / 12	0.71 / 18	0.94 / 24	1.10 / 28	1.34 / 34						
	Wt	lb/kg	- / -	- / -	- / -	6.6 / 3	9.9 / 4.5	13.2 / 6	14.3 / 6.5	19.8 / 9	26.5 / 12						

NAVCO®

GLOBE VALVE SW/NPT - 800/1500

# Part	Standard Service	NACE Sour	NACE (-50°F) Low Temp
1 Body	A105N	A105N	A350 LF2
2 Bonnet	A105N	A105N	A350 LF2
3 Gland Flange	A105N	A105N	A350 LF2
4 Body Studs	A193 B7	A193 B7M	A320 L7M
5 Body Nuts	A194 2H	A194 2HM	A194 7M
*6 Gland Studs	A193 B7	A193 B7M	A320 L7M
7 Gland Nuts	A194 2H	A194 2HM	A194 7M
8 Stem	A182 F6	A182 F316	A182 F316
9 Disc	A182 F6	A182 F316	A182 F316
10 Seat	F6 HF	F316 HF	F316 HF
11 Gland	A182 F6	A182 F316	A182 F316
12 Yoke Nut	A439 D2	A304	A304
13 Handwheel	Carbon Steel		
14 Handwheel Nut	Carbon Steel		
15 Gasket	S.S Spiral Wound Graphite		
16 Stem Packing	Graphite/Graphoil		
17 Nameplate	Aluminium		

* Valve may be supplied with eyebolt design



Pressure Ratings (ASTM A105/A350 Gr. LF2)	
Class	Pressure
800	1975 psi @ 100°F
1500	3705 psi @ 100°F

Class 800		1/4		3/8		1/2		3/4		1		1 1/4		1 1/2		2	
		in/mm	Wt	in/mm	Wt	in/mm	Wt	in/mm	Wt	in/mm	Wt	in/mm	Wt	in/mm	Wt	in/mm	Wt
A	in/mm	3.11	79	3.11	79	3.15	80	3.54	90	4.33	110	5.00	127	6.10	155	6.69	170
B	in/mm	6.93	176	6.93	176	5.98	152	6.26	159	7.17	182	8.43	214	11.14	283	12.05	306
C	in/mm	3.94	100	3.94	100	3.64	90	3.64	90	4.33	110	4.72	120	5.51	140	5.51	140
D	in/mm	0.31	8	0.39	10	0.35	9	0.49	12.5	0.69	17.5	0.89	22.5	1.10	28	1.26	32
Wt	lb/kg	4.85	2.2	4.63	2.1	3.7	1.7	4.4	2	7.1	3.2	11.7	5.3	17.2	7.8	23.4	10.6

Class 1500		1/4		3/8		1/2		3/4		1		1 1/4		1 1/2		2	
		in/mm	Wt	in/mm	Wt	in/mm	Wt	in/mm	Wt	in/mm	Wt	in/mm	Wt	in/mm	Wt	in/mm	Wt
A	in/mm	3.54	90	3.54	90	3.54	90	4.33	110	5.00	127	6.10	155	6.69	170	8.27	210
B	in/mm	6.65	169	6.65	169	6.65	169	7.13	181	8.27	210	9.69	246	10.04	255	12.09	307
C	in/mm	4.33	110	4.33	110	4.33	110	4.33	110	4.72	120	5.51	140	5.51	140	6.89	175
D	in/mm	0.28	6.5	0.35	9	0.39	10	0.51	13	0.71	18	0.91	23	1.10	28	1.34	34
Wt	lb/kg	5.3	2.4	5.3	2.4	5.3	2.4	8.2	3.7	12.1	5.5	18.3	8.3	25.1	11.4	37.0	16.8



NORTH AMERICAN VALVE COMPANY LTD.

1-PC. HEX BALL VALVE MODEL H1
REDUCED BORE
1/2" to 2"

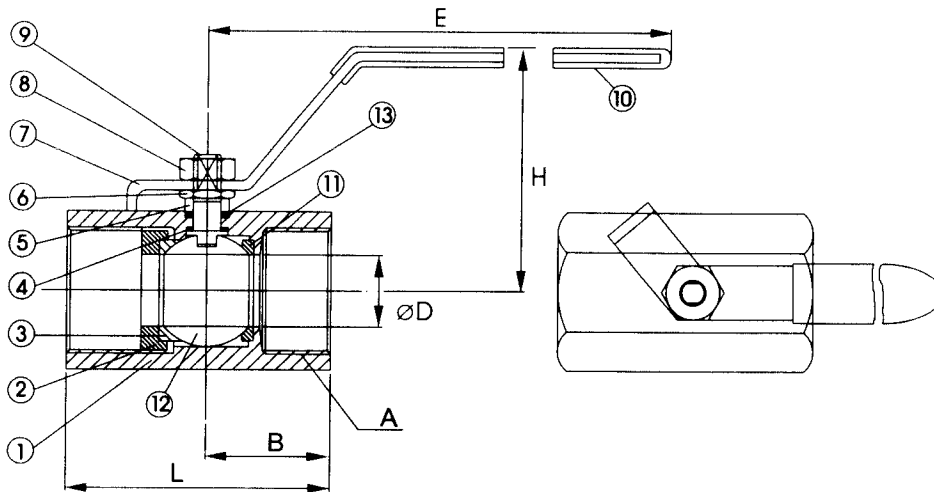
Carbon Steel



FEATURES:

- Pipe thread in accordance with ANSI B2.1, BS 21, DIN 259/2999
- Blowout-proof stem
- 2000 W.O.G.
- Carbon Steel
- Female NPT
- NACE MR-01-75 as a standard

TECHNICAL DATA - HEX BAR REDUCED BORE MODEL H1



1/2"	9.0 / .35	35 / 1.38	70 / 2.76	110 / 4.33	63.3 / 2.49	1/2" NPT
3/4"	12.5 / .49	34 / 1.34	68 / 2.68	110 / 4.33	62 / 2.44	3/4" NPT
1"	15 / .59	40 / 1.57	80 / 3.15	121 / 4.76	66.7 / 2.63	1" NPT
1 1/4"	20 / .79	48 / 1.89	96 / 3.78	146 / 5.75	82.6 / 3.25	1 1/4" NPT
1 1/2"	25 / .98	51.5 / 2.03	103 / 4.06	146 / 5.75	82.6 / 3.25	1 1/2" NPT
2"	32 / 1.26	59.5 / 2.34	119 / 4.68	152 / 5.98	87.4 / 3.44	2" NPT

1	BODY	1	Carbon Steel
2	END PLUG	1	Carbon Steel
3	BIG SEAT	2	RTFE
4	THRUST WASHER	1	PTFE
5	GLAND	1	304 SS
6	GLAND NUT	1	304 SS
7	HANDLE	1	Carbon Steel
8	STEM NUT	1	304 SS
9	STEM	1	304 SS
10	HANDLE COVER	1	Plastic
11	SEAT	1	RTFE
12	BALL	1	304 SS
13	STEM PACKING	1	PTFE

For additional technical information, please consult North American-Nutron Company®
We reserve the right to change dimensions or substitute materials.

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116



NEWCO VALVES

Newmans Inc., Newmans Valve Ltd.

**Newco Forged Valve
Operation & Maintenance
Manual**





TABLE OF CONTENTS

1. Introduction and Safety Information	1
1.1. Introduction.....	1
1.2. Safety Information.....	1
2. Storage, preparation and Installation	2
2.1. Storage.....	2
2.1.1. Temporary Storage.....	2
2.1.2. Long Term Storage.....	2
2.2. Preparation.....	2
2.3. Installation.....	3
2.3.1. Flanged Valves.....	3
2.3.2. Socket and Threaded Valves.....	3
3. Maintenance and Repair	4
3.1. Inspection and Maintenance.....	4
3.1.1. Periodic Inspection.....	4
3.1.2. Post Inspection.....	4
3.1.3. Maintenance.....	4
3.2. Trouble-shooting.....	5
3.3. Stem Packing Replacement.....	6
4. Newco Forged Steel Valves.....	8
4.1. Bolted/Welded Bonnet Gate and Globe Valves	8
4.1.1. Operation.....	8
4.1.2. Disassembly.....	8
4.1.3. Reassembly.....	8
4.2. Bolted/Welded Cap Swing-Type Check Valves.....	10
4.2.1. Operation.....	10
4.2.2. Disassembly.....	10
4.2.3. Reassembly.....	10
4.3. Bolted/Welded Cap Lift Check Valves.....	11
4.3.1. Operation.....	11
4.3.2. Disassembly.....	11
4.3.3. Reassembly.....	11
5. About Newco Valves.....	12
5.1. Identifying Newco Figure Numbers	12
5.2. Ordering Parts.....	13
Appendix A.....	14
Table A – Torque Values for Bonnet Bolting.....	14



1. INTRODUCTION AND SAFETY INFORMATION

1.1. Introduction

This manual has been prepared to serve as a guide to insure continuous satisfactory service and assist in restoring of a valve to proper working condition.

It covers 'NEWCO' Forged Class 150 through 2500, bolted/welded bonnet, outside screw and yoke, flanged /threaded /socket welded, carbon steel, stainless steel and alloy steel valves. The installation, storage, operation, disassembly / reassembly inspection and repair, service problems, maintenance and preventive maintenance covering these valves are also included in this manual.

Prior to performing any work on these valves, it would be useful to have a general understanding of their construction. Chapter 4 shows the valve's basic construction.

1.2. Safety Information

The following general safety notices supplement the specific warnings and cautions appearing elsewhere in this manual. They are recommended precautions that must be understood and applied during operation and maintenance of the equipment covered herein.

- a. **To avoid injury, never attempt disassembly while there are pressures either upstream or downstream. Even when replacing packing rings caution is necessary to avoid possible injury.**
- b. **Do not attempt to disassemble a valve while there is pressure in the line. Make sure both upstream and downstream pressures are removed before disassembly. Disassemble with caution in the event that all pressures have not been relieved.**
- c. **Prior to replacing packing rings, remove all pressure from the valve. The packing can also be replaced while there is pressure BUT the valve must be tightly backseated. This will not insure complete safety and it is not recommended. If the backseat faces have been damaged by foreign material the backseat may leak into the packing chamber.**



2. STORAGE, PREPARATION AND INSTALLATION

2.1. Storage.

2.1.1. Temporary Storage.

If valves are to be stored before installation, the following should be observed:

- a. Keep the valves wrapped and protected as shipped from the manufacturer.
- b. Do not remove the protective end covering until the valve is ready for installation. This will reduce the possibility of foreign material damaging internal valve components.
- c. Valves stored outdoors should be positioned such that water does not accumulate in the valve body.

2.1.2. Long Term Storage.

If the valves are to be stored in excess of one year, they should be prepared in the following manner:

- a. Remove the packing and apply a preservative to the packing chamber.
- b. Do not remove the protective end covering.
- c. Valve, which will remain in storage for an excessive period of time should have a preservative, applied to the external surface.
- d. Do not store the valves outdoors.

2.2. Preparation.

- a. Remove the valve end protection.
- b. Prior to shipment from the manufacturer, a preservative may have been applied to the inner body of the valve. This preservative may be removed with a solvent.
- c. The inside of the valve should be inspected and blown out with compressed air. Adjacent piping must be clean and free from debris to prevent damage to the valve.
- d. Make sure the valve is positioned such that there is sufficient space so that the handwheel is easily and safely reached and there is enough clearance for the stem when the valve is open.
- e. Install the valve according to the flow indicator on the valve body. Note gate valves can be installed in any position without regard for the direction of the flow, unless marked with the flow direction.
- f. Gate valves and globe valves are not designed for throttling and should be kept in the fully open or closed position. Should the valve be used in a partially open or closed position, the bottom of the wedge and the seat may become eroded in a very short time. This may also cause a chatter noise in the line.



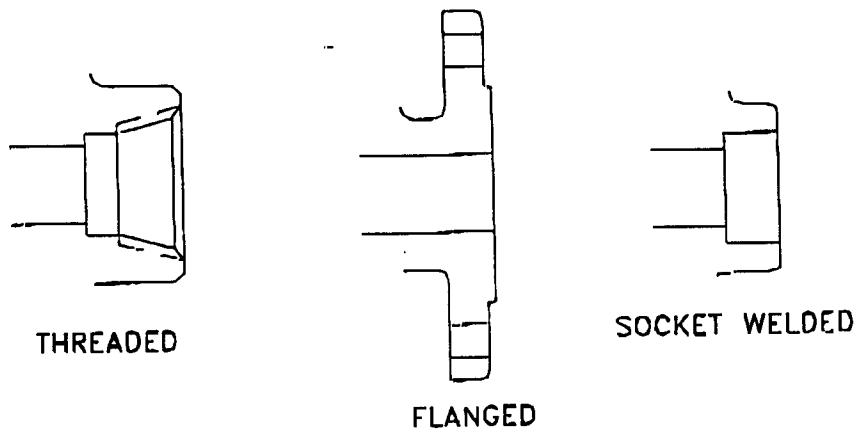
2.3. Installation

2.3.1. Flanged Valves.

Bolting and gasket material should be compatible with the valve's body material and pressure class. Care should be taken that flanges are straight and parallel. Bolts should be evenly tightened in a star pattern. This will ensure a uniform gasket loading.

2.3.2. Socket and Threaded Valves.

Ensure that the socket/threaded connection is clean and free from any foreign debris or burrs. For any welding required, check that body material (as specified on nameplate), and pipe material are compatible for weld procedure.



VALVE END CONNECTIONS



3. MAINTENANCE AND REPAIR

3.1. Inspection and Maintenance

A periodic inspection and maintenance schedule should be established for each valve. The time frame given for the implementation of these schedules are to be used as a guide only in establishing routine inspection and maintenance schedules. Exact time periods for performing these procedures cannot be provided due to the unknown nature of the service conditions each valve is in.

3.1.1. Periodic Inspection.

A periodic inspection should be performed on each unit. As mentioned previously, this time frame should be adjusted depending on usage and service conditions. An infrequently used unit may have a longer time period between the performance of a periodic inspection. If, on the other hand, a valve is in constant service a shorter time period between inspection would be appropriate.

The inspection is used as a means to identify a problem before it can cause a shutdown of the system. A periodic inspection should include the following:

- a. Examine the valve stem for cleanliness and lubrication. The stem threads should be coated with a clean grease lubricant.
- b. Some valves have a grease fitting in the bonnet or yoke. If it is dry, lubricate with a hand grease gun.
- c. Open and close the valve. The actions should be smooth without any binding of the stem through full travel.
- d. If valve is in service and under pressure:
 - i) Examine the body to bonnet connection for leakage through the gasket. If leakage is found, tighten the bonnet nuts evenly in a star pattern until the leakage stops. Do not exceed the maximum torque values in Table A. If the leakage persists, see section 3.2. (NOTE: this does not apply to welded bonnets)
 - ii) Check the stem packing for any leakage during the opening and closing action. If a leak is found tighten the gland nuts alternately with no more than a quarter turn on each nut until the leak stops. If the leakage persists, see section 3.2.
 - iii) Inspect the exterior of the valves for cleanliness. Remove any dirt, grime or oil from the valve body and bonnet.

3.1.2. Post Inspection.

After completion of this periodic inspection, valves that are providing satisfactory service require no further disassembly or inspection. Should a valve be found which is not performing satisfactorily, see section 3.2 "Troubleshooting".

3.1.3. Maintenance.

Other than periodic inspection, no routine maintenance is required. Routine replacement of parts, such as gasket and packing is not usually performed until these parts fail. Once in service, it may become apparent that these and other parts require repair or replacement due to usage and service conditions. A maintenance schedule should be developed taking these conditions into consideration to replace parts, which have a tendency to wear within a given time frame. These can then be replaced during a routine overhaul prior to any failure.

3.2. Trouble-shooting



The following chart will cover the various problems, which are common to most valves. It will provide information, which will aid in isolating and correcting these problems.

Table 3-2 Valve Troubleshooting

PROBLEM	PROBABLE CAUSE	SOLUTION
Leakage through the stem packing	<ul style="list-style-type: none"> a. Gland nuts are loose b. Gland is binding against the stem or packing chamberwall c. Inadequate amount of packing rings d. Packing is hard and dry e. Packing was not properly cut and staggered f. Stem is damaged. 	<ul style="list-style-type: none"> a. Tighten gland bolting. b. Check to insure gland is centered and evenly tightened c. Install additional packing rings see section 3.3 d. Replace with new packing see section 3.3 e. Replace with new packing see section 3.3 f. Repair or replace as required
Problems in operating valve	<ul style="list-style-type: none"> g. Stem binding during travel h. Stem packing is exerting excessive force on the stem i. Stem is damaged j. Internal components may be damaged 	<ul style="list-style-type: none"> g. Remove dirt and lubricate stem with grease h. Check torque on gland nuts. i. Examine stem through full open and close action. Repair or replace as required j. Disassemble the valve. Inspect and repair as needed.
Bonnet Leakage	<ul style="list-style-type: none"> k. Bonnet nuts are loose l. Gasket is damaged m. Flange faces are damaged 	<ul style="list-style-type: none"> k. Tighten to values listed in Table A. l. Disassemble and install a new gasket. m. Repair and install a new gasket
Seat Leakage	<ul style="list-style-type: none"> n. Valve not properly seated o. Internal components are damaged or worn 	<ul style="list-style-type: none"> n. Check to see if valve is tightly closed o. Inspect internal components and repair as required (for detailed repair consult Newmans representative).



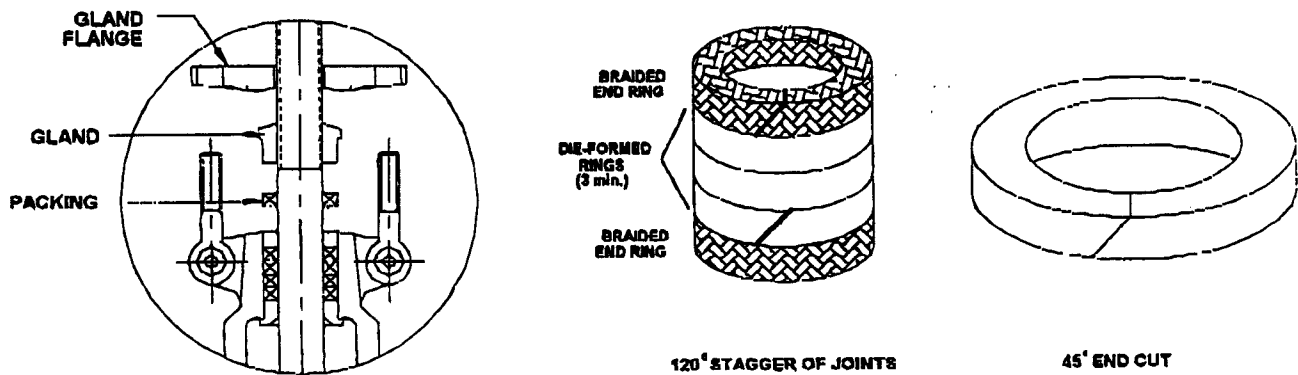
3.3. Stem Packing Replacement

WARNING

To prevent injury ensure that all pressure is removed from the valve both upstream and downstream before disassembly.

- a. Check original tightness of valve operation. Remove gland nuts. Lift the gland up the stem clear of the packing chamber.
- b. Remove the existing or defective packing rings with a sharp tool or packing remover. Do not scratch or score the machined surfaces of the stem or packing chamber.
- c. Examine the machined surface of the stem in the packing chamber. Remove any scratches, scoring or burrs with emery cloth or hand filing. Clean the stem with a solvent soaked cloth.
- d. Count original number of rings and measure x-section thickness. If original packing cannot be counted or measured, follow the steps below:
 - 1.) Measure the stem diameter (OD), stuffing box diameter (ID) and stuffing box depth (d).
 - 2.) Packing x-section (R) = $(ID - OD)/2$
 - 3.) #Rings = $(1.25 \times d)/R$
- e. Install new packing. Cut each ring at a 45-degree angle and stagger the joints at 120 degrees, every fourth joint will be in the same position as the first. Install rings individually using a split ring spacer, compressing each ring by hand tightening = 1/4 turns on each gland nut.
- f. When packing chamber becomes filled with packing, reassemble gland and gland flange. Alternate tightening gland flange nuts 1/4 turn at a time until eyebolts begin to get tight. (If gland travels more than the height of one packing ring into the packing chamber, insert one more ring and repeat step F until chamber is filled.
- g. Compare valve operation to original tightness. If valve operation is considerably tighter than original operating tightness, back off 1/4 turn on each gland nut and recheck tightness.
- h. Several hours after a repacked valve has been returned to service, inspect the area to ensure full compression, tight bolting and no leakage. Should leakage occur, tighten gland nuts at 1/4-turn increments until leakage stops.

Figure 3.1.3-1 (a) Valve Stuffing Box Assembly (b) Packing Detail





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4. NEWCO FORGED STEEL VALVES

4.1. Bolted/Welded Bonnet Gate and Globe Valves

4.1.1. Operation

By turning the handwheel counter-clockwise, the stem, to which the wedge (or disc) is attached at the base, is drawn up through the yokesleeve. By turning the handwheel clockwise, the action is reversed and the wedge (or disc) is lowered into the closed position.

4.1.2. Disassembly

WARNING

To prevent injury ensure that all pressure is removed from the valve both upstream and downstream before disassembly.

NOTE: Welded bonnet valves can be disassembled but is not justifiable due to the amount of time required to do this.

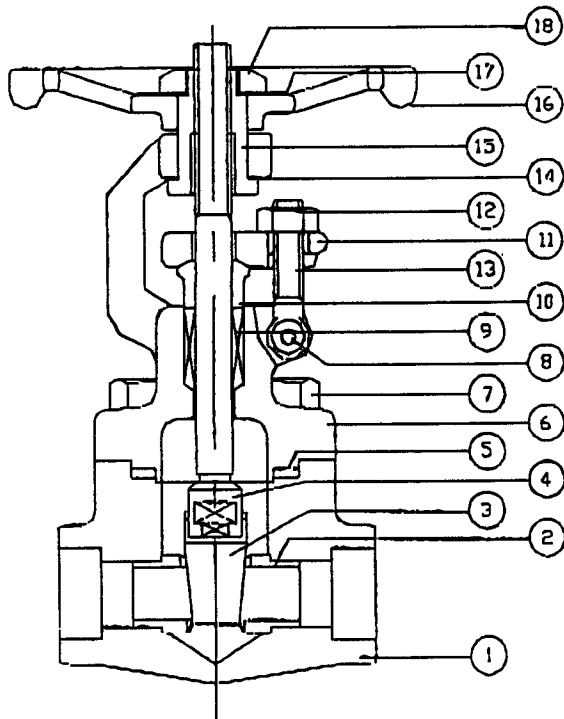
- a. Close the valve and then open, two full handwheel turns. Match or mark flange with metal tool or paint to clearly show the original position for reassembly.
- b. Caution should be taken when loosening body-bonnet bolting as pressure may still be present in bonnet.
- c. Once assured there is no more pressure in the line, remove the bonnet bolting. Lift the bonnet-stem-wedge (or disc) assembly out of the body, taking care not to scratch the seating surface. For gate valves, as the assembly is drawn out of the body, match or mark the wedge so that it can be replaced in the same position.
- d. Remove the bonnet gasket from the valve body flange.
- e. For gate valves, remove the wedge from the stem "T" head, carefully protecting the seating surface. For globe valves, remove the disc from the stem by cutting tackwelds and unthreading the disc nut or bushing.
- f. Unfasten the handwheel nut. Remove the handwheel from the valve.
- g. To remove the valve stem, loosen the gland bolting and gland. Disengage the stem from the yokesleeve by rotating it counterclockwise and pulling from below until the stem is free of the packing chamber. Be careful not to score or scratch the stem-machined surface or the threads.

4.1.3. Reassembly

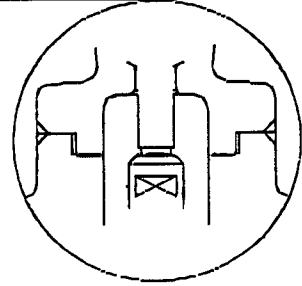
- a. Thoroughly clean the valve interior, body and bonnet flange surfaces and all components. Remove all scale, oil, grease or other foreign material. Wipe the seating surface of the wedge (or disc) and valve seat with a solvent soaked cloth.
- b. Install the stem carefully, sliding it through the packing and gland until the threads are engaged with the yokesleeve. Slowly rotate the stem clockwise until it extends beyond the bonnet.
- c. Place handwheel in position atop the valve, stem nut for gate valves and stem for globe valves. Secure with handwheel nut.
- d. Position a new gasket on the body flange aligned with the boltholes. The gasket should not extend over the open body cavity. The gasket may be coated with a light oil.
- e. For gate valves, install the wedge to the "T" head of the stem connection. For globe valves, install the disc and secure it with the bushing or disc nut to the stem and tackweld.
- f. Lift the bonnet-stem-wedge assembly up and over the body. Check the location marks on the body, bonnet flange and wedge. Carefully lower the assembly until the body and bonnet flanges and the location marks meet. Again, caution must be used to prevent scoring or scratching of the seating surfaces. Keeping the bonnet stationary, open the valve a few turns to ensure the wedge (or disc) is not touching the seat.
- g. Line up the body and bonnet holes. Make sure the gasket does not extend into any of the boltholes. Install the bonnet bolting and tighten in a star pattern to evenly load the gasket to the torque values listed in Table A.
- h. Install new packing as per section 3.3.
- i. Align and center the gland in the packing chamber. Evenly tighten the gland nuts until snug, then alternate tightening with no more than a quarter turn on each.
- j. Open and close the valve using the handwheel. The action should be smooth and regular through full stem travel.



Figure 4.1-1 Bolted Bonnet Gate Valve with Welded Bonnet



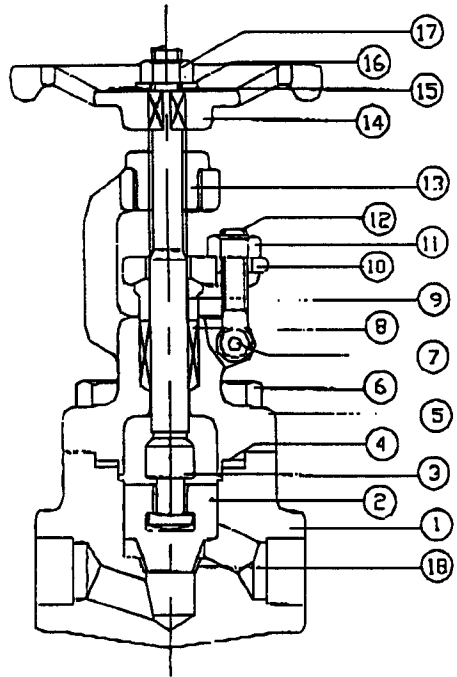
18	HAND WHEEL NUT
17	NAME PLATE
16	HAND WHEEL
15	SLEEVE
14	SLEEVE WASHER
13	EYE BOLT
12	EYE BOLT NUT
11	GLAND FLANGE
10	GLAND
09	PACKING
08	EYE BOLT PIN
07	BONNET BOLT
06	BONNET
05	GASKET
04	STEM
03	WEDGE
02	SEAT RING
01	BODY



WELDED BONNET DETAIL

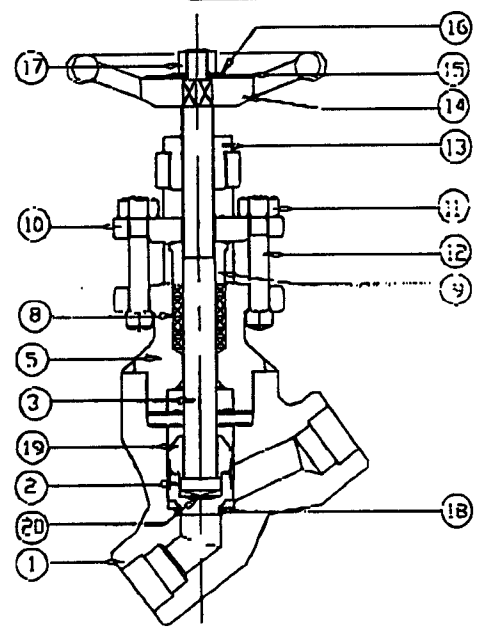
Figure 4.1-2 Bolted Bonnet Globe Valve with Welded Bonnet

20° SEAT RING



19°	DISC NUT
18	SEAT RING
17	NUT
16	WASHER
15	NAME PLATE
14	HANDWHEEL
13	STEM NUT
12°	EYE BOLT/STUD
11	EYE BOLT NUT
10	GLAND FLANGE
09	GLAND
08	GLAND PACKING
07°	EYE BOLT PIN
06°	BONNET BOLT
05	BONNET
04°	GASKET
03	STEM
02	DICK
01	BODY

Y-Pattern Globe



• MAY VARY WITH DESIGN

4.2. Bolted/Welded Cap Swing-Type Check Valves

4.2.1. Operation



The Swing Check valve's operation is automatic and requires no assistance. When the flow exerts sufficient pressure against the disc to overcome the disc's weight, the disc which is set on a hinge, lifts allowing the flow to continue through the piping system. As the pressure decreases, the disc lowers until its own weight forces it to seat. This prevents the possibility of a reversal in the flow.

4.2.2. Disassembly

WARNING

To prevent injury ensure that all pressure is removed from the valve both upstream and downstream before disassembly.

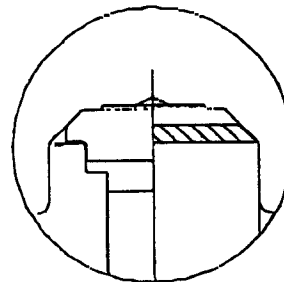
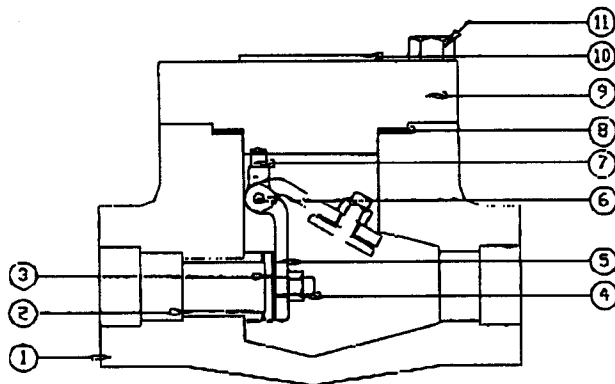
NOTE: Welded cap valves can be disassembled but is not justifiable due to the amount of time required to do this.

- a. Match or mark cover and body with metal tool or paint to clearly show the original position for reassembly.
- b. Caution should be taken when loosening body-cover bolting as pressure may still be present.
- c. Once assured there is no more pressure in the line, remove the cover bolting and lift the cover off the body.
- d. Remove the gasket from the valve body flange.
- e. If so equipped remove any tackwelds.
- f. Remove the hinge pin from support arms in cap. It may be necessary to use a punch, as pin may have been panned over.
- g. To remove the disc from swing arm, remove the cotter pin and unfasten the disc nut.

4.2.3. Reassembly

- a. Thoroughly clean the valve interior and all components. Remove all scale, oil, grease, or other foreign material. Wipe the seating surface of the disc and valve seat with a solvent soaked cloth. Clean the body and cover flange surfaces and all bolting.
- b. Install the disc and secure it to the arm with the disc nut. Insert and secure a new pin (peen over if required). Do not use the old pin unless a new one is unavailable.
- c. Place the disc-arm assembly in the valve and insert the hinge pin.
- d. Replace any tackwelds as required.
- e. Open the valve by lifting the arm. The action should be smooth and regular through full hinge pin rotation.
- f. Position a new gasket on the body flange aligned with the boltholes. The gasket should not extend over the open body cavity. Do not reuse a gasket. The gasket may be coated with a light oil.
- g. Line up the body and cover holes. Make sure the gasket does not extend into any of the boltholes. Install the cover bolting and tighten in a star pattern to evenly load the gasket to the torque values listed in Table A.

Figure 4.2-1 Bolted/Welded Cap Swing-Type Check Valve



11	COVER BOLT
10	NAME PLATE
9	COVER
8	GASKET
7	SUPPORTER
6	SUPPORTER PIN
5	HINGE
4	RETAINING NUT
3	DISC
2	SEAT RING
1	BODY

DETAIL

WELDED BONNET

4.3. Bolted/Welded Cap Lift Check Valves

4.3.1. Operation

The Lift Check valve's operation is automatic and requires no assistance. When the flow exerts sufficient pressure against the plug/ball to overcome the plug/ball weight, the plug/ball, lifts allowing the flow to continue through the piping system.



As the pressure decreases, the plug/ball lowers until its own weight forces it to seat. This prevents the possibility of a reversal in the flow.

4.3.2. Disassembly

WARNING

To prevent injury ensure that all pressure is removed from the valve both upstream and downstream before disassembly.

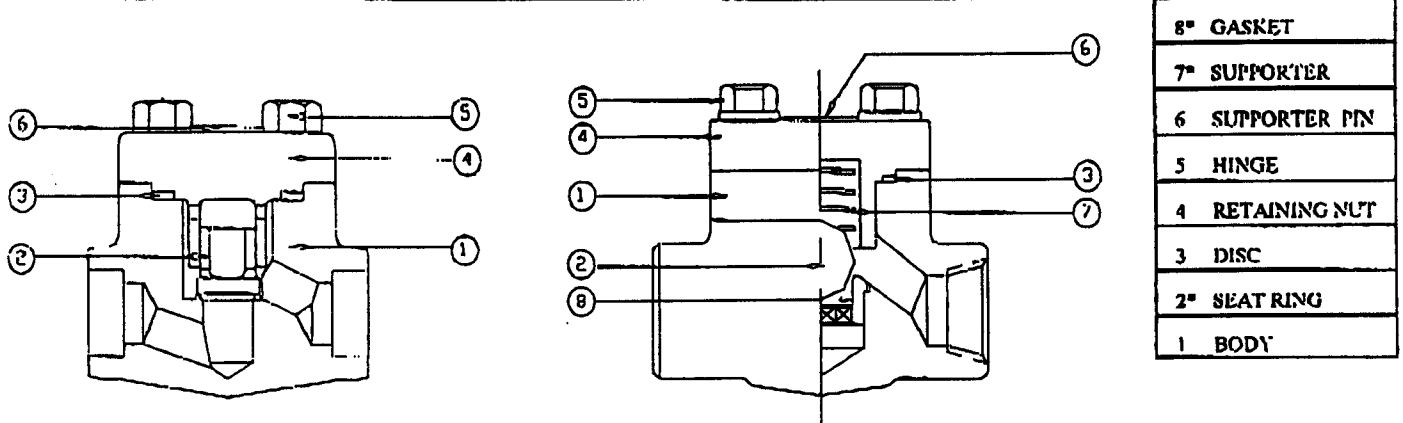
NOTE: Welded cap valves can be disassembled but is not justifiable due to the amount of time required to do this.

- a. Match or mark cover and body with metal tool or paint to clearly show the original position for reassembly.
- b. Caution should be taken when loosening body-cover bolting as pressure may still be present.
- c. Once assured there is no more pressure in the line, remove the cover bolting and lift the cover off the body.
- d. Remove the gasket from the valve body flange.
- g. For ball type valves remove spring (if so equipped) before sliding out the ball. For plug type simply slide out the plug.

4.3.3. Reassembly

- a. Thoroughly clean the valve interior and all components. Remove all scale, oil, grease, or other foreign material. Wipe the seating surface of the plug/ball and valve seat with a solvent soaked cloth. Clean the body and cover flange surfaces and all bolting.
- d. Replace ball/plug by sliding it back into the body. If so equipped place spring in following ball.
- c. Open the valve by sliding plug/ball up and down. The action should be smooth and regular through full plug/ball travel.
- f. Position a new gasket on the body flange aligned with the boltholes. The gasket should not extend over the open body cavity. Do not reuse a gasket. The gasket may be coated with a light oil.
- g. Line up the body and cover holes. Make sure the gasket does not extend into any of the boltholes. Install the cover bolting and tighten in a star pattern to evenly load the gasket to the torque values listed in Table A.

Figure 4.3-1 Bolted/Welded Cap Lift Check Valve



* VARIES WITH DESIGN

5. ABOUT NEWCO VALVES

5.1. Identifying Newco Figure Numbers

Newco valves can be identified by a distinct figure number on the identification plate. This plate is located either on the body/bonnet flange or on the bonnet yoke. The figure number gives all the necessary information for identifying valve type, material, end connections, pressure rating, etc. Listed below is the basic set-up.



Type	Pressure Class	End Connections	Trim Material
1 - Gate, OS&Y	1 - 150	F - Flanged	1 - CR13
2 - Globc, OS&Y	2 - 125	W - Butt Weld	2 - CR13/HF**
3 - Swing Check	3 - 300	J - RTJ	3 - HF/HF**
4 - Lift Check	4 - 400	S - Socket Weld	4 - 316
5 - Ball	5 - 250	T - Threaded	5 - Ni CU (Monel***)
6 - Gate, NRS	6 - 600	B - Wafer	6 - Alloy 20
7 - Angle, OS&Y	8 - 800	X - Special	7 - Bronze
8 - Plug	9 - 900	(Customer to specify)	8 - Iron
9 - Butterfly	15 - 1500		9 - Special (Customer to specify)
	25 - 2500		
	45 - 4500		

- *SUFFIX LETTERS**
- PS - Pressure Seal Bonnet
 - SO - Safe-O-Seal Bonnet
 - WB - Welded Bonnet
 - UB - Union Bonnet
 - HP - Horizontal Piston Check
 - HB - Horizontal Ball Check
 - VB - Vertical Ball Check
 - TD - Tilting Disc Check
 - FP - Full Port
 - RP - Regular Port
 - TF - Teflon* Insert
 - VT - Viton* Insert
 - SC - Stop-Check
 - NR - Non-Return
 - SG - Solid Wedge, Gate
 - N1 - Material to NACE MR-01-75
 - HL - High Lift
 - FS - Firesafe
 - PT - PTFE Seats
 - GO - Gear Operator
 - MO - Motor Operator
 - PO - Pneumatic Operator
 - HO - Hydraulic Operator
 - CR - Cryogenic Service
 - OL - Outside Weight & Lever
 - VP - V-Port Disc
 - BP - By-Pass
 - OX - Oxygen Service
 - CL - Chlorine Service
 - GI - Grease Injection
 - BS - Bellows Seal
 - VG - Venturi Gate
 - ST - Socket Weld x Threaded
 - SL - Special Lining

FIG. 11F-CB2*

BODY/BONNET MATERIAL

- CB - ASTM A216, WCB..... Cast Carbon Steel
- CS - ASTM A217, C5..... Cast Alloy Steel (5% Chrome, 1/2% Moly)
- C6 - ASTM A217, WC6..... Cast Alloy Steel (1 1/4% Chrome, 1/2% Moly)
- CR - ASTM A217, WC9..... Cast Alloy Steel (2 1/4% Chrome, 1% Moly)
- C12 - ASTM A217, C12..... Cast Alloy Steel (9% Chrome, 1% Moly)
- LC8 - ASTM A352, LC8..... Cast Low Temperature Carbon Steel
- LC3 - ASTM A352, LC3..... Cast Low Temperature 2 1/2% Nickel Steel
- CF8 - ASTM A351, CF8..... Cast 304 Stainless Steel
- C8M - ASTM A351, CF8M..... Cast 316 Stainless Steel
- A20 - ASTM A351, CN7M..... Cast Alloy 20
- MO - ASTM A298, M35..... Cast Ni CU (Monel***)
- FS - ASTM A105..... Forged Carbon Steel
- F5 - ASTM A182, F5..... Forged Alloy Steel (5% Chrome, 1/2% Moly)
- LF-2 - ASTM A350, LF2..... Forged Low Temperature Carbon Steel
- F11 - ASTM A182, F11..... Forged Alloy Steel (1 1/4% Chrome, 1/2% Moly)
- F22 - ASTM A182, F22..... Forged Alloy Steel (2 1/4% Chrome, 1% Moly)
- F8M - ASTM A182, F316..... Forged 316 Stainless Steel
- F8 - ASTM A182, F304..... Forged 304 Stainless Steel
- F8C - ASTM A182, F321..... Forged 321 Stainless Steel
- DI - ASTM A335..... Cast Ductile Iron
- IB - ASTM A126, CLB..... Cast Iron
- BR - ASTM B51..... Bronze
- SPL - Special (Customer to specify)

* Viton and Teflon are registered trademarks of DuPont Company.
 ** HF = Hardfaced - AWS 5.13 Class C₀C₁A
 *** Monel is a registered trademark of International Nickel Company.

Please order by size, figure number (which specifies type), pressure class, end connections, materials and special features, as shown above.

For End Connections, Body Materials and Trims not listed, please specify.



5.2. Ordering Parts

Although valves have many parts common to one another, they are not interchangeable, other than those of identical material, size and pattern. All the valve's parts can be replaced, but with proper care and maintenance they will provide continuous satisfactory service. Should a part require replacement, please provide the following information:

- Valve Size
- Newco Figure
- Two Digit Foundry Code (on body)
- Part Description
- Drawing No. (If known)
- Item No. (If known)

It is recommended that a spare gasket and set of packing for the various valves be kept in stock.



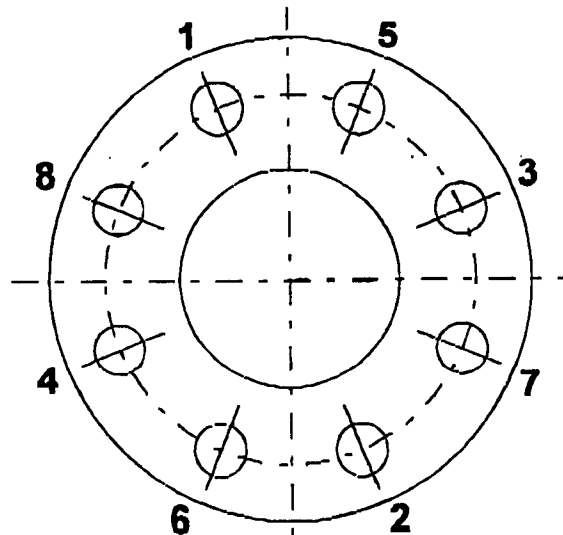
APPENDIX A

Table A -- Torque Values for Bonnet Bolting

Bolt Nominal Diameter (in.)	Torque		Bolt Nominal Diameter (in.)	Torque	
	(ft-lb)	(N-M)		(ft-lb)	(N-M)
1/4	4	5	1	200	271
5/16	8	11	1-1/8	375	509
3/8	12	16	1-1/4	525	712
7/16	20	27	1-3/8	715	970
1/2	30	41	1-1/2	925	1254
9/16	45	61	1-5/8	1200	1627
5/8	60	81	1-3/4	1500	2034
3/4	110	149	1-7/8	1850	2509
7/8	170	231	2	2260	3064

Notes:

1. Values are for B7 bolting only. For other bolting material, please consult your local Newco representative.
2. Values above are based on 30,000 psi (206.85 Mpa) bolting stress and lubricated with a heavy graphite and oil mixture. Non-lubricated bolts have an efficiency of 50% of the values stated.
3. Do not exceed by more than 25% of values stated when emergency torquing is required.
4. All bolts shall be torqued in a star pattern as shown below to ensure uniform gasket loading.



Bolt torquing sequence. 1-2-3-4-5-6-7-8

BATTERY STORAGE

Everything You Need to...
Store, Relocate and Secure
Your Batteries



BATTERY STORAGE

Noco Racing™ Aluminum Sealed Battery Boxes

Noco Racing Aluminum Sealed Battery Boxes are fabricated from a durable aluminum sheet metal for optimal resistance to shock, vibration and corrosion. A completely sealed design features an external vent tube for adequate ventilation of acid vapors. Easy to install and comes complete with stainless steel 3/8" j-bolts, hold-down, nuts and bolts.

Meets NHRA 8:1 and IHRA, USCG Code of Federal Regulation 183.420 and ABYC E-10.7 specification. Available in six different finishes for the extreme racer in you.



HM245, Sealed Group 24 Aluminum Battery Box



HM246, Sealed Group 24 Aluminum Battery Box



HM251, Sealed Group 27 Aluminum Battery Box

	Part No.	Group	Color	Inside Dim. (LxWxH)	Wt. (lbs)
Sealed	HM241	24	■ Unpolished	11.76" x 8.39" x 10.38"	7.7
	HM242	24	■ Polished	11.76" x 8.39" x 10.38"	7.7
	HM243	24	■ Blue	11.76" x 8.39" x 10.38"	7.7
	HM244	24	■ Green	11.76" x 8.39" x 10.38"	7.7
	HM245	24	■ Purple	11.76" x 8.39" x 10.38"	7.7
	HM246	24	■ Red	11.76" x 8.39" x 10.38"	7.7
	HM251	27	■ Unpolished	13.98" x 8.89" x 11.00"	9.3
	HM252	27	■ Polished	13.98" x 8.89" x 11.00"	9.3
	HM253	27	■ Blue	13.98" x 8.89" x 11.00"	9.3
	HM254	27	■ Green	13.98" x 8.89" x 11.00"	9.3
	HM255	27	■ Purple	13.98" x 8.89" x 11.00"	9.3
	HM256	27	■ Red	13.98" x 8.89" x 11.00"	9.3



HM253, Sealed Group 27 Aluminum Battery Box



HM254, Sealed Group 27 Aluminum Battery Box



Sealed Aluminum Battery Box Features:



Captive Lid
Latches secure lid to base.



Cable Grommets
Protect cables from abrasion and provides air-tight seal.



Lid Gasket
Provides air-tight seal between lid and base when latches are engaged.



Vent Hole
Takes away condensation and prevents build-up of gases.



Hold-Down
Secures the battery and box to mounting surface.

IHRA Recommends

All wet-cell batteries must not be relocated into the driver or passenger compartments and must be securely mounted. A maximum of two (2) automobile batteries are permitted of 150 lbs. combined maximum weight. Plastic battery hold-down straps are not permitted. Minimum bolt size 3/8 inch steel. ... Dragsters with battery mounted behind rear end must have a steel plate of 1/8 inch or aluminum of 1/4 inch between rear end and battery.

	Part No.	Group	Color	Inside Dim. (LxWxH)	Wt. (lbs)
Non-Sealed	HM226	24-27	■ Black	12.71" x 8.13" x 10.38"	10.8
	HM227	24-27	■ Aluminum	12.71" x 8.13" x 10.38"	10.8
	HM228	24-27	■ Blue	12.71" x 8.13" x 10.38"	10.8
	HM229	24-27	■ Green	12.71" x 8.13" x 10.38"	10.8
	HM230	24-27	■ Purple	12.71" x 8.13" x 10.38"	10.8
	HM231	24-27	■ Red	12.71" x 8.13" x 10.38"	10.8

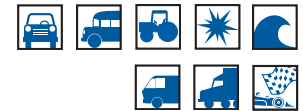
Noco Racing™ Aluminum Non-Sealed Battery Boxes



HM226, Non-Sealed Group 24-27 Aluminum Battery Box

Noco Racing Non-Sealed Aluminum Battery Box are fabricated from a durable aluminum sheet metal for optimal resistance to shock, vibration and corrosion. A non-sealed design that allows configuration of the battery box for multiple applications and cable runs; front, back, side, high or low. Easy to install and comes complete with stainless steel 3/8" U-bolt, mount brackets, nuts and bolts.

Meets NHRA 8:1, IHRA, USCG Code of Federal Regulation 183.420 and ABYC E-10.7 specification.



HM227, Non-Sealed Group 24-27 Aluminum Battery Box



HM228, Non-Sealed Group 24-27 Aluminum Battery Box



HM229, Non-Sealed Group 24-27 Aluminum Battery Box



HM230, Non-Sealed Group 24-27 Aluminum Battery Box



HM231, Non-Sealed Group 24-27 Aluminum Battery Box

	Part No.	Group	Color	L x W x H	Wt. (lbs)
Performance Battery Trays	HT350	24-31	■ Stainless	13.13" x 7.19" x 0.42"	2.3
	HT351	24-31	■ Blue	13.13" x 7.19" x 0.42"	1.7
	HT352	24-31	■ Green	13.13" x 7.19" x 0.42"	1.7
	HT353	24-31	■ Purple	13.13" x 7.19" x 0.42"	1.7
	HT354	24-31	■ Red	13.13" x 7.19" x 0.42"	1.7

Noco Racing™ Battery Tray Kits



HT350, Stainless Steel Battery Tray & Mounting Kit

Noco Racing Battery Tray Kits are constructed of stainless steel for superior resistance to movement, shock, vibration and corrosion.

Comes complete with battery tray, j-bolts, wing-nuts, hold-down, mounting brackets and insulators.



HT351, Stainless Steel Battery Tray & Mounting Kit



HT352, Stainless Steel Battery Tray & Mounting Kit



HT353, Stainless Steel Battery Tray & Mounting Kit



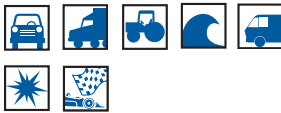
HT354, Stainless Steel Battery Tray & Mounting Kit

BATTERY STORAGE

Noco® Snap-Top™ Battery Boxes

Noco Snap-Top Battery Boxes are manufactured from injection molded polypropylene plastic that effectively collects electrolyte, allows ventilation and prevents accidental contact of underground battery terminals.

All Noco Snap-Top Battery Boxes meet USCG Code of Federal Regulations 183.420 and ABYC E-10.7 specification.



HM300BK, Group 24 Battery Box



HM300R, Group 24 Battery Box



HM327BK, Group 27 Battery Box



HM318W, Group 24-31 Battery Box



	Part No.	Group	Color	Inside Dim. (LxWxH)	Weight (lbs)
Standard	HM300BK	24	■ Black	11.00" x 7.87" x 9.75"	2.3
	HM300R	24	■ Red	11.00" x 7.87" x 9.75"	2.3
	HM300W	24	□ White	11.00" x 7.87" x 9.75"	2.3
	HM327BK	27	■ Black	13.37" x 7.75" x 10.75"	2.8
	HM327R	27	■ Red	13.37" x 7.75" x 10.75"	2.8
	HM327W	27	□ White	13.37" x 7.75" x 10.75"	2.8
Heavy Duty	HM318BK	24-31	■ Black	14.50" x 7.87" x 9.75"	3.1
	HM318R	24-31	■ Red	14.50" x 7.87" x 9.75"	3.1
	HM318W	24-31	□ White	14.50" x 7.87" x 9.75"	3.1

USCG Code of Federal Regulations 183.420

- Each installed battery must not move more than one inch in any direction when a pulling force of 90 pounds or twice the battery weight, whichever is less, is applied through the center of gravity of the battery as follows:
 - Vertically for a duration of one minute.
 - Horizontally and parallel to the boat's center line for a duration of one minute fore and one minute aft.
 - Horizontally and perpendicular to the boat's center line for a duration of one minute to starboard and one minute to port.
- Each battery must be installed so that metallic objects cannot come in contact with the ungrounded battery terminals.
- A vent system or other means must be provided to permit the discharge from the boat of hydrogen gas released by the battery.

Snap-Top Battery Box Features:



Heavy Duty Handles
Are reinforced to resist cracking.



Large Divider
Secures battery for various group size applications (HM318 only).



Locking Tabs
Fasten lid to base.



Vent Caps
Limit water entry.

... I prefer the (polypropylene battery boxes) made by Noco..."

David Seldman, *Boating Magazine*, August 2000

Noco® Utility Battery Box

Noco Utility Battery Box is designed for smaller batteries used in lawn and garden equipment, power wheelchairs and personal watercraft.



HM082, Group U-1 Battery Box

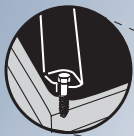
Noco Utility Battery Boxes feature a standard lid.

	Part No.	Group	Color	Inside Dim. (LxWxH)	Weight (lbs)
Utility	HM082	U-1	■ Black	11.00" x 7.50" x 8.75"	1.2

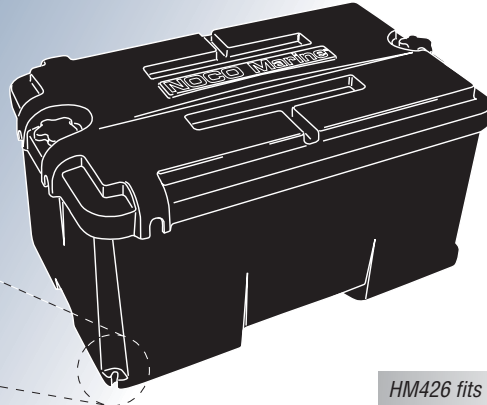
	Part No.	Group	Color	Inside Dim. (LxWxH)	Weight (lbs)
Commercial	HM408	4D	■ Black	20.50" x 9.50" x 11.50"	9.0
	HM484	8D	■ Black	21.50" x 11.50" x 11.00"	11.0
	HM426	Dual 6V	■ Black	14.75" x 10.75" x 12.00"	9.0

Superior Quality Boxes for Golf Cart, 4D and 8D Batteries

- Full flow ventilation
- Linear low-density polyethylene
- Acid, gasoline, oil, salt & chemical resistant
- Impact resistant to -40 °F (-40 °C)



Easy to install...
Fastens from the top/down for quick installation.



HM426 fits
2 Golf Cart Batteries

Noco Marine™ Commercial Battery Boxes



HM408, 4D Commercial Battery Box



HM484, 8D Commercial Battery Box



HM426, Dual 6V Commercial Battery Box

Noco Marine Commercial Battery Boxes are rotationally molded from a low density polyethylene plastic. These rugged boxes maintain their tough impact properties in climates down to -40 °F (-40 °C).

Features a four-corner fastening system, a captive lid, large cable entry holes and a large electrolyte reservoir.

Meets USCG Code of Federal Regulation 183.420 and ABYC E-10.7 specification.



	Part No.	Group	Color	Inside Dim. (LxWxH)	Weight (lbs)
Plastic	HT008	U-1	■ Black	8.00" x 5.50" x 0.42"	0.3
	HT111	24	■ Black	10.25" x 7.06" x 0.90"	0.6
	HT251	27-31	■ Black	13.37" x 7.25" x 0.90"	0.7
Metal	HT110	24	■ Black	11.00" x 7.19" x 0.42"	1.6
	HT250	27-31	■ Black	13.13" x 7.19" x 0.42"	1.7

Recommendation:

All ungrounded terminals should be covered by an insulator boot or non-conductive material, pg.74



Use Noco mounting hardware: crossbar hold-downs, j-bolts or other forms of securing your battery to these high quality battery trays.

See page 40.



Noco® Plastic and Metal Battery Trays



HT111, Group 24 Plastic Battery Tray



HT251, Group 27-31 Plastic Battery Tray



HT110, Group 24 Metal Battery Tray



HT250, Group 27-31 Metal Battery Tray

Noco Plastic Battery Trays are injection molded with the purest polypropylene plastic. Feature external mounting holes to resist battery movement.

Noco Metal Battery Trays are fabricated out of 16 gauge steel and covered with a vinyl coating to resist rust, corrosion and battery movement. Feature water escape slips for adequate drainage.



BATTERY STORAGE

Noco® Battery Storage Replacement Hardware

Noco Battery Box Straps feature a woven polypropylene strap that is resistant to acid, salt water, oil and sunlight.

Noco Replacement Divider is an injection molded polypropylene replacement part for HM318 (group 24-31) battery boxes only.

Noco Battery Tray Straps feature a woven polypropylene strap with heavy-duty plastic buckles that mate securely to resist battery movement.



Add "CS" to the part number for clamshell retail packaging. **Yellow Dot** indicates products available in clamshell.



HM001, 38" Battery Box Strap



HTBB40
38" Battery Tray Strap

	Part No.	Description	Color
Kit	HM001	38" Battery Box Strap	■ Black
	HM004	Replacement Divider for HM318 Battery Boxes	■ Black
	HTBB40	38" Battery Tray Strap w/Plastic Buckle	■ Black

Easy to use divider allows you to fit battery sizes from Group 24-31



HM004, Replacement Divider for HM318

Noco Racing™ Battery Trunkmount Kit

Noco Racing Battery Trunkmount Kit offers everything you need to relocate your batteries. Whether you need an additional battery to power your new high-amperage audio system, transfer weight or just clean up your engine compartment, the Noco Battery Trunkmount kit is your easy and convenient solution.

Meets NHRA 8:1 and IHRA specification.



BTMK1, Battery Trunkmount Kit

	Part No.	Group	Description
Kit	BTMK1	24-31	Battery Trunkmount Kit <i>Kit Includes: Black Battery Box, Group 24-31, (2) 10" x 3/8" J-Bolts, Battery Strap, 3' Black - 2 Ga. Battery Cable, 20' Red - 2 Ga. Battery Cable, Crossbar Hold-down, and Hardware</i>

NHRA Requirement

8:1 BATTERIES

All batteries must be securely mounted. Batteries may not be relocated into the driver or passenger compartments. Rear firewall of .024-inch steel or .032-inch aluminum (including package tray) required when battery is relocated in trunk. In lieu of rear firewall, battery may be located in a sealed .024-inch steel, .032-inch aluminum, or NHRA accepted poly box. If sealed box is used in lieu of rear firewall, box may not be used to secure battery and must be vented outside of body. Relocated battery(s) must be fastened to frame or frame structure with a minimum of two 3/8-inch diameter bolts.

Noco Racing™ Remote Battery Mounting Kit

Noco Racing Remote Battery Mounting Kit offers you the right components to relocate your batteries. Ideal for cleaning up your engine compartment and distributing racing weight.



BCK1
Remote Battery Mount Kit

	Part No.	Description
Kit	BCK1	Remote Battery Mount Kit <i>Kit Includes: 15' Red - 1 Ga.; Battery Cable, 3' Black - 1 Ga.; Battery Cable; (2) Hefty-Hefty Copper Lugs, 3/8"; (2) Side Terminal Charging Posts</i>

Part No.	Group	Description
Kit BRK1	24-31	Single Mount Relocator Kit <i>Kit Includes: Metal Battery Tray; (2) 10" x 3/8" J-Bolts; 3' Black 2 Ga. Battery Cable; 16' Red 2 Ga. Battery Cable; Crossbar Hold-down; Heat Shrink Tubing and Hardware</i>
BRK2	24-31	Dual Mount Relocator Kit <i>Kit Includes: (2) Metal Battery Trays; (4) 10" x 3/8" J-Bolts; 3' Black 2 Ga. Battery Cable; 17' Red 2 Ga. Battery Cable; Crossbar Hold-down; Heat Shrink Tubing and Hardware</i>
BRK3	24-31	Spread Mount Relocator Kit <i>Kit Includes: (2) Metal Battery Trays; (4) 10" x 3/8" J-Bolts; 6' Black 2 Ga. Battery Cable; 6' Red 2 Ga. Battery Cable; 18" Black 4 Ga. Lug to Lug Battery Cable; 16' Red 2 Ga. Battery Cable; (4) Hefty-Hefty Copper Lugs, 2 Ga., 3/8"; (2) Marine Wing-Nut Battery Terminals; Heat Shrink Tubing and Hardware</i>

Noco Racing™ Battery Relocator Kits



BRK1
Single Mount Relocator Kit

Noco Racing Battery Relocator Kits offer a simple and easy way to distribute weight and clean up your engine compartment. Ideal for hot rods, off-road or other racing vehicles.

Meets NHRA 8:1 and IHRA specification.



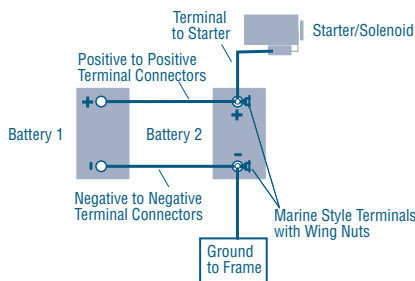
BRK3, Spread Mount Relocator Kit



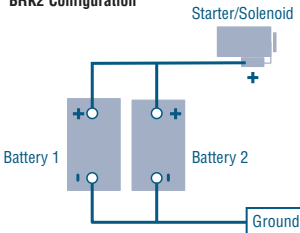
BRK2, Dual Mount Relocator Kit

Typical Battery Relocator Mounting Configurations:

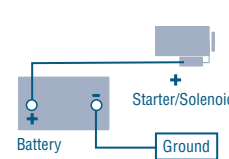
BRK3 Configuration



BRK2 Configuration



BRK1 Configuration



	Part No.	Color	Strength (lbs)	Wt (lbs)	L	W	H
Fiberglass	CT1	White	2500	50	48.00"	48.00"	4.25"
	CT2	White	1200	26	24.00"	48.00"	4.25"
Polyethelene	CT5	Orange	2000	60	42.00"	52.00"	6.00"

Noco® Acid Containment Trays



CT1
Fiberglass Acid Containment Tray, 18 gal.

Noco Acid Containment Trays effectively collect electrolyte from used or damaged batteries. Features a large reservoir that contains up to 18 gallons of electrolyte and a heavy-duty frame that withstands up to 2500 lbs of pressure. Resists corrosion, moisture and other harsh contaminants.



CT2
Fiberglass Acid Containment Tray, 9 gal.



Features
pallet jack entry
holes

CT5, Polyethelene Acid Containment Tray, 15 gal.

BATTERY STORAGE

Noco® Battery Hold-Downs

Noco Battery Hold-Downs are designed to securely mount batteries to prevent movement or shifting.

Standard Hold-Downs are made of heavy-duty steel and coated in vinyl to protect against corrosion.

Offset Adjustable Hold-Downs are made from a heavy-duty injection molded polypropylene plastic that resists corrosion.

Universal Hold-Down Bolts are a steel threaded bolt with zinc plating to help secure batteries from movement.



Add "CS" to the part number for clamshell or "C" for carded package. **Yellow Dot** indicates products available in clamshell. **Blue Dot** indicates products available on card. **Red Dot** indicates this product available in "Retail Packaging Only"



HD203, Side/End Battery Hold-Down



HD304, Base Mount Battery Hold-Down



HD405, Crossbar Battery Hold-Down



HD406, Crossbar Battery Hold-Down with Slide Groove

	Part No.	Description	Color/Style
Standard	• HD203	Side/End Battery Hold-Down	■ Red
	• HD304	Base Mount Battery Hold-Down	■ Red
	• HD405	Crossbar Battery Hold-Down	■ Red
	HD406	Crossbar Battery Hold-Down w/ Slide Groove	■ Black
	• HD504	Rubberized Battery Hold-Down	■ Black
	• HD605	Frame Hold-Down	■ Red
	HD706	Hold-Down Bar w/ Dual Eyelets	■ Black
	HD807	Hold-Down Bar w/Dual Eyelets & Mounting Bracket	■ Black
Bolts	• HB102	8" x 1/4" - 16 UNC	J Style
	• HB201	10" x 1/4" - 16 UNC	J Style
	• HB302	12" x 1/4" - 16 UNC	J Style
	• HB403	8" x 1/4" - 16 UNC	L Style
	HB504	10" x 3/8" - 16 UNC	J Style
Adjustable	• HD588	Adjusts from 5-1/4" to 7-1/2"	■ Black



HB201
1/4" Hold-Down Bolt



HD605, Frame Hold-Down



HD504
Rubberized Battery Hold-Down



HD706, Hold-Down Bar with Eyelets

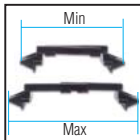
Offset Adjustable Hold-Down Features:



Superior Construction
Fabricated from fiberglass-reinforced polypropylene for extreme durability & corrosion resistance.



Non-Conductive Hold-Down
Manufactured from a non-conduction material to permit safe mounting of batteries.



Adjustable
Easily adjusts to accommodate different battery widths.



HD588, Offset Adjustable Battery Hold-Down



HD807, Hold-Down Bar with Mounting Bracket





COOPER CAMERON VALVES

OPERATION AND MAINTENANCE MANUAL

NUTRON BALL VALVE

Model T3

1/2" FP – 4" RP 150# - 2500#

1/4" FP – 4" RP 1000 WOG – 6000 WOG

FLANGED, FNPT and WELD END

For technical questions, please contact the following:

Engineering Department

2125 - 64 Avenue

Edmonton, Alberta

T6P 1Z4

Phone: (780) 468-2732

Fax: (780) 450-1359

OPERATION

The Nutron Model T3 ball valve is a floating ball, quarter turn valve designed for shut off service. The ball valve construction is a three piece threaded design. The handle direction corresponds with the valve position. When the handle is inline with the body, the valve is open and if at a right angle to the body, the valve is closed. The valve should be operated until the capscrew head travel stop limits the handle's movement. Operating the valve in a partially open or partially closed position will damage and/or shorten the life of the valve seats.

Due to the critical nature of pressurized piping systems it is recommended that the compatibility to the service of the metallic and non-metallic components be confirmed prior to installation.

CAUTION

READ CAREFULLY BEFORE INSTALLING OR OPERATING THE VALVE

Hazards are inherent with the construction, operation and maintenance of high pressure piping systems. The following information and precautions are provided to minimize these hazards:

- 1. The valve's nameplate indicates maximum operating pressure, as well as minimum and maximum operating temperatures. The valve may be safely operated within these limits.*
- 2. The valve's end connections are provided in accordance with ASME flanged end, threaded end or weld end requirements.*
- 3. T3 valves are firesafe, and are in accordance with API 607 requirements.*
- 4. The valve has been factory pressure tested based on the nameplate maximum operating pressure.*
- 5. The valves may be lifted using slings. Fittings and other devices, which may be attached to the valve, are not intended to be used as lifting points. Always follow local safety regulations when lifting heavy valves.*
- 6. Nutron valves are designed, manufactured and tested under a certified quality system. Only quality parts and materials are used in the assembly of Nutron valves. Pressure containing components are suitable for the minimum temperature marked on the nameplate. Factory certification is available. (Note: Some NPT valves may be marked only with maximum temperature.)*
- 7. If the valve, in service, is exposed to hazards such as traffic, wind or earthquake loading contact the factory, if it is necessary, to confirm that the valve design is suitable for the application. The factory requires a complete description of the hazard before making any recommendations.*
- 8. If the valve, in service, is exposed to hazards such as excessive piping system reaction forces and moments contact the factory, if it is necessary, to confirm that the valve design is suitable for the application. The factory requires a complete description of the hazard before making any recommendations.*
- 9. If the valve, in service, is exposed to hazards such as corrosive or abrasive fluids or atmospheric conditions contact the factory, if it is necessary, to confirm that the valve design is suitable for the application. The factory requires a complete description of the hazard before making any recommendations.*
- 10. The valve has been designed and manufactured so that under normal operation conditions hazards such as material fatigue, brittle fracture, creep rupture or buckling*

- will not occur. Do not operate the valve beyond the pressures and temperatures marked on the nameplate. The factory requires a complete description of the hazard before making any recommendations.*
- 11. The user is responsible for minimizing other hazards associated with the construction, operation and maintenance of high pressure piping systems, such as:
 - a. Possibility of decomposition of unstable fluids*
 - b. Provisions for the release or blow off of pressure*
 - c. Prevention of physical access to system under pressure*
 - d. Prevention of physical access to surfaces at extreme temperature*
 - e. Provisions for inspection*
 - f. Provisions for draining and venting*
 - g. Provisions for filling*
 - h. Provision for equipment access*
 - i. Prevention of over-pressurization, over-heating and over-filling*
 - j. Provision for fault indication**
 - 12. The user is responsible for meeting applicable local safety regulations.*

INSTALLATION

All valves are shipped in the open position with protective covers on the end connections to prevent contaminants from entering the valve cavity and potentially damaging the ball or resilient seat surfaces during storage. The covers should be repaired or replaced if damaged and not removed until the valve is to be installed.

For handling the valve, proper slings and rigging procedures must be used. Attached fittings, gearboxes, actuators, handles and pipe handles are not to be used as lifting points. The valves should be rigged such that the slings safely clear all fittings, gearboxes, actuators, handles and pipe handles.

When installing the valve, it must remain in the fully open position to protect the seal surfaces of the ball from damage. Leave the valve in the open position and do not operate until the line has been thoroughly cleaned and flushed. Valves, which need to be positioned either fully opened or fully closed, can be locked in place with optional locking device.

The valve may be installed with flow in either direction. It may be positioned horizontally, vertically or at a gradient without impairing the operation of the valve.

Valves installed at the end of a line require that all appropriate and necessary safety practices be followed.

For actuated valves, please refer to the actuator manufacturer's specifications for the valve's orientation to ensure optimal performance.

If system hydrostatic tests are to be performed at pressures exceeding the rated working pressure of the valve, the ball should be left in the partially opened position. This prevents seats from experiencing these pressures while the body cavity can accept up to 150% rated working pressure.

After pressure tests, with the valve in the half open position and all test pressure relieved, the body cavity should be completely drained via the attached piping system to prevent corrosion. The valve may then be placed in the required operating position.

Flanged Connections

Care must be taken not to damage the flange seal faces and that they are clean for assembly. The end-user must provide gaskets and mating flanges of equal ratings to that of the valve for proper installation. When bolting the flanges together, bolt threads should be lubricated to obtain maximum loading on the bolts. The bolts should be tightened using a criss-cross pattern for even loading. When ring type joints are supplied the ring number is marked on the rim of the RTJ flange.

MAINTENANCE

CAUTION: *Safety practices for pressurized equipment must be followed and address hazards inherent in pressurized systems. Extreme caution and safety procedures are to be exercised whenever a valve, or fitting in a valve, are serviced or maintained. The valve requires no periodic maintenance. If the valve leaks by the stem seal (Key 9), tighten both capscrews (Key 13) equally to re-compress the stem packing.*

TOOLS REQUIRED FOR DISASSEMBLY AND ASSEMBLY

List for all valve sizes:

Allen Keys: 5/32, 3/16, 1/4 or 5/16

Wrench sizes for handle nuts: 7/16, 1/2, 11/16 or 15/16

2-1/2" Chain Wrench or Vice

6" Screwdriver

20" Adjustable Wrench

Lubricant Jetlube KOPR-KOTE or equivalent

Loctite 549 or equivalent

DISASSEMBLY

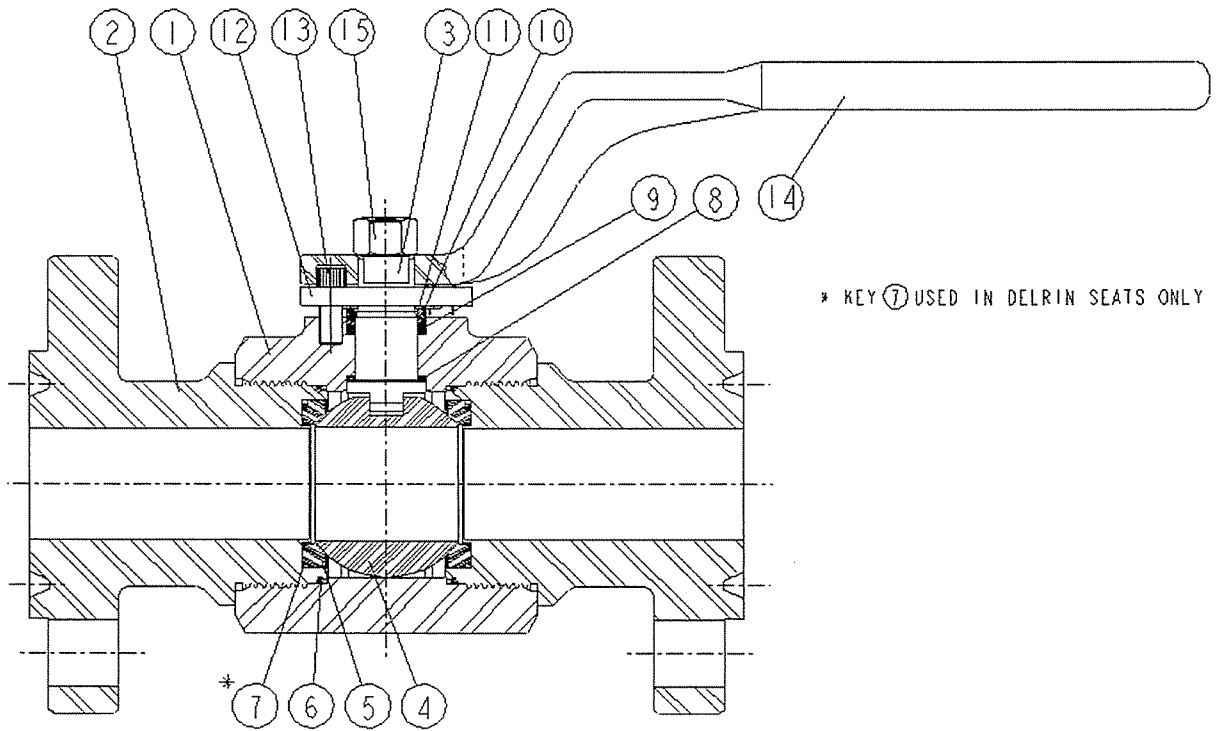
- 1. **CAUTION:** Before removal from the line and before disassembly isolate the valve from line pressure. With the valve in the half open position ensure all pressure is bled from the valve body via the attached piping system.*
- 2. Remove handle capscrew (Key 15) or nut followed by the handle (Key 14).*
- 3. Remove the gland flange capscrews (Key 13), gland flange (Key 12), Belleville washer (Key 11), and packing follower (Key 10) from the valve.*
- 4. For flange connections, scribe line-up marks on the body and caps. Mark the caps to determine which side of the valve they are removed from. This ensures the caps are fully tightened upon reassembly and installed on proper side.*
- 5. Unscrew 1st cap (Key 2) from the body (Key 1). Remove the body seal (Key 6), seat (Key 5) and seat seal¹ (Key 7) from cap (Key 2). NOTE: Heat may be required to remove cap from body as Loctite was used in assembling the valve.*
- 6. Remove the ball (Key 4) from the valve. The ball must be in the closed position.*
- 7. Remove the stem (Key 3), stem packing (Key 9) and the stem thrust washer (Key 8) from the body (Key 1).*

8. *Clean and inspect all components for wear and/or damage:*
 - ~ *replace ball if it has nicks, pits, or scars in the sealing areas or if damage has occurred where the stem inserts into the ball*
 - ~ *replace seats if there are nicks, cuts, or deformation of the sealing surface*
 - ~ *inspect thrust washer (Key 8) for wear or damage*
 - ~ *remove all o-rings and replace if broken, nicked, stretched, swollen, hard, brittle or sticky*

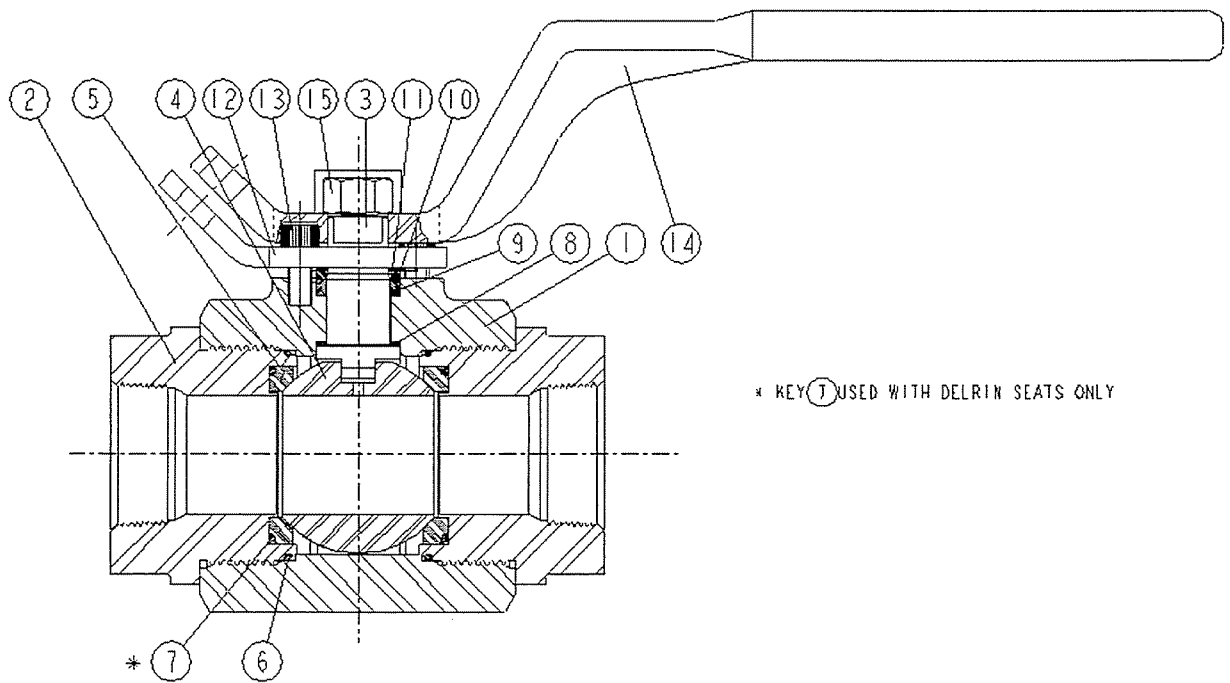
ASSEMBLY

1. *Ensure all components for the assembly are clean of dirt and contaminants. Install seats (Key 5) and seat seals¹ (Key 7), if required, on to the end connections. Ensure that the correct sealing surface of the seat is facing the ball. Apply a compatible light grease to the seat or seat/o-ring assembly, and its mating bore.*
2. *Install body seal (Key 6) onto 1st cap and apply grease to seal. Apply Loctite to the threads of the cap and screw cap fully into the valve body. Tighten with chain wrench, on flanged ends, until scribed line of body and cap are lined up.*
3. *Apply Jetlube KOPR-KOTE or equivalent to stem (Key 3). Place the thrust washer (Key 8) on the stem (Key 3) and insert into the valve body (Key 1).*
4. *Install the ball (Key 4) into the valve body. NOTE: Ball to be in closed position when tightening caps.*
5. *Install body seal (Key 6) on 2nd cap and grease the seal.*
6. *Screw the cap (Key 2) fully onto the valve body and tighten with a chain wrench, on flanged ends, until scribed line of body and cap line up.*
7. *Place the stem packing (Key 9) followed by the packing follower (Key 10) on the valve stem (Key 3).*
8. *Place the belleville washer (Key 11) on the valve stem. Ensure the washer is installed correctly.*
9. *Install the gland flange (Key 12) and capscrews (Key 13) and tighten equally until the belleville washer is flattened fully. Ensure that the gland flange is installed so that the valve closes clockwise. When necessary, gland flange may be turned 90 degrees to allow clockwise opening of the valve.*
10. *Place the handle (Key 14) on the valve stem and secure with the handle nut (Key 15).*
11. *Ensure valve operates properly and leave in the full open position.*
12. *Valve should be tested to the appropriate specifications.*

¹ *Only applicable in some Delrin Seated Valves*



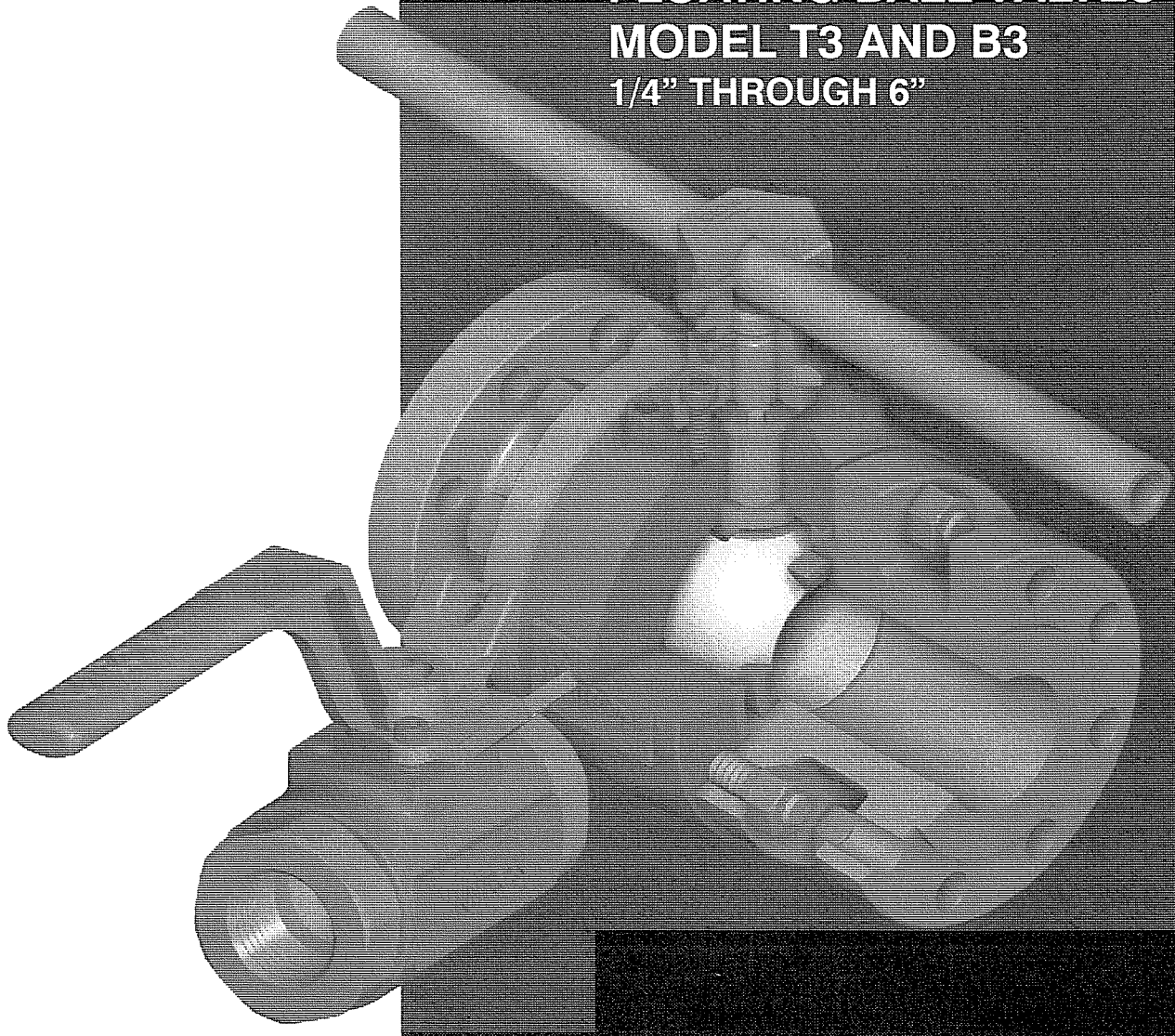
Nutron - T3 Ball Valve – Flanged



Nutron - T3 Ball Valve – FNPT

NUTRON[®]

**FORGED STEEL
FLOATING BALL VALVES
MODEL T3 AND B3
1/4" THROUGH 6"**



NUTRON[®] Industries

NUTRON®

NUTRON® Industries is a long established and recognized manufacturer and supplier of valve products to industrial markets around the world.

NUTRON® brand ball valves, API 6D swing check valves, chokes and NAVCO® brand gate, globe and check valves are products used by our customers in oil, gas, petrochemical, refinery, pipeline, pulp and paper, mining and other industrial applications.

For many years, NUTRON® has developed an ability to meet customer requirements for custom valve products for critical and corrosive service utilizing special stainless steel alloys.

NUTRON® Plastics supplies valve seats, thrust washers and flange protectors for NUTRON® brand ball valves.

As a policy and goal, all NUTRON® Industries products must reflect the highest quality standards. Their design, development, manufacturing and tested performance are of paramount importance. As a commitment to this policy and goal, we have constructed a fire test facility to test the fire safe features of our valve products.

The employees of NUTRON® Industries accept the responsibility that all products meet and exceed industry standards. Value for a high quality product is a priority.

NUTRON® and NAVCO® brand products are marketed around the world. NUTRON® Industries global presence includes distribution centers, sales offices and manufacturing facilities in Canada, the United States and various international locations, providing excellent technical support for our customers.

NUTRON® quality, value, performance and superior service - our commitment to you.

COMPLIANCE TO SPECIFICATIONS

ISO 9001: Registered Quality System

API 6A, 6D, 598, 607 4th Edition (Fire Safe), Q1 (Quality Specification)

ASME B16.34, B16.10

NACE MR0175 Sulfide Stress Cracking Resistant Metallic Materials for Oilfield Equipment

CSA Z245.15 Steel Valves

ASME Section VIII Division 1 Boiler and Pressure Vessel Code

Canadian Registration Number (CRN)



STANDARD FEATURES

CAP SCREWS

Dual purpose; allows for easy stem packing adjustment without handle removal while providing a stop for the handle.

PACKING

Self-adjusting by means of a Belleville washer. Allows for long service life before manual packing adjustment is necessary.

BALL

The floating ball design allows for positive shut-off in either flow direction. Includes pressure equalization hole to prevent trapping of pressure in the body cavity.

BODY SEALS

Body seal O-rings are placed ahead of the body cap threads to protect the threads from the flow media.

STEM

Blowout-proof stem is back-seated through the valve body.

THRUST WASHER

Acts as a bearing between the body and stem.

SEATS

Materials available are Teflon[®], Delrin[®], PEEK and Devlon[®].

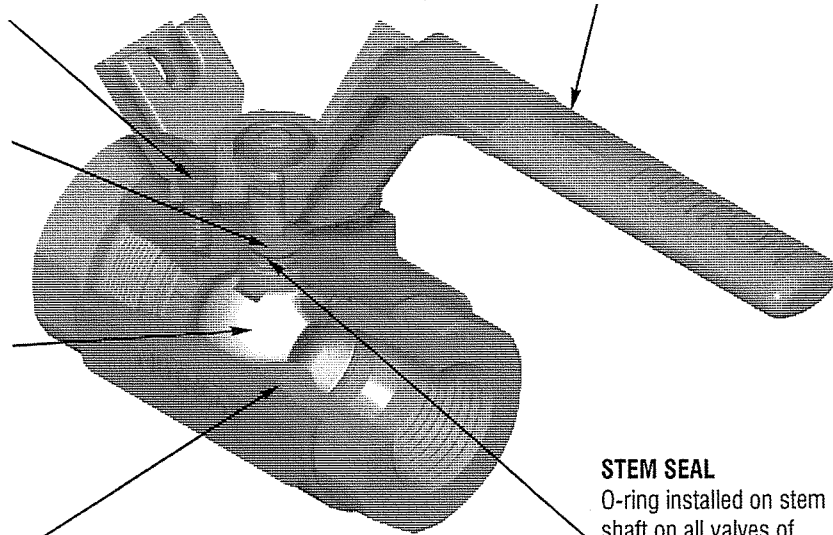
BODY CONSTRUCTION

Forged steel three-piece threaded (T3) or bolted (B3) construction. A machined pad area is drilled and tapped for actuation as a standard. Threaded and bolted construction allows for combinations of end connections.

HANDLE

Rugged cast handle for long life. Handle position indicates flow position. When the handle is positioned in line with the pipe, the valve is open. When the handle is positioned perpendicular to the pipe, the valve is closed. Locking handle is standard for all 2" reduced bore and smaller valves with either socket weld or FNPT end connections.

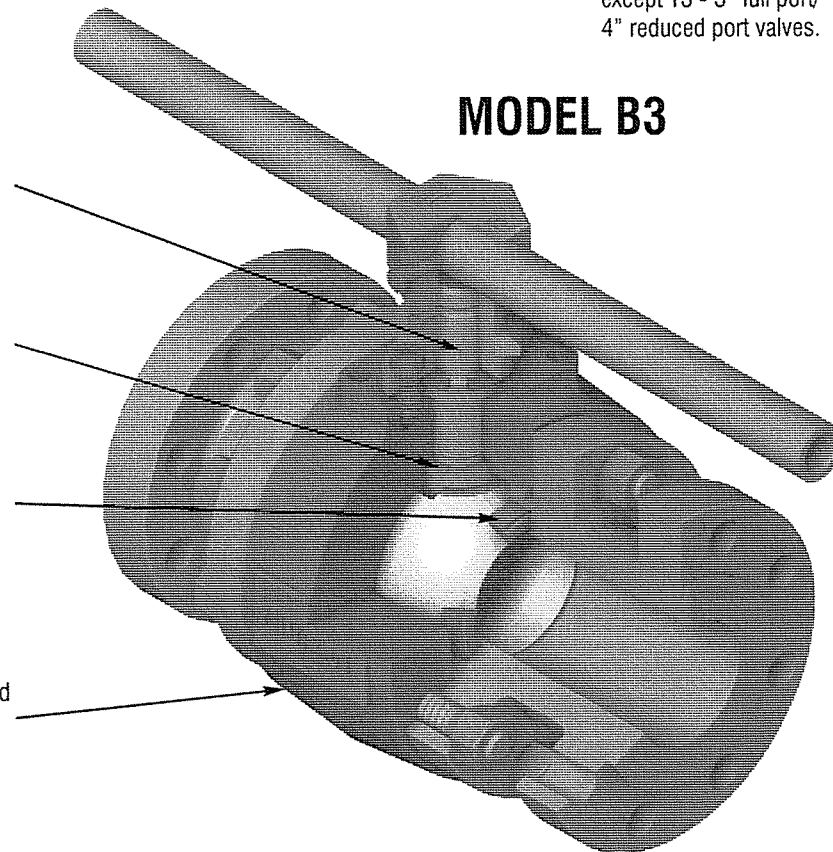
MODEL T3



STEM SEAL

O-ring installed on stem shaft on all valves of 1 1/2" and larger bores except T3 - 3" full port/4" reduced port valves.

MODEL B3

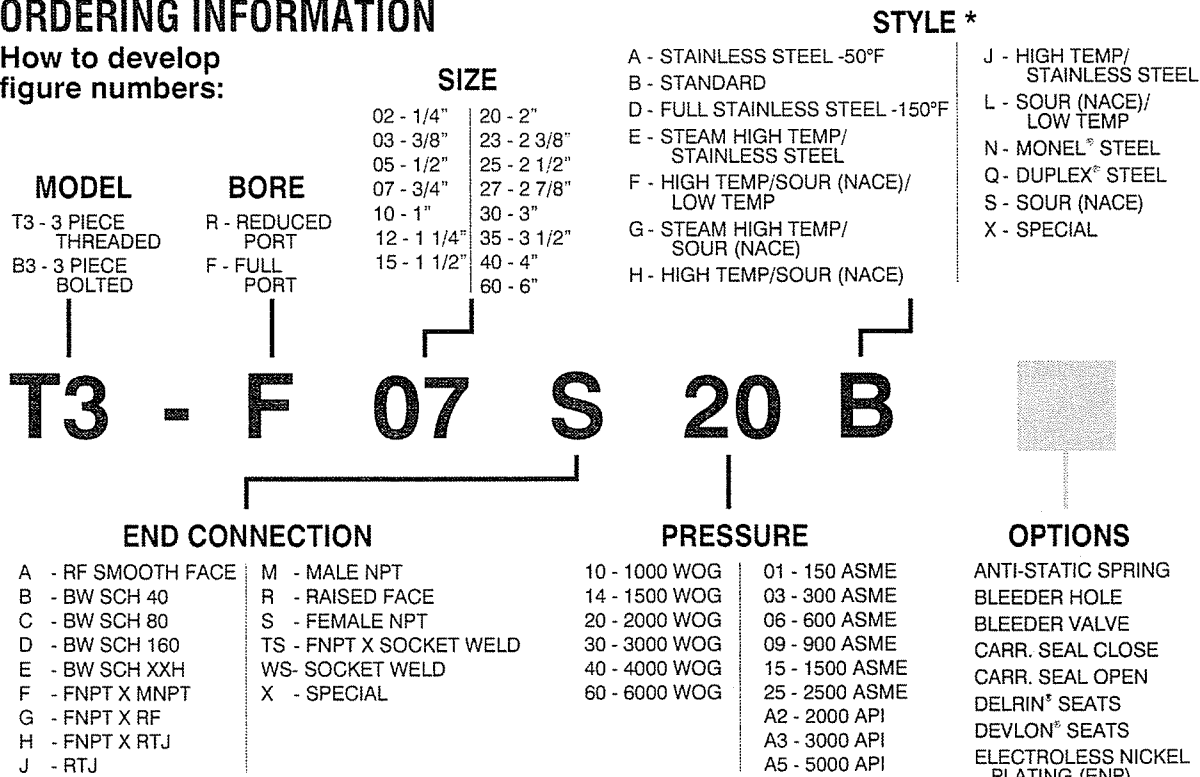


SIZES AVAILABLE (INCHES)

ASME CLASS	150	300	600	900	1500	2500
T3 - Full Port	1/2 thru 3	1/2 thru 3	1/2 thru 2	1/2 thru 2	1/2 thru 2	1/2 thru 2
T3 - Reduced Port	3/4 thru 4	3/4 thru 4	3/4 thru 3	3/4 thru 3	3/4 thru 3	3/4 thru 3
B3 - Full Port	4	4	2, 3	2, 3	2, 3	
B3 - Reduced Port	6	6	3, 4	3, 4	3, 4	
WOG	1000	2000	3000	4000	6000	
T3 - Full Port, Threaded		3	1/4 thru 3	1/4 thru 2	1/4 thru 2	1/4 thru 2
T3 - Reduced Port, Threaded		4	3/4 thru 3	3/4 thru 3	3/4 thru 3	3/4 thru 3
T3 - Full Port, Socket Weld			1/2 thru 2	1/2 thru 2	1/2 thru 2	1/2 thru 2
T3 - Reduced Port, Socket Weld			3/4 thru 3	3/4 thru 3	3/4 thru 3	3/4 thru 2
B3 - Full Port, Threaded			3		3	
B3 - Reduced Port, Threaded			4			

ORDERING INFORMATION

How to develop figure numbers:



Examples:

- T3-F07S20B = Model T3, Full Port, 3/4", Female NPT, 2000 WOG, Standard Valve.
- B3-R40R06L = Model B3, Reduced Port, 4", Raised Face Flanges, 600 ASME, Sour (NACE)/Low Temp Valve.
- T3-R10TS30S = Model T3, Reduced Port, 1", Female NPT x Socket Weld, 3000 WOG, Sour (NACE) Valve.

* Consult NUTRON® Industries Sales Department for detailed valve style descriptions, full range of options, materials, actuation packages or for a particular special valve service application.

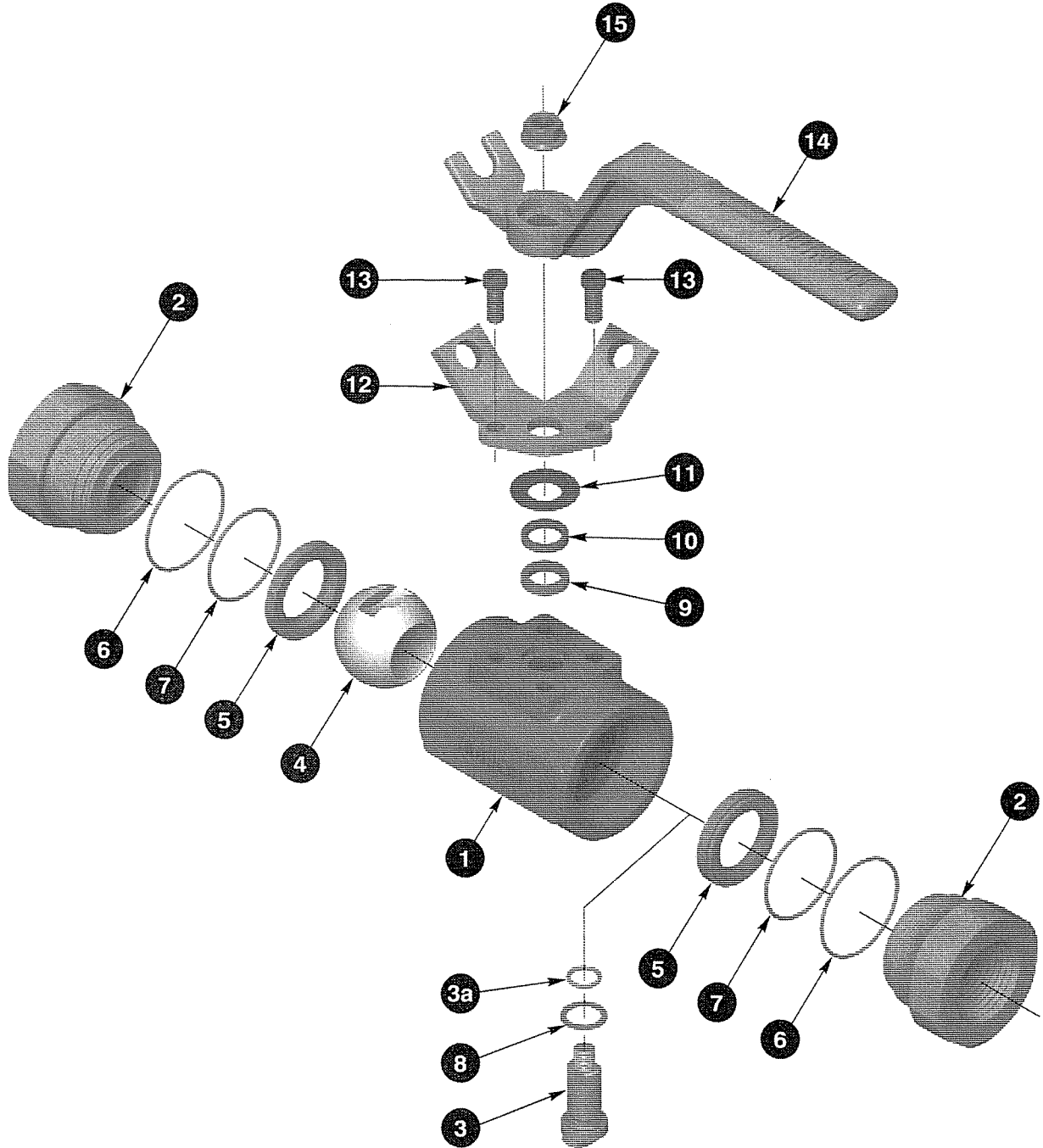
NUTRON® reserves the right to substitute materials listed on the fore-mentioned pages with alternate materials for the designated service.

NUTRON®
 T3/B3-01/02-AP-3M



FLOATING BALL VALVE

THREADED END CONNECTIONS





MATERIALS LIST - THREADED END CONNECTIONS

ITEM	PART	WORKING PRESSURE	STANDARD	SOUR (NACE)
1	Body	All	ASTM A105	ASTM A105
2	End Caps	All	ASTM A105	ASTM A105
†	3	2000 & 3000 4000 & 6000	ASTM A108, Plated ASTM A564 17-4 PH	ASTM A564 17-4 PH ASTM A564 17-4 PH
**	3a*	2000, 3000 & 4000 6000	Nitrile HSN	Viton HSN
†	4	2000, 3000 & 4000 6000	ASTM A576 CHR. PL. ASTM A564 17-4 PH	ASTM A351 Gr. CF8M ASTM A564 17-4 PH
**	5	2000 3000 & 4000 6000	Teflon Delrin PEEK	Teflon Delrin PEEK
**	6	2000, 3000 & 4000 6000	Nitrile Teflon	Viton Teflon
**	7	3000 & 4000	Nitrile	Viton
**	8	2000 3000 & 4000 6000	Teflon Delrin PEEK	Teflon Delrin PEEK
**	9	All	Teflon	Teflon
	10	All	Carbon Steel, Plated	Stainless Steel
	11	All	Carbon Steel	Stainless Steel
	12	All	Carbon Steel, Plated	Carbon Steel, Plated
	13	All	Carbon Steel	Stainless Steel
	14	All	Carbon Steel	Carbon Steel
	15	All	Carbon Steel, Plated	Carbon Steel, Plated

ITEM	PART	WORKING PRESSURE	SOUR (NACE) & LOW TEMP	STAINLESS STEEL -50°F
1	Body	All	ASTM A350 LF2	ASTM A479 TYPE 316
2	End Caps	All	ASTM A350 LF2	ASTM A479 TYPE 316
†	3	All	ASTM A564 17-4 PH	ASTM A564 17-4 PH
**	3a*	2000, 3000 & 4000 6000	Viton HSN	HSN HSN
†	4	2000, 3000 & 4000 6000	ASTM A351 Gr. CF8M ASTM A564 17-4 PH	ASTM A351 Gr. CF8M ASTM A564 17-4 PH
**	5	2000 3000 & 4000 6000	Teflon Delrin PEEK	Teflon PEEK PEEK
**	6	2000, 3000 & 4000 6000	Viton Teflon	Teflon Teflon
**	7	3000 & 4000	Viton	N/A
**	8	2000 3000 & 4000 6000	Teflon Delrin PEEK	Teflon PEEK PEEK
**	9	All	Teflon	Teflon
	10	All	Stainless Steel	Stainless Steel
	11	All	Stainless Steel	Stainless Steel
	12	All	Carbon Steel, Plated	Carbon Steel, Plated
	13	All	Stainless Steel	Stainless Steel
	14	All	Carbon Steel	Carbon Steel
	15	All	Carbon Steel, Plated	Carbon Steel, Plated

* Item 3a is only available on bore sizes 1 1/2" and larger except 3" full port/4" reduced port valves.

** Locking device standard on 1/4" to 2" RP. Consult NUTRON® Industries Sales Department for fire safe trim.

† Major repair kit.

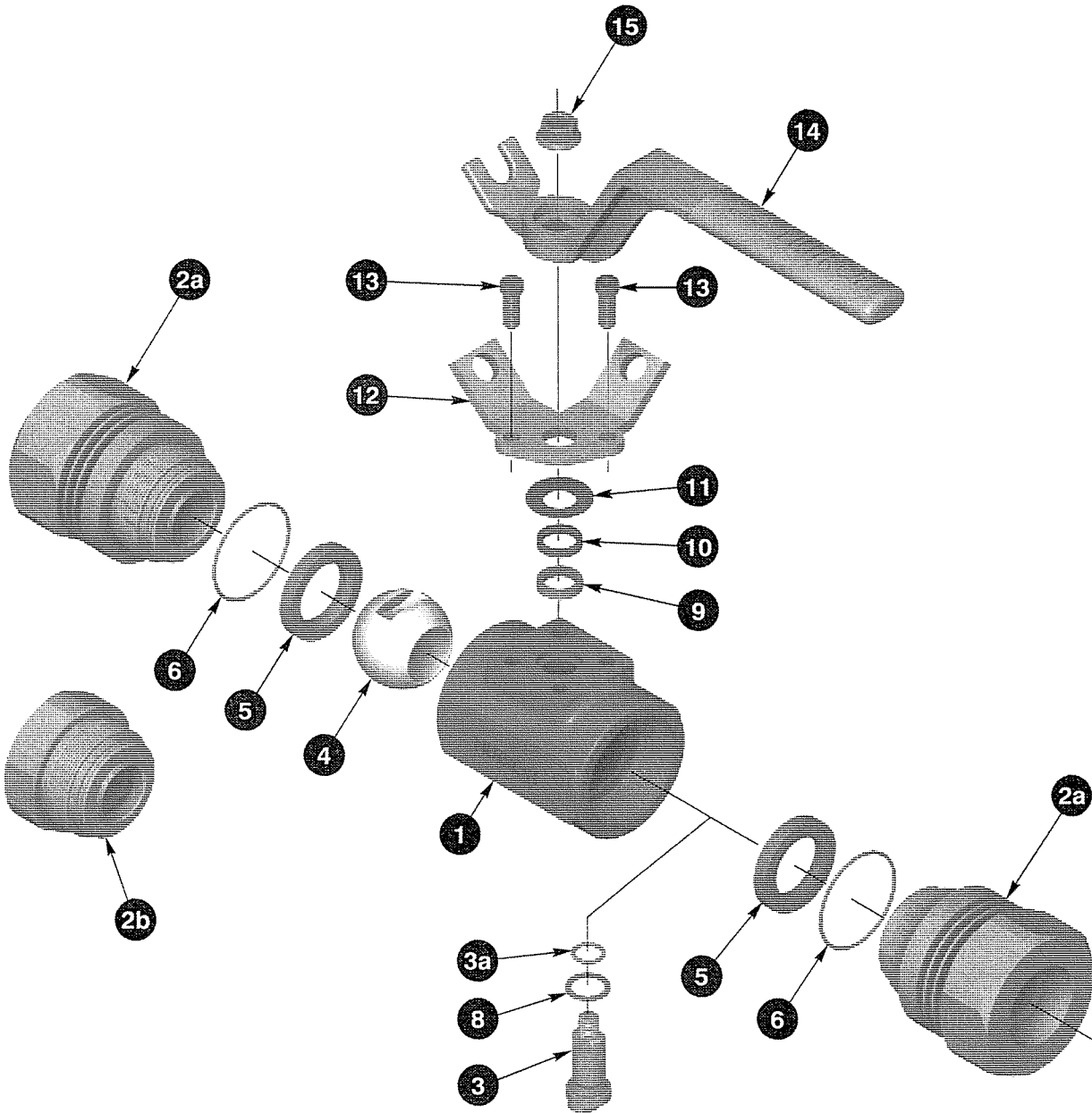
‡ Minor repair kit.

NUTRON®
T3/B3-01/02-AP-3M



FLOATING BALL VALVE

SOCKET WELD or THREADED x SOCKET WELD END CONNECTIONS





MATERIALS LIST - SOCKET WELD or THREADED x SOCKET WELD END CONNECTIONS

ITEM	PART	WORKING PRESSURE	STANDARD	SOUR (NACE)
1	Body	All	ASTM A105	ASTM A105
2a	End Caps - SW	All	ASTM A350 Gr. LF2	ASTM A350 Gr. LF2
2b	End Cap - NPT	All	ASTM A105	ASTM A105
* 3	Stem	2000 & 3000 4000 & 6000	ASTM A108, Plated ASTM A564 17-4 PH	ASTM A564 17-4 PH ASTM A564 17-4 PH
** 3a*	Stem O-Ring	All	HSN	HSN
† 4	Ball	2000 3000, 4000 & 6000	ASTM A351 Gr. CF8M ASTM A564 17-4 PH	ASTM A351 Gr. CF8M ASTM A564 17-4 PH
** 5	Seats	2000 3000, 4000 & 6000	Teflon PEEK	Teflon PEEK
** 6	Body O-Rings	All	Teflon	Teflon
** 8	Thrust Washer	2000 3000, 4000 & 6000	Teflon PEEK	Teflon PEEK
** 9	Packing	All	Teflon	Teflon
10	Packing Follower	All	Carbon Steel, Plated	Stainless Steel
11	Belleville Washer	All	Carbon Steel	Stainless Steel
12	Gland Flange **	All	Carbon Steel, Plated	Carbon Steel, Plated
13	Cap Screws	All	Carbon Steel	Stainless Steel
14	Handle	All	Carbon Steel	Carbon Steel
15	Handle Nut	All	Carbon Steel, Plated	Carbon Steel, Plated

ITEM	PART	WORKING PRESSURE	SOUR (NACE) & LOW TEMP	STAINLESS STEEL -50°F
1	Body	All	ASTM A350 LF2	ASTM A479 TYPE 316
2a	End Caps - SW	All	ASTM A350 LF2	ASTM A479 TYPE 316 L
2b	End Cap - NPT	All	ASTM A350 LF2	ASTM A479 TYPE 316
* 3	Stem	All	ASTM A564 17-4 PH	ASTM A564 17-4 PH
** 3a*	Stem O-Ring	All	HSN	HSN
† 4	Ball	2000 3000, 4000 & 6000	ASTM A351 Gr. CF8M ASTM A564 17-4 PH	ASTM A351 Gr. CF8M ASTM A564 17-4 PH
** 5	Seats	2000 3000, 4000 & 6000	Teflon PEEK	Teflon PEEK
** 6	Body O-Rings	All	Teflon	Teflon
** 8	Thrust Washer	2000 3000, 4000 & 6000	Teflon PEEK	Teflon PEEK
** 9	Packing	All	Teflon	Teflon
10	Packing Follower	All	Stainless Steel	Stainless Steel
11	Belleville Washer	All	Stainless Steel	Stainless Steel
12	Gland Flange **	All	Carbon Steel, Plated	Carbon Steel, Plated
13	Cap Screws	All	Stainless Steel	Stainless Steel
14	Handle	All	Carbon Steel	Carbon Steel
15	Handle Nut	All	Carbon Steel, Plated	Carbon Steel, Plated

* Item 3a is only available on bore sizes 1 1/2" and larger.

** Locking device standard on 1/4" to 2" RP. Consult NUTRON[®] industries Sales Department for fire safe trim.

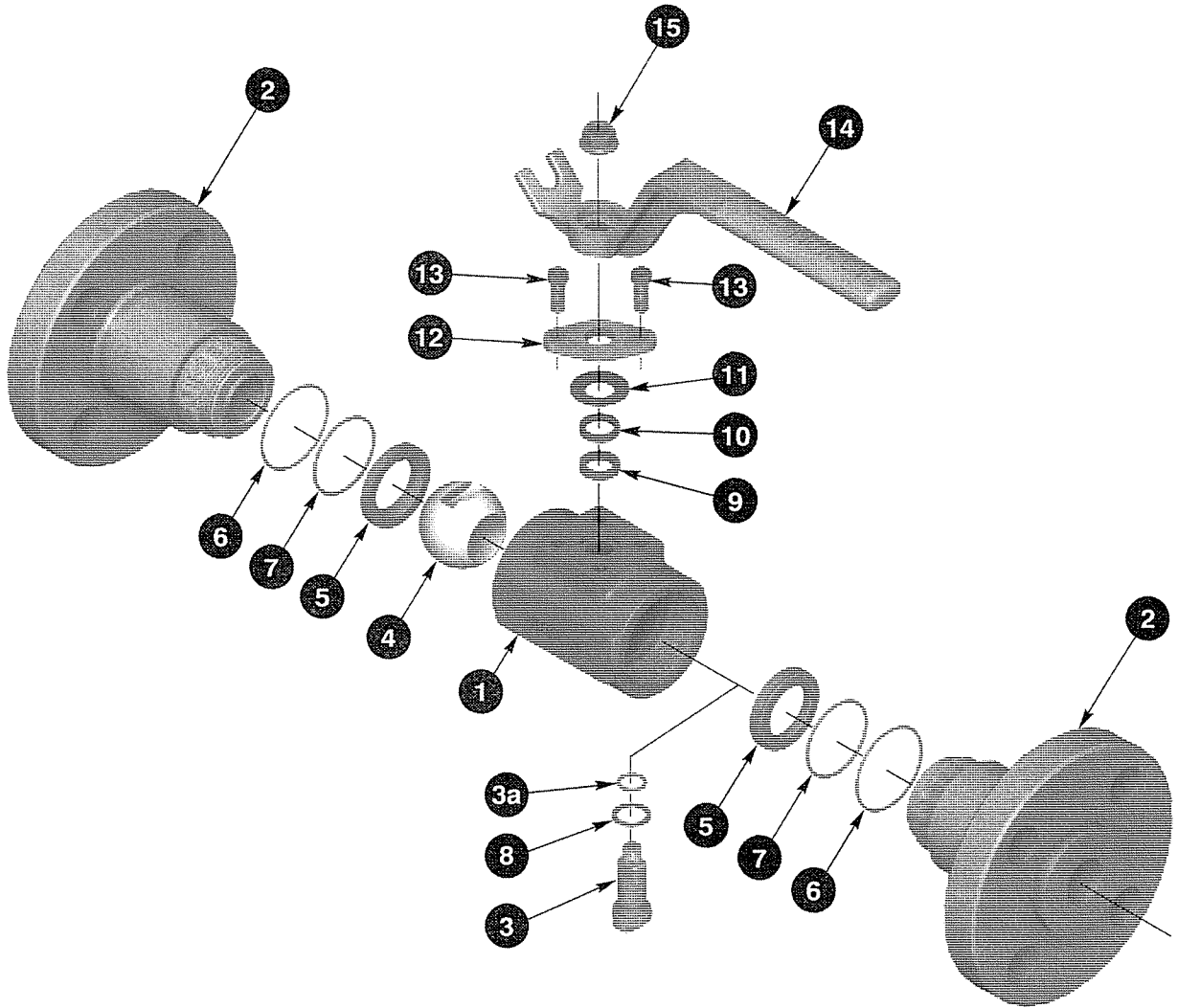
† Major repair kit.

‡ Minor repair kit.



FLOATING BALL VALVE

FLANGED END CONNECTIONS





MATERIALS LIST - FLANGED END CONNECTIONS

ITEM	PART	ASME CLASS	STANDARD	SOUR (NACE)
1	Body	All	ASTM A105	ASTM A105
2	End Caps	All	ASTM A105	ASTM A105
† 3	Stem	150, 300, 600 & 900 1500 & 2500	ASTM A108, Plated ASTM A564 17-4 PH	ASTM A564 17-4 PH ASTM A564 17-4 PH
†† 3a*	Stem O-Ring	150 thru 1500 2500	Nitrile HSN	Viton HSN
† 4	Ball	150 thru 1500 2500	ASTM A576 Gr. 1020 H. CHR. PL. ASTM A564 17-4 PH	ASTM A351 Gr. CF8M ASTM A564 17-4 PH
†† 5	Seats	150 thru 1500 2500	Delrin PEEK	Delrin PEEK
†† 6	Body O-Rings	150 thru 1500 2500	Nitrile Teflon	Viton Teflon
†† 7	Seat O-Rings	150 thru 1500	Nitrile	Viton
†† 8	Thrust Washer	150 thru 1500 2500	Delrin PEEK	Delrin PEEK
†† 9	Packing	All	Teflon	Teflon
10	Packing Follower	All	Carbon Steel, Plated	Stainless Steel
11	Belleville Washer	All	Carbon Steel	Stainless Steel
12	Gland Flange	All	Carbon Steel, Plated	Carbon Steel, Plated
13	Cap Screws	All	Carbon Steel	Stainless Steel
14	Handle	All	Carbon Steel	Carbon Steel
15	Handle Nut	All	Carbon Steel, Plated	Carbon Steel, Plated

ITEM	PART	ASME CLASS	SOUR (NACE) & LOW TEMP	STAINLESS STEEL -50°F
1	Body	All	ASTM A350 LF2	ASTM A479 TYPE 316
2	End Caps	All	ASTM A350 LF2	ASTM A479 TYPE 316
† 3	Stem	All	ASTM A564 17-4 PH	ASTM A564 17-4 PH
†† 3a*	Stem O-Ring	150 thru 1500 2500	Viton HSN	HSN HSN
† 4	Ball	150, 300 & 600 900 & 1500 2500	ASTM A351 Gr. CF8M ASTM A351 Gr. CF8M ASTM A564 17-4 PH	ASTM A351 Gr. CF8M ASTM A564 17-4 PH ASTM A564 17-4 PH
†† 5	Seats	150, 300 & 600 900 & 1500 2500	Delrin Delrin PEEK	Teflon PEEK PEEK
†† 6	Body O-Rings	150 thru 1500 2500	Viton Teflon	Teflon Teflon
†† 7	Seat O-Rings	150 thru 1500	Viton	N/A
†† 8	Thrust Washer	150, 300 & 600 900 & 1500 2500	Delrin Delrin PEEK	Teflon PEEK PEEK
†† 9	Packing	All	Teflon	Teflon
10	Packing Follower	All	Stainless Steel	Stainless Steel
11	Belleville Washer	All	Stainless Steel	Stainless Steel
12	Gland Flange	All	Carbon Steel, Plated	Carbon Steel, Plated
13	Cap Screws	All	Stainless Steel	Stainless Steel
14	Handle	All	Carbon Steel	Carbon Steel
15	Handle Nut	All	Carbon Steel, Plated	Carbon Steel, Plated

* Item 3a is only available on bore sizes 1 1/2" and larger except 3" full port/4" reduced port valves.
Consult NUTRON® Industries Sales Department for fire safe trim.
Teflon seat material available as an option on 150, 300 and 600 ASME.

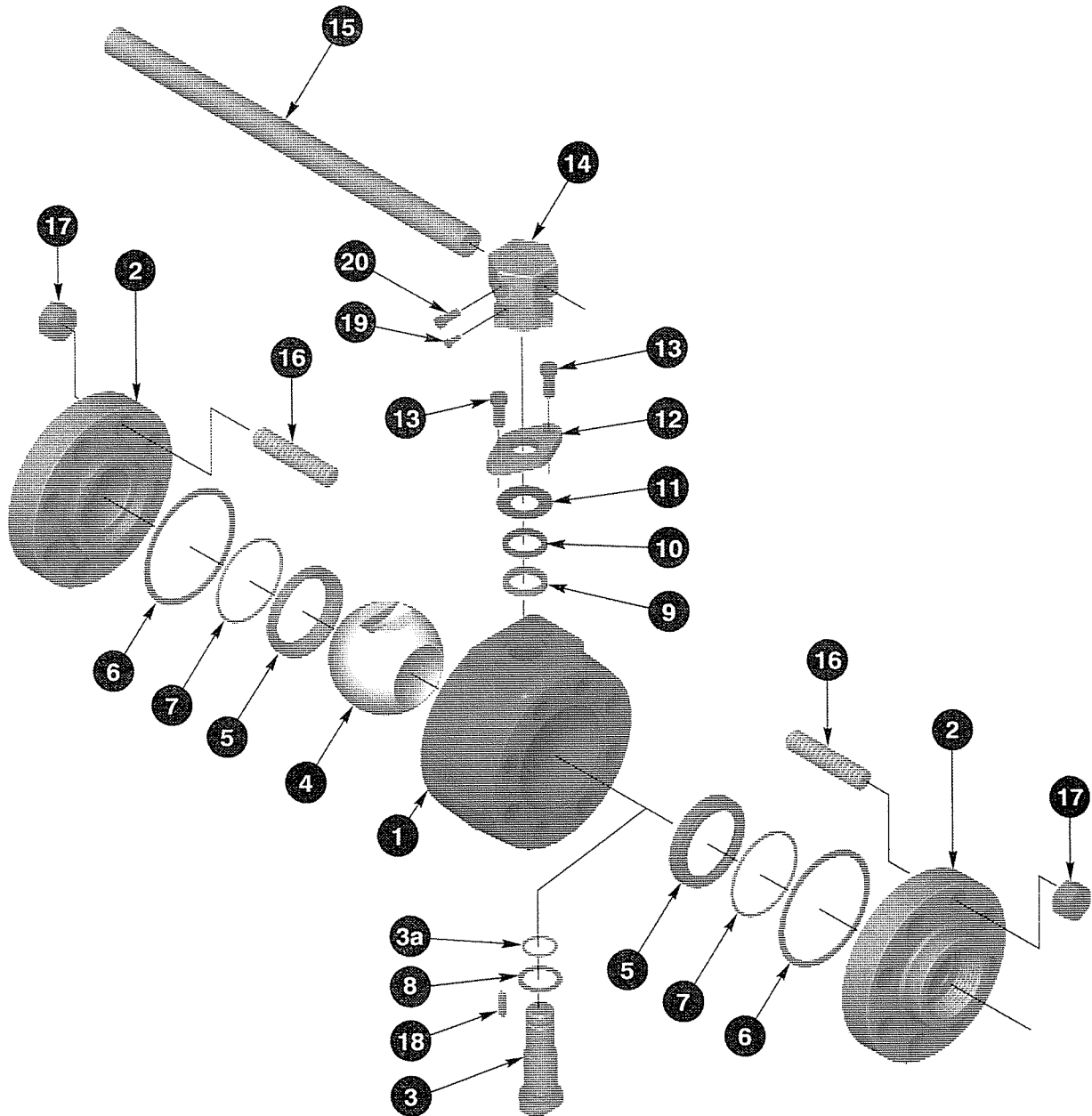
† Major repair kit.
‡ Minor repair kit.

NUTRON®
T3/B3-01/02-AP-3M



FLOATING BALL VALVE

THREADED END CONNECTIONS





MATERIALS LIST - THREADED END CONNECTIONS

ITEM	PART	WORKING PRESSURE	STANDARD	SOUR (NACE)
1	Body	All	ASTM A105	ASTM A105
2	End Caps	All	ASTM A105	ASTM A105
† 3	Stem	2000 & 4000	ASTM A322 Gr. 4130, Plated	ASTM A564 17-4 PH
†† 3a	Stem O-Ring	All	HSN	HSN
† 4	Ball	All	ASTM A675 CHR. PL.	ASTM A351 Gr. CF8M
†† 5	Seats	2000 4000	Teflon Delrin	Teflon Delrin
†† 6	Body Seals	All	Spiral Wound Gasket	Spiral Wound Gasket
†† 7	Seat O-Rings	4000	Nitrile	Viton
†† 8	Thrust Washer	2000 4000	Teflon Delrin	Teflon Delrin
†† 9	Packing	All	Graphite	Graphite
10	Packing Follower	All	Carbon Steel, Plated	Stainless Steel
11	Belleville Washer	All	Carbon Steel	Stainless Steel
12	Gland Flange	All	Carbon Steel, Plated	Carbon Steel, Plated
13	Cap Screws	All	Carbon Steel	Stainless Steel
14	Handle Nut	All	Carbon Steel	Carbon Steel
15	Pipe	All	Carbon Steel	Carbon Steel
16	Studs	All	ASTM A193 B7	ASTM A193 B7M
17	Nuts	All	ASTM A194 2H	ASTM A194 2HM
18	Key	All	Carbon Steel	Carbon Steel
19	Screw	All	Carbon Steel, Plated	Carbon Steel, Plated
20	Screw	All	Carbon Steel, Plated	Carbon Steel, Plated

ITEM	PART	WORKING PRESSURE	SOUR (NACE) & LOW TEMP	STAINLESS STEEL -50°F
1	Body	All	ASTM A350 LF2	ASTM A479 TYPE 316
2	End Caps	All	ASTM A350 LF2	ASTM A479 TYPE 316
† 3	Stem	All	ASTM A564 17-4 PH	ASTM A564 17-4 PH
†† 3a	Stem O-Ring	All	HSN	HSN
† 4	Ball	All	ASTM A351 Gr. CF8M	ASTM A351 Gr. CF8M
†† 5	Seats	2000 4000	Teflon Delrin	Teflon PEEK
†† 6	Body Seals	All	Spiral Wound Gasket	Spiral Wound Gasket
†† 7	Seat O-Rings	4000	Viton	N/A
†† 8	Thrust Washer	2000 4000	Teflon Delrin	Teflon PEEK
†† 9	Packing	All	Graphite	Graphite
10	Packing Follower	All	Stainless Steel	Stainless Steel
11	Belleville Washer	All	Stainless Steel	Stainless Steel
12	Gland Flange	All	Carbon Steel, Plated	Carbon Steel, Plated
13	Cap Screws	All	Stainless Steel	Stainless Steel
14	Handle Nut	All	Carbon Steel	Carbon Steel
15	Pipe	All	Carbon Steel	Carbon Steel
16	Studs	All	ASTM A320 L7M	ASTM A320 L7M, Coated
17	Nuts	All	ASTM A194 L7M	ASTM A194 L7M, Coated
18	Key	All	Carbon Steel	Carbon Steel
19	Screw	All	Carbon Steel, Plated	Carbon Steel, Plated
20	Screw	All	Carbon Steel, Plated	Carbon Steel, Plated

† Major repair kit.

†† Minor repair kit.



Type 1510 Electric Level Switch

Form 498

Type 1510 is a horizontally-mounted, float-operated level switch suitable for plant and OEM applications where open or closed contacts are required to signal presence or absence of liquid at a discrete level. The float extension arm moves a magnet which actuates (deactuates) a hermetically sealed reed switch. Actuation (deactuation) can be reversed by rotating the unit 180 degrees.

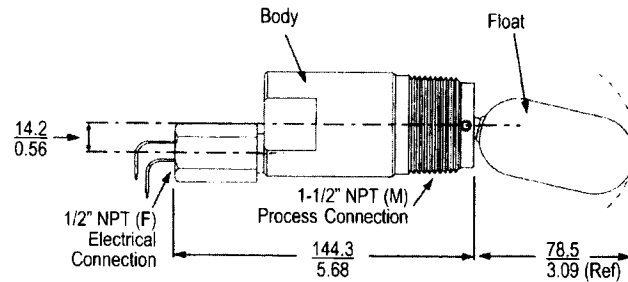


Product Specifications

Mounting (Half coupling only)	
Orientation	Horizontal mount only
Connection Size	1-1/2 NPT(M) Standard
For	Change
2 NPT(M)	G5A
G5A	G2A
Flanged Mounting ...	G5A
*See flange table on page 2 for option designator (316SS construction only)	
Maximum Process Pressure	1500 psi (100 bar)
Electrical	
Switch Type	Hermetically sealed reed switch with 18" 20 AWG wire leads
Switch Rating (resistive)	1 amp at 110 VAC 3 amps at 28 VDC
Housing	Class I, Group A, B, C & D; Div. 1 & 2
Relay Housing	Class I, Group C, D; Div. 1 & 2
Connection Size	1/2 NPT(F)
Contact Form	SPST
(For SPDT change W9 to W1 in the model number.)	
Minimum Specific Gravity	0.40
Design Code	ANSI B31.3
Shipping Weight	Approximately 6 pounds (3 kg)
Agency Listing	CSA Certified (optional). See Page 2.

Design and specifications are subject to change without notice.

Dimensions



Linear = $\frac{\text{mm}}{\text{in.}}$

How to Order

Select model number from table below. Accessory designator(s) may be added after ES if required. See Page 2.

Body Material	Float Material	Process Rating		Model Number
303SS* (Standard)	316SS (Standard)	1500 psi -40 to 400°F	100 bar	1510B-G5A-C-W9-ES
	Monel	900 psi -40 to 400°F	62 bar	1510B-G5A-M-W9-ES
	Polypropylene	5000 psi -40 to 150°F	345 bar	1510B-G5A-S-W9-ES
316SS	316SS	1500 psi -40 to 400°F	100 bar	1510C-G5A-C-W9-ES
	Monel	900 psi -40 to 400°F	62 bar	1510C-G5A-M-W9-ES
	Polypropylene	5000 psi -40 to 150°F	345 bar	1510C-G5A-S-W9-ES

*303SS is not recognized as an ANSI B31.3 approved material.

An ISO 9001 Registered Company

Optional Flanges (316SS) construction only)

Designator	Raised Face Flange	
G7C	2-1/2"	150#
G7D		300#
G7E		600#
G3C	3"	150#
G3D		300#
G3E		600#

Designator	Raised Face Flange	
G4C	4"	150#
G4D		300#
G6C	6"	150#
G6D		300#

On flanged units, the float will be detached from the unit during shipping.

*CS option is required on all flange mounted units.

Optional Accessories

Add option designator(s) to end of model number.

Designator	Description
BB	Wetted parts are cleaned for industrial oxygen service.
CR	3/4 NPT(F) conduit connection
CS	CSA Certified. Class I, Group A, B, C, D, Div 1 & 2. For relay option; Class I, Group C, D, Div 1 & 2.
NC	NACE construction - MR-01-75. Available only with 316SS materials of construction.
PP	Tag, fiber. Attached with plastic wire to housing. Stamped with customer specified tagging information.
RB	24 VDC Powered DPDT relay in explosion proof terminal box. Contact rating: 10 amps @115 VAC. (Class I, Group C, D; Div. 1 & 2)
RC	120 VAC Powered DPDT relay in explosion proof terminal box. Contact rating: 10 amps @115 VAC (Class I, Group C, D; Div. 1 & 2)
RR	Tag, stainless steel. Attached with stainless steel wire to housing. Stamped with customer specified tagging information
TT	Stainless steel nameplate permanently attached to housing. Stamped with customer specified tagging information
W	Fungicidal varnish. Covers exterior except working parts.
YY	Epoxy coating. Exterior only. Polyamide epoxy with 316SS pigment.
CZ	ANSI B31.3 certificate of conformance.

Replacement Parts

Part Number	Description
3130-091	SPST Hermetically Sealed Reed Switch Capsule
3130-242	SPDT Hermetically Sealed Reed Switch Capsule
3130-106	SPST Hermetically Sealed Reed Switch Capsule for CSA Certified units
3130-243	SPDT Hermetically Sealed Reed Switch Capsule for CSA Certified units
3130-052	316SS Float Assembly

Limited Warranty

SOR agrees to repair or replace any switch found to be defective in material or workmanship within five years from date of shipment. The limited warranty is valid only if the switch was installed in accordance with published factory installation instructions, operated within the design limitations stated on the nameplate, and returned to the factory for inspection, freight prepaid, within the warranty period. Contact the factory for return authorization. No claim for labor or consequential damages will be allowed.



SOR Form 498 (06.01) Printed in USA

14685 West 105th Street, Lenexa, Kansas 66215 913-888-2630 Fax 913-888-0767 www.sorinc.com

Plug Valves



P4T and P6T Series

- Working pressures up to 3000 psig (206 bar)
- Swagelok® tube fitting and NPT and ISO tapered pipe end connections
- 1/8 through 1/2 in. and 6 through 12 mm sizes
- Brass and 316 stainless steel materials

Swagelok

2 Plug Valves

Features

Swagelok plug valves offer low-torque, quarter-turn operation in a simple, compact design that provides positive shutoff of forward flow with up to 3000 psig (206 bar) pressure.

- Straight-through flow path
- Forward-flow throttling
- Simple design, easy to clean and maintain
 - One-piece body
 - Replaceable plug assembly
 - O-ring seal to atmosphere.

Pressure-Temperature Ratings^①

Series	P4T, P6T	P4T	P6T
Material	316 SS	Brass	
Temperature, °F (°C)	Working Pressure, psig (bar) ^②		
-10 (-23) to 100 (37)	3000 (206)	3000 (206)	2000 (137)
150 (65)	3000 (206)	2500 (172)	2000 (137)
200 (93)	3000 (206)	2000 (137)	2000 (137)
250 (121)	2000 (137)	1500 (103)	1500 (103)
300 (148)	1000 (68.9)	1000 (68.9)	1000 (68.9)
350 (176)	1000 (68.9)	1000 (68.9)	1000 (68.9)
400 (204)	1000 (68.9)	400 (27.5)	400 (27.5)

① Based on PTFE-coated fluorocarbon FKM O-rings.

② Differential pressure is limited to 150 psig (10.3 bar) maximum if reverse flow occurs. Reverse-flow throttling may damage O-ring.

Materials of Construction



Component	Valve Body Materials	
	316 SS	Brass
	Material Grade/ASTM Specifications	
1 Handle	Polyetherimide	
2 Pin	316 SS	
3 Plug	<i>PTFE-coated 316 SS/A479</i>	<i>PTFE-coated brass/B453</i>
4 O-rings	<i>PTFE-coated fluorocarbon FKM</i>	
5 Pin	316 SS	
6 Body	<i>316 SS/A479</i>	<i>Brass/B453</i>
7 Snap ring	PH 15-7 Mo [®] SS	
Lubricant	<i>Silicone-based</i>	

Wetted components listed in *italics*.

Flow Data at 70°F (20°C)

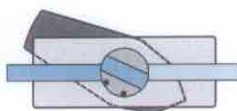
End Connections		C _v	Series	Pressure Drop to Atmosphere, psi (bar)					
				1 (0.068)	5 (0.34)	10 (0.68)	1 (0.068)	5 (0.34)	10 (0.68)
Inlet/Outlet	Size			Air Flow, std ft ³ /min (std L/min)			Water Flow, U.S. gal/min (L/min)		
Fractional Swagelok tube fittings	1/8 in.	0.10	P4T	0.3 (8.4)	0.8 (22)	1.1 (31)	0.1 (0.37)	0.2 (0.75)	0.3 (1.1)
	1/4 in.	1.6		6.0 (160)	13 (360)	18 (500)	1.6 (6.0)	3.6 (13)	5.1 (19)
	3/8 in.	1.1		4.1 (110)	8.9 (250)	12 (330)	1.1 (4.1)	2.5 (9.4)	3.5 (13)
		6.4	23 (650)	52 (1470)	72 (2030)	6.4 (24)	14 (52)	20 (75)	
Metric Swagelok tube fittings	1/2 in.	4.4	P6T	16 (450)	35 (990)	49 (1380)	4.4 (16)	9.8 (37)	13 (49)
	6 mm	1.6	P4T	6.0 (160)	13 (360)	18 (500)	1.6 (6.0)	3.6 (13)	5.1 (19)
	8 mm	6.4	P6T	23 (650)	52 (1470)	72 (2030)	6.4 (24)	14 (52)	20 (75)
	10 mm			17 (480)	39 (1100)	54 (1520)	4.8 (18)	10 (37)	15 (56)
Female NPT	12 mm	4.8							
	1/8 in.	1.2	P4T	4.4 (120)	9.7 (270)	13 (360)	1.2 (4.5)	2.7 (10)	3.8 (14)
	1/4 in.	0.9		3.3 (93)	7.3 (200)	10 (280)	0.9 (3.4)	2.0 (7.5)	2.8 (10)
		4.3	P6T	16 (450)	34 (960)	48 (1350)	4.3 (16)	9.6 (36)	13 (49)
Male NPT	1/2 in.	2.7		10 (280)	21 (590)	30 (840)	2.7 (10)	6.0 (22)	8.5 (32)
	1/8 in.	1.0	P4T	3.7 (100)	8.1 (220)	11 (310)	1.0 (3.7)	2.2 (8.3)	3.2 (12)
	1/4 in.			9.0 (250)	19 (530)	27 (760)	2.4 (9.0)	5.4 (20)	7.6 (28)
Male NPT/ Swagelok tube fitting	1/2 in.	2.4	P6T						
Male NPT/ Swagelok tube fitting	1/4 in.	0.9	P4T	3.3 (93)	7.3 (200)	10 (280)	0.9 (3.4)	2.0 (7.5)	2.8 (10)
Male/female NPT	1/4 in.	1.0		3.7 (100)	8.1 (220)	11 (310)	1.0 (3.7)	2.2 (8.3)	3.2 (12)
Female ISO	1/4 in.	0.9		3.3 (93)	7.3 (200)	10 (280)	0.9 (3.4)	2.0 (7.5)	2.8 (10)
	1/2 in.	2.7	P6T	10 (280)	21 (590)	30 (840)	2.7 (10)	6.0 (22)	8.5 (32)

Operation

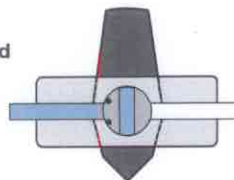
Open



Forward-Flow Throttling



Closed



Testing

Every Swagelok plug valve is factory tested for shutoff at 600 psig (41.3 bar).

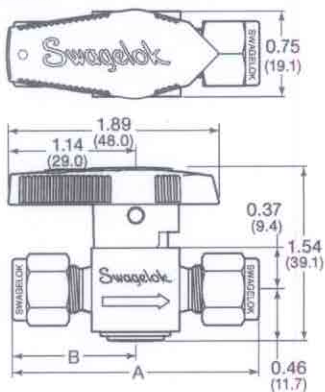
Cleaning and Packaging

Every Swagelok plug valve is cleaned and packaged in accordance with Swagelok standard cleaning and packaging specification (SC-10), MS-06-62.

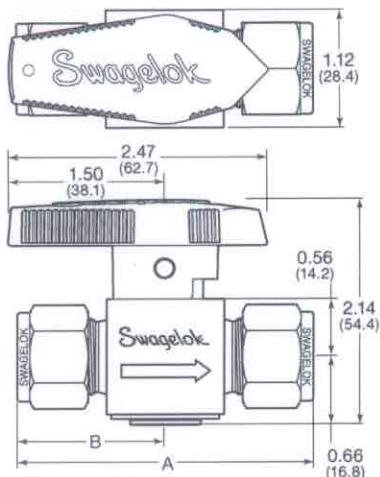
Ordering Information and Dimensions

Dimensions, in inches (millimeters), are for reference only and are subject to change.

P4T Series



P6T Series



End Connections		Ordering Numbers		Series	Dimensions, in. (mm)				
Inlet/Outlet	Size	Stainless Steel	Brass		Orifice	A	B		
Fractional Swagelok tube fittings	1/8 in.	SS-2P4T	B-2P4T	P4T	0.093 (2.3)	1.99 (50.5)	0.98 (24.9)		
	1/4 in.	SS-4P4T	B-4P4T			2.17 (55.1)	1.08 (27.4)		
	3/8 in.	SS-6P4T	B-6P4T			2.29 (58.2)	1.14 (29.0)		
		SS-6P6T	B-6P6T	P6T	0.283 (7.2)	2.66 (67.6)	1.33 (33.8)		
	1/2 in.	SS-8P6T	B-8P6T			2.88 (73.2)	1.44 (36.6)		
Metric Swagelok tube fittings	6 mm	SS-6P4T-MM	B-6P4T-MM	P4T	0.172 (4.4)	2.17 (55.1)	1.08 (27.4)		
	8 mm	SS-8P6T-MM	B-8P6T-MM	P6T		2.66 (67.6)	1.30 (33.0)		
	10 mm	SS-10P6T-MM	B-10P6T-MM			2.68 (68.1)	1.34 (34.0)		
	12 mm	SS-12P6T-MM	B-12P6T-MM			2.96 (75.2)	1.44 (36.6)		
Female NPT	1/8 in.	SS-2P4T4	B-2P4T4	P4T	0.172 (4.4)	1.78 (45.2)	0.89 (22.6)		
	1/4 in.	SS-4P4T4	B-4P4T4	P6T		0.283 (7.2)	2.09 (53.1)	1.05 (26.7)	
		SS-4P6T4	B-4P6T4				2.38 (60.5)	1.19 (30.2)	
Male NPT	1/2 in.	SS-8P6T4	B-8P6T4	P4T	0.283 (7.2)	2.88 (73.2)	1.44 (36.6)		
	1/8 in.	SS-2P4T2	B-2P4T2			P4T	0.172 (4.4)	1.53 (38.9)	0.76 (19.3)
	1/4 in.	SS-4P4T2	B-4P4T2					1.90 (48.3)	0.95 (24.1)
Male NPT/ Swagelok tube fitting	1/2 in.	SS-8P6T2	B-8P6T2	P6T	0.283 (7.2)	2.64 (67.1)	1.32 (33.5)		
	1/4 in.	SS-4P4T1	B-4P4T1	P4T		0.172 (4.4)	2.03 (51.2)	0.95 (24.1)	
Male/female NPT	1/4 in.	SS-4P4T5	B-4P4T5		2.00 (50.8)				
Female ISO ^①	1/4 in.	SS-4P4T4-RT	B-4P4T4-RT		P6T		0.283 (7.2)	2.21 (56.1)	1.11 (28.2)
	1/2 in.	SS-8P6T4-RT	B-8P6T4-RT	3.14 (79.8)		1.57 (39.9)			

Dimensions shown with Swagelok tube fitting nuts finger-tight.

① See specifications ISO 7/1, BS21, DIN-2999, and JIS B0203.

Options

Optional Body Materials

Valve bodies and plugs of other alloys are available in some P4T models. Contact your authorized Swagelok sales and service representative for more information.

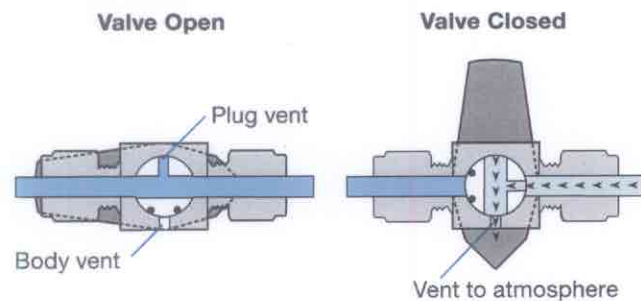
Optional O-ring Materials

PTFE-coated fluorocarbon FKM is standard. For an optional material, add a designator to the valve ordering number.

O-ring Material	Designator
Kalrez®	-KZ
PTFE-coated Buna N	-TB
PTFE-coated ethylene propylene	-TE
PTFE-coated neoprene	-TN

Example: SS-2P4T-KZ

Downstream Vent



Vented plug and valve body allow pressure release to atmosphere when valve is closed.

- 150 psig (10.3 bar) maximum operating pressure
- Red polyetherimide handle standard

To order, replace **T** with **V** in the valve ordering number.

Example: SS-2P4V

Plastic Handle Colors

Dark green is standard. For an optional color, add a handle color designator to the valve ordering number.

Handle Color	Designator
Black	-BK
Blue	-BL
Red	-RD

Example: SS-2P4T-BL

Other colors are available; contact your authorized Swagelok representative.

Warranty Information

Swagelok products are backed by The Swagelok Limited Lifetime Warranty. For a copy, visit swagelok.com or contact your authorized Swagelok representative.

Safe Product Selection

When selecting a product, the total system design must be considered to ensure safe, trouble-free performance. Function, material compatibility, adequate ratings, proper installation, operation, and maintenance are the responsibilities of the system designer and user.

Caution: Do not mix or interchange parts with those of other manufacturers.

Locking Handle

Lever locks to plate to secure valve open or closed.

- Meets OSHA Lockout/Tagout Standard 29 CFR Part 1910.147, *Control of Hazardous Energy*



- Accommodates padlock shackle length of 3/4 in. (19 mm) minimum and diameter of 1/4 to 3/8 in. (6.4 to 9.5 mm)
- Nylon handle with brass insert; 316 SS lever, plate, mounting bracket, and screws

Locking handles are available factory assembled or as a retrofit kit. See the Swagelok *Locking Handles for Plug Valves* catalog, MS-02-12, for dimensions and ordering information.

Metal Handle

Removing the roll pin protects against accidental actuation—the valve opens and closes with a wrench.



- 300 series stainless steel or aluminum

To order, add **-M1** for stainless steel or **-M2** for aluminum to the valve ordering number.

Example: SS-2P4T-M1

Panel Mounting



Bracket mounts to panels 1/16 to 3/8 in. (1.5 to 9.5 mm) thick.

- Includes mounting hole template and label to indicate open and closed positions
- Nylon handle with brass insert; polycarbonate label; 316 SS mounting bracket and screws

Panel mounting capability is available on factory-assembled valves or as a retrofit kit. See the Swagelok *Panel Mounting for Plug Valves* catalog, MS-02-11, for dimensions and ordering information.

Check Valves



C, CA, CH, CP, and CPA Series

- Working pressures up to 6000 psig (413 bar)
- Adjustable and fixed cracking pressures
- Variety of end connections
- 316 stainless steel and brass materials

Swagelok

Contents

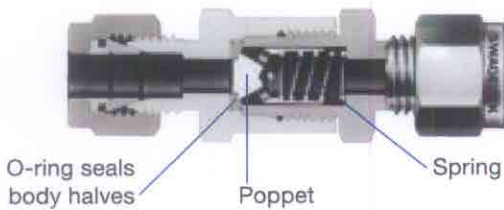
Features	2	Flow Data	7
Technical Data	3	Testing	10
Pressure-Temperature Ratings	3	Cleaning and Packaging	10
Cracking and Reseal Pressures	4	Ordering Information and Dimensions	11
Materials of Construction	5	Options and Accessories	14

Features

Fixed Cracking Pressures

From 1/3 to 25 psi (0.03 to 1.8 bar)

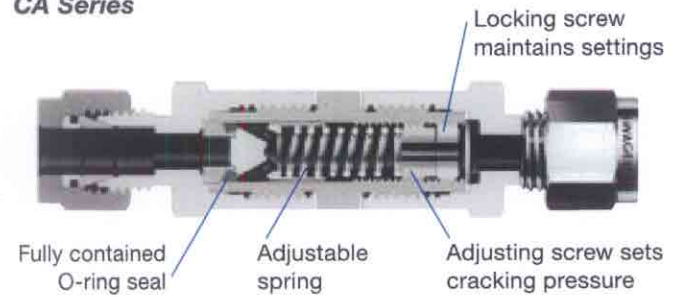
C Series



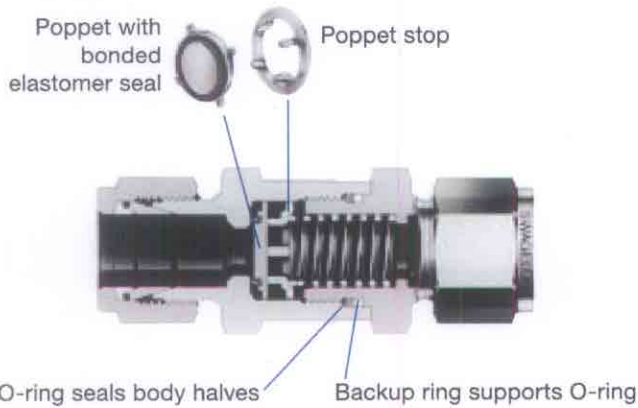
Adjustable Cracking Pressures

From 3 to 600 psi (0.21 to 41.4 bar)

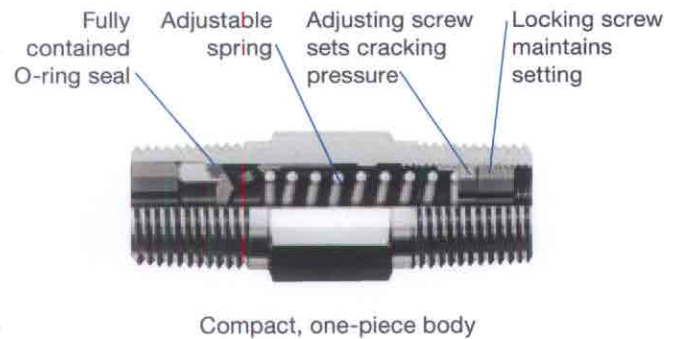
CA Series



CH Series



CPA Series



CP Series



Technical Data

Cracking pressure—the upstream pressure at which the first indication of flow occurs.

Reseal pressure—the pressure at which there is no indication of flow.

⚠ For valves not actuated for a period of time, initial cracking pressure may be higher than the set cracking pressure.

Series	Maximum Flow Coefficient (C _v)	Nominal Cracking Pressure psi (bar)	Downstream Pressure at 70°F (20°C) psig (bar)
Fixed Cracking Pressure			
2C	0.10	1/3, 1, 10 and 25 (0.03, 0.07, 0.69, and 1.8)	1000 (68.9) ^①
4C	0.47		200 (13.7)
6C	1.47		
8C	1.68		
12C, 16C	4.48		
CH4	0.67	1/3, 1, 5, 10 and 25 (0.03, 0.07, 0.35 0.69, and 1.8)	6000 (413)
CH8	1.8		5000 (344)
CH16	4.7		3000 (206)
4CP	0.35		
8CP	1.20	1/3, 1, 10 and 25 (0.03, 0.07, 0.69, and 1.8)	
Adjustable Cracking Pressure			
CA	0.37	3 to 50 (0.21 to 3.5) 50 to 150 (3.5 to 10.4) 150 to 350 (10.4 to 24.2) 350 to 600 (24.2 to 41.4)	3000 (206)
4CPA	0.35		
8CPA	1.20		

① For cracking pressure of 25 psi (1.8 bar), downstream pressure is 3000 psig (206 bar).

Pressure-Temperature Ratings

C (2C, 4C, 6C, and 8C), CA, CP, and CPA Series

Ratings based on fluorocarbon FKM O-rings in 316 stainless steel valves and Buna N in brass valves.

Material	316 SS	Brass
Temperature, °F (°C)	Working Pressure, psig (bar)	
-10 (-23) to 100 (37)	3000 (206)	3000 (206)
200 (93)	2575 (177)	2600 (179)
250 (121)	2450 (168)	2405 (165)
300 (148)	2325 (160)	—
375 (190)	2185 (150)	—

C Series (12C and 16C)

Ratings based on fluorocarbon FKM O-rings in 316 stainless steel valves and Buna N in brass valves.

Material	316 SS	Brass
Temperature, °F (°C)	Working Pressure, psig (bar)	
-10 (-23) to 100 (37)	2000 (137)	1500 (103)
200 (93)	1715 (118)	1300 (89.5)
250 (121)	1630 (112)	1200 (82.6)
300 (148)	1545 (106)	—
375 (190)	1450 (99.9)	—

CH Series

Ratings based on fluorocarbon FKM seals.

Material	316 SS	
Series	CH4, CH8	CH16
Temperature, °F (°C)	Working Pressure, psig (bar)	
-10 (-23) to 100 (37)	6000 (413)	5000 (344) ^①
200 (93)	5160 (355)	4290 (295)
250 (121)	4910 (338)	4080 (281)
300 (148)	4660 (321)	3875 (266)
400 (204)	4280 (294)	3560 (245)

For more information about pressure ratings of valves with tube fitting end connections, see Swagelok® *Tubing Data*, MS-01-107.

① Pressure ratings may be limited by the end connection. See **Dimensions**, page 12.

Cracking and Reseal Pressures at 70°F (20°C)

Cracking pressure—the upstream pressure at which the first indication of flow occurs.

Reseal pressure—the pressure at which there is no indication of flow.

⚠ For valves not actuated for a period of time, initial cracking pressure may be higher than the set cracking pressure.

C Series

Nominal Cracking Pressure psi (bar)	Cracking Pressure Range psi (bar)	Reseal Pressure psi (bar)
1/3 (0.03)	Up to 3 (0.21)	Up to 6 (0.42) downstream pressure
1 (0.07)	Up to 4 (0.28)	Up to 6 (0.42) downstream pressure
10 (0.69)	7 to 15 (0.49 to 1.1)	3 (0.21) or more upstream pressure
25 (1.8)	20 to 30 (1.4 to 2.1)	17 (1.2) or more upstream pressure

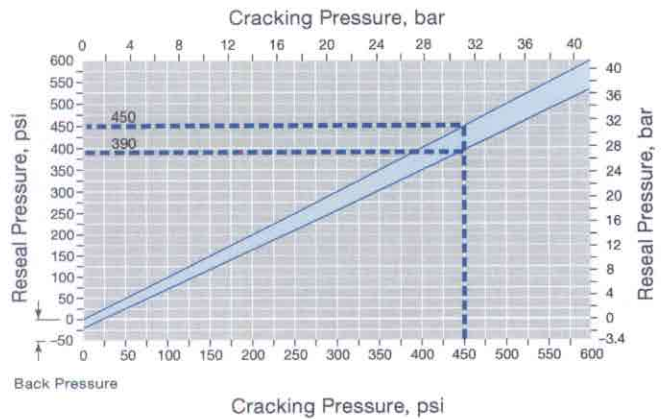
CH Series

Nominal Cracking Pressure psi (bar)	Cracking Pressure Range psi (bar)	Reseal Pressure psi (bar)
1/3 (0.03)	Up to 3 (0.21)	Up to 6 (0.42) back pressure
1 (0.07)	Up to 4 (0.28)	Up to 5 (0.35) back pressure
5 (0.35)	3 to 9 (0.21 to 0.63)	Up to 2 (0.14) back pressure
10 (0.69)	7 to 15 (0.49 to 1.1)	3 (0.21) or more upstream pressure
25 (1.8)	20 to 30 (1.4 to 2.1)	17 (1.2) or more upstream pressure

CP Series

Nominal Cracking Pressure psi (bar)	Cracking Pressure Range psi (bar)	Reseal Pressure psi (bar)
1/3 (0.03)	Up to 3 (0.21)	6 to 20 (0.42 to 1.4) downstream pressure
1 (0.07)	Up to 4 (0.28)	5 to 20 (0.35 to 1.4) downstream pressure
10 (0.69)	7 to 13 (0.49 to 0.90)	3 to 10 (0.21 to 0.69) downstream pressure
25 (1.8)	21 to 29 (1.5 to 2.0)	5 (0.35) or more upstream pressure

CA and CPA Series



Warranty Information

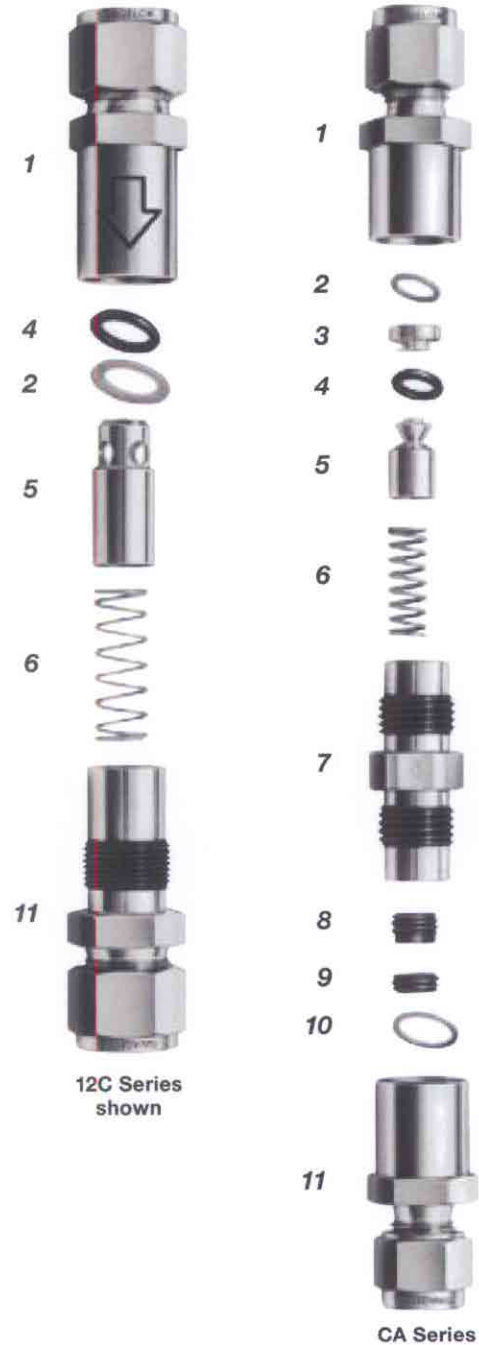
Swagelok products are backed by The Swagelok Limited Lifetime Warranty. For a copy, visit swagelok.com or contact your authorized Swagelok representative.

Materials of Construction

C and CA Series

Component	Valve Body Materials	
	316 SS	Brass
	Material Grade/ASTM Specification	
1 Inlet body	316 SS/A479	Brass 360/B16
2 Inlet gasket (CA series)	PTFE-coated 316 SS/A240	
Inlet gasket (6C and 8C series with ≥ 50 psi [3.5 bar] spring)	PTFE-coated 316 SS/A240	
Inlet gasket (12C and 16C series)	PTFE-coated 316 SS/A240	PTFE-coated aluminum/B209
3 Insert (CA series)	316 SS/A479	Naval brass 485/B21
4 O-ring	Fluorocarbon FKM	Buna N
5 Poppet	316 SS/A479	Brass 360/B16
6 Spring	302 SS/A313	
7 Center body (CA series)	316 SS/A479	Brass 360/B16
8 Adjusting screw (CA series)	316 SS/A276	
9 Locking screw (CA series)	316 SS/A276	
10 Outlet gasket (CA series)	PTFE-coated 316 SS/A240	
11 Outlet body	316 SS/A479	Brass 360/B16
Lubricants	<i>Silicone-based and molybdenum disulfide-based (C series); PTFE-based and molybdenum disulfide-based (CA series)</i>	<i>Silicone-based (C series); PTFE-based (CA series)</i>

Wetted components listed in *italics*.

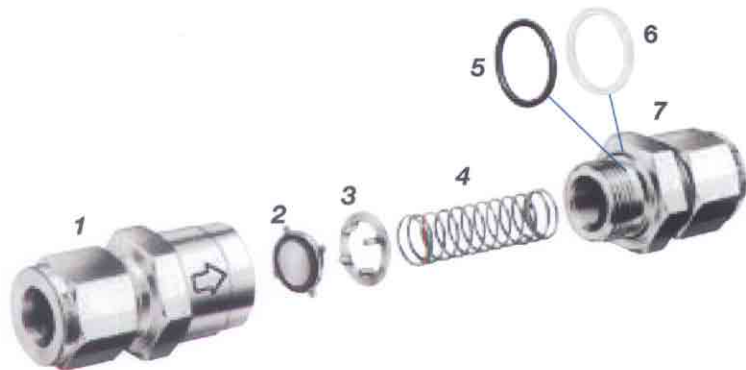


CH Series

Component	Material Grade/ASTM Specification
1 Inlet body	316 SS/A479
2 Poppet	<i>Fluorocarbon FKM-bonded^① 316 SS/A479</i>
3 Poppet stop	316 SS/A240
4 Spring	302 SS/A313
5 O-ring	Fluorocarbon FKM
6 Backup ring	PTFE/D1710
7 Outlet body	316 SS/A479
Lubricant	<i>Fluorocarbon-based</i>

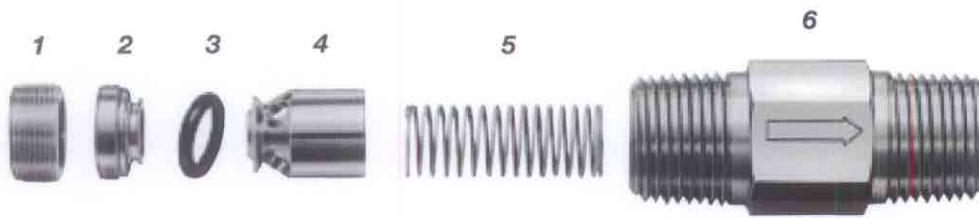
Wetted components listed in *italics*.

① Material Safety Data Sheet for bonding agent available on request.

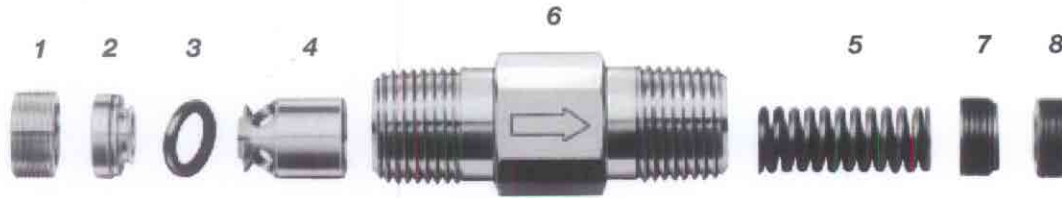


Materials of Construction

CP Series



CPA Series



Component	Valve Body Materials				
	316 SS	Brass			
		4CP	8CP	4CPA	8CPA
	Material Grade/ASTM Specification				
1 Insert lock screw	316 SS/A276 or A479	Brass 485/ B21	Brass 360/ B16	Brass 485/ B21	Brass 360/ B16
2 Insert	316 SS/A479				
3 O-ring	Fluorocarbon FKM	Buna N			
4 Poppet	316 SS/A479	Brass 360/B16			
5 Spring		302 SS/A313			
6 Body	316 SS/A479	Brass 360/B16			
7 Adjusting screw (CPA series)	316 SS/A276	—		316 SS/A276	Brass 360 ^① / B16
8 Locking screw (CPA series)					
Lubricants	PTFE-based				

Wetted components listed in *italics*.

① Adjusting screw in valve with 150 or 350 psi (10.4 or 24.2 bar) spring is 316 SS.

Flow Data at 70°F (20°C)

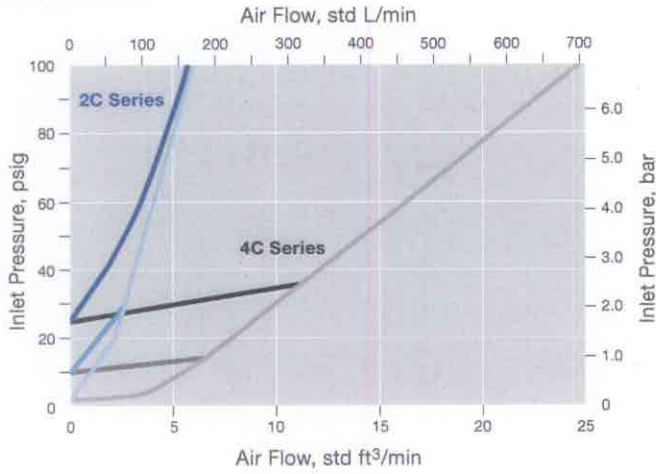
C Series

Nominal Cracking Pressures

- | | | | |
|--------------------|--------------------|---------------------|--------------------|
| 2C, 6C, 16C Series | — 1 psi (0.07 bar) | — 10 psi (0.69 bar) | — 25 psi (1.8 bar) |
| 4C, 8C Series | — 1 psi (0.07 bar) | — 10 psi (0.69 bar) | — 25 psi (1.8 bar) |

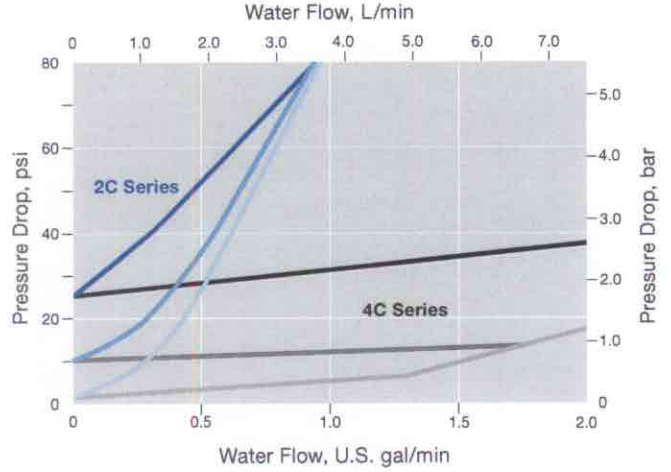
Air

2C, 4C Series

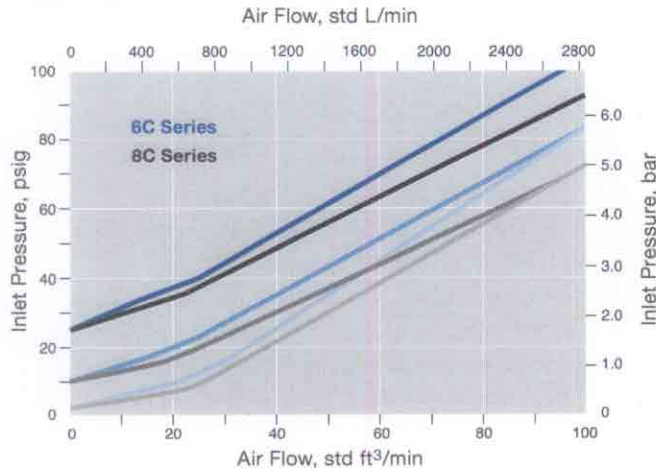


Water

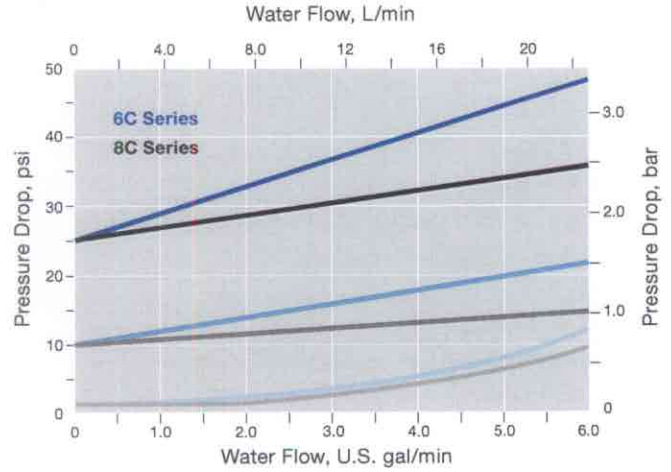
2C, 4C Series



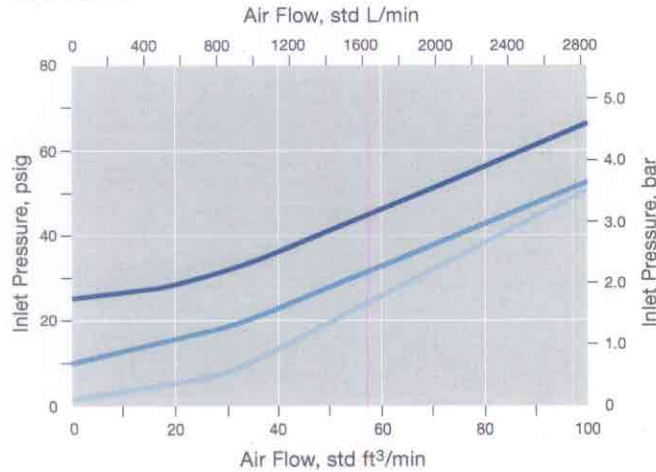
6C, 8C Series



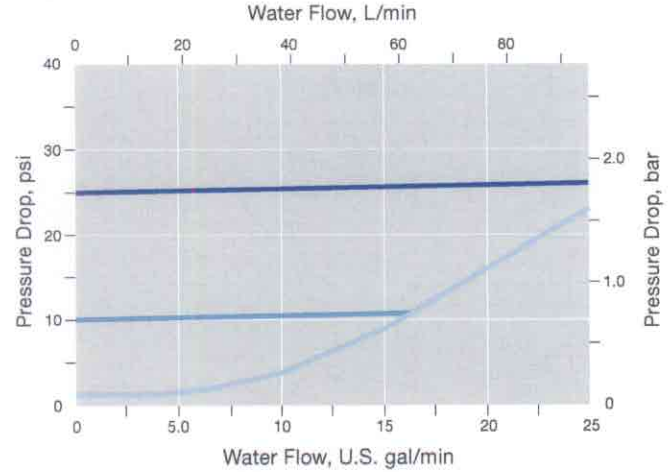
6C, 8C Series



16C Series



16C Series



Flow Data at 70°F (20°C)

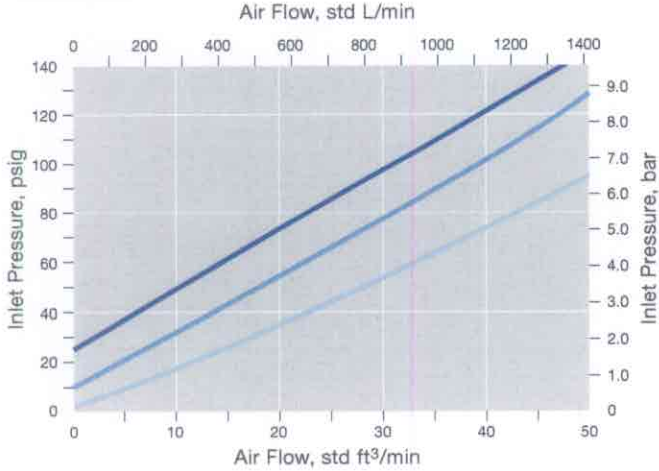
CH Series

Nominal Cracking Pressures

— 1 psi (0.07 bar) — 10 psi (0.69 bar) — 25 psi (1.8 bar)

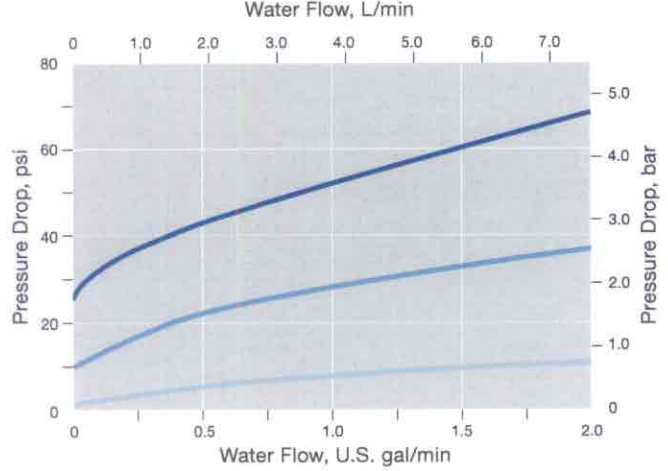
Air

CH4 Series

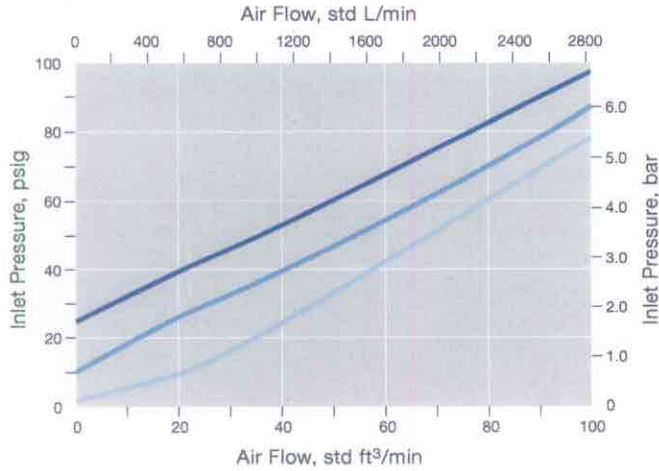


Water

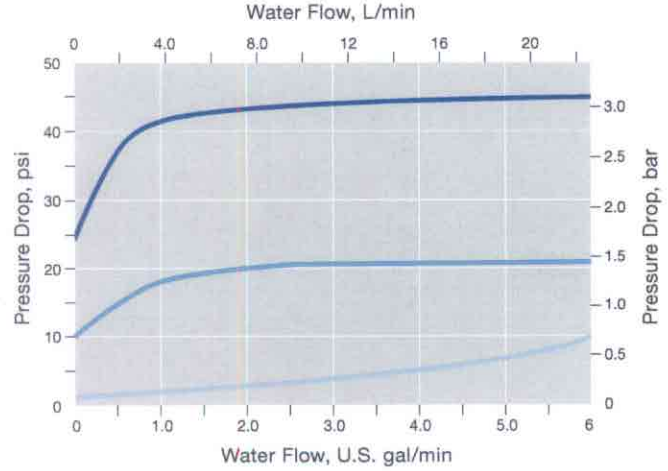
CH4 Series



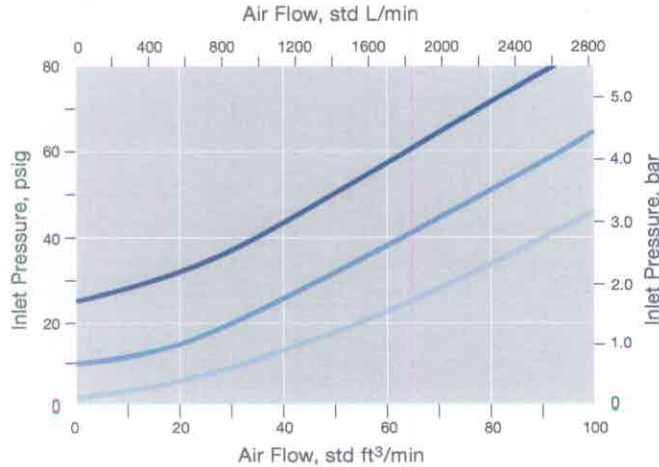
CH8 Series



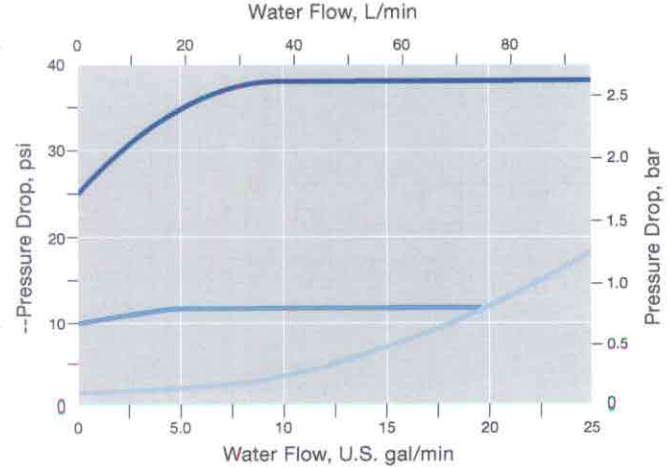
CH8 Series



CH16 Series



CH16 Series



Flow Data at 70°F (20°C)

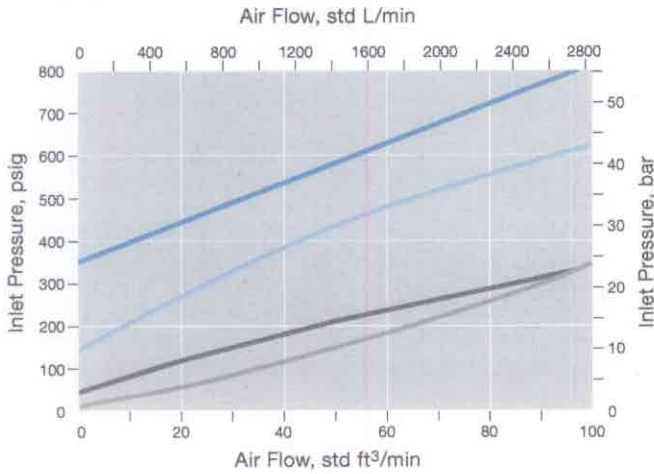
CA and CPA Series

Nominal Cracking Pressures

— 3 psi (0.21 bar) — 50 psi (3.5 bar) — 150 psi (10.4 bar) — 350 psi (24.2 bar)

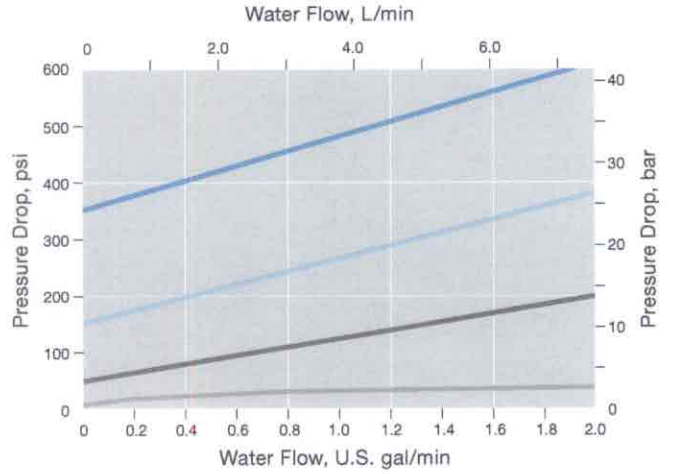
Air

CA Series

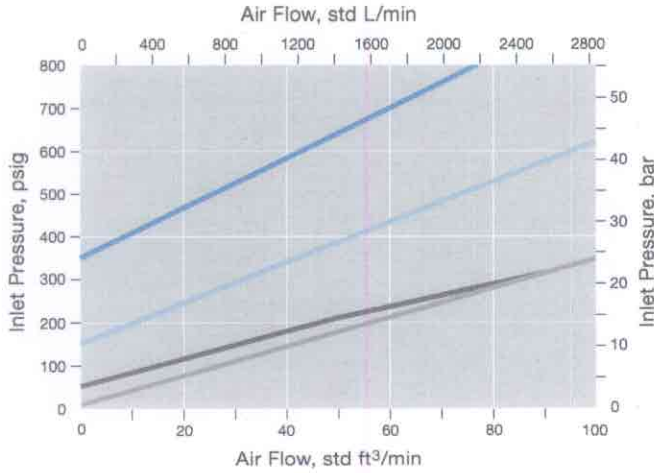


Water

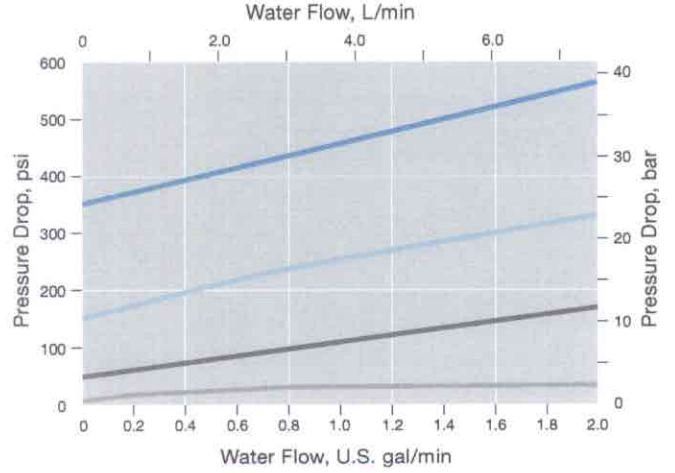
CA Series



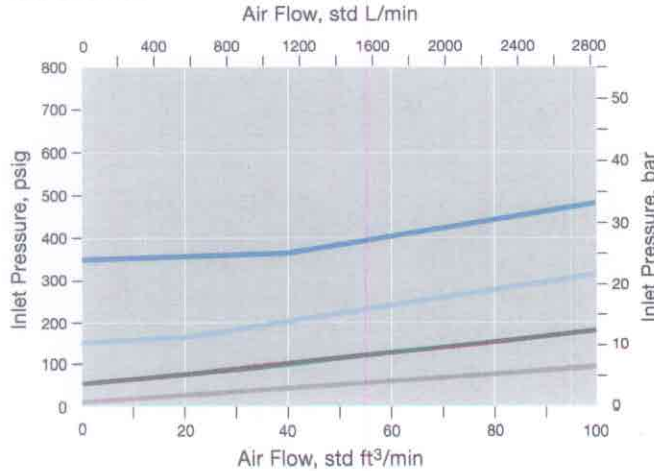
4CPA Series



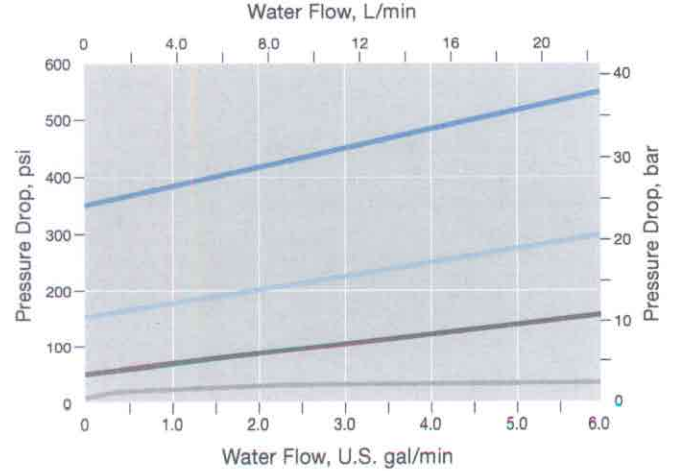
4CPA Series



8CPA Series



8CPA Series



Flow Data at 70°F (20°C)

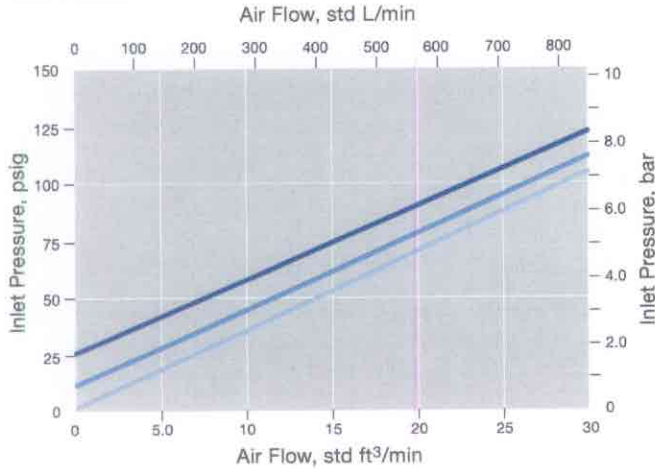
CP Series

Nominal Cracking Pressures

— 1 psi (0.07 bar) — 10 psi (0.69 bar) — 25 psi (1.8 bar)

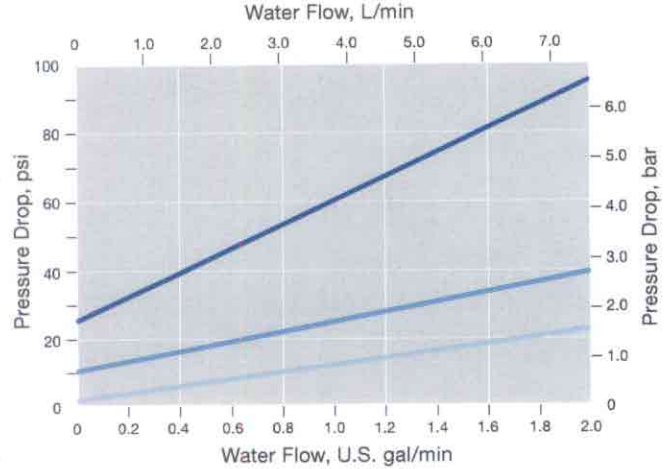
Air

4CP Series

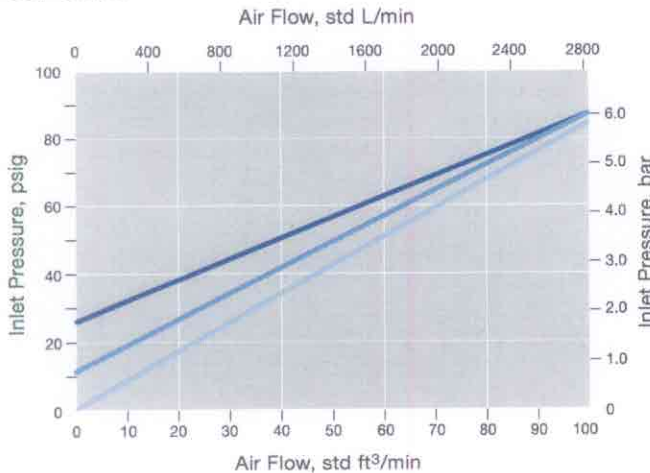


Water

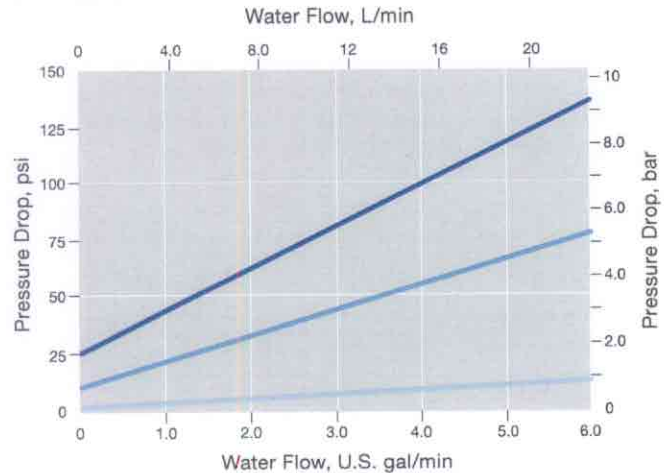
4CP Series



8CP Series



8CP Series



Testing

Every C, CA, CH, CP, and CPA series check valve is factory tested for crack and reseal performance with a liquid leak detector.

Check valves with fixed cracking pressures, C, CP, and CH series, are cycled six times prior to testing. Every valve is tested to ensure it seals within 5 s at the appropriate reseal pressure.

Check valves with adjustable cracking pressures, CA and CPA series, are tested at two pressure points. Every valve is tested at a low-pressure setting. Ten percent of the valves in each order are tested at the high-pressure setting. All valves must seal within 5 s at the appropriate reseal pressure.

Cleaning and Packaging

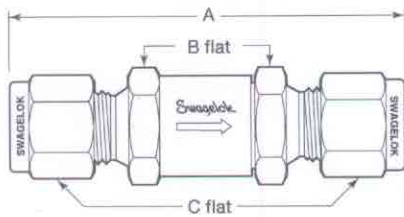
Every C, CA, and CH series check valve with VCR® or VCO® end connections is processed in accordance with Swagelok *Special Cleaning and Packaging (SC-11)*, MS-06-63, to ensure compliance with product cleanliness requirements as stated in ASTM G93 Level C.

All other C, CA, and CH series check valves, as well as every CP and CPA series check valve, are cleaned to Swagelok standard cleaning and packaging specification (SC-10), MS-06-62.

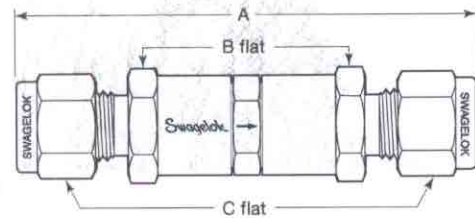
Dimensions

Dimensions, shown with Swagelok tube fitting nuts finger-tight, are for reference only and are subject to change.

C Series



CA Series



End Connections		Basic Ordering Number	Series	Dimensions, in. (mm)		
Inlet/Outlet	Size			A	B	C
Fixed Cracking Pressure, C Series						
Fractional Swagelok tube fittings	1/8 in.	SS-2C-	2C	2.19 (55.6)	5/8	7/16
	1/4 in.	SS-4C-	4C	2.35 (59.7)		9/16
	3/8 in.	SS-6C-	6C	3.17 (80.5)	7/8	11/16
	1/2 in.	SS-8C-	8C	3.42 (86.9)		7/8
	3/4 in.	SS-12C-	12C	4.32 (110)	1 1/4	1 1/8
Metric Swagelok tube fittings	1 in.	SS-16C-	16C	4.74 (120)	1 3/8	1 1/2
	6 mm	SS-6C-MM-	4C	2.36 (59.9)	5/8	(14)
	10 mm	SS-10C-MM-	8C	3.32 (84.3)	7/8	(19)
12 mm	SS-12C-MM-	3.42 (86.9)		(22)		
Female NPT	1/8 in.	SS-2C4-	2C	1.89 (48.0)	5/8	-
	1/4 in.	SS-4C4-	4C	2.15 (54.6)	3/4	
	3/8 in.	SS-6C4-	6C	2.98 (75.7)	7/8	
	1/2 in.	SS-8C4-	8C	3.58 (90.9)	1 1/16	
	3/4 in.	SS-12C4-	12C	4.08 (104)	1 1/4	
	1 in.	SS-16C4-	16C	4.84 (123)	1 5/8	
Male NPT	1/8 in.	SS-2C2-	2C	1.71 (43.4)	5/8	-
	1/4 in.	SS-4C2-	4C	2.09 (53.1)		
	3/8 in.	SS-6C2-	6C	2.78 (70.6)	7/8	
	1/2 in.	SS-8C2-	8C	3.16 (80.3)		
	3/4 in.	SS-12C2-	12C	4.08 (104)	1 1/4	
	1 in.	SS-16C2-	16C	4.52 (115)	1 5/8	
Male NPT/ Swagelok tube fitting	1/4 in.	SS-4C1-	4C	2.22 (56.4)	5/8	9/16
Male VCR fittings	1/4 in.	SS-4C-VCR-	4C	2.21 (56.1)	5/8	-
	1/2 in.	SS-8C-VCR-	8C	3.56 (90.4)	15/16	
	3/4 in.	SS-12C-VCR-	12C	4.64 (118)	1 5/8	
	1 in.	SS-16C-VCR-	16C	4.76 (121)		
Adjustable Cracking Pressure, CA Series						
Swagelok tube fittings	1/4 in.	SS-4CA-	CA	3.23 (82.0)	5/8	9/16
	6 mm	SS-6CA-MM-				(14)
	8 mm	SS-8CA-MM-				(16)
Male NPT/ Swagelok tube fitting	1/4 in.	SS-4CA1-		3.12 (79.2)		9/16
Male VCR fittings	1/4 in.	SS-4CA-VCR-		3.09 (78.5)		-

Ordering Information

Basic ordering numbers specify stainless steel material. To order brass, replace **SS** with **B** in the basic ordering number.

Example: **B-2C-**

C Series

To order, add a cracking pressure designator to the basic ordering number.

Cracking Pressure psi (bar)	Designator
1/3 (0.03)	1/3
1 (0.07)	1
10 (0.69)	10
25 (1.8)	25

Example: **SS-2C-1/3**

CA Series

To order, add a cracking pressure range designator to the basic ordering number.

Cracking Pressure psi (bar)	Designator
3 to 50 (0.21 to 3.5)	3
50 to 150 (3.5 to 10.4)	50
150 to 350 (10.4 to 24.2)	150
350 to 600 (24.2 to 41.4)	350

Example: **SS-4CA-3**

⚠ Check valves are designed for directional flow control only. Swagelok check valves should never be used as code safety relief devices.

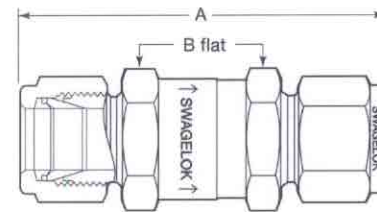
Dimensions

Dimensions, shown with Swagelok tube fitting nuts finger-tight, are for reference only and are subject to change.

End Connections		Pressure Rating at 100°F (37°) psig (bar)	Basic Ordering Number	Series	Dimensions in. (mm)	
Type	Size				A	B
Fractional Swagelok tube fitting	1/8 in.	6000 (413)	SS-CHS2-	CH4	2.27 (57.7)	11/16
	1/4 in.		SS-CHS4-		2.43 (61.7)	
	3/8 in.		SS-CHS6-	CH8	2.75 (69.9)	
	1/2 in.		SS-CHS8-		2.96 (75.2)	
	3/4 in.	5000 (344)	SS-CHS12-	CH16	3.52 (89.4)	1 5/8
	1 in.	4700 (323)	SS-CHS16-		3.88 (98.6)	
Metric Swagelok tube fitting	6 mm	6000 (413)	SS-CHS6MM-	CH4	2.43 (61.7)	11/16
	8 mm		SS-CHS8MM-		2.70 (68.6)	
	10 mm		SS-CHS10MM-	CH8	2.80 (71.1)	
	12 mm		SS-CHS12MM-		2.96 (75.2)	
	22 mm	5000 (344)	SS-CHS22MM-	CH16	3.48 (88.4)	1 5/8
	25 mm	SS-CHS25MM-	3.88 (98.6)			
Female NPT	1/4 in.	6000 (413)	SS-CHF4-	CH4	2.13 (54.1)	11/16
	3/8 in.	5000 (344)	SS-CHF6-		CH8	
	1/2 in.	4600 (316)	SS-CHF8-	CH16		3.03 (77.0)
	3/4 in.	4300 (296)	SS-CHF12-		CH16	3.23 (82.0)
	1 in.	4100 (282)	SS-CHF16-	3.83 (97.3)		
	Male NPT	1/8 in.	6000 (413)	SS-CHM2-	CH4	1.79 (45.5)
1/4 in.		SS-CHM4-		2.17 (55.1)		
3/8 in.		SS-CHM6-		CH8	2.36 (59.9)	
1/2 in.		SS-CHM8-			2.73 (69.3)	
3/4 in.		5000 (344)	SS-CHM12-	CH16	3.29 (83.6)	1 5/8
1 in.		SS-CHM16-	3.67 (93.2)			
Female ISO ^①	1/4 in.	6000 (413)	SS-CHF4RT-	CH4	2.28 (57.9)	11/16
	1/2 in.	4600 (316)	SS-CHF8RT-	CH8	3.29 (83.6)	1 1/16
	3/4 in.	4300 (296)	SS-CHF12RT-	CH16	3.55 (90.2)	1 5/8
	1 in.	4100 (282)	SS-CHF16RT-		3.83 (97.3)	
Male ISO ^①	1/4 in.	6000 (413)	SS-CHM4RT-	CH4	2.17 (55.1)	11/16
	1/2 in.		SS-CHM8RT-	CH8	2.73 (69.3)	1
	3/4 in.	5000 (344)	SS-CHM12RT-	CH16	3.35 (85.1)	1 5/8
	1 in.	SS-CHM16RT-	3.67 (93.2)			
Female SAE/MS	1/2 in.	4600 (316)	SS-CHF8ST-	CH8	2.74 (69.6)	1
Male SAE/MS	1/2 in.	SS-CHM8ST-	2.48 (63.0)			
Male VCO fitting	1/4 in.	6000 (413)	SS-CHVCO4-	CH4	1.98 (50.3)	11/16
	1/2 in.		SS-CHVCO8-	CH8	2.35 (59.7)	1
	3/4 in.	5000 (344)	SS-CHVCO12-	CH16	2.90 (73.7)	1 5/8
	1 in.		SS-CHVCO16-			
Male VCR fitting	1/4 in.	6000 (413)	SS-CHVCR4-	CH4	2.28 (57.9)	11/16
	1/2 in.	3500 (241)	SS-CHVCR8-	CH8	2.73 (69.3)	1
	3/4 in.	3000 (206)	SS-CHVCR12-	CH16	3.78 (96.0)	1 5/8

① See specifications ISO 7/1, BS EN 10226-1, DIN-2999, JIS B0203.

CH Series



Ordering Information

To order, add a cracking pressure designator to the basic ordering number.

Cracking Pressure psi (bar)	Designator
1/3 (0.03)	1/3
1 (0.07)	1
5 (0.35)	1
10 (0.69)	10
25 (1.8)	25

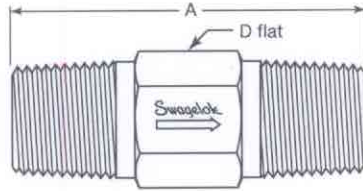
Example: SS-CHS2-1/3

⚠ Check valves are designed for directional flow control only. Swagelok check valves should never be used as code safety relief devices.

Dimensions

Dimensions, shown with Swagelok tube fitting nuts finger-tight, are for reference only and are subject to change.

CP and CPA Series



End Connections		Basic Ordering Number	Series	Dimensions, in. (mm)	
Inlet/Outlet	Size			A	D
Fixed Cracking Pressure, CP Series					
Female NPT	1/4 in.	SS-4CP4-	4CP	2.41 (61.2)	3/4
	1/2 in.	SS-8CP4-	8CP	3.71 (94.2)	1 1/16
Male NPT	1/4 in.	SS-4CP2-	4CP	1.62 (41.1)	9/16
	1/2 in.	SS-8CP2-	8CP	2.28 (57.9)	7/8
Female/male NPT	1/4 in.	SS-4CP6-	4CP	2.29 (58.2)	3/4
Male/female NPT	1/4 in.	SS-4CP5-		1.75 (44.4)	3/4
	1/2 in.	SS-8CP5-	8CP	2.83 (71.9)	1 1/16
Female ISO ^①	1/4 in.	SS-4CP4-RT-	4CP	2.54 (64.5)	3/4
Male ISO ^①	1/4 in.	SS-4CP2-RT-		1.62 (41.1)	9/16
Adjustable Cracking Pressure, CPA Series					
Female NPT	1/4 in.	SS-4CPA4-	4CPA	2.98 (75.7)	3/4
Male NPT	1/4 in.	SS-4CPA2-		1.62 (41.1)	9/16
	1/2 in.	SS-8CPA2-	8CPA	2.56 (65.0)	7/8
Male ISO ^①	1/4 in.	SS-4CPA2-RT-	4CPA	1.62 (41.1)	9/16
	1/2 in.	SS-8CPA2-RT-	8CPA	2.56 (65.0)	7/8

^① See specifications ISO 7/1, BS EN 10226-1, DIN-2999, and JIS B0203.

Ordering Information

Basic ordering numbers specify stainless steel material. To order brass, replace **SS** with **B** in the basic ordering number.

Example: **B-4CP4-**

CP Series

To order, add a cracking pressure designator to the basic ordering number.

Cracking Pressure psi (bar)	Designator
1/3 (0.03)	1/3
1 (0.07)	1
10 (0.69)	10
25 (1.8)	25

Example: **B-4CP4-1/3**

CPA Series

To order, add a cracking pressure range designator to the basic ordering number.

Cracking Pressure psi (bar)	Designator
3 to 50 (0.21 to 3.5)	3
50 to 150 (3.5 to 10.4)	50
150 to 350 (10.4 to 24.2)	150
350 to 600 (24.2 to 41.4)	350

Example: **SS-4CPA4-3**

⚠ Check valves are designed for directional flow control only. Swagelok check valves should never be used as code safety relief devices.

Options and Accessories

Seal Materials (All Series)

Fluorocarbon FKM O-rings are standard in 316 stainless steel valves; Buna N O-rings are standard in brass valves. Other elastomer seals (poppet bonding material and O-ring) are available. To order, insert the seal material designator into the valve ordering number.

Seal Material	Designator	Temperature Rating °F (°C)
Buna N	-BU	-10 to 250 (-23 to 121)
Ethylene propylene	-EP	-50 to 300 (-45 to 148)
Fluorocarbon FKM	-VI	-10 to 375 (-23 to 190)
Neoprene	-NE	-40 to 250 (-40 to 121)

Example: B-2C-**VI**-1/3

Additional seal materials are available. Contact your authorized Swagelok sales and service representative for details.

Special Alloys (All Series)

Springs of alloy 400 or alloy C-276 are available in some sizes. Valve bodies of alloy R-405, carbon steel, aluminum, or other alloys are available in some sizes. Contact your authorized Swagelok representative for more information.

Special Cleaning and Packaging (SC-11)

Every C, CA, and CH series check valve with VCR or VCO end connections is processed in accordance with Swagelok *Special Cleaning and Packaging (SC-11)*, MS-06-63, to ensure compliance with product cleanliness requirements stated in ASTM G93 Level C.

To order special cleaning and packaging for C, CA, and CH series check valves with other end connections, add **-SC11** to the ordering number.

Example: SS-2C-1/3-**SC11**

PTFE-Coated Springs (C, CA, CP, and CPA Series)

Springs with PTFE coating are available in some sizes. Contact your authorized Swagelok representative for more information.

ECE R110-Compliant Valves (CH Series)

Stainless steel CH series check valves with 1/4 and 1/2 in. Swagelok tube fitting end connections and Buna C seals are available for use in alternative fuel service.

- Pressure rating at 70°F (20°C): 3770 psig (259 bar)
- Temperature ratings: -40 to 185°F (-40 to 85°C)

Ordering numbers: 1/4 in. size—**SS-CH4-BC**
1/2 in. size—**SS-CH8-BC**

Safe Product Selection

When selecting a product, the total system design must be considered to ensure safe, trouble-free performance. Function, material compatibility, adequate ratings, proper installation, operation, and maintenance are the responsibilities of the system designer and user.

Caution: Do not mix or interchange parts with those of other manufacturers.

Sour Gas Valves (CH Series)

CH series valves with Swagelok tube fitting end connections are available for sour gas service. Materials for wetted components are selected in accordance with NACE Specification MR0175 for sulfide stress cracking-resistant materials.

Technical Data

Pressure Rating at 70°F (20°C)

CH4 and CH8 series: 5000 psig (344 bar)
CH16 series: 4700 psig (323 bar)

Temperature Rating

-50 to 300°F (-45 to 148°C)

Nominal Cracking Pressures

1/3, 1, and 5 psi (0.03, 0.07, and 0.35 bar)

End Connections

1/4, 3/8, 1/2, 3/4, and 1 in. Swagelok tube fittings

Materials of Construction

Body, poppet—alloy R-405/B164

Seals—ethylene propylene

Backup ring—PTFE

Spring—alloy X-750/AMS 5699

All other materials and lubricant same as standard product. See **Materials of Construction**, page 5.

Ordering Information

To order, replace **SS** with **M** and insert **-SG** into the ordering number.

Example: **M-CHS2-SG**-1/3

Deflector Cap (CP and CPA Series)

A polyethylene deflector cap is available for CP and CPA series valves with male NPT end connections. The deflector cap deflects flow from direct contact with personnel and prevents atmospheric contaminants from entering the valve. The deflector cap screws easily onto the male NPT outlet end of the valve. Maximum rating is 300 psig at 100°F (20.6 bar at 37°C).

To order, insert **-DG** for a green cap or **-DR** for a red cap into the ordering number.

Example: SS-4CPA2-**DR**-3



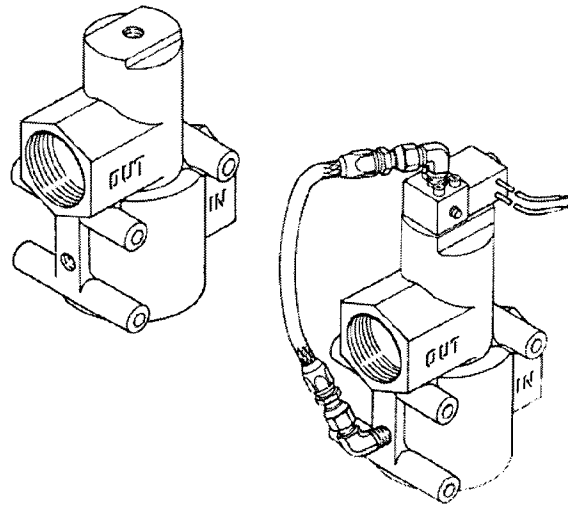
Maintenance Kits

Spring kits and seal kits are available for retrofit or maintenance. See the Swagelok *Check Valve Maintenance Kits* catalog, MS-02-115.

Oxygen Service Hazards

For more information about hazards and risks of oxygen-enriched systems, see the Swagelok *Oxygen System Safety* technical report, MS-06-13.

OPERATING & SERVICE MANUAL



TURBO VALVE

TABLE OF CONTENTS

SECTION	SUBJECT	PAGE
1.0	General Information.....	1
2.0	<i>TURBOVALVE</i> Operation.....	1
3.0	<i>TURBOVALVE</i> Installation.....	2
4.0	<i>TURBOVALVE</i> Disassembly.....	2
5.0	<i>TURBOVALVE</i> Assembly.....	3
6.0	Disassembly/Assembly (Electrical).....	3

LIST OF ILLUSTRATIONS

FIGURES	TITLE	PAGE
1	<i>TURBOVALVE</i> (Pneumatically Controlled).....	1
2	<i>TURBOVALVE</i> (Electrically Controlled).....	2
3	Opening Pressure vs. Supply.....	2
4	Piston Removal.....	3
5	<i>TURBOVALVE</i> Dimensional Data.....	4
6	T30-I Installation Diagram (Electrical).....	5
7	T50-P Installation Diagram.....	6
8	T100 Series Installation Diagram.....	7
9	T100-V Installation Diagram.....	8
10	<i>TURBOVALVE</i> (Pneumatically Controlled).....	10
11	<i>TURBOVALVE</i> (Electrically Controlled).....	12

TDI *TURBOTWIN*TM

FROM TECH DEVELOPMENT, INC.

1.0 GENERAL INFORMATION

The TDI *TURBOVALVE* is a versatile starting air or control relay valve available in a pilot operated version or with an integrated solenoid that eliminates extra plumbing. Its high flow capacity reduces pressure drop through the valve, providing for a broad range of applications.

An auxiliary port provides a convenient point for accessing the pressure at the supply (IN port) ... using it for indication, control or pilot actuation.

FEATURES

- Low pressure pilot
- Optional integrated solenoid versions
- 450 psig Rating (Pneumatically controlled version only)
- High flow capacity
- Replaceable O-Rings
- 1-1/4" or 1-1/2" pipe sizes
- 3-Point mounting for secure attachment
- Replaces Sealco (P/N: 10900, 11900, 14900, and 110250) and Ingersoll-Rand (P/N:SRV125 and SRV150) relay valves

SPECIFICATIONS

- Valve Housing: Aluminum (Nickel plated for corrosion resistance).
- Internal Parts: Aluminum
- O-Rings: VITON or Buna N
- Operating Temperature: -20 to 200°F (-29° to 93°C)
- Valve Working Pressure Rating: 450 psig (31 Bar) (Pneumatically controlled version only)
- Weight: 2.9 pounds (1.3 kg)
- Optional Solenoid Voltages: 12, 24, 48, 110 VDC/120 or VAC/60 Hz
- Cv = 41

2.0 OPERATION

2.1 Pneumatically controlled *TURBOVALVE*

- a. Air is supplied to the Applied Pressure Port (APP), which forces the piston to the open position. The pressure required to open the relay valve is based on the supply pressure. See figure 3.
- b. The main ports (IN and OUT) open to allow flow through the valve.
- c. When the pilot pressure is released, the spring allows the piston to retract, closing the main port.

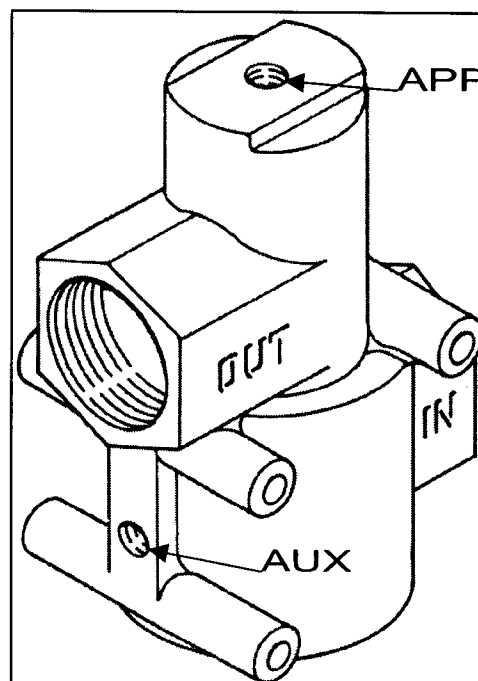


Figure 1. TurboValve-Pneumatically Controlled

2.2 Electrically controlled *TURBOVALVE*

- a. Electricity is applied to the solenoid valve allowing air to access the relay valve via the APP.

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- b. The main ports (IN and OUT) are opened to allow flow through the valve.
- c. When the start button is released, the electric solenoid vents, allowing the relay valve piston to retract, closing the main port.

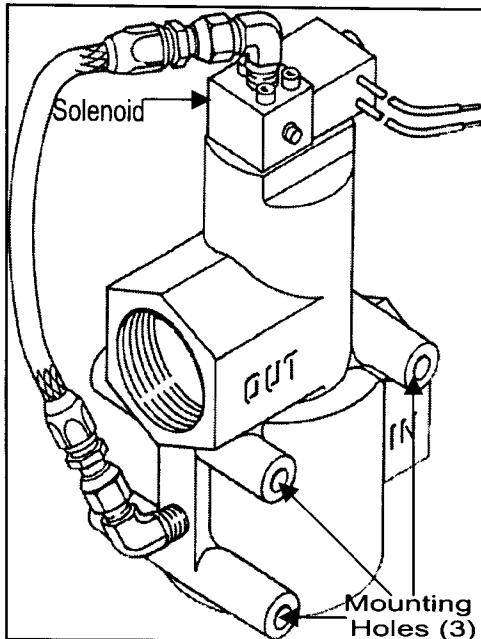


Figure 2. TurboValve-Electrically Controlled

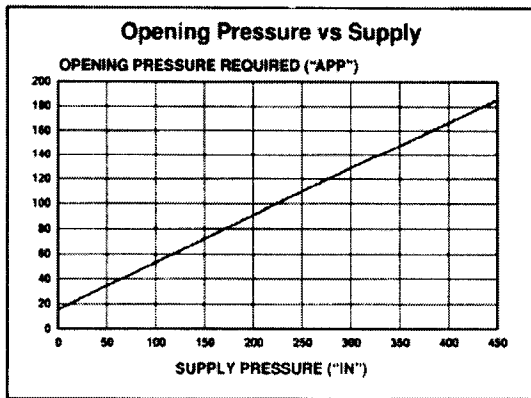


Figure 3. Opening Pressure vs. Supply

3.0 INSTALLATION

The valve may be mounted in any position using the three holes located

on the relay valve body as shown in figure 2. The air to the Applied Pressure Port (APP) should be clean and dry. Connection piping to the APP and IN ports should be cleaned to remove excess thread sealant, chips, and other foreign matter that could get trapped in the valve or the pilot chamber and cause seals to fail.

The TURBOVALVE may be ordered using the full description as shown or by specifying a Part Number using the Model Code System. Example: the Part Number for a standard pneumatic valve with a 1-1/2\" NPT threads and Buna N O-Ring is RLVA-25683-001-1-01. (Please Note: TDI RLVA-25683-001-2-00 replaces TDI 42-23356, and TDI RLVA-25683-001-1-01 replaces TDI 52-93503.)

4.0 DISASSEMBLY

WARNING

Never attempt to remove the starter relay valve or retainer snap-ring from bottom side of valve until the air pressure has been bled off. Failure to do this could result in internal parts being blown out with considerable force.

Carefully remove retaining ring (11) from relay valve housing (1).

Remove end cap (9), spring (7), and piston (4) from relay valve housing.

WARNING

If necessary, apply low pressure air to the relay valve APP to disengage the piston from valve housing. The aft end of valve must be positioned toward workbench surface to block piston as shown in figure 4.

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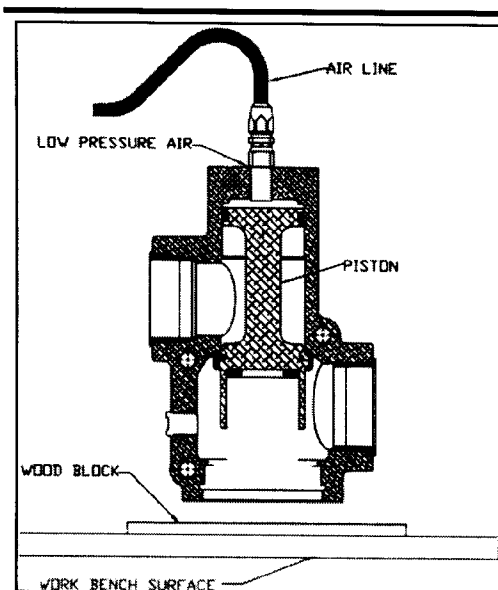


Figure 4. Piston Removal

Remove O-Rings (8,10) from end cap.

Remove O-Ring cap (6), shock dampener (5) and O-Rings (2,3) from piston (4).

5.0 ASSEMBLY

Use either 2-26119-001 (Buna N) or 2-26119-002 (Viton) repair kit to rebuild the TURBOVALVE.

Coat all O-Rings, end cap, piston, and bore of relay valve housing with a good grade of silicon based grease (TDI P/N 9-94082-001).

Place O-Rings (8,10) on end cap (9) and O-Rings (2,3) on piston (4).

Install shock dampener (5) into piston housing (4) bore.

Install O-Ring cap (6) onto piston (4) and seat over O-Ring (3).

Hand press piston assembly into relay valve housing (1) until seated.

Install spring (7) into bore of valve housing (1).

Install end cap assembly (8,9,10) into valve bore and secure with retainer ring (11).

6.0 DISASSEMBLY / ASSEMBLY (RELAY VALVE – ELECTRICALLY CONTROLLED)

Follow the above procedure to remove and install the internal parts in electrically controlled relay valve.

If necessary, rotate the connectors on the ends of the hose assembly (5) counter-clockwise to remove from relay valve assembly.

Rotate 90° elbows (4,6) counter-clockwise to remove from relay valve assembly.

Remove the screws (2) to separate the solenoid valve (1) from the relay valve housing (7).

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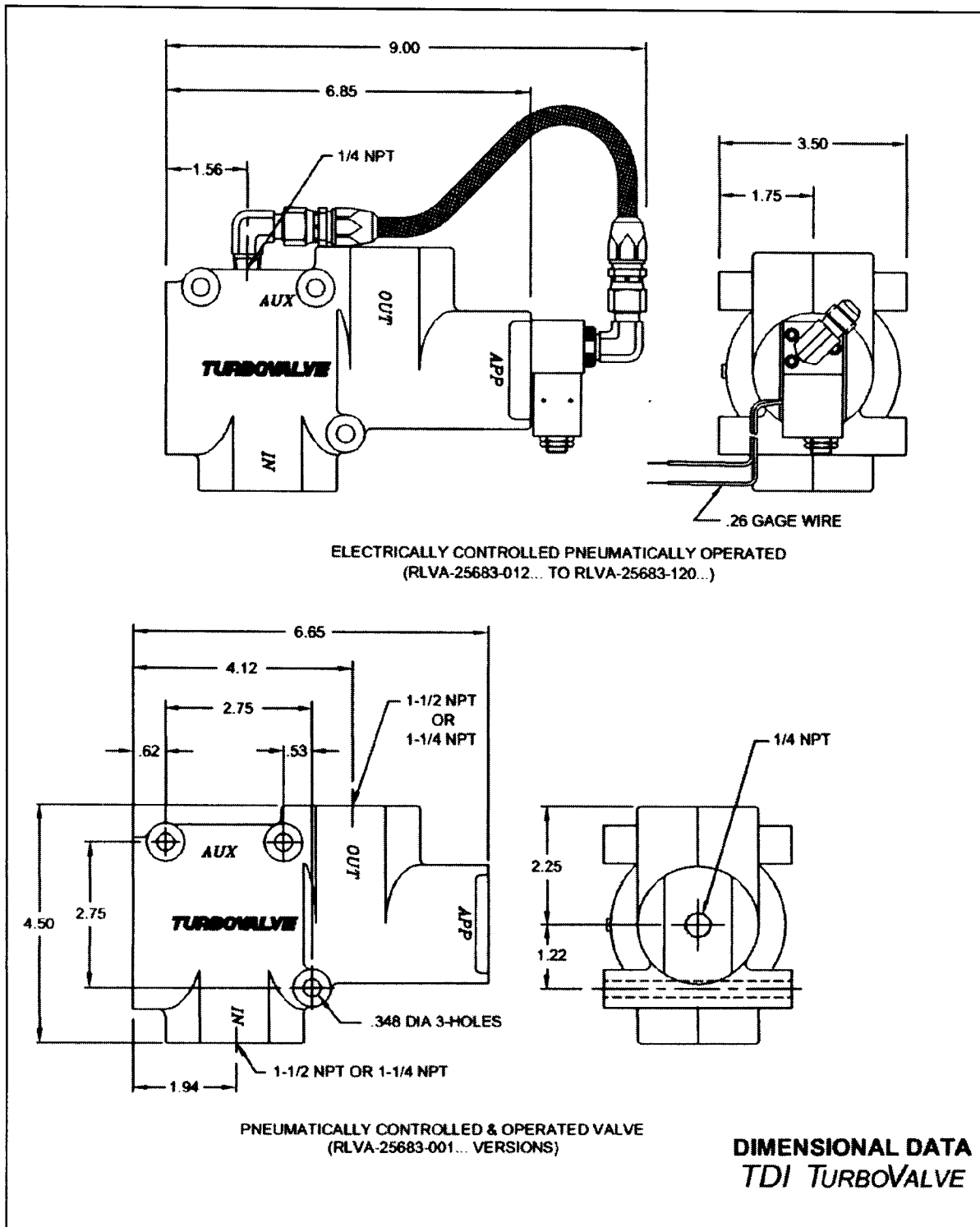


Figure 5. *TURBOVALVE* Dimensional Data

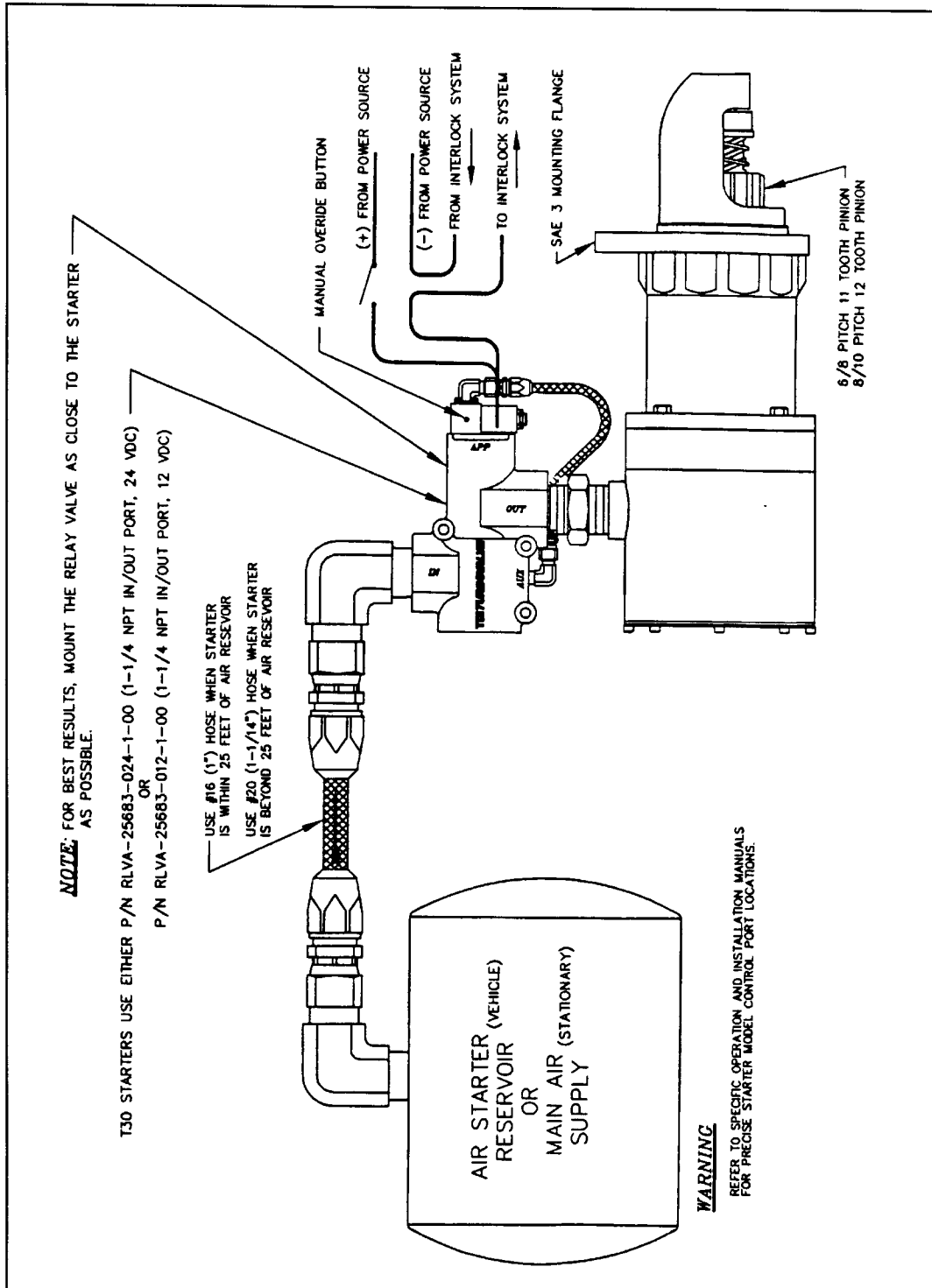


Figure 6. T30-I TURBOTWIN Air Starter Installation Diagram (Electrical)

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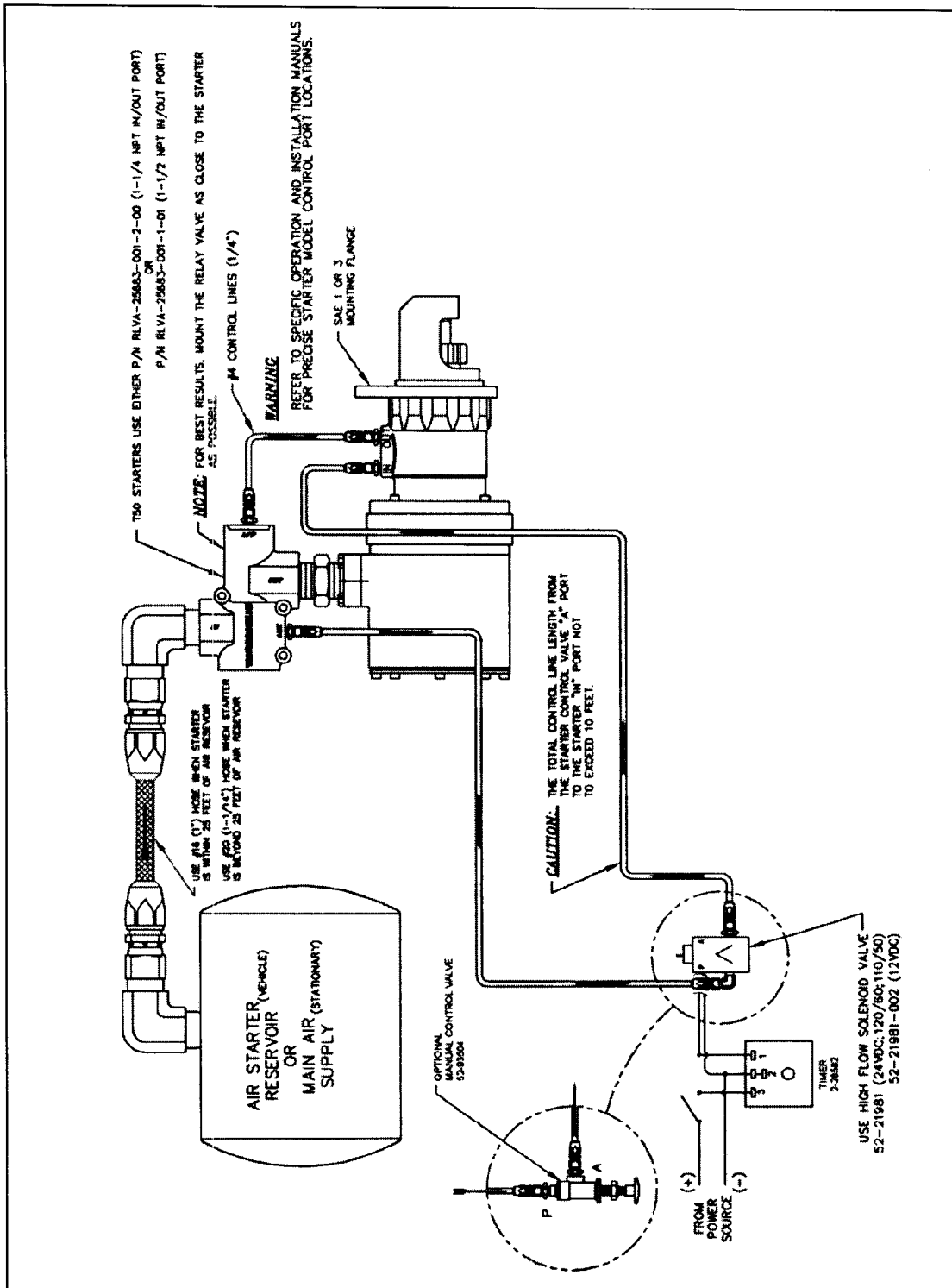


Figure 7. T50-P TURBOTWIN Air Starter Installation Diagram

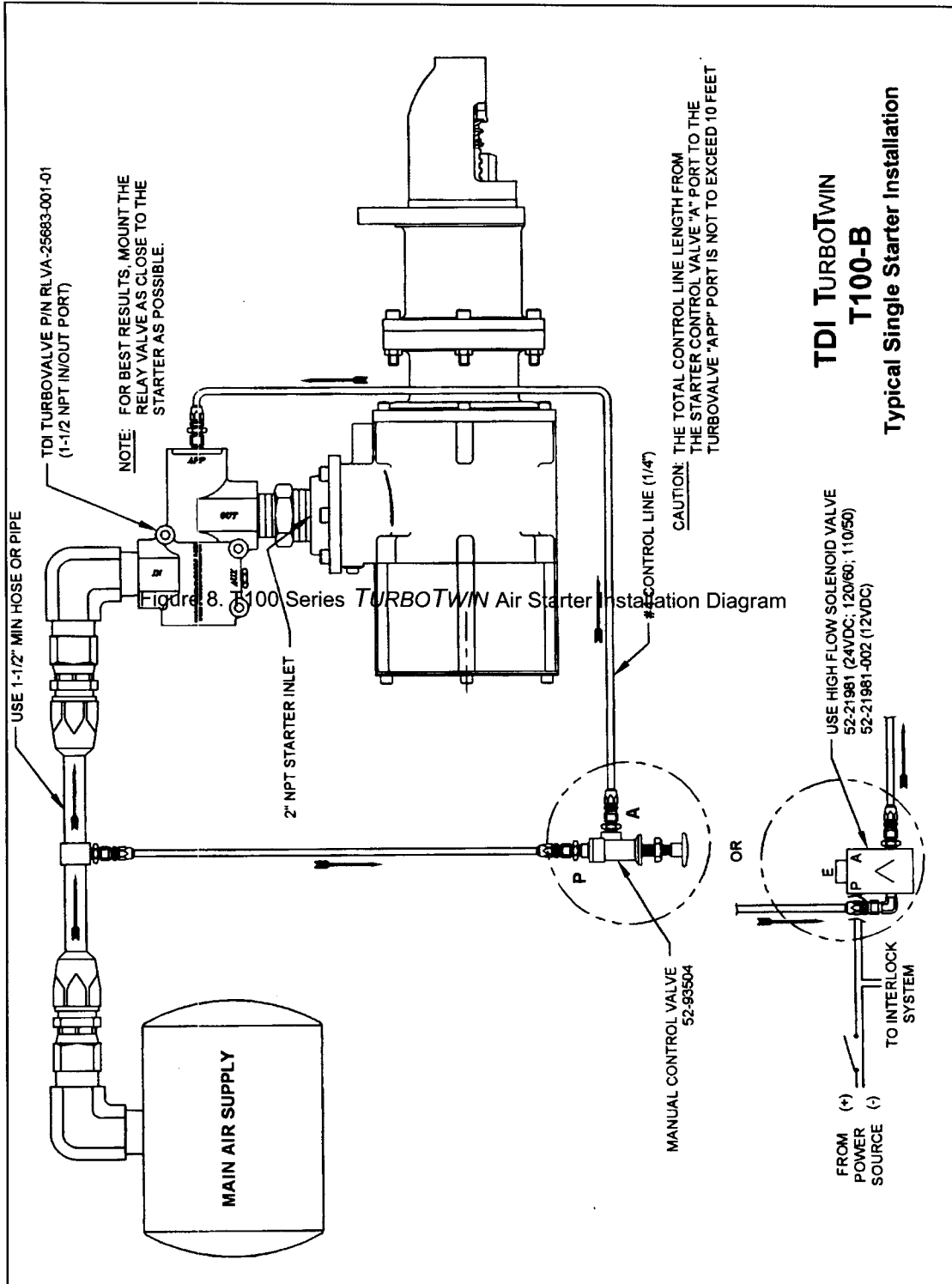


Figure 8. T100 Series *TURBOTWIN* Air Starter Installation Diagram

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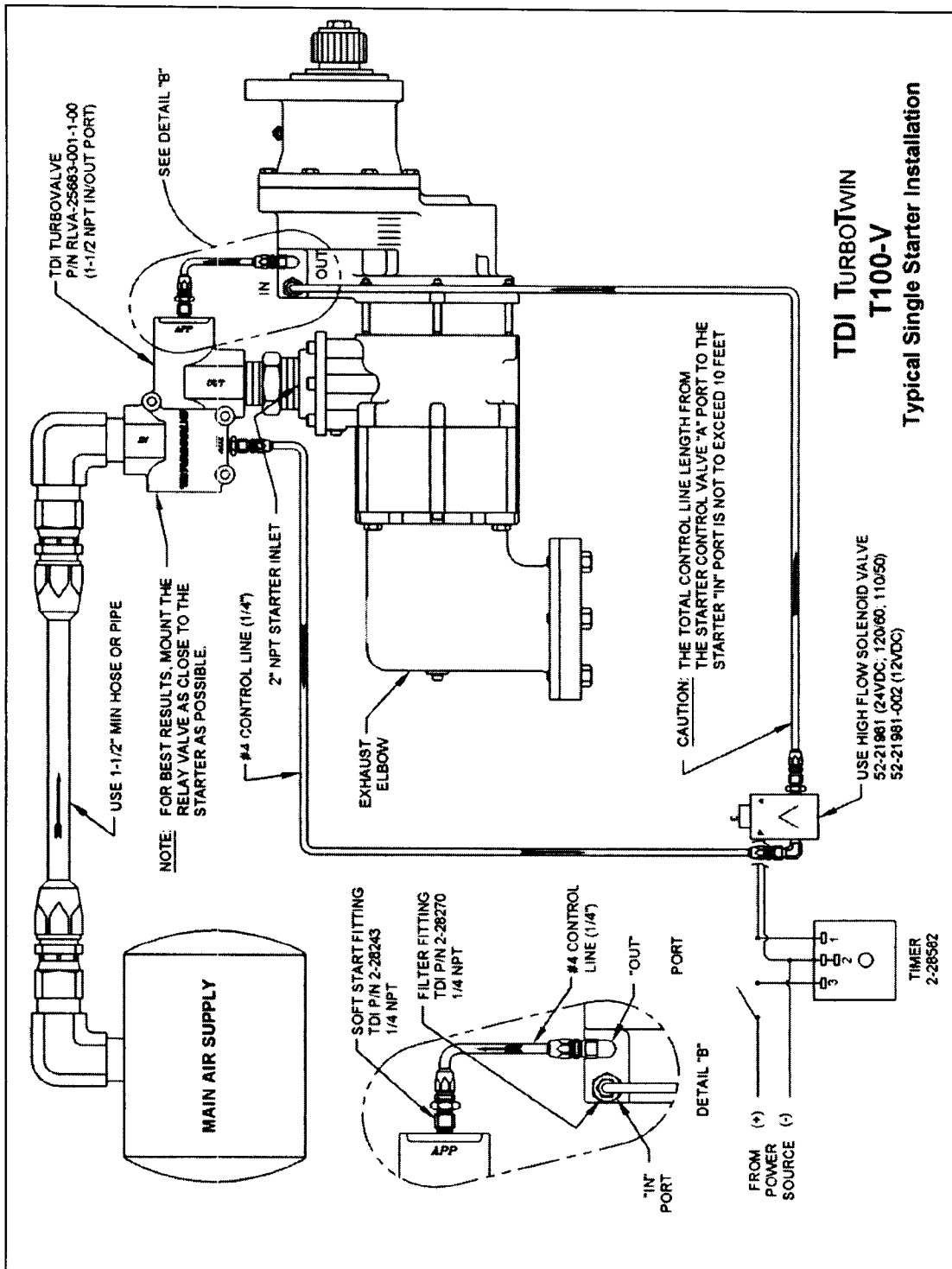


Figure 9. T100-V TURBOTWIN Air Starter Installation Diagram

6.0 ILLUSTRATED PARTS BREAKDOWN (Pneumatically Controlled)

PART NUMBER	IN PORT	OUT PORT	O-RINGS	OVERHAUL KIT
RLVA-25683-001-1	1 ¼"	1 ¼"	Buna-N	2-26119-001
RLVA-25683-001-2	1 ¼"	1 ¼"	Viton	2-26119-002
RLVA-25683-001-1-01	1 ½"	1 ½"	Buna-N	2-26119-001
RLVA-25683-001-2-01	1 ½"	1 ½"	Viton	2-26119-002

KEY NO.	DESCRIPTION	PART NUMBER
1	Housing, Relay Valve (1 ¼" NPT)	2-25764
1	Housing, Relay Valve (1 ½" NPT)	2-25764-001
2	O-Ring, Buna - N	9-90001-221
2	O-Ring, Viton	9-90002-221
3	O-Ring, Buna - N	9-90031-324
3	O-Ring, Viton	9-90030-324
4	Piston	2-25694
5	Dampener, Shock	2-25107
6	Cap, O-Ring	2-25106
7	Spring, Compression	9-90435
8	O-Ring, Buna - N	9-90001-218
8	O-Ring, Viton	9-90002-218
9	End Cap	2-25693
10	O-Ring, Buna - N	9-90001-035
10	O-Ring, Viton	9-90002-035
11	Ring, Retaining	9-92001-016

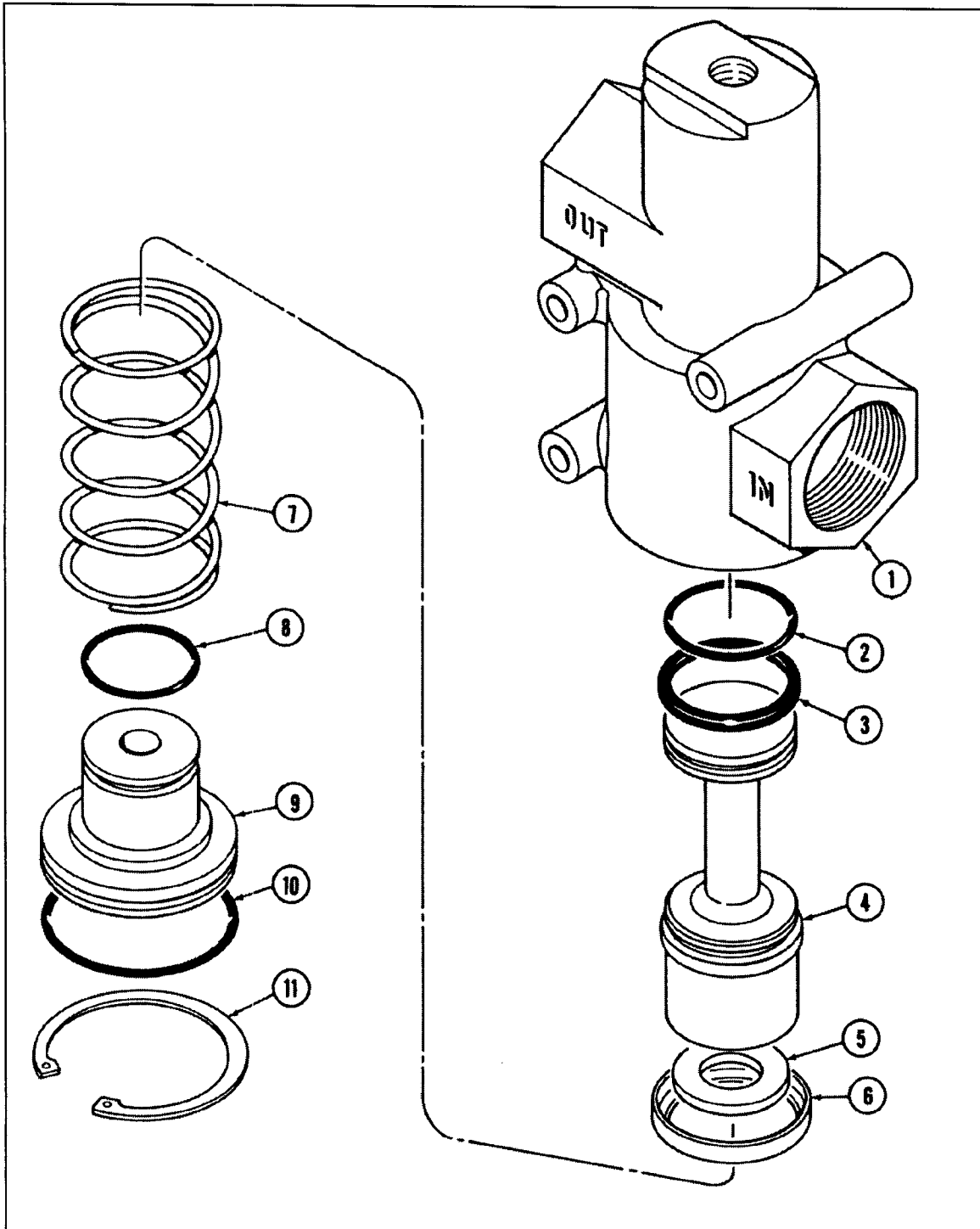


Figure 10. Exploded View of *TURBOVALVE* (Pneumatically Controlled)

7.0 ILLUSTRATED PARTS BREAKDOWN (Electrically Controlled)

PART NUMBER	IN PORT	OUT PORT	O-RINGS	VOLTAGE	VALVE PART NUMBER	OVERHAUL KIT
RLVA-25683-012-1	1 ¼"	1 ¼"	Buna-N	12 VDC	2-26324-001	2-26119-001
RLVA-25683-012-2	1 ¼"	1 ¼"	Viton	12 VDC	2-26324-001	2-26119-002
RLVA-25683-012-1-01	1 ½"	1 ½"	Buna-N	12 VDC	2-26324-001	2-26119-001
RLVA-25683-012-2-01	1 ½"	1 ½"	Viton	12 VDC	2-26324-001	2-26119-002
RLVA-25683-024-1	1 ¼"	1 ¼"	Buna-N	24 VDC	2-26324-010	2-26119-001
RLVA-25683-024-2	1 ¼"	1 ¼"	Viton	24 VDC	2-26324-010	2-26119-002
RLVA-25683-024-1-01	1 ½"	1 ½"	Buna-N	24 VDC	2-26324-010	2-26119-001
RLVA-25683-024-2-01	1 ½"	1 ½"	Viton	24 VDC	2-26324-010	2-26119-002
RLVA-25683-110-2-01	1 ½"	1 ½"	Viton	110 VDC	2-26324-003	2-26119-002
RLVA-25683-120-2-01	1 ½"	1 ½"	Viton	120 VAC	2-26324-004	2-26119-002

KEY NO.	DESCRIPTION	PART NUMBER
1	Valve (12VDC)	2-26324-001
2	Screw (3)	11F-19024-020
3	O-Ring, Buna - N	9-90001-010
3	O-Ring, Viton	9-90002-010
4	Elbow, 90° Male	9-93565-001
5	Hose Assembly	1P-23448-001
6	Elbow, 90° Male	9-93565-002
7	Housing, Relay Valve (1 ¼" NPT)	2-25692
7	Housing, Relay Valve (1 ½" NPT)	2-25692-001
8	O-Ring, Buna - N	9-90001-221
8	O-Ring, Viton	9-90002-221
9	O-Ring, Buna - N	9-90031-324
9	O-Ring, Viton	9-90030-324
10	Piston	2-25694
11	Dampener, Shock	2-25107
12	Cap, O-Ring	2-25106
13	Spring, Compression	9-90435
14	O-Ring, Buna - N	9-90001-218
14	O-Ring, Viton	9-90002-218
15	End Cap	2-25693
16	O-Ring, Buna - N	9-90001-035
16	O-Ring, Viton	9-90002-035
17	Ring, Retaining	9-92001-016

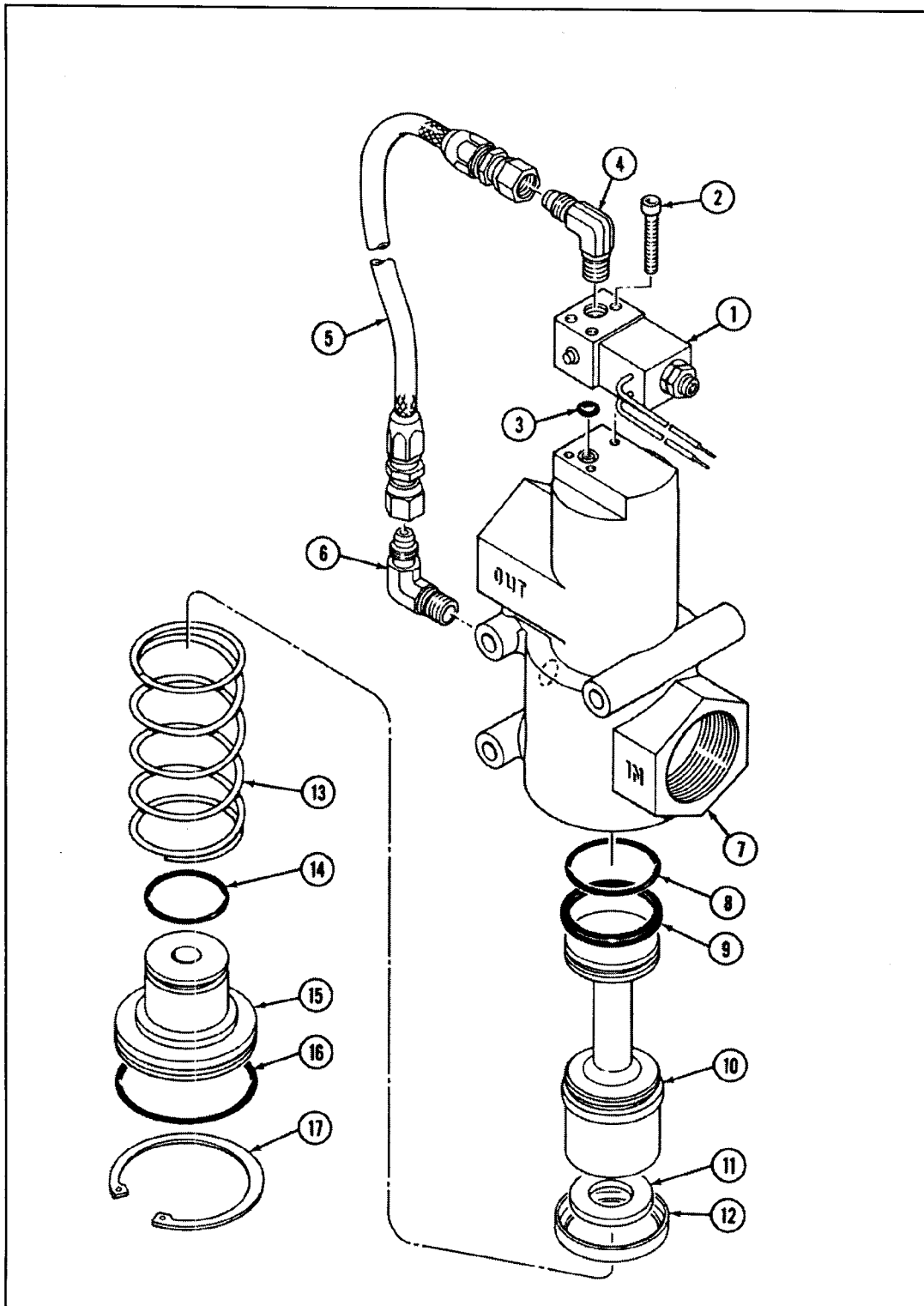


Figure 11. Exploded View of *TURBOVALVE* (Electrically Controlled)

TABLE OF CONTENTS

SECTION	SUBJECT	PAGE
1.0	GENERAL INFORMATION	2
1.1	DESCRIPTION	2
1.2	PRODUCT IDENTIFICATION	2
1.3	PERFORMANCE	3
2.0	ORIENTATION OF THE STARTER	3
2.1	GENERAL	3
3.0	INSTALLING THE STARTER	3
3.1	SUPPLY LINE INSTALLATION	3
3.2	NLET PRESSURE PORT	4
3.3	EXHAUST PIPING	4
3.4	NATURAL GAS INSTALLATION	4
3.5	PIPING SYSTEM	4
3.6	BACKLASH	5
4.0	STARTER OPERATION	5
4.1	BASIC OPERATION	6
4.2	AUTOMATED START PANEL	6
5.0	PREVENTIVE MAINTENANCE	6
6.0	TROUBLE SHOOTING GUIDE	7
7.0	<i>TURBOTWIN</i> WARRANTY	8

LIST OF FIGURES

1. TURBOTWIN PART NUMBER LISTING
2. MODEL T112B/T121B INSTALLATION DRAWING
3. MODEL T106F/T112F INSTALLATION DRAWING
4. MODEL T112D/T121D INSTALLATION DRAWING (STD MESH)
5. MODEL T112D/T121D INSTALLATION DRAWING

TDI *TURBOTWIN*

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1.0 GENERAL INFORMATION

This manual provides instructions for the installation and operation of the TDI T100 *TURBOTWIN* Starters (Series: B,D,F,P). If there are questions not answered in this manual, please contact your TDI *TURBOTWIN* distributor or dealer for assistance.

The T100 *TURBOTWIN* models are turbine driven starters with an inertially engaged starter drive. Depending on the starter model and engine installation, the *TURBOTWIN* starters have applications ranging from 1200 CID (20 Liters) on diesel engines and up to 15000 CID (250 Liters) on gas engines. The *TURBOTWIN* models are suited to operate within a wide range of inlet pressures and ambient temperatures. The engine size and parasitic loading will determine the exact minimum pressure that will assure reliable starting.

The T100 *TURBOTWIN* starters are designed for operation with compressed air or natural gas; materials used are compatible with "sour" natural gas and marine environments. Small amounts of foreign matter or liquid in the air stream will not adversely affect *TURBOTWIN* starters. As with all other TDI starters, no lubrication is required in the air supply.

Please review the rest of this manual before installing the T100 *TURBOTWIN* series air starter.

WARNINGS, CAUTIONS AND NOTES

Certain types of information are highlighted in this manual for your attention:

WARNING - used where injury to personnel or damage to the equipment is likely.

CAUTION - used where there is the possibility of damage to the equipment.

NOTE - used to point out special interest information.

NOTE

Throughout this manual, the term "air" is used to designate the starter drive medium. Unless other wise stated, air " means either compressed air or natural gas.

1.1 DESCRIPTION

All models feature three basic subassemblies: a unique two stage turbine motor section, a planetary gearbox section and an inertia drive assembly.

The two stage motor section features greater stall torque than a single stage turbine plus aerodynamic speed control.

This aerodynamic speed control helps protect the *TURBOTWIN* starter from damage caused by starter motor over speed.

The T100 *TURBOTWIN*S employ a 7.5:1 or 9:1 ratio planetary gearbox. This low gear ratio allows the turbine motor to spin at low speeds for long bearing life. At a typical 3000 rpm pinion speed, the turbine is cruising at a low 22500 rpm (7.5:1 ratio). Reliability and part commonality are designed into all *TURBOTWIN*S.

A simple and reliable inertia drive delivers the torque to the pinion. The pinion is thrown out to engage the engine's ring gear by the turbine motor's acceleration. Lighter weight rotating parts used in the *TURBOTWIN* provide low inertia and even "softer" engagement. In the event of over-pressure, the friction clutch used in every *TURBOTWIN* protects ring gear teeth from static torque overloads. In addition, an inertia engaged starter eliminates the need for complex pre-engagement control plumbing...and is easier to install and maintain than pre-engaged type starters.

Compressed air or natural gas is used to power T100 *TURBOTWIN* air starters through the inlet port. The air or gas is expanded through the first nozzle or stators. The high velocity gas impinges on the first stage rotor to yield torque to the gearbox. The gas is further expanded through the second stage stators, which impart additional torque to the second stage rotor.

1.2 PRODUCT IDENTIFICATION

The starter nameplate which is attached to the turbine housing contains the following information: model number, serial number, part number, direction of rotation and the maximum rated operating pressure.

The directions of rotation are either right hand or left hand rotation as shown in Figure 1. Right Hand rotation is defined as clockwise rotation as viewed from the pinion end of the starter, and Left Hand rotation is counter clockwise rotation viewed from the pinion end of the starter.

The maximum operating pressure is also stamped on the nameplate. This pressure is measured at the check port on the starter inlet with the starter in operation.

CAUTION

Exceeding the maximum pressure shown on the nameplate may result in drive failure, damage to the starter, or damage to the engine.

The housing proof pressure is 600 psig and is also shown on the nameplate. This means the turbine housing will not burst when subjected to a static pressure of 600 psig.

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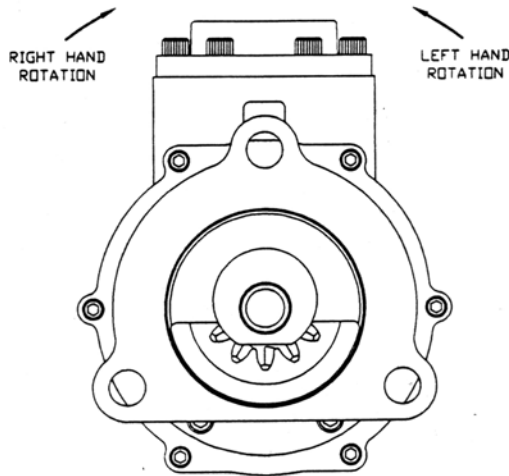


Figure 1. Direction of Rotation viewed from Pinion End.

1.3 PERFORMANCE

Graphs of the performance curves feature pinion torque versus pinion speed (rpm) at constant drive air pressures and shaft horsepower versus pinion speed at constant drive air pressures. Pinion speed is shown on the horizontal axis. The pinion torque is shown along the left edge vertical axis. The shaft horsepower is shown along the right edge vertical axis. Air consumption rates are given for the various drive pressure lines. These performance curves feature air as the drive gas and have open exhaust (standard exhaust guard) which have no back pressure.

2.0 ORIENTATION OF THE STARTER

2.1 GENERAL

If the factory orientation of the starter's pinion housing assembly in relation to the inlet port does not fit your engine installation, these components can easily be re-oriented.

All **TURBOTWIN**s have the capability to rotate the inlet port relative to the drive opening for the optimum inlet port location. The number of different positions is 6 to 12 depending on model.

3.0 INSTALLING THE STARTER

A turbine air starter does not require lubrication in the supply air. Therefore, if a vane type starter motor is being replaced, TDI recommends that all lubrication devices and lines removed to minimize flow restrictions.

WARNING

If a fuel (pulse) lubricator has previously been installed in the system, disconnect and plug the line to eliminate spraying diesel fuel on the engine.

The starter should be installed with the inlet in a position between horizontal and straight down. Any condensation will be restricted to the air lines and not in the starter.

WARNING

Do not operate this starter unless it is properly connected to an engine.

3.1 SUPPLY LINE INSTALLATION

WARNING

Be sure to either bleed the pressurized air reservoir and/or safety the system such as closing all valves prior to installing starter supply line.

The **T100 TURBOTWIN series** air starters come standard with a 2" NPT female pipe thread for the inlet connection port. The supply line consists of the line from the air source, a pressure regulator (when necessary), a manual or relay valve, and the connection to the starter inlet. Hard piping may be used, but a section of flexible tubing should be installed at the starter to prevent leaks due to engine vibration.

Care must be taken to ensure that all inlet supply line piping is no less than 1.5" and all components used are capable of passing the required air flow.

NOTE

Valves with a Cv of 40 or higher are recommended.

If the supply line must be longer than 20 feet, the inlet supply line piping should be increased to 2" in diameter to ensure proper performance by your **TURBOTWIN**.

Because turbine starters such as the **T100 TURBOTWIN series** are sensitive to flow restrictions, care must be taken to use uniform hose or tubing and fittings for connection of the supply line. Tees, elbows and line length must be kept to a minimum. TDI recommends that hose or flex couplings are installed to eliminate possible leakage caused by strain on the supply line.

Normally, an air strainer is not required. However, in dirty environments use of a #40 mesh Y-strainer is recommended. The **T100 TURBOTWIN series** is highly tolerant of dirt in the air line, however, starter life can be increased with the use of an air strainer.

TDI *TURBOTWIN*

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A pressure regulator is required when the air supply pressure is great enough to exceed the starter operating pressure (at the inlet port) and/or the maximum torque.

A manual ball valve may be used to admit drive air/gas to the starter. The manual valve should be located in a safe position away from the engine.

A preferred valve is pilot-operated, which can be pneumatically or electrically actuated. The valve should be located close to or even on the starter inlet for best performance. Pneumatic or electrical control lines may be routed virtually anywhere for the customer's preferred operating station. This type of valve actuates from a fully closed to a fully open position very rapidly. TDI offers a variety of relay valves such as P/N RLVA-25683-001-2-01, which is a 1-1/2" port, pneumatically actuated valve.

The supply line should be dry-fitted for proper alignment /location prior to final assembly. All pipe threaded joints should be sealed with Loctite Pipe Thread Sealant (TDI P/N 9-94085) or equivalent for leak tight joints prior to final assembly. Be sure to tighten all joints to proper torque after final assembly.

CAUTION

In cold weather climates, care should be taken while designing your installation to prevent condensation from developing in the starter system. In systems with a regulator valve or relay valve, there is the possibility of freeze-ups.

A tee connection with a quick disconnect can be added to the inlet. This will allow an external air source to be used to accomplish a "blow start" if the system freezes. Once the engine has been started, the other system components may be thawed.

CAUTION

On new installations, it is strongly recommended to blow out the supply line with air to remove possible dirt and welding slag prior to final connection to the *TURBOTWIN* starter. Be sure to secure the free end of the supply line prior to blowing out the line.

3.2 INLET PRESSURE PORT

A 1/4" NPT port is located on the air inlet. This port may be used to check the supply pressure at the starter when the starter is operating. Remove the 1/4" NPT pipe plug and save for later use. Install a 1/4" minimum size tubing to the port. Route the tubing away from the starter to a safe location away from the engine. Install a pressure gauge on the tubing. This pressure monitoring line/gauge may be permanently installed. Use Loctite Pipe Thread Sealant or equivalent. Alternately, a pressure transducer may be

installed at the pressure check port and electrical lines routed to a digital display at the operator's station.

This pressure port is invaluable in diagnosing air starter and/or installation problems.

3.3 EXHAUST PIPING

The turbine exhaust may be plumbed away from the starter area. All starters using natural gas must be piped according to industry codes and local regulations.

The performance of a turbine starter will be decreased because of back pressure when smaller than recommended exhaust piping is installed. If back pressure hampers starter performance, compensation can be made by increasing the supply pressure. Consult your TDI distributor for advice.

Exhaust piping should be routed downward to help prevent any accumulation of condensation in the starter motor.

If the overhung section of the starter is not otherwise supported, TDI recommends supporting the exhaust piping with a suitable bracket(s).

Exhaust piping should be routed downward to help prevent any accumulation of condensate in the starter motor.

3.4 NATURAL GAS INSTALLATION

The installation of the starter using natural gas is similar to the air installation except all fittings, piping, valves and regulators must be compatible with natural gas.

Proper control of natural gas is a major consideration when used in the starter system. All starters using natural gas must pipe the exhaust according to industry codes and local regulations.

There is a natural gas vent port in the turbine housing that is plugged for compressed air use. This vent is used to remove any natural gas that could leak past the primary turbine shaft seal. Remove this 3/8"NPT plug and install a line to carry gas away from the starter area.

WARNING

Do not connect the turbine housing vent line to the turbine exhaust line. Exhaust gas can pressurize the housing.

3.5 PIPING SYSTEM

Only type approved metallic hose assemblies are approved in permanently pressurized compressed air lines of starters. Non-metallic hose assemblies are allowed only in case the piping system will be emptied after the starting procedure.

Pipe unions must be type approved by GL. Downstream of the pressure regulator a pressure relief valve is to be provided.

3.6 BACKLASH

Backlash is the "free play" between the mesh of two gears. Figure 15 shows the backlash between two gears. Maintaining the proper gear backlash setting allows the gears to mesh smoothly. Proper backlash and alignment allows smooth engagement/disengagement of the pinion gear and loads the tooth face surfaces evenly producing longer gear life. The correct backlash setting for 6/8 diametral pitch gearing used on larger engines is as follows:

Minimum backlash	.015 inch
Maximum backlash	.025 inch

To check the backlash, the pinion will need to be rolled out onto the end of the drive prior to starter installation. This can be accomplished by using a hex drive wrench to rotate the turbine end of the starter while holding the pinion from rotating. The pinion will simply walk to the end of the shaft. An access hole to reach the turbine screw is provided in the turbine exhaust guard. The starter must then be installed on the engine. Checking backlash can be accomplished using a dial indicator or a simple blade-type feeler gauge. Because ring gears are not usually perfectly round, it is necessary to

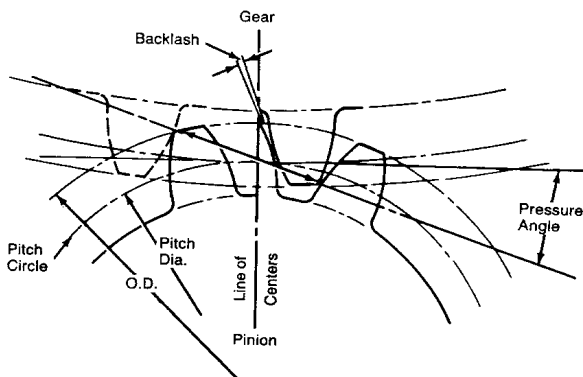


Figure 2. Checking Backlash

check backlash at several (six or more) points around the circumference of the ring gear. Average the highs and lows to allow a setting that is in the range cited above.

Setting the correct backlash may involve "shimming" and/or moving the starter bracket(s). An adjustable starter bracket design will simplify this procedure. Always re-check the backlash after a ring gear replacement.

Liberal grease the starter's drive teeth with chassis lube and then mount the **TURBOTWIN** starter on the engine. Tighten all mounting hardware as appropriate. Make sure to use Loctite Threadlocker #290 or equivalent on the starter

mounting bolts. Torque the three 5/8" screws to 100 lb-ft.

4.0 STARTER OPERATION

Prior to operation, check that all connections are tight and free from leaks. Check the 1/4" NPT pipe plug or a pressure gauge/transducer that may be connected to the pressure port on the starter inlet.

WARNING

Do not operate the TDI *TURBOTWIN* starter with air pressure greater than the pressure rating on the nameplate. This pressure is measured at the starter inlet while the starter is running.

The maximum operating pressure limit is the inlet pressure measured at the starter's inlet pressure check port. In order to check the starter, a 1/4"NPT pipe tap connection is provided in the inlet housing to attach a pressure gauge/transducer). The maximum pressure assumes an open exhaust (standard turbine exhaust guard). The standard exhaust guard causes no back pressure.

The static non-flowing supply pressure will always be higher than the operating (dynamic) pressure. The maximum pressure limit (proof pressure) that the TDI *TURBOTWIN* starter housings may be subjected to is 600 PSIG (42 BAR). System pressure that exceeds the maximum operating limit must use a pressure reducing device to ensure that the operating pressure limit to the TDI *TURBOTWIN* starter is maintained.

System static pressure that exceeds the 600 PSIG (42 BAR) limit must, in addition to pressure reducer devices incorporate a pressure relief valve set below 600 PSIG (42 BAR) in the supply air line.

NOTE

For maximum life of the starter pinion and for the protection of the engine ring gear, limit the operating pressure to that necessary to start the engine at its most difficult starting conditions.

All appropriate local pressure codes and pressure limitations on other system components must be adhered to and supersede the guidelines given in this manual.

Consult your TDI distributor if you have exhaust plumbing that creates back pressure and reduces starter performance. You may be able to increase the supply pressure to restore the lost power.

Follow the engine manufacturer's instructions for starting the engine.

4.1 BASIC OPERATION

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The basic operation of the starter is as follows:

Pressurized air or natural is admitted to the starter by opening of the manual or relay valve. The air expands through the turbine, which produces shaft rotation and torque. The acceleration of the drive assembly causes the pinion to advance and engage the ring gear of the engine.

The starter motor torque causes the engine to accelerate. This acceleration causes the pinion to be disengaged from the ring gear. The fuel and ignition systems now fire the engine. Closing the relay valve stops the starter.

The operator may decrease starter life by the continual operation of the starter after the engine has started. Upon a successful engine start, turn the air off to the starter immediately. Minimizing the time the starter is operating unloaded (i.e. the engine is running) will maximize starter life. If a start is aborted, a restart may be attempted after the engine and the starter has come to rest.

CAUTION

Do not engage the starter while the engine is running.

The drive air pressure is the primary starter control parameter. It is important, especially on new installations, to measure this pressure during several engine starts. The secondary parameter is the starter pinion speed. This speed is usually measured by knowledge of the engine starting speed and the starter cranking ratio. The cranking ratio is the number of ring gear teeth divided by the number of pinion teeth. The starter pinion speed is then found by multiplying the engine speed by the cranking ratio. The pinion speed is usually 2000-3500 rpm at typical engine starting speed.

4.2 AUTOMATED START PANEL

The starter drive pressure measured at the starter inlet must be set. As noted above, for maximum life of the starter pinion and for the protection of the engine ring gear, limit the operating pressure to that necessary to start the engine at its most difficult starting conditions.

The speed control parameter will then need to be set. Engine starting speed along with the cranking ratio number can be used to determine starter pinion speed. The pinion speed is usually 2000-3500 rpm for a typical engine starting speed. Once the start sequence has begun, the air is admitted to the starter. The starter begins to accelerate the engine. Once the firing speed of the engine is reached, the automated start panel may deliver fuel to the engine. The engine will begin to accelerate under its own power. The starter should be dropped out of the sequence at a rpm higher than the firing speed, but less than the engine idle

speed.

The automated start panel should monitor engine speed to determine air on and air off. Do not simply use time as a control parameter. Avoiding excessive operation of the starter after the engine is firing will maximize the starter life.

5.0 PREVENTIVE MAINTENANCE

The TDI *TURBOTWIN* starters provide distinct advantages of size and efficiency as compared to electric motor, vane-type or other turbine-type starters. It is important to properly install the starter to receive full benefit of these advantages. Repair technicians or service organizations without turbine starter experience should not attempt to repair this machine until they receive factory approved training from TDI, or its representatives.

Proper operation and repair of your TDI *TURBOTWIN* starter will assure continued reliable and superior performance for many years.

5.1 Every Six (6) Months

Perform the following procedures at six(6) months intervals if the normal cranking cycle is 0 - 10 seconds.

5.1.1 Check the amount and condition of grease in the planetary gearbox. If gearbox requires re-greasing, only use TDI grease. Approximately one (1) pint of grease is needed to repack the gearbox.

5.1.2 Check the turbine bearing and carrier output bearings for freedom of rotation without excessive play between races. If bearings are damaged, replace them with genuine TDI parts. Refer to TDI Service Manual for part numbers.

5.1.3 Place a small amount of chassis lube on the starter's pinion teeth.

5.2 Every Three (3) Months

Follow the six (6) month procedures if there is severe starter loading or extended duration crank cycles. Also perform these procedures every three (3) months when starter is used for motoring the engine for maintenance or valve adjustments.

Motoring Crank Cycle: 10 -60 seconds

Extended Crank Cycle: 60 seconds or longer

starter, use only genuine TDI replacement parts. The component part numbers are found in the Illustrated Parts Breakdown.

6.0 TROUBLESHOOTING CHART

TROUBLE	PROBABLE CAUSE	SOLUTION
1. Starter does not run; small air flow from exhaust.	A. Relay valve not fully open.	A. Repair or replace relay valve.
	B. Nozzle blockage.	B. Remove blockage or obstruction from nozzles.
2. Starter does not run; normal air flow from exhaust.	A. Broken turbine rotor.	A. Replace all damaged parts.
	B. Broken gear train.	B. Repair or replace geartrain.
	C. Damaged starter drive.	C. Repair or replace starter drive.
3. Reduced Starter output power.	A. Inlet air pressure too low.	A. Increase air pressure in 10 PSIG (0.6 BAR) increments; DO NOT EXCEED OPERATING LIMIT.
	B. Inlet supply piping too small.	B. Supply piping must be a minimum of 1.5" diameter.
	C. Pressure regulator orifice too small.	C. Increase orifice size or replace pressure regulator
	D. Inlet supply line valve (ball, gate, relay, plug) too small.	D. Install larger valve.
	E. In line lubricator installed in supply line.	E. Remove lubricator.
	F. Y-Strainer in supply line clogged.	F. Clean strainer.
	G. Excessive back pressure; exhaust restricted.	G. Clean exhaust piping or increase size to at least the minimum diameter recommended.
	H. Damaged turbine nozzle.	H. Replace turbine nozzle.
	I. Broken started drive.	I. Repair or replace starter drive.
	J. Wrong rotation starter.	J. Replace with starter or proper rotation.
	K. Wrong size starter.	K. Check the Application Guide for the correct starter.
4. Engine cranks too quickly.	A. Inlet air pressure too high.	A. Decrease air pressure in 10 PSIG (0.6 BAR) increments. OR If there is a manual shut-off valve in the supply line, partially close it. OR Install a restriction orifice in the inlet supply line.
	B. Wrong size starter.	B. Check the Application Guide for the correct starter.

TDI TURBOTWIN

FROM TECH DEVELOPMENT INC

7.0 WARRANTY

TDI TURBOTWIN ENGINE STARTER WARRANTY

Tech Development Inc. (TDI) warrants to the original user of the TDI TurboTwin™ Model T30 Series air starters to be free from defects in material and workmanship for a period of one year from date of purchase by such user. The warranty period shall begin on the actual delivery date to the original user or twelve (12) months from the date of shipment from TDI, whichever comes first. The conditions of this warranty are: **a)** TDI is notified within this period by return of such product to TDI or its authorized distributor or dealer, transportation prepaid by user; **b)** such product has been installed according to TDI's specifications; **c)** such product has not been misused, abused or improperly maintained by user; **d)** the defect is not the result of normal wear and tear; and **e)** such starter product has not been repaired with parts not manufactured or authorized by TDI, and TDI installation and repair procedures as outlined in the appropriate manual were properly followed.

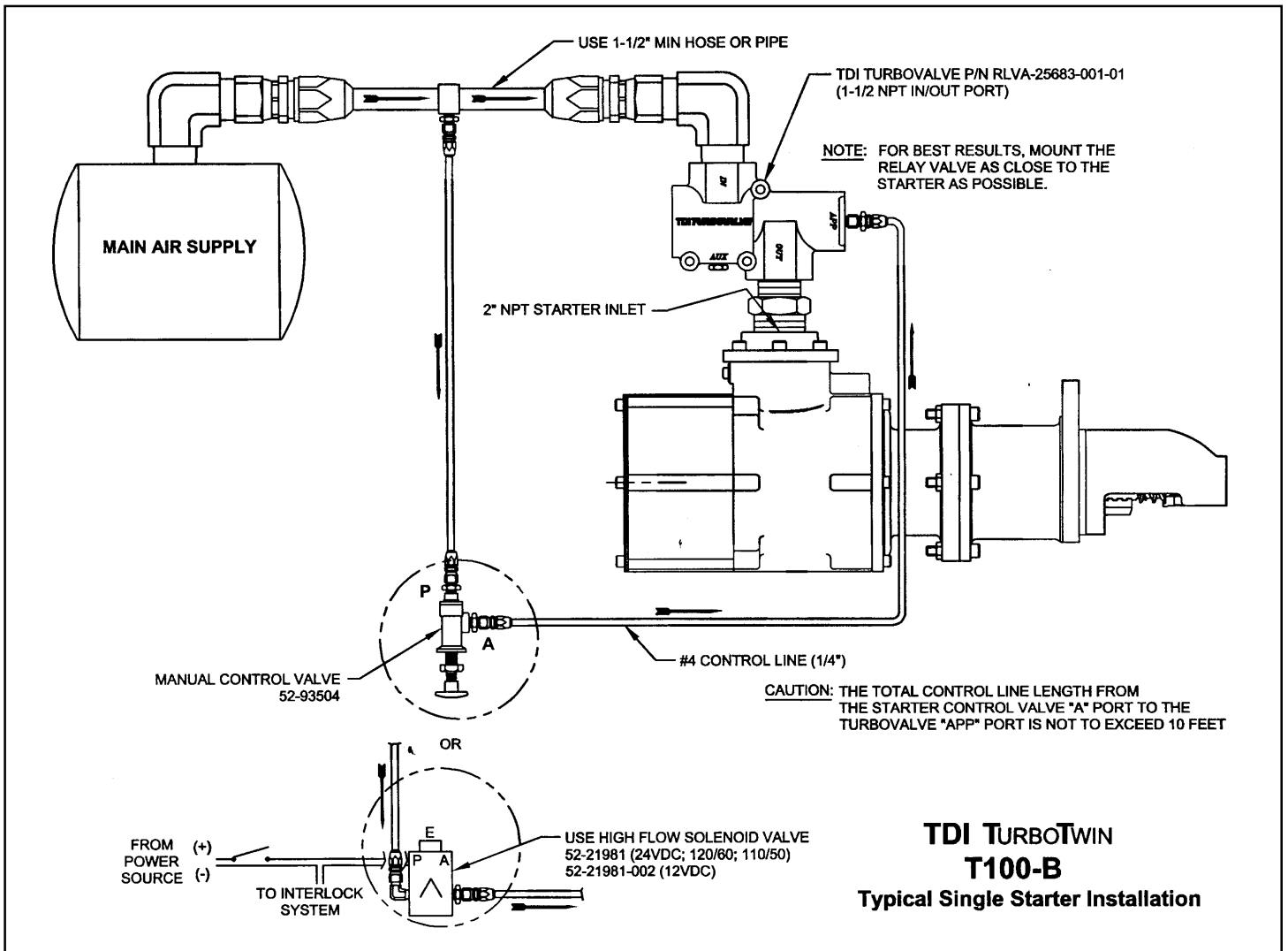
Tech Development Inc. shall, at its option, either repair or replace, without charge, any such starter product found by TDI's examination to be defective, or by mutual agreement, refund the user's purchase price in exchange for such starter product. Repairs or replacements are warranted for the remainder of the original warranty period.

Tech Development Inc. makes no other warranty, and IMPLIED WARRANTIES INCLUDING ANY WARRANTY OR MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE ARE HEREBY DISCLAIMED.

This warranty constitutes the entire obligation of Tech Development Inc. relating to the sale and use of such product, and TDI's maximum liability is limited to the purchase price of such product at the date of purchase. In no event shall TDI be liable for incidental, indirect, consequential or special damages of any nature arising from the sale or use of such engine starter product.

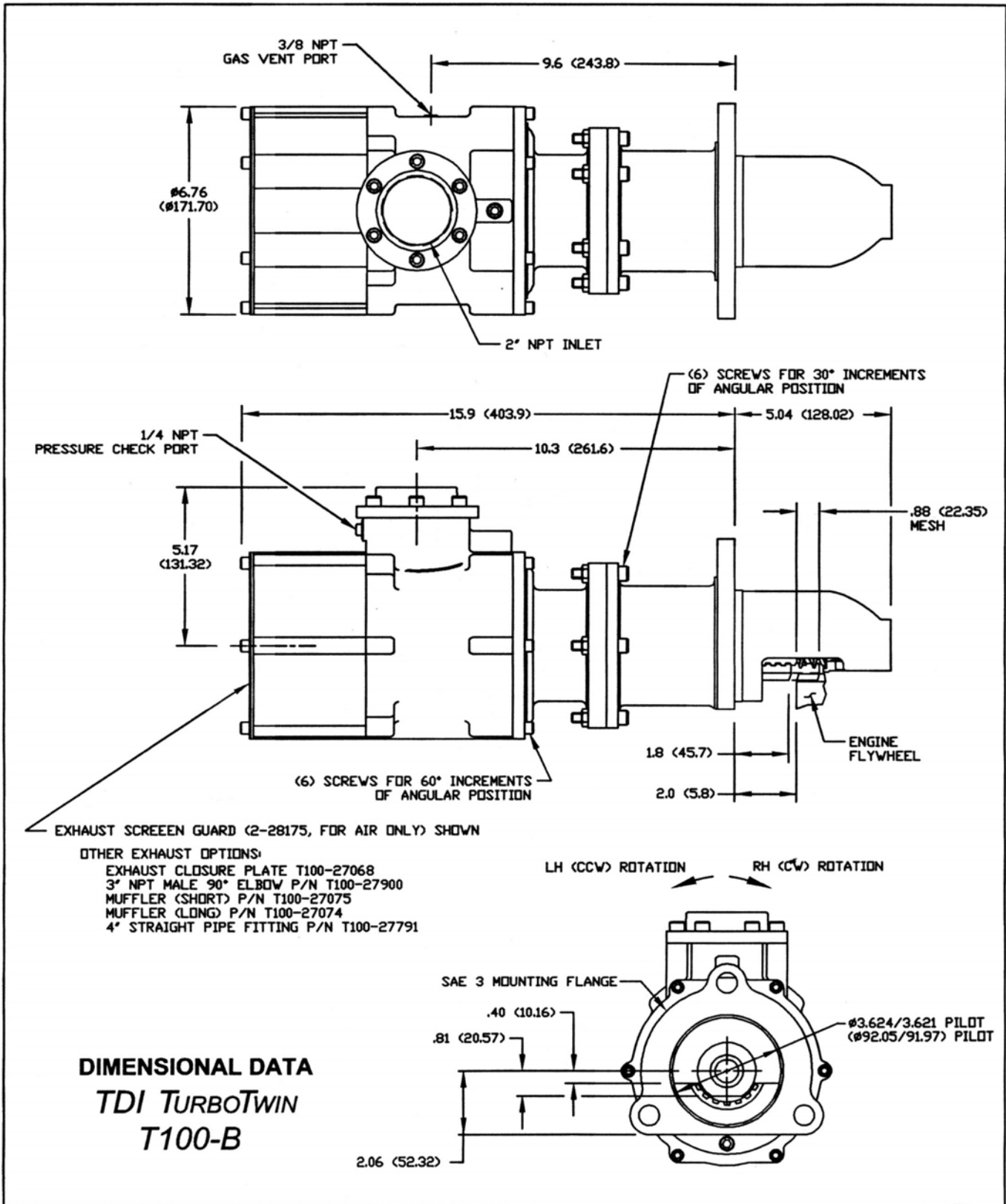
TDI TURBOTWIN

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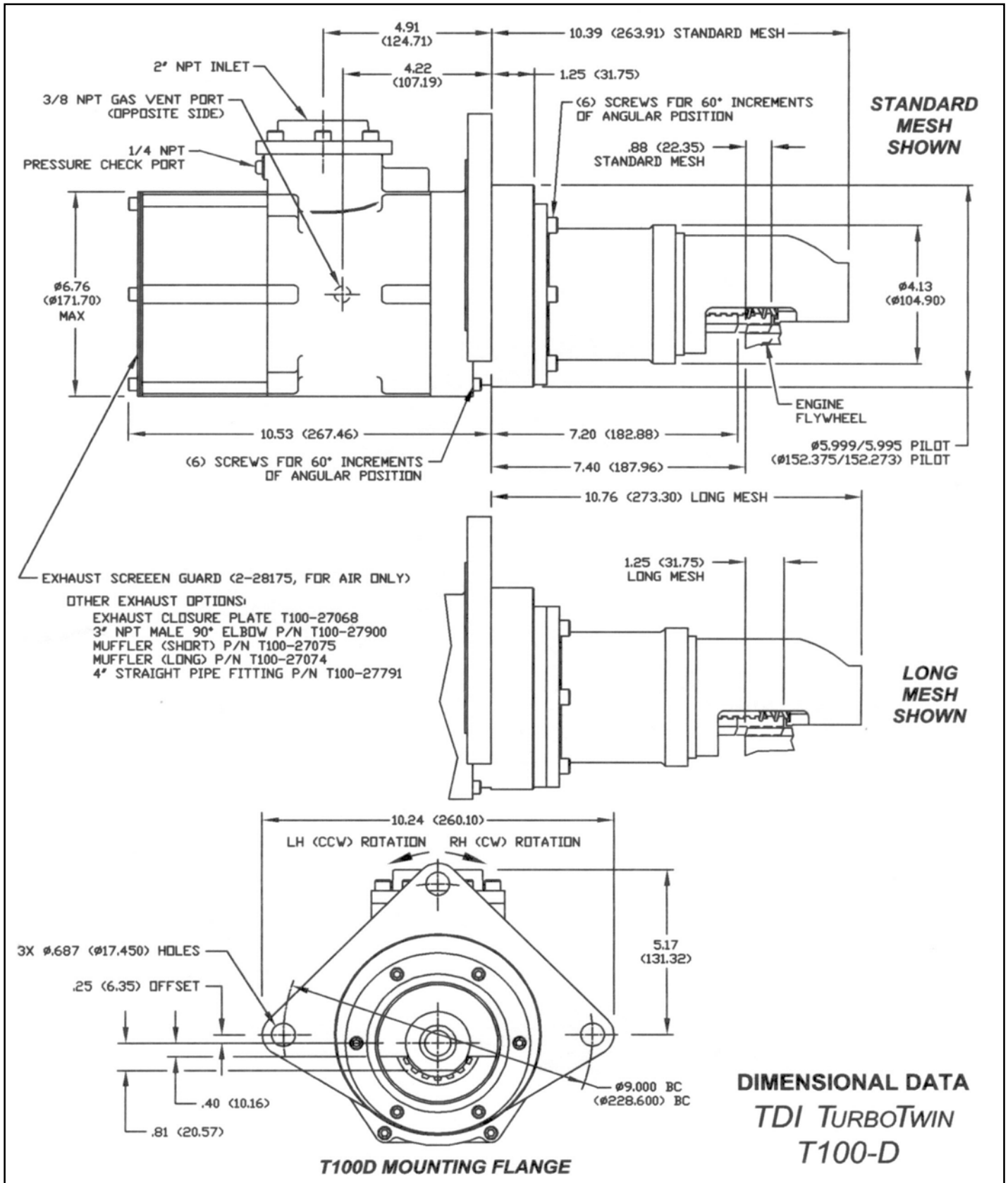
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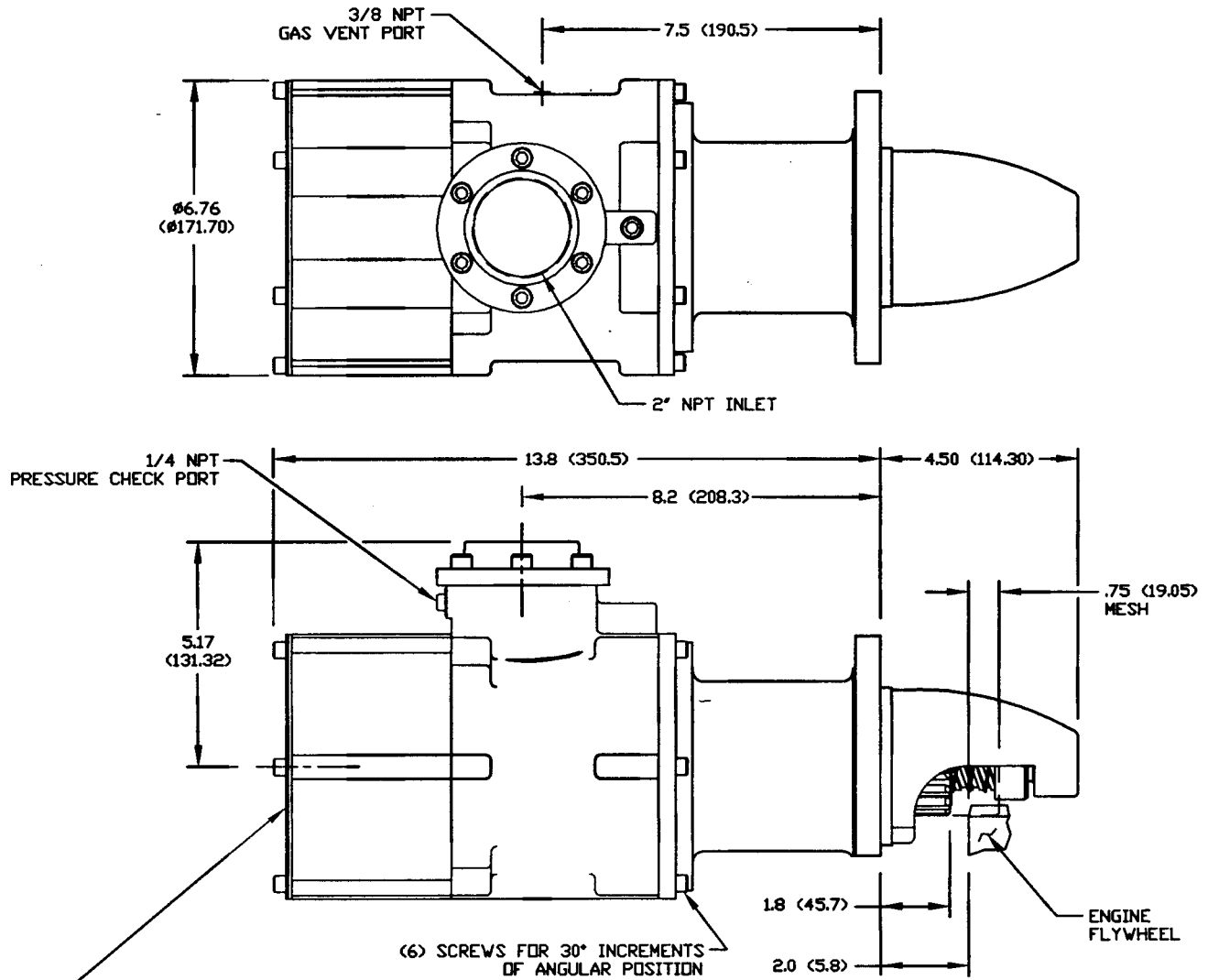
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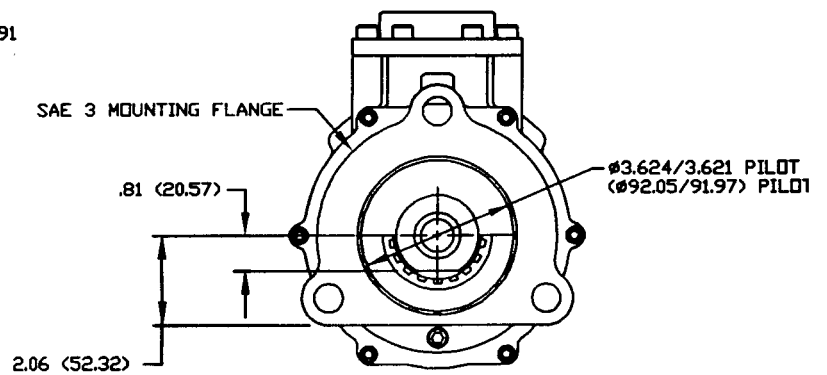
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EXHAUST SCREEN GUARD (2-28175, FOR AIR ONLY) SHOWN

- OTHER EXHAUST OPTIONS:
- EXHAUST CLOSURE PLATE T100-27068
 - 3" NPT MALE 90° ELBOW P/N T100-27900
 - MUFFLER (SHORT) P/N T100-27075
 - MUFFLER (LONG) P/N T100-27074
 - 4" STRAIGHT PIPE FITTING P/N T100-27791

LH (CCW) ROTATION RH (CW) ROTATION



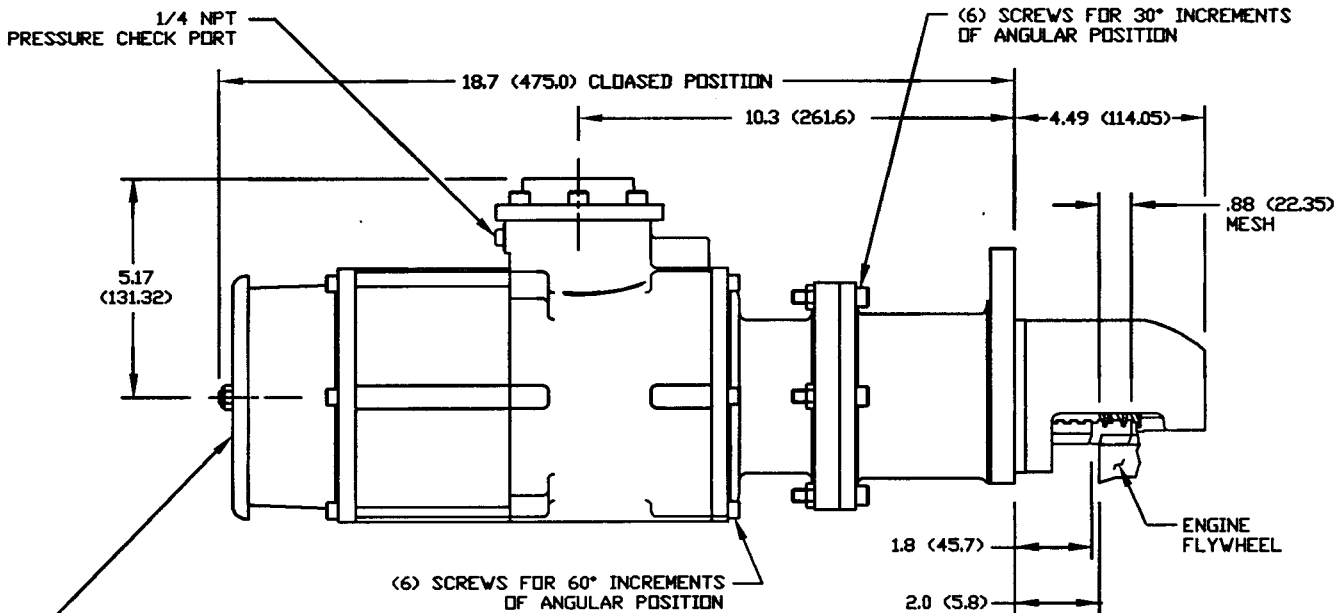
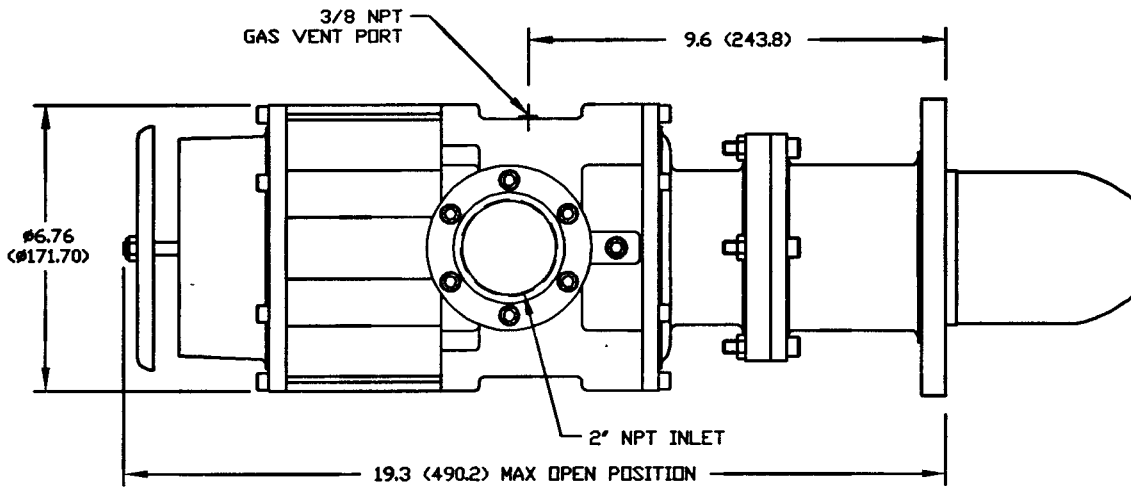
DIMENSIONAL DATA

TDI TURBOTWIN

T100-F

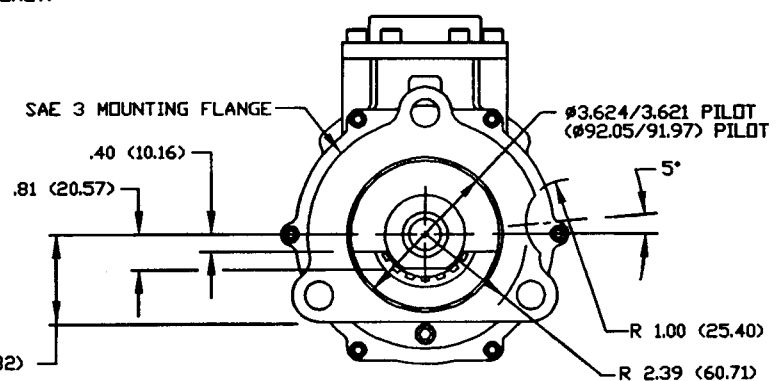
TDI TURBOTWIN

FROM TECH DEVELOPMENT INC



EXHAUST CLOSURE PLATE (2-27271 FOR AIR ONLY) SHOWN
 OTHER EXHAUST OPTIONS:
 EXHAUST SCREEN GUARD (2-28175, FOR AIR ONLY)
 3" NPT MALE 90° ELBOW P/N T100-27900
 MUFFLER (SHORT) P/N T100-27075
 MUFFLER (LONG) P/N T100-27074
 4" STRAIGHT PIPE FITTING P/N T100-27791

LH (CCW) ROTATION RH (CW) ROTATION



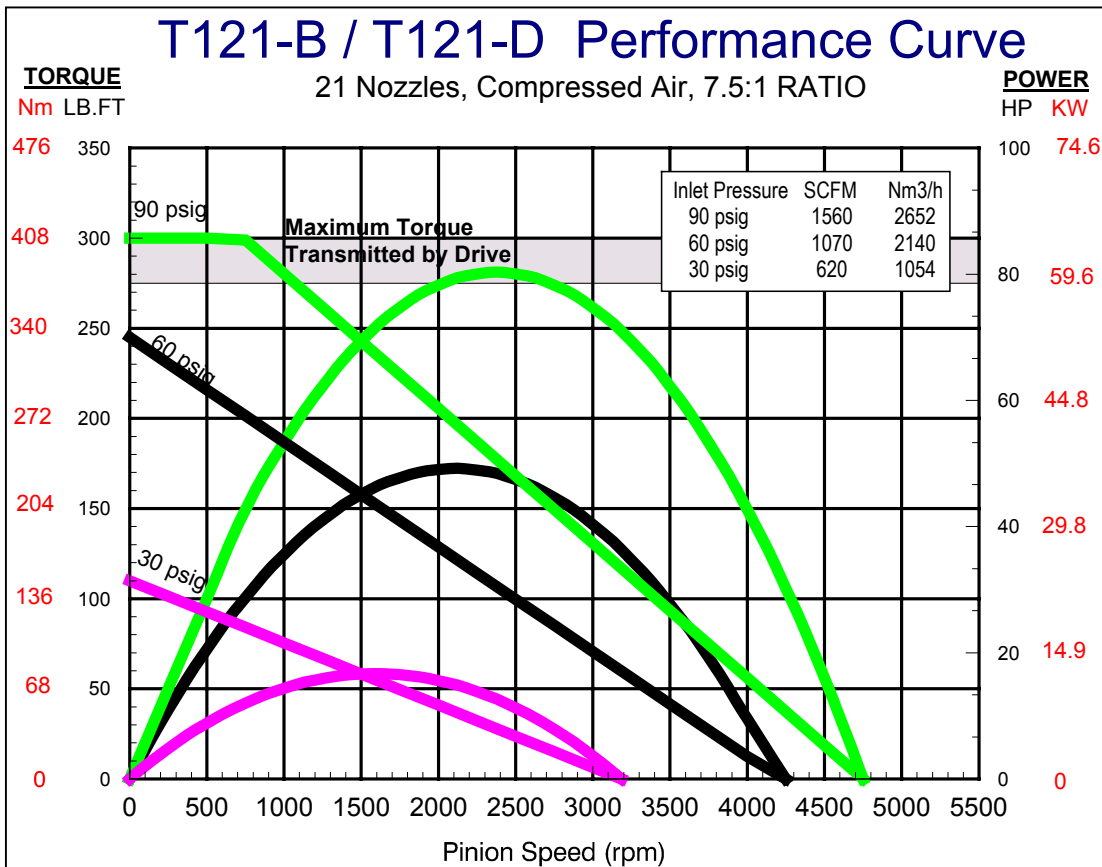
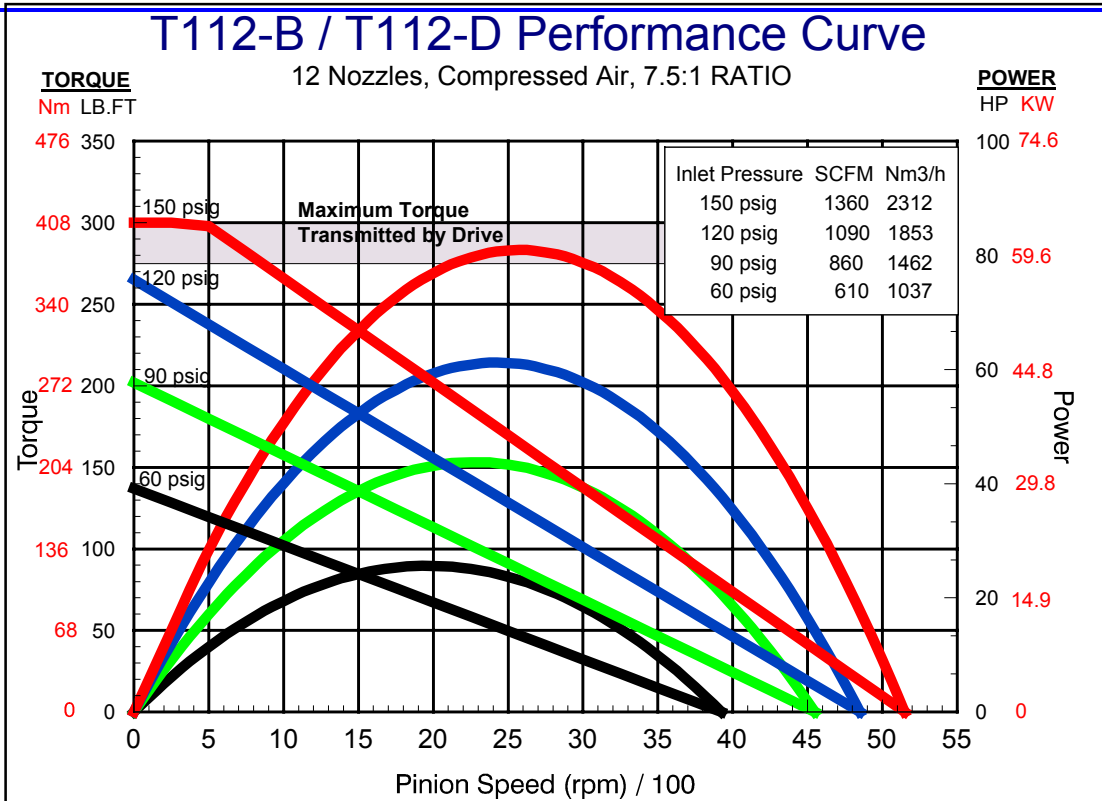
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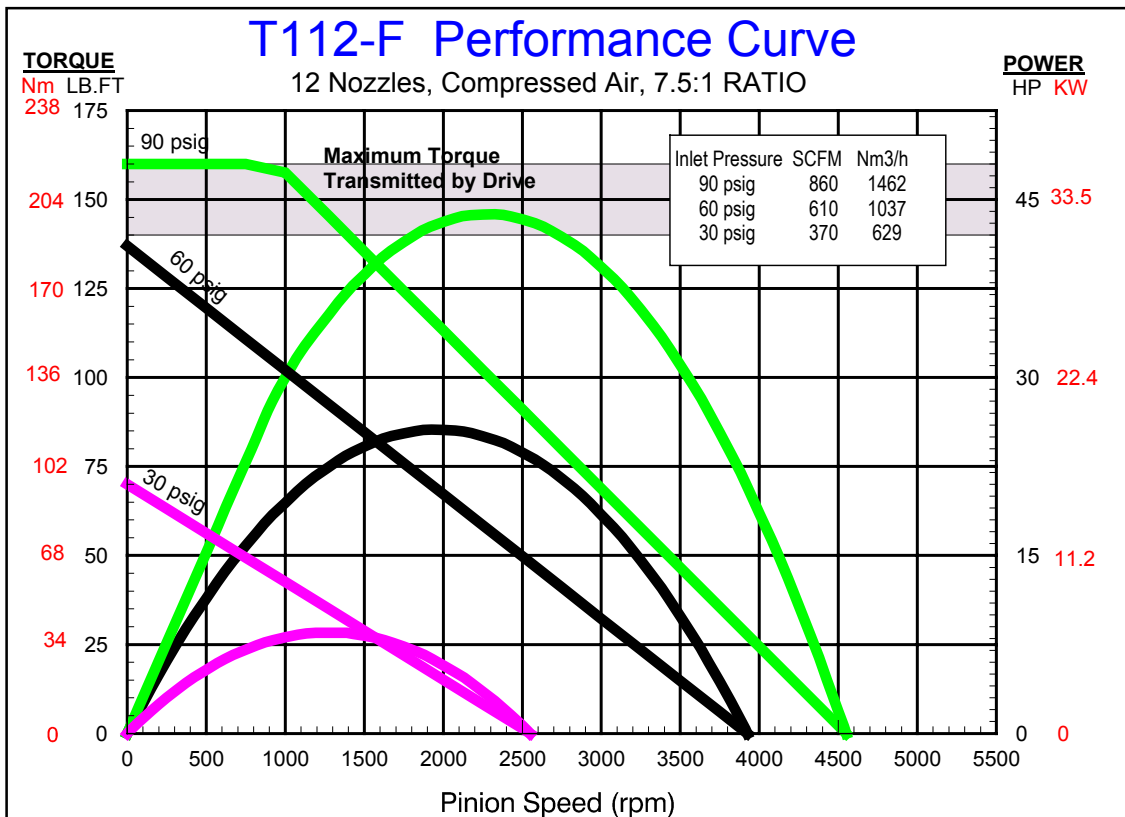
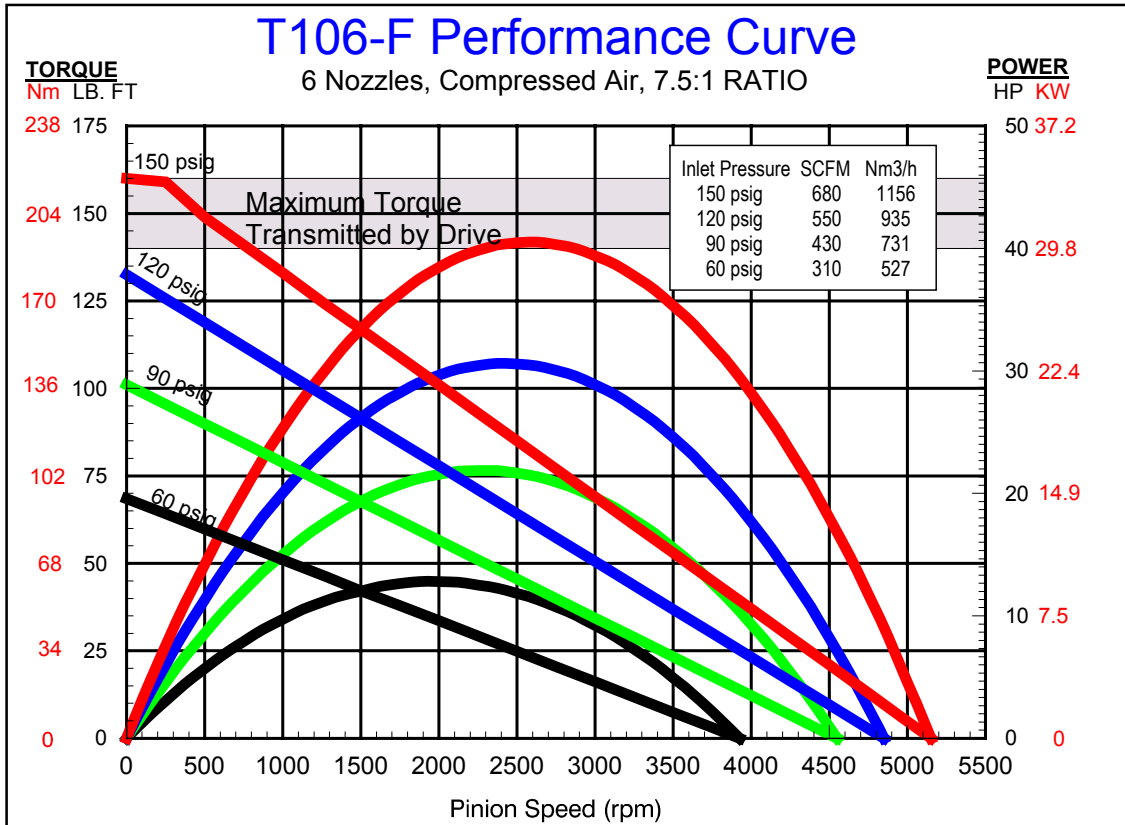
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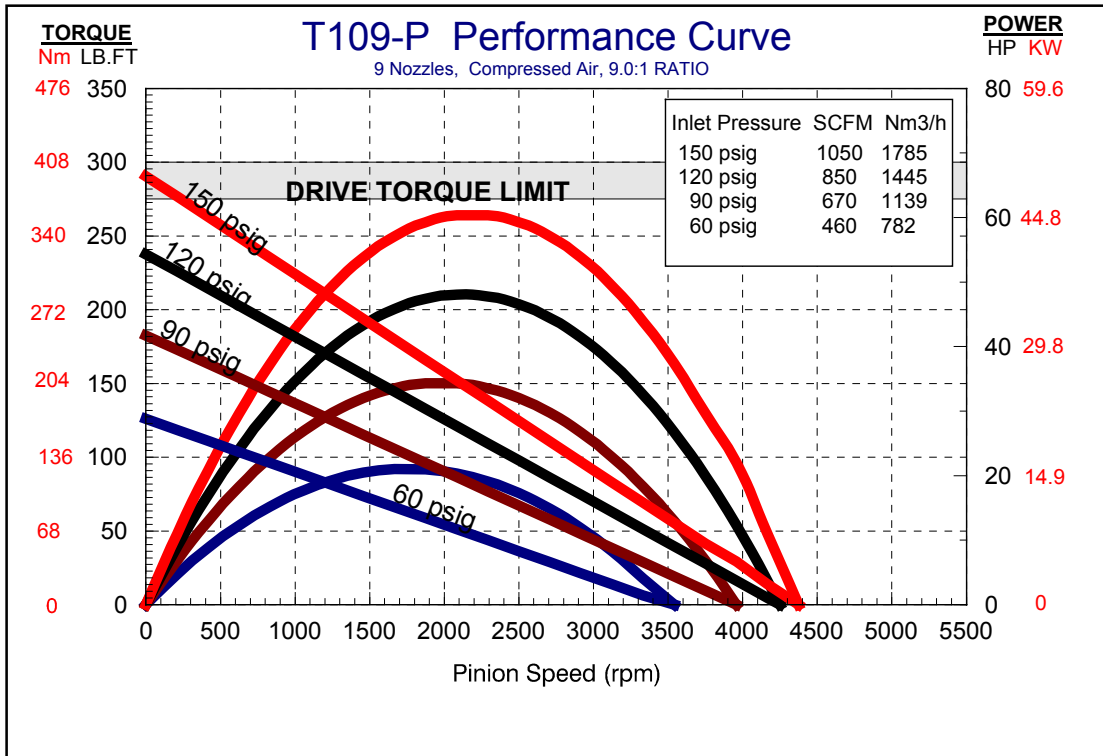
T100-P

TDI TURBOTWIN

FROM TECH DEVELOPMENT INC







**INSTALLATION & OPERATING MANUAL
FOR
MODELS T106F/T112F, T112B/T121B, T112D/T121D
TURBINE STARTERS**

USE WITH COMPRESSED AIR OR NATURAL GAS

TABLE OF CONTENTS

- 1.0 GENERAL INFORMATION**
 - 1.1 DESCRIPTION
 - 1.2 PRODUCT IDENTIFICATION
 - 1.3 PHYSICAL CHARACTERISTICS
 - 1.4 PERFORMANCE

- 2.0 INSTALLING THE STARTER**
 - 2.1 GENERAL
 - 2.2 STARTER ORIENTATION
 - 2.3 INERTIA DRIVE ASSEMBLY
 - SUPPLY LINE
 - INLET PRESSURE PORT
 - 2.6 EXHAUST CONNECTION
 - 2.7 NATURAL GAS USAGE

- 3.0 HARDWARE AND ACCESSORIES**

- 4.0 STARTER OPERATION**
 - 4.1 BASIC OPERATION
 - 4.2 MANUAL VALVE OPERATION
 - 4.3 AUTOMATED START PANEL

- 5.0 PREVENTIVE MAINTENANCE**

- 6.0 STARTER DISASSEMBLY AND REPAIR**

- 7.0 OPERATOR'S TROUBLE SHOOTING GUIDE**

- 8.0 TURBOTWIN WARRANTY**

LIST OF FIGURES

- 1. TURBOTWIN PART NUMBER LISTING
- 2. MODEL T112B/T121B INSTALLATION DRAWING
- 3. MODEL T106F/T112F INSTALLATION DRAWING
- 4. MODEL T112D/T121D INSTALLATION DRAWING (STD MESH)
- 5. MODEL T112D/T121D INSTALLATION DRAWING (LONG MESH)
- 6. INERTIA DRIVE ASSEMBLY SPECIFICATIONS
- 7. EXAMPLE NAMEPLATE
- 8. DIRECTION OF ROTATION DEFINITION
- 9. PERFORMANCE GRAPH MODEL T121B/T121D
- 10. PERFORMANCE GRAPH MODEL T112B/T112D
- 11. PERFORMANCE GRAPH MODEL T112F
- 12. PERFORMANCE GRAPH MODEL T106F
- 13. TYPICAL STARTER INSTALLATION - COMPRESSED AIR
- 14. TYPICAL STARTER INSTALLATION - NATURAL GAS
- 15. INERTIA DRIVE PINION BACKLASH
- 16. EXHAUST ADAPTER RING INSTALLATION
- 17. EXHAUST HARDWARE KITS
- 18. ILLUSTRATED EXHAUST HARDWARE OPTIONS
- 19. INSTALLATION ACCESSORIES

TDI *TURBOTWIN*

FROM TECH DEVELOPMENT INC

1.0 GENERAL INFORMATION

This manual provides instructions for the installation and operation of the TDI *TURBOTWIN* Starters. If there are questions not answered in this manual, please contact your TDI *TURBOTWIN* distributor or dealer for assistance. See appendix A for the listing of distributors by state.

The *TURBOTWIN* models are turbine driven starters with an inertially engaged starter drive. Depending on the starter model and engine installation, the *TURBOTWIN* starters have applications ranging from 1000 CID (16 Liters) on diesel engines and up to 20000 CID (320 Liters) on gas engines. The *TURBOTWIN* models are suited to operate within a wide range of inlet pressures and ambient temperatures. Refer to Figure 1 for general specification information. The engine size and parasitic loading will determine the exact minimum pressure that will assure reliable starting.

The *TURBOTWIN* starters are designed for operation with compressed air or natural gas; materials used are compatible with "sour" natural gas and marine environments. Small amounts of foreign matter or liquid in the air stream will not adversely affect *TURBOTWIN* starters. As with all other TDI starters, no lubrication is required in the air supply.

You need to review the rest of this manual before installing your TDI *TURBOTWIN* starter.

Note

Throughout this manual, the term "air" is used to denote the starter drive medium. Unless otherwise stated, "air" means either compressed air or natural gas.

WARNINGS, CAUTIONS AND NOTES

Certain types of information are highlighted in this manual for your attention:

WARNING - used where injury to personnel or damage to the equipment is likely.

CAUTION - used where there is the possibility of damage to the equipment.

NOTE - used to point out special interest information.

1.1 DESCRIPTION

Figures 2, 3, 4 and 5 show the outline of the four basic *TURBOTWIN* models of starters. All models feature three basic subassemblies: a unique two stage turbine motor section, a planetary gearbox section and an inertia drive assembly.

Compressed air or natural gas is used to power the *TURBOTWIN* through the inlet port. The air or gas is expanded through the first nozzle or stators. The high velocity gas impinges on the first stage rotor to yield torque to the gearbox. The gas is further expanded through the second stage stators which impart additional torque to the second stage rotor.

The two stage motor section features greater stall torque than a single stage turbine plus aerodynamic speed control. This aerodynamic speed control helps protect the *TURBOTWIN* starter from damage caused by starter motor over speed. In addition, a steel motor housing module and low-mass rotors provide fail-safe operation.

All *TURBOTWIN*s employ the same basic 7.5:1 ratio planetary gearbox. Reliability and part commonality are designed into all *TURBOTWIN*s. This low gear ratio allows the turbine motor to spin at low speeds for long bearing life. At a typical 3000 rpm pinion speed, the turbine is cruising at a low 22500 rpm.

A simple and reliable inertia drive delivers the torque to the pinion. The pinion is thrown out to engage the engine's ring gear by the turbine motor's acceleration. Lighter weight rotating parts used in the *TURBOTWIN* provide low inertia and even "softer" engagement. In the event of over-pressure, the friction clutch used in every *TURBOTWIN* protects ring gear teeth from static torque overloads. In addition, an inertia engaged starter eliminates the need for complex pre-engagement control plumbing...and is easier to install and maintain than pre-engaged type starters.

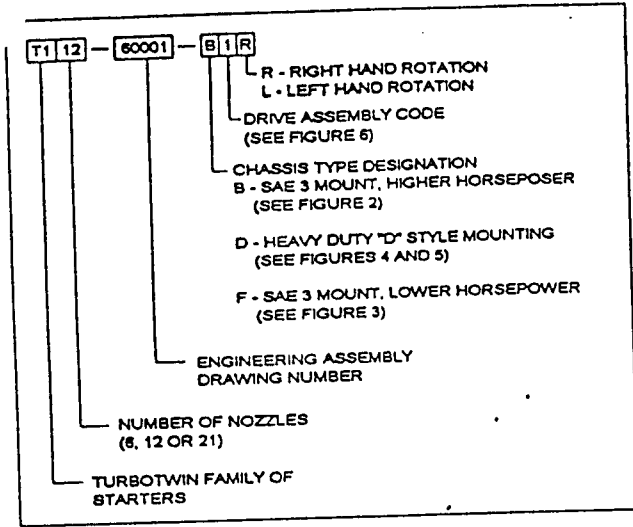
1.2 PRODUCT IDENTIFICATION

Figure 1 lists the available part numbers for the TDI *TURBOTWIN* Starters. The starter nameplate which is pinned to the turbine housing contains the following information: model number, serial number, part number, direction of rotation and the maximum rated operating pressure. An example nameplate is shown in Figure 7.

The model number is a shorthand description of the part number. The part number is described as follows:

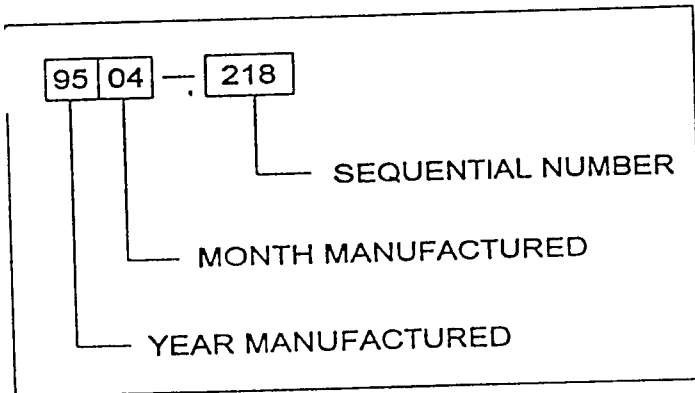
TDI TURBOTWIN

FROM TECH DEVELOPMENT INC



The direction of rotation is either right hand or left hand rotation as defined by Figure 8. Right Hand rotation is defined as counterclockwise rotation as viewed from the exhaust end of the starter.

The serial number is coded as follows:



The maximum operating pressure is also stamped on the nameplate. The example nameplate shows 150 psig. This pressure is measured at the check port on the starter inlet with the starter in operation.

CAUTION

Exceeding the maximum operating pressure shown on the nameplate may result in drive failure, damage to the starter, damage to the engine or cause personal injury.

The proof pressure is 600 psig and is also shown on the nameplate. This means the turbine housing will not burst when subjected to a static pressure of 600 psig.

Figures 2, 3, 4 and 5 show the installation drawings for the four basic variations of the *TURBOTWIN* Starter.

TDI TURBOSTART™

Engine Air Starter
FROM TECH DEVELOPMENT, INC
A BARBER-COLMAN COMPANY
6800 POE AVE., DAYTON, OH 45414

MODEL NO. SERIAL NO.

T112B	9504-218
PART NUMBER	
T112-60001-B1R	

CW (RH) CCW (LH)

<input checked="" type="checkbox"/>	<input type="checkbox"/>	AIR OR NAT. GAS USAGE
-------------------------------------	--------------------------	-----------------------

MAX PRESS. 150 PSIG

MEASURED AT INLET WHILE OPERATING
PROOF PRESSURE OF HOUSING IS 600 PSIG

WARNING: DO NOT OPERATE UNLOADED OR WITHOUT TURBINE GUARD OR EXHAUST FITTING.

U.S. PATENT 4509896

Figure 7. Nameplate

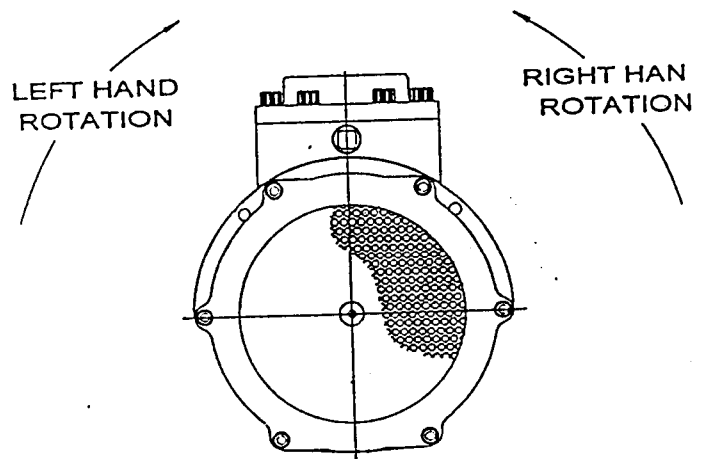


Figure 8. Direction of Rotation as viewed from exhaust end of Starter.

1.3 PHYSICAL CHARACTERISTICS

Figures 2, 3, 4 and 5 show the outlines and package dimensions of the four sizes of *TURBOTWIN* starters.

TDI TURBOTWIN

FROM TECH DEVELOPMENT INC

MODEL NUMBER	PART NUMBER	PRESSURE RANGE (PSIG)	PRESSURE RANGE (BAR)	PINION ROTATION	MAX STALL TORQUE lb-ft	TDI DRIVE NUMBER
T121B	T121-60001-B1R	30 - 90	3.1 - 7.2	RIGHT HAND	300	1-18828
T121B	T121-60001-B2L	30 - 90	3.1 - 7.2	LEFT HAND	300	1-19083
T112B	T112-60001-B1R	60 - 150	5.2 - 11.4	RIGHT HAND	300	1-18828
T112B	T112-60001-B2L	60 - 150	5.2 - 11.4	LEFT HAND	300	1-19083
T106F	T106-60002-F3R	60 - 150	5.2 - 11.4	RIGHT HAND	160	2-22147
T106F	T106-60002-F4L	60 - 150	5.2 - 11.4	LEFT HAND	160	2-22148
T112F	T112-60002-F3R	30 - 90	3.1 - 7.2	RIGHT HAND	160	2-22147
T112F	T112-60002-F4L	30 - 90	3.1 - 7.2	LEFT HAND	160	2-22148
T121D	T121-60003-D1R	30 - 90	3.1 - 7.2	RIGHT HAND	300	1-18828
T121D	T121-60003-D2L	30 - 90	3.1 - 7.2	LEFT HAND	300	1-19083
T112D	T112-60003-D1R	60 - 150	5.2 - 11.4	RIGHT HAND	300	1-18828
T112D	T112-60003-D2L	60 - 150	5.2 - 11.4	LEFT HAND	300	1-19083
T112D	T112-60004-D5R	60 - 150	5.2 - 11.4	RIGHT HAND	300	2-22795
T112D	T112-60004-D6L	60 - 150	5.2 - 11.4	LEFT HAND	300	2-22796
T121D	T121-60004-D5R	30 - 90	3.1 - 7.2	RIGHT HAND	300	2-22795
T121D	T121-60004-D6L	30 - 90	3.1 - 7.2	LEFT HAND	300	2-22796

Figure 1. TURBOTWIN Starter Part Number Listing

Figure 2 shows the Models T112B/T121B which are 20.1" long overall and 8.2" in height. This model weighs 54 pounds. The turbine housing diameter is 6.8" which is common to all TURBOTWINs. The rotary inertia of all rotating components is _____ lb-in².

Figure 3 shows the Models T106F/T112F which are 17.4" long overall and 8.2" in height. This model weighs 47 pounds. The turbine housing diameter is 6.8". The rotary inertia of all rotating components is _____ lb-in².

Figure 4 shows the Models T112D/T121D which are 20.1" long overall and 8.4" in height. The mounting flange is 10.2" diameter. This model weighs 70 pounds. The turbine housing diameter is 6.8". The rotary inertia of all rotating components is _____ lb-in².

Figure 5 shows the Models T106F/T112F which are 20.4" long overall and 8.4" in height. The mounting flange is 10.2" diameter. This model weighs 70 pounds. The turbine housing diameter is 6.8". The rotary inertia of all rotating components is _____ lb-in².

PERFORMANCE

Graphs of the performance curves are shown in Figures 9 through 12. These graphs feature pinion torque versus pinion speed (rpm) at constant drive air pressures and shaft horsepower versus pinion speed at constant drive air

pressures. Pinion speed is shown on the horizontal axis. The pinion torque is shown along the left edge vertical axis. The shaft horsepower is shown along the right edge vertical axis. Air consumption rates are given for the various drive pressure lines. These performance curves feature air as the drive gas and have open exhaust (standard exhaust guard) which have basically no back pressure.

2.0 INSTALLING THE STARTER

WARNING

Do not operate this starter unless it is properly attached to an engine.

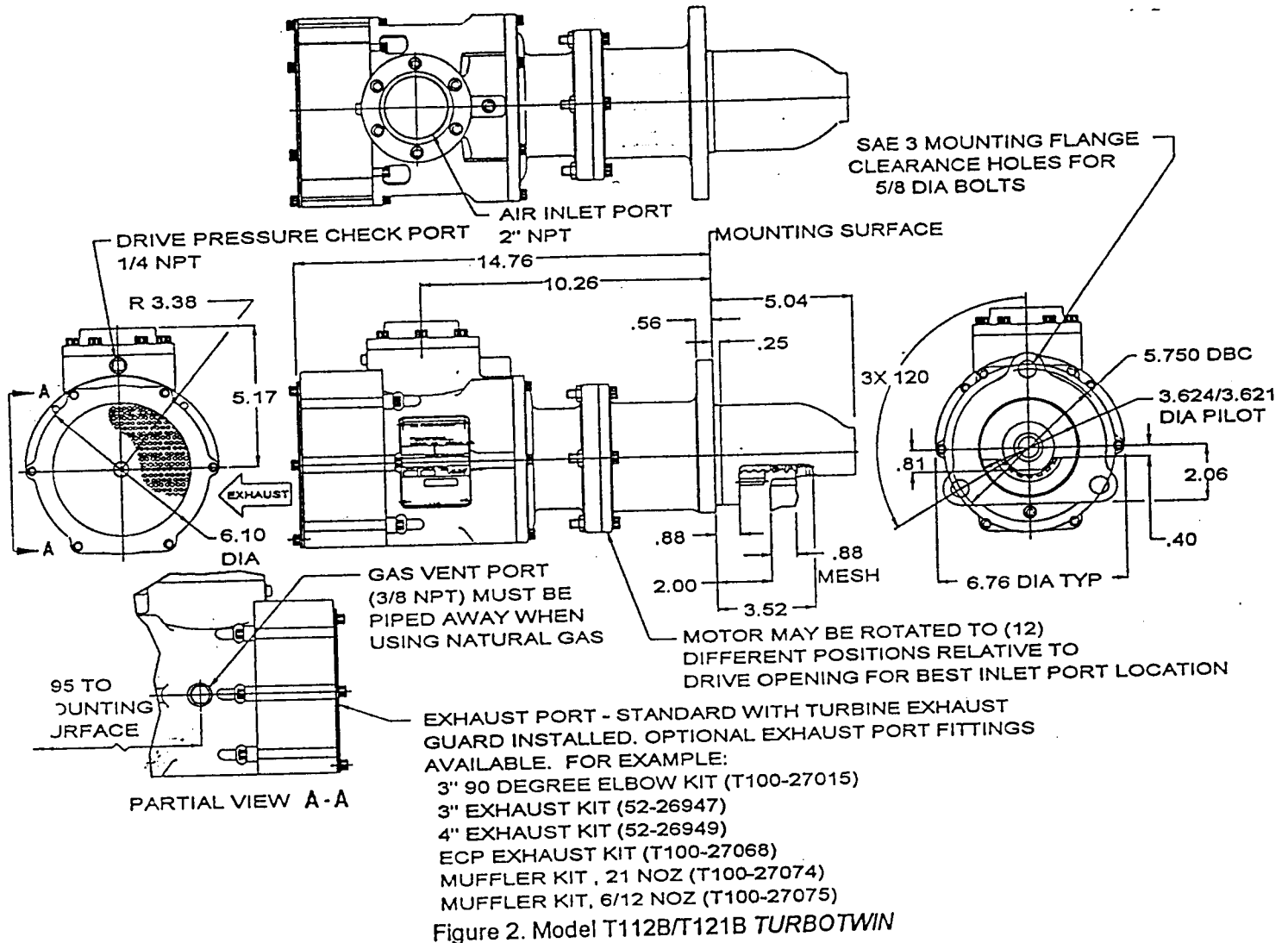
Information on typical TURBOTWIN installations is shown in Figures 13 and 14. The components illustrated may vary in shape, but there must at least be an air source, a starter valve or switch and an air piloted relay valve in order to properly install the TURBOTWIN starter. Refer to Section 3 for information on TDI accessories.

2.1 GENERAL

Figure 13 shows a typical starter installation using compressed air. The starter is mounted to the SAE 3 engine mounting pad and is secured with three 5/8" bolts on TURBOTWIN models T1XXB and T1XXF. Model T1XXD

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FROM TECH DEVELOPMENT INC



has the heavy-duty "D" style mounting flange which also uses three 5/8" bolts.

The air line to the starter contains a pressure regulator (when necessary) and a manual or remotely controlled valve. All *TURBOTWIN* starters features a 2" NPT pipe thread on the inlet port.

Most compressed air installations may use the standard exhaust guard. Figure 17 lists the optional exhaust hardware kits. Figure 18 shows illustrations of the various exhaust options.

2.2 ORIENTATION OF THE STARTER

the factory orientation of the starter's pinion housing assembly, in relation to the inlet port, does not fit your engine installation, these components can easily be re-oriented. Refer to Figures 2, 3, 4 and 5.

All *TURBOTWINS* have the capability to rotate the inlet port relative to the drive opening for the optimum inlet port location. the number of different positions is 6 to 12 depending on model and application.

The starter should be installed with the inlet valve in a position between horizontal and straight down. Any condensation will be restricted to the air lines, and not in the starter.

CAUTION

All screw threads are treated at the factory with a fastener retention compound. Every screw and tapped hole must be clean and have a drop of Loctite 290 applied to the threads before being reinstalled.

TDI TURBOTWIN

FROM TECH DEVELOPMENT INC

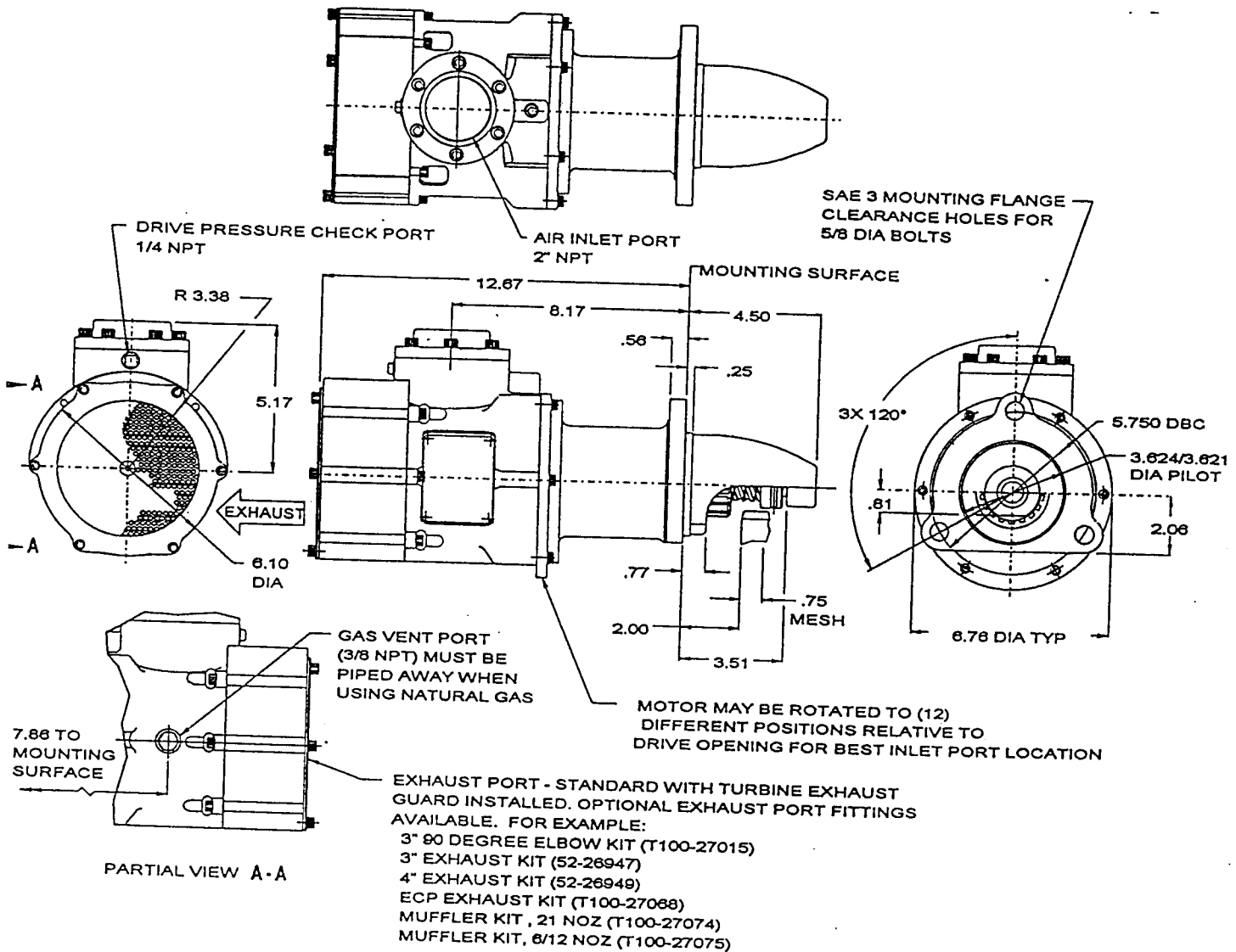


Figure 3. Model T106F/T112F TURBOTWIN

1 MODELS T112B/T121B

Refer to Figure 2. The drive housing may be rotated to 12 different positions relative to the inlet port. This task should be completed prior to installing the starter on the engine. The following procedure describes how to accomplish this. First, remove the (6) 5/16" X 1.5" long bolts by loosening the nuts. Next, rotate the drive housing without removing it from the starter to the desired position. Clean the bolts and nuts with Loctite Safety Solvent or equivalent. Reinstall the bolts and nuts using Loctite #290 Threadlocker adhesive or equivalent. Torque the bolts and nuts to 25 lb-ft maximum.

2.2.2 MODELS T106F/T112F

Refer to Figure 3. The drive housing may be rotated to 12 different positions relative to the inlet port. This task should be completed prior to installing the starter on the engine. The following procedure describes how to accomplish this. First, remove the (6) 1/4" X .75" long screws which attach the drive housing to the turbine housing. Next, rotate the drive housing without removing it from the starter to the desired position. Clean the screws with Loctite Safety Solvent or equivalent. Reinstall the (6) screws using Loctite #290 Threadlocker adhesive or equivalent. Torque the screws to 10 lb-ft maximum.

TDI TURBOTWIN

FROM TECH DEVELOPMENT INC

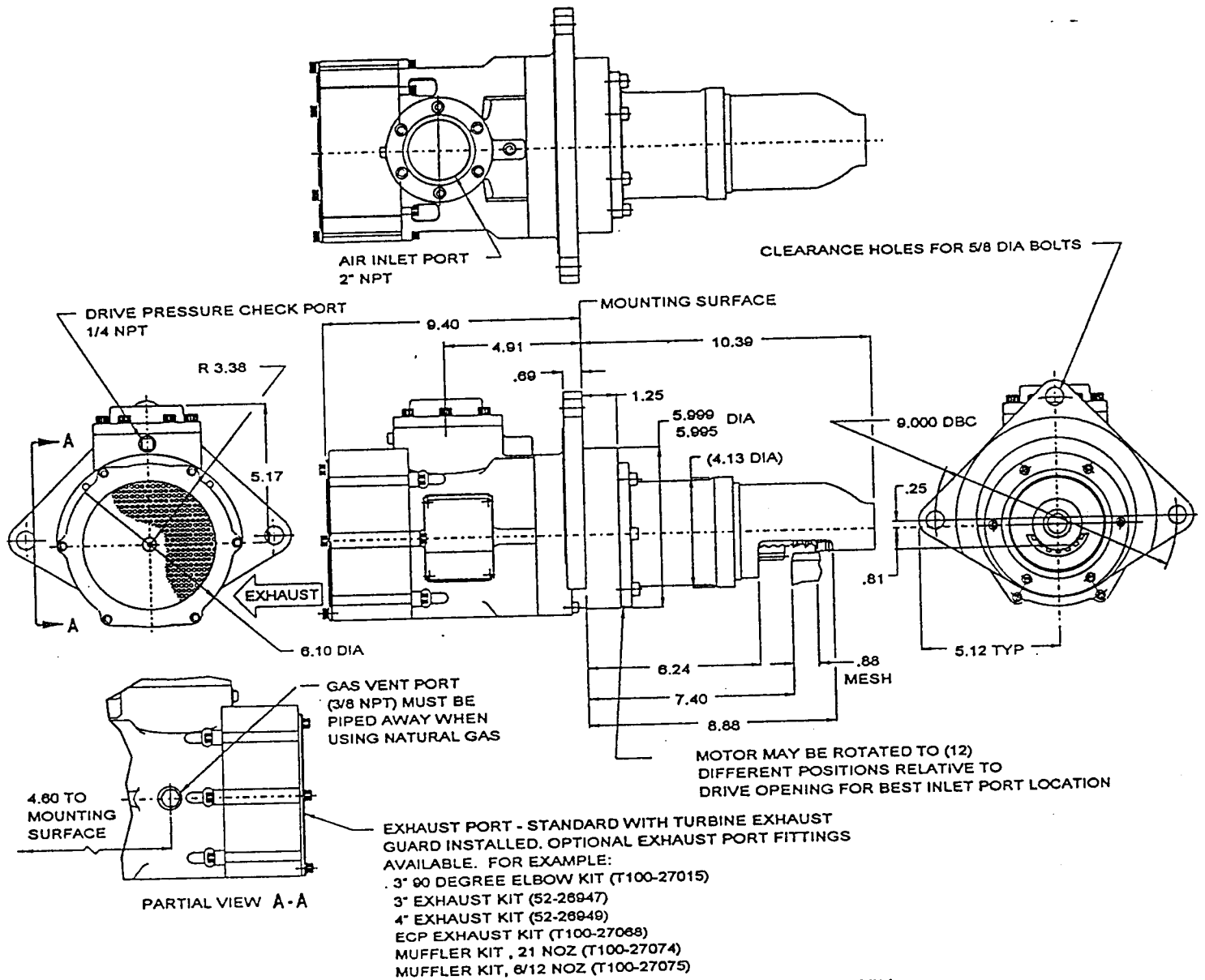


Figure 4. T112D/T121D (Standard Mesh) TURBOTWIN

2.2.3 MODELS T112D/T121D

Refer to Figure 4 or 5. The drive housing may be rotated to 12 different positions relative to the inlet port. This task should be completed prior to installing the starter on the engine. The following procedure describes how to accomplish this. First, remove the (6) 5/16" X 1.25" long screws which attach the drive housing to the turbine housing. Next, rotate the drive housing without removing it from the starter to the desired position. Clean the screws with Loctite Safety Solvent or equivalent. Reinstall the (6) screws using Loctite #290 Threadlocker adhesive or equivalent. Torque the screws to 25 lb-ft maximum.

2.3 INERTIA DRIVE ASSEMBLY

The inertia drive assembly consists of a friction clutch pack and the drive pinion which rides on a helical shaft. The pinion is thrown out to engage the engine's ring gear by the turbine motor's acceleration. Lighter weight rotating parts used in the TURBOTWIN provide low inertia and even "softer" engagement. In the event of over-pressure, the friction clutch used in every TURBOTWIN protects ring gear teeth from static torque overloads.

The torque carrying limit on the friction clutch pack is factory set by the manufacturer. Models T112B/T121B and T112D/T121D are set to 275-300 lb-ft. Models

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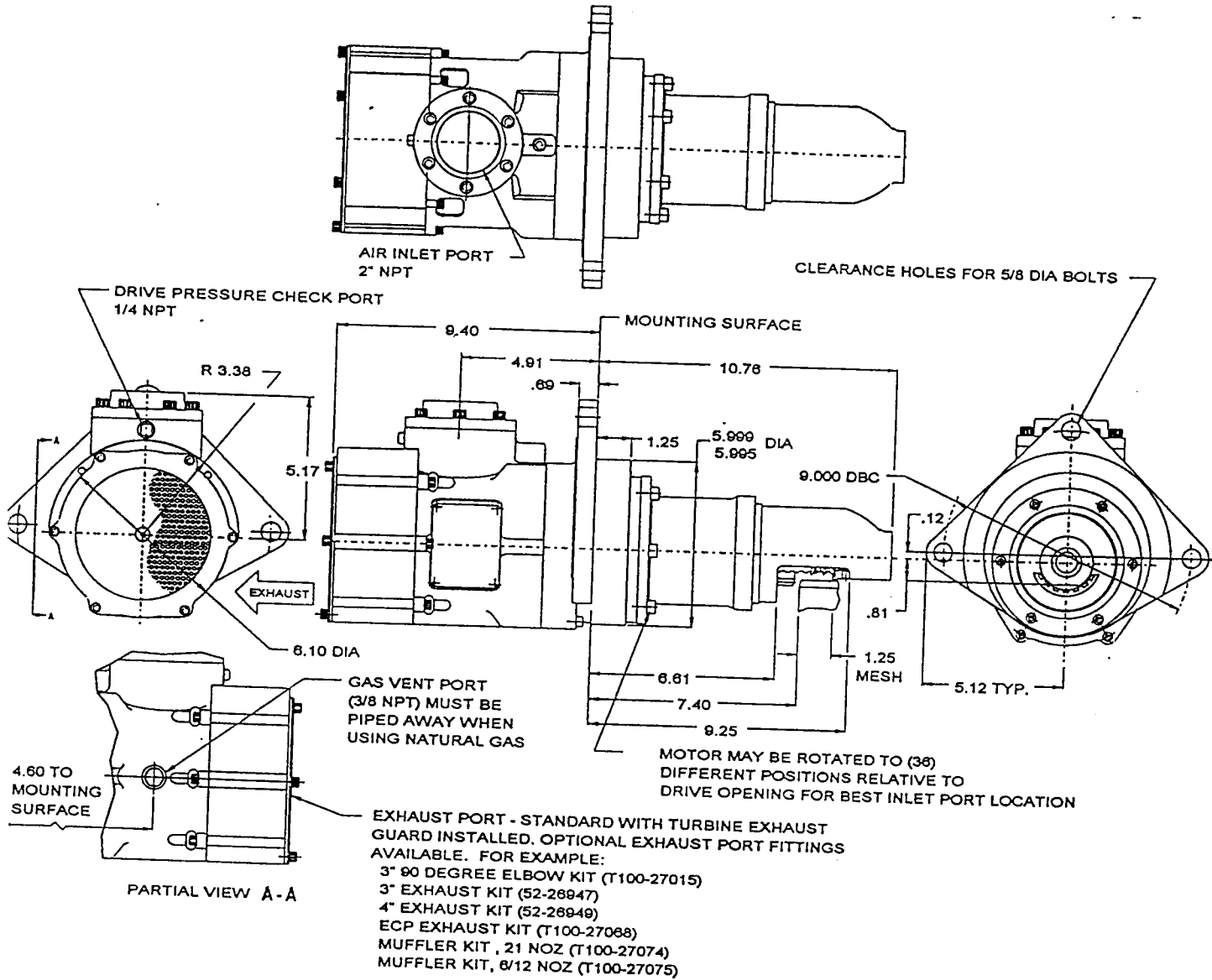


Figure 5. Model T112D/T121D (Long Mesh) TURBOTWIN

ENDIX CODE	TDI PART NUMBER	ROTATION	PITCH	#TEETH/BLANK	PINION PITCH DIA	PRESSURE ANGLE	CLUTCH SET.	LENGTH	TRAVEL	PIN O.D.
1	1-18828	R.H.	6/8	12/12	2.000	20	275-300	8.875	1.062	2.250
2	1-19083	L.H.	6/8	12/12	2.000	20	275-300	8.875	1.062	2.250
3	2-22147	R.H.	6/8	12/11	2.000	20	140-160	7.450	1.000	2.250
4	2-22148	L.H.	6/8	12/11	2.000	20	140-160	7.450	1.000	2.250
5	2-22795	R.H.	6/8	12/12	2.000	20	275-300	9.312	1.4375	2.250
6	2-20927-001	L.H.	6/8	12/12	2.000	20	275-300	9.312	1.4375	2.250

Figure 6. Inertia Drive Assembly Specifications

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6FT112F are set to 140-160 lb-ft.

All *TURBOTWIN* starters listed in this manual have a pinion with 6/8 diametral pitch teeth.

The pinion gear data and clutch torque settings are listed in Figure 6.

Backlash is the "free play" between the mesh of two gears. Figure 15 shows the backlash between two gears. Maintaining the proper gear backlash setting allows the gears to mesh smoothly. Proper backlash and alignment allow smooth engagement/disengagement of the pinion gear and loads the tooth face surfaces evenly producing longer gear life. The correct backlash setting for 6/8 diametral pitch gearing used on larger engines is as follows:

Minimum backlash	.015 inch
Maximum backlash	.025 inch

To check the backlash, the pinion will need to be rolled out onto the end of the drive prior to starter installation. This can be accomplished by using a hex drive wrench to rotate the turbine end of the starter while holding the pinion from rotating. The pinion will simply walk to the end of the shaft. An access hole to reach the turbine screw is provided in the turbine standard exhaust guard. The starter must then be installed on the engine. Checking backlash can be accomplished using a dial indicator or a simple blade-type feeler gauge. Because ring gears are not usually perfectly round, it is necessary to check backlash at several (six or more) points around the circumference of the ring gear. Average the highs and lows to allow a setting that is in the range cited above.

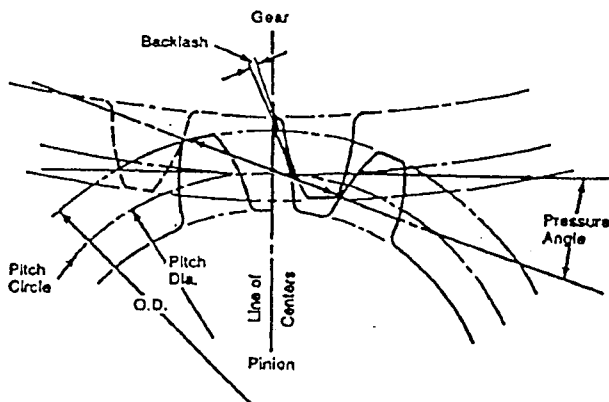


Figure 15. Inertia Drive Pinion Backlash

Setting the correct backlash may involve "shimming" and/or moving the starter bracket(s). An adjustable starter bracket design will simplify this procedure. Always re-check backlash after the installation of a ring gear replacement.

Liberal grease the starter's drive teeth with chassis lube and then mount the *TURBOTWIN* starter on the engine. Tighten all mounting hardware as appropriate. Make sure to use Loctite Threadlocker #290 or equivalent on the starter mounting bolts. Torque the three 5/8" screws to 100 lb-ft.

After mounting the starter to the engine, attach the supply air line to the starter, connect the control air lines and install the solenoid between the ignition switch and air piloted relay valve. See Sections 2.4, 2.5 and 2.6. The following sections describe the connection of the supply line, exhaust piping and optional control lines.

2.4 Supply Line Installation

CAUTION

Be sure to either bleed the pressurized air reservoir and /or safety the air system such as closing all valves prior to installing any starter supply line.

All *TURBOTWIN* starters come standard with a 2" NPT female pipe thread for the inlet connection port. Figures 13 and 14 show typical starter installations. The supply line consists of the line from the air source, a pressure regulator (when necessary), a manual or relay valve, and then the connection to the starter inlet. Hard piping may be used, but a section of flexible tubing should be used right at starter for mobile applications to prevent leaks due to engine vibration.

A turbine driven starter does not require lubrication in the supply air. Therefore, if a vane-type starter motor is being replaced, TDI recommends that all lubrication devices and lines be removed to minimize flow restrictions.

WARNING

If a fuel (pulse) lubricator has previously been installed in the system, disconnect and plug the line to eliminate spraying diesel fuel on the engine.

Care must be taken to ensure that all inlet supply line piping is no less than 1.5" (38 mm) and that all valves used are capable of passing the required air flow.

NOTE

Valves with a C_v of 40, or higher, are recommended.

If the supply line must be longer than 20 feet (6.1M), then the inlet supply line piping should be increased to 2" (50 mm) to assure proper performance by your *TURBOTWIN*.

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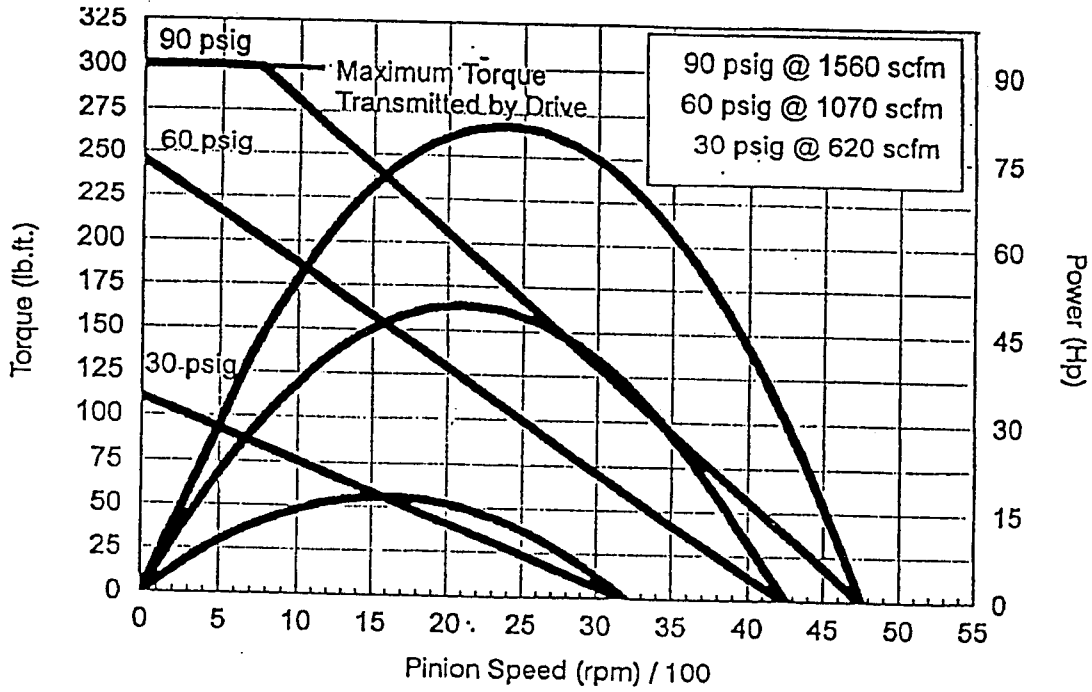


Figure 9. Performance Curves for Model T121B/T121D (21 Nozzles, Air, 7.5:1)

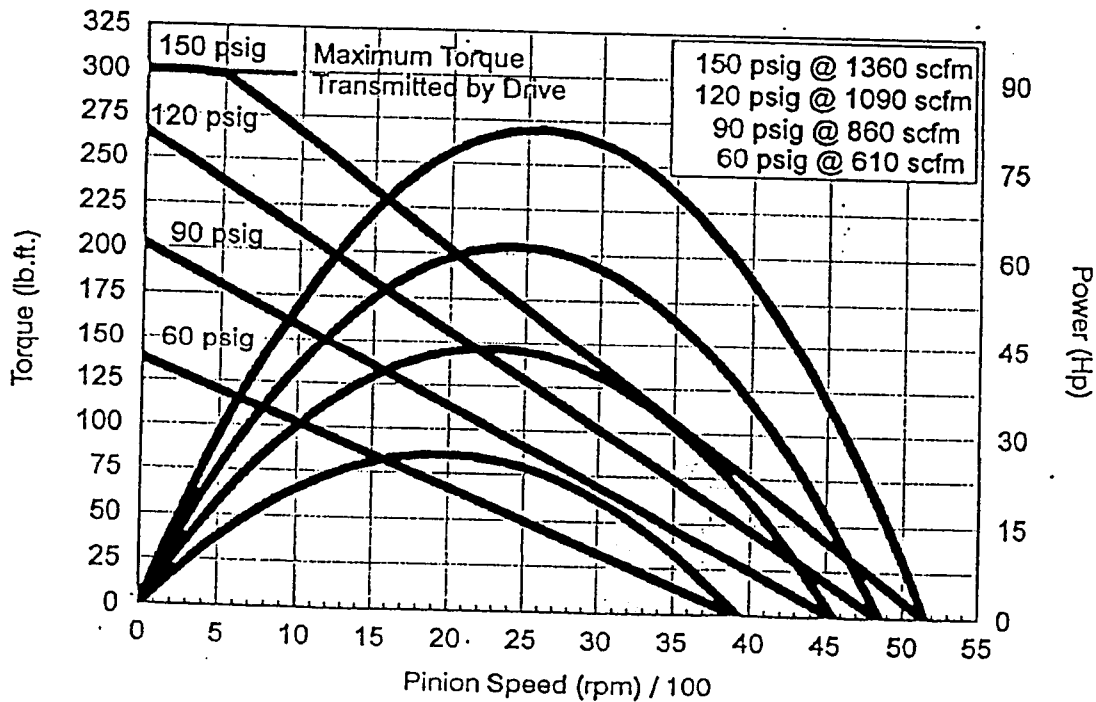


Figure 10. Performance Curves for Model T112B/T112D (12 Nozzles, Air, 7.5:1)

TDI TURBOTWIN

FROM TECH DEVELOPMENT INC

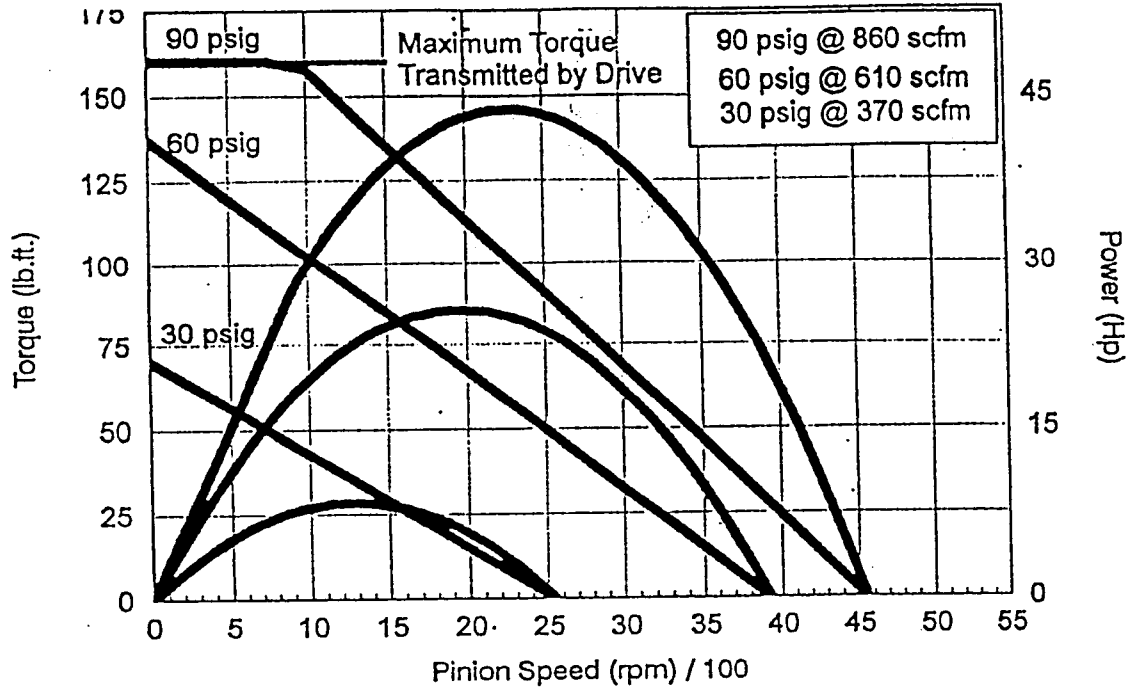


Figure 11. Performance Curves for Model T112F
(12 Nozzles, Air, 7.5:1)

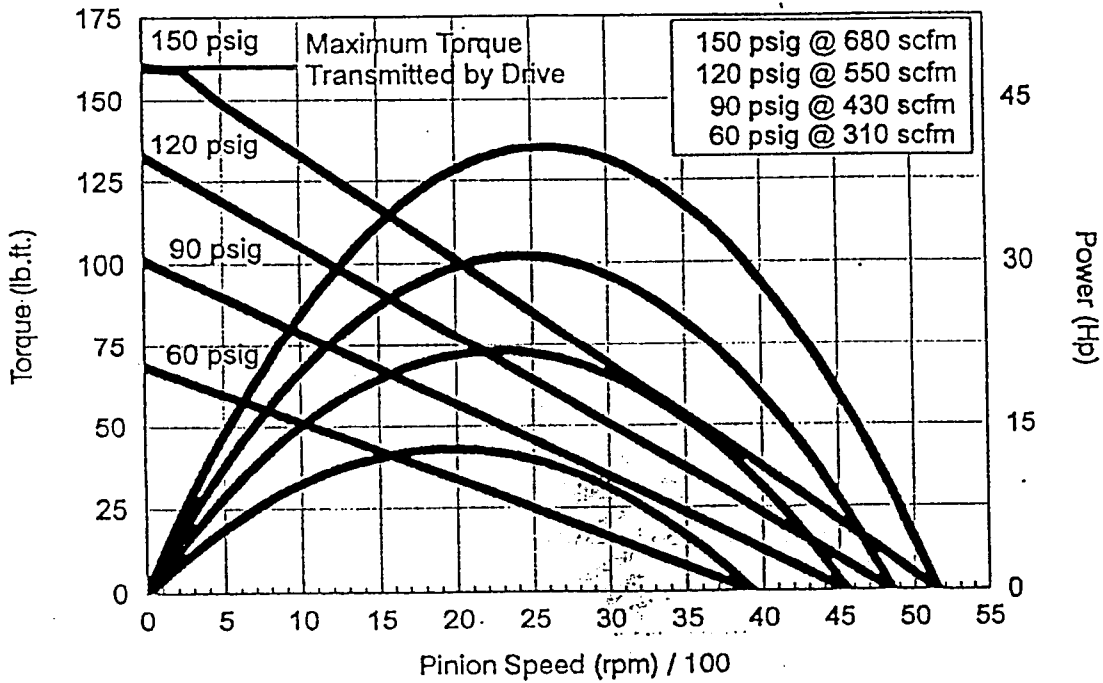
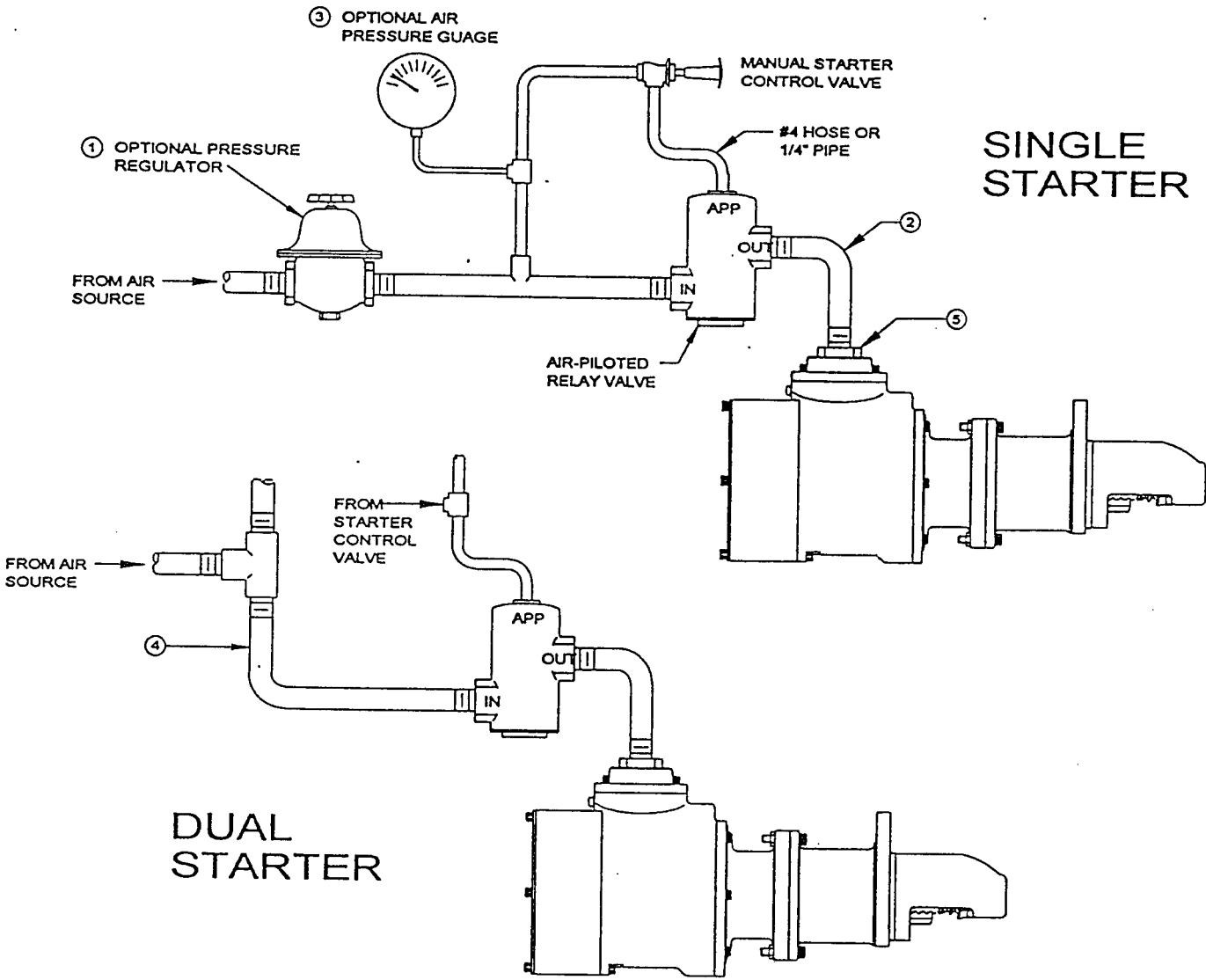


Figure 12. Performance Curves for Model T106F
(6 Nozzles, Air, 7.5:1)

STARTER INSTALLATION - AIR USAGE

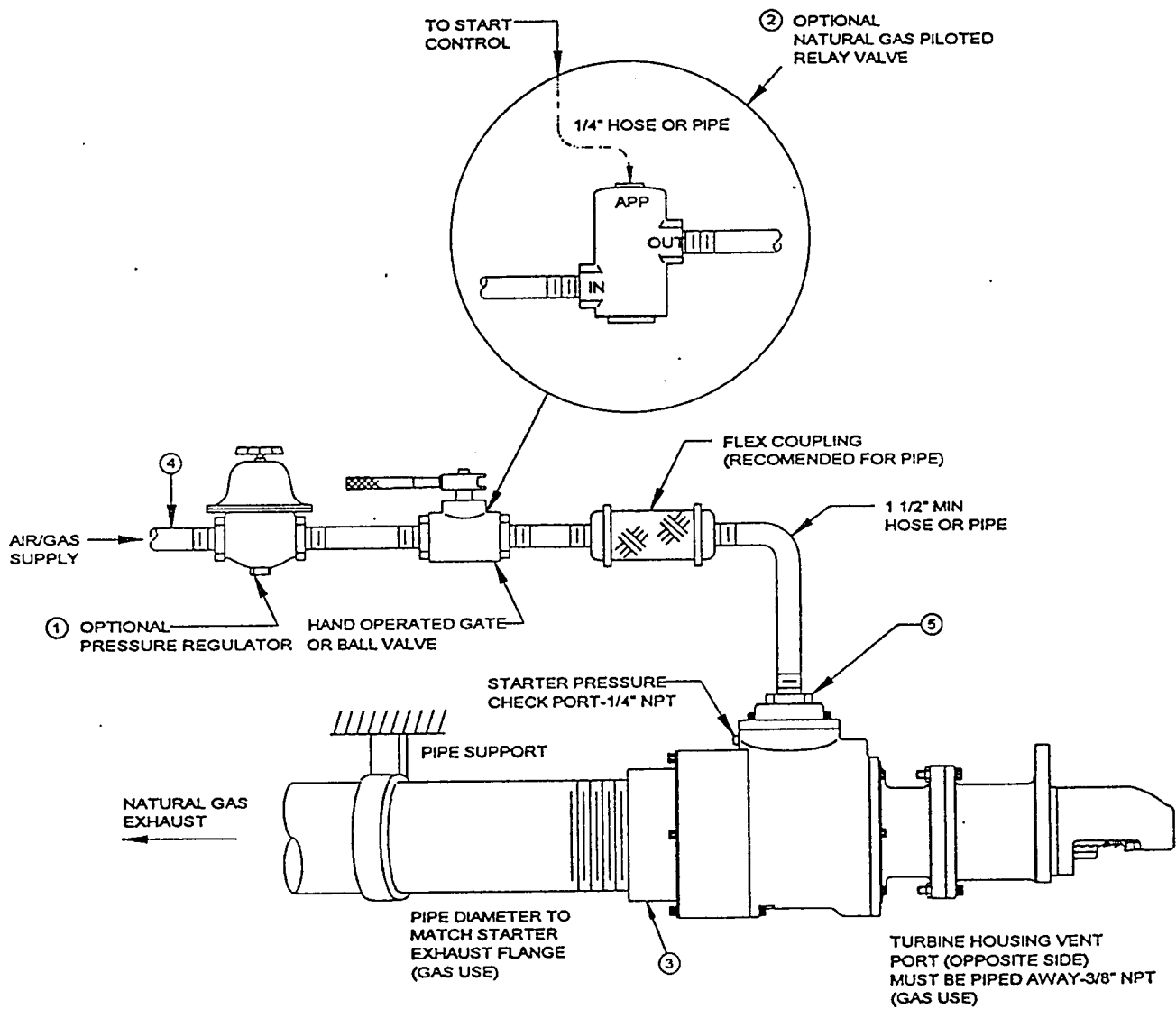


- NOTES:**
- ① IF DUAL STARTERS ARE USED, A SINGLE PRESSURE REGULATOR DEVICE SHOULD BE USED IF PRESSURE REGULATION IS REQUIRED.
 - ② REFER TO SECTION 4.0 FOR HARDWARE AND ACCESSORIES AVAILABLE FROM TDI.
 - ③ 4" NPT EXHAUST FLANGE - ALL STARTERS, 15 NOZZLES AND HIGHER.
 3" NPT EXHAUST FLANGE - ALL STARTERS, 14 NOZZLES AND HIGHER.
 - ④ INLET PIPE SIZE: 1.5" - ALL STARTERS, 14 NOZZLES AND LOWER
 2.0" - ALL STARTERS, 15 NOZZLES AND LOWER
 - ⑤ 2" TO 1" NPT REDUCING BUSHING - ALL STARTERS, 14 NOZZLES AND LOWER.

Figure 13. Typical Starter Installation - Compressed Air

TDI TURBOTWIN
FROM TECH DEVELOPMENT INC

STARTER INSTALLATION - NATURAL GAS USAGE



- NOTES:**
- ① IF DUAL STARTERS ARE USED, A SINGLE PRESSURE REGULATOR DEVICE SHOULD BE USED IF PRESSURE REGULATION IS REQUIRED.
 - ② REFER TO SECTION 4.0 FOR HARDWARE AND ACCESSORIES AVAILABLE FROM TDI.
 - ③ 4" NPT EXHAUST FLANGE - ALL STARTERS, 15 NOZZLES AND HIGHER.
3" NPT EXHAUST FLANGE - ALL STARTERS, 14 NOZZLES AND HIGHER.
 - ④ INLET PIPE SIZE: 1.5" - ALL STARTERS, 14 NOZZLES AND LOWER
2.0" - ALL STARTERS, 15 NOZZLES AND LOWER
 - ⑤ 2" TO 1" NPT REDUCING BUSHING - ALL STARTERS, 14 NOZZLES AND LOWER.

Figure 14. Typical Starter Installation - Natural Gas

TDI TURBOTWIN

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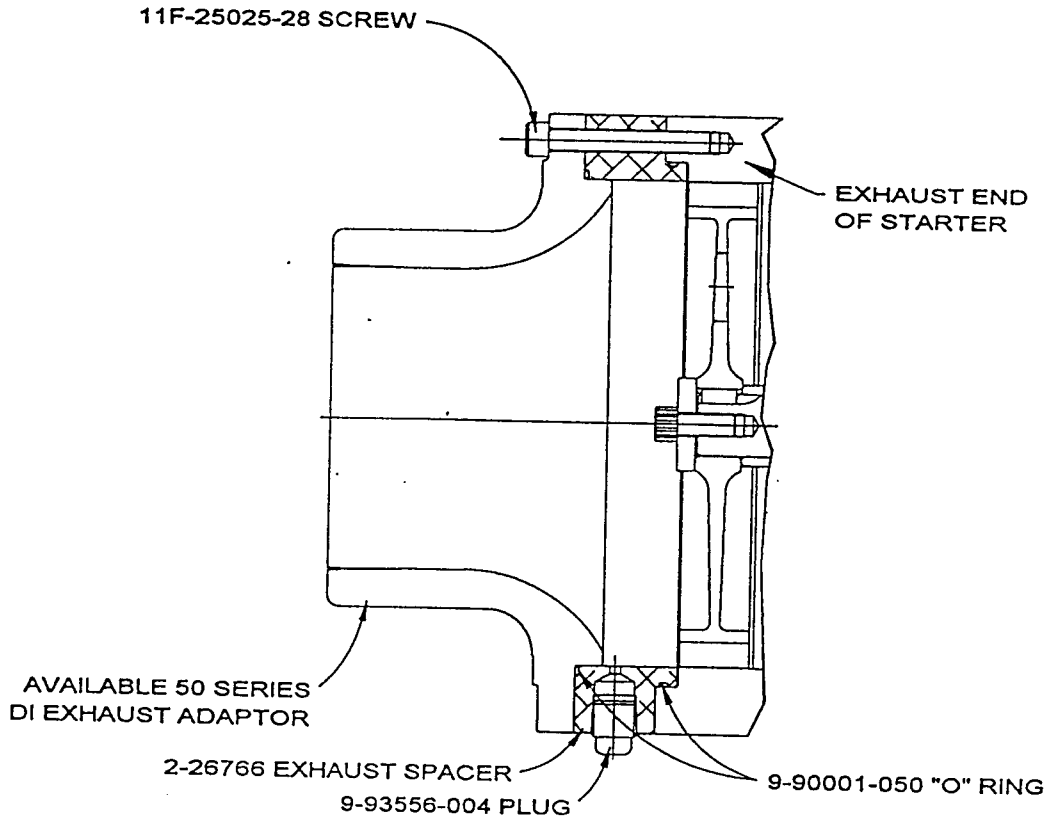


Figure 16. Part Number 52-26839 Exhaust Adaptor Kit

cause turbine starters such as the *TURBOTWIN* are sensitive to flow restrictions, care must be taken to use uniform hose or tubing and fittings for connection of the supply air line. Tees, elbows and line length must be kept to a minimum. TDI recommends that hose or flex couplings be installed to eliminate possible leakage caused by strain in the supply air line.

Normally, an air strainer is not required. In dirty environments, use of a #40 mesh Y-strainer is recommended. The *TURBOTWIN* is highly tolerant of dirt in the air line, however, the starter life can be increased with use of the air strainer.

A pressure regulator is required when the air supply pressure is great enough to exceed the starter operating pressure (at the inlet port) and/or the maximum torque.

A manual ball valve may be used to admit air to the starter. The manual valve should be located in a safe position away from the engine.

A preferred valve is pilot-operated relay valve which can be pneumatically or electrically actuated. The valve can be

located very close or even on the starter inlet for better performance. Pneumatic or electrical control lines may be routed virtually anywhere for the customer's preferred operating station. This type of valve actuates from a fully closed to a fully open position very rapidly (usually $\frac{1}{2}$ second or less). TDI offers a variety of relay valves such as P/N RLVA-25683-001-2-01 which is a 1-1/2" port, pneumatically actuated valve.

The supply line should be dry-fitted for proper alignment/location prior to final assembly. All pipe threaded joints should be sealed with Loctite Pipe Thread Sealant (TDI P/N 9-94085) or equivalent for leak tight joints prior to final assembly. Be sure to tighten all joints to proper torque after final assembly.

CAUTION

In cold climate conditions, care should be taken while designing your installation to prevent condensation from developing in the starter system. In systems with a regulator valve or relay valve, there is the possibility of freeze-up.

A tee connection with a quick disconnect can be added to

TDI TURBOTWIN

FROM TECH DEVELOPMENT INC

let. This will allow an external air source to be used to accomplish a "blow start" if the system freezes. Once the engine has been started, the other system components may be thawed.

This installation option may be especially useful in off-highway equipment.

CAUTION

Especially on new installations, it is strongly recommended to blow out the supply line with air to remove possible dirt and weld slag prior to final connection to the *TURBOTWIN* starter. Be sure to secure the free end of the supply line prior to the blow-down.

KIT PART NUMBER	DESCRIPTION	USED ON MODELS
52-420	Exhaust Guard Screen Kit	All
T100-27068	Exhaust Closure Plate Kit	All
T100-27015	3 Inch NPT 90 Degree Elbow Kit	All
52-26947	3 Inch NPT Straight Fitting Kit	All
52-26949	4 Inch NPT Straight Fitting Kit	All
T100-27075	Short Muffler Kit	T106F/T112F T121B/T121D
T100-27074	Long Muffler Kit	T121B/T121D
52-26839	Exhaust Adaptor Kit	All

Figure 17. Exhaust Hardware Kits

2.5 Inlet Pressure Port

A 1/4" NPT port is located on the exhaust side of the air inlet. This port may be used to check the supply pressure at the starter when the starter is operating. Remove the 1/4" NPT pipe plug and save for later use. Install a 1/4" minimum size tubing to the port. Route the tubing away from the starter to a safe location away from the engine. Install a pressure gauge on the tubing. This pressure monitoring line/gauge may be permanently installed. Use Loctite Pipe Thread Sealant or equivalent. Alternately, a pressure transducer may be installed at the pressure check port and electrical lines would be routed to a digital display at the operator's station.

This pressure port is invaluable in diagnosing air starter performance problems.

2.6 Exhaust Piping

The turbine exhaust may be plumbed away from the starter. 3" NPT and 4" NPT exhaust fittings are available from

TDI. Also see Section 3. All starters using natural gas must be piped away according to industry codes and local regulations.

The performance of a turbine starter will be decreased because of back pressure when smaller than recommended exhaust piping is installed. When the starter's exhaust is to be piped away, refer to Figure 8 for minimum piping size and TDI kit numbers. If back pressure hampers starter performance, compensation can be made by increasing the supply pressure. Consult your TDI distributor for advice.

The various exhaust fitting options are listed and shown in Figures 17 and 18, respectively. The standard exhaust treatment is the turbine exhaust guard P/N 52-420. This exhaust guard should not be used with natural gas.

In installations with a starter length restriction, the 3" right angle exhaust elbow may be required. The 3" NPT 90 degree elbow kit is P/N T100-27015 and features a welded steel pipe with a male 3" NPT pipe thread. An aluminum adapter ring is included with this kit to attach this elbow fitting to the *TURBOTWIN*.

The exhaust closure plate kit is P/N T100-27068. This kit features a movable plate which protects the inside of the starter from dirt when the starter is not operating. The end plate opens during starter operation. This exhaust fitting should not be used with natural gas.

The 3" NPT straight exhaust fitting features a female 3" NPT pipe thread. This kit is P/N 52-26947. An adapter ring is included with this kit.

The 4" NPT straight exhaust fitting features a female 4" NPT pipe thread. This kit is P/N 52-26949. An adapter ring is included with this kit.

The muffler kit for the 6 or 12 nozzle *TURBOTWIN* starter is P/N T100-27075. This exhaust fitting should not be used with natural gas.

The muffler kit for the 21 nozzle *TURBOTWIN* starter is P/N T100-27074. This exhaust fitting should not be used with natural gas.

All older TDI Series 52 exhaust options may be used on the *TURBOTWIN* with the exhaust adapter kit P/N 52-26839. A typical installation using the adapter ring is shown in Figure 16. This adapter ring must be used with the older fittings, otherwise the starter will be damaged.

Exhaust piping should be routed downward to help prevent any accumulation of condensate in the starter motor.

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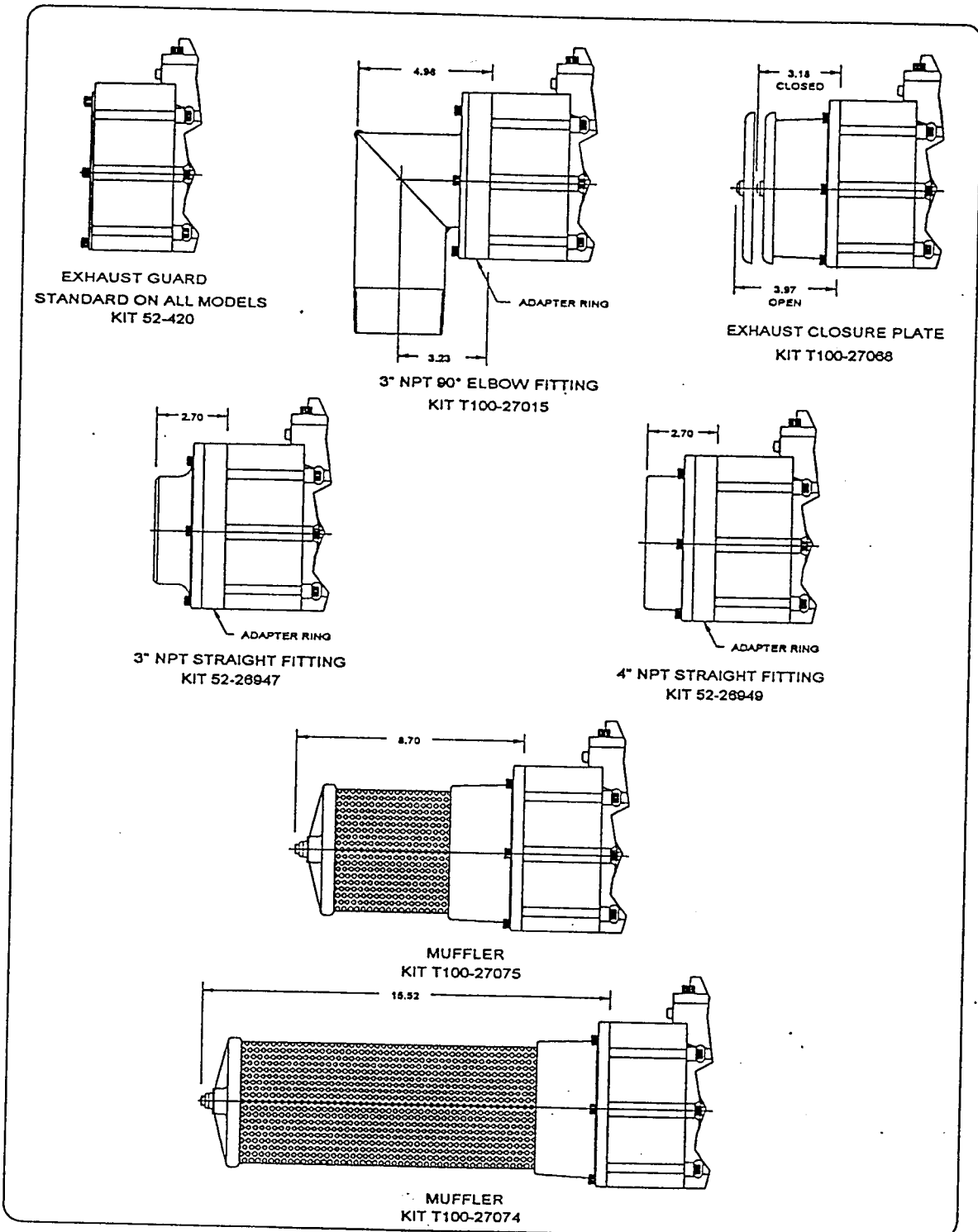


Figure 18. Illustrated Exhaust Hardware Options

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The overhung section of the starter is not otherwise supported, TDI recommends that the exhaust piping be supported with a suitable bracket(s).

2.7 Natural Gas Installation

The installation of the starter using natural gas is similar to the air installation except all fittings, piping, valves and regulators must be compatible with natural gas.

Proper control of natural gas is a major consideration when used in the starter system. All starters using natural gas must be piped away on the exhaust according to industry codes and local regulations.

There is a natural gas vent port in the turbine housing that is plugged for compressed air use. This vent is used to remove any natural gas which could leak past the primary turbine shaft seal. Remove this 3/8"NPT plug and install a line to carry gas away from the starter area and vent to atmosphere; refer to Figures 2,3,4 and 5. Do not connect this vent line to the starter exhaust line.

CAUTION

Do not connect the turbine housing vent line to the turbine exhaust line; exhaust gas can pressurize the turbine housing.

3.0 HARDWARE and ACCESSORIES

Refer to Figures 16 through 19 for exhaust hardware and installation accessories available from Tech Development.

DESCRIPTION	PART NUMBER
Pressure Regulator, Air, 1.5"	52-20724-100
Pressure Regulator, Air, 2.0"	52-20724-200
Pressure Gauge, 0 - 200 PSIG	52-21982
Pressure Gauge, with U-Clamp, 0 - 200 PSIG	52-21982-100
Manual Control Valve, Air	52-93504
Natural Gas Piloted Relay Valve, 1.5"	52-93505
Natural Gas Piloted Relay Valve, 2.0"	52-93505-100
Air Piloted Relay Valve, Buna-N, 1.5"	RLVA-25683-001-1-01
Air Piloted Relay Valve, Viton, 1.5"	RLVA-25683-001-2-01
Air Piloted Relay Valve, High Pressure, 1.5"	RLVA-25683-001-3-01
Solenoid Control Air Valve, 12VDC, 1.5" Buna-N	RLVA-25683-012-1-01
Solenoid Control Air Valve, 12VDC, 1.5" Viton	RLVA-25683-012-2-01

Figure 19. Installation Accessories

DESCRIPTION	PART NUMBER
Solenoid Control Air Valve, 24VDC, 1.5" Buna-N	RLVA-25683-014-1-01
Solenoid Control Air Valve, 24VDC, 1.5", Viton	RLVA-25683-024-2-01
Solenoid Control Air Valve, 110VDC, 1.5"	RLVA-25683-110-2-01
Solenoid Control Air Valve, 120 VAC, 1.5"	RLVA-25683-120-2-01
Valve, Natural Gas, Manually Operated / Spring Loaded, 1.5"	52-93508
Valve, Natural Gas, Manually Operated / Spring Loaded, 2.0"	52-93508-400
Pressure Regulator, Natural Gas, 2", 300 PSIG Max Upstream Pressure	52-93552
Pressure Regulator, Natural Gas, 2", 125 PSIG Max Upstream Pressure	52-93553
Y-Strainer, 1.5 NPT, Natural Gas, 600 PSIG	52-93549-100
Y-Strainer, 2.0" NPT, Natural Gas, 600 PSIG	52-93549-200
Y-Strainer, 1.5" NPT, Air, 250 PSIG	52-93550-100
Y-Strainer, 2.0" NPT, Air, 250 PSIG	52-93550-200
Grease, 1 Lb Can	9-94121
Grease, 16 Oz Tube	9-94121-002
Anti-Seize Compound, 1 Oz Tube	42-94081
Anti-Seize Compound, 1 Lb Can	9-94081
Sealant, Pipe Thread, Loctite 59231, 1.69 Oz Tube	9-94085

Figure 19. (Continued) Installation Accessories

4.0 STARTER OPERATION

Prior to operation, check that all connections are tight and free from leaks. Check the 1/4" NPT pipe plug (from Section 2.5) or a pressure gauge/transducer and air line is connected to the pressure port on the starter inlet.

WARNING

Do not operate the TDI *TURBOTWIN* starter with air pressure greater than the pressure rating on the nameplate. This pressure is to be measured at the starter inlet while the starter is running.

The maximum operating pressure limit is the inlet pressure when measured at the starter inlet pressure check port and reflects all supply air pipe and valving losses. In order to check the starter, a 1/4"NPT pipe tap connection is provided in the inlet housing to attach a pressure gauge/transducer; refer to Figures 4 and 5.) **IN NO CASE SHOULD INLET OPERATING PRESSURE EXCEED 200 PSIG (14.8 BAR) WITH AN OPEN EXHAUST!** This will exceed the maximum torque limit of the inertia drive assembly. The maximum

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operating pressure limit of all models of *TURBOTWIN* starters is shown in Figure 1. These maximum pressures assume air as the working gas and an open exhaust (the standard turbine exhaust guard). The standard exhaust guard basically causes no back pressure.

The static supply pressure will always be higher than the operating pressure. As a guideline, the maximum pressure limit (proof pressure) that the *TURBOTWIN* starter housings may be subjected to is 600 PSIG (42 BAR). System pressure that exceeds the maximum operating limit must use a pressure reducer device to ensure that the operating pressure limit to the *TURBOTWIN* starter is maintained.

System pressure that exceeds the 600 PSIG (42 BAR) limit must, in addition to pressure reducer devices, incorporate a pressure relief valve, set below 600 PSIG (42 BAR), in the supply air line.

All appropriate local pressure codes and pressure limitations on other system components must be adhered to and would supersede the guidelines given in this manual.

Consult your TDI distributor if you have exhaust plumbing which creates back pressure and reduces starter performance. You may be able to increase the supply pressure to restore the lost power.

Follow the engine manufacturer's instructions for starting the engine.

4.1 Basic Operation

The basic operation of the starter follows:

Pressurized air or natural gas is admitted to the starter by the opening of the manual or relay valve. The air expands through the turbine which produces shaft rotation and torque. The acceleration of the drive assembly causes the pinion to advance and engage the ring gear of the engine. The starter motor torque causes the engine to accelerate. The fuel and ignition systems now fire the engine. The starter is stopped by closing the manual or relay valve.

The *TURBOTWIN* features a unique two stage turbine which limits the maximum starter speed from its aerodynamic design. The operator may prematurely decrease starter life by the continual operation of the starter after the engine has started. Upon a successful engine start, shut the air off to the starter immediately. Minimizing the time the starter is operating unloaded (i.e. the engine is running) will maximize the starter life. If a start is aborted, a restart may be attempted after the engine and the starter have come to rest.

WARNING

Do not engage the starter while the engine is running.

The drive air pressure is the primary starter control parameter. It is important, especially on new installations, to measure this pressure during several engine starts. The secondary parameter is the starter pinion speed. This speed is usually measured by knowledge of the engine starting speed and the starter cranking ratio. The cranking ratio is the number of ring gear teeth divided by the number of pinion teeth. The starter pinion speed is then found by multiplying the engine speed by the cranking ratio. The pinion speed is usually 2000-3500 rpm for a typical engine starting speed.

If the engine fails to function properly when first operated, or its performance deteriorates with use, refer to the Operator's Trouble Shooting Guide, Section 7.0. If you cannot solve the problem, or repair is necessary, contact your local TDI *TURBOTWIN* distributor or dealer.

4.2 Manual Valve Operation

The operator opens a valve manually to admit pressurized air to the starter. As the engine approaches starting engine speed, the operator must monitor the various engine parameters or listen for the engine firing. Upon engine firing, the operator must stop the air flow to the starter by closing the manual valve.

Leaving the air on to the starter more than one second after the engine is running, may result in damage to the starter.

4.3 Automated Start Panel

As mentioned previously, the starter drive pressure will need to be set. This pressure is measured at the starter inlet.

The speed control parameter will then need to be set. Engine starting speed along with the cranking ratio number can be used to determine starter pinion speed. The pinion speed is usually 2000-3500 rpm for a typical engine starting speed. Once the start sequence has begun, the air is admitted to the starter. The starter begins to accelerate the engine. Once the firing speed of the engine is reached, the automated start panel may start fuel to the engine (diesel). The engine will begin to accelerate under its own power. The starter should be dropped out of the sequence at an rpm slightly higher than the firing speed, but certainly less than the engine idle speed.

The automated start panel should be set to monitor engine

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ed and/or starter speed to determine air on and air off. Do not use simply time as a control parameter. Avoiding excessive over speed of the starter after the engine is firing will maximize the starter life.

5.0 PREVENTIVE MAINTENANCE

The TDI *TURBOTWIN* starters provide distinct advantages of size and efficiency as compared to electric motor, vane-type or other turbine-type starters. It is important to properly install the starter to receive full benefit of these advantages. Repair technicians or service organizations without turbine starter experience should not attempt to repair this machine until they receive factory approved training from TDI, or its representatives.

Proper operation and repair of your TDI *TURBOTWIN* starter will assure continued reliable and superior performance for many years.

5.1 Every Six (6) Months

Perform the following procedures at six(6) months intervals if the normal cranking cycle is 0 - 10 seconds.

5.1.1 Check the amount and condition of grease in the planetary gearbox. If gearbox requires re-greasing, only use TDI grease. Approximately one (1) pint of grease is needed to repack the gearbox.

5.1.2 Check the turbine bearing and carrier output bearings for freedom of rotation without excessive play between races. If bearings are damaged, replace them with genuine TDI parts. Refer to TDI Service Manual for part numbers.

5.1.3 Place a small amount of chassis lube on the starter's pinion teeth.

5.2 Every Three (3) Months

Follow the six (6) month procedures if there is severe starter loading or extended duration crank cycles. Also perform these procedures every three (3) months when starter is used for motoring the engine for maintenance or valve adjustments.

Motoring Crank Cycle: 10 -60 seconds

Extended Crank Cycle: 60 seconds or longer

6.0 STARTER DISASSEMBLY AND REPAIR

The TDI service manual P/N T1-701 provides a step by step procedure to assemble and disassemble the *TURBOTWIN* starter. All models are covered by this manual.

Section 2.2 discusses the partial disassembly in detail to change the orientation of the air inlet relative to the starter mounting flange.

Repair technicians or service organizations without turbine starter experience should not attempt to repair this machine until they receive factory approved training from TDI or its representatives. If repair is required, consult your local TDI *TURBOTWIN* dealer or distributor.

For safe and reliable operation of your TDI *TURBOTWIN* starter, use only genuine TDI replacement parts. The component part numbers are found in the Illustrated Parts Breakdown which is P/N T1-703. All models are covered in this publication.

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TROUBLE	PROBABLE CAUSE	SOLUTION
1. Starter does not run; small air flow from exhaust.	A. Relay valve not fully open.	A. Repair or replace relay valve.
	B. Nozzle blockage.	B. Remove blockage or obstruction from nozzles.
2. Starter does not run; normal air flow from exhaust.	A. Broken turbine rotor.	A. Replace all damaged parts.
	B. Broken gear train.	B. Repair or replace geartrain.
	C. Damaged starter drive.	C. Repair or replace starter drive.
3. Reduced Starter output power.	A. Inlet air pressure too low.	A. Increase air pressure in 10 PSIG (0.6 BAR) increments; DO NOT EXCEED OPERATING LIMIT.
	B. Inlet supply piping too small.	B. Supply piping must be a minimum of 1.5" diameter.
	C. Pressure regulator orifice too small.	C. Increase orifice size or replace pressure regulator
	D. Inlet supply line valve (ball, gate, relay, plug) too small.	D. Install larger valve.
	E. In line lubricator installed in supply line.	E. Remove lubricator.
	F. Y-Strainer in supply line clogged.	F. Clean strainer.
	G. Excessive back pressure; exhaust restricted.	G. Clean exhaust piping or increase size to at least the minimum diameter recommended.
	H. Damaged turbine nozzle.	H. Replace turbine nozzle.
	I. Broken started drive.	I. Repair or replace starter drive.
	J. Wrong rotation starter.	J. Replace with starter or proper rotation.
	K. Wrong size starter.	K. Check the Application Guide for the correct starter.
4. Engine cranks too quickly.	A. Inlet air pressure too high.	A. Decrease air pressure in 10 PSIG (0.6 BAR) increments. OR If there is a manual shut-off valve in the supply line, partially close it. OR Install a restriction orifice in the inlet supply line.
	B. Wrong size starter.	B. Check the Application Guide for the correct starter.

7.0 OPERATOR'S TROUBLE SHOOTING GUIDE

If repair is required, consult your local TDI *TURBOTWIN* dealer or distributor.

For your nearest TDI dealer contact:

Phone: (513)898-9600 Customer Service
 Fax: (513)898-8431 Tech Development Inc
 6800 Poe Avenue
 Dayton, Ohio 45414

TDI TURBOTWIN
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WARRANTY

TDI TURBOSTART ENGINE STARTER WARRANTY

Tech Development Inc. Warrants to the original user of the TDI TURBOTWIN starters that the starters and related components manufactured by TDI will be free from defects in material and workmanship for a period of One (1) Year from the date of purchase by such user. The conditions of this warranty are: a) TDI is notified within this period by return of such product to TDI or its authorized distributor or dealer, transportation prepaid by user; b) such product has been installed according to TDI's specifications; c) such product has not been misused, abused, or improperly maintained by user; d) the defect is not the result of normal wear and tear; and e) such starter product has not been repaired with parts not manufactured or authorized by TDI and that TDI installation and repair procedures as outlined in the appropriate manual were properly followed.

Tech Development Inc. shall, at its option, either repair or replace, without charge, any such starter product found upon TDI's examination to be so defective, or by mutual agreement, refund the user's purchase price in exchange for such starter product. Repairs or replacements under this warranty are warranted for the remainder of the original warranty period.

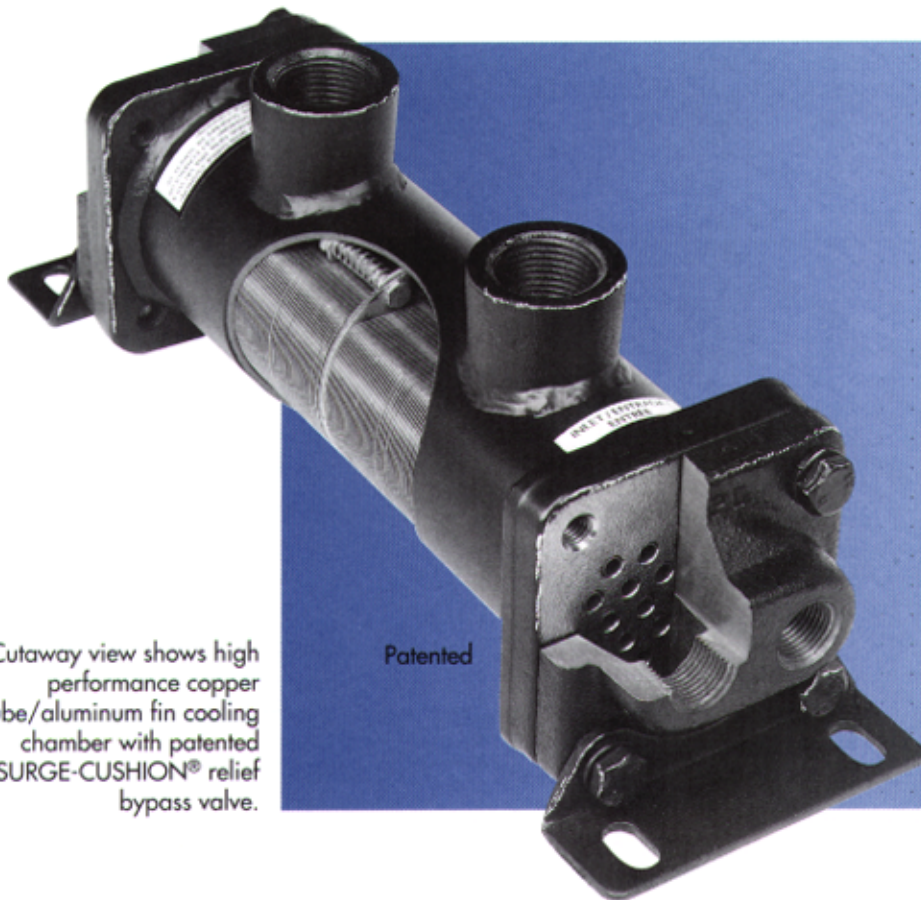
Tech Development Inc. Makes no other warranty, and IMPLIED WARRANTIES INCLUDING ANY WARRANTY OR MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE ARE HEREBY DISCLAIMED.

This warranty constitutes the entire obligation of Tech Development Inc. Relating to the sale and use of such product, and TDI's maximum liability is limited to the purchase price of such product at the date of purchase. In no event shall TDI be liable for incidental, indirect, consequential or special damages of any nature from the sale of such engine starter product.

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WATER COOLED – INDUSTRIAL OIL COOLERS

EK Series



Cutaway view shows high performance copper tube/aluminum fin cooling chamber with patented SURGE-CUSHION® relief bypass valve.

Patented

COMPACT SIZE

HIGH EFFICIENCY
FINNED BUNDLE DESIGN

LOW COST

OPTIONAL PATENTED BUILT-IN
SURGE-CUSHION RELIEF BYPASS

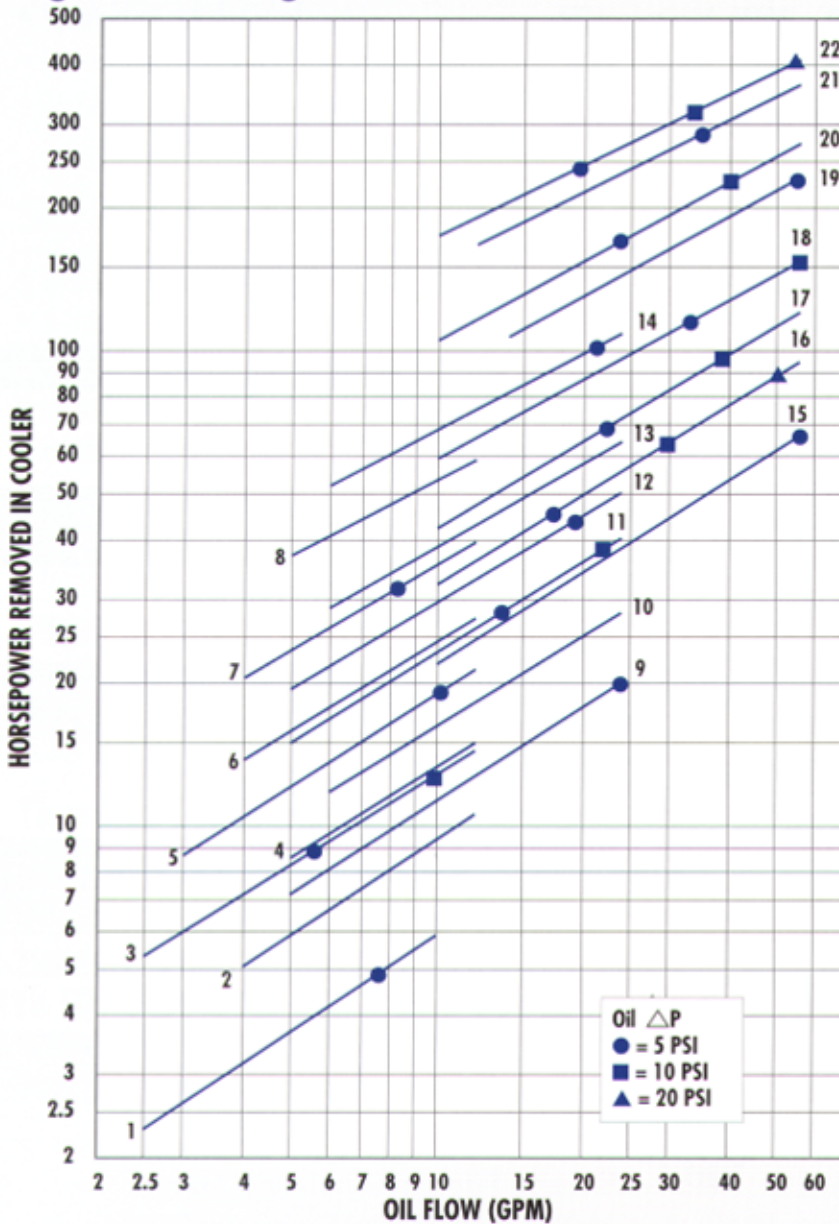
- Heat removal up to 400 horsepower (300 kW)
- Oil flow rates up to 80 U.S. GPM (300 Liters/min.)
- Large oil connections for minimum entering and exiting flow restriction
- Removable end bonnets for easy tube cleaning
- Mounting brackets designed so that cooler can be rotated in 90° increments
- High pressure ratings
- Off-the-shelf delivery on EK and EKS Models
- Complete line of accessories available



**TE Thermal
Transfer Products**
A THERMAL COMPONENTS COMPANY

PERFORMANCE CURVES 1:1 OIL TO WATER RATIO

High water usage



MODELS	WEIGHTS (LBS.)	
	NET	APPROX. SHIPPING
1. EK-505-0	6	7
2. EK-508-0	7	8
3. EK-510-0	8	9
4. EK-512-0	9	10
5. EK-514-0	10	11
6. EK-518-0	11	12
7. EK-524-0	13	14
8. EK-536-0	17	18
9. EK-708-0	15	16
10. EK-712-0	18	19
11. EK-714-0	19	20
12. EK-718-0	22	23
13. EK-724-0	26	28
14. EK-736-0	34	36
15. EK-1012-0	35	37
16. EK-1014-0	38	40
17. EK-1018-0	42	45
18. EK-1024-0	50	55
19. EK-1036-9-0	67	85
20. EK-1036-6-0	67	85
21. EK-1048-8-0	78	95
22. EK-1048-6-0	78	95

SPECIFICATIONS

Materials

Shell - Steel	Tubes - Copper
Tubesheets - Steel	Fins - Aluminum
Baffles - Steel	End Caps - Grey Iron
Mounting Brackets - Steel	
Gaskets - Nitrile Rubber/Cellulose Fiber	
Nameplate - Aluminum Foil	

SELECTION PROCEDURE

Performance Curves are based on 100SSU oil leaving the cooler 40°F higher than the incoming water temperature used for cooling. This is also referred to as a 40°F approach temperature.

Step 1. Determine the Heat Load.

This will vary with different systems, but typically coolers are sized to remove 25 to 50% of the input nameplate horsepower. (Example: 100 HP Power Unit x .33 = 33 HP Heat load.) If BTU/Hr. is known: $HP = \frac{BTU/Hr}{2545}$

Step 2. Determine Approach Temperature.

Desired oil leaving cooler °F - Water Inlet temp. °F = Actual Approach (Max. reservoir temp.)

Step 3. Determine Curve Horsepower Heat Load.

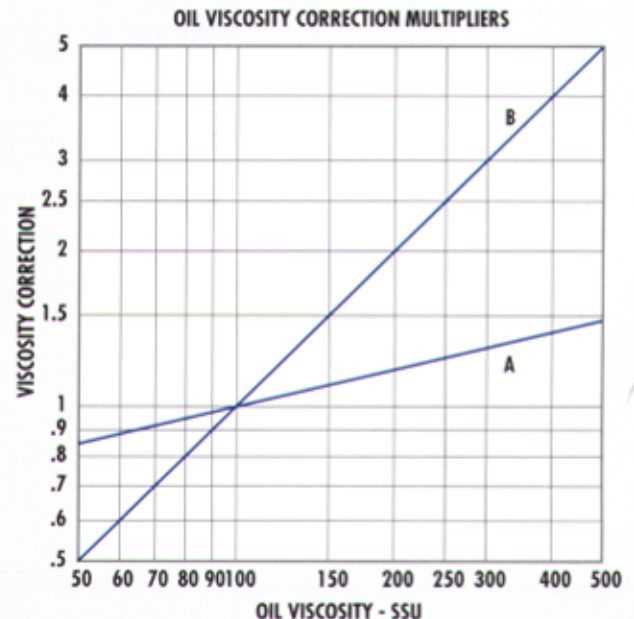
Enter the information from above:
 $\text{Horsepower heat load} \times \frac{40}{\text{Actual Approach}} \times \text{Viscosity Correction A} = \text{Curve HP}$

Step 4. Enter curves at oil flow through cooler and curve horsepower.

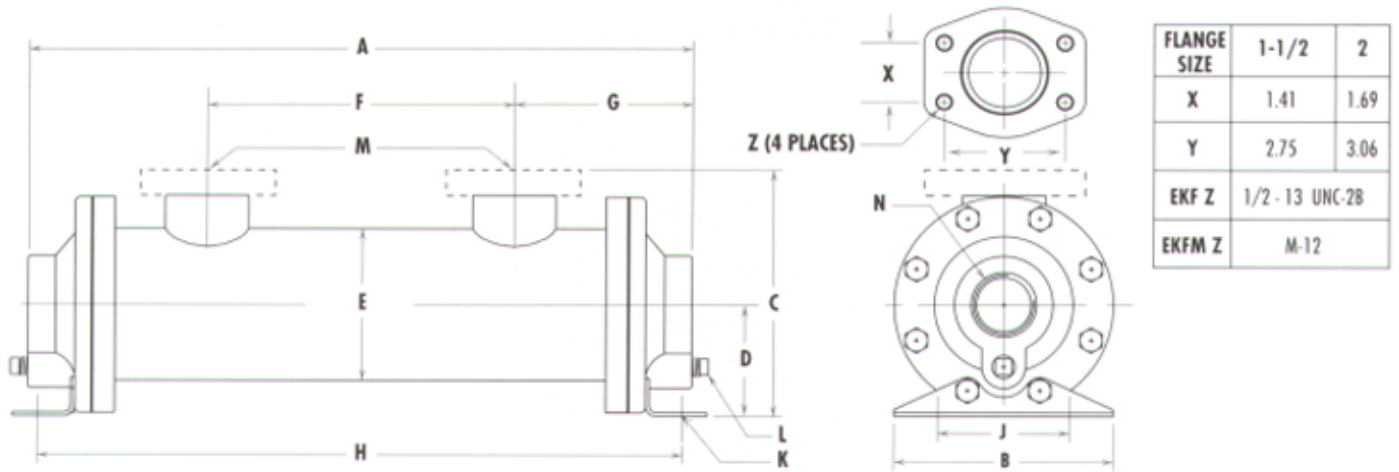
Any curve above the intersecting point will work.

Step 5. Determine Oil Pressure Drop from Curves:

● = 5 PSI; ■ = 10 PSI; ▲ = 20 PSI. Multiply pressure drop from curve by correction factor B found on oil viscosity correction curve.



ONE PASS DIMENSIONS



FLANGE SIZE	1-1/2	2
X	1.41	1.69
Y	2.75	3.06
EKF Z	1/2 - 13 UNC-2B	
EKFM Z	M-12	

MODEL	A	B	C		D	E	F	G	H	J	K	L	M				N	
			NPT / BSPP SAE O-RING	SAE FLANGE									NPT	SAE O-RING	SAE FLANGE	BSPP		NPT BSPP
EK-505	7.38	3.5 MAX. WIDTH	3.74	N/A	1.62	2.55 DIA.	2.19	3.26	7.44	2.50	.34 x .62 SLOT	N/A	1/2	#8 3/4-16 UNF-2B	N/A	3/4	1/2	3/4
EK-508	10.38		3.85				10.44											
EK-510	12.38		5.85				12.44											
EK-512	14.38		7.85				14.44											
EK-514	16.38		9.85				16.44											
EK-518	20.38		13.85				20.44											
EK-524	26.38		19.85				26.44											
EK-536	38.38		31.85				38.44											
EK-708	11.12	5.0 MAX. WIDTH	5.47	5.71	2.59	3.52 DIA.	3.00	4.07	10.71	3.00	.44 x .75 SLOT	1/4	1 1/2	#24 1 1/8-12 UN-2B	1 1/2	1 1/2	1 1/4	
EK-712	15.12						7.00		14.71									
EK-714	17.12						9.00		16.71									
EK-718	21.12						13.00		20.71									
EK-724	27.12						19.00		26.71									
EK-736	39.12						31.00		38.71									
EK-1012	15.33	6.5 MAX. WIDTH	7.64	8.28	4.00	5.05 DIA.	6.18	4.57	15.45	4.00	.44 x 1.00 SLOT	2	2	2	2	1 1/2	1 1/2	
EK-1014	17.33						8.18		17.45									
EK-1018	21.33						12.18		21.45									
EK-1024	27.33						18.18		27.45									
EK-1036	39.33						30.18		39.45									
EK-1048	51.33						42.18		51.45									

NOTE: We reserve the right to make reasonable design changes without notice. All dimensions are in inches.

SURGE-CUSHION (optional)

The SURGE-CUSHION® is a protective device (patented) designed to internally bypass a portion of the oil flow during cold start conditions, or when sudden flow surges temporarily exceed the maximum flow allowed for a given cooler. This device may replace an external bypass valve, but it is not intended to bypass the total oil flow.

MAXIMUM FLOW RATES

UNIT SIZE	SHELL SIDE GPM	TUBE SIDE GPM		
		ONE PASS	TWO PASS	FOUR PASS
500	20	13	6	N/A
700	60	24	12	6
1000	80	56	28	14

Incorrect installation can cause premature failure.

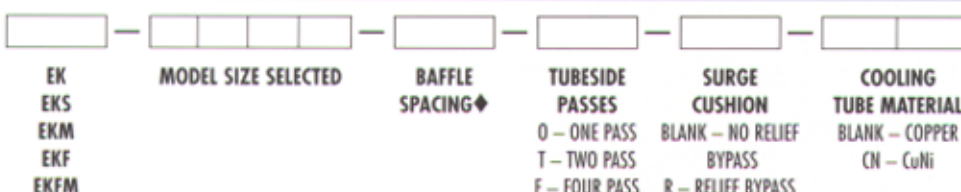
RATINGS

Maximum Shell Side Pressure 500 PSI

Maximum Tube Side Pressure 150 PSI

Maximum Temperature 250°F

HOW TO ORDER

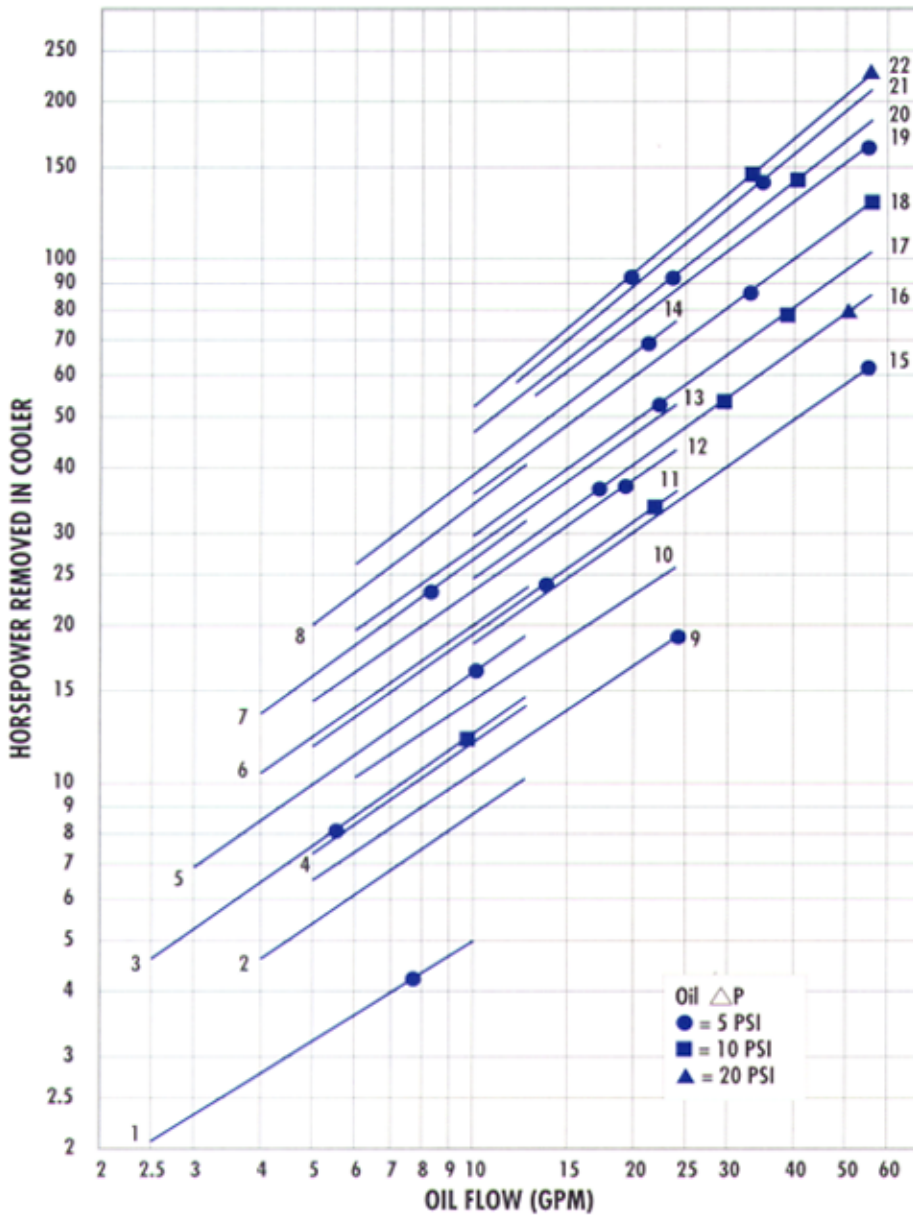


◆EK-1036 and EK-1048 Models only.

EK = NPT Oil connections; NPT Water connections.
 EKS = SAE O-Ring Oil connections; NPT Water connections.
 EKM = BSPP Oil connections; BSPP Water connections.
 EKF = SAE 4 Bolt Flange (Tapped SAE) Oil connections; NPT Water connections.
 EKFM = SAE 4 Bolt Flange (Tapped Metric) Oil connections; BSPP Water connections.

PERFORMANCE CURVES 2:1 OIL TO WATER RATIO

Medium water usage



MODELS	WEIGHTS (LBS.)	
	NET	APPROX. SHIPPING
1. EK-505-T	6	7
2. EK-508-T	7	8
3. EK-510-T	8	9
4. EK-512-T	9	10
5. EK-514-T	10	11
6. EK-518-T	11	12
7. EK-524-T	13	14
8. EK-536-T	17	18
9. EK-708-T	15	16
10. EK-712-T	18	19
11. EK-714-T	19	20
12. EK-718-T	22	23
13. EK-724-T	26	28
14. EK-736-T	34	36
15. EK-1012-T	35	37
16. EK-1014-T	38	40
17. EK-1018-T	42	45
18. EK-1024-T	50	55
19. EK-1036-9-T	67	85
20. EK-1036-6-T	67	85
21. EK-1048-8-T	78	95
22. EK-1048-6-T	78	95

SPECIFICATIONS

Materials

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Tubesheets - Steel	Fins - Aluminum
Baffles - Steel	End Caps - Grey Iron
Mounting Brackets - Steel	
Gaskets - Nitrile Rubber/Cellulose Fiber	
Nameplate - Aluminum Foil	

SELECTION PROCEDURE

Performance Curves are based on 100SSU oil leaving the cooler 40°F higher than the incoming water temperature used for cooling. This is also referred to as a 40°F approach temperature.

Step 1. Determine the Heat Load.

This will vary with different systems, but typically coolers are sized to remove 25 to 50% of the input nameplate horsepower. (Example: 100 HP Power Unit x .33 = 33 HP Heat load.) If BTU/Hr. is known: $HP = \frac{BTU/Hr}{2545}$

Step 2. Determine Approach Temperature.

Desired oil leaving cooler °F - Water Inlet temp. °F = Actual Approach (Max. reservoir temp.)

Step 3. Determine Curve Horsepower Heat Load.

Enter the information from above:

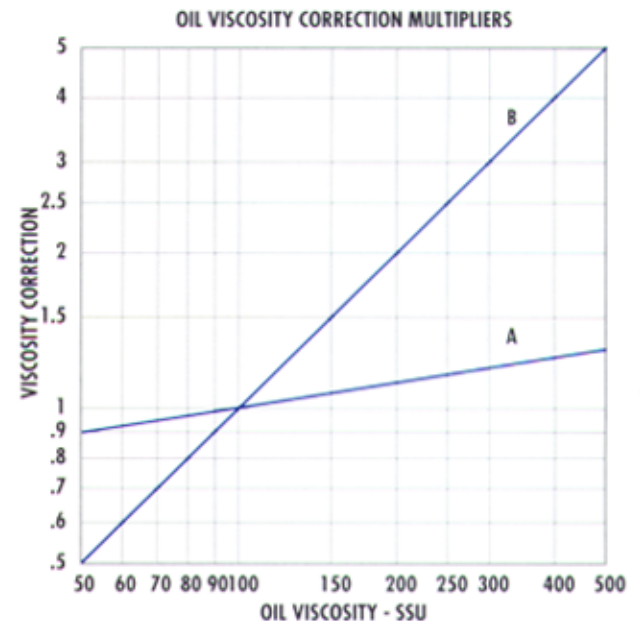
Horsepower heat load x $\frac{40}{\text{Actual Approach}}$ x Viscosity Correction A = Curve HP

Step 4. Enter curves at oil flow through cooler and curve horsepower.

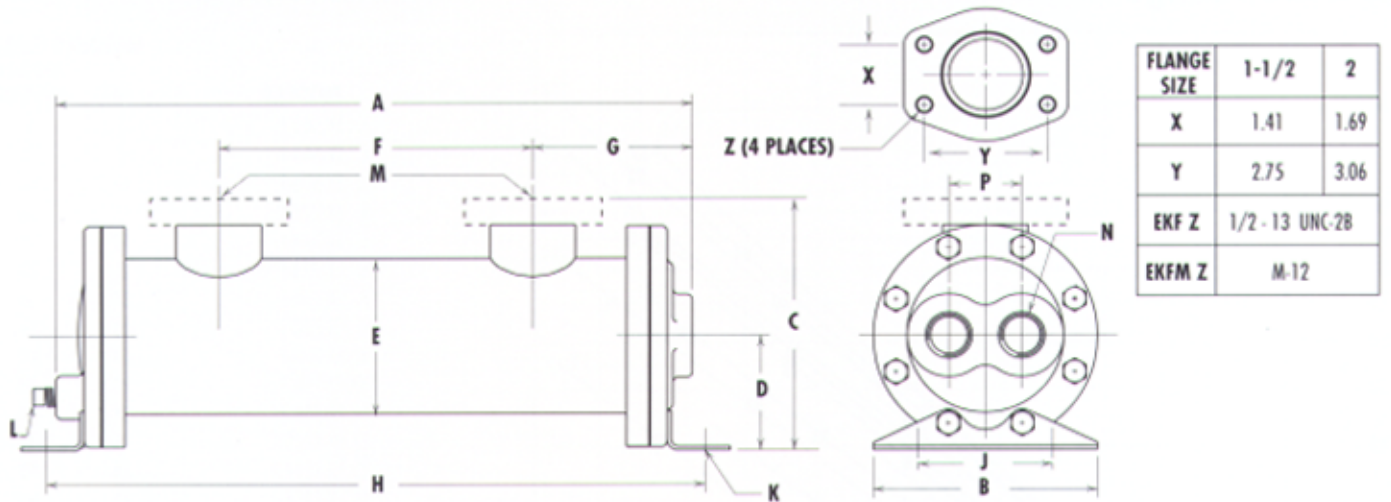
Any curve above the intersecting point will work.

Step 5. Determine Oil Pressure Drop from Curves:

● = 5 PSI; ■ = 10 PSI; ▲ = 20 PSI. Multiply pressure drop from curve by correction factor B found on oil viscosity correction curve.



TWO PASS DIMENSIONS



FLANGE SIZE	1-1/2	2
X	1.41	1.69
Y	2.75	3.06
EKF Z	1/2 - 13 UNC-2B	
EKFM Z	M-12	

MODEL	A	B	C		D	E	F	G	H	J	K	L		M			N		P
			NPT / BSPP SAE O-RING	SAE FLANGE								NPT	NPT	SAE O-RING	SAE FLANGE	BSPP	NPT BSPP		
EK-505	7.38	3.5 MAX. WIDTH	3.74	N/A	1.62	2.55 DIA.	2.19	3.26	7.44	2.50	.34 x .62 SLOT	N/A	3/4	#8 3/4-16 UN-2B	N/A	3/4	3/8	1.12	
EK-508	10.38		3.85				10.44												
EK-510	12.38		5.85				12.44												
EK-512	14.38		7.85				14.44												
EK-514	16.38		9.85				16.44												
EK-518	20.38		13.85				20.44												
EK-524	26.38		19.85				26.44												
EK-536	38.38		31.85				38.44												
EK-708	10.19	5.0 MAX. WIDTH	5.47	5.71	2.59	3.52 DIA.	3.00	3.57	10.71	3.00	.44 x .75 SLOT	1 1/2	1 1/2	#12 1 1/16-12 UN-2B	N/A	3/4	3/4	1.62	
EK-712	14.19						7.00		14.71										
EK-714	16.19						9.00		16.71										
EK-718	20.19						13.00		20.71										
EK-724	26.19						19.00		26.71										
EK-736	39.19						31.00		38.71										
EK-1012	14.58	6.5 MAX. WIDTH	7.64	8.28	4.00	5.05 DIA.	6.18	4.45	15.45	4.00	.44 x 1.00 SLOT	1/4	2	#24 1 7/8-12 UN-2B	2	1 1/2	1.0	2.38	
EK-1014	16.58						8.18		17.45										
EK-1018	20.58						12.18		21.45										
EK-1024	26.58						18.18		27.45										
EK-1036	38.58						30.18		39.45										
EK-1048	50.58						42.18		51.45										

NOTE: We reserve the right to make reasonable design changes without notice. All dimensions are in inches.

SURGE-CUSHION (optional)

The SURGE-CUSHION® is a protective device (patented) designed to internally bypass a portion of the oil flow during cold start conditions, or when sudden flow surges temporarily exceed the maximum flow allowed for a given cooler. This device may replace an external bypass valve, but it is not intended to bypass the total oil flow.

MAXIMUM FLOW RATES

UNIT SIZE	SHELL SIDE GPM	TUBE SIDE GPM		
		ONE PASS	TWO PASS	FOUR PASS
500	20	13	6	N/A
700	60	24	12	6
1000	80	56	28	14

Incorrect installation can cause premature failure.

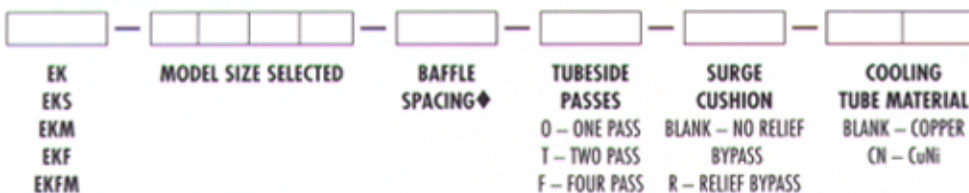
RATINGS

Maximum Shell Side Pressure 500 PSI

Maximum Tube Side Pressure 150 PSI

Maximum Temperature 250°F

HOW TO ORDER

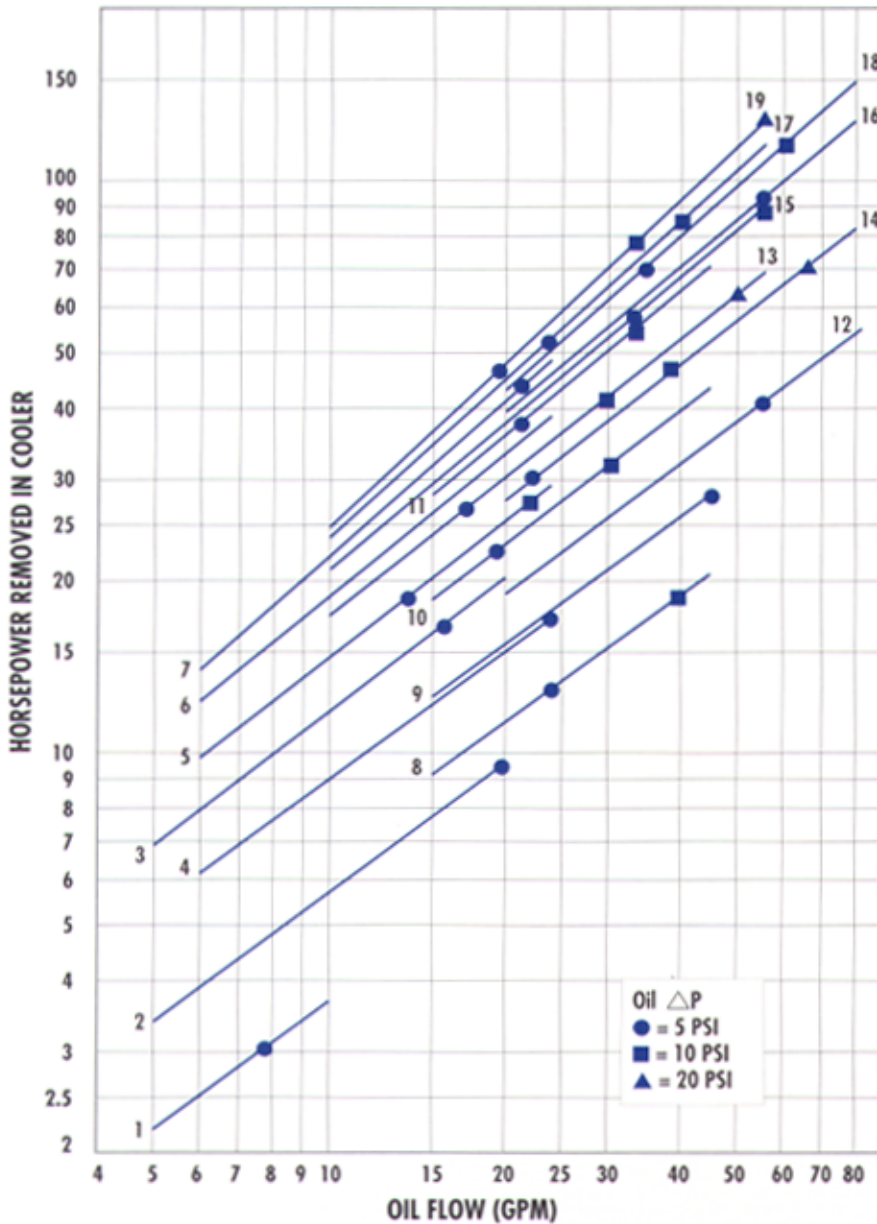


EK = NPT Oil connections; NPT Water connections.
 EK S = SAE O-Ring Oil connections; NPT Water connections.
 EK M = BSPP Oil connections; BSPP Water connections.
 EK F = SAE 4 Bolt Flange (Tapped SAE) Oil connections; NPT Water connections.
 EK FM = SAE 4 Bolt Flange (Tapped Metric) Oil connections; BSPP Water connections.

◆EK-1036 and EK-1048 Models only.

PERFORMANCE CURVES 4:1 OIL TO WATER RATIO

Low water usage



MODELS	WEIGHTS (LBS.)	
	NET	APPROX. SHIPPING
1. EK-505-T	6	7
2. EK-508-T	7	8
3. EK-518-T	11	12
4. EK-708-F	15	16
5. EK-714-F	19	20
6. EK-724-F	26	28
7. EK-736-F	34	36
8. EK-708-T	15	16
9. EK-712-T	18	19
10. EK-718-T	22	23
11. EK-736-T	34	36
12. EK-1012-T	35	37
13. EK-1014-F	38	40
14. EK-1018-T	42	45
15. EK-1024-F	50	55
16. EK-1036-9-T	67	85
17. EK-1036-6-F	67	85
18. EK-1048-8-T	78	95
19. EK-1048-6-F	78	95

SPECIFICATIONS

Materials

Shell - Steel	Tubes - Copper
Tubesheets - Steel	Fins - Aluminum
Baffles - Steel	End Caps - Grey Iron
Mounting Brackets - Steel	
Gaskets - Nitrile Rubber/Cellulose Fiber	
Nameplate - Aluminum Foil	

SELECTION PROCEDURE

Performance Curves are based on 100SSU oil leaving the cooler 40°F higher than the incoming water temperature used for cooling. This is also referred to as a 40°F approach temperature.

Step 1. Determine the Heat Load.

This will vary with different systems, but typically coolers are sized to remove 25 to 50% of the input nameplate horsepower. (Example: 100 HP Power Unit x .33 = 33 HP Heat load.) If BTU/Hr. is known: $HP = \frac{BTU/Hr}{2545}$

Step 2. Determine Approach Temperature.

Desired oil leaving cooler °F - Water Inlet temp. °F = Actual Approach (Max. reservoir temp.)

Step 3. Determine Curve Horsepower Heat Load.

Enter the information from above:

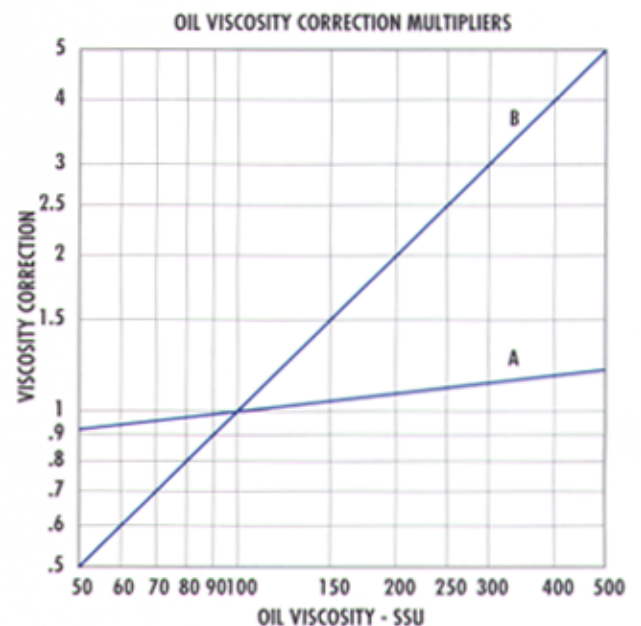
Horsepower heat load x $\frac{40}{\text{Actual Approach}}$ x Viscosity Correction A = Curve HP

Step 4. Enter curves at oil flow through cooler and curve horsepower.

Any curve above the intersecting point will work.

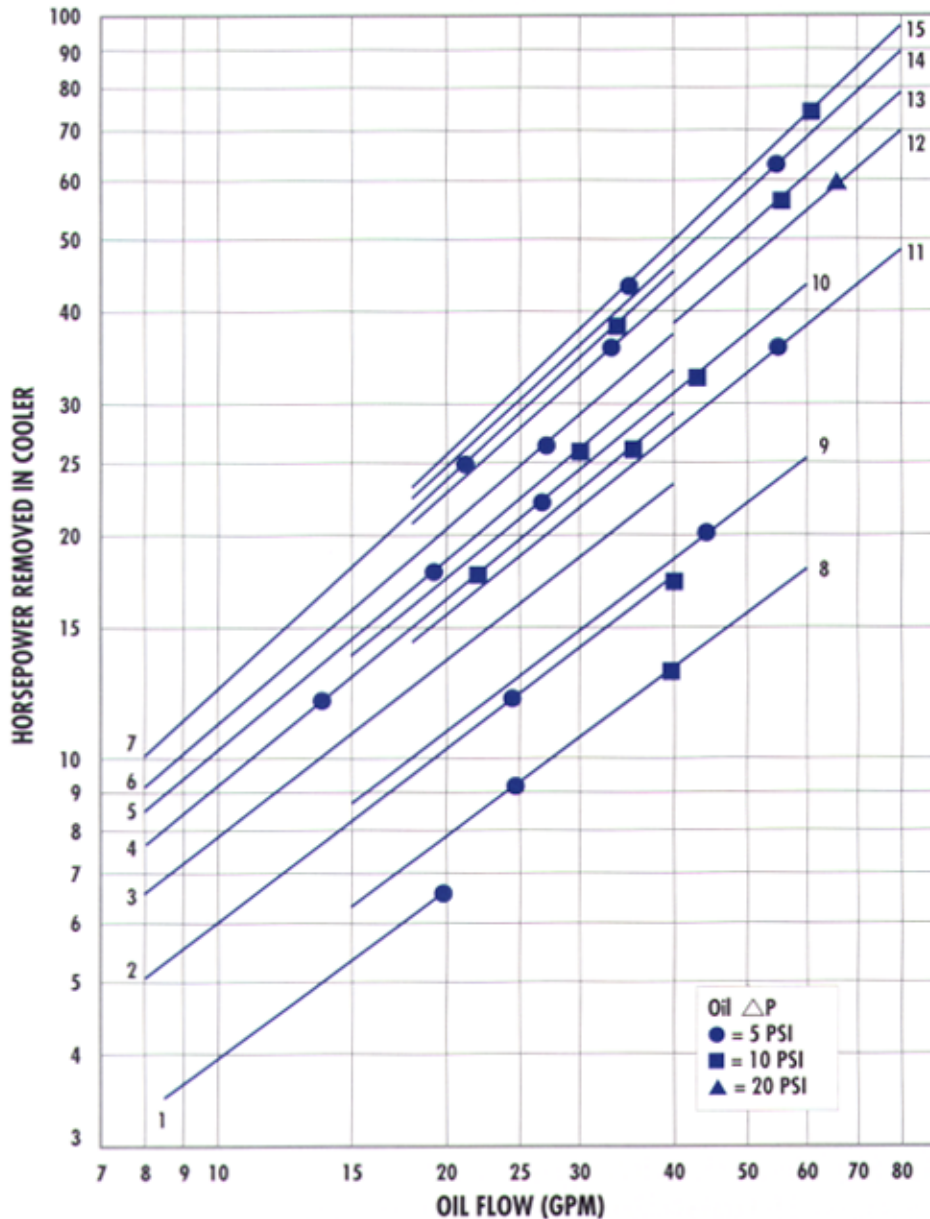
Step 5. Determine Oil Pressure Drop from Curves:

● = 5 PSI; ■ = 10 PSI; ▲ = 20 PSI. Multiply pressure drop from curve by correction factor B found on oil viscosity correction curve.



PERFORMANCE CURVES 7:1 OIL TO WATER RATIO

Lower water usage



MODELS	WEIGHTS (LBS.)	
	NET	APPROX. SHIPPING
1. EK-508-T	7	8
2. EK-708-F	15	16
3. EK-712-F	18	19
4. EK-714-F	19	20
5. EK-718-F	22	23
6. EK-724-F	26	28
7. EK-736-F	34	36
8. EK-708-T	15	16
9. EK-712-T	18	19
10. EK-724-T	26	28
11. EK-1012-F	35	37
12. EK-1018-F	42	45
13. EK-1024-F	50	55
14. EK-1036-9-F	67	85
15. EK-1048-8-F	78	95

SPECIFICATIONS

Materials

Shell - Steel
 Tubes - Copper
 Tubesheets - Steel
 Fins - Aluminum
 Baffles - Steel
 End Caps - Grey Iron
 Mounting Brackets - Steel
 Gaskets - Nitrile Rubber/Cellulose Fiber
 Nameplate - Aluminum Foil

SELECTION PROCEDURE

Performance Curves are based on 100SSU oil leaving the cooler 40°F higher than the incoming water temperature used for cooling. This is also referred to as a 40°F approach temperature.

Step 1. Determine the Heat Load.

This will vary with different systems, but typically coolers are sized to remove 25 to 50% of the input nameplate horsepower. (Example: 100 HP Power Unit x .33 = 33 HP Heat load.) If BTU/Hr. is known: $HP = \frac{BTU/Hr}{2545}$

Step 2. Determine Approach Temperature.

Desired oil leaving cooler °F - Water Inlet temp. °F = Actual Approach (Max. reservoir temp.)

Step 3. Determine Curve Horsepower Heat Load.

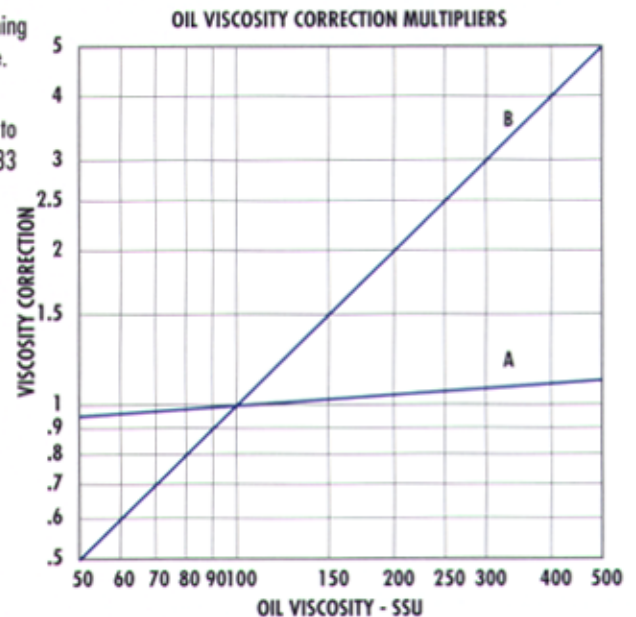
Enter the information from above:
 $\text{Horsepower heat load} \times \frac{40}{\text{Actual Approach}} \times \text{Viscosity Correction A} = \text{Curve HP}$

Step 4. Enter curves at oil flow through cooler and curve horsepower.

Any curve above the intersecting point will work.

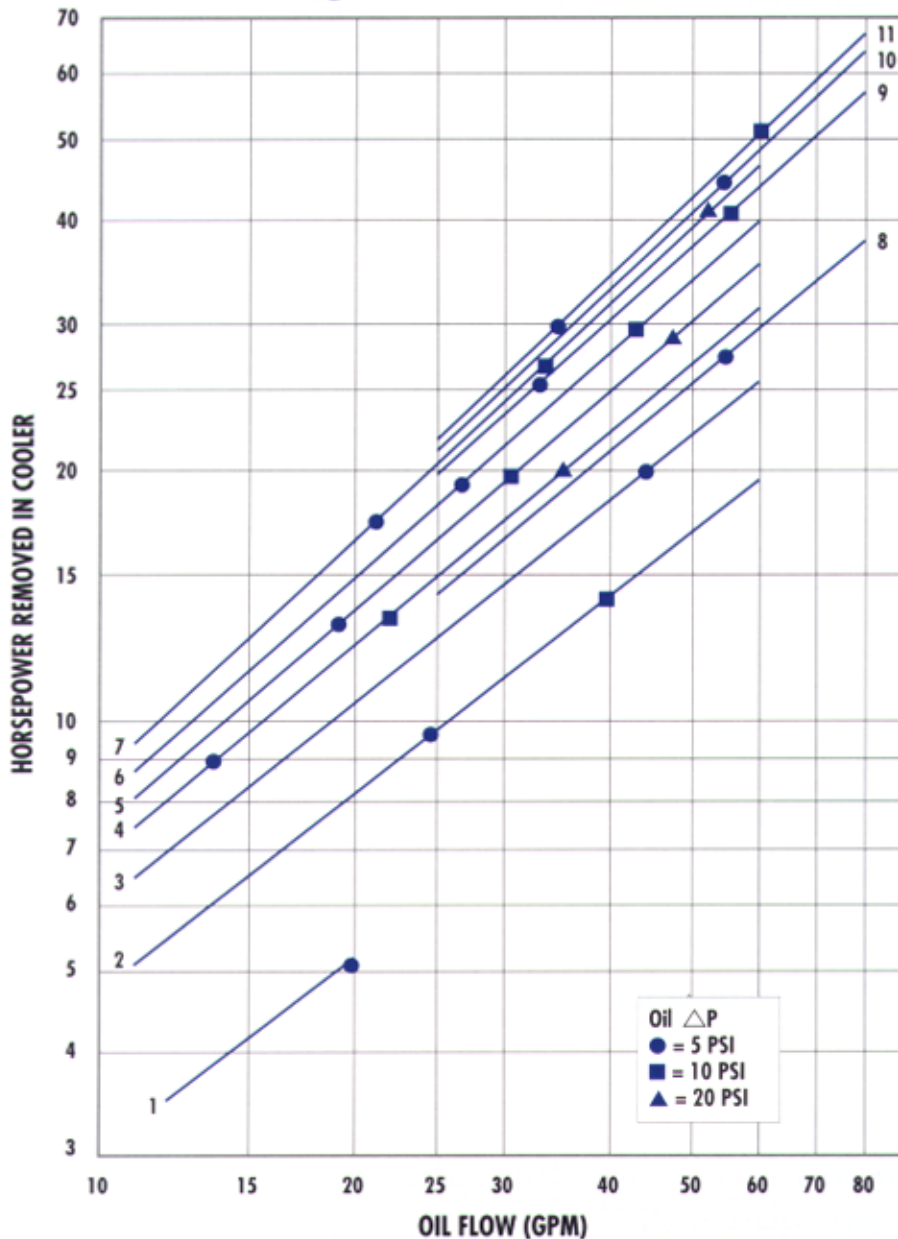
Step 5. Determine Oil Pressure Drop from Curves:

● = 5 PSI; ■ = 10 PSI; ▲ = 20 PSI. Multiply pressure drop from curve by correction factor B found on oil viscosity correction curve.



PERFORMANCE CURVES 10:1 OIL TO WATER RATIO

Lowest water usage



MODELS	WEIGHTS (LBS.)	
	NET	APPROX. SHIPPING
1. EK-508-T	7	8
2. EK-708-F	15	16
3. EK-712-F	18	19
4. EK-714-F	19	20
5. EK-718-F	22	23
6. EK-724-F	26	28
7. EK-736-F	34	36
8. EK-1012-F	35	37
9. EK-1024-F	50	55
10. EK-1036-9-F	67	85
11. EK-1048-8-F	78	95

SPECIFICATIONS

Materials

Shell - Steel	Tubes - Copper
Tubesheets - Steel	Fins - Aluminum
Baffles - Steel	End Caps - Grey Iron
Mounting Brackets - Steel	
Gaskets - Nitrile Rubber/Cellulose Fiber	
Nameplate - Aluminum Foil	

SELECTION PROCEDURE

Performance Curves are based on 100SSU oil leaving the cooler 40°F higher than the incoming water temp. used for cooling. This is also referred to as a 40°F approach temp.

Determine the Heat Load.

This will vary with different systems, but typically coolers are sized to remove 25 to 50% of the input nameplate horsepower. (Example: 100 HP Power Unit x .33 = 33 HP Heat load.) If BTU/Hr. is known: $HP = \frac{BTU/Hr}{2545}$

Step 2. Determine Approach Temperature.

Desired oil leaving cooler °F - Water Inlet temp. °F = Actual Approach (Max. reservoir temp.)

Step 3. Determine Curve Horsepower Heat Load.

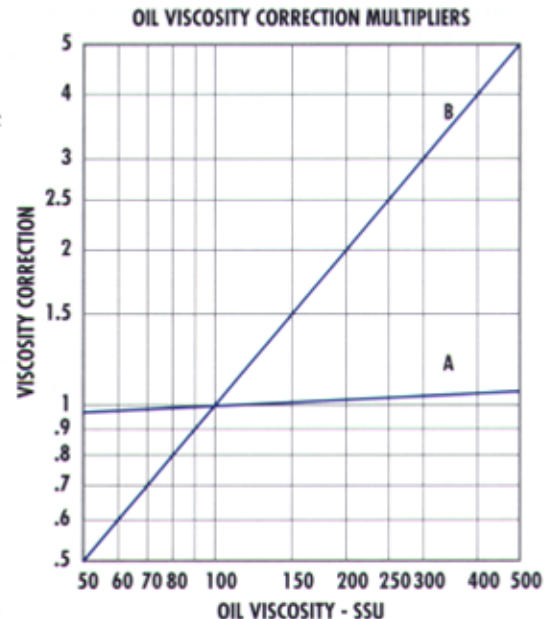
Enter the information from above:
 $\text{Horsepower heat load} \times \frac{40}{\text{Actual Approach}} \times \text{Viscosity Correction A} = \text{Curve HP}$

Step 4. Enter curves at oil flow through cooler and curve horsepower.

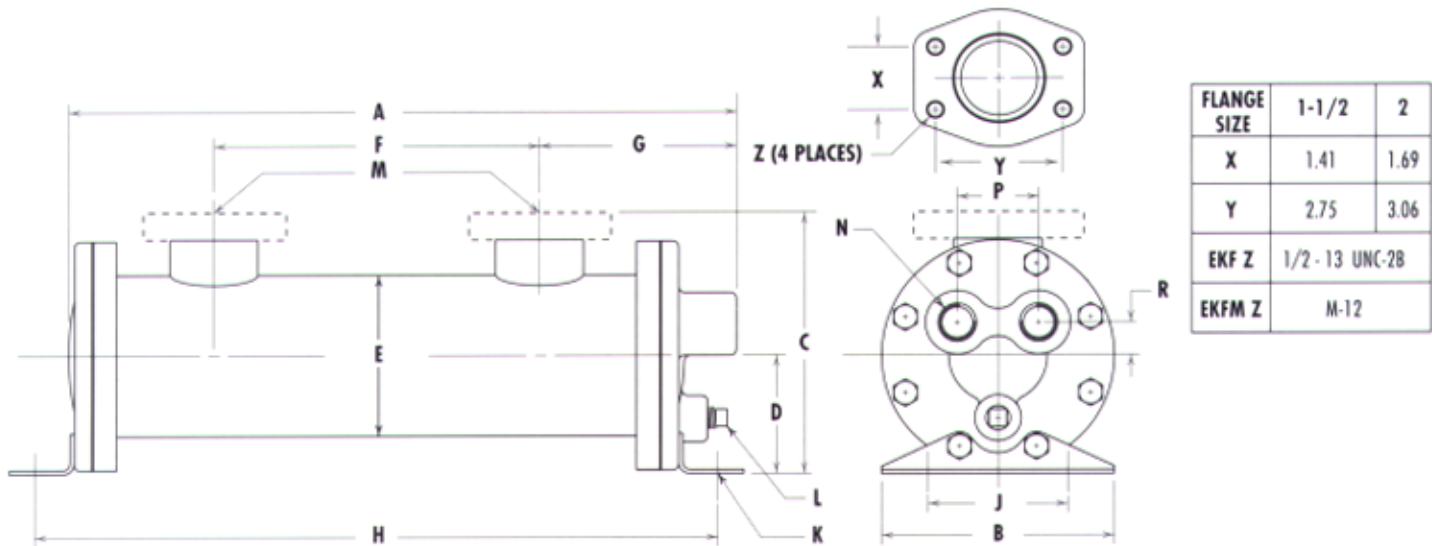
Any curve above the intersecting point will work.

Step 5. Determine Oil Pressure Drop from Curves:

● = 5 PSI; ■ = 10 PSI; ▲ = 20 PSI. Multiply pressure drop from curve by correction factor B found on oil viscosity correction curve.



FOUR PASS DIMENSIONS



FLANGE SIZE	1-1/2	2
X	1.41	1.69
Y	2.75	3.06
EKF Z	1/2 - 13 UNC-2B	
EKFM Z	M-12	

MODEL	A	B	C		D	E	F	G	H	J	K	L		M			N		P	R
			NPT / BSPP SAE O-RING	SAE FLANGE								NPT	NPT	SAE O-RING	SAE FLANGE	BSPP	NPT BSPP			
EK-708	10.37	MAX. WIDTH	5.47	5.71	2.59	3.52 DIA.	3.00	4.25	10.71	3.00	.44 x .75 SLOT	1/4	1 1/2	#24 1 7/8-12 UN-2B	1 1/2	1/2	1.75	.70		
EK-712	14.37						7.00		14.71											
EK-714	16.37						9.00		16.71											
EK-718	20.37						13.00		20.71											
EK-724	26.37						19.00		26.71											
EK-736	38.37						31.00		38.71											
EK-1012	14.33	MAX. WIDTH	7.64	8.28	4.00	5.05 DIA.	6.18	4.45	15.45	4.00	.44 x 1.00 SLOT	2	2	1 1/2	3/4	2.50	.89			
EK-1014	16.33						8.18		17.45											
EK-1018	20.33						12.18		21.45											
EK-1024	26.33						18.18		27.45											
EK-1036	38.33						30.18		39.45											
EK-1048	50.33						42.18		51.45											

NOTE: We reserve the right to make reasonable design changes without notice. All dimensions are in inches.

SURGE-CUSHION (optional)

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MAXIMUM FLOW RATES

UNIT SIZE	SHELL SIDE GPM	TUBE SIDE GPM		
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700	60	24	12	6
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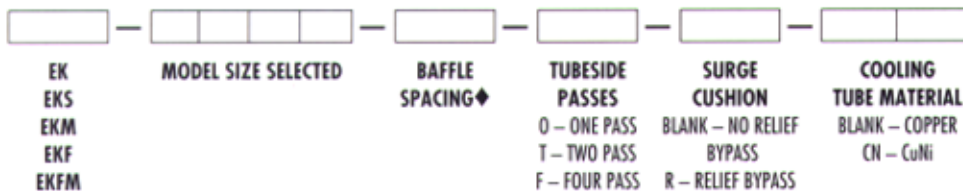
RATINGS

Maximum Shell Side Pressure 500 PSI

Maximum Tube Side Pressure 150 PSI

Maximum Temperature 250°F

HOW TO ORDER



EK = NPT Oil connections; NPT Water connections.
 EKS = SAE O-Ring Oil connections; NPT Water connections.
 EKM = BSPP Oil connections; BSPP Water connections.
 EKF = SAE 4 Bolt Flange (Tapped SAE) Oil connections; NPT Water connections.
 EKFM = SAE 4 Bolt Flange (Tapped Metric) Oil connections; BSPP Water connections.

♦EK-1036 and EK-1048 Models only.

Our Facilities

- 170,000 Square Feet of Manufacturing and Office Space
- Located on 15 Acres of Land
- Automated Manufacturing Equipment
- ASME Section VIII Approved Testing Equipment
(Can manufacture to ASME Section VIII Code with Stamp)

Significant Facts

- 240 Employees – 40 Office and 200 Factory
- 5 Designers with CAD Systems
- Dedicated Service and Repair Personnel
- Manufacturing in Current Location Since 1982
- Established, 1970

Technical Support

A fully developed TechCenter located in Montgomery, Alabama supports the individual manufacturing facilities with the combined capability of a full-time staff comprised of specialized design and test Engineers and Metallurgist. In addition to the Technical Staff, the TechCenter is equipped with a full complement of sophisticated laboratory test and analysis equipment. The TechCenter's mission is to supply the technology to develop new products to meet the current and future needs of our customers.

Thermal Components

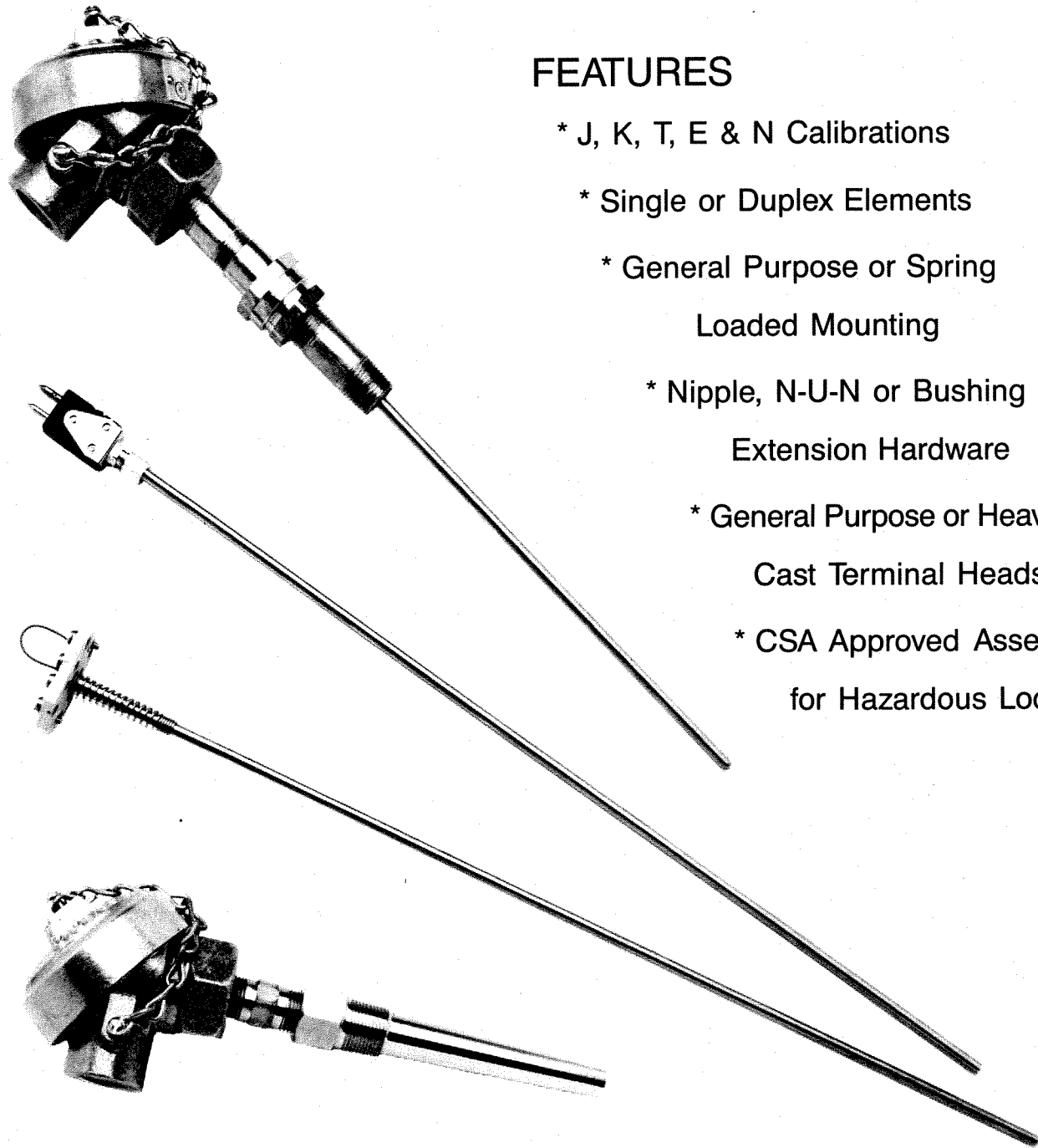
Thermal Components offers a wide variety of products and services to the heat transfer industry. Aluminum and copper/brass tubing and multiple heat exchanger designs make up the core competencies of the company. The individual business units and their major product groups include:

- **TCD Heat Exchangers; Montgomery, Alabama:** Aluminum heat exchangers – radiators – condensers – oil coolers, etc.
- **General ThermoDynamics/Great Lake; Milwaukee, Wisconsin and Detroit, Michigan:** copper/brass and aluminum heat exchanger products – radiators – oil coolers – charge air coolers
- **Thermal Transfer Products; Racine, Wisconsin:** full line of industrial oil coolers
- **TCD Tubing Products; Montgomery, Alabama:** aluminum and copper/brass tubing; aluminum manifolds
- **ARUP, Dortmund; Germany:** aluminum seamed welded tubing; aluminum manifolds
- **Thermalex; Montgomery, Alabama** (50-50 joint venture with Mitsubishi Aluminum): aluminum extrusions – micro tubing; aluminum extruded shapes, etc.

TC Thermal Transfer Products

A THERMAL COMPONENTS COMPANY

5215 - 21st Street, Racine, Wisconsin 53406-5024
Telephone: (262) 554-8330 • FAX: (262) 554-8536



FEATURES

- * J, K, T, E & N Calibrations
- * Single or Duplex Elements
- * General Purpose or Spring Loaded Mounting
- * Nipple, N-U-N or Bushing Extension Hardware
- * General Purpose or Heavy Duty Cast Terminal Heads
- * CSA Approved Assemblies for Hazardous Locations



THERMO-KINETICS
COMPANY LIMITED

Sensible Solutions to Temperature Measurement

Toronto • Montreal • Calgary
Edmonton • Vancouver

®Registered Trademark of Thermo-Kinetics Company Limited

STANDARD T-PAK® THERMOCOUPLE PROBE

1 CALIBRATION CODES

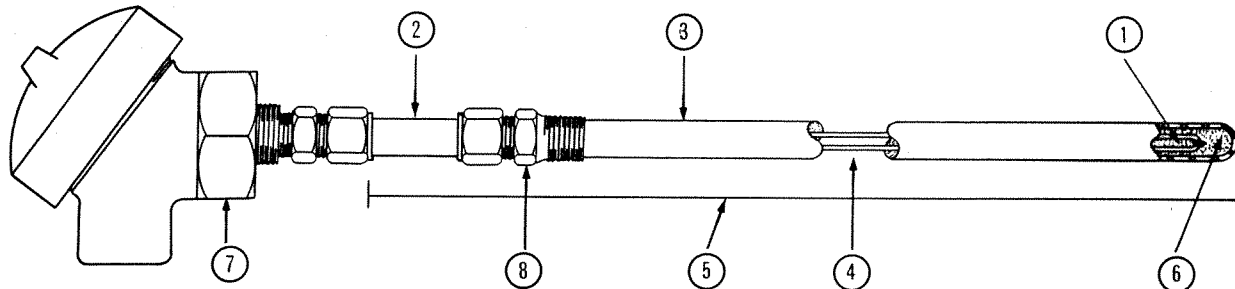
J — Type J T/C
 K — Type K T/C
 N — Type N T/C
 T — Type T T/C
 E — Type E T/C
 O — Kotherm (K)

2 SHEATH DIAMETER CODES

020 — .020" OD
 040 — .040" OD
 063 — .063" OD
 125 — .125" OD
 188 — .188" OD
 250 — .250" OD
 313 — .313" OD
 375 — .375" OD
 500 — .500" OD
 625 — .625" OD
 750 — .750" OD

3 SHEATH MATERIAL CODES

304 — 304L SS
 310 — 310S SS
 316 — 316L SS
 347 — 347 SS
 446 — 446 SS
 600 — Inconel 600
 HSX — Hastelloy X
 BLB — Pyrosil B
 BLC — Pyrosil C



4 FORM CODES

S — Simplex
 D — Duplex

5 LENGTH

Specify length in inches.

6 MEASURING JUNCTION CODES

A — Grounded Junction
 B — Insulated Junction
 C — Exposed Junction
 E — Grounded Junction with Weld Pad
 H — Insulated Junction with Weld Pad

7 TERMINATION CODES

Refer to pages 7-9.

8 COMPRESSION FITTING CODES

Z — Brass
 Y — Stainless Steel

T-PAK® thermocouples are magnesium oxide (MgO) insulated, metal sheath assemblies that are accurate and sensitive. The outer sheath of stainless steel or other alloys coupled with tightly compacted MgO ensures relatively long life by protecting the thermocouple from oxidizing, reducing or other corrosive atmospheres.

T-PAK PROPERTIES

- **Long Stable Life:** Long element life is assured because the construction protects the conductors from adverse environmental effects.
- **Mechanical Strength:** The tightly compacted powder contained within the tough metal sheath locks the wires rigidly in position, permitting the cable to be bent, flattened, or twisted.
- **Electrical Shielding:** The sheath offers excellent shielding against electrostatic interference in sensitive temperature measuring circuits.
- **Insulation Resistance:** High insulation resistance is attainable over a wide range of temperature and humidity conditions.
- **Moisture/Pressure:** The homogeneous metal sheaths are impervious to most liquids and gases and will withstand high external pressures.
- **Long Lengths:** Continuous lengths up to 2000 feet are available in 1/8" diameter.
- **Ease of Installation:** The pliable construction of the cable allows it to be easily bent to a tight radius and retain its form after being bent. Its metal sheath can be welded or brazed to special attachments.
- **Corrosion Resistant:** Many sheath materials are available to ensure the proper selection depending on the detrimental elements present in specific environments.
- **Rapid Response:** The small mass and high thermal conductivity promotes rapid heat transfer from heat source to measuring junction.

RESISTANCE DATA

SHEATH	LOOP RESISTANCE ($\Omega/100$ ft)									
	SINGLE					DUPLEX				
	J	K	T	N	E	J	K	T	N	E
.040	805	1177	669	1633	1473	—	—	—	—	—
.063	323	472	271	609	593	—	—	—	—	—
.125	81.9	117	67.7	161	148	114	178	94.0	240	219
.188	37.7	54.2	31.3	73.2	68.2	45.3	77.0	37.4	99.1	91.0
.250	21.7	31.8	17.9	41.4	39.6	27.7	42.0	25.3	56.8	52.0
.313	14.2	19.9	11.9	27.3	25.4	17.7	28.7	14.5	36.7	34.1
.375	10.4	13.4	8.8	18.4	18.0	12.3	19.7	10.1	25.7	23.5
.500	5.4	7.8	4.5	10.3	9.8	7.8	11.3	—	19.0	14.2
.625	3.5	5.0	2.8	6.6	6.3	5.0	7.1	—	12.1	9.0
.750	2.2	4.0	2.3	5.3	5.0	3.2	5.8	—	9.6	7.2

Insulation Resistance: >200 M $\Omega/1000$ ft at 500 VDC

PHYSICAL PROPERTIES

SHEATH DIAMETER	SIMPLEX			DUPLEX		
	COND SIZE	SHEATH WALL	WEIGHT	COND SIZE	SHEATH WALL	WEIGHT
.040	.007	.006	3.4	—	—	—
.063	.011	.009	8.4	.009	.009	10
.125	.023	.016	34	.018	.019	38
.188	.033	.024	77	.028	.029	86
.250	.044	.032	130	.037	.039	139
.313	.054	.040	200	.046	.049	233
.375	.066	.048	320	.055	.058	335
.500	.088	.064	510	.073	.064	580
.625	.110	.080	565	.092	.080	644
.750	.132	.096	670	.110	.096	763

Dimensions are in inches; weight in #/mft

MgO CHEMISTRY

ELEMENT	INSULATION PURITY	
	STANDARD	HIGH*
MgO (%)	96.3-97.3	99.5-99.7
SiO ₂ (%)	1.45-2.06	.04-.14
CaO (%)	.73-1.25	.14-.21
Fe ₂ O ₃ (%)	.16-.30	.03-.10
Al ₂ O ₃ (%)	.06-.30	.03-.08
B (ppm)	85-1000	10-20
Cd (ppm)	< 10	< 10
S (ppm)	< 50	< 50
C (ppm)	< 200	< 200

*Conforms to ASTM E585 & E1652

T/C MATERIAL

TYPE	POSITIVE	NEGATIVE
J	Iron	Constantan (Cu-45%Ni)
K	Chromel (Ni-10%Cr)	Alumel (MnSiAl-95%Ni)
T	Copper	Constantan
N	Nicrosil (Ni-4%Cr)	Nisil (Ni-4%Si)
E	Chromel (Ni-9%Cr)	Constantan
O	(Ni-9%Cr)	(Ni-3%Si)

SHEATH APPLICATION DATA

SHEATH MATERIAL	MELTING TEMP.	CONTINUOUS MAX. TEMP.	APPLICATION NOTES
304L SS	1400°C (2550°F)	900°C (1650°F)	Good resistance to corrosion and oxidation.
310S SS	1400°C (2550°F)	1150°C (2100°F)	High temperature strength and scale resistance. Good resistance to carburizing and reducing environments. Withstands sulphurous gas at elevated temperatures.
316L SS	1370°C (2500°F)	925°C (1700°F)	Good corrosion resistance and creep strength at elevated temperatures. Resists tendency to pit in phosphoric and acetic acids. Withstands sulphuric acid compounds.
321 SS	1400°C (2550°F)	870°C (1600°F)	Excellent scale and corrosion resistance at high temperature. Suitable for oxidizing, sulphurous and reducing atmospheres.
347 SS	1425°C (2600°F)	870°C (1600°F)	High corrosion resistance. Excellent for heating and cooling applications between 425 & 875°C (800 & 1600°F).
446 SS	1480°C (2700°F)	1100°C (2000°F)	Good high temperature oxidation resistance. Resists attack by sulphur gas. Good in oxidizing and reducing atmospheres.
Inconel 600	1400°C (2550°F)	1150°C (2100°F)	High corrosion resistance at elevated temperatures. High hot strength. Used in sulphur-free environments. Resists oxidizing and reducing atmospheres.
Hastelloy X	1285°C (2350°F)	1150°C (2100°F)	Good temperature strength and exceptional resistance to oxidation. Good for reducing conditions. Resists attack by sulphur compounds at high temperature.
Pyrosil B	1420°C (2590°F)	1250°C (2280°F)	Excellent oxidation resistance at elevated temperatures. High aqueous corrosion resistance. Minimizes contamination of thermo-element.
Pyrosil C	1420°C (2590°F)	1250°C (2280°F)	Similar to Pyrosil B. Excellent for carburizing and sulphidizing atmospheres.

SHEATH CHEMISTRY (%)

MAT	Ni	Cr	Si	Mn	C	Mo	CU	Al	Fe	Mg	Nb
304L	10	19	1	2	.03						
310S	20	25	1.5	2	.08			.1			
316L	12	17	1	2	.03	2.5					
321	10	18	1	2	.08						
347	11	18	1	2	.08						
446	.2	25	1	1.5	.2				74		
600	76	16	.5	1	.1						
HSX	45	22	1	1	.1	9	.5		.8		
BLB	81	14	1.4	.2						.15	1.8
BLC	73	24	1.4	.2						.15	.5

(Percentages are nominal.)

CALIBRATION CODES

CODE	DESCRIPTION
J	Type J (Iron-Constantan) Thermocouple
K	Type K (Chromel-Alumel) Thermocouple
T	Type T (Copper-Constantan) Thermocouple
N	Type N (Nicrosil-Nisil) Thermocouple
E	Type E (Chromel-Constantan) Thermocouple

SHEATH MATERIAL CODES

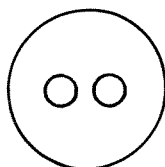
CODE	DESCRIPTION
304	304L Stainless Steel
310	310S Stainless Steel
316	316L Stainless Steel
321	321 Stainless Steel
347	347 Stainless Steel
446	446 Stainless Steel
600	Inconel 600
HSX	Hastelloy X
BLB	Pyrosil B
BLC	Pyrosil C

SHEATH DIAMETER CODES

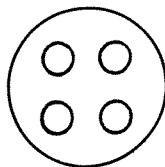
CODE	020	040	063	125	188	250	313	375	500	625	750
Simplex	.02"	.04"	1/16"	1/8"	3/16"	1/4"	5/16"	3/8"	1/2"	5/8"	3/4"
Duplex	—	—	1/16"	1/8"	3/16"	1/4"	5/16"	3/8"	*	*	*

*Not available for type T or sheath materials 321, 347, HSX or BLB

JUNCTION FORM CODES



Simplex

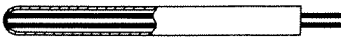
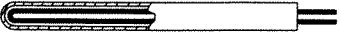

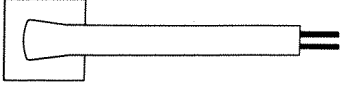


Duplex

CODE		INSULATION PURITY	LIMITS OF ERROR
SPLX	DPLX		
S	D	Standard	Standard
R	E	Standard	Special
Q	F	High	Standard
P	G	High	Special

High purity & special limits of error not available for sizes larger than .375"

MEASURING JUNCTION CODES

JUNCTION	CODE	DESCRIPTION
	A	GROUNDING JUNCTION The junction is welded directly to the sheath.
	B	INSULATED JUNCTION The junction is insulated from the sheath. Duplex junctions are also insulated from each other.
	K	INSULATED COMMON JUNCTION Duplex junctions are welded together, but are insulated from the sheath.
	C	EXPOSED JUNCTION The junction is formed beyond the end of the sheath.
	E	WELD PAD with GROUNDING JUNCTION The junction is grounded to the sheath which is welded to a 1" x 1" x 1/8" 316 S.S. pad.
	H	WELD PAD with INSULATED JUNCTION The junction is insulated from the sheath which is welded to a 1" x 1" x 1/8" 316 S.S. pad.
	M	Same as 'E' except weld pad is same alloy as sheath.
	N	Same as 'H' except weld pad is same alloy as sheath.
<p>NOTES: Standard weld pad construction is T/C parallel to pad. If pad is to be curved, specify tube diameter.</p>		

COMPARATIVE RESPONSE DATA

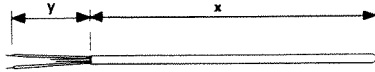
SHEATH SIZE	GROUNDING JCT		INSULATED JCT		EXPOSED JCT	
	WATER	AIR	WATER	AIR	WATER	AIR
.313	5.5	55	16	150	.5	5.0
.250	4.0	34	10	120	.3	2.5
.188	2.5	26	5	75	.2	2.0
.125	1.5	14	3	28	.1	1.0
.063	0.5	5	1	10	.05	0.5
.040	0.3	2.5	0.6	5	.01	0.05

Time constants in seconds.

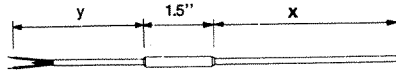
Water flow: 5 ft/sec
Air flow: 60 ft/sec

No. of Time Constants	0.1	1.0	2.3	4.6	6.9
Per Cent Change	10.0%	63.2%	90.0%	99.0%	99.9%

TERMINATION CODES



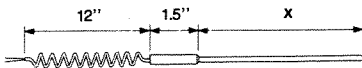
0 0 0 Exposed leadwire 2" long
 Sheath sizes: .125 - .750
 Specify "y" length (Standard = 2")



Potting Adaptor with flexible leadwire
 (20 ga for single; 24 ga for duplex)
 Sheath sizes: .040 - .750
 Specify "y" length (Standard = 3")

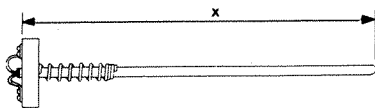
LEADWIRE INSULATION	ADDITIONAL FEATURES	LEADS ONLY	PLUG	PLUG/JACK	MINI PLUG	MINI PLUG/JK
Fiberglas (475°C)	None	10N	11N	12N	15N	16N
	Relief Spring	10R	11R	12R	15R	16R
	SS Overbraid	10S	11S	12S	15S	16S
	Armour*	10X	11X	12X	15X	16X
PVC (100°C)	None	40N	41N	42N	45N	46N
	Relief Spring	40R	41R	42R	45R	46R
	SS Overbraid	40S	41S	42S	45S	46S
	Armour*	40X	41X	42X	45X	46X
Teflon (200°C)	None	70N	71N	72N	75N	76N
	Relief Spring	70R	71R	72R	75R	76R
	SS Overbraid	70S	71S	72S	75S	76S
	Armour*	70X	71X	72X	75X	76X

*Single conductor stranded wires inside armour



Retractable Cable 100°C PVC jacket
 12" coiled, extends to 60"
 Sheath sizes: .063 - .375
 Duplex not available

END OF CABLE TERMINATION	CODE
Stripped Leads	210
Plug	220
Plug & mating jack	230
Jack	221
Jack & mating plug	231
Mini plug	225
Mini plug & mating jack	235
Mini jack	226
Mini jack & mating plug	236

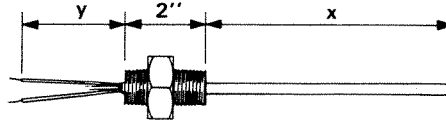


Spring-loaded, Captive T/B
 (Replacement element for industrial assemblies)
 Sheath sizes: .188 & .250 only

HEAD	LENGTH "X"	CODE
General Purpose	A + N + 2.0"	260
Heavy Duty	A + N + 2.25"	250

TERMINATION CODES

Mounting Adaptor, Stainless Steel, 1/2" x 1/2" NPT
Specify "y" length (Standard = 3")



CODE	PROBE ATTACHMENT TO ADAPTOR	SHEATH SIZE
310	Probe Welded to Adaptor	.125-.375
311	Integral Transition	.063-.375
312	Fixed Compression Adaptor	.250
313	Adjustable Compression Adaptor	.250
314	Probe Brazed to Adaptor	.125-.375
320	Spring-loaded	.188 & .250
330	Spring-loaded, O-Ring Seal	.188 & .250

NOTES:

If used with a thermowell:

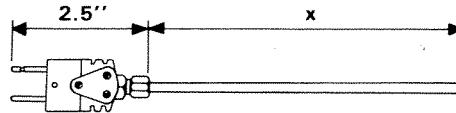
X = A - 1/2" (for fixed probes)

X = A (for spring-loaded probes)

where O-Ring seal rated 500 psig at 260°C.

A = bore length of thermowell

2-Pole Connectors Plug or Jack



TYPE	PLUG	PLUG/JACK*	JACK	JACK/PLUG**
Standard (200°C)	410	420	411	421
Standard (425°C)	450	460	451	461
Mini (200°C)	430	440	431	441
Mini (425°C)	470	480	471	481

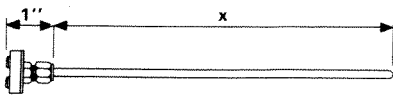
NOTES:

1. Sizes: Standard: .063-.375

Mini: .040-.063

2. *Plug attached to probe

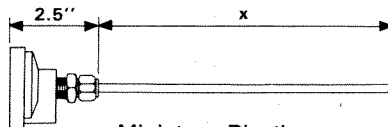
**Jack attached to probe



Open-type Micro Connector Block

200°C	425°C
510	520

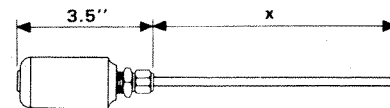
Sizes: .063-.250



Miniature Plastic Weatherproof Head

Material	200°C	425°C
Brass C.F.	550	560
S/S C.F.	555	565

Sizes: .063-.313



Miniature Aluminum Screw Cover Head

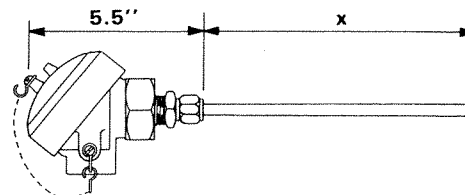
Brass C.F.	610
S/S C.F.	620

Sizes: .063-.375

Screw Cover Terminal Head

3/4" conduit thread

Mounted to probe with compression fitting



HEAD	FITTING	G.P.	H.D.
Aluminum	Brass	710	730
	Stainless Steel	720	740
Cast Iron	Brass	750	770
	Stainless Steel	760	780

NOTES:

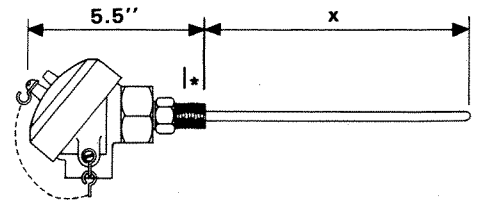
Sheath sizes: .063-.500

G.P. = General purpose

H.D. = Heavy duty

TERMINATION CODES

Screw Cover Terminal Head
 3/4" conduit thread
 1/2" x 1/2" NPT SS mounting adaptor
 Heads: Aluminum or Cast Iron
 General Purpose (G.P.)
 or Heavy Duty (H.D.)



*Thread engagement = .35" fr 1/2" NPT

Probe Welded to Adaptor

NOTES

1. Sheath sizes: .063-.375
2. If used with a thermowell X = bore depth of T/W - 1/2"
3. For replacement element, refer to termination 310

HEAD	G.P.	H.D.
Aluminum	810	850
Cast Iron	910	950

Probe Spring-loaded to Captive Terminal block (See below for drawing)

NOTES

1. Sheath sizes: .188 & .250 only
2. X = unsprung length of probe
3. If used with a thermowell X = bore depth of T/W
4. For replacement element, refer to:
 termination 250 for H.D.
 or termination 260 for G.P.

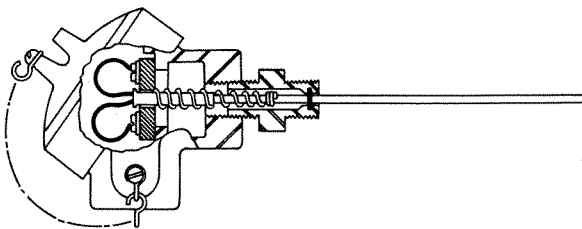
HEAD	G.P.	H.D.
Aluminum	820	860
Cast Iron	920	960
with O-Ring Seal		
Aluminum	830	870
Cast Iron	930	970

Probe Spring-loaded to Adaptor (See below for drawing)

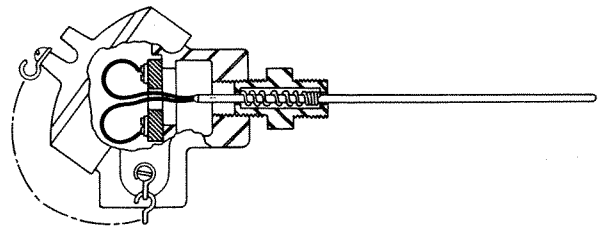
NOTES

1. Sheath sizes: .188 & .250 only
2. X = unsprung length of probe
3. If used with a thermowell X = bore depth of T/W
4. For replacement element, refer to:
 termination 320 for spring-loaded
 or termination 330 for O-Ring type

HEAD	G.P.	H.D.
Aluminum	825	865
Cast Iron	925	965
with O-Ring Seal		
Aluminum	835	875
Cast Iron	935	975



Detail of "Captive Terminal Block"



Detail of "Spring-loaded Adaptor"

COMPRESSION FITTING CODES

SEAL OR FERRULE MATERIAL	FITTING MATERIAL	
	BRASS	316 SS
Metal Ferrule	ZMX	YMX
Teflon Seal	ZTX	YTX
Grafoil Seal	ZGX	YGX
Lava Seal	ZLX	YLX



X = Mounting thread size code
 Metal ferrule is same material as fitting.

SHEATH SIZE	MOUNTING THREAD SIZE (X) CODE				
	1/8"	1/4"	3/8"	1/2"	3/4"
063	1	—	—	—	—
125	1	2	—	—	—
188	1	2	—	—	—
250	1	2	3	4	—
313	—	2	—	—	—
375	—	2	3	4	—
500	—	—	—	4	6
625	—	—	—	—	6
750	—	—	—	—	6

MOUNTING THREAD SIZE CODE	
SIZE	CODE (X)
1/8" NPT	1
1/4" NPT	2
3/8" NPT	3
1/2" NPT	4
3/4" NPT	6

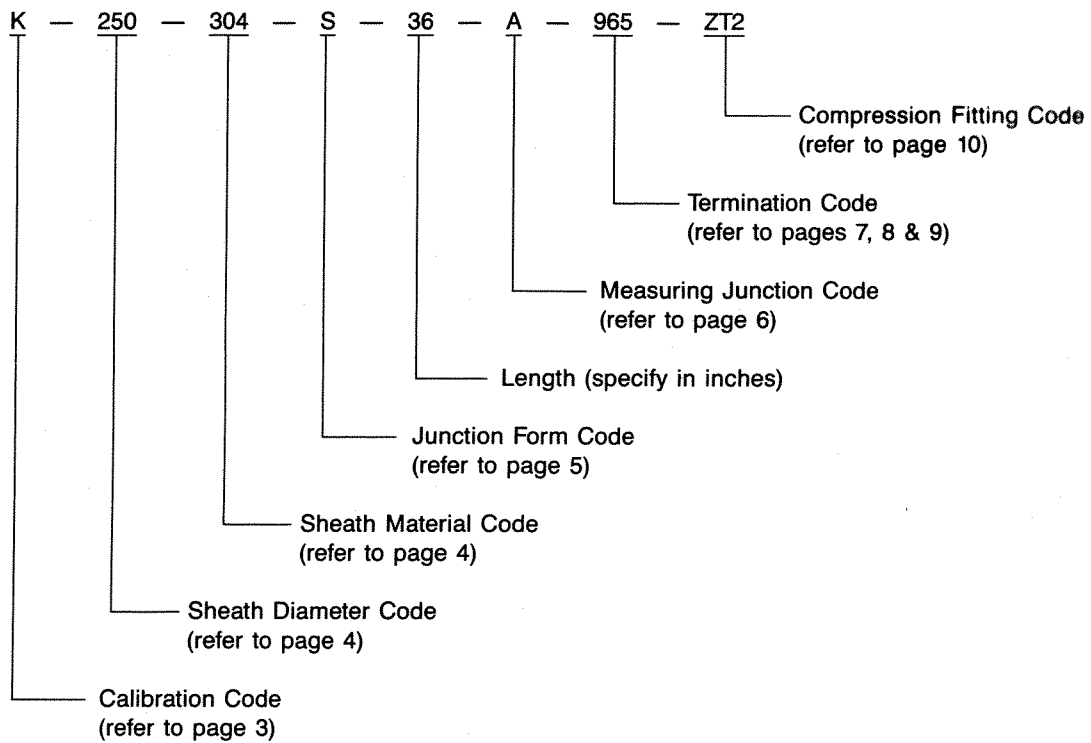
SEAL MATERIAL GUIDE

SEALANT MATERIAL	TEMPERATURE RATING	PRESSURE RATING	CHEMICAL RESISTANCE	TYPE OF MATERIAL	MATERIAL CHARACTERISTICS
Teflon (T)	-175° to 260°C	Vacuum* Up to 5,000 psi	Excellent	Tetrafluoraethylene Plastic (Thermoplastic Resin)	It is less permeable to gasses than neoprene and has moderate resistance to nuclear radiation. It is also normally reusable.
Grafoil (G)	-200 to 3000°C **	Up to 5,000 psig	Excellent	Flexible Graphite	High corrosion resistance. Moderate resistance to nuclear radiation.
Lava (L)	-175 to +1000°C	Up to 7,500 psi	Excellent	Natural Magnesium Silicate (Soap Stone)	Crushes to a powdered mass under compression and is slightly porous to gases. Not recommended for vacuum applications. The compressed powder will break away when the fitting is taken apart and therefore the seal must be replaced.

**450°C max is exposed oxidizing atmosphere. *005 Microns 5 × 10⁶ MM. Hg Abs.

ORDERING INFORMATION

An 8-part catalog number is used to specify a complete **T-PAK**[®] assembly:



Example: The above catalog number identifies a type K thermocouple, with a .250" OD 304 stainless steel sheath, a single element 36" long with grounded junction, a heavy duty cast iron screw cover head, a 1/2" x 1/2" stainless steel spring-loaded bushing and a brass compression fitting (1/4" NPT) with teflon seal.

Many variations are available on **T-PAK**[®] elements and assemblies which are not covered in this sheet. Among them are multiple probe (bundle), coiled, bent/angled type and superheater, pad-type thermocouples.

Post assembly certified traceable calibration, is available upon request. Consult the factory for further information and part numbers.

INDUSTRIAL ASSEMBLIES

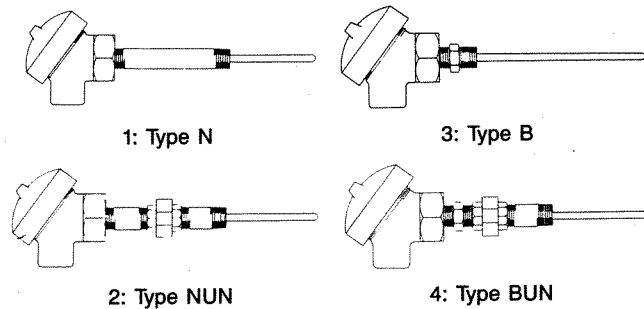
SHEATH

MATERIAL	CODE
304 S.S.	1
316 S.S.	2
Inconel 600	3

DIAMETER	CODE
.188" O.D.	1
.250" O.D.	2

CONFIGURATION

MOUNTING ARRANGEMENT	CODE
General Purpose (fixed)	1
Spring-Loaded, Captive T/B	2
Sprg-Ld, Captive T/B, O-Ring Seal	3
Bushing, Spring-Loaded	4



1, 3 & 4 require B or BUN extension (1/2" only)

EXTENSION HARDWARE	CODE
Nipple (N)	1
Nipple-Union-Nipple (N-U-N)	2
Bushing (B)	3
Bushing-Union-Nipple (B-U-N)	4

SIZE / MATERIAL	CODE
1/2" NPT, Galvanized	1
3/4" NPT, Galvanized	2
1/2" NPT, Stainless Steel	3
3/4" NPT, Stainless Steel	4

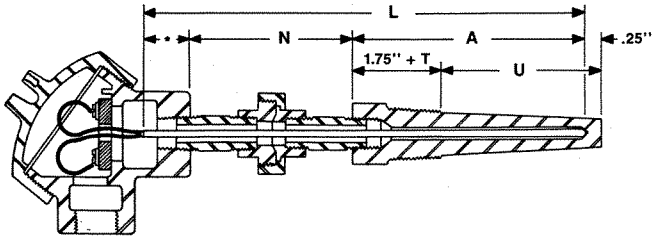
REPLACEMENT ELEMENT LENGTH (X)

HEAD	MOUNTING	TERM*	N/NUN	B/BUN
General Purpose (G.P.)	General Purpose (1)	000	A+N+0.5"	—
		310, 311	—	A+N-1.5"
	Spring Loaded, Captive T/B (2,3)	260	A+N+2"	A+N+2"
	Spring Loaded Bushing (4)	320	—	A+N-1"
Heavy Duty (H.D.)	General Purpose (1)	000	A+N+1"	—
		310, 311	—	A+N-1.5"
	Spring Loaded, Captive T/B (2,3)	250	A+N+2.25"	A+N+2.25"
	Spring Loaded Bushing (4)	320	—	A+N-1"

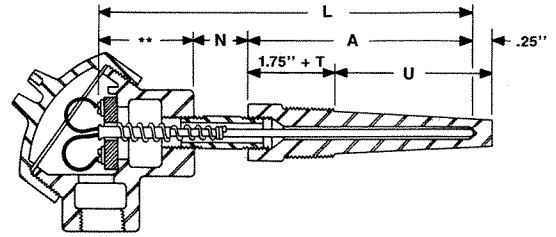
*refer to pages 7 & 8 for replacement element terminations.

INDUSTRIAL ASSEMBLIES

N or N-U-N EXTENSION

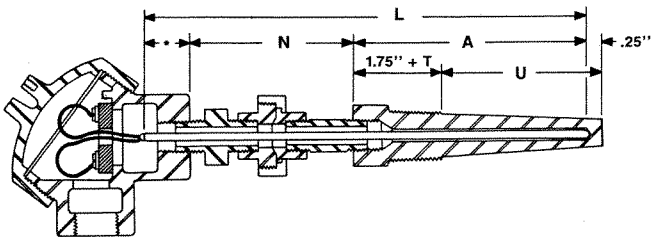


Type 1 Mounting Arrangement

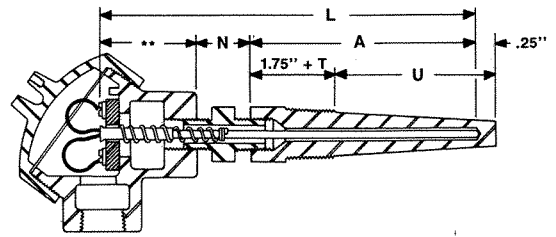


Type 2 Mounting Arrangement

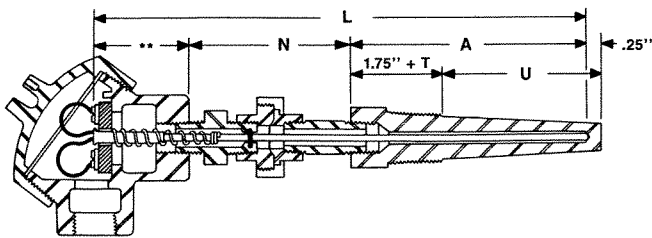
B or B-U-N EXTENSION



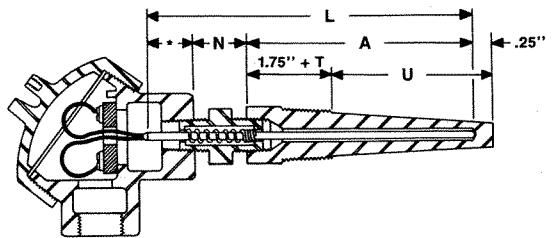
Type 1 Mounting Arrangement



Type 2 Mounting Arrangement



Type 3 Mounting Arrangement



Type 4 Mounting Arrangement

**2.0\" for HD Head
1.75\" for GP Head

Thread Engagement
.35\" for 1/2\" NPT

*1.0\" for HD Head
0.5\" for GP Head

“N” DIMENSION

The “N” dimension is the overall hardware length between the head and the thermowell.

“U” DIMENSION

The “U” dimension is the thermowell insertion length below the thread which is exposed to the process.

“A” DIMENSION

The “A” dimension is the element immersion length into the cavity of the thermowell.

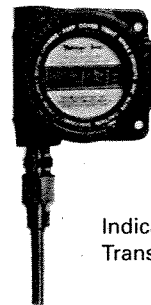
“L” LENGTH

The “L” length is the overall length of the element. For spring loaded assemblies, an extra .25\" is added to ensure contact with the bottom of the thermowell.

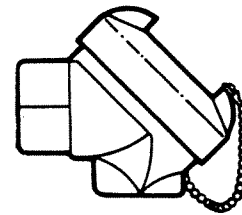
INDUSTRIAL ASSEMBLIES

TERMINAL HEADS

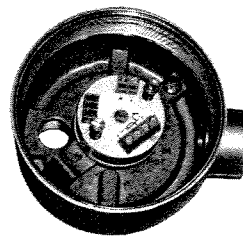
HEAD	CODE
General Purpose Aluminum	1
General Purpose Cast Iron	2
Heavy Duty Aluminum	3
Heavy Duty Cast Iron	4
Close-coupled Indicating Transmitter	I
Close-Coupled Transmitter (Isolated)	Q
Close-Coupled Transmitter (Isolated), N4x	W



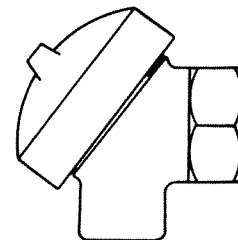
Indicating Transmitter (I)



General Purpose (GP)



Close-Coupled Transmitter (Q)



Heavy Duty (HD)

JUNCTION-CALIBRATION-FORM

CALIB	FORM	GROUNDED JUNCTION	INSULATED JUNCTION	
			SEPARATE	COMMON
J	Single	11	51	-
	Duplex	12	52	55
K	Single	21	61	-
	Duplex	22	62	65
T	Single	31	71	-
	Duplex	32	72	75
E	Single	41	81	-
	Duplex	42	82	85
N	Single	01	91	-
	Duplex	02	92	95
O	Single	24	27	-
	Duplex	25	28	68

NOTES

Separate duplex junctions are insulated from each other as well as from the sheath.

For other J-C-F arrangements (eg: premium grade wire), use 99 and describe.

OPTIONS

CODE	DESCRIPTION
OO	None
CS	CSA Type 1 Electrical Approved (Heads 1, 2, 3 & 4)
TW	Assembled to Thermowell (Ordered separately)
EX	CSA Approved, Explosion-proof rating (Class 1, Group B, C & D)*

*For selected configurations only; contact factory for details.

INDUSTRIAL ASSEMBLIES

ORDERING INFORMATION

A 6-part catalogue number is used to specify a complete **T-PAK**[®] industrial assembly:
(See pages 12-14 for details.)

2 2 - 2 2 1 1 - 7 2 - 3 5 - 1 2 5 - 0 0

SHEATH (Page 12)

MATERIAL _____

- 1 - 304 Stainless Steel
- 2 - 316 Stainless Steel
- 3 - Inconel 600

DIAMETER _____

- 1 - .188" O.D.
- 2 - .250" O.D.

CONFIGURATION (Page 12)

MOUNTING ARRANGEMENT _____

- 1 - General Purpose (Fixed)
- 2 - Spring-loaded, Captive Terminal Block
- 3 - Spring-loaded, Captive Terminal Block, O-Ring
- 4 - Spring-loaded Bushing (B or BUN extension only)

EXTENSION HARDWARE _____

- 1 - N Type Hardware
- 2 - NUN Type Hardware
- 3 - B Type Hardware (1/2" only)
- 4 - BUN Type Hardware (1/2" only)

SIZE/MATERIAL _____

- 1 - 1/2" NPT, Galvanized Fittings
- 2 - 3/4" NPT, Galvanized Fittings
- 3 - 1/2" NPT, Stainless Fittings
- 4 - 3/4" NPT, Stainless Fittings

HEAD _____

- | | |
|--------------------------------|---------------------------------|
| 1 - General Purpose, Aluminum | I - c/c Indic. Transmitter |
| 2 - General Purpose, Cast Iron | U - c/c Transmitter (Isolated) |
| 3 - Heavy Duty, Aluminum | T - c/c Transmitter (Non-Isol.) |
| 4 - Heavy Duty, Cast Iron | |

J-C-F CODE _____

Refer to table on page 14.

"N" LENGTH (Page 13) _____

Specify "N" length to 0.1" (eg: 35 = 3.5")

"A" LENGTH (Page 13) _____

Specify "A" length to 0.1" (eg: 125 = 12.5")

OPTIONS (Page 14) _____

- 00 - None
 - TW - Assembled to Thermowell (ordered separately)
 - EX - Explosion-proof Rating (Class 1, Group B, C & D)*
- *For selected configurations only; contact factory for details.

Example: The above catalog number specifies a 316 stainless steel .25" O.D. probe, spring-loaded captive terminal block mounting with NUN hardware, 1/2" NPT galvanized steel fittings, a general purpose aluminum head, and a type T duplex element with insulated junction; "N" length = 3.5" and "A" length = 12.5"; no options.

OPERATING RANGE

TC TYPE	RECOMMENDED MAX TEMP (°C)								
	.063	.125	.188	.250	.313	.375	.500	.625	.750
J	500	600	600	700	700	700	750	750	750
K	900	1000	1000	1100	1100	1100	1200	1200	1200
N	900	1000	1000	1100	1100	1100	1200	1250	1250
T	200	300	300	370	370	370	370	370	370
E	700	700	800	1000	1000	1000	1000	1000	1000

INITIAL CALIBRATION TOLERANCES

TC TYPE	TEMPERATURE RANGE		TOLERANCES*	
	°C	°F	STANDARD	SPECIAL
J	0 to 750°C	32 to 1400°F	±.75% or 2.2°C (4°F)	±.4% or 1.1°C (2°F)
K	0 to 1250°C -200 to 0°C	32 to 2300°F -330 to 32°F	±.75% or 2.2°C (4°F) ±2% or 2.2°C (4°F)	±.4% or 1.1°C (2°F) —
N	0 to 1260°C	32 to 2300°F	±.75% or 2.2°C (4°F)	+ .4% or 1.1°C (2°F)
T	0 to 350°C -200 to 0°C	32 to 700°F -330 to 32°F	±.75% or 1°C (1.8°F) ±1.5% or 1°C (1.8°F)	±.4% or .5°C (.9°F) ±.8% or .5°C (.9°F)
E	0 to 900°C -200 to 0°C	32 to 1600°F -330 to 32°F	±.5% or 1.7°C (3°F) ±1% or 1.7°C (3°F)	±.4% or 1°C (1.8°F) ±1°C

*Percent or fixed error, whichever is greater.

NOTE: Percent limits apply directly to temperatures in °C units, but for °F, equivalents are applied to the number of °F above or below the ice point (+32°F).

(i.e., limit (°F) = (Temp. °F - 32°F) × Percentage)

Product Reference Guides are also available for:

Industrial Thermocouples, RTDs, Thermowells, Protection Tubes



THERMO-KINETICS
COMPANY LIMITED

Sensible Solutions to Temperature Measurement

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(Fax) 463-5164

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130-10691 Shellbridge Way
Richmond, B.C.
V6X 2W8

(604) 231-0711
(Fax) 270-3644

Bourdon Tube Pressure Gauges

Standard Series, Radial Pressure Entry • Model 111.10

Pressure Gauges

Service intended

General purpose pressure gauge. Suitable for all gaseous and liquid media that will not obstruct the pressure system or attack copper alloy parts.

Design

EN 837-1

Nominal size

40, 50, 63, 80, 100 and 160 mm

Accuracy class per EN 837-1 /6

40, 50 and 63 mm: 1.6 / 2.5 *

80, 100 and 160 mm: 1.6

Scale ranges per EN 837-1 /5

0 ... 0.6 to 0 ... 400 bar (max. 40 bar with 160 mm)

or other equivalent units of pressure or vacuum.

Working pressure

Steady: $\frac{3}{4}$ of full scale value

Fluctuating: $\frac{2}{3}$ of full scale value

Short time: full scale value

Operating Temperature

Ambient: -40 ... +60 °C

Medium: +60 °C maximum

Temperature error

Additional error when temperature of the pressure element deviates from +20 °C

Rising temperature: +0.3%/10 K of true scale value

Falling temperature: -0.3%/10 K of true scale value

Standard features

Pressure connection

Material: Cu-alloy

Threaded entry (radial) per EN 837-1 /7.3

40 mm: G $\frac{1}{8}$ B, 12 mm flats

50 and 63 mm: G $\frac{1}{4}$ B, 14 mm flats

80, 100 and 160 mm: G $\frac{1}{2}$ B, 22 mm flats

Pressure element

Material: Cu-alloy

≤ 40 bar: C-type

> 40 bar: helical type

Movement

Cu-alloy

Dial

40, 50 and 63 mm: white plastic, with pointer stop pin

80, 100 and 160 mm: white aluminium, with pointer stop pin

With black lettering



Pointer

Black plastic

160 mm only: black aluminium

Case

Black plastic

160 mm only: black finish steel

Window

Crystal-clear plastic, snap-fit

160 mm only: instrument glass

Bezel ring

Without bezel

160 mm only: black finish steel

Optional extras

- Other pressure connection

- Black finish steel case

- Slip-on bezel

Back pressure entry see data sheet PM 01.09

Panel mounting, back pressure entry see data sheet PM 01.10

* for stock instruments or as option: class 1.6

Special versions

For closed central heating

63 and 80 mm, accuracy class 2.5
With red mark pointer and adjustable green sector
Scale range 0 ... 4 bar, red mark at 2.5 or 3 bar

Refrigerant gauges 63 and 80 mm

(80 mm with black finish steel case, accuracy class 1.0)
Featuring scales in °C for refrigerants R 744, R 764, R 40, R 22 or R 134 a

Refrigerant field service gauges

80 mm with black finish steel case, accuracy class 1.0
Featuring SAE flare connection, knife edge pointer, scales in °C for refrigerants R 22, R 134 a and R 404 A

Tyre inflation gauges with EEC approval mark

80 mm with black finish steel case
Scale ranges 0 ... 4 and 0 ... 10 bar

For domestic central heating

80, 100 and 160 mm, accuracy class 2.5
Scale ranges 0 ... 0.6 or 0 ... 1 bar with retard scale spacing and red mark pointer

For water-level-indicator and central heating

80, 100 and 160 mm, accuracy class 2.5
Scale ranges 0 ... 0.6 to 0 ... 40 bar with 2nd scale of mWS (metres of water)

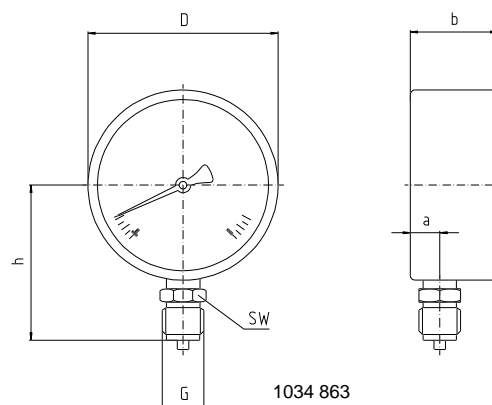
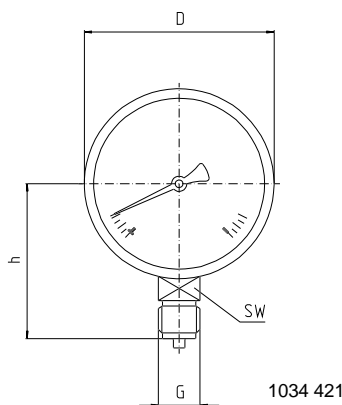
Dimensions

Standard versions

Radial bottom pressure connection

40, 50, 63 and 160 mm

80 and 100 mm



Nominal size	Dimensions [mm]						Weight [kg]
	a	b ± 0.5	D	G	h ± 1	SW	
40	8	24	41	G ⅙ B	36	12	0.06
50	10	27,5	49	G ¼ B	45	14	0.10
63	10	27,5	62	G ¼ B	53.5	14	0.13
80	11.5	30	79	G ½ B	72	22	0.18
100	11.5	30	99	G ½ B	83.5	22	0.21
160	15.5	41.5	160	G ½ B	115.5	22	0.85

Standard pressure entry with parallel thread and seating to EN 837-1 /7.3

Ordering information

State:

Pressure gauge model / Nominal size / Scale range / Size of connection / Optional extras required

Specifications and dimensions given in this leaflet represent the state of engineering at the time of printing. Modifications may take place and materials specified may be replaced by others without prior notice.

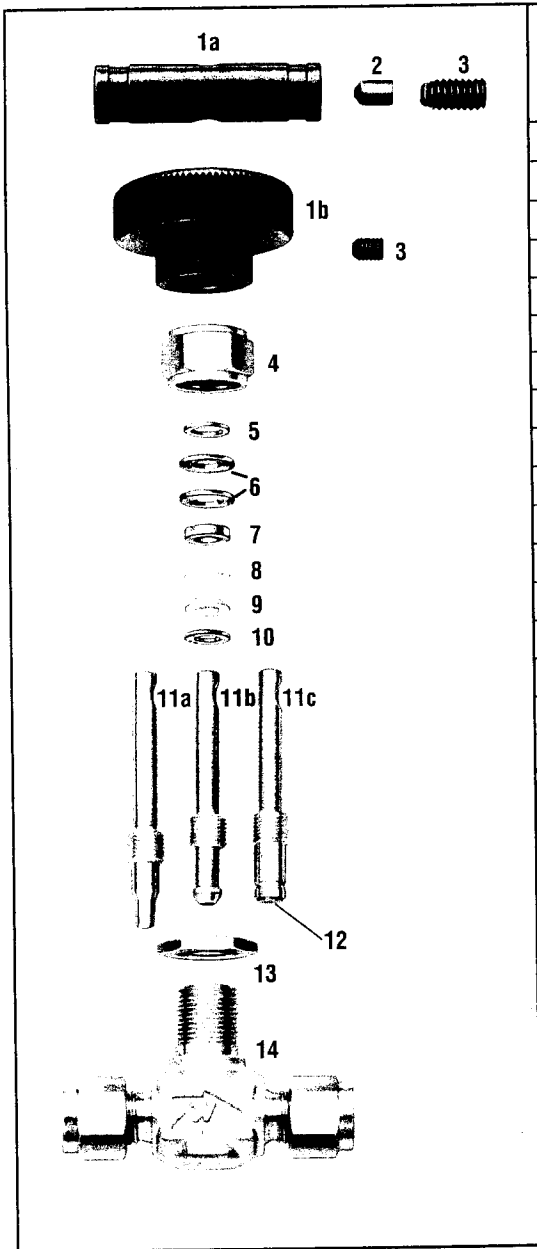
WIKA Alexander Wiegand GmbH & Co.

Alexander-Wiegand-Straße · 63911 Klingenberg
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<http://www.wika.de> · E-mail: info@wika.de



MATERIALS OF CONSTRUCTION

Knob handles are standard on the "O" and "1" Series Valves. Bar handles are standard on the "18" Series Valves. Optional handles are available on all series – Refer to Page 4 for selection and ordering information.



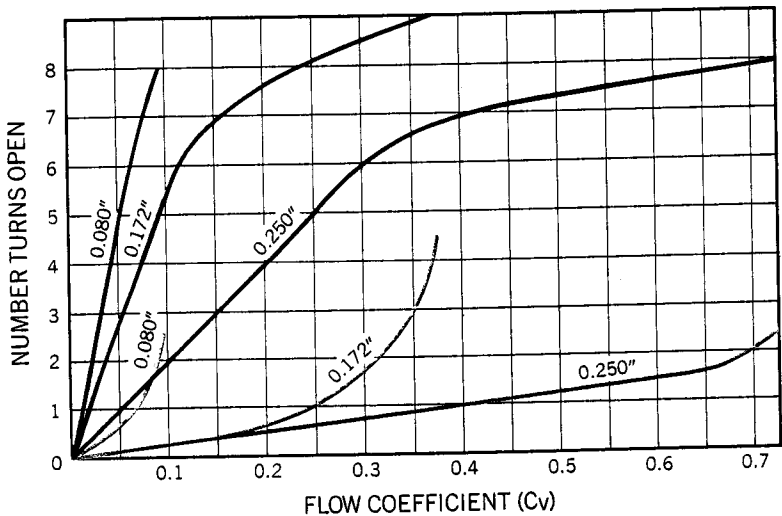
Wetted parts numbered in red.
Lubrication: Tungsten disulfide and fluorocarbon base.

	VALVE BODY MATERIALS			
	316SS	Brass	Steel	Alloy 400
	GRADE/ASTM SPECIFICATION			
1a Bar Handle	Aluminum			
1b Knob Handle	Phenolic			
2 Handle Pin	Steel			
3 Set Screw				
4 Packing Nut	316SS/A276	Brass 360/B16	12L14/A108	Alloy R-405/B164
5 Gland ^②	Stainless Steel			
6 Packing Springs ^③	17-7PH/A693			
7 Packing Gland	316SS/A276, A167, B783			
8 Upper Packing	PFA			
9 Lower Packing				
10 Lower Gland	316SS/A167		Alloy 400/B127	
11a Regulating Stem	316SS/A276		Alloy R-405/B164	
11b Vee Stem				
11c Soft Seat Stem				
12 Stem Tip (Soft Seat)	Kel-F (CTFE)			
13 Panel Nut	Stainless Steel	Brass 360/B16	Stainless Steel	
14 Body	316SS/A182	Brass 377/B283	11L17/A108	Alloy 400/B564

^② Utilized in valves with the following orifice size: 0.080 and 0.172 in. (2.0 and 4.4 mm).
^③ Number of springs will vary depending on valve series.

FLOW COEFFICIENT (C_v) @ TURNS OPEN

"O" & "1" Series ■ Regulating Stem ■ Vee or Kel-F Stem



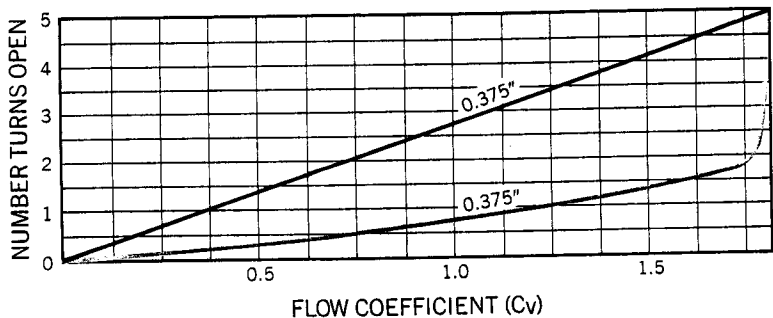
TESTING

Standard Production Test – Every valve is factory tested @ 1000 psig (68 bar) for leakage at the seats to a maximum allowable leak rate of 0.1 scc/min. The packings are tested for no detectable leakage.

Optional Hydrostatic Test – This hydrostatic shell test is performed with deionized water at 1-1/2 times the working pressure.

Other optional tests are available. Consult your Authorized SWAGELOK Sales & Service Representative.

"18" Series



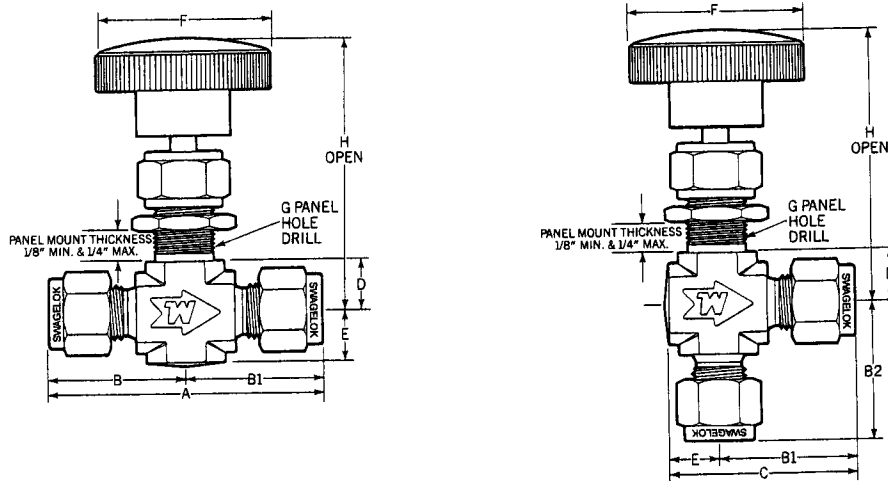


TABLE OF DIMENSIONS

BASIC ORDERING NUMBER	ORIFICE		C _v	CONNECTION SIZE		DIMENSIONS (inches)									
	in.	mm		INLET	OUTLET	A	B	B1	B2	C	D	E	F	G	H OPEN
-ORF2	0.080	2.0	0.09	1/8 Female NPT		1.88	.94	.94	.94	1.25	.44	.31	1.00	.47	2.29
-ORM2				1/8 Male NPT		1.50	.75	.75	.75	1.06					
-ORM2-S2				1/8 Male NPT	1/8 SWAGELOK	1.72	.97	.97	.97	1.28					
-ORS2				1/8 SWAGELOK		1.94	.97	.97	.97	1.28					
-ORS3MM				3mm SWAGELOK		1.94	.97	.97	.97	1.28					
-1RF2	0.172	4.4	0.37	1/8 Female NPT		1.62	.81	.81	.81	1.19	.44	.38	1.38	.53	2.34
-1RM2				1/8 Male NPT		1.62	.81	.81	.81	1.19					
-1RM4				1/4 Male NPT		1.96	.98	.98	.98	1.36					
-1RM4-S4				1/4 Male NPT	1/4 SWAGELOK	2.11	1.13	1.13	1.13	1.51					
-1RS6MM				6mm SWAGELOK		2.26	1.13	1.13	1.13	1.51					
-1RS4				1/4 SWAGELOK		2.26	1.13	1.13	1.13	1.51					
-1RS8MM				8mm SWAGELOK		2.34	1.17	1.17	1.17	1.55					
-1RF4				1/4 Female NPT		2.12	1.06	1.06	1.06	1.56					
-1RF4RT [®]	1/4 ISO Female Tapered		2.12	1.06	1.06	1.06	1.56								
-1RM4-F4	0.250	6.4	0.73	1/4 Male NPT	1/4 Female NPT	2.19	1.13	1.29	1.13	1.79	.50	.50	1.88	.78	2.81
-1RM4-S6				1/4 Male NPT	3/8 SWAGELOK	2.42	1.13	1.13	1.13	1.63					
-1RM6				3/8 Male NPT		2.26	1.13	1.13	1.13	1.79					
-1RM6-S6				3/8 Male NPT	3/8 SWAGELOK	2.42	1.13	1.13	1.13	1.79					
-1RM6-S8				3/8 Male NPT	1/2 SWAGELOK	2.53	1.40	1.40	1.40	1.90					
-1RS10MM				10mm SWAGELOK		2.60	1.30	1.30	1.30	1.80					
-1RS6				3/8 SWAGELOK		2.58	1.29	1.29	1.29	1.79					
-1RS12MM				12mm SWAGELOK		2.80	1.40	1.40	1.40	1.90					
-1RS8				1/2 SWAGELOK		2.80	1.40	1.40	1.40	1.90					
-18RF6				0.375	9.5	1.80	3/8 Female NPT		3.00	1.50					
-18RF6RT [®]	3/8 ISO Female Tapered														
-18RF8	1/2 Female NPT														
-18RF8RT [®]	1/2 ISO Female Tapered														
-18RM8	1/2 Male NPT														
-18RM8-F8	1/2 Male NPT	1/2 Female NPT													
-18RS8	1/2 SWAGELOK														
-18RS12	3/4 SWAGELOK														

[®] Valves with RT ends conform to ISO 7/1. The following are various descriptions of the 7/1 thread: DIN-2999, BS 21, and JIS B0203. Consult your Authorized SWAGELOK Sales & Service Representative for further information.

Dimensions shown with SWAGELOK nuts finger-tight, where applicable. All dimensions are for reference only, subject to change.

ORDERING INFORMATION

Materials: Use **B** for brass, **SS** for 316 stainless steel, **S** for carbon steel, or **M** for alloy 400 as a prefix to the Basic Ordering Number. Example: **S**-1RF4

Stems: Basic Ordering Numbers specify Regulating stems (R). For a Vee stem, replace the R with V; for a Kel-F stem, replace the R with K. Example: SS-1V54

Patterns: To order angle pattern valves, use **-A** as a suffix to the Ordering Number. Example: SS-1RF2-A. Some of the above valves are available in a cross pattern. Cross pattern valves offer uninterrupted flow between side ports at all times; on-off or metered flow through bottom port. Contact your Authorized SWAGELOK Sales & Service Representative for more information.

SOUR GAS SERVICE

Materials for wetted valve components are selected in accordance with N.A.C.E. standard MR0175-94 for sulfide stress cracking resistant materials. Stem and lower gland are alloy 400 or alloy R-405. To order, use **-SG** as a suffix to the valve Ordering Number. Example: SS-ORF2-SG

For information on the use of stainless steel instrument tube fittings in sour gas service, please refer to the N.A.C.E. MR0175-94 specification.

CAUTION:

Do not mix or interchange parts with those of other manufacturers

OPTIONS/ACCESSORIES

STEM PACKING SEALS

Factory-Assembled in Valve

Valves are standard with a two-piece chevron style PFA packing. Optional packing materials are described below.

UHMWPE (Ultra-high Molecular Weight Polyethylene) is intended for service where fluorocarbons are not acceptable. Maximum temperature rating is 250°F (121°C). To order valves with factory-assembled UHMWPE seals, use **-P** as a suffix to the valve Ordering Number. Example: SS-1RF4**P**

PEEK (Polyetheretherketone) is a two-piece chevron packing which can extend the valve's temperature rating.

316 stainless steel: -65°F to 600°F @ 3130 psig (-54°C to 315°C @ 215 bar)

Alloy 400: -65°F to 500°F @ 2375 psig (-54°C to 260°C @ 163 bar)
Carbon steel and brass valve ratings do not change.

To order valves with factory-assembled PEEK seals, use **-PK** as a suffix to the valve Ordering Number. Example: SS-1RS4**PK**

Stem Packing Kits

PFA, UHMWPE and PEEK packing kits are available. Kits contain stem packings, springs, lubrication, and instructions.

VALVE SERIES	ORIFICE SIZE	PACKING KIT ORDERING NUMBERS		
		PFA	UHMWPE	PEEK
"O"	0.080"	PFA-91K-O	PE-91K-O	PK-91K-O
"1"	0.172"	PFA-91K-14	PE-91K-14	PK-91K-14
"1"	0.250"	PFA-91K-16	PE-91K-16	PK-91K-16
"18"	0.375"	PFA-91K-18	PE-91K-18	PK-91K-18
Lubrication:		Tungsten disulfide and fluorocarbon base	Molybdenum disulfide and hydrocarbon base	Molybdenum disulfide, Tungsten disulfide, and fluorocarbon base

HANDLES

Factory-Assembled to Valve

The "O" and "1" Series Valves are standard with black phenolic knob handles. To order valves with *colored* handles factory-assembled, use the desired color designator in the chart below as a suffix to the valve Ordering Number. Example: SS-1RF4**GR**. To order valves with *black aluminum bar* handles factory-assembled, use **-BKB** as a suffix to the valve Ordering Number. Example: SS-ORS2**BKB**

VALVE SERIES	COLOR DESIGNATORS				
	BLUE	GREEN	ORANGE	RED	YELLOW
"O" & "1"	-BL	-GR	-OG	-RD	-YW

The "18" Series Valve is standard with a black aluminum bar handle. To order valves with *black phenolic knob* handles, use **-BKP** as a suffix to the valve Ordering Number. Example: SS-18RF8**BKP**

To order valves with *316 stainless steel bar* handles, for all series, use **-SH** as a suffix to the valve Ordering Number. Example: M-1RS4**SH**

Handles as Spare Parts

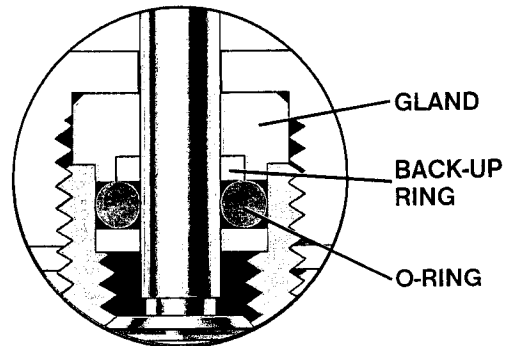
To order handles as spare parts, reference chart below.

VALVE SERIES	ORIFICE SIZE	ORDERING NUMBERS		
		BLACK PHENOLIC KNOB	BLACK ALUMINUM BAR	316 STAINLESS STEEL BAR
"O"	0.080"	PH-5K-OK-BK [®]	A-5K-14B-BK	SS-5K-14B
"1"	0.172"	PH-5K-14K-BK [®]		SS-5K-6NB
"1"	0.250"	PH-5K-4K-BK [®]	A-5K-6NB-BK	SS-5K-6NB
"18"	0.375"	PH-5K-7K-BK	A-5K-18B-BK	SS-5K-7B

[®] To order *colored* phenolic knob handles, replace -BK in the Ordering Number with one of these color designators: -BL (Blue), -GR (Green), -OG (Orange), -RD (Red), -YW (Yellow).
Example: PH-5K-14K**BL**

O-RING STEM SEALS

O-Ring Stem Seals are available for special applications, factory assembled in the valve or as a maintenance kit. Conversion requires a special gland, back-up ring, and O-Ring.



Factory-Assembled in Valve

To order valves with factory-assembled O-Ring Stem Seals, use the desired O-Ring material designator listed below as a suffix to the valve Ordering Number. Example: SS-1RM4**BC**

Viton A: **-V** Buna N: **-B** Silicone: **-SI**
Buna C: **-BC** Ethylene Propylene: **-E** Kalrez: **-KZ**

O-Ring Stem Seal Kits

These kits are to *maintain valves* having O-Ring seals. Each kit contains O-Ring(s), back-up ring, and lubrication. Kits are standard with a TFE back-up ring, except the Ethylene Propylene kit, which has a polyethylene back-up ring.

To order, combine Material, Kit, and Valve Designators from chart below. Example: VA70-9K-16

O-RING MATERIAL	MATERIAL DESIGNATOR	TEMPERATURE RATING	KIT DESIGNATOR	VALVE DESIGNATOR
Viton A	VA70	-20°F to 450°F (-29°C to 232°C)	-9K-	O (0.080") 14 (0.172") 16 (0.250") 18 (0.375")
Kalrez	KZ70			
Buna N	BN70			
Silicone	SI70			
Ethylene Propylene	EP70			
Buna C	BC70	-65°F to 250°F (-54°C to 121°C)		

SAFE COMPONENT SELECTION

When selecting a component, the total system design must be considered to ensure safe, trouble-free performance. Component function, materials compatibility, adequate ratings, proper installation, operation and maintenance are the responsibility of the system designer and user.

Kel-F – TM 3M Company/ Viton, Kalrez – TM DuPont/ 17-7PH – TM Armco Steel

Your Local Authorized SWAGELOK Sales & Service Representative:



Printed in U.S.A.
SP (E)
December, 1997

SERVICE & OPERATING MANUAL



Model G05 Metallic Design Level 1

Designed to meet CSA Requirement 2.01 U.S. for sweet natural gas operated diaphragm pumps.



II 2GD b T5



U.S. Patent #
5,996,627; 6,241,487
Other U.S. Patents
Applied for

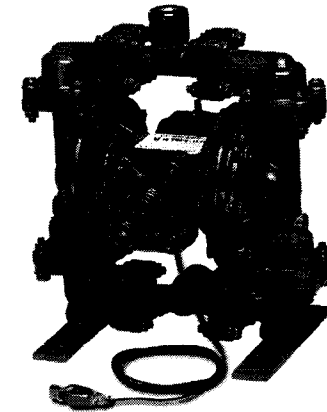


Table of Contents

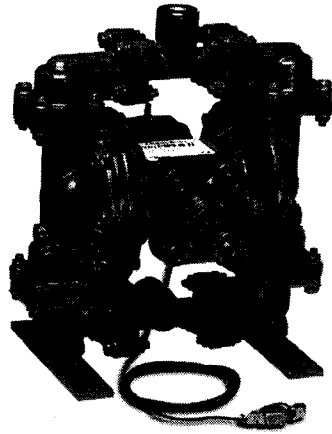
Engineering Data and Temperature Limitations	1	Material Codes	12
Explanation of Pump Nomenclature	2	Composite Repair Parts Drawing	14
Performance Curve	3	Available Service and Conversion Kits	14
Dimensions (Aluminum Model)	4	Composite Repair Parts List	15
Metric Dimensions (Aluminum Model)	5	Natural Gas Distribution Valve Assembly Drawing and Parts List	16
Dimensions (Stainless Steel Model)	6	Natural Gas Distribution Valve Servicing	17
Metric Dimensions (Stainless Steel Model)	7	Diaphragm Service Drawing, with Overlay	18
Principle of Pump Operation	8	Diaphragm Service Drawing, Non-Overlay	18
Installation and Start-Up	8	Diaphragm Servicing	19
Natural Gas Supply	8	Overlay Diaphragm Servicing	19
Natural Gas Valve Lubrication	8	Actuator Plunger Servicing	20
Natural Gas Line Moisture	8	Check Valve Servicing	21
Natural Gas Inlet and Priming	8	Check Valve Drawing	21
Between Uses	8	Provision for Piping Gas Exhaust	22
Installation Guide	9	Pumping Hazardous Liquids	22
Troubleshooting	10	Piping Exhaust Natural Gas	22
Warranty	10	Exhaust Illustration	22
Recycling	11	Grounding The Pump	23
Important Safety Information	11	ATEX Declaration of Conformity	24

**WARREN
RUPP®**

Quality System
ISO9001 Certified

Environmental
Management System
ISO14001 Certified

IDEX
IDEX CORPORATION



II 2GD b T5



U.S. Patent #
5,996,627; 6,241,487
Other U.S. Patents
Applied for

SANDPIPER®
A WARREN RUPP PUMP BRAND

G05 Metallic

**Designed to meet CSA
Requirement 2.01 U.S.
for sweet natural gas
operated diaphragm
pumps.**

ENGINEERING, PERFORMANCE
& CONSTRUCTION DATA

INTAKE/DISCHARGE PIPE SIZE	CAPACITY	GAS VALVE	SOLIDS-HANDLING	HEADS UP TO	DISPLACEMENT/STROKE
½" NPT or ½" BSPT Tapered (internal) ½" NPT or ½" BSPT Tapered (external)	0 to 15 gallons per minute (0 to 56 liters per minute)	No-lube, no-stall design	Up to .125 in. (3mm)	125 psi or 289 ft. of water (8.6 Kg/cm ² or 86 meters)	.026 Gallon / .098 liter
CAUTION! Operating temperature limitations are as follows:					
Materials			Maximum*	Operating Temperatures Minimum*	Optimum**
Buna General purpose, oil-resistant. Shows good solvent, oil, water and hydraulic fluid resistance. Should not be used with highly polar solvents like acetone and MEK, ozone, chlorinated hydrocarbons and nitro hydrocarbons.			190°F 88°C	-10°F -23°C	50° to 140°F 10°C to 60°C
Virgin PTFE Chemically inert, virtually impervious. Very few chemicals are known to react chemically with PTFE: molten alkali metals, turbulent liquid or gaseous fluorine and a few fluoro-chemicals such as chlorine trifluoride or oxygen difluoride which readily liberate free fluorine at elevated temperatures.			212°F 100°C	-35°F -37°C	50°F to 212°F 10°C to 100°C
Polyurethane Shows good resistance to abrasives, has poor resistance to most solvents and oils.			150°F 66°C	32°F 0°C	50°F to 110°F 10°C to 43°C

For specific applications, always consult "Chemical Resistance Chart" Technical Bulletin

*Definite reduction in service life.

**Minimal reduction in service life at ends of range.

These G05 SandPIPER® models are designed to be powered only by sweet natural gas.

Explanation of Pump Nomenclature

G05 Metallic - Design Level 1- Ball Valve

MODEL	Pump Brand	Pump Size	Check Valve Type	Design Level	Wetted Material	Diaphragm/ Check Valve Materials	Check Valve Seat	Non-Wetted Material Options	Porting Options	Pump Style	Pump Options	Kit Options	Shipping Weight lbs. (kg)
G05B1ABTXNSX00.	G	05	B	1	A	B	T	X	N	S	X	00.	15 (7)
G05B1APTXXNSX00.	G	05	B	1	A	P	T	X	N	S	X	00.	15 (7)
G05B1SBTXNSX00.	G	05	B	1	S	B	T	X	N	S	X	00.	21 (10)
G05B1SPTXNSX00.	G	05	B	1	S	P	T	X	N	S	X	00.	21 (10)
G05B1ABTXBSX00.	G	05	B	1	A	B	T	X	B	S	X	00.	15 (7)
G05B1APTXXBSX00.	G	05	B	1	A	P	T	X	B	S	X	00.	15 (7)
G05B1SBTXBSX00.	G	05	B	1	S	B	T	X	B	S	X	00.	21 (10)
G05B1SPTXXBSX00.	G	05	B	1	S	P	T	X	B	S	X	00.	21 (10)

Pump Brand
G= Sweet Gas Operated

Pump Size
05=1/2"

Check Valve Type
B= Ball

Design Level
1= Design Level

Wetted Material
S= Stainless Steel
A= Aluminum

Diaphragm Check Ball Materials
B= Buna/Buna
P=Polyurethane/PTFE

Check Valve Seat
T= Virgin PTFE

Non-Wetted Material Options
X= Unpainted Aluminum

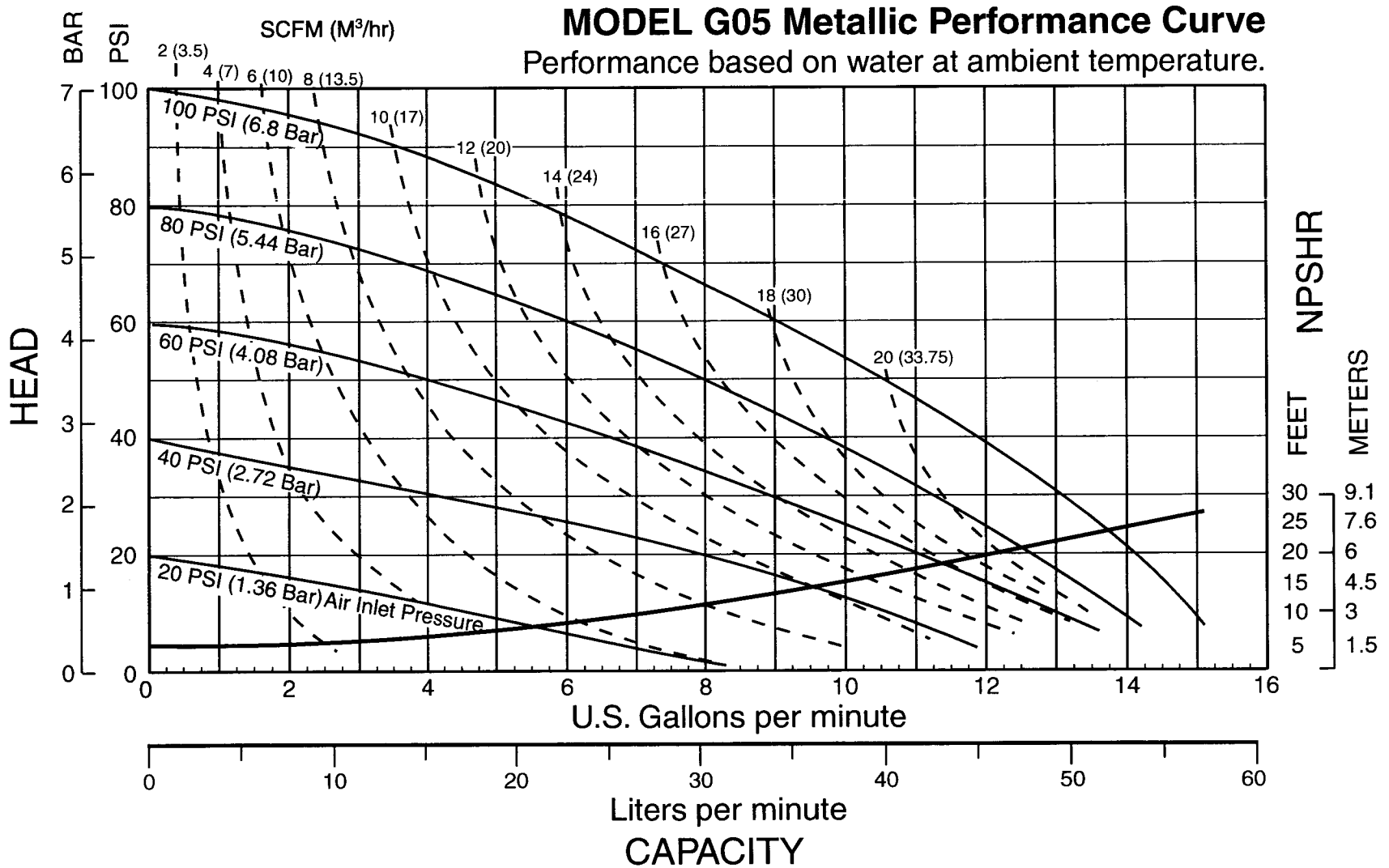
Porting Options
N=NPT Threads
B= BSPT (Tapered) Threads

Pump Style
S= Standard

Pump Options
X= No Muffler

These pump models are designed to pump the following fluids:
Crude Oil, Salt Water, Drilling Mud, Condensate, Lubrication Oils,
Glycol, Caustic liquids, and Acids.

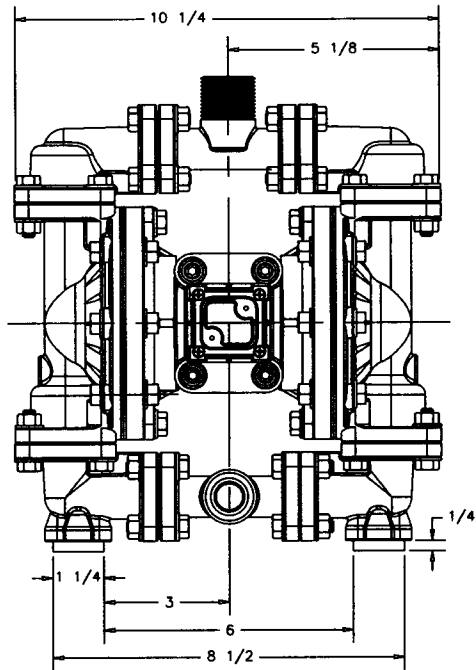
Performance Curve, G05 Model Metallic Design Level 1



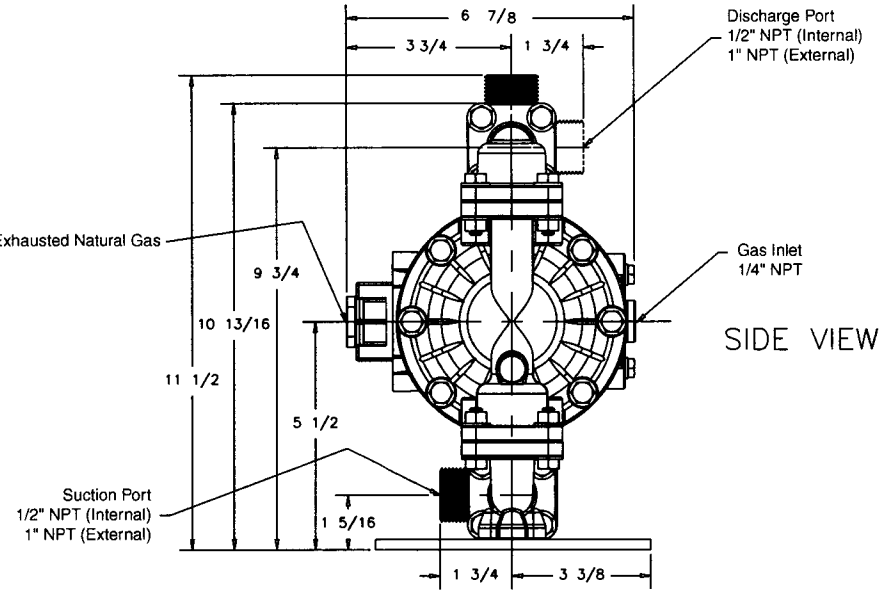
Dimensions: G05 Metallic (Aluminum Model)

Dimensions in Inches

Dimensional Tolerance: $\pm 1/8$ "



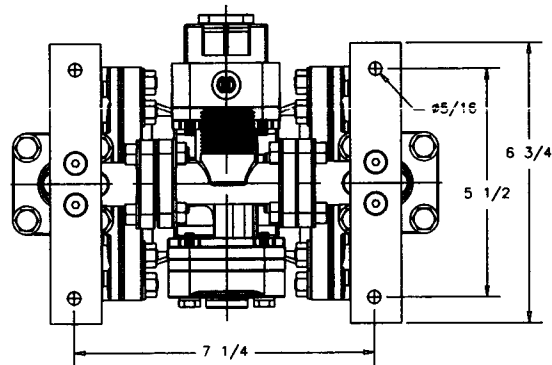
FRONT VIEW



Discharge Port
1/2" NPT (Internal)
1" NPT (External)

Gas Inlet
1/4" NPT

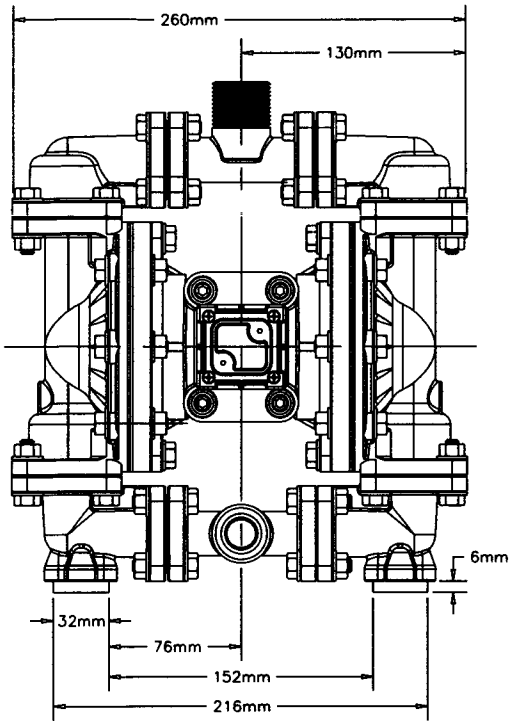
Both Suction And Discharge
Ports Are Available In
1/2" BSPT (Tapered Internal)
1" BSPT (Tapered External)



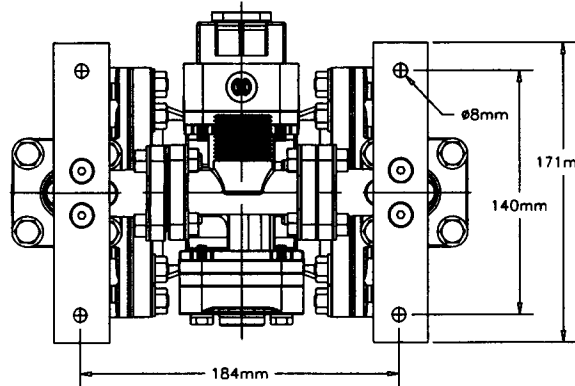
BOTTOM VIEW

Metric Dimensions: G05 Metallic (Aluminum Model)

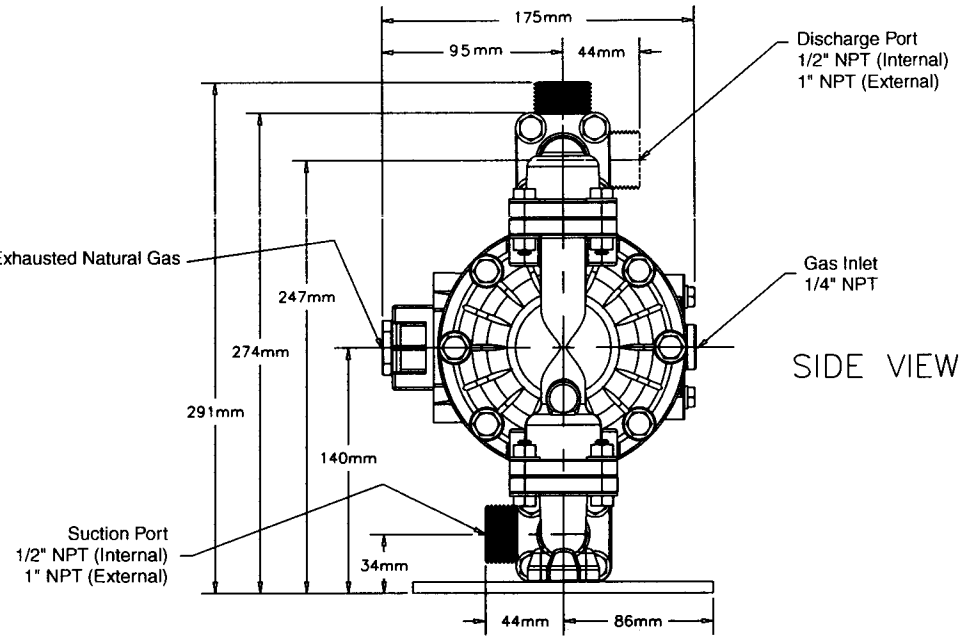
Dimensions in Millimeters
Dimensional Tolerance: $\pm 3\text{mm}$



FRONT VIEW



BOTTOM VIEW

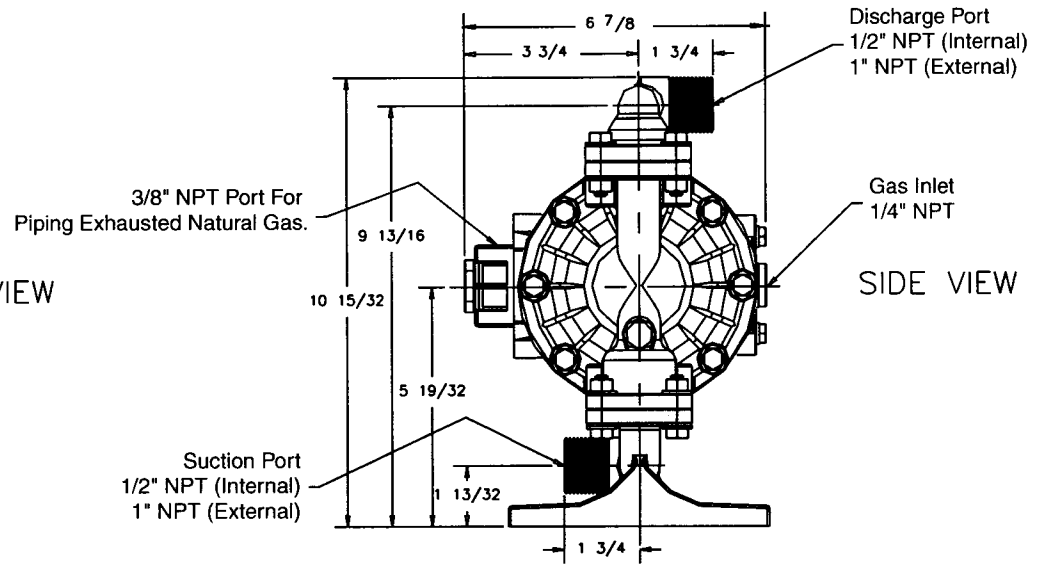
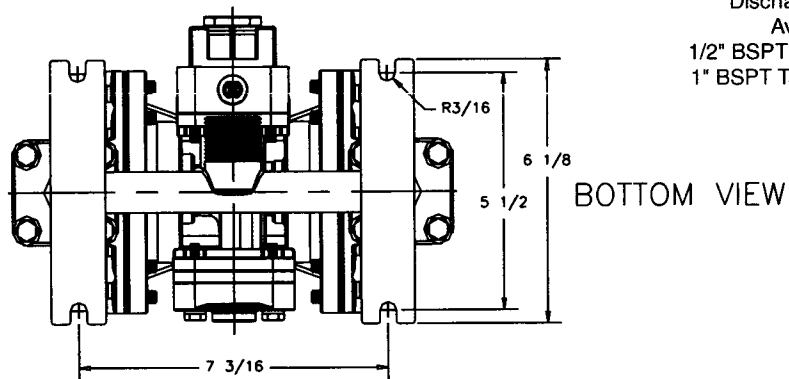
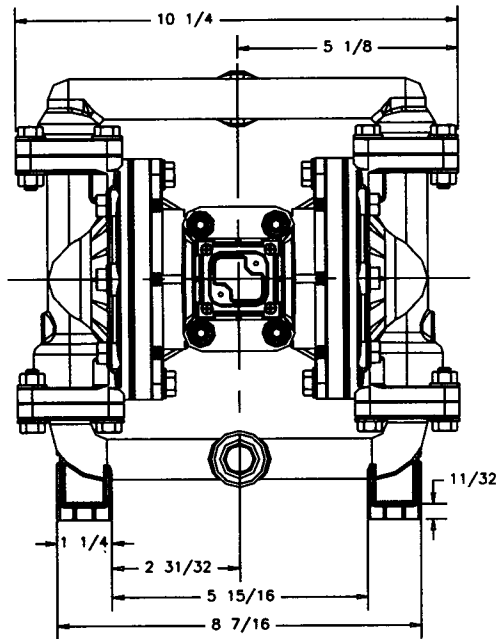


SIDE VIEW

Both Suction and Discharge
Ports Are Available In
1/2" BSPT (Tapered Internal)
1" BSPT (Tapered External)

Dimensions: G05 Metallic (Stainless Steel Model)

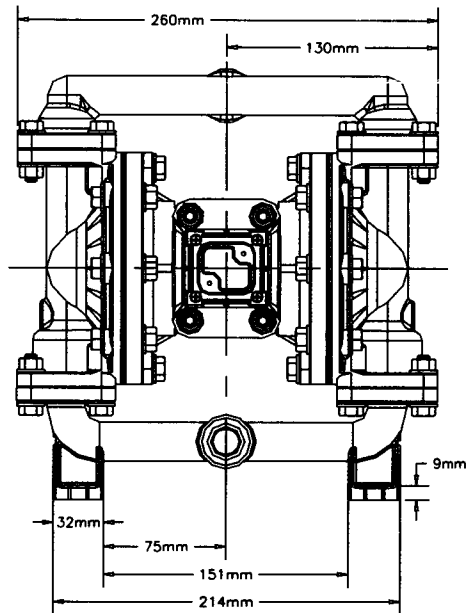
Dimensions in Inches
Dimensional Tolerance: $\pm 1/8$ "



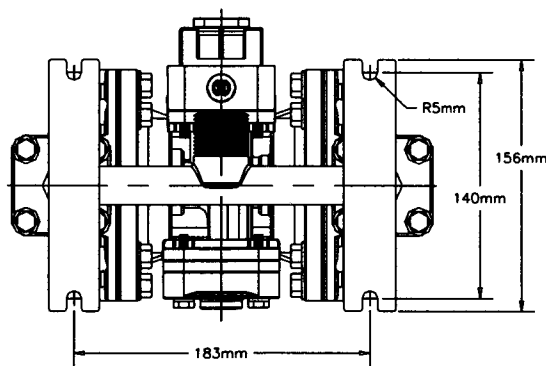
Both Suction And
Discharge Ports Are
Available In
1/2" BSPT Tapered (Internal)
1" BSPT Tapered (External)

Metric Dimensions: G05 Metallic (Stainless Steel Model)

Dimensions in Millimeters
Dimensional Tolerance: ± 3mm



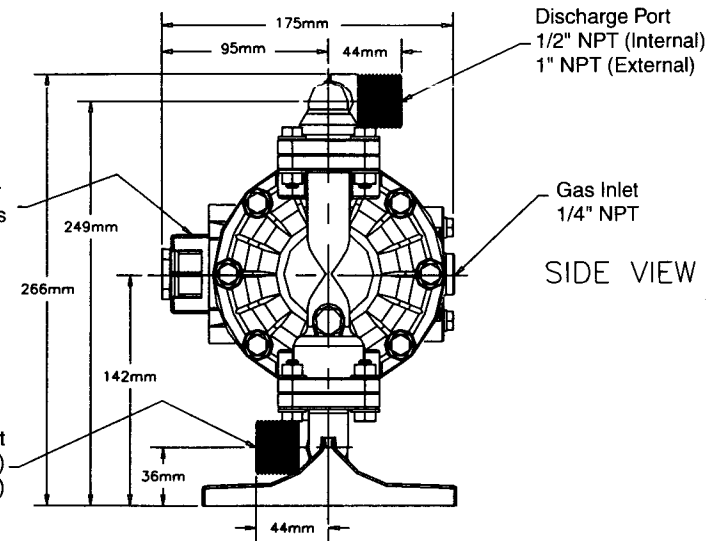
FRONT VIEW



BOTTOM VIEW

3/8" NPT Port For
Piping Exhausted Natural Gas

Both Suction And
Discharge Ports Are
Available In
1/2" BSPT Tapered (Internal)
1" BSPT Tapered (External)



SIDE VIEW

PRINCIPLE OF PUMP OPERATION

This ball type check valve pump is powered by sweet natural gas and is a 1:1 ratio design. The inner side of one diaphragm chamber is alternately pressurized while simultaneously exhausting the other inner chamber. This causes the diaphragms, which are connected by a common rod secured by plates to the centers of the diaphragms, to move in a reciprocating action. (As one diaphragm performs the discharge stroke the other diaphragm is pulled to perform the suction stroke in the opposite chamber.) Gas pressure is applied over the entire inner surface of the diaphragm while liquid is discharged from the opposite side of the diaphragm. The diaphragm operates in a balanced condition during the discharge stroke which allows the pump to be operated at discharge heads over 200 feet (61 meters) of water.

For maximum diaphragm life, keep the pump as close to the liquid being pumped as possible. Positive suction head in excess of 10 feet of liquid (3.048 meters) may require a back pressure regulating device to maximize diaphragm life.

Alternate pressurizing and exhausting of the diaphragm chamber is performed by an externally mounted, pilot operated, four way spool type gas distribution valve. When the spool shifts to one end of the valve body, inlet pressure is applied to one diaphragm chamber and the other diaphragm chamber exhausts. When the spool shifts to the opposite end of the valve

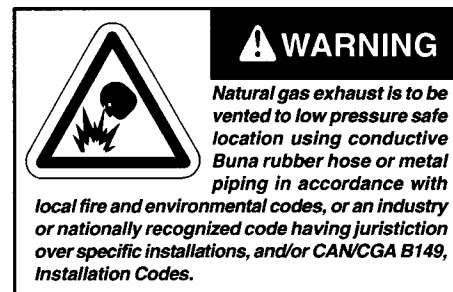
body, the pressure to the chambers is reversed. The gas distribution valve spool is moved by an internal pilot valve which alternately pressurizes one end of the valve while exhausting the other end. The pilot valve is shifted at each end of the diaphragm stroke when an actuator plunger is contacted by the diaphragm plate. This actuator plunger then pushes the end of the pilot valve spool into position to activate the gas distribution valve.

The chambers are connected with manifolds with a suction and discharge check valve for each chamber, maintaining flow in one direction through the pump.

INSTALLATION AND START-UP

Locate the pump as close to the product being pumped as possible. Keep the suction line length and number of fittings to a minimum. Do not reduce the suction line diameter.

For installations of rigid piping, short sections of flexible conductive hose should be installed between the pump and the piping. The flexible conductive hose reduces vibration and strain to the pumping system. A surge suppressor is recommended to further reduce pulsation in flow.



NATURAL GAS SUPPLY

Natural gas inlet pressure must be regulated to 100 (7 bar) psi with a pressure regulator. Connect the pump gas inlet to an gas supply of sufficient capacity and pressure required for desired performance. When the gas supply line is solid piping, use a short length of flexible conductive hose not less than 3/4" (19mm) in diameter between the pump and the piping to reduce strain to the piping. The weight of the gas supply line, regulators and filters must be supported by some means other than the gas inlet cap. Failure to provide support for the piping may result in damage to the pump. A pressure regulating valve should be installed to insure gas supply pressure does not exceed recommended limits.

VALVE LUBRICATION

The natural gas distribution valve and the pilot valve are designed to operate WITHOUT lubrication. This is the preferred mode of operation. There may be instances of personal preference or poor quality gas supplies when lubrication of the supply is required. The pump system will operate with properly lubricated supply. Proper lubrication requires the use of an gas line lubricator (available from Warren Rupp) set to deliver one drop of SAE 10 non-detergent oil for every 20 SCFM (9.4 liters/sec.) of gas the pump consumes at the point of operation. Consult the pump's published Performance Curve to determine this.

GAS INLET AND PRIMING


To start the pump, open the gas valve approximately 1/2" to 3/4" turn. After the pump primes, the valve can be opened to increase gas flow as desired. If opening the valve increases cycling rate, but does not increase the rate of flow, cavitation has occurred. The valve should be closed slightly to obtain the most efficient gas flow to pump flow ratio.

BETWEEN USES

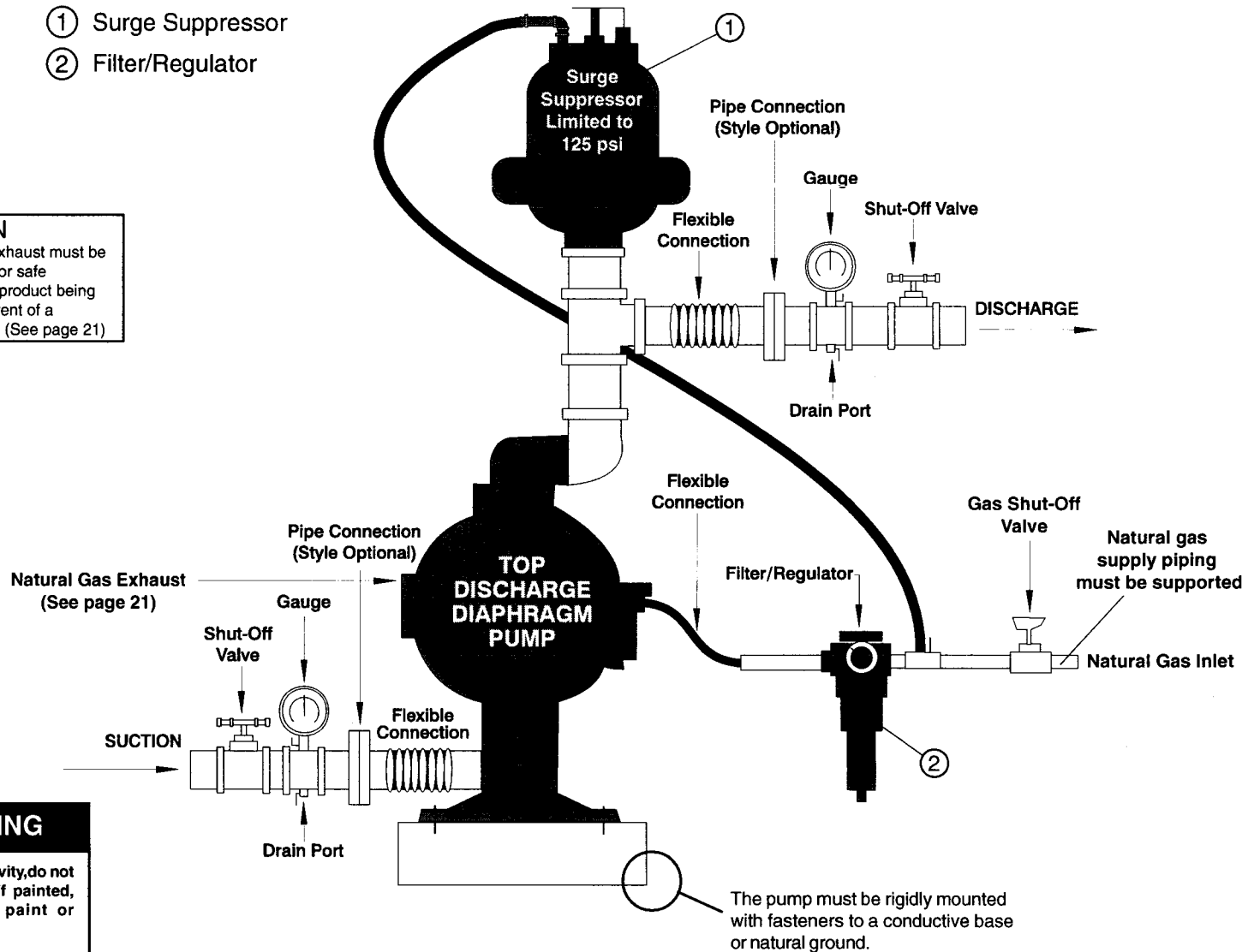
When the pump is used for materials that tend to settle out or solidify when not in motion, the pump should be flushed after each use to prevent damage. (Product remaining in the pump between uses could dry out or settle out. This could cause problems with the diaphragms and check valves at restart.) In freezing temperatures the pump must be completely drained between uses in all cases.


INSTALLATION GUIDE Top Discharge Ball Valve Pump

- ① Surge Suppressor
- ② Filter/Regulator



CAUTION
The natural gas exhaust must be piped to an area for safe disposition of the product being pumped, in the event of a diaphragm failure. (See page 21)





WARNING
To maintain conductivity, do not paint the pump, or if painted, use a conductive paint or coating.

TROUBLESHOOTING

Possible Symptoms:

- Pump will not cycle.
- Pump cycles, but produces no flow.
- Pump cycles, but flow rate is unsatisfactory.
- Pump cycle seems unbalanced.
- Pump cycle seems to produce excessive vibration.

What to Check: Excessive suction lift in system.

Corrective Action: For lifts exceeding 20 feet (6 meters), filling the pumping chambers with liquid will prime the pump in most cases.

What to Check: Excessive flooded suction in system.

Corrective Action: For flooded conditions exceeding 10 feet (3 meters) of liquid, install a back pressure device.

What to Check: System head exceeds natural gas supply pressure.

Corrective Action: Increase the inlet gas pressure to the pump. Most diaphragm pumps are designed for 1:1 pressure ratio at zero flow.

What to Check: Natural gas supply pressure or volume exceeds system head.

Corrective Action: Decrease inlet gas pressure and volume to the pump as calculated on the published PERFORMANCE CURVE. Pump is cavitating the fluid by fast cycling.

What to Check: Undersized suction line.

Corrective Action: Meet or exceed pump connection recommendations shown on the DIMENSIONAL DRAWING.

What to Check: Restricted or undersized gas line.

Corrective Action: Install a larger gas line and connection. Refer to gas inlet recommendations shown in your pump's SERVICE MANUAL.

What to Check: Check the externally serviceable gas distribution system of the pump.

Corrective Action: Disassemble and inspect the natural gas distribution valve, pilot valve and pilot valve actuators. Refer to the parts drawing and valve section of the SERVICE MANUAL. Check for clogged discharge or closed valve before reassembly.

What to Check: Pumped fluid in gas exhaust line.

Corrective Action: Disassemble pump chambers. Inspect for diaphragm rupture or loose diaphragm plate assembly. Refer to the Diaphragm Replacement section of your pump SERVICE MANUAL.

What to Check: Fluid suction side air leakage or air in product.

Corrective Action: Visually inspect all suction side gaskets and pipe connections.

What to Check: Obstructed check valve.

Corrective Action: Disassemble the wet end of the pump and manually dislodge obstruction in the check valve pocket. Refer to the Check Valve section of the pump SERVICE MANUAL for disassembly instructions.

What to Check: Worn or misaligned check valve or check valve seat.

Corrective Action: Inspect check valves and seats for wear and proper seating. Replace if necessary. Refer to Check Valve section of the pump SERVICE MANUAL for disassembly instructions.

What to Check: Blocked suction line.

Corrective Action: Remove or flush obstruction. Check and clear all suction screens and strainers.

What to Check: Blocked discharge line.

Corrective Action: Check for obstruction or closed discharge line valves.

What to Check: Blocked pumping chamber.

Corrective Action: Disassemble and inspect the wetted chambers of the pump. Remove or flush any obstructions. Refer to the pump SERVICE MANUAL for disassembly instructions.

What to Check: Entrained air or vapor lock in one or both fluid pumping chambers.

Corrective Action: Purge chambers through tapped chamber vent plugs. PURGING THE CHAMBERS OF AIR CAN BE DANGEROUS! Contact the Warren Rupp Technical Services Group before performing this procedure. Any model with top-ported discharge will reduce or eliminate problems with entrained air.

If your pump continues to perform below your expectations, contact your local Warren Rupp Distributor or factory Technical Services Group for a service evaluation.

WARRANTY


Refer to the enclosed Warren Rupp Warranty Certificate.

RECYCLING

Many components of Natural Gas Operated SandPIPER® Metallic pumps are made of recyclable materials (see chart on page 10 for material specifications). We encourage pump users to recycle worn out parts and pumps whenever possible, after any hazardous pumped fluids are thoroughly flushed.




⚠ WARNING
Do not smoke near the pump or use the pump near an open flame. Fire or explosion could result.




⚠ WARNING
This pump must not be used for fluid transfer into aircraft.

IMPORTANT SAFETY INFORMATION




⚠ IMPORTANT
Read these safety warnings and instructions in this manual completely, before installation and start-up of the pump. It is the responsibility of the purchaser to retain this manual for reference. Failure to comply with the recommendations stated in this manual will damage the pump, and void factory warranty.



⚠ CAUTION
Before pump operation, inspect all gasketed fasteners for looseness caused by gasket creep. Re-torque loose fasteners to prevent leakage. Follow recommended torques stated in this manual.




⚠ WARNING
Before maintenance or repair, shut off the compressed natural gas line, bleed the pressure, and disconnect the gas line from the pump. The discharge line may be pressurized and must be bled of its pressure.



⚠ WARNING
In the event of diaphragm rupture, pumped material may enter the natural gas end of the pump, and be discharged into the atmosphere. The gas exhaust must be piped to an appropriate area for safe disposition.




⚠ WARNING
Take action to prevent static sparking. Fire or explosion can result, especially when handling flammable liquids. The pump, piping, valves, containers or other miscellaneous equipment must be grounded.



⚠ WARNING
This pump is pressurized internally with natural gas pressure during operation. Always make certain that all bolting is in good condition and that all of the correct bolting is reinstalled during assembly.



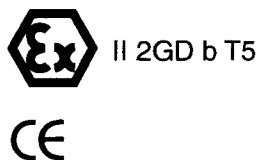
⚠ WARNING
When used for toxic or aggressive fluids, the pump should always be flushed clean prior to disassembly.



⚠ WARNING
Before doing any maintenance on the pump, be certain all pressure is completely vented from the pump, suction, discharge, piping, and all other openings and connections. Be certain the natural gas supply is locked out or made non-operational, so that it cannot be started while work is being done on the pump. Be certain that approved eye protection and protective clothing are worn all times in the vicinity of the pump. Failure to follow these recommendations may result in serious injury or death.



⚠ WARNING
Airborne particles and loud noise hazards. Wear ear and eye protection.



Pump complies with EN809 Pumping Directive, Directive 98/37/EC Safety of Machinery, and Directive 94/9/EC Equipment for use in Potentially Explosive Environments

MATERIAL CODES

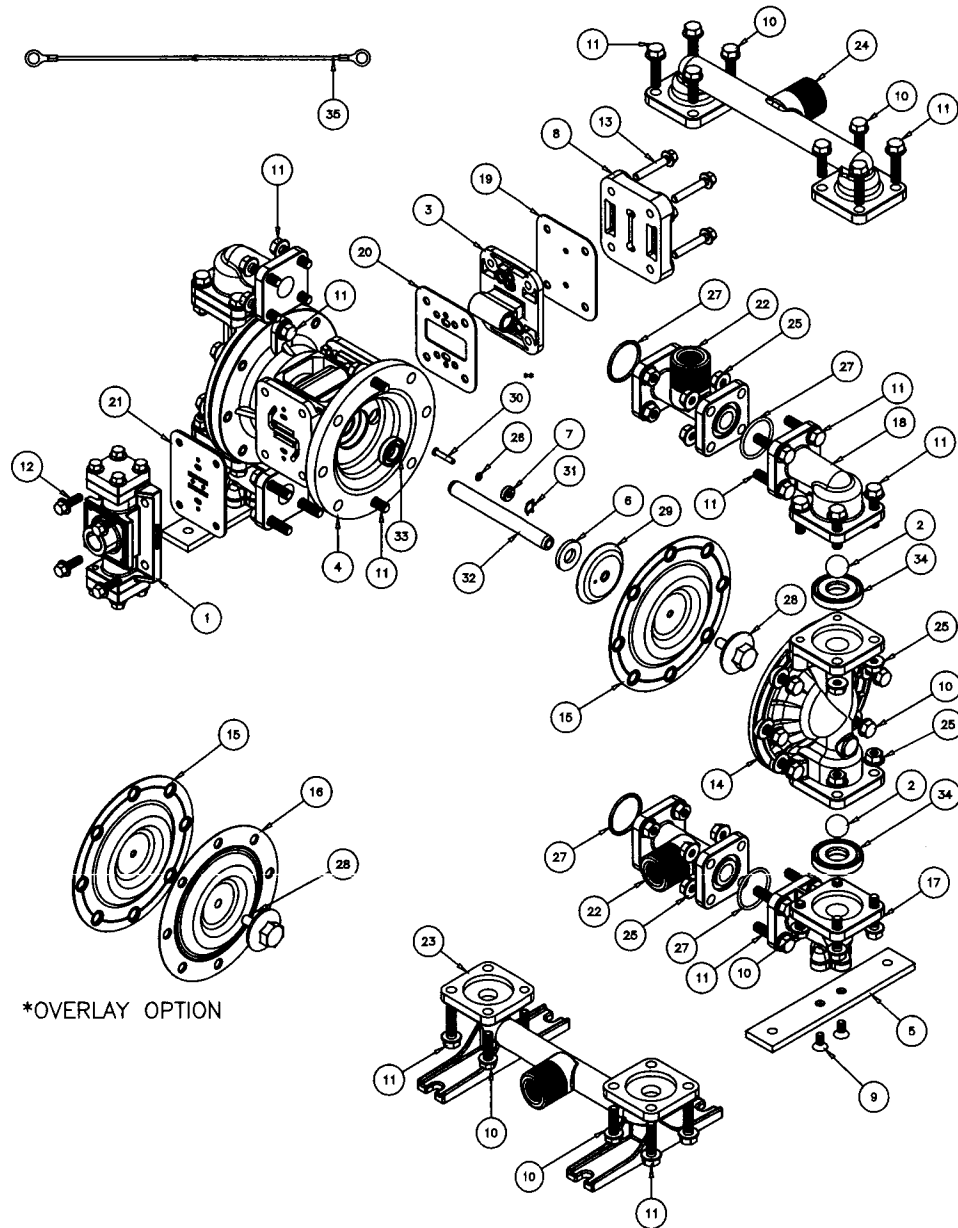
The Last 3 Digits of Part Number

000 Assembly, sub-assembly; and some purchased items	175 Die Cast Zinc	374 Carboxylated Nitrile	603 Blue Gylon
010 Cast Iron	180 Copper Alloy	375 Fluorinated Nitrile	604 PTFE
012 Powered Metal	305 Carbon Steel, Black Epoxy Coated	377 Conductive HNBR	607 Envelon
015 Ductile Iron	306 Carbon Steel, Black PTFE Coated	378 High Density Polypropylene	606 PTFE
020 Ferritic Malleable Iron	307 Aluminum, Black Epoxy Coated	379 Conductive Nitrile	608 Conductive PTFE
025 Music Wire	308 Stainless Steel, Black PTFE Coated	405 Cellulose Fibre	610 PTFE Encapsulated Silicon
080 Carbon Steel, AISI B-1112	309 Aluminum, Black PTFE Coated	408 Cork and Neoprene	611 PTFE Encapsulated Viton
100 Alloy 20	310 Kynar Coated	425 Compressed Fibre	632 Neoprene/Hytrel
110 Alloy Type 316 Stainless Steel	330 Zinc Plated Steel	426 Blue Gard	633 Viton/PTFE
111 Alloy Type 316 Stainless Steel (Electro Polished)	331 Chrome Plated Steel	440 Vegetable Fibre	634 EPDM/PTFE
112 Alloy "C" (Hastelloy equivalent)	332 Aluminum, Electroless Nickel Plated	465 Fibre	635 Neoprene/PTFE
113 Alloy Type 316 Stainless Steel (Hand Polished)	333 Carbon Steel, Electroless Nickel Plated	500 Delrin 500	637 PTFE , Viton/PTFE
114 303 Stainless Steel	334 Cast Iron, Electroless Nickel Plated	501 Delrin 570	638 PTFE , Hytrel/PTFE
115 302/304 Stainless Steel	335 Galvanized Steel	502 Conductive Acetal, ESD-800	639 Buna-N/TFE
117 440-C Stainless Steel (Martensitic)	336 Zinc Plated Yellow Brass	503 Conductive Acetal, Glass-Filled	643 Santoprene®/EPDM
120 416 Stainless Steel (Wrought Martensitic)	337 Silver Plated Steel	505 Acrylic Resin Plastic	644 Santoprene®/PTFE
123 410 Stainless Steel (Wrought Martensitic)	340 Nickel Plated	506 Delrin 150	649 PTFE Buna-N/PTFE
148 Hardcoat Anodized Aluminum	342 Filled Nylon	520 Injection Molded PVDF Natural color	656 Santoprene Diaphragm and Check Balls/EPDM Seats
149 2024-T4 Aluminum	353 Geolast; Color: Black	541 Nylon	
150 6061-T6 Aluminum	354 Injection Molded #203-40 Santoprene- Duro 40D +/-5; Color: RED	542 Nylon	
151 6063-T6 Aluminum	355 Thermal Plastic	544 Nylon Injection Molded	Delrin, Viton and Hytrel are registered tradenames of E.I. DuPont.
152 2024-T4 Aluminum (2023-T351)	356 Hytrel	550 Polyethylene	Gylon is a registered tradename of Garlock, Inc.
154 Almag 35 Aluminum	357 Injection Molded Polyurethane	551 Glass Filled Polypropylene	Nylatron is a registered tradename of Polymer Corp.
155 356-T6 Aluminum	358 Urethane Rubber (Some Applications) (Compression Mold)	552 Unfilled Polypropylene	Santoprene is a registered tradename of Monsanto Corp.
156 356-T6 Aluminum	359 Urethane Rubber	553 Unfilled Polypropylene	Rulon II is a registered tradename of Dixon Industries Corp.
157 Die Cast Aluminum Alloy #380	360 Buna-N Rubber. Color coded: RED	555 Polyvinyl Chloride	Hastelloy-C is a registered tradename of Cabot Corp.
158 Aluminum Alloy SR-319	361 Buna-N	556 Black Vinyl	
159 Anodized Aluminum	363 Viton (Fluorel). Color coded: YELLOW	558 COnductive HDPE	
162 Brass, Yellow, Screw Machine Stock	364 E.P.D.M. Rubber. Color coded: BLUE	570 Rulon II	
165 Cast Bronze, 85-5-5-5	365 Neoprene Rubber. Color coded: GREEN	580 Ryton	
166 Bronze, SAE 660	366 Food Grade Nitrile	590 Valox	
170 Bronze, Bearing Type, Oil Impregnated	368 Food Grade EPDM	591 Nylatron G-S	
	370 Butyl Rubber. Color coded: BROWN	592 Nylatron NSB	
	371 Philthane (Tuftane)	600 PTFE (virgin material) Tetrafluorocarbon (TFE)	
		601 PTFE (Bronze and moly filled)	
		602 Filled PTFE	
			Warren Rupp, SandPIPER, Portapump, Tranquilizer and SludgeMaster are registered tradenames of Warren Rupp, Inc.

Composite Repair Parts Drawing

Available Service Kits:

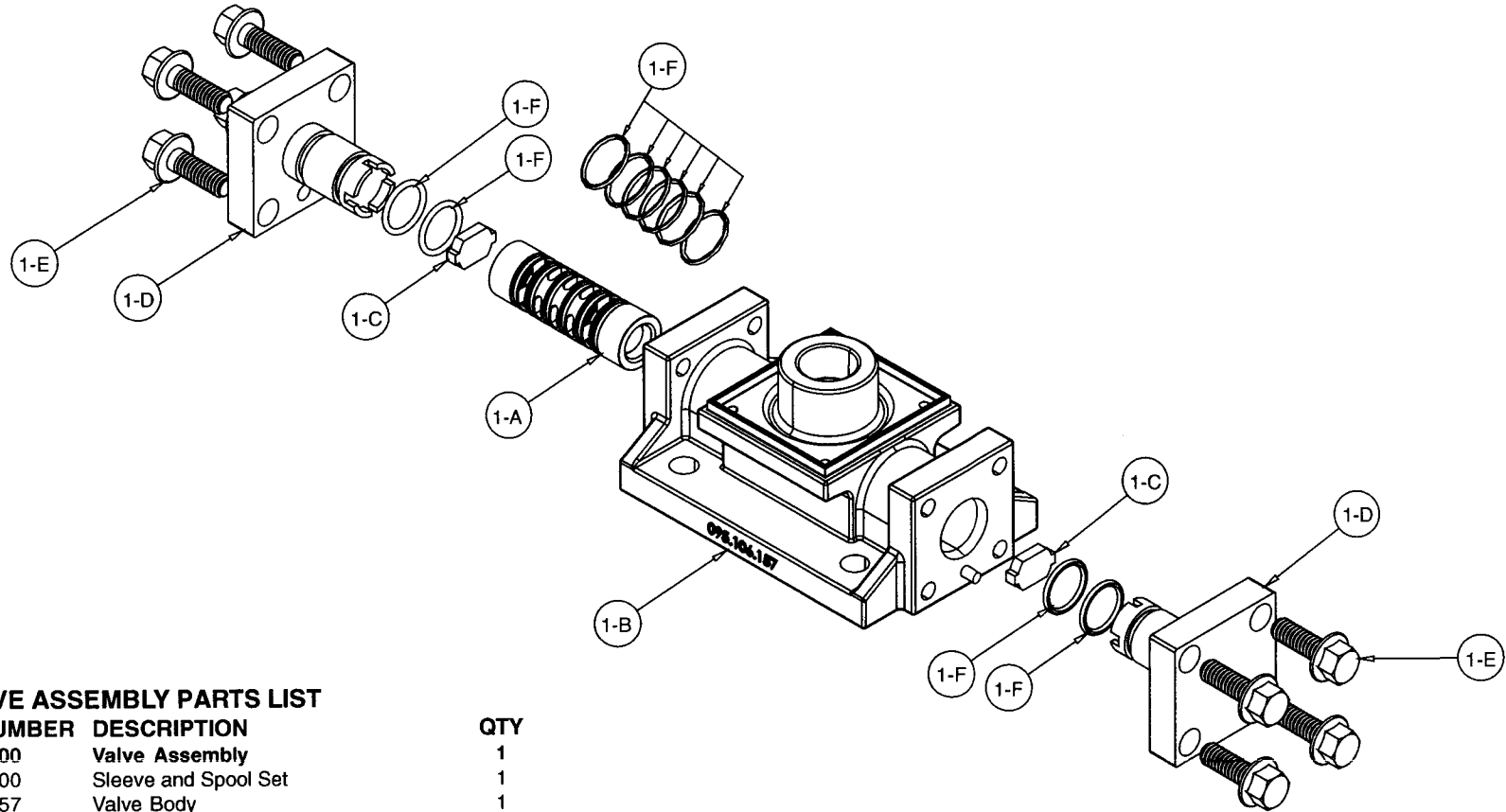
- 476-237-000 Gas End Kit**
Seals, O-Rings, Gaskets, Bumpers,
Retaining Rings, Valve Assembly and
Pilot Valve Assembly
- 476-238-360 Wetted End Kit**
Buna Diaphragms, Buna Check Balls
and PTFE Seats
- 476-238-665 Wetted End Kit**
Polyurethane Diaphragm, PTFE
Overlay Diaphragm, PTFE Check
Balls and PTFE Seats



Composite Repair Parts List

ITEM	PART NUMBER	DESCRIPTION	QTY	ITEM	PART NUMBER	DESCRIPTION	QTY
1	031-174-000	Gas Valve Assembly	1	18	312-111-157	Elbow, Discharge (Aluminum Only)	2
2	050-022-600	Ball, Check	4	19	360-100-379	Gasket, Gas Inlet	1
	050-027-360	Ball, Check	4	20	360-101-379	Gasket, Pilot Valve	1
3	095-116-000	Pilot Valve Assembly	1	21	360-102-360	Gasket, Gas Valve	1
4	114-025-157	Intermediate Bracket	1	22	518-157-157	Manifold (see item 29) (Aluminum Only)	2
5	115-152-151	Bracket, Mounting (Aluminum)	2		518-157-157E	Manifold 1/2" BSP (Tapered) (Alum Only)	2
6	132-034-360	Bumper, Diaphragm	2	23	518-158-110	Manifold, Suction (SS)	1
7	135-036-506	Bushing, Plunger	2		518-158-110E	Manifold, Suction 1/2" BSP (Tapered) (SS)	1
8	165-110-157	Cap, Gas Inlet	1	24	518-159-110	Manifold, Discharge (SS)	1
9	171-017-330	Capscrew, Flat Socket Head 1/4-20 X .50 (Aluminum)	4		518-159-110E	Manifold, Discharge 1 1/2" BSP (Tapered) (SS)	1
10	171-062-330	Capscrew, Flanged 5/16-18 X 1.00	20	25	544-005-330	Nut, Hex Flanged 5/16-18 (Alum)	24
11	171-063-330	Capscrew, Flanged 5/16-18 X 1.25 (Alum)	28	26	544-005-330	Nut, Hex Flanged 5/16-18 (SS)	8
	171-063-330	Capscrew, Flanged 5/16-18 X 1.25 (SS)	12	27	560-001-360	O-ring	2
12	171-076-330	Capscrew, Flanged 1/4-20 X .75	4	28	560-083-360	O-ring (Aluminum Manifold)	4
13	171-077-330	Capscrew, Flanged 1/4-20 X 1.50	4		720-064-600	Seal (Aluminum Manifold)	4
14	196-171-110	Chamber, Outer	2	29	612-091-110	Plate, Outer Diaphragm	2
	196-171-157	Chamber, Outer	2		612-091-157	Plate, Outer Diaphragm	2
15	286-095-360	Diaphragm	2	30	612-177-330	Plate, Inner Diaphragm	2
	286-095-357	Diaphragm (use w/PTFE Overlays Only)	2	31	620-019-115	Pin, Actuator	2
16	286-096-600	Diaphragm, Overlay	2	32	675-042-115	Ring, Retaining	1
17	312-110-157	Elbow, Suction (Aluminum Only)	2	33	685-056-120	Rod, Diaphragm	2
				34	720-012-360	Seal, U-Cup Shaft	4
				35	722-094-600	Seat, Check Ball	4
					920-025-000	Ground Strap	1

Gas Distribution Valve Assembly Drawing



MAIN AIR VALVE ASSEMBLY PARTS LIST

ITEM	PART NUMBER	DESCRIPTION	QTY
1	031-174-000	Valve Assembly	1
1-A	031-188-000	Sleeve and Spool Set	1
1-B	095-106-157	Valve Body	1
1-C	132-038-357	Bumper	2
1-D	165-128-157	End Cap	2
1-E	171-076-330	Hex Flange Capscrew 1/4-20 x .75	8
1-F	560-101-379	O-ring	4

NATURAL GAS DISTRIBUTION VALVE SERVICING

To service the natural gas valve first shut off the compressed gas, bleed pressure from the pump, and disconnect the gas supply line from the pump.

Step #1: See COMPOSITE REPAIR PARTS DRAWING.

Using a 3/8" wrench or socket, remove the four hex capscrews (items 12). Remove the gas valve assembly from the pump.

Remove and inspect gasket (item 21) for cracks or damage. Replace gasket if needed.

Step #2: Disassembly of the natural gas valve.

Using a 3/8" wrench or socket, remove the eight hex capscrews (items 1-E) that fasten the end caps to the valve body. Next remove the two end caps (items 1-D). Inspect the two o-rings (items 1-F) on each end cap for damage or wear. Replace the o-rings as needed.

Remove the bumpers (items 1-C). Inspect the bumpers for damage or wear. Replace the bumpers as needed.

Remove the spool (part of item 1-A) from the sleeve. Be careful not to scratch or damage the outer diameter of the spool. Wipe spool with a soft cloth and inspect for scratches or wear.

Inspect the inner diameter of the sleeve (part of item 1-A) for dirt, scratches, or other contaminants. Remove the sleeve if needed and replace with a new sleeve and spool set (item 1-A).

Step #3: Reassembly of the natural gas valve.

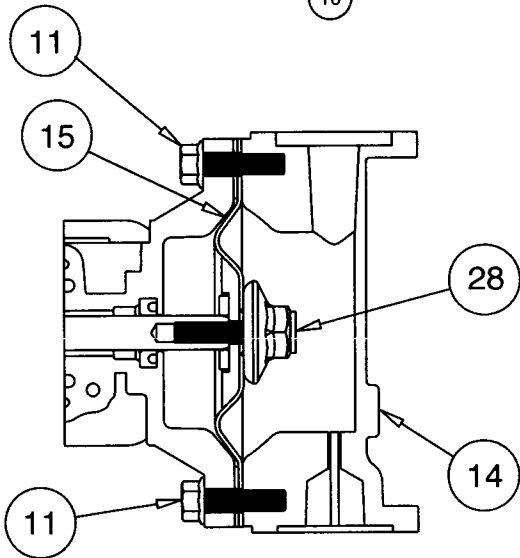
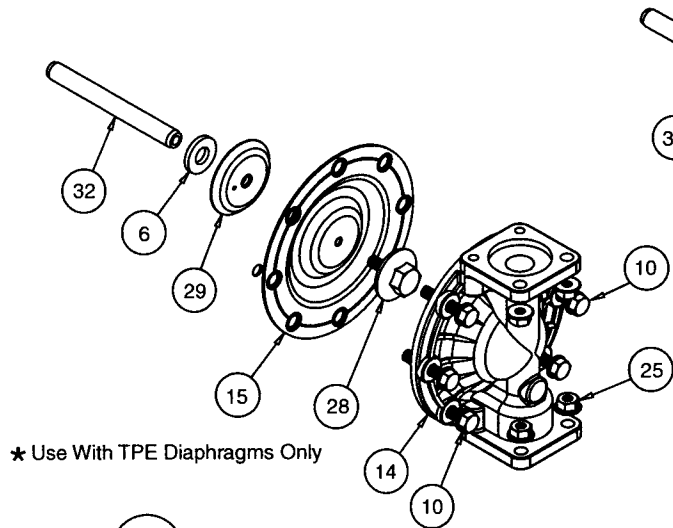
Install one bumper (item 1-C) and one end cap (item 1-D), with two o-rings (items 1-F), and fasten with four hex capscrews (items 1-E) to the valve body (item 1-B). Align hole in end cap with roll pin on valve body.

Remove the new sleeve and spool set (item 1-A) from the plastic bag. Carefully remove the spool from the sleeve. Install the six o-rings (item 1-F) into the six grooves on the sleeve. Apply a light coating of grease to the o-rings before installing the sleeve into the valve body (item 1-B), align the slots in the sleeve with the slots in the valve body. Insert the spool into the sleeve. Be careful not to scratch or damage the spool during installation. Install the remaining bumper and end cap (with o-rings), and fasten with the remaining hex capscrews. Align hole in end cap with roll pin on valve body.

Fasten the natural gas valve assembly (item 1) and gasket to the pump. Connect the compressed gas line to the pump. The pump is now ready for operation.



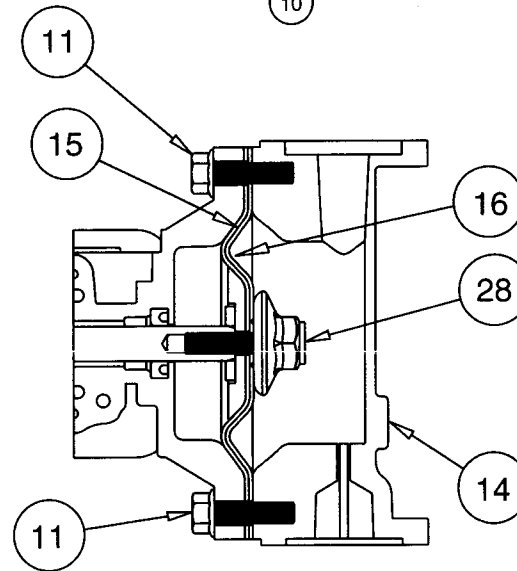
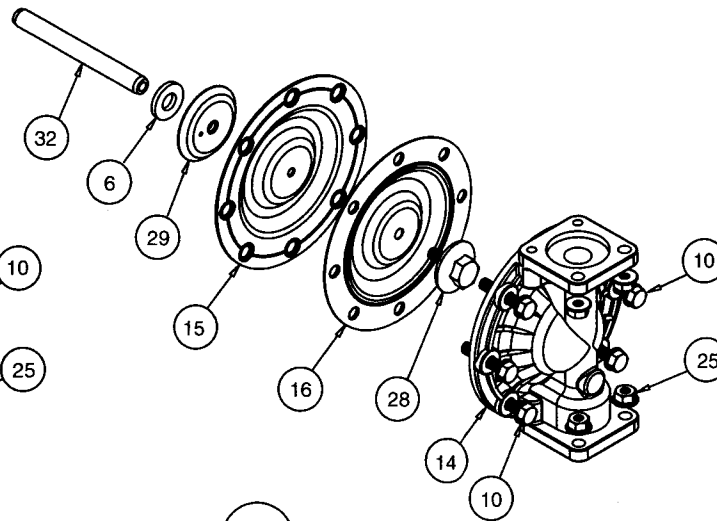
Diaphragm Service Drawing, with Overlay



Diaphragm Orientation

Install diaphragm and spacer
as shown above.

Diaphragm Service Drawing, Non-Overlay



Diaphragm Orientation

Install diaphragm and overlay
as shown above.

DIAPHRAGM SERVICING

To service the diaphragm first shut off the suction, then shut off the discharge lines to the pump. Shut off the natural gas supply, bleed the pressure from the pump, and disconnect the natural gas supply line from the pump. Drain any remaining liquid from the pump.

Step #1: See the pump composite repair parts drawing, and the diaphragm servicing illustration.

Using a 1/2" wrench or socket, remove 8 capscrews (items 10 & 11), and nuts that fasten the discharge elbows (item 18) or the discharge manifold (item 24). Remove the elbows and manifold assembly (items 18 & 22) or manifold (item 24). Use the same procedure to remove the suction elbows (item 17) or suction manifold (item 23).

Step #2: Removing the outer chambers. Using a 1/2" wrench or socket, remove the 16 capscrews (items 10 & 11), and nuts that fasten the outer chambers (item 14), diaphragms (items 15 & 16) and intermediate bracket (item 4) together.

Step #3: Removing the diaphragm assemblies.

Use a 3/4" (19mm) wrench or six pointed socket to remove the diaphragm assemblies (outer plate, diaphragm, and inner plate) from the diaphragm rod (item 32) by turning counterclockwise.

Insert a 6-32 set screw into the smaller tapped hole in the inner

diaphragm plate (item 29). Insert the protruding stud and the 6-32 fastener loosely into a vise. Use a 3/4" wrench or socket to remove the outer diaphragm plate (item 28) by turning counterclockwise. Inspect the diaphragm (item 15 & 16) for cuts, punctures, abrasive wear or chemical attack. Replace the diaphragms if necessary.

Step #4: Installing the diaphragms.

Push the threaded stud of the outer diaphragm plate through the center hole of the diaphragm. Thread the inner plate clockwise onto the stud. Insert the loose assembly with the above 6-32 fastener back into the vise. Use a torque wrench to tighten the diaphragm assembly together to 7.5 ft. Lbs. (10.17 Newton meters). Allow a minimum of 15 minutes to elapse after torquing, then re-torque the assembly to compensate for stress relaxation in the clamped assembly.

Step #5: Installing the diaphragm assemblies to the pump.

Make sure the bumper (item 6) is installed over the diaphragm rod.

Thread the stud of the one diaphragm assembly clockwise into the tapped hole at the end of the diaphragm rod (item 32) until the inner diaphragm plate is flush to the end of the rod. Insert rod into pump.

Align the bolt holes in the diaphragm with the bolt pattern in the intermediate (item 4).

Fasten the outer chamber (item 14) to the pump, using the capscrews (items 10 and 11) and flanged nuts.

On the opposite side of the pump, pull the diaphragm rod out as far as possible. Make sure the bumper (item 6) is installed over the diaphragm rod.

Thread the stud of the remaining diaphragm assembly clockwise into the tapped hole at the end of the diaphragm rod (item 32) as far as possible and still allow for alignment of the bolt holes in the diaphragm with the bolt pattern in the inner chamber. Install diaphragms with convolutions facing towards center of pump. See sectional view on previous page.

Fasten the remaining outer chamber (item 14) to the pump, using the capscrews (items 10 and 11) and flanged nuts.

Step #6: Re-install the elbow/spacer/manifold assemblies to the pump, using the capscrews (item 10 and 11) and flanged nuts (item 25).

The pump is now ready to be re-installed, connected and returned to operation.

OVERLAY DIAPHRAGM SERVICING

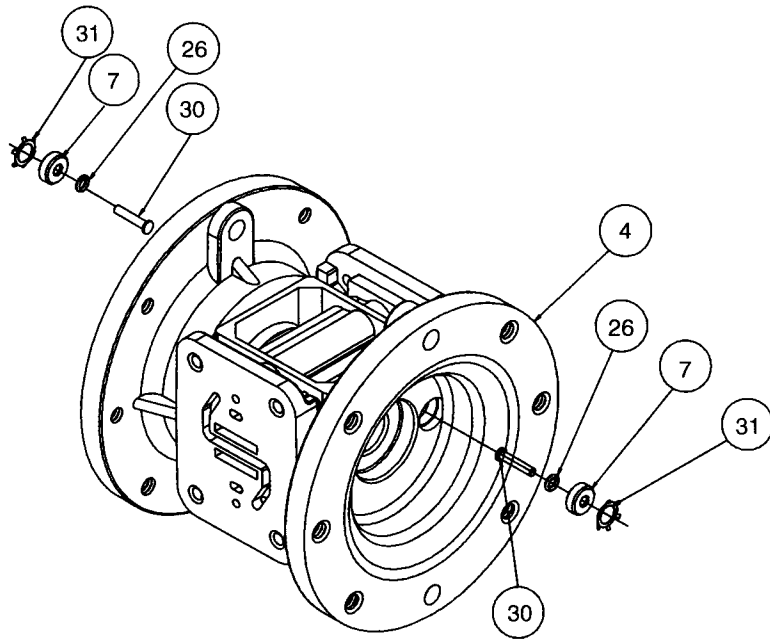
The overlay diaphragm (item 16) is designed to fit snugly over the exterior of the standard TPE diaphragm (item 15).



⚠ IMPORTANT

Read these instructions completely, before installation and start-up. It is the responsibility of the purchaser to retain this manual for reference. Failure to comply with the recommendations stated in this manual will damage the pump, and void factory warranty.

Intermediate Assembly Drawing



INTERMEDIATE REPAIR PARTS LIST

ITEM	PART NUMBER	DESCRIPTION	QTY
4	114-023-157	Bracket, Intermediate	1
7	135-036-506	Bushing, Plunger	2
26	560-001-360	O-Ring	2
30	620-019-115	Plunger, Actuator	2
31	675-042-115	Ring, Retaining*	2

*NOTE: It is recommended that when plunger components are serviced, new retaining rings be installed.

Intermediate Assembly Servicing

ACTUATOR PLUNGER SERVICING

To service the actuator plunger first shut off the natural gas supply, bleed the pressure from the pump, and disconnect the air supply line from the pump.

Step #1: See PUMP ASSEMBLY DRAWING.

Using a 3/8" wrench or socket, remove the four capscrews (items 13). Remove the gas inlet cap (item 8) and air inlet gasket (item 19). The pilot valve assembly (item 3) can now be removed.

Step #2: Servicing the actuator plungers.

See PUMP ASSEMBLY DRAWING.

The actuator plungers (items 30) can be reached through the stem cavity of the pilot valve in the intermediate bracket (item 4). To service bushings, o-rings and retaining rings, see Intermediate Drawing.

Remove the plungers (items 30) from the bushings (item 7) in each end of the intermediate cavity. Inspect for wear or damage. Replace plunger as needed. Apply a light coating of grease to each o-ring and re-install the plungers in to the bushings. Push the plungers in as far as they will go.

Step #3: Re-install the pilot valve assembly into the intermediate assembly.

Be careful to align the ends of the stem between the plungers when inserting the stem of the pilot valve into the cavity of the intermediate.

Re-install the gasket (item 19), gas inlet cap (item 8) and capscrews (items 13).


Connect the gas supply to the pump. The pump is now ready for operation.

PLUNGER BUSHING, O-RING, AND RETAINING RING SERVICING

To service the plunger bushing components first remove the two retaining rings (items 31) using a small flat screwdriver. *Note: It is recommended that new retaining rings be installed.

Next remove the two plunger bushings (items 7). Inspect the bushings for wear or scratches. Replace the bushings as necessary.

Inspect the two o-rings (26) for cuts and/or wear.



IMPORTANT

Read these instructions completely, before installation and start-up. It is the responsibility of the purchaser to retain this manual for reference. Failure to comply with the recommendations stated in this manual will damage the pump, and void factory warranty.

CHECK VALVE SERVICING

Before servicing the check valve components, first shut off the suction line and then the discharge line to the pump. Next, shut off the compressed natural gas supply, bleed gas pressure from the pump, and disconnect the air supply line from the pump. Drain any remaining fluid from the pump. The pump can now be removed for service.

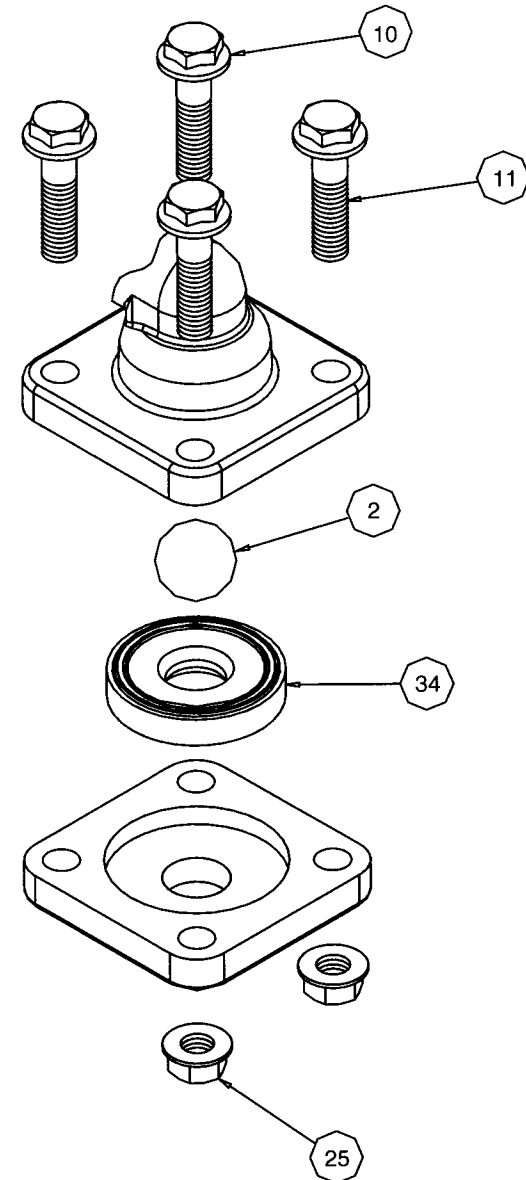
To access the check valve components, remove the manifold/manifold assembly. Use a 1/2" wrench or socket to remove the fasteners. Once the manifold is removed, the check valve components can be seen.

Inspect the check balls (items 2) for wear, abrasion, or cuts on the spherical surface. The check valve seats (item 34) should be inspected for cuts, abrasive wear, or embedded material on the surfaces of both the external and internal chambers. The spherical surface of the check balls must seat flush to the surface of the check valve seats for the pump to operate to peak efficiency. Replace any worn or damaged parts as necessary.

Re-assemble the check valve components. The seat should fit into the counter bore of the outer chamber.

The pump can now be reassembled, reconnected and returned to operation.

Check Valve Drawing



PUMPING HAZARDOUS LIQUIDS

When a diaphragm fails, the pumped liquid or fumes enter the natural gas end of the pump. Fumes are exhausted into the surrounding environment. When pumping hazardous or toxic materials, the exhaust gas must be piped to an appropriate area for safe disposal. See illustration #1 at right.

This pump can be submerged if the pump materials of construction are compatible with the liquid being pumped. The natural gas exhaust must be piped above the liquid level. See illustration #2 at right. Piping used for the gas exhaust must not be smaller than 1/2" (1.27 cm) diameter. Reducing the pipe size will restrict natural gas flow and reduce pump performance. When the pumped product source is at a higher level than the pump (flooded suction condition), pipe the exhaust gas higher than the product source to prevent siphoning spills. See illustration #3 at right.

PIPING THE NATURAL GAS EXHAUST

The following steps are necessary to pipe the exhaust gas away from the pump.

The gas distribution valve assembly (item 1) has 3/8" NPT threads for piped exhaust.

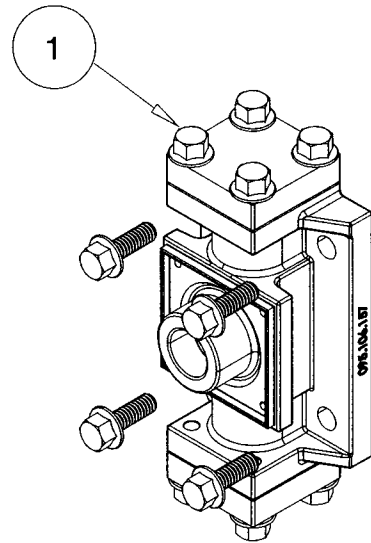
IMPORTANT INSTALLATION NOTE:

The manufacturer recommends installing a flexible conductive hose or connection between the pump and any rigid plumbing. This reduces stresses on the molded threads of the natural gas exhaust port. Failure to do so may result

in damage to the natural gas distribution valve body.

Any piping or hose connected to the pump's natural gas exhaust port must be conductive and physically supported. Failure to support these connections could also result in damage to the valve body.

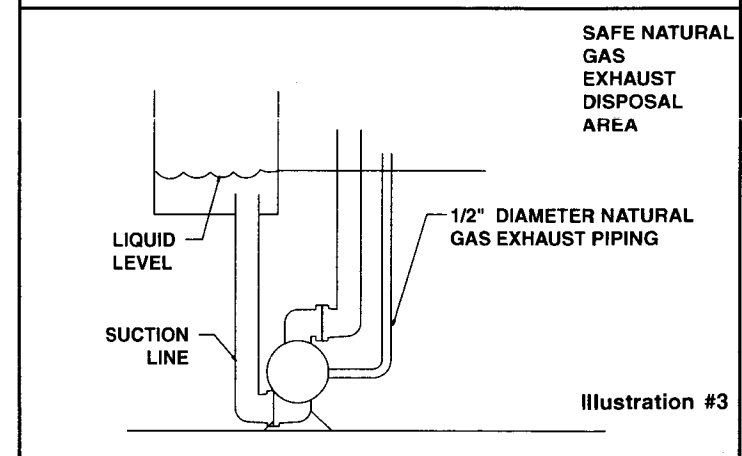
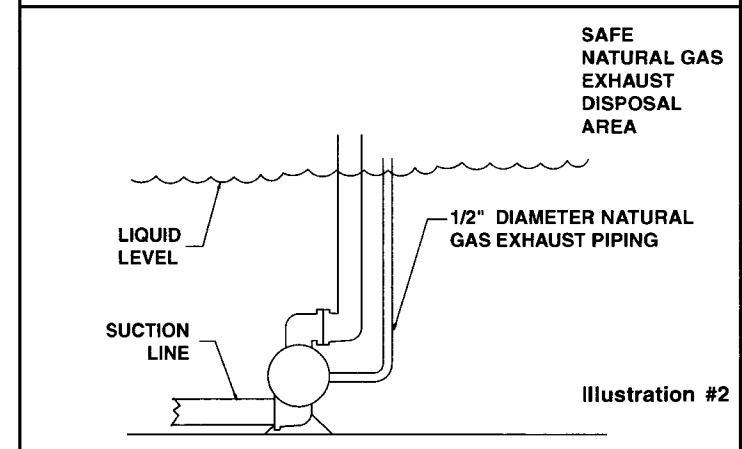
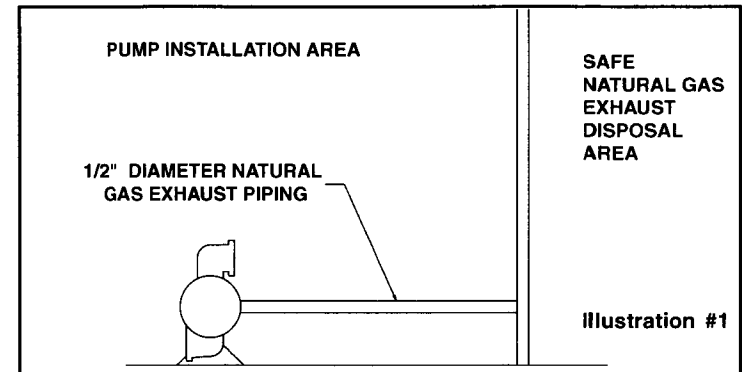
If a high pressure gas spike is possible through the exhaust line, a pressure regulator is required in the exhaust piping.



WARNING

Natural gas exhaust is to be vented to low pressure safe location using conductive Buna rubber hose or metal piping in accordance with local fire and environmental codes, or an industry or nationally recognized code having jurisdiction over specific installations, and/or CAN/CGA B149, Installation Codes.

NATURAL GAS EXHAUST ILLUSTRATION



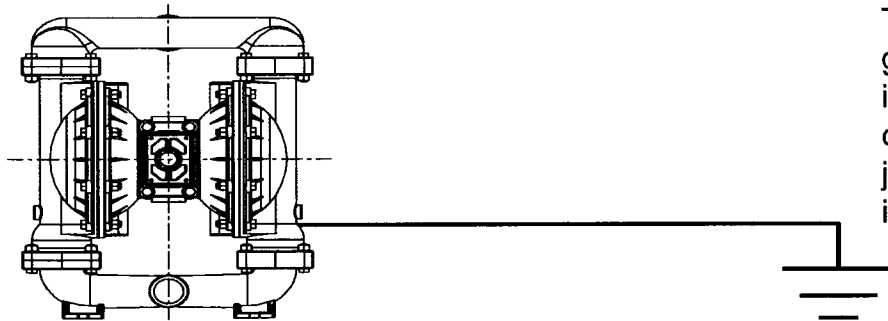
Grounding The Pump

One eyelet is installed to a true earth ground.
(Requires a maximum 5/16 or 8mm maximum diameter bolt)




One eyelet is fastened to the pump hardware.

This 8 foot long (244 centimeters) Ground Strap (Item 35) is shipped with the eyelet end fastened to the pump hardware.



To reduce the risk of static electrical sparking, this pump must be grounded. Check the local electrical code for detailed grounding instruction and the type of equipment required, or in the absence of local codes, an industry or nationally recognized code having jurisdiction over specific installations, and/or CAN/CGA B149, installation codes.

	! WARNING
	<i>Take action to prevent static sparking. Fire or explosion can result, especially when handling flammable liquids. The pump, piping, valves, containers or other miscellaneous equipment must be grounded.</i>

**WARREN
RUPP®**

IDEX
IDEX CORPORATION

Declaration of Conformity ATEX 100a

In accordance with Directive 94/9/EC, Annex VIII Equipment intended for use in potentially explosive environments. Technical File is stored at KEMA, Notified Body 0344, under document number 203040000.

Manufacturer:

Warren Rupp, Inc.
800 North Main Street
P.O. Box 1568
Mansfield, OH 44902 USA



Models:

Air-Operated Double Diaphragm Metallic Pumps
Series: G, SA, SB, S, ST, and U under Sandpiper and Marathon Brands

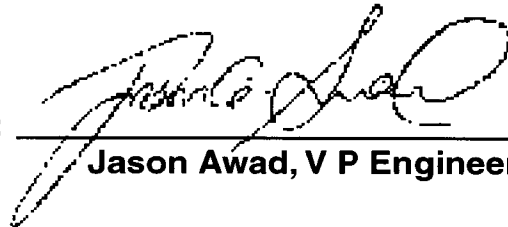
SANDPIPER®
A WARREN RUPP PUMP BRAND

MARATHON
A WARREN RUPP PUMP BRAND

DATE/APPROVAL/TITLE:

8 May 2003

Rev B 23 October 2003



Jason Awad, V P Engineering

Bourdon Tube Pressure Gauges

Standard Series, Radial Pressure Entry • Model 111.10

Pressure Gauges

Service intended

General purpose pressure gauge. Suitable for all gaseous and liquid media that will not obstruct the pressure system or attack copper alloy parts.

Design

EN 837-1

Nominal size

40, 50, 63, 80, 100 and 160 mm

Accuracy class per EN 837-1 /6

40, 50 and 63 mm: 1.6 / 2.5 *

80, 100 and 160 mm: 1.6

Scale ranges per EN 837-1 /5

0 ... 0.6 to 0 ... 400 bar (max. 40 bar with 160 mm)

or other equivalent units of pressure or vacuum.

Working pressure

Steady: $\frac{3}{4}$ of full scale value

Fluctuating: $\frac{2}{3}$ of full scale value

Short time: full scale value

Operating Temperature

Ambient: -40 ... +60 °C

Medium: +60 °C maximum

Temperature error

Additional error when temperature of the pressure element deviates from +20 °C

Rising temperature: +0.3%/10 K of true scale value

Falling temperature: -0.3%/10 K of true scale value

Standard features

Pressure connection

Material: Cu-alloy

Threaded entry (radial) per EN 837-1 /7.3

40 mm: G $\frac{1}{8}$ B, 12 mm flats

50 and 63 mm: G $\frac{1}{4}$ B, 14 mm flats

80, 100 and 160 mm: G $\frac{1}{2}$ B, 22 mm flats

Pressure element

Material: Cu-alloy

≤ 40 bar: C-type

> 40 bar: helical type

Movement

Cu-alloy

Dial

40, 50 and 63 mm: white plastic, with pointer stop pin

80, 100 and 160 mm: white aluminium, with pointer stop pin

With black lettering



Pointer

Black plastic

160 mm only: black aluminium

Case

Black plastic

160 mm only: black finish steel

Window

Crystal-clear plastic, snap-fit

160 mm only: instrument glass

Bezel ring

Without bezel

160 mm only: black finish steel

Optional extras

- Other pressure connection
- Black finish steel case
- Slip-on bezel

Back pressure entry see data sheet PM 01.09

Panel mounting, back pressure entry see data sheet PM 01.10

* for stock instruments or as option: class 1.6

Special versions

For closed central heating

63 and 80 mm, accuracy class 2.5
With red mark pointer and adjustable green sector
Scale range 0 ... 4 bar, red mark at 2.5 or 3 bar

Refrigerant gauges 63 and 80 mm

(80 mm with black finish steel case, accuracy class 1.0)
Featuring scales in °C for refrigerants R 744, R 764, R 40, R 22 or R 134 a

Refrigerant field service gauges

80 mm with black finish steel case, accuracy class 1.0
Featuring SAE flare connection, knife edge pointer, scales in °C for refrigerants R 22, R 134 a and R 404 A

Tyre inflation gauges with EEC approval mark

80 mm with black finish steel case
Scale ranges 0 ... 4 and 0 ... 10 bar

For domestic central heating

80, 100 and 160 mm, accuracy class 2.5
Scale ranges 0 ... 0.6 or 0 ... 1 bar with retard scale spacing and red mark pointer

For water-level-indicator and central heating

80, 100 and 160 mm, accuracy class 2.5
Scale ranges 0 ... 0.6 to 0 ... 40 bar with 2nd scale of mWS (metres of water)

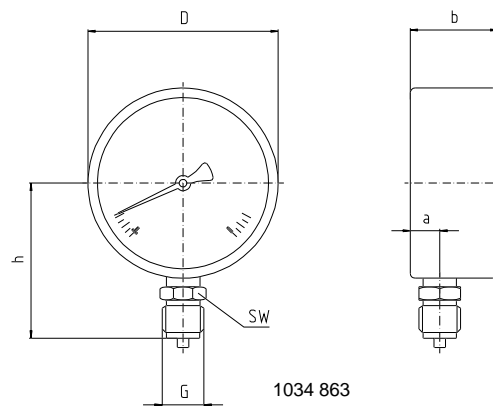
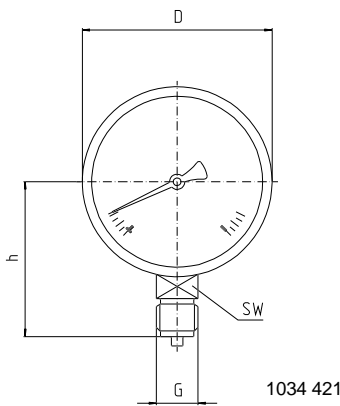
Dimensions

Standard versions

Radial bottom pressure connection

40, 50, 63 and 160 mm

80 and 100 mm



Nominal size	Dimensions [mm]						Weight [kg]
	a	b ± 0.5	D	G	h ± 1	SW	
40	8	24	41	G 1/8 B	36	12	0.06
50	10	27,5	49	G 1/4 B	45	14	0.10
63	10	27,5	62	G 1/4 B	53.5	14	0.13
80	11.5	30	79	G 1/2 B	72	22	0.18
100	11.5	30	99	G 1/2 B	83.5	22	0.21
160	15.5	41.5	160	G 1/2 B	115.5	22	0.85

Standard pressure entry with parallel thread and seating to EN 837-1 /7.3

Ordering information

State:

Pressure gauge model / Nominal size / Scale range / Size of connection / Optional extras required

Specifications and dimensions given in this leaflet represent the state of engineering at the time of printing. Modifications may take place and materials specified may be replaced by others without prior notice.

WIKA Alexander Wiegand GmbH & Co.

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http://www.wika.de · E-mail: info@wika.de





Bourdon Tube Pressure Gauges

Stainless Steel Case

Stainless Steel Wetted Parts

Accuracy $\pm 3/2/3\%$ - Grade B

Industrial Series • Dry Case • Model 232.53A

• Liquid Filled • Model 233.53A

Pressure Gauges

Application

Suitable for corrosive environments compatible with 316 stainless steel wetted parts, dry and liquid fillable case, where vibration and/or pulsation occur in liquid or gaseous media which will not obstruct the pressure system.

Sizes

4" (100 mm)

Accuracy

$\pm 3/2/3\%$ of span (ASME B40.1 Grade B)

Ranges (All ranges not stocked)

Pressure from 30 PSI to 15,000 PSI
or other equivalent units

Working Range

Steady: 3/4 of full scale value

Fluctuating: 2/3 of full scale value

Short time: full scale value

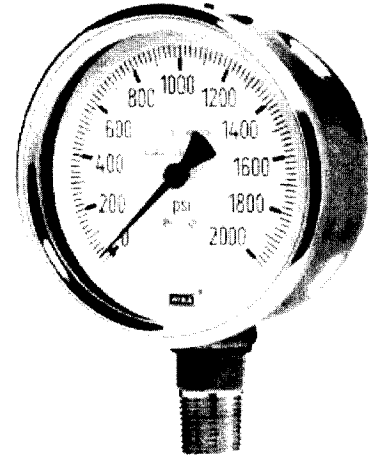
Operating Temperature

Ambient: -40°F to 140°F (-40°C to 60°C) ^{NOTE 1}

Media: max. 212°F (+100°C)

Temperature Error

Additional error when temperature changes from reference temperature of 68°F (20°C) $\pm 0.3\%$ for every 18°F (10°C) rising or falling. Percentage of span.



Standard Features

Connection

Material: 316 stainless steel

Lower mount (LM)

1/4" NPT or 1/2" NPT

Bourdon Tube

Material: 316 stainless steel

30 PSI to 1,000 PSI: C-type

1,500 to 15,000 PSI: Helical type

Movement

Stainless steel

Dial

White aluminum with black lettering

Pointer

Black aluminum

Case

304 stainless steel with vent plug and SS crimping ring.

Case welded to socket.

Weather Protection

Weather resistant (IP 54) - dry

Weather-tight (IP 65) - liquid-filled

Standard Scales (other scales available upon request)

PSI, PSI/kPa, kPa

Window Gasket

Buna-N

Window

Acrylic

Case Filling

None filled - 232.53A

Filled - 233.53A

ORDER OPTIONS (min. order may apply)

Custom dial layout

Rear flange

316 SS threaded restrictor

Other pressure scales available:

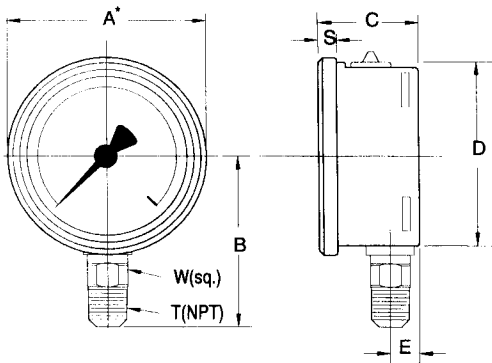
Bar, kPa, Kg/cm², °C and dual scales

Note 1 Temperature Ranges (Liquid filled gauges)

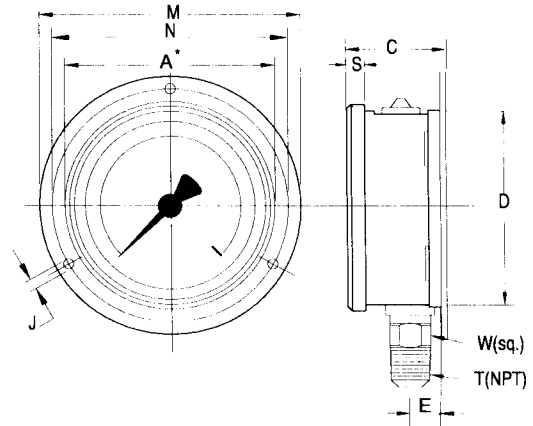
Glycerine: -4°F to 140°F (-20°C to 60°C)

Silicone: -49°F to 140°F (-45°C to 60°C)

Glycerine/H₂O: -49°F to 140°F (-45°C to 60°C)



2XX.53A LM



2XX.53A LM/RF

A* NOMINAL SIZE

TYPE/SIZE	WEIGHT	KEY	A*	B	C	D	E	J	M	N	S	T	W
23X.53A 4"	1.10 lbs.	mm	100	87 ¹	48	100	15.5	4.8	132	116	8	--	22
		in	4	3.43 ¹	1.89	3.94	0.61	0.19	5.20	4.57	0.31	1/2"	0.87

¹ For 4" gauges with 1/4" NPT connections, B* dimension changes to 82 mm (3.23 in.).

Ordering Information:

State computer part number (if available) / type number / size / range / connection size and location / options required.

WIKA reserves the right to make design changes without prior notice.

WIKA Instrument Head Office

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<http://www.wika.ca>



Bourdon Tube Pressure Gauges

Field Repairable

All Stainless Steel Construction

Process Industry Series Liquid Fillable • Type 23x.54

Pressure Gauges

Application

Suitable for corrosive environments compatible with 316 stainless steel wetted parts, dry and liquid fillable case, where vibration and/or pressure pulsation occur in liquid or gaseous media which will not obstruct the pressure system. Ideal for pressure gauge / chemical seal combinations where recalibration is required.

Sizes

2½" & 4" (63 & 100mm)

Accuracy

2½": ±1.5% of span

4": ±1.0% of span (ASME B40.1 Grade 1A)

Ranges (All ranges not stocked)

Vacuum / Compound to 30"HG / 0 / 200 PSI

Pressure from 15 PSI to 15,000 PSI

or other equivalent units of pressure or vacuum

Receiver scales 3...15 PSI

Ammonia: 30 "Hg/0/150 PSI (84°F)

30 "Hg/6/300 PSI (126°F)

Working Range

2½" Steady: 3/4 of full scale value
Fluctuating: 2/3 of full scale value
Short time: full scale value

4" Steady: Full scale value
Fluctuating: 0.9 x full scale value
Short time: 1.3 x full scale value

Operating Temperature

Ambient: -40°F to 140°F (-40°C to 60°C) ^{Note 1}

Media: max. 212°F (+100°C)

Temperature Error

Additional error when temperature changes from reference temperature of 68°F (20°C) ±0.4% for every 18°F (10°C) rising or falling. Percentage of span.

Standard Features

Connection

Material: 316 stainless steel

Lower mount (LM)

Center back mount (CBM) 2½"

Lower back mount (LBM) 4"

1/4" NPT or 1/2" NPT limited to wrench flat area

Bourdon Tube

Material: 316 stainless steel

30"Hg (Vac) to 1000 PSI C-type (2½")

30"Hg (Vac) to 1500 PSI C-type (4" & 4½")

1500 PSI to 15,000 PSI helical type (2½")

2000 PSI to 15,000 PSI helical type (4" & 4½")

Movement

300-series stainless steel

Dial

White aluminum with black lettering. 2½" with stop pin.

Pointer

Black aluminum, friction adjustable (must remove bezel/window to access; not accessible with liquid filling)

Case

304 stainless steel with vent plug and polished stainless steel bayonet ring. Welded case/socket connection



Weather Protection

Weather resistant (NEMA 3 / IP 54) - dry case

Weather tight (NEMA 4X / IP 65) - liquid-filled case

Standard Scale

PSI, PSI/BAR, PSI/KG/CM²

Receiver: 0/100% linear 0/10 sq. rt.

Ammonia: PSI/°F

Window Gasket

Buna-N

Window

Laminated safety glass

Case Filling

232.54 - none

233.54 - glycerine

ORDER OPTIONS (min. order may apply)

Improved accuracy to ±0.5% of span (4" only)

Custom dial layout

Front flange stainless steel polished

Rear flange stainless steel

Steel zinc plated u-clamp bracket (field installable)

Stainless steel u-clamp bracket (field installable)

316 SS threaded restrictor

Silicone or fluorolube case filling (**Type 233.54**) ^(NOTE 1)

Acrylic or flat glass window

Special connections limited to wrench flat area

Other pressure scales available:

Bar, kPa, MPa, Kg/cm² and dual scales

DIN standards

Cleaned for oxygen service

Externally adjustable red drag pointer (max. hand)

Externally adjustable red mark pointer (set pointer)

Chemical seals available

Note 1 Temperature Ranges (Liquid filled gauges)

Glycerine: -4°F to 140°F (-20°C to 60°C)

Silicone: -40°F to 140°F (-40°C to 60°C)

APM 23X.54
(APM 02.14)



Pressure Transmitters

Industrial Grade • Ranges 10 INWC to 25 INWC • Model 891.13.501

• Ranges 50 INWC to 300 PSI • Model 891.13.500

• Ranges 400 PSI to 40,000 PSI • Model 891.23.510

Tronic

WIKA piezoresistive and thin film pressure transmitters are precision engineered to fit the majority of industrial pressure measurement applications. Each unit undergoes quality control testing and calibration to achieve an accuracy of 0.25% full scale. The printed circuit board uses state-of-the-art surface mount technology and is potted in silicone gel for protection against vibration, shock and humidity. Each unit is temperature compensated to assure accuracy and long term stability under severe ambient temperature variations.

The compact design provides a rugged transmitter suitable for various applications in hydraulics & pneumatics, vacuum, test equipment, liquid level measurement, press control, compressor control, pump protection and numerous other processing and control operations.

Specifications for the 891.13.500 (vacuum, compound and ranges to 0-300 PSI) and 891.23.510 (0-400 PSI and higher) are given below. The 891.13.501 is an extremely low pressure version suitable for dry, inert media.

RANGE	STANDARD RANGES	
	MAXIMUM*	BURST**
Model 891.13.501		
0-10 INWC	100 INWC	100 INWC
0-15 INWC	100 INWC	100 INWC
0-25 INWC	100 INWC	100 INWC
Model 891.13.500		
30"-0 HgVac	70 PSI	70 PSI
30"-0-30 PSIG	250 PSI	250 PSI
30"-0-60 PSIG	500 PSI	500 PSI
30"-0-100 PSIG	500 PSI	500 PSI
30"-0-160 PSIG	500 PSI	500 PSI
30"-0-200 PSIG	1100 PSI	1100 PSI
0-50 INWC	30 PSI	30 PSI
0-100 INWC	30 PSI	30 PSI
0-5 PSIG	30 PSI	30 PSI
0-10 PSIG	60 PSI	60 PSI
0-15 PSIG(A)	70 PSI	70 PSI
0-25 PSIG(A)	145 PSI	145 PSI
0-30 PSIG	145 PSI	145 PSI
0-50 PSIG(A)	250 PSI	250 PSI
0-60 PSIG	250 PSI	250 PSI
0-100 PSIG(A)	500 PSI	500 PSI
0-160 PSIG	500 PSI	500 PSI
0-200 PSIG	500 PSI	500 PSI
0-250 PSIG(A)	1100 PSI	1100 PSI
0-300 PSIG	1100 PSI	1100 PSI
Model 891.23.510		
0-400 PSIG	725 PSI	3600 PSI
0-500 PSIG(A)	1100 PSI	5800 PSI
0-600 PSIG	1100 PSI	5800 PSI
0-750 PSIG	1100 PSI	5800 PSI
0-1000 PSIG	1750 PSI	8000 PSI
0-1500 PSIG	2900 PSI	11,600 PSI
0-2000 PSIG	4600 PSI	14,500 PSI
0-3000 PSIG	4600 PSI	14,500 PSI
0-5000 PSIG	11,600 PSI	25,000 PSI
0-8000 PSIG	17,400 PSI	35,000 PSI
0-10,000 PSIG	17,400 PSI	35,000 PSI
0-15,000 PSIG	21,750 PSI	43,500 PSI

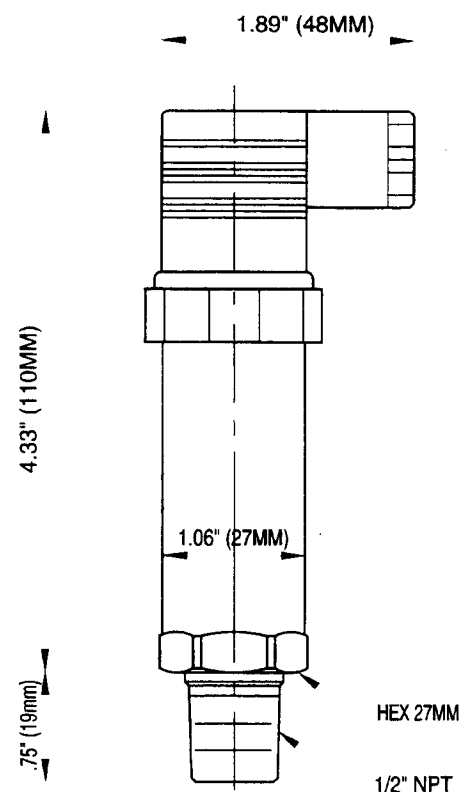
For higher pressures up to 100,000 PSI please contact factory

Notes:

* Maximum pressure, causing no permanent changes in specifications but may lead to adjustable zero and span shifts.

** Burst pressure, leading to permanent, non-adjustable changes in specifications (i.e. zero offsets) or destruction of transmitter.

(A) Standard ranges available with absolute pressure reference.



Specifications

Input

10-30 VDC
(14-30 VDC for 0-10V Output Signal)

Output & load limitations

4-20mA 2-wire $R_{(max)} = (V_s - 10V) / 0.02 A$
 0-5 V 3-wire $R_{(min)} = 5 k \text{ Ohm}$
 0-10 V 3-wire $R_{(min)} = 10 k \text{ Ohm}$
 0-100 mV 4-wire $R_{(min)} = 1000 k \text{ Ohm}$

Accuracy

Linearity (B.F.S.L.) $\leq 0.25\%$ of span
 Hysteresis $\leq 0.1\%$ of span
 Repeatability $\leq 0.05\%$ of span
 1 yr. stability $\leq 0.2\%$ of span
 Response time $\leq 1 \text{ ms}$
 (10-90% full scale)
 Zero & span adjustment Approximately +/- 5.0% full scale

Temperature

Temperature compensated (+32°F to 175°F) (0°C to 80°C)
 Media (-25°F to 212°F) (-30°C to 100°C)
 Ambient (-5°F to 175°F) (-20 to 80°C)
 Storage (-40°F to 212°F) (-40°C to 100°C)

Temperature error (reference temperature 70 °F)

On zero (% of span/18 °F) ≤ 0.2
 On span (% of span/18 °F) ≤ 0.2

Process connection

1/2" NPT
 See price sheet for other options

Electrical connection

DIN 43650 Solderless Screw Terminal
 (IP 65 / NEMA 5)
 See options under wiring

Material

Wetted parts 316 stainless steel
 (891.13.501 - 316 SS,
 aluminum, silicon, gold)
 Body material 304 stainless steel

Transmitting liquid

Silicone oil
 Fluorocarbon oil available for O₂ service

Electrical protection

Protected against reverse polarity, short circuit output
 and suppressor diode for high-voltage protection

Vibration protection

Internal electronics 100% potted in silicone gel

Shock and vibration resistance

Shock: 1000g, 1ms per DIN IEC 68-2
 Vibration: 15-2000 Hz, 15g per DIN IEC 68-2

Wiring

2-Wire Current Loop

SIGNAL	DIN PLUG	WIRE COLOR
Supply +	Pin 1	Brown
Signal -	Pin 2	Green

3-Wire Voltage Output

SIGNAL	DIN PLUG	WIRE COLOR
Supply +	Pin 1	Brown
Supply-Signal-	Pin 2	Green
Signal+	Pin 3	White

Use pin 4 or blue wire for shield



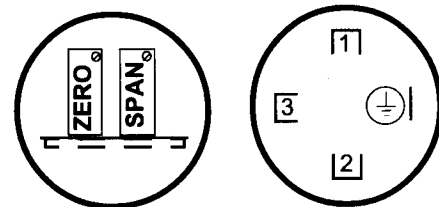
Electrical Connector Options

(Indicate connector part number in addition to transmitter part number or description.)

4 pin Mil Plug (PTO2E-8-4P IP65/NEMA 5)	8990935
6 pin Mil Plug (PTO2E-10-6P IP65/NEMA 5)	9744460
1.5 meter cable with free end (IP67 / NEMA 4)	9744479
DIN 43650 w/ 1/2" NPTF conduit connection (IP 65/NEMA 5)	1632159
DIN 43650 w/ integral 2 meter cable (IP 65 / NEMA 5)	9734821
DIN 43650 w/ integral RFI protection (IP 65 / NEMA 5)	1242733

All WIKA transmitters are calibrated at the factory. In the event calibration is required as a maintenance procedure, please use the following steps:

1. Remove cap
2. Set zero pot
3. Test zero
4. Set span pot
5. Test span
6. Replace cap



Ordering Information:

State computer part number (if available) / model number / range / output / connections required. See price sheet for special options.

WIKA reserves the right to make design changes without prior notice.

WIKA Instrument Head Office

WIKA Instruments Canada Ltd.
 9220 - 25 Avenue, Edmonton, Alberta T6N 1E1
 TEL (780) 438-6662 FAX (780) 437-0889

WIKA Branch Office

1535 Meyerside Drive, Unit #6
 Mississauga, Ontario L5T 1M9
 TEL (905) 795-1677 Fax (905) 795-1669
<http://www.wika.ca>

ENERFLEX

QC DATA

Certificate of Inspection Permit

ENERFLEX SYSTEMS LTD, EFX COMPRESSION
4700 47 STREET SE

CALGARY, AB
T2B 3R1

PREFERRED RE-INSP. INTERVAL: Yr.

YEAR BUILT: 2006

CRN: R0780.2

SERIAL #: 051378-01

VOLUME: 0.249 M3

HEATING SURFACE:

SURFACE AREA:

COMPANY CODE:

DESCRIPTION: STAGE 1 DISCHARGE BOTTLE

LOCATION: STOCK, CALGARY

MANUFACTURER: ENERFLEX SYSTEMS LTD, EFX COMPRESSION

Safety Valves _____

PART	MAX. AUTHORIZED WORKING PRESSURE	MAX. TEMP	MIN. TEMP	VALVE ID	SETTING	CAPACITY	LOCATION
VESSEL	8908 KPA	177 C	-29 C	SV1			TO BE INSTALLED

OWNER INSTRUCTIONS/REMARKS:

NOT SUBJECT TO ANNUAL FEES AS PER INFORMATION BULLETIN IB03-003 (e)(iii)
PRESSURE VESSELS HAVING A VOLUME NOT EXCEEDING 0.5 M3 (500 LITRES) THAT ARE DESIGNATED FOR THE FOLLOWING USES: SUCTION, DISCHARGE, SCRUBBER OR PULSATION VESSELS FOR COMPRESSORS;

Owner to verify integrity of vessel by periodic inspection program.

Verify that vessel/boiler is protected by an acceptable ASME Code pressure relief device, of adequate capacity, set at no more than maximum pressure authorized and installed in accordance with the Safety Codes Act & Regulations.

Vessel/Boiler to be installed in accordance with the Safety Codes Act and Regulations.

Safety Codes Officer: GORMAN, PAUL

Signature: 

NOTE: REQUIREMENTS OF THE SAFETY CODES ACT AND THE REGULATIONS ISSUED THEREUNDER:

The owner or person in charge shall report all accidents involving Pressure Equipment to the district Safety Codes Officer immediately and shall send a full report in writing to the Administrator as required by the Act. No repairs or alterations may be made unless authorized by a Safety Codes Officer.

Certificate of Inspection Permit

ENERFLEX SYSTEMS LTD, EFX COMPRESSION
4700 47 STREET SE

CALGARY, AB
T2B 3R1

PREFERRED RE-INSP. INTERVAL: 1.00 Yr.

YEAR BUILT: 2006

CRN: R8707.2

SERIAL #: 060083-01

VOLUME: 0.991 M3

HEATING SURFACE:

SURFACE AREA:

COMPANY CODE:

DESCRIPTION: STAGE 1 SUCTION SCRUBBER

LOCATION: STOCK, CALGARY

MANUFACTURER: ENERFLEX SYSTEMS LTD, EFX COMPRESSION

Safety Valves _____

PART	MAX. AUTHORIZED WORKING PRESSURE	MAX. TEMP	MIN. TEMP	VALVE ID	SETTING	CAPACITY	LOCATION
VESSEL	9067 KPA	149 C	-29 C	SV1			TO BE INSTALLED

OWNER INSTRUCTIONS/REMARKS:

Contact the ABSA Safety Codes Officer before placing the vessel/boiler in service.

Verify that vessel/boiler is protected by an acceptable ASME Code pressure relief device, of adequate capacity, set at no more than maximum pressure authorized and installed in accordance with the Safety Codes Act & Regulations.

Vessel/Boiler to be installed in accordance with the Safety Codes Act and Regulations.

Safety Codes Officer: GORMAN, PAUL

Signature: 

NOTE: REQUIREMENTS OF THE SAFETY CODES ACT AND THE REGULATIONS ISSUED THEREUNDER:

The owner or person in charge shall report all accidents involving Pressure Equipment to the district Safety Codes Officer immediately and shall send a full report in writing to the Administrator as required by the Act. No repairs or alterations may be made unless authorized by a Safety Codes Officer.

Certificate of Inspection Permit

ENERFLEX SYSTEMS LTD, EFX COMPRESSION
4700 47 STREET SE

CALGARY, AB
T2B 3R1

PREFERRED RE-INSP. INTERVAL: Yr.

YEAR BUILT: 2006

CRN: L7030.2

SERIAL #: 060373-01

VOLUME: 0.017 M3

HEATING SURFACE:

SURFACE AREA:

COMPANY CODE:

DESCRIPTION: FUEL GAS SCRUBBER

LOCATION: STOCK, CALGARY

MANUFACTURER: ENERFLEX SYSTEMS LTD, EFX COMPRESSION

Safety Valves

PART	MAX. AUTHORIZED WORKING PRESSURE	MAX. TEMP	MIN. TEMP	VALVE ID	SETTING	CAPACITY	LOCATION
VESSEL	1965 KPA	38 C	-29 C	SV1			TO BE INSTALLED

OWNER INSTRUCTIONS/REMARKS:

NOT SUBJECT TO ANNUAL FEES AS PER INFORMATION BULLETIN IB03-003 (e) (v)
PRESSURE VESSELS HAVING A VOLUME NOT EXCEEDING 0.5 M3 (500 LITRES) THAT ARE DESIGNATED FOR THE
FOLLOWING USES: FUEL GAS SCRUBBERS;

Owner to verify integrity of vessel by periodic inspection program.

Vessel/Boiler to be installed in accordance with the Safety Codes Act and Regulations.

Verify that vessel/boiler is protected by an acceptable ASME Code pressure relief device, of adequate capacity, set at no more than maximum pressure authorized and installed in accordance with the Safety Codes Act & Regulations.

Safety Codes Officer: GORMAN, PAUL

Signature: _____



NOTE: REQUIREMENTS OF THE SAFETY CODES ACT AND THE REGULATIONS ISSUED THEREUNDER:

The owner or person in charge shall report all accidents involving Pressure Equipment to the district Safety Codes Officer immediately and shall send a full report in writing to the Administrator as required by the Act. No repairs or alterations may be made unless authorized by a Safety Codes Officer.

Certificate of Inspection Permit

ENERFLEX SYSTEMS LTD, EFX COMPRESSION
4700 47 STREET SE

CALGARY, AB
T2B 3R1

PREFERRED RE-INSP. INTERVAL: 1.00 Yr.

YEAR BUILT: 2006

CRN: R7478.2

SERIAL #: 060079-01

VOLUME: 0.677 M3

HEATING SURFACE:

SURFACE AREA:

COMPANY CODE:

DESCRIPTION: SUCTION SCRUBBER

LOCATION: STOCK, CALGARY

MANUFACTURER: ENERFLEX SYSTEMS LTD, EFX COMPRESSION

Safety Valves

PART	MAX. AUTHORIZED WORKING PRESSURE	MAX. TEMP	MIN. TEMP	VALVE ID	SETTING	CAPACITY	LOCATION
VESSEL	9067 KPA	149 C	-29 C	SV1			TO BE INSTALLED

OWNER INSTRUCTIONS/REMARKS:

Vessel/Boiler to be installed in accordance with the Safety Codes Act and Regulations.

Contact the ABSA Safety Codes Officer before placing the vessel/boiler in service.

Verify that vessel/boiler is protected by an acceptable ASME Code pressure relief device, of adequate capacity, set at no more than maximum pressure authorized and installed in accordance with the Safety Codes Act & Regulations.

Safety Codes Officer: GORMAN, PAUL

Signature: _____



NOTE: REQUIREMENTS OF THE SAFETY CODES ACT AND THE REGULATIONS ISSUED THEREUNDER:

The owner or person in charge shall report all accidents involving Pressure Equipment to the district Safety Codes Officer immediately and shall send a full report in writing to the Administrator as required by the Act. No repairs or alterations may be made unless authorized by a Safety Codes Officer.

Certificate of Inspection Permit

BTB COMPRESSION LIMITED
4700 47 STREET SE

CALGARY, AB
T2B 3R1

PREFERRED RE-INSP. INTERVAL: _____ Yr.

YEAR BUILT: 2006

CRN: R0778.2

SERIAL #: 051388-01

VOLUME: 0.133 M3

HEATING SURFACE:

SURFACE AREA:

COMPANY CODE:

DESCRIPTION: STAGE TWO SUCTION BOTTLE

LOCATION: STOCK, CALGARY

MANUFACTURER: ENERFLEX SYSTEMS LTD, EFX COMPRESSION

Safety Valves _____

PART	MAX. AUTHORIZED WORKING PRESSURE	MAX. TEMP	MIN. TEMP	VALVE ID	SETTING	CAPACITY	LOCATION
VESSEL	9067 KPA	149 C	-29 C	SV1			TO BE INSTALLED

OWNER INSTRUCTIONS/REMARKS:

NOT SUBJECT TO ANNUAL FEES AS PER INFORMATION BULLETIN IB03-003 (e)(iii)
PRESSURE VESSELS HAVING A VOLUME NOT EXCEEDING 0.5 M3 (500 LITRES) THAT ARE DESIGNATED FOR THE FOLLOWING USES: SUCTION, DISCHARGE, SCRUBBER OR PULSATION VESSELS FOR COMPRESSORS;

Owner to verify integrity of vessel by periodic inspection program.

Verify that vessel/boiler is protected by an acceptable ASME Code pressure relief device, of adequate capacity, set at no more than maximum pressure authorized and installed in accordance with the Safety Codes Act & Regulations.

Vessel/Boiler to be installed in accordance with the Safety Codes Act and Regulations.

Safety Codes Officer: BOLT, LARRY

Signature: 

NOTICE: REQUIREMENTS OF THE SAFETY CODES ACT AND THE REGULATIONS ISSUED THEREUNDER:

The owner or person in charge shall report all accidents involving Pressure Equipment to the district Safety Codes Officer immediately and shall send a full report in writing to the Administrator as required by the Act. No repairs or alterations may be made unless authorized by a Safety Codes Officer.

Certificate of Inspection Permit

ENERFLEX SYSTEMS LTD, EFX COMPRESSION
4700 47 STREET SE

CALGARY, AB
T2B 3R1

PREFERRED RE-INSP. INTERVAL: Yr.
YEAR BUILT: 2006
CRN: R7655.2
SERIAL #: 060103-01
VOLUME: 0.105 M3
HEATING SURFACE:
SURFACE AREA:

COMPANY CODE:
DESCRIPTION: STAGE 2 DISCHARGE BOTTLE
LOCATION: STOCK, CALGARY
MANUFACTURER: ENERFLEX SYSTEMS LTD, EFX COMPRESSION

Safety Valves _____

PART	MAX. AUTHORIZED WORKING PRESSURE	MAX. TEMP	MIN. TEMP	VALVE ID	SETTING	CAPACITY	LOCATION
VESSEL	13341 KPA	177 C	-29 C	SV1			TO BE INSTALLED

OWNER INSTRUCTIONS/REMARKS:

NOT SUBJECT TO ANNUAL FEES AS PER INFORMATION BULLETIN IB03-003 (e)(iii)
PRESSURE VESSELS HAVING A VOLUME NOT EXCEEDING 0.5 M3 (500 LITRES) THAT ARE DESIGNATED FOR THE FOLLOWING USES: SUCTION, DISCHARGE, SCRUBBER OR PULSATION VESSELS FOR COMPRESSORS;

Owner to verify integrity of vessel by periodic inspection program.

Verify that vessel/boiler is protected by an acceptable ASME Code pressure relief device, of adequate capacity, set at no more than maximum pressure authorized and installed in accordance with the Safety Codes Act & Regulations.

Vessel/Boiler to be installed in accordance with the Safety Codes Act and Regulations.

Safety Codes Officer: GORMAN, PAUL

Signature:  _____

NOTE: REQUIREMENTS OF THE SAFETY CODES ACT AND THE REGULATIONS ISSUED THEREUNDER:

owner or person in charge shall report all accidents involving Pressure Equipment to the district Safety Codes Officer immediately and shall send a full report in writing to the Administrator as required by the Act. No repairs or alterations may be made unless authorized by a Safety Codes Officer.

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 Code Rules, Section VIII, Division 1

A 552650

1. Manufactured and certified by ENERFLEX SYSTEMS LTD., EFX COMPRESSION, 4700 47 STREET SE CALGARY, AB T2B 3R1
 (Name and address of Manufacturer)

Manufactured for ENERFLEX SYSTEMS LTD., EFX COMPRESSION, 4700 47 STREET SE CALGARY, AB T2B 3R1
 (Name and address of Purchaser)

3. Location of installation EFX COMPRESSION STOCK
 (Name and address)

4. Type SUCTION SCRUBBER 060079-01 R7478.231 V040239G REV 1 -- 2006
 (Horiz. or vert. tank) (Mfgr's serial No.) (CRN) (Drawing no.) (Nat'l Bd. No.) (Year built)

5. The chemical and physical properties of all parts meet the requirements of material specifications of the ASME BOILER AND PRESSURE VESSEL CODE. The design, construction, and workmanship conform to ASME Rules, Section VIII, Division 1 2004
 Year

to 2005 Addenda (Date) -- Code Case Nos. -- Special Service per UG 120(d) --

6. Shell: SA-516-70N 1.125" 0.125" 2' 3.75" 4' 7.19"
 Matl. (Spec. No., Grade) Nom. Thk. (in.) Corr. Allow. (in.) Diam. I.D. (ft. & in.) Length (overall) (ft. & in.)

7. Seams: TYPE 1 FULL 100 1150 1.50 TYPE 1 FULL* 100 1
 Long. (Welded, Dbl., Sngl., Lap, Butt) R.T. (Spot or Full) Eff. (%) H.T. Temp (°F) Time (hr) Girth (Welded, Dbl., Sngl., Lap, Butt) R.T. (Spot or Full) Eff (%) No. of Courses

8. Heads: (a) Matl. SA-516-70N (b) Matl. SA-516-70N
 (Spec No., Grade) (Spec No., Grade)

	Location (Top, Bottom, Ends)	Minimum Thickness	Corrosion Allowance	Crown Radius	Knuckle Radius	Elliptical Ratio	Conical Apex Angle	Hemispherical Radius	Flat Diameter	Side to Pressure (Convex or Concave)
(a)	TOP	1.125"	0.125"	--	--	2:1	--	--	--	CONCAVE
(b)	BOTTOM	1.125"	0.125"	--	--	2:1	--	--	--	CONCAVE

If removable, bolts used (describe other fastenings) --
 (Matl., Spec. No., Gr., Size, No.)

9. MAWP 1315 N/A psi at max. temp. 300 N/A °F
 (internal) (external) (internal) (external)

Min. design metal temp. -20 °F at 1315 psi. Hydro., pneu., or comb. Test pressure HYDRO AT 1710 psi.

10. Nozzles, inspection and safety valve openings:

Purpose (Inlet, Outlet, Drain)	No.	Diam. or Size	Type	Matl.	Nom. Thk.	Reinforcement Matl.	How Attached	Location
PROCESS INLET	1	6"	RFWN CL 600	SA105N/SA106B/SA234WPB	0.864"	SA-516-70N	FIG UW-16.1 (H)	SHELL
PROC OUTLET/INSP	1	4"	RFSO CL 600	SA105N	3.375"	--	FIG UW-16.1 (C)	HEAD
HLSD	1	2"	TOL	SA105N	CL 6000	--	FIG UW-16.1 (A)	SHELL
LEVEL CONTROLLER	1	2"	TOL	SA105N	CL 6000	--	FIG UW-16.1 (A)	SHELL
AUTO DUMP	1	1"	RFWN CL 600	SA105N/SA106B/SA234WPB	0.358"	--	FIG UW-16.1 (A)	SHELL
SCRUBBER DRAIN	1	1.5"	RFWN CL 600	SA105N/SA106B/SA234WPB	0.400"	--	FIG UW-16.1 (C)	HEAD
LEVEL INDICATOR	2	0.75"	TOL	SA105N	CL 6000	--	FIG UW-16.1 (A)	SH/HD
LEVEL INDICATOR	1	0.50"	TOL	SA105N	CL 6000	--	FIG UW-16.1 (A)	NOZZLE
PT, TE, GS	4	0.75"	TOL	SA105N	CL 6000	--	FIG UW-16.1 (A)	SHELL
INSPECTION	1	2"	TOL	SA105N	CL 6000	--	FIG UW-16.1 (A)	SHELL

11. Supports: Skirt YES Lugs 4 Legs N/A Other N/A Attached HEADS WELDED
 (Yes or No) (No.) (No.) (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 this report: NONE
 (Name of part, item number, Mfgr's name and identifying stamp)

SERVICE: SOUR GAS PSV ON PIPE AS PER UG-125
CONST. DRAWING NO.: V060079A REV 1 RADIOGRAPHY: *FULL PER UW-11(A)
TESTING: NO CHARPY IMPACT TEST REQUIRED PER UG-20(F) 1-5, UCS-66(A) & (B), & UCS-68(C) CUBIC CAPACITY: 23.9 CUBIC FEET

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 Code for Pressure Vessels, Section VIII, Division 1. "U" Certificate of Authorization No. 30961 expires APRIL 15, 2008.
 Date MAY 29, 2006 Co. name Enerflex Systems Ltd., EFX Compression Signed [Signature]
 (Manufacturer) (Representative)

CERTIFICATE OF SHOP/FIELD INSPECTION

Vessel constructed by Enerflex Systems Ltd., EFX Compression at CALGARY, ALBERTA, CANADA.
 I, the undersigned, holding a valid commission issued by The National Board of Boiler and Pressure Vessel Inspectors and the State or Province of ALBERTA and employed by ABSA have inspected the component described in this Manufacturer's Data Report on 31 MAY, 2006, and state that, to the best of my knowledge and belief, the manufacturer has constructed this pressure vessel in accordance with ASME Code, Section VIII, Division 1. By signing this certificate neither the Inspector nor his employer makes any warranty, expressed or implied, concerning the pressure vessel described in this Manufacturer's Data Report. Furthermore, neither the Inspector nor his 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 MAY 31 2006 Signed [Signature] Commissions 213-A ALBERTA
 (Authorized Inspector) (Nat'l Board. (incl. endorsements) State, Prov. and No.)

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 Code Rules, Section VIII, Division 1

A 544050

1. Manufactured and certified by ENERFLEX SYSTEMS LTD., EFX COMPRESSION, 4700 47 STREET SE CALGARY, AB T2B 3R1
 (Name and address of Manufacturer)

Manufactured for BTB COMPRESSION, 4700 47 STREET S.E. CALGARY, AB T2B 3R1
 (Name and address of Purchaser)

3. Location of installation BTB STOCK
 (Name and address)

4. Type STAGE TWO SUCTION BOTTLE 051388-01 R0778.213 115508 REV 0 -- 2006
 (Horiz. or vert. tank) (Mfgr's serial No.) (CRN) (Drawing no.) (Nat'l Bd. No.) (Year built)

5. The chemical and physical properties of all parts meet the requirements of material specifications of the ASME BOILER AND PRESSURE VESSEL CODE. The design, construction, and workmanship conform to ASME Rules, Section VIII, Division 1 2004
 Year

to -- -- --
 Addenda (Date) Code Case Nos. Special Service per UG 120(d)

6. Shell: SA-106B 0.688" 0.125" 0' 11.63" 6' 0"
 Matl. (Spec. No., Grade) Nom. Thk. (in.) Corr. Allow. (in.) Diam. I.D. (ft. & in.) Length (overall) (ft. & in.)

7. Seams: SMLS N/A 100 1150 1.25 TYPE 1 FULL*/100 1
 Long. (Welded, Dbl., Sngl., Lap, Butt) R.T. (Spot or Full) Eff. (%) H.T. Temp (°F) Time (hr) Girth (welded, Dbl., Sngl., Lap, Butt) R.T. (Spot, EFF %, or Full) No. of Courses

8. Heads: (a) Matl. SA-516-70N (b) Matl. SA-516-70N
 (Spec No., Grade) (Spec No., Grade)

	Location (Top, Bottom, Ends)	Minimum Thickness	Corrosion Allowance	Crown Radius	Knuckle Radius	Elliptical Ratio	Conical Apex Angle	Hemispherical Radius	Flat Diameter	Side to Pressure (Convex or Concave)
(a)	END	0.5625"	0.125"	--	--	2:1	--	--	--	CONCAVE
(b)	END	0.5625"	0.125"	--	--	2:1	--	--	--	CONCAVE

If removable, bolts used (describe other fastenings) --
 (Matl., Spec. No., Gr., Size, No.)

9. MAWP 1315 N/A psi at max. temp. 300 N/A °F
 (internal) (external) (internal) (external)

Min. design metal temp. -20 °F at 1315 psi. Hydro., pneu., or comb. Test pressure HYDRO AT 1710 psi.

10. Nozzles, inspection and safety valve openings:

Purpose (Inlet, Outlet, Drain)	No.	Diam. or Size	Type	Matl.	Nom. Thk.	Reinforcement Matl.	How Attached	Location
INLET/INSPECTION	1	4"	RFWN CL 600	SA105N/SA106B	0.531"	SA-516-70N	FIG UW-16.1 (H)	SHELL
OUTLET	2	4"	RFWN CL 1500	SA105N/SA106B	0.531"	SA-516-70N	FIG UW-16.1 (H)	SHELL
INSPECTION	1	0.75"	TOL	SA105N	CL 6000	--	FIG UW-16.1 (A)	HEAD
--	--	--	--	--	--	--	--	--
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11. Supports: Skirt NO Lugs N/A Legs N/A Other N/A Attached N/A
 (Yes or No) (No.) (No.) (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 this report: NONE
 (Name of part, item number. Mfgr's name and identifying stamp)

SERVICE: SOUR GAS PSV ON PIPE AS PER UG-125
 CONST. DRAWING NO.: V051388A REV 2 RADIOGRAPHY: *FULL PER UW-11(A)
 TESTING: NO CHARPY IMPACT TEST REQUIRED PER UG-20(F) 1 THROUGH 5 CUBIC CAPACITY: 4.7 CUBIC FEET

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 Code for Pressure Vessels, Section VIII, Division 1. "U" Certificate of Authorization No. 30961 expires APRIL 15, 2008.
 Date APRIL 6, 2006 Co. name Enerflex Systems Ltd., EFX Compression Signed [Signature]
 (Manufacturer) (Representative)

CERTIFICATE OF SHOP/FIELD INSPECTION

Vessel constructed by Enerflex Systems Ltd., EFX Compression at CALGARY, ALBERTA, CANADA.
 I, the undersigned, holding a valid commission issued by The National Board of Boiler and Pressure Vessel Inspectors and the State or Province of ALBERTA and employed by ABSA have inspected the component described in this Manufacturer's Data Report on April 4, 2006, and state that, to the best of my knowledge and belief, the manufacturer has constructed this pressure vessel in accordance with ASME Code, Section VIII, Division 1. By signing this certificate neither the Inspector nor his employer makes any warranty, expressed or implied, concerning the pressure vessel described in this Manufacturer's Data Report. Furthermore, neither the Inspector nor his 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 06-04-11 Signed [Signature] Commissions ALBERTA #76
 (Authorized Inspector) (Nat'l Board. (incl. endorsements) State, Prov. and No.)

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 Code Rules, Section VIII, Division 1 (A) 552626

1. Manufactured and certified by ENERFLEX SYSTEMS LTD., EFX COMPRESSION, 4700 47 STREET SE CALGARY, AB T2B 3R1
 (Name and address of Manufacturer)

Manufactured for ENERFLEX SYSTEMS LTD., EFX COMPRESSION, 4700 47 STREET SE CALGARY, AB T2B 3R1
 (Name and address of Purchaser)

3. Location of installation EFX COMPRESSION STOCK
 (Name and address)

4. Type STAGE TWO DISCHARGE BOTTLE 060103-01 R7655.213 121887 REV 1 -- 2006
 (Horiz. or vert. tank) (Mfg'r's serial No.) (CRN) (Drawing no.) (Nat'l Bd. No.) (Year built)

5. The chemical and physical properties of all parts meet the requirements of material specifications of the ASME BOILER AND PRESSURE VESSEL CODE. The design, construction, and workmanship conform to ASME Rules, Section VIII, Division 1 2004
 Year

to 2005 -- --
 Addenda (Date) Code Case Nos. Special Service per UG 120(d)

6. Shell: SA-106B 1.00" 0.125" 0' 10.75" 5' 2"
 Matl. (Spec. No., Grade) Nom. Thk. (in.) Corr. Allow. (in.) Diam. I.D. (ft. & in.) Length (overall) (ft. & in.)

7. Seams: SMLS N/A 100 1150 1.25 TYPE 1 FULL* 100 1
 Long. (Welded, Dbl., Sngl., Lap, Butt) R.T. (Spot or Full) Eff. (%) H.T. Temp (°F) Time (hr) Girth (Welded, Dbl., Sngl., Lap, Butt) R.T. (Spot, or Full) Eff (%) No. of Courses

8. Heads: (a) Matl. SA-516-70N (b) Matl. SA-516-70N
 (Spec No., Grade) (Spec No., Grade)

	Location (Top, Bottom, Ends)	Minimum Thickness	Corrosion Allowance	Crown Radius	Knuckle Radius	Elliptical Ratio	Conical Apex Angle	Hemispherical Radius	Flat Diameter	Side to Pressure (Convex or Concave)
(a)	END	0.875"	0.125"	--	--	2:1	--	--	--	CONCAVE
(b)	END	0.875"	0.125"	--	--	2:1	--	--	--	CONCAVE

If removable, bolts used (describe other fastenings) --
 (Matl., Spec. No., Gr., Size, No.)

9. MAWP 1935 N/A psi at max. temp. 350 N/A °F
 (internal) (external) (internal) (external)

Min. design metal temp. -20 °F at 1935 psi. Hydro., pneu., or comb. Test pressure HYDRO AT 2516 psi.

10. Nozzles, inspection and safety valve openings:

Purpose (Inlet, Outlet, Drain)	No.	Diam. or Size	Type	Matl.	Nom. Thk.	Reinforcement Matl.	How Attached	Location
INLET	2	4"	RFWN CL 1500	SA105N/SA106B	0.674"	SA-516-70N	FIG UW-16.1 (H)	SHELL
OUTLET	1	3"	RFWN CL 900	SA105N/SA106B	0.438"	SA-516-70N	FIG UW-16.1 (H)	HEAD
INSPECTION	2	0.75"	TOL	SA105N	CL 6000	--	FIG UW-16.1 (A)	HD/SH
DRAIN	1	0.75"	TOL	SA105N	CL 6000	--	FIG UW-16.1 (A)	SHELL
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
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11. Supports: Skirt NO Lugs N/A Legs N/A Other N/A Attached N/A
 (Yes or No) (No.) (No.) (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 this report: NONE
 (Name of part, item number. Mfg'r's name and identifying stamp)

SERVICE: SOUR GAS PSV ON PIPE AS PER UG-125
CONST. DRAWING NO.: V060103A REV 1 RADIOGRAPHY: *FULL PER UW-11(A)
TESTING: NO CHARPY IMPACT TEST REQUIRED PER UG-20(F) 1 THROUGH 5 CUBIC CAPACITY: 3.7 CUBIC FEET

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 Code for Pressure Vessels, Section VIII, Division 1. "U" Certificate of Authorization No. 30961 expires APRIL 15, 2008.
 Date MAY 19, 2006 Co. name Enerflex Systems Ltd., EFX Compression Signed [Signature]
 (Manufacturer) (Representative)

CERTIFICATE OF SHOP/FIELD INSPECTION

Vessel constructed by Enerflex Systems Ltd., EFX Compression at CALGARY, ALBERTA, CANADA.
 I, the undersigned, holding a valid commission issued by The National Board of Boiler and Pressure Vessel Inspectors and the State or Province of ALBERTA and employed by ABSA have inspected the component described in this Manufacturer's Data Report on 24 MAY, 2006, and state that, to the best of my knowledge and belief, the manufacturer has constructed this pressure vessel in accordance with ASME Code, Section VIII, Division 1. By signing this certificate neither the Inspector nor his employer makes any warranty, expressed or implied, concerning the pressure vessel described in this Manufacturer's Data Report. Furthermore, neither the Inspector nor his 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 MAY 24 2006 Signed [Signature] Commissions 213 A ALBERTA
 (Authorized Inspector) (Nat'l Board. (incl. endorsements) State, Prov. and No.)

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 Code Rules, Section VIII, Division 1

A 552597

1. Manufactured and certified by ENERFLEX SYSTEMS LTD., EFX COMPRESSION, 4700 47 STREET SE CALGARY, AB T2B 3R1
 (Name and address of Manufacturer)

Manufactured for ENERFLEX SYSTEMS LTD., EFX COMPRESSION, 4700 47 STREET SE CALGARY, AB T2B 3R1
 (Name and address of Purchaser)

3. Location of installation EFX COMPRESSION STOCK
 (Name and address)

4. Type STAGE ONE DISCHARGE BOTTLE 051378-01 R0780.213 115507 REV 0 -- 2006
 (Horiz. or vert. tank) (Mfr's serial No.) (CRN) (Drawing no.) (Nat'l Bd. No.) (Year built)

5. The chemical and physical properties of all parts meet the requirements of material specifications of the ASME BOILER AND PRESSURE VESSEL CODE. The design, construction, and workmanship conform to ASME Rules, Section VIII, Division 1 2004
 Year

to -- Addenda (Date) -- Code Case Nos. -- Special Service per UG 120(d) --

6. Shell: SA-516-70N 0.750" 0.125" 1' 4.5" 5' 2"
 Matl. (Spec. No., Grade) Nom. Thk. (in.) Corr. Allow. (in.) Diam. I.D. (ft. & in.) Length (overall) (ft. & in.)

7. Seams: TYPE 1 FULL 100 1150 1.25 TYPE 1 FULL*/100 1
 Long. (Welded, Dbl., Sngl., Lap, Butt) R.T. (Spot or Full) Eff. (%) H.T. Temp (°F) Time (hr) Girth (welded, Dbl., Sngl., Lap, Butt) R.T. (Spot, EFF %, or Full) No. of Courses

8. Heads: (a) Matl. SA-516-70N (b) Matl. SA-516-70N
 (Spec No., Grade) (Spec No., Grade)

	Location (Top, Bottom, Ends)	Minimum Thickness	Corrosion Allowance	Crown Radius	Knuckle Radius	Elliptical Ratio	Conical Apex Angle	Hemispherical Radius	Flat Diameter	Side to Pressure (Convex or Concave)
(a)	END	0.750"	0.125"	--	--	2:1	--	--	--	CONCAVE
(b)	END	0.750"	0.125"	--	--	2:1	--	--	--	CONCAVE

If removable, bolts used (describe other fastenings) --
 (Matl., Spec. No., Gr., Size, No.)

9. MAWP 1292 N/A psi at max. temp. 350 N/A °F
 (internal) (external) (internal) (external)

Min. design metal temp. -20 °F at 1292 psi. Hydro., pneu., or comb. Test pressure HYDRO AT 1680 psi.

10. Nozzles, inspection and safety valve openings:

Purpose (Inlet, Outlet, Drain)	No.	Diam. or Size	Type	Matl.	Nom. Thk.	Reinforcement Matl.	How Attached	Location
INLET	2	6"	RFWN CL 600	SA105N/SA106B	0.864"	SA-516-70N	FIG UW-16.1 (H)	SHELL
OUTLET	1	4"	RFWN CL 600	SA105N/SA106B	0.531"	SA-516-70N	FIG UW-16.1 (H)	HEAD
INSPECTION	2	1.5"	TOL	SA105N	CL 6000	--	FIG UW-16.1 (A)	HD/SH
DRAIN	1	0.75"	TOL	SA105N	CL 6000	--	FIG UW-16.1 (A)	SHELL
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--

11. Supports: Skirt NO Lugs N/A Legs N/A Other N/A Attached N/A
 (Yes or No) (No.) (No.) (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 this report: NONE
 (Name of part, item number, Mfr's name and identifying stamp)

SERVICE: SOUR GAS PSV ON PIPE AS PER UG-125
 CONST. DRAWING NO.: V051378A REV 1 RADIOGRAPHY: *FULL PER UW-11(A)
 TESTING: NO CHARPY IMPACT TEST REQUIRED PER UG-20(F) 1 THROUGH 5 CUBIC CAPACITY: 8.8 CUBIC FEET

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 Code for Pressure Vessels, Section VIII, Division 1. "U" Certificate of Authorization No. 30961 expires APRIL 15, 2008.
 Date MAY 15, 2006 Co. name Enerflex Systems Ltd., EFX Compression Signed [Signature]
 (Manufacturer) (Representative)

CERTIFICATE OF SHOP/FIELD INSPECTION

Vessel constructed by Enerflex Systems Ltd. EFX Compression at CALGARY, ALBERTA, CANADA.
 I, the undersigned, holding a valid commission issued by The National Board of Boiler and Pressure Vessel Inspectors and the State or Province of ALBERTA and employed by ABSA have inspected the component described in this Manufacturer's Data Report on 16 MAY, 2006, and state that, to the best of my knowledge and belief, the manufacturer has constructed this pressure vessel in accordance with ASME Code, Section VIII, Division 1. By signing this certificate neither the Inspector nor his employer makes any warranty, expressed or implied, concerning the pressure vessel described in this Manufacturer's Data Report. Furthermore, neither the Inspector nor his 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 MAY 16 2006 Signed [Signature] Commissions 213 A ALBERTA
 (Authorized Inspector) (Nat'l Board. (incl. endorsements) State, Prov. and No.)

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 Code Rules, Section VIII, Division 1 (A) 552659

1. Manufactured and certified by ENERFLEX SYSTEMS LTD., EFX COMPRESSION, 4700 47 STREET SE CALGARY, AB T2B 3R1
 (Name and address of Manufacturer)

Manufactured for ENERFLEX SYSTEMS LTD., EFX COMPRESSION, 4700 47 STREET SE CALGARY, AB T2B 3R1
 (Name and address of Purchaser)

3. Location of installation EFX COMPRESSION STOCK
 (Name and address)

4. Type STAGE ONE SUCTION SCRUBBER 060083-01 R8707.213 112427 REV 0 -- 2006
 (Horiz. or vert. tank) (Mfgr's serial No.) (CRN) (Drawing no.) (Nat'l Bd. No.) (Year built)

5. The chemical and physical properties of all parts meet the requirements of material specifications of the ASME BOILER AND PRESSURE VESSEL CODE. The design, construction, and workmanship conform to ASME Rules, Section VIII, Division 1 2004
 Year

to 2005 -- --
 Addenda (Date) Code Case Nos. Special Service per UG 120(d)

6. Shell: SA-516-70N 1.375" 0.125" 2' 9.5" 4' 5.25"
 Matl. (Spec. No., Grade) Nom. Thk. (in.) Corr. Allow. (in.) Diam. I.D. (ft. & in.) Length (overall) (ft. & in.)

7. Seams: TYPE 1 FULL 100 1150 1.75 TYPE 1 FULL* 100 1
 Long. (Welded, Dbl., Sngl., Lap, Butt) R.T. (Spot or Full) Eff. (%) H.T. Temp (°F) Time (hr) Girth (Welded, Dbl., Sngl., Lap, Butt) R.T. (Spot, or Full) Eff (%) No. of Courses

8. Heads: (a) Matl. SA-516-70N (b) Matl. SA-516-70N
 (Spec No., Grade) (Spec No., Grade)

	Location (Top, Bottom, Ends)	Minimum Thickness	Corrosion Allowance	Crown Radius	Knuckle Radius	Elliptical Ratio	Conical Apex Angle	Hemispherical Radius	Flat Diameter	Side to Pressure (Convex or Concave)
(a)	TOP	1.250"	0.125"	--	--	2:1	--	--	--	CONCAVE
(b)	BOTTOM	1.250"	0.125"	--	--	2:1	--	--	--	CONCAVE

If removable, bolts used (describe other fastenings) --
 (Matl., Spec. No., Gr., Size, No.)

9. MAWP 1315 N/A psi at max. temp. 300 N/A °F
 (internal) (external) (internal) (external)

Min. design metal temp. -20 °F at 1315 psi. Hydro., pneu., or comb. T est pressure HYDRO AT 1710 psi.

10. Nozzles, inspection and safety valve openings:

Purpose (Inlet, Outlet, Drain)	No.	Diam. or Size	Type	Matl.	Nom. Thk.	Reinforcement Matl.	How Attached	Location
PROCESS INLET	1	8"	RFWN CL 600	SA105N/SA106B/SA234WPB	0.875"	SA-516-70N	FIG UW-16.1 (H)	SHELL
PROC OUTLET/INSP	1	6"	RFSO CL 600	SA350-LF2	4.000"	--	FIG UW-16.1 (C)	HEAD
HLSD	1	2"	TOL	SA105N	CL 6000	--	FIG UW-16.1 (A)	SHELL
LEVEL CONTROLLER	1	2"	TOL	SA105N	CL 6000	--	FIG UW-16.1 (A)	SHELL
AUTO DUMP	1	1"	RFWN CL 600	SA105N/SA106B/SA234WPB	0.358"	--	FIG UW-16.1 (A)	SHELL
SCRUBBER DRAIN	1	1.5"	RFWN CL 600	SA105N/SA106B/SA234WPB	0.400	--	FIG UW-16.1 (C)	HEAD
LEVEL INDICATOR	1	0.5"	TOL	SA105N	CL 6000	--	FIG UW-16.1 (A)	NOZZLE
LI, PT, TE	4	0.75"	TOL	SA105N	CL 6000	--	FIG UW-16.1 (A)	SH/HD
INSPECTION	1	2"	TOL	SA105N	CL 6000	--	FIG UW-16.1 (A)	SHELL
GS, GS	2	0.75"	TOL	SA105N	CL 6000	--	FIG UW-16.1 (A)	SHELL

11. Supports: Skirt YES Lugs 4 Legs N/A Other N/A Attached HEADS WELDED
 (Yes or No) (No.) (No.) (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 this report: NONE
 (Name of part, item number. Mfgr's name and identifying stamp)

SERVICE: SOUR GAS PSV ON PIPE AS PER UG-125
 CONST. DRAWING NO.: V060083A REV 1 RADIOGRAPHY: *FULL PER UW-11(A)
 TESTING: NO CHARPY IMPACT TEST REQUIRED PER UG-20(F) 1 THROUGH 5. UCS-66(A) & 66(B) CUBIC CAPACITY: 35 CUBIC FEET

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 Code for Pressure Vessels, Section VIII, Division 1. "U" Certificate of Authorization No. 30961 expires APRIL 15, 2008.
 Date JUNE 1, 2006 Co. name Enerflex Systems Ltd., EFX Compression Signed [Signature]
 (Manufacturer) (Representative)

CERTIFICATE OF SHOP/FIELD INSPECTION

Vessel constructed by Enerflex Systems Ltd. EFX Compression at CALGARY, ALBERTA, CANADA
 I, the undersigned, holding a valid commission issued by The National Board of Boiler and Pressure Vessel Inspectors and the State or Province of ALBERTA and employed by ABSA have inspected the component described in this Manufacturer's Data Report on JUNE 1, 2006, and state that, to the best of my knowledge and belief, the manufacturer has constructed this pressure vessel in accordance with ASME Code, Section VIII, Division 1. By signing this certificate neither the Inspector nor his employer makes any warranty, expressed or implied, concerning the pressure vessel described in this Manufacturer's Data Report. Furthermore, neither the Inspector nor his 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 JUN 01 2006 Signed [Signature] Commissions 213 A ALBERTA
 (Authorized Inspector) (Nat'l Board. (incl. endorsements) State, Prov. and No.)

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 Code Rules, Section VIII, Division 1 (A) 552522

1. Manufactured and certified by ENERFLEX SYSTEMS LTD., EFX COMPRESSION, 4700 47 STREET SE CALGARY, AB T2B 3R1
 (Name and address of Manufacturer)

Manufactured for ENERFLEX SYSTEMS LTD., EFX COMPRESSION, 4700 47 STREET SE CALGARY, AB T2B 3R1
 (Name and address of Purchaser)

3. Location of installation EFX COMPRESSION STOCK
 (Name and address)

4. Type FUEL GAS SCRUBBER 060373-01 L7030.213 C1972C REV 1 -- 2006
 (Horiz. or vert. tank) (Mfr's serial No.) (CRN) (Drawing no.) (Nat'l Bd. No.) (Year built)

5. The chemical and physical properties of all parts meet the requirements of material specifications of the ASME BOILER AND PRESSURE VESSEL CODE. The design, construction, and workmanship conform to ASME Rules, Section VIII, Division 1 2004
 Year

to 2005 -- --
 Addenda (Date) Code Case Nos. Special Service per UG 120(d)

6. Shell: SA-106B 0.258" 0.0625" 0' 5.05" 3' 7"
 Matl. (Spec. No., Grade) Nom. Thk. (in.) Corr. Allow. (in.) Diam. I.D. (ft. & in.) Length (overall) (ft. & in.)

7. Seams: SMLS N/A 100 N/A N/A TYPE 1 FULL*/100 1
 Long. (Welded, Dbl., Sngl., Lap, Butt) R.T. (Spot or Full) Eff. (%) H.T. Temp (°F) Time (hr) Girth (welded, Dbl., Sngl., Lap, Butt) R.T. (Spot, EFF %, or Full) No. of Courses

8. Heads: (a) Matl. SA-105N (b) Matl. SA-234-WPB
 (Spec No., Grade) (Spec No., Grade)

	Location (Top, Bottom, Ends)	Minimum Thickness	Corrosion Allowance	Crown Radius	Knuckle Radius	Elliptical Ratio	Conical Apex Angle	Hemispherical Radius	Flat Diameter	Side to Pressure (Convex or Concave)
(a)	TOP	0.9375"	0.0625"	--	--	2:1	--	--	--	CONCAVE
(b)	BOTTOM	0.2258"	0.0625"	--	--	2:1	--	--	--	CONCAVE

If removable, bolts used (describe other fastenings) --
 (Matl., Spec. No., Gr., Size, No.)

9. MAWP 285 N/A psi at max. temp. 100 N/A °F
 (internal) (external) (internal) (external)

Min. design metal temp. -20 °F at 285 psi. Hydro., pneu., or comb. Test pressure HYDRO AT 428 psi.

10. Nozzles, inspection and safety valve openings:

Purpose (Inlet, Outlet, Drain)	No.	Diam. or Size	Type	Matl.	Nom. Thk.	Reinforcement Matl.	How Attached	Location
INLET	1	1.5"	H.CPLG	SA105N	CL 3000	--	FIG UW-16.1 (C)	SHELL
OUTLET	1	1.5"	TOL	SA105N	CL 3000	--	FIG UW-16.1 (A)	SHELL
OUTLET	1	1.5"	TOL	SA105N	CL 3000	--	FIG UW-16.1 (A)	SHELL
INSP OPENING	1	5"	RFSO	SA105N	CL 150	--	DBL/FLT	HEAD
BOTTOM DRAIN	1	1"	TOL	SA105N	CL 3000	--	FIG UW-16.1 (A)	HEAD
LEVEL SWITCH	1	1.5"	TOL	SA105N	CL 3000	--	FIG UW-16.1 (A)	SHELL
LEVEL CONTROL	1	2"	TOL	SA105N	CL 3000	--	FIG UW-16.1 (A)	SHELL
AUTO DUMP/INSP	1	1"	TOL	SA105N	CL 3000	--	FIG UW-16.1 (A)	SHELL
UP LEVEL GAUGE	1	0.75"	TOL	SA105N	CL 6000	--	FIG UW-16.1 (A)	SHELL
VENT	1	0.5"	TOL	SA105N	CL 6000	--	FIG UW-16.1 (A)	HEAD

11. Supports: Skirt NO Lugs N/A Legs N/A Other N/A Attached N/A
 (Yes or No) (No.) (No.) (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 this report: NONE
 (Name of part, item number. Mfr's name and identifying stamp)

SERVICE: SWEET GAS PSV ON PIPE AS PER UG-125
 CONST. DRAWING NO.: V060373A REV 1 RADIOGRAPHY: *FULL PER UW-11(A)
 TESTING: NO CHARPY IMPACT TEST REQUIRED PER UG-20(F) 1 THROUGH 5 CUBIC CAPACITY: 0.6 CUBIC FEET

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 Code for Pressure Vessels, Section VIII, Division 1. "U" Certificate of Authorization No. 30961 expires APRIL 15, 2008.
 Date APRIL 7, 2006 Co. name Enerflex Systems Ltd., EFX Compression Signed [Signature]
 (Manufacturer) (Representative)

CERTIFICATE OF SHOP/FIELD INSPECTION

Vessel constructed by Enerflex Systems Ltd. EFX Compression at CALGARY, ALBERTA, CANADA.
 I, the undersigned, holding a valid commission issued by The National Board of Boiler and Pressure Vessel Inspectors and the State or Province of ALBERTA and employed by ABSA have inspected the component described in this Manufacturer's Data Report on 7 APRIL, 2006, and state that, to the best of my knowledge and belief, the manufacturer has constructed this pressure vessel in accordance with ASME Code, Section VIII, Division 1. By signing this certificate neither the Inspector nor his employer makes any warranty, expressed or implied, concerning the pressure vessel described in this Manufacturer's Data Report. Furthermore, neither the Inspector nor his 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 APR 07 2006 Signed [Signature] Commissions 213-A ALBERTA
 (Authorized Inspector) (Nat'l Board. (incl. endorsements) State, Prov. and No.)

FORM U-1A MANUFACTURER'S DATA REPORT FOR PRESSURE VESSELS
 (Alternative Form for Single Chamber, Completely Shop or Field Fabricated Vessels Only) **561309**
 As Required by the Provisions of the ASME Code Rules, Section VIII, Division 1

1. Manufactured and certified by AXH air-coolers, LLC, 401 E. Lowry Road, Claremore, Oklahoma 74017
 (Name and address of manufacturer)

2. Manufactured for ENERFLEX SYSTEMS LTD. 4700 - 47TH STREET SOUTHEAST, CALGARY, ALBERTA, CANADA T2B 3R1
 (Name and address of purchaser)

3. Location of installation UNKNOWN
 (Name and address)

4. Type: HORIZ. H. EXCHANGER 64468C.3 R2615.213 64468 IC-1 R0 2506 2006
 (Horiz. or vert. tank) (Mfr's serial No.) (CRN) (Drawing no.) (Nat'l Bd. No.) (Year built)

5. The chemical and physical properties of all parts meet the requirements of material specifications of the ASME BOILER AND PRESSURE VESSEL CODE. The design, construction, and workmanship conform to ASME Rules, Section VIII, Division 1 2004
 Year

6. Shell: TUBE & PLUG SA-516 70N FR 1 1/8" BK 1 1/8" .1250 FR 7 5/16" BK 7 5/16" 2' 11 3/4"
 Addenda (Date) Code Case Nos. Special Service per UG 120(d)
 Matl. (Spec. No., Grade) Nom. Thk. (in.) Corr. Allow. (in.) Diam. I.D. (ft. & in.) Length (overall) (ft. & in.)

7. Seams: CORNER JOINT SEE REMARKS 1.0 1150 1 1/4 SEE REMARKS *2
 Long. (Welded, Dbl., Sngl., Lap, Butt) R.T. (Spot or Full) Eff. (%) H.T. Temp (°F) Time (hr) Girth (Welded, Dbl., Sngl., Lap, Butt) R.T. (Spot, Partial, or Full) No. of Courses

8. Heads: (a) Matl. WRAPPERS: SA-516 70N (b) Matl. ENDS: SA-516 70N
 (Spec No., Grade) (Spec No., Grade)

	Location (Top, Bottom, Ends)	Minimum Thickness	Corrosion Allowance	Crown Radius	Knuckle Radius	Elliptical Ratio	Conical Apex Angle	Hemispherical Radius	Flat Diameter	Side to Pressure (Convex or Concave)
(a)	WRAPPERS	1 1/8"	.1250						**	FLAT
(b)	ENDS	7/8"	.1250						***	FLAT

If removable, bolts used (describe other fastenings) _____ (Matl., Spec. No., Gr., Size, No.)

9. MAWP _____ 1292 psi at max. temp. _____ 350 °F
 Min. design metal temp. _____ -20 °F at _____ 1292 psi. Hydro. test pressure _____ 1680 psi.

10. Nozzles, inspection and safety valve openings:

Purpose (Inlet, Outlet, Drain)	No.	Diam. or Size	Type	Matl.	Nom. Thk.	Reinforcement Matl.	How Attached	Location
INLET/OUTLET	2	6"	PIPE	SA-106 B	S/80	NONE	UW-16(a)	HEADER
VENT & TEMP	1	1"	CPLG	SA-105	6000#	NONE	UW-16(a)	HEADER
PLUGS	180	3/4-16	UNF 3A	SA-105				HEADER

11. Supports: Skirt NO Lugs _____ Legs _____ Other STRUCTURE Attached BOLTED
 (Yes or no) (No.) (No.) (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:
PSV SET @ 1270 PSI SCFM 19383
 (Name of part, item number, Mfr's name and identifying stamp)

*2 HEADERS ONE AT EACH END. **WRAPPERS FLAT DIAMETER 5 3/4" X 35 3/4". ***ENDS FLAT DIAMETER 5 3/4" X 5 1/16".
 90 TUBES SA-179 STL 5/8" O.D. .065 MW 24' LG. CONSTRUCTED IN ACCORD. W/APPENDIX 28. IMPACTS EXEMPT PER UCS 66(a) CURVE D.
 PRESSURE RELIEF DEVICE BY OTHERS. X-RAYS PER CUSTOMER SPECS. ENERFLEX TAG NO. 060158-ENCANA. HDR VOL.: 990 CU. IN.

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 Code for Pressure Vessels, Section VIII, Division 1. "U" Certificate of Authorization No. 34.950 expires 2/07/2008.

Date 5/18/06 Co. Name AXH air-coolers, LLC Signed [Signature] (Manufacturer) (Representative)

CERTIFICATE OF SHOP / FIELD INSPECTION

Vessel constructed by AXH air-coolers, LLC at 401 E. Lowry Road, Claremore, Oklahoma 74017

I, the undersigned, holding a valid commission issued by The National Board of Boiler and Pressure Vessel Inspectors and the State or Province of OKLAHOMA and employed by SENECA INSURANCE COMPANY OF TEXAS have inspected the component described in this Manufacturer's Data Report on 5-10-06, and state that, to the best of my knowledge and belief, the Manufacturer has constructed this pressure vessel in accordance with ASME Code, Section VIII, Division 1. By signing this certificate neither the Inspector nor his employer makes any warranty, expressed or implied, concerning the pressure vessel described in this Manufacturer's Data Report. Furthermore, neither the Inspector nor his 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 5-18-06 Signed [Signature] Commissions WB12461A DL093
 (Authorized Inspector) (Nat'l Board, (incl. endorsements) State, Prov. and No.)

060158

FORM U-1A MANUFACTURER'S DATA REPORT FOR PRESSURE VESSELS
 (Alternative Form for Single Chamber, Completely Shop or Field Fabricated Vessels Only) **A 5 6 1 3 1 0**
 As Required by the Provisions of the ASME Code Rules, Section VIII, Division 1

1. Manufactured and certified by AXH air-coolers, LLC 401 E. Lowry Road Claremore Oklahoma 74017
 (Name and address of manufacturer)

2. Manufactured for ENERFLEX SYSTEMS LTD. 4700 - 47TH STREET SOUTHEAST CALGARY, ALBERTA, CANADA T2B 3R1
 (Name and address of purchaser)

3. Location of installation UNKNOWN
 (Name and address)

4. Type: HORIZ. H. EXCHANGER 64468C.4 R7233.213 64468 IC-2 R0 2507 2006
 (Horiz. or vert. tank) (Mfr's serial No.) (CRN) (Drawing no.) (Nat'l Bd. No.) (Year built)

5. The chemical and physical properties of all parts meet the requirements of material specifications of the ASME BOILER AND PRESSURE VESSEL CODE. The design, construction, and workmanship conform to ASME Rules, Section VIII, Division 1 2004
 Year

6. Shell: 2005 Addenda (Date) Code Case Nos. Special Service per UG 120(d)

TUBE & PLUG SA-516 70 FR 1 1/4", BK 1 1/4" .1250 FR 5 13/16", BK 5 13/16" 2' 1 3/8"
 (Spec. No., Grade) (Nom. Thk. (in.)) (Corr. Allow. (in.)) (Diam. I. D. (ft. & in.)) (Length (overall) (ft. & in.))

7. Seams: CORNER JOINT SEE REMARKS 1.0 1150 1 SEE REMARKS *2
 (Long. (Welded, Dbl., Sngl., Lap, Butt)) (R.T. (Spot or Full)) (Eff. (%)) (H.T. Temp (°F)) (Time (hr)) (Girth (Welded, Dbl., Sngl., Lap, Butt)) (R.T. (Spot, Partial, or Full)) (No. of Courses)

8. Heads: (a) Matl. WRAPPERS: SA-516 70 (b) Matl. ENDS: SA-516 70
 (Spec. No., Grade) (Spec. No., Grade)

	Location (Top, Bottom, Ends)	Minimum Thickness	Corrosion Allowance	Crown Radius	Knuckle Radius	Elliptical Ratio	Conical Apex Angle	Hemispherical Radius	Flat Diameter	Side to Pressure (Convex or Concave)
(a)	WRAPPERS	7/8"	.1250						**	FLAT
(b)	ENDS	3/4"	.1250						***	FLAT

If removable, bolts used (describe other fastenings) _____ (Matl., Spec. No., Gr., Size, No.)

9. MAWP 1935 psi at max. temp. 350 °F
 Min. design metal temp. -20 °F at 1935 psi. Hydro. test pressure 2516 psi.

10. Nozzles, inspection and safety valve openings:

Purpose (Inlet, Outlet, Drain)	No.	Diam. or Size	Type	Matl.	Nom. Thk.	Reinforcement Matl.	How Attached	Location
INLET/OUTLET	3	4"	PIPE	SA-106 B	S/160	NONE	UW-16(a)	HEADER
PLUGS	88	7/8-14	UNF 3A	SA-105				HEADER

11. Supports: Skirt NO Lugs NO Legs NO Other STRUCTURE Attached BOLTED
 (Yes or no) (No.) (No.) (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:
PSV SET @ 1650 PSI SCFM 16105
 (Name of part, item number, Mfr's name and identifying stamp)

*2 HEADERS ONE AT EACH END. **WRAPPERS FLAT DIAMETER 3 1/4" X 25 3/8". ***ENDS FLAT DIAMETER 3 1/4" X 4 1/16".
44 TUBES SA-179 STL 3/4" O.D. .065 MW 24' LG. CONSTRUCTED IN ACCORD. W/ APPENDIX 28. IMPACTS EXEMPT PER UG 20(f).
PRESSURE RELIEF DEVICE BY OTHERS. X-RAYS PER CUSTOMER SPECS. ENERFLEX TAG NO.: 060158 ENCANA. HDR VOL.: 315 CU.IN.

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 Code for Pressure Vessels, Section VIII, Division 1. "U" Certificate of Authorization No. 34.950 expires 2/07/2008

Date 5/18/06 Co. Name AXH air-coolers, LLC Signed [Signature]
 (Manufacturer) (Representative)

CERTIFICATE OF SHOP / FIELD INSPECTION

Vessel constructed by AXH air-coolers, LLC at 401 E. Lowry Road Claremore, Oklahoma 74017

I, the undersigned, holding a valid commission issued by The National Board of Boiler and Pressure Vessel Inspectors and the State or Province of OKLAHOMA and employed by SENECA INSURANCE COMPANY OF TEXAS have inspected the component described in this Manufacturer's Data Report on 5-11-06, and state that, to the best of my knowledge and belief, the Manufacturer has constructed this pressure vessel in accordance with ASME Code, Section VIII, Division 1. By signing this certificate neither the Inspector nor his employer makes any warranty, expressed or implied, concerning the pressure vessel described in this Manufacturer's Data Report. Furthermore, neither the Inspector nor his 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 5-18-06 (Signed) [Signature] Commissions [Signature]
 (Authorized Inspector) (Nat'l Board, (incl. endorsements) State, Prov. and No.)

060158

FORM U-1A MANUFACTURER'S DATA REPORT FOR PRESSURE VESSELS
 (Alternative Form for Single Chamber, Completely Shop or Field Fabricated Vessels Only) **561311**
 As Required by the Provisions of the ASME Code Rules, Section VIII, Division 1

1. Manufactured and certified by AXH air-coolers, LLC, 401 E. Lowry Road, Claremore, Oklahoma 74017
 (Name and address of manufacturer)

2. Manufactured for ENERFLEX SYSTEMS LTD. 4700 - 47TH STREET SOUTHEAST, CALGARY, ALBERTA, CANADA T2B 3R1
 (Name and address of purchaser)

3. Location of installation UNKNOWN
 (Name and address)

4. Type: HORIZ. H. EXCHANGER 64468C.5 R7233.213 64468 AC R0 2508 2006
 (Horiz. or vert. tank) (Mfr's serial No.) (CRN) (Drawing no.) (Nat'l Bd. No.) (Year built)

5. The chemical and physical properties of all parts meet the requirements of material specifications of the ASME BOILER AND PRESSURE VESSEL CODE. The design, construction, and workmanship conform to ASME Rules, Section VIII, Division 1 2004
 Year

6. Shell: TUBE & PLUG SA-516 70 FR 1 1/4", BK 1 1/4" 1250 FR 5 13/16", BK 5 13/16" 2' 7 5/8"
 Addenda (Date) Code Case Nos. Special Service per UG 120(d)
 Mat'l. (Spec. No., Grade) Nom. Thk. (in.) Corr. Allow. (in.) Diam. I.D. (ft. & in.) Length (overall) (ft. & in.)

7. Seams: CORNER JOINT SEE REMARKS 1.0 1150 1 SEE REMARKS *2
 Long. (Welded, Dbl., Sngl., Lap, Butt) R.T. (Spot or Full) Eff. (%) H.T. Temp. (°F) Time (hr) Girth (Welded, Dbl., Sngl., Lap, Butt) R.T. (Spot, Partial, or Full) No. of Courses

8. Heads: (a) Mat'l. WRAPPERS: SA-516 70 (b) Mat'l. ENDS: SA-516 70
 (Spec No., Grade) (Spec No., Grade)

	Location (Top, Bottom, Ends)	Minimum Thickness	Corrosion Allowance	Crown Radius	Knuckle Radius	Elliptical Ratio	Conical Apex Angle	Hemispherical Radius	Flat Diameter	Side to Pressure (Convex or Concave)
(a)	WRAPPERS	7/8"	.1250						**	FLAT
(b)	ENDS	3/4"	.1250						***	FLAT

If removable, bolts used (describe other fastenings) _____
 (Mat'l. Spec. No., Gr., Size, No.)

9. MAWP 1935 psi at max. temp. 350 °F
 Min. design metal temp. -20 °F at 1935 psi. Hydro. 2516 psi. ~~test pressure~~

10. Nozzles, inspection and safety valve openings:

Purpose (Inlet, Outlet, Drain)	No.	Diam. or Size	Type	Mat'l.	Nom. Thk.	Reinforcement Mat'l.	How Attached	Location
INLET/OUTLET	3	4"	PIPE	SA-106 B	S/160	NONE	UW-16(a)	HEADER
PLUGS	88	7/8-14	UNF 3A	SA-105				HEADER

11. Supports: Skirt NO Lugs _____ Legs _____ Other STRUCTURE Attached BOLTED
 (Yes or no) (No.) (No.) (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:
PSV SET @ 1650 PSI SCFR 1. 16105
 (Name of part, item number. Mfr's name and identifying stamp)
*2 HEADERS ONE AT EACH END. **WRAPPERS FLAT DIAMETER 3 1/4" X 31 5/8". ***ENDS FLAT DIAMETER 3 1/4" X 4 1/16".
44 TUBES SA-179 STL 3/4" O.D. .065 MW 24' LG. CONSTRUCTED IN ACCORD. W/ APPENDIX 28. IMPACTS EXEMPT PER UG 20(f).
PRESSURE RELIEF DEVICE BY OTHERS. X-RAYS PER CUSTOMER SPECS. ENERFLEX TAG NO.: 060158 ENCANA. HDR VOL.: 398 CUIN.

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 Code for Pressure Vessels, Section VIII, Division 1. "U" Certificate of Authorization No. 34.950 expires 2/07/2008
 Date 5/18/06 Co. Name AXH air-coolers, LLC Signed [Signature] (Manufacturer) (Representative)

CERTIFICATE OF SHOP / FIELD INSPECTION

Vessel constructed by AXH air-coolers, LLC at 401 E. Lowry Road, Claremore, Oklahoma 74017
 I, the undersigned, holding a valid commission issued by The National Board of Boiler and Pressure Vessel Inspectors and the State or Province of OKLAHOMA and employed by SENECA INSURANCE COMPANY OF TEXAS have inspected the component described in this Manufacturer's Data Report on 5-11-06 and state that, to the best of my knowledge and belief, the Manufacturer has constructed this pressure vessel in accordance with ASME Code, Section VIII, Division 1. By signing this certificate neither the inspector nor his employer makes any warranty, expressed or implied, concerning the pressure vessel described in this Manufacturer's Data Report. Furthermore, neither the Inspector nor his 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 5-18-06 Signed [Signature] Commissions WB124614 OK293
 (Authorized Inspector) (Nat'l Board, (incl. endorsements) State, Prov. and No.)

060158

121994

CERTIFIED BY

EFX Compress

GALGARY, ALBERTA, CANADA



W

RT-1

HT

MAWP	1315	PSI @	300
MDMT	-20	PSI @	1315
SN	060079-01	QTY	2006
CRN	R7478.231	QA	0.125
SH THK	1.125	IN	SA 516-70N
HD THK	1.125	IN	SA 516-70N
REG. NO.	(A) 5 5 2 6 5 0		

115508B

U

W

RT-1

HT

1315

-20

051388-01

R0778.213

0.688

0.5625

300

1315

2000

0.125

106-B

516-70N



54050

121887

CERTIFIED BY

EFX Compression

U

W

RT-1

HT

MAWP 1935

WIDMT -20

ESN 060103-01

CRN R7655.213

SH THK 1.00

HD THK 0.875

PSIG 350

YR 1935

YEAR 2006

DA 0.125

SA 106-B

SA 516-70N

REG. NO. (A) 552626

115507

REGISTERED BY

EXAMINER

EXAMINER

U

W

RT-1

HT

1292

350

-20

1292

051378-01

YEAR

2000

R0780213

C.A.

0.125

0.750

MITL

SA516-70N

0.750

MITL

SA516-70N

REG. NO.

(A)

552597

112427B

CERTIFIED BY

EPX Compression

CALGARY ALBERTA CANADA



W
RT-1
HT

MAWP	1315	PSI @	300
MDMT	-20	PSI	1315
SN	060083-01	YEAR	2006
CRN	R8707213	DA	0.125
SH THK	1375	MTL	SA 516-70N
HD THK	1250	MTL	SA 516-70N

REG. NO.

(A) 5 5 2 6 5 9

109467B

CERTIFIED BY

EPX COMPANY

U

W

RT-1

MAWA 285

PAWA 100

MIDMIT -20

285

SIN 060373-01

YAL 2006

CON L7030.213

MA 0.0625

SH.THK 0.258

MT MTL SA 106-B

HD.THK 0.2258

MT MTL SA 234-WPB



REG. NO.



A



552522

CERTIFIED BY **AXH air-coolers, LLC**
W 64468C CLAREMORE, OKLAHOMA EJW
MAX. ALLOWABLE WORKING PRESSURE 14 PSI @ 300 °F
MIN. DESIGN METAL TEMP. -20 °F @ 14 PSI
SER. NO. 64468C.1 CRN. -
YEAR 2006 HYDRO. 75 PSIG SERVICE

CERTIFIED BY **AXH air-coolers, LLC**
W 64468C CLAREMORE, OKLAHOMA AUX-W
MAX. ALLOWABLE WORKING PRESSURE 14 PSI @ 300 °F
MIN. DESIGN METAL TEMP. -20 °F @ 14 PSI
SER. NO. 64468C.2 CRN. -
YEAR 2006 HYDRO. 75 PSIG SERVICE

  2506
CERTIFIED BY **AXH air-coolers, LLC**
W 64468C CLAREMORE, OKLAHOMA IC-1
HT MAX. ALLOWABLE WORKING PRESSURE 1292 PSI @ 350 °F
MIN. DESIGN METAL TEMP. -20 °F @ 1292 PSI
SER. NO. 64468C.3 CRN. R2615.213
YEAR 2006 HYDRO. 1680 PSIG SERVICE

  2507
CERTIFIED BY **AXH air-coolers, LLC**
W 64468C CLAREMORE, OKLAHOMA IC-2
HT MAX. ALLOWABLE WORKING PRESSURE 1935 PSI @ 350 °F
MIN. DESIGN METAL TEMP. -20 °F @ 1935 PSI
SER. NO. 64468C.4 CRN. R7233.213
YEAR 2006 HYDRO. 2516 PSIG SERVICE

  2508
CERTIFIED BY **AXH air-coolers, LLC**
W 64468C CLAREMORE, OKLAHOMA AC
HT MAX. ALLOWABLE WORKING PRESSURE 1935 PSI @ 350 °F
MIN. DESIGN METAL TEMP. -20 °F @ 1935 PSI
SER. NO. 64468C.5 CRN. R7233.213
YEAR 2006 HYDRO. 2516 PSIG SERVICE



CONSTRUCTION DATA REPORT FOR PIPING SYSTEMS

In accordance with the provisions of the Safety Codes Act

Shop Construction ; Field Construction ; Final Data Report ;
 Partial Data Report (from one ABSA-authorized Contractor to another
 ABSA- authorized Contractor).

Complete both sides of this Form

1. Constructed By: ENERFLEX SYSTEMS LTD., EFX COMPRESSION Owner's Job No: 060158 (051197)
(Name of ABSA authorized primary contractor or subcontractor)
4700 - 47TH ST. S.E. CALGARY, AB T2B 3R1
(Address)

Alberta Quality Program No. AQP-1044 Expiry Date: APRIL 15, 2008

2. Constructed For: N/A
(Name of primary contractor if different from above)
N/A
(Address)

Alberta Quality Program No. AQP- N/A Expiry Date: N/A
(Required when the primary contractor undertakes some/all of the quality functions, e.g., Mat'l supply, NDE, PWHT, Tie-in, fabrication, hydro test, final assembly etc.)

3. Owner: ENCANA CORPORATION, 150-9 AVENUE S.W. CALGARY, AB T2P 3H9
(Name and address)
ENCANA STOCK - EFX COMPRESSION STOCK YARD
(Location of installation)

Alberta Quality Program No. AQP- N/A Expiry Date: N/A
(Required when the owner undertakes some/all of the quality functions, e.g., Mat'l supply, NDE, PWHT, Tie-in, fabrication, hydro test, final assembly etc.)

4. Piping Design Alberta Registration No.: PP- N/A
(Required if aggregate piping volume is over 0.5m³)

5. WP No.: WP-807.2 ; Company: ENERFLEX SYSTEMS LTD. EFX COMPRESSION ; Owner's WP No. (If used): WP-N/A
(Alberta Registration No.) (Alberta Registration No.)
 WPS No(s). used: ESL-102/104/118 ; Owner's WPS No(s). (If used): N/A

6. Code: ASME B31.1 Non Boiler External Piping ; ASME B31.1 Boiler External Piping ;
 ASME B31.3 - Service category: Normal , D , M , High Pressure ; B31.5 ; B31.9 .

Drawing No. Rev. No. Line No.	Fluid (Air/Stm. Etc.)	Des. Press. PSI	Des. Temp. °F	Test Press. PSI	Test Medium	Pipe Mat'l Spec. & Grade	C.A.	Pipe NPS & Schedule	Flange Material & Rating	PWHT/ Preheat Temp. °F	R.T. %	Other NDE
1D1	GAS	1292	350	2225	H ₂ O	SA106B	1/8"	4"XS	SA105N 600#	1150	100	VIS
1D2	GAS	1292	350	2225	H ₂ O	SA106B		6"XS	SA105N 600#	1150	100	VIS
1D3	GAS	1292	350	2225	H ₂ O	SA106B		2"160 6"XS	SA105N 600#	1150	100	VIS
1S1	GAS	1315	300	2225	H ₂ O	SA106B		8"80	SA105N 600#	1150	100	VIS
1S2	GAS	1315	300	2225	H ₂ O	SA106B		6"XS	SA105N 600#	1150	100	VIS
2D1	GAS	1935	350	3350	H ₂ O	SA106B		3"160	SA105N 900#	1150	100	VIS



CONSTRUCTION DATA REPORT FOR PIPING SYSTEMS

In accordance with the provisions of the Safety Codes Act

Shop Construction ; Field Construction ; Final Data Report ;
 Partial Data Report (from one ABSA-authorized Contractor to another
 ABSA- authorized Contractor).

Complete both sides of this Form

1. Constructed By: **ENERFLEX SYSTEMS LTD., EFX COMPRESSION** Owner's Job No: **060158 (051197)**
(Name of ABSA authorized primary contractor or subcontractor)
4700 - 47TH ST. S.E. CALGARY, AB T2B 3R1
(Address)

Alberta Quality Program No. **AQP-1044** Expiry Date: **APRIL 15, 2008**

2. Constructed For: **N/A**
(Name of primary contractor if different from above)
N/A
(Address)

Alberta Quality Program No. AQP- **N/A** Expiry Date: **N/A**
(Required when the primary contractor undertakes some/all of the quality functions, e.g., Mat'l supply, NDE, PWHT, Tie-in, fabrication, hydro test, final assembly etc.)

3. Owner: **ENCANA CORPORATION, 150-9 AVENUE S.W. CALGARY, AB T2P 3H9**
(Name and address)
ENCANA STOCK - EFX COMPRESSION STOCK YARD
(Location of installation)

Alberta Quality Program No. AQP- **N/A** Expiry Date: **N/A**
(Required when the owner undertakes some/all of the quality functions, e.g., Mat'l supply, NDE, PWHT, Tie-in, fabrication, hydro test, final assembly etc.)

4. Piping Design Alberta Registration No.: PP- **N/A**
(Required if aggregate piping volume is over 0.5m³)

5. WP No.: **WP-807.2** ; Company: **ENERFLEX SYSTEMS LTD. EFX COMPRESSION** ; Owner's WP No. (If used): **WP-N/A**
(Alberta Registration No.) (Alberta Registration No.)
 WPS No(s). used: **ESL-102/104/118** ; Owner's WPS No(s). (If used): **N/A**

6. Code: ASME B31.1 Non Boiler External Piping ; ASME B31.1 Boiler External Piping ;
 ASME B31.3 - Service category: Normal , D , M , High Pressure ; B31.5 ; B31.9 .

Drawing No. Rev. No. Line No.	Fluid (Air/Stm. Etc.)	Des. Press. PSI	Des. Temp. °F	Test Press. PSI	Test Medium	Pipe Mat'l Spec. & Grade	C.A.	Pipe NPS & Schedule	Flange Material & Rating	PWHT/ Preheat Temp. °F	R.T. %	Other NDE
2D2	GAS	1935	350	3350	H ₂ O	SA106B	1/8"	4"160	SA105N 900#	1150	100	VIS
2D3	GAS	1935	350	3350	H ₂ O	SA106B		1-1/2"XXS 4"160	SA105N 900#	1150	100	VIS
2D4	GAS	1935	350	3350	H ₂ O	SA106B		4"160	SA105N 900#	1150	100	VIS
2S1	GAS	1315	300	2225	H ₂ O	SA106B		6"STD 6"XS	SA105N 600#	1150	100	VIS
2S2	GAS	1315	300	2225	H ₂ O	SA106B		6"XS	SA105N 600#	1150	100	VIS
2S3	GAS	1315	300	2225	H ₂ O	SA106B		6"XS	SA105N 600#	1150	100	VIS



CONSTRUCTION DATA REPORT FOR PIPING SYSTEMS

In accordance with the provisions of the Safety Codes Act

Shop Construction ; Field Construction ; Final Data Report ;
 Partial Data Report (from one ABSA-authorized Contractor to another
 ABSA- authorized Contractor).

Complete both sides of this Form

1. Constructed By: ENERFLEX SYSTEMS LTD., EFX COMPRESSION Owner's Job No: 060158 (051197)
(Name of ABSA authorized primary contractor or subcontractor)
4700 - 47TH ST. S.E. CALGARY, AB T2B 3R1
(Address)

Alberta Quality Program No. AQP-1044 Expiry Date: APRIL 15, 2008

2. Constructed For: N/A
(Name of primary contractor if different from above)
N/A
(Address)

Alberta Quality Program No. AQP-N/A Expiry Date: N/A
(Required when the primary contractor undertakes some/all of the quality functions, e.g., Mat'l supply, NDE, PWHT, Tie-in, fabrication, hydro test, final assembly etc.)

3. Owner: ENCANA CORPORATION, 150-9 AVENUE S.W. CALGARY, AB T2P 3H9
(Name and address)
ENCANA STOCK - EFX COMPRESSION STOCK YARD
(Location of installation)

Alberta Quality Program No. AQP-N/A Expiry Date: N/A
(Required when the owner undertakes some/all of the quality functions, e.g., Mat'l supply, NDE, PWHT, Tie-in, fabrication, hydro test, final assembly etc.)

4. Piping Design Alberta Registration No.: PP-N/A
(Required if aggregate piping volume is over 0.5m³)

5. WP No.: WP-807.2 ; Company: ENERFLEX SYSTEMS LTD. EFX COMPRESSION ; Owner's WP No. (If used): WP-N/A
(Alberta Registration No.) (Alberta Registration No.)
 WPS No(s). used: ESL-102/104/118 ; Owner's WPS No(s). (If used): N/A

6. Code: ASME B31.1 Non Boiler External Piping ; ASME B31.1 Boiler External Piping ;
 ASME B31.3 - Service category: Normal , D , M , High Pressure ; B31.5 ; B31.9 .

Drawing No. Rev. No. Line No.	Fluid (Air/Stm. Etc.)	Des. Press. PSI	Des. Temp. °F	Test Press. PSI	Test Medium	Pipe Mat'l Spec. & Grade	C.A.	Pipe NPS & Schedule	Flange Material & Rating	PWHT/ Preheat Temp. °F	R.T. %	Other NDE
2S4	GAS	1315	300	2225	H ₂ O	SA106B	1/8"	4"XS	SA105N 600#	1150	100	VIS
AC1	GAS	1970	300	3350	H ₂ O	SA106B		4"160	SA105N 900#	1150	100	VIS
AC2	GAS	1970	300	3350	H ₂ O	SA106B		4"160	SA105N 900#	1150	100	VIS
AC3	GAS	1970	300	3350	H ₂ O	SA106B		4"160	SA105N 900#	1150	100	VIS
AC4	GAS	1970	300	3350	H ₂ O	SA106B		4"160	SA105N 900#	1150	100	VIS
BPI	GAS	1970	300	3350	H ₂ O	SA106B		3"160	SA105N 900#	1150	100	VIS



CONSTRUCTION DATA REPORT FOR PIPING SYSTEMS

In accordance with the provisions of the Safety Codes Act

Shop Construction ; Field Construction ; Final Data Report ;
 Partial Data Report (from one ABSA-authorized Contractor to another
 ABSA- authorized Contractor).

Complete both sides of this Form

1. Constructed By: ENERFLEX SYSTEMS LTD., EFX COMPRESSION Owner's Job No: 060158 (051197)
(Name of ABSA authorized primary contractor or subcontractor)
4700 - 47TH ST. S.E. CALGARY, AB T2B 3R1
(Address)

Alberta Quality Program No. AQP-1044 Expiry Date: APRIL 15, 2008

2. Constructed For: N/A
(Name of primary contractor if different from above)
N/A
(Address)

Alberta Quality Program No. AQP-N/A Expiry Date: N/A
(Required when the primary contractor undertakes some/all of the quality functions, e.g., Mat'l supply, NDE, PWHT, Tie-in, fabrication, hydro test, final assembly etc.)

3. Owner: ENCANA CORPORATION, 150-9 AVENUE S.W. CALGARY, AB T2P 3H9
(Name and address)
ENCANA STOCK - EFX COMPRESSION STOCK YARD
(Location of installation)

Alberta Quality Program No. AQP-N/A Expiry Date: N/A
(Required when the owner undertakes some/all of the quality functions, e.g., Mat'l supply, NDE, PWHT, Tie-in, fabrication, hydro test, final assembly etc.)

4. Piping Design Alberta Registration No.: PP-N/A
(Required if aggregate piping volume is over 0.5m³)

5. WP No.: WP-807.2 ; Company: ENERFLEX SYSTEMS LTD. EFX COMPRESSION ; Owner's WP No. (If used): WP-N/A
(Alberta Registration No.) (Alberta Registration No.)
 WPS No(s). used: ESL-102/104/118 ; Owner's WPS No(s). (If used): N/A

6. Code: ASME B31.1 Non Boiler External Piping ; ASME B31.1 Boiler External Piping ;
 ASME B31.3 - Service category: Normal , D , M , High Pressure ; B31.5 ; B31.9 .

Drawing No. Rev. No. Line No.	Fluid (Air/Stm. Etc.)	Des. Press. PSI	Des. Temp. °F	Test Press. PSI	Test Medium	Pipe Mat'l Spec. & Grade	C.A.	Pipe NPS & Schedule	Flange Material & Rating	PWHT/ Preheat Temp. °F	R.T. %	Other NDE
BP2	GAS	1315	300	2225	H ₂ O	SA106B	1/8"	3"XS	SA105N 900#	1150	100	VIS
BP3	GAS	1315	300	2225	H ₂ O	SA106B		3"XS	SA105N 600#	1150	100	VIS
HP1	GAS	230	300	450	H ₂ O	SA106B		4"STD	SA105N 150#	1150	100	VIS
HP2	GAS	230	300	450	H ₂ O	SA106B		4"STD	SA105N 150#	1150	100	VIS
HP3	GAS	230	300	450	H ₂ O	SA106B		4"STD	SA105N 150#	1150	100	VIS
HP4	GAS	230	300	450	H ₂ O	SA106B		3"STD 4"STD	SA105N 150# 300#	1150	100	VIS



CONSTRUCTION DATA REPORT FOR PIPING SYSTEMS

In accordance with the provisions of the Safety Codes Act

Shop Construction ; Field Construction ; Final Data Report ;
 Partial Data Report (from one ABSA-authorized Contractor to another
 ABSA- authorized Contractor).

Complete both sides of this Form

1. Constructed By: **ENERFLEX SYSTEMS LTD., EFX COMPRESSION** Owner's Job No: **060158 (051197)**
(Name of ABSA authorized primary contractor or subcontractor)
4700 - 47TH ST. S.E. CALGARY, AB T2B 3R1
(Address)

Alberta Quality Program No. **AQP-1044** Expiry Date: **APRIL 15, 2008**

2. Constructed For: **N/A**
(Name of primary contractor if different from above)
N/A
(Address)

Alberta Quality Program No. AQP- **N/A** Expiry Date: **N/A**
(Required when the primary contractor undertakes some/all of the quality functions, e.g., Mat'l supply, NDE, PWHT, Tie-in, fabrication, hydro test, final assembly etc.)

3. Owner: **ENCANA CORPORATION, 150-9 AVENUE S.W. CALGARY, AB T2P 3H9**
(Name and address)
ENCANA STOCK - EFX COMPRESSION STOCK YARD
(Location of installation)

Alberta Quality Program No. AQP- **N/A** Expiry Date: **N/A**
(Required when the owner undertakes some/all of the quality functions, e.g., Mat'l supply, NDE, PWHT, Tie-in, fabrication, hydro test, final assembly etc.)

4. Piping Design Alberta Registration No.: PP- **N/A**
(Required if aggregate piping volume is over 0.5m³)

5. WP No.: **WP-807.2** ; Company: **ENERFLEX SYSTEMS LTD. EFX COMPRESSION** ; Owner's WP No. (If used): **WP-N/A**
(Alberta Registration No.) (Alberta Registration No.)
 WPS No(s). used: **ESL-102/104/118** ; Owner's WPS No(s). (If used): **N/A**

6. Code: ASME B31.1 Non Boiler External Piping ; ASME B31.1 Boiler External Piping ;
 ASME B31.3 - Service category: Normal , D , M , High Pressure ; B31.5 ; B31.9 .

Drawing No. Rev. No. Line No.	Fluid (Air/Stm. Etc.)	Des. Press. PSI	Des. Temp. °F	Test Press. PSI	Test Medium	Pipe Mat'l Spec. & Grade	C.A.	Pipe NPS & Schedule	Flange Material & Rating	PWHT/ Preheat Temp. °F	R.T. %	Other NDE
FG	GAS	165	100	182	N	SA106B	1/8"	2"XS 1-1/2"XS 1"XS	SA105N 150#	1150	100	VIS
SG	GAS	165	100	182	N	SA106B		2"XS 1-1/2"XS	SA105N 150#	1150	100	VIS
BLOW DOWN	GAS	410	100	450	N	SA106B		1"XS 1-1/2"XS	SA105N 150#	1150	100	VIS
BLOW DOWN	GAS	410	100	450	N	SA106B		1"XS 1-1/2"XS	SA105N 150#	1150	100	VIS
BLOW DOWN	GAS	3045	100	3350	N	SA106B		1"XXS 1-1/2"XXS	SA105N 900#	1150	100	VIS
SC.DRAIN	GAS	2045	100	2250	N	SA106B		1-1/2"160 2"160	SA105N 600#	1150	100	VIS

BOILER AND PRESSURE VESSEL STATUS REPORT

This status report form has been provided for you to report any changes to your boilers and/or pressure vessels. If you complete the form below, we would be pleased to make the required changes to our records and credit your account if credits are due.

RE: Vessel (A)	1) <u>A552597</u>	2) <u>A552659</u>	3) <u>A552522</u>
Serial No.	<u>051378-01</u>	<u>060083-01</u>	<u>060373-01</u>
CRN	<u>R0780.213</u>	<u>R8707.213</u>	<u>L7030.213</u>

The above vessel(s) was (were) sold. Please transfer the registration of the vessel(s) to:

Name of New Owner: ENCANA CORPORATION

Mailing Address: 150 - 9 AVENUE S.W. CALGARY, AB T2P 2S5

Location of Vessel: ENCANA STOCK; EFX COMPRESSION STOCK

Contact Person: _____ Tel: _____

Date of Sale: AUGUST 31, 2006 P.O. No: EFX JOB #060158

- The above vessel(s) was (were) removed from service on _____
- The above vessel(s) was (were) destroyed and disposed of as scrap material on _____ (Date). The Alberta Identification (A) Number has been obliterated.
- The above vessel(s) has (have) been relocated to _____
- The above vessel(s) has (have) been operating outside of the Province of Alberta since _____ (Date). Please remove from annual registration.
- The above vessel was returned to service on _____

Company Name: ENERFLEX SYSTEMS LTD., EFX COMPRESSION

Position Title: QUALITY CONTROL SUPERVISOR Tel: (403) 720-1658

(Please print name) LARRY COWAN E-Mail: larry.cowan@enerflex.com

Signature:  Date: AUGUST 31, 2006

Note: The owner of the boiler or pressure vessel is responsible for ensuring that the above equipment is inspected by ABSA prior to its being returned to service in the Province of Alberta.

Please Return This Report To: **ABSA, the pressure equipment safety authority**
9410 - 20th Avenue, Edmonton, AB T6N 0A4
(780) 437-9100 Fax (780) 437-7787

BOILER AND PRESSURE VESSEL STATUS REPORT

This status report form has been provided for you to report any changes to your boilers and/or pressure vessels. If you complete the form below, we would be pleased to make the required changes to our records and credit your account if credits are due.

RE: Vessel (A)	1) <u>A552650</u>	2) <u>A544050</u>	3) <u>A552626</u>
Serial No.	<u>060079-01</u>	<u>051388-01</u>	<u>060103-01</u>
CRN	<u>R7478.231</u>	<u>R0778.213</u>	<u>R7655.213</u>

The above vessel(s) was (were) sold. Please transfer the registration of the vessel(s) to:

Name of New Owner: ENCANA CORPORATION

Mailing Address: 150 - 9 AVENUE S.W. CALGARY, AB T2P 2S5

Location of Vessel: ENCANA STOCK; EFX COMPRESSION STOCK

Contact Person: _____ Tel: _____

Date of Sale: AUGUST 31, 2006 P.O. No: EFX JOB #060158

- The above vessel(s) was (were) removed from service on _____
- The above vessel(s) was (were) destroyed and disposed of as scrap material on _____ (Date). The Alberta Identification (A) Number has been obliterated.
- The above vessel(s) has (have) been relocated to _____
- The above vessel(s) has (have) been operating outside of the Province of Alberta since _____ (Date). Please remove from annual registration.
- The above vessel was returned to service on _____

Company Name: ENERFLEX SYSTEMS LTD., EFX COMPRESSION

Position Title: QUALITY CONTROL SUPERVISOR Tel: (403) 720-1658

(Please print name) LARRY COWAN E-Mail: larry.cowan@enerflex.com

Signature:  Date: AUGUST 31, 2006

Note: The owner of the boiler or pressure vessel is responsible for ensuring that the above equipment is inspected by ABSA prior to its being returned to service in the Province of Alberta.

Please Return This Report To: **ABSA, the pressure equipment safety authority**
9410 - 20th Avenue, Edmonton, AB T6N 0A4
(780) 437-9100 Fax (780) 437-7787



BOILER AND PRESSURE VESSEL STATUS REPORT

This status report form has been provided for you to report any changes to your boilers and/or pressure vessels. If you complete the form below, we would be pleased to make the required changes to our records and credit your account if credits are due.

RE: Vessel (A)	1) <u>ⓐ 5 6 1 3 0 9</u>	2) <u>ⓐ 5 6 1 3 1 0</u>	3) <u>ⓐ 5 6 1 3 1 1</u>
Serial No.	<u>64468C.3</u>	<u>64468C.4</u>	<u>64468C.5</u>
CRN	<u>R2615.213</u>	<u>R7233.213</u>	<u>R7233.213</u>

The above vessel(s) was (were) sold. Please transfer the registration of the vessel(s) to:

Name of New Owner: Encana Corporation

Mailing Address: 150 - 9 Ave. S.W. Calgary, AB T2P 3H9

Location of Vessel: Encana stock; EFX yard

Contact Person: Darryl Burns Tel: 403 645-5536

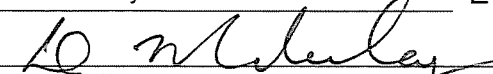
Date of Sale: February 1, 2006 P.O. No: EFX Job# 060158 (sour)

- The above vessel(s) was (were) removed from service on _____
- The above vessel(s) was (were) destroyed and disposed of as scrap material on _____ (Date). The Alberta Identification (A) Number has been obliterated.
- The above vessel(s) has (have) been relocated to _____
- The above vessel(s) has (have) been operating outside of the Province of Alberta since _____ (Date). Please remove from annual registration.
- The above vessel was returned to service on _____

Company Name: EFX Compression

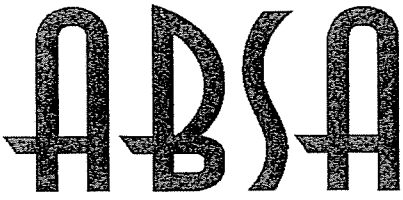
Position Title: Senior Quality Inspector Tel: (403) 720-1240

(Please print name) Dave Maberley E-Mail: david.maberley@enerflex.com

Signature:  Date: August 28, 2006

Note: The owner of the boiler or pressure vessel is responsible for ensuring that the above equipment is inspected by Alberta Boilers Safety Association prior to its being returned to service in the Province of Alberta.

Please Return This Report To: **ALBERTA BOILERS SAFETY ASSOCIATION**
#200, 4208 - 97 Street, Edmonton, AB T6E 5Z9
(780) 437-9100 Fax (780) 437-7787



Alberta Boilers Safety Association

#200, 4208 - 97 Street

Edmonton, Alberta, Canada T6E 5Z9

Tel: (780) 437-9100 / Fax: (780) 437-7787

May 28, 2004

Rana Khan
ENERFLEX SYSTEMS LTD
4700 47 STREET SE
COMPRESSION & POWER DIVISION
CALGARY, AB T2B 3R1

Dear Rana Khan,

The drawings, specifications and/or information received on May 04, 2004 are accepted for registration as follows:

CRN : R7478.2 **Accepted on:** May 28, 2004

Tracking No. : 2004-03400

Reg Type : New Design

Drawing No. : V040239G Rev 1 As Noted

Description	Design Pressure	Design Temperature	MDMT
Internal Pressure	9067 kPa	149°C	-29°C

The registration is conditional on your compliance with the following notes:

- We have added to note 19 paragraphs UCS-66(a)&(b) and have deleted the reference to UCS-66(b)(3).
- We have added to weld detail "G" the studding outlet outside projection: 26.5 mm minimum.
- Maximum hole to be cut in the shell for the 3/4" TOL's shall be 1.05".

An invoice covering survey and registration fees will be forwarded from our Revenue Accounts.

Enclosed are stamped prints for your reference.

Sincerely,

DE LEON, JESUS, P. Eng.
Design Survey Engineer



88 6th Street, Suite 400
New Westminster, BC V3L 5B3

Phone: (604) 660 - 6266
Toll Free: 1-866-566-SAFE
Fax: (604) 660 - 6215
www.safetyauthority.ca

ENERFLEX SYSTEMS LIMITED
4700 47 STREET SE
CALGARY AB T2B 3R1

Date: June 11, 2004
Account #: 27095
Journal #: 33908
Our File #: 2732566

Attn: RANA KHAN

Re: Application for Design Registration

The design, as detailed in your, 040239, for a Pressure Vessel is accepted for registration as follows:

Registered To: ENERFLEX SYSTEMS LIMITED CRN: R7478.21

MDMT: -20 deg F

MAWT: 300 deg F

MAWP: 1315 psig

Drawing #: V040239G

Drawing Revision: 1

Reviewer's Notes:

Alberta issued CRN R7478.2 on May 28, 2004
Notes per ABSA acceptance letter also apply to this CRN.

	<u>Amount</u>	<u>GST</u>	<u>Total</u>
Total fee for reviewing your design:	\$67.00	\$0.00	\$67.00
Amount received with submission:	\$0.00		

An invoice for \$67.00 will follow.

Contact me if you have any questions.

SUBHASH GUPTA
(604) 660-6239
Subhash.Gupta@safetyauthority.ca
Design Engineer

CC:



Corrections and
Public Safety

Licensing and Inspections

Boiler Pressure Vessel Safety
330, 1855 Victoria Avenue
REGINA, SK S4P 3V7

REGISTRATION APPROVAL

TEL : (306)787-4522
FAX : (306)787-9273

Tuesday, June 08, 2004

Enerflex Systems Ltd
Compression & Power Division
4700 47 Street SE
Calgary, AB T2B 3R1

FAXING
June 3/04

Our File 33966 [0 V]

ATTENTION : Rana Khan, Vessel Checker

With reference to your submission respecting the registration of the item below, for legal use in the province, please note we have surveyed, approved and registered this design as noted.


MANUFACTURER :	Enerflex Systems Ltd	
ITEM :	DRAWING NUMBER :	CRN :
Scrubber	V040239G Rev. 1	R7478.23

An invoice covering survey and registration fees will be forwarded from our Codes and Standards Compliance Office.

We wish to point out that every vessel must be constructed strictly in accordance with the registered design, CSA B-51, and the Saskatchewan Boiler and Pressure Vessel Act and associated regulations.

In addition to stamping every vessel with the registration number given above and as required in CSA Code B51, a Manufacturer's Data Report must be forwarded to this office immediately at the time a vessel is shipped. Such forms may be obtained upon request.

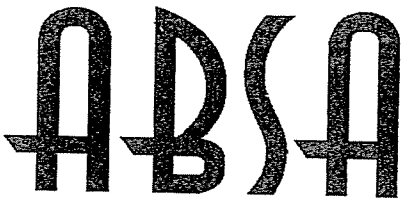
Sincerely,


Chris Selinger

Codes and Standards Compliance

#327 Reg. of Design

REMARKS: CRN registered under reciprocal agreement and conditional upon compliance with the notes on the original registration.



Alberta Boilers Safety Association

#200, 4208 - 97 Street

Edmonton, Alberta, Canada T6E 5Z9

Tel: (780) 437-9100 / Fax: (780) 437-7787

October 25, 2002

Detlef Weber
ENERFLEX SYSTEMS LTD
4700-47 STREET SE
CALGARY, AB T2B 3R1

Dear Detlef Weber,

The drawings, specifications and/or information received on October 11, 2002 are accepted for registration as follows:

CRN : R0778.2

Accepted on: October 25, 2002

Tracking No. : 2002-06481

Reg Type : New Design

Drawing No. : 115508 Rev 0

Description	Design Pressure	Design Temperature	MDMT
Internal Pressure	9067 kPa	149°C	-29°C

An invoice covering survey and registration fees will be forwarded from our Revenue Accounts.

Enclosed are stamped prints for your reference.

Sincerely,

CHAN, SIDNEY, P. Eng.
Design Survey Engineer



Corrections and
Public Safety

Licensing and Inspections

Boiler & Pressure Vessel Safety
330, 1855 Victoria Avenue
REGINA, SK S4P 3V7
PH : (306)787-4522
FAX : (306)787-9273

APPROVAL AND INVOICE

Wednesday, October 30, 2002

Enerflex Systems Ltd.
Compression & Power Division
4700 - 47 Street S.E.
Calgary, AB
T2B 3R1

Our File 31759 [0 V]

ATTENTION : Detlef Weber

With reference to your submission respecting the registration of the item below, for legal use in the province, please note we have surveyed, approved and registered this design as noted.

MANUFACTURER :	Enerflex Systems Ltd.	
ITEM :	DRAWING NUMBER :	CRN :
Stage 2 Suction Bottle	115508 Rev 0	R0778.23
REGISTRATION FEE:	\$60.00	(CANADIAN FUNDS ONLY)

PLEASE SEND REMITTANCE WITH A COPY OF THIS INVOICE TO: MINISTER OF FINANCE. WE ACCEPT PAYMENT BY CHEQUE/MONEY ORDER OR BANK DRAFT.

We wish to point out that every vessel must be constructed strictly in accordance with the registered design.

In addition to stamping every vessel with the registration number given above and as required in CSA Code B51, a Manufacturer's Data Report must be forwarded to this office immediately at the time a vessel is shipped. Such forms may be obtained upon request.

Sincerely,

John Gosselink

Codes and Standards Compliance

#327 Reg. of Design

REMARKS: CRN registered under reciprocal agreement.



TO: ENERFLEX SYSTEMS LTD
 COMPRESSION & POWER DIVISION
 4700 47TH ST SE
 CALGARY AB
 T2B 3R1

Registered: 2002/11/04
 Journal #: 29939
 Account #: 37990


Attn: DETLEF WEBER

Re: ENERFLEX MANUFACTURING

DESIGN REGISTRATION

C.R.N.

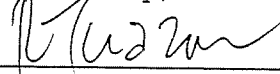
R0778.21

Drawings / Documents	Description			
STG 2 SUCTION BOTTLE 115508 REV 0 	MDMT ----- -20 F	MAWT ----- 300 F	MAWP ----- 1315 psi	EXT PRESS -----
Code: ASME Sec VIII Div 1, 01 Ed.				

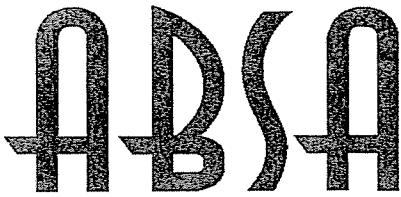
Remarks: This design has been registered as noted above. An invoice for survey will follow in the amount of \$ 60.00

dc

Yours truly,



 R. TUAZON
 Design Surveyor



Alberta Boilers Safety Association

#200, 4208 - 97 Street

Edmonton, Alberta, Canada T6E 5Z9

Tel: (780) 437-9100 / Fax: (780) 437-7787

June 10, 2004

Rana Khan
ENERFLEX SYSTEMS LTD
4700 47 STREET SE
COMPRESSION & POWER DIVISION
CALGARY, AB T2B 3R1

Dear Rana Khan,

The drawings, specifications and/or information received on May 19, 2004 are accepted for registration as follows:

CRN : R7655.2 **Accepted on:** June 10, 2004

Tracking No. : 2004-03874

Reg Type : New Design

Drawing No. : 121887 Rev 1 As Noted

Description	Design Pressure	Design Temperature	MDMT
Internal Pressure	13341 kPa	177 ^o C	-29 ^o C

The registration is conditional on your compliance with the following notes:

-We have deleted from weld detail "A" the reference to Fig. UW-16.1(c).

An invoice covering survey and registration fees will be forwarded from our Revenue Accounts.

Enclosed are stamped prints for your reference.

Sincerely,

DE LEON, JESUS, P. Eng.
Design Survey Engineer

Saskatchewan



Corrections and
Public Safety

Licensing and Inspections

Boiler Pressure Vessel Safety
330, 1855 Victoria Avenue
REGINA, SK S4P 3V7

REGISTRATION APPROVAL

TEL : (306)787-4522
FAX : (306)787-9273

Monday, June 14, 2004

Enerflex Systems Ltd
Compression & Power Division
4700 47 Street SE
Calgary, AB T2B 3R1

Our File 33978 [0 V]

ATTENTION : Rana Khan, Vessel Checker

With reference to your submission respecting the registration of the item below, for legal use in the province, please note we have surveyed, approved and registered this design as noted.

MANUFACTURER :	Enerflex Systems Ltd	
ITEM :	DRAWING NUMBER :	CRN :
Discharge Bottle	121887 Rev. 1	R7655.23

An invoice covering survey and registration fees will be forwarded from our Codes and Standards Compliance Office.

We wish to point out that every vessel must be constructed strictly in accordance with the registered design, CSA B-51, and the Saskatchewan Boiler and Pressure Vessel Act and associated regulations.

In addition to stamping every vessel with the registration number given above and as required in CSA Code B51, a Manufacturer's Data Report must be forwarded to this office immediately at the time a vessel is shipped. Such forms may be obtained upon request.

Sincerely,

Chris Selinger

Codes and Standards Compliance

#327 Reg. of Design

REMARKS: CRN registered under reciprocal agreement and conditional upon compliance with the notes on the original registration.



88 6th Street, Suite 400
New Westminster, BC V3L 5B3

Phone: (604) 660 - 6286
Toll Free: 1-866-566-SAFE
Fax: (604) 660 - 6215
www.safetyauthority.ca

ENERFLEX SYSTEMS LIMITED
4700 47 STREET SE
CALGARY AB T2B 3R1

Date: June 16, 2004
Account #: 27095
Journal #: 34032
Our File #: 2751415

Attn: RANA KHAN

Re: Application for Design Registration

The design, as detailed in your, Dwg. No. 121887 Rev 1, for a Pressure Vessel is accepted for registration as follows:

Registered To: ENERFLEX SYSTEMS LIMITED **CRN:** R7655.21

MDMT: -20 deg F

MAWT: 350 deg F

MAWP: 1935 psig

Drawing #: 121887

Drawing Revision: 1 (As noted by ABSA June 10, 2004)

Conditions Of Registration:

Reg Type: New Design
Item: Stage 2 Discharge Bottle
Size: 12.75" O.D. x 62" S/S
Volume: 3.7 cu ft

	<u>Amount</u>	<u>GST</u>	<u>Total</u>
Total fee for reviewing your design:	\$67.00	\$0.00	\$67.00
Amount received with submission:	\$0.00		

An invoice for \$67.00 will follow.

Contact me if you have any questions.

HEYE KLAVER
(604) 660-6238
Heye.Klaver@safetyauthority.ca
Design Engineer



Alberta Boilers Safety Association

#200, 4208 - 97 Street

Edmonton, Alberta, Canada T6E 5Z9

Tel: (780) 437-9100 / Fax: (780) 437-7787

October 25, 2002

Detlef Weber
ENERFLEX SYSTEMS LTD
4700-47 STREET SE
CALGARY, AB T2B 3R1

Dear Detlef Weber,

The drawings, specifications and/or information received on October 15, 2002 are accepted for registration as follows:

CRN : R0780.2

Accepted on: October 25, 2002

Tracking No. : 2002-06524

Reg Type : New Design

Drawing No. : 115507 Rev 0

Description	Design Pressure	Design Temperature	MDMT
Internal Pressure	8908 kPa	177°C	-29°C

An invoice covering survey and registration fees will be forwarded from our Revenue Accounts.

Enclosed are stamped prints for your reference.

Sincerely,

CHAN, SIDNEY, P. Eng.
Design Survey Engineer



TO: ENERFLEX SYSTEMS LTD
 COMPRESSION & POWER DIVISION
 4700 47TH ST SE
 CALGARY AB
 T2B 3R1

Registered: 2002/11/04
 Journal #: 29938
 Account #: 37990


Attn: DETLEF WEBER

Re: ENERFLEX MANUFACTURING

DESIGN REGISTRATION

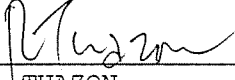
C.R.N.

R0780.21

Drawings / Documents	Description			
STG 1 DISCHARGE BOTTLE 115507 REV 0 	MDMT ----- -20 F	MAWT ----- 350 F	MAWP ----- 1292 psi	EXT PRESS -----
Code: ASME Sec VIII Div 1, 01 Ed.				

Remarks: This design has been registered as noted above. An invoice for survey will follow in the amount of \$ 60.00

Yours truly,



 R. TUAZON
 Design Surveyor

dc



Corrections and
Public Safety

Licensing and Inspections

Boiler & Pressure Vessel Safety
330, 1855 Victoria Avenue
REGINA, SK S4P 3V7
PH : (306)787-4522
FAX : (306)787-9273

APPROVAL AND INVOICE

Wednesday, October 30, 2002

Enerflex Systems Ltd.
Compression & Power Division
4700 - 47 Street S.E.
Calgary, AB
T2B 3R1

Our File 31760 [0V]

ATTENTION : Detlef Weber

With reference to your submission respecting the registration of the item below, for legal use in the province, please note we have surveyed, approved and registered this design as noted.

MANUFACTURER :	Enerflex Systems Ltd.	
ITEM :	DRAWING NUMBER :	CRN :
Stage 1 Discharge Bottle	115507 Rev 0	R0780.23
REGISTRATION FEE: \$60.00	(CANADIAN FUNDS ONLY)	

PLEASE SEND REMITTANCE WITH A COPY OF THIS INVOICE TO: MINISTER OF FINANCE. WE ACCEPT PAYMENT BY CHEQUE/MONEY ORDER OR BANK DRAFT.

We wish to point out that every vessel must be constructed strictly in accordance with the registered design.

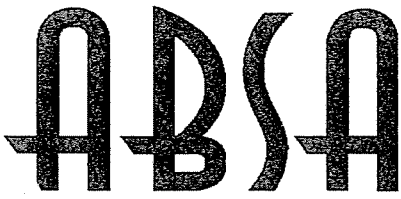
In addition to stamping every vessel with the registration number given above and as required in CSA Code B51, a Manufacturer's Data Report must be forwarded to this office immediately at the time a vessel is shipped. Such forms may be obtained upon request.

Sincerely,

John Gosselink
Codes and Standards Compliance

#327 Reg. of Design

REMARKS: CRN registered under reciprocal agreement.



Alberta Boilers Safety Association

#200, 4208 - 97 Street

Edmonton, Alberta, Canada T6E 5Z9

Tel: (780) 437-9100 / Fax: (780) 437-7787

August 30, 2004

Rana Khan
ENERFLEX SYSTEMS LTD
4700 47 STREET SE
COMPRESSION & POWER DIVISION
CALGARY, AB T2B 3R1

Dear Rana Khan,

The drawings, specifications and/or information received on August 19, 2004 are accepted for registration as follows:

CRN : R8707.2 **Accepted on:** August 30, 2004

Tracking No. : 2004-06274

Reg Type : New Design

Drawing No. : 112427 SHT 1, 2, & 3 Rev 0 As Noted

Description	Design Pressure	Design Temperature	MDMT
Internal Pressure	9067 kPa	149 ^o C	-29 ^o C

The registration is conditional on your compliance with the following notes:

I have taken the liberty of correcting your drawing to show that:

- Substitute material, SA-350-LF2, should read Class 1, on General Note #10. Please update your drawings accordingly.

An invoice covering survey and registration fees will be forwarded from our Revenue Accounts.

Enclosed are stamped prints for your reference.

Sincerely,

DE LEON, JESUS, P. Eng.
Design Survey Engineer



Corrections and
Public Safety

Licensing and Inspections

Boiler Pressure Vessel Safety
330, 1855 Victoria Avenue
REGINA, SK S4P 3V7

TEL : (306)787-4522
FAX : (306)787-9273

REGISTRATION APPROVAL

Tuesday, August 31, 2004

Enerflex Systems Ltd
Compression & Power Division
4700 47 Street SE
Calgary, AB T2B 3R1

FAXED
Sept 11 04

Our File 34421 [0V]

ATTENTION : ~~Phana~~ ^{RANA} Khan, Vessel Checker

With reference to your submission respecting the registration of the item below, for legal use in the province, please note we have surveyed, approved and registered this design as noted.

MANUFACTURER :	Enerflex Systems Ltd	
ITEM :	DRAWING NUMBER :	CRN :
Stage 1 Suction Scrubber	112427 Rev 0	R8707.23

An invoice covering survey and registration fees will be forwarded from our Codes and Standards Compliance Office.

We wish to point out that every vessel must be constructed strictly in accordance with the registered design, CSA B-51, and the Saskatchewan Boiler and Pressure Vessel Act and associated regulations.

In addition to stamping every vessel with the registration number given above and as required in CSA Code B51, a Manufacturer's Data Report must be forwarded to this office immediately at the time a vessel is shipped. Such forms may be obtained upon request.

Sincerely,

John Gosselink

Codes and Standards Compliance

#327 Reg. of Design

REMARKS: CRN registered under reciprocal agreement.





88 6th Street, Suite 400
New Westminster, BC V3L 5B3

Phone: (604) 660 - 6286
Toll Free: 1-866-566-SAFE
Fax: (604) 660 - 6215
www.safetyauthority.ca

ENERFLEX SYSTEMS LIMITED
4700 47 STREET SE
CALGARY AB T2B 3R1

Date: September 10, 2004
Account #: 27095
Journal #: 34743
Our File #: 2821514

Attn: RANA KHAN

Re: Application for Design Registration

The design, as detailed in your, REF# 112427-040568, for a Pressure Vessel is accepted for registration as follows:

Registered To: ENERFLEX SYSTEMS LIMITED CRN: R8707.21

MDMT: -20 deg F

MAWT: 300 deg F

MAWP: 1315 psig

Drawing #: 112427

Drawing Revision: 0

	<u>Amount</u>	<u>GST</u>	<u>Total</u>
Total fee for reviewing your design:	\$127.00	\$0.00	\$127.00
Amount received with submission:	\$0.00		

An invoice for \$127.00 will follow.

Contact me if you have any questions.

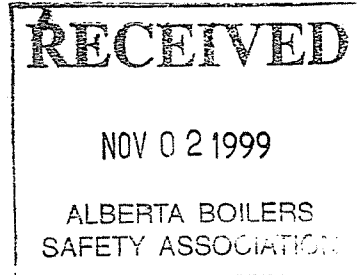
ROMEO TUAZON
(604) 660-6246
Romeo.Tuazon@safetyauthority.ca
Design Engineer

cc:



TO: ALBERTA BOILERS SAFETY ASSOCIATION
 200 4208 97TH ST
 EDMONTON ALTA
 T6E 5Z9

Registered: 1999/10/12
 Journal #: 22215
 Account #: 34986



Attn: CYNTHIA FORMANIUK
 Re: ENERFLEX MANUFACTURING

DESIGN REGISTRATION

C.R.N.

L7030.21

Drawings / Documents	Description			
FUEL GAS SCRUBBER C1972C REV1	MDMT ----- -20 F	MAWT ----- 100 F	MAWP ----- 285 psi	EXT PRESS -----
Code: ASME Sec VIII Div 1, 98 Ed.				

REGISTERED

Remarks: This design has been registered as noted above. An invoice for survey will follow in the amount of \$ 60.00

Yours truly,

R. TUAZON
 Design Surveyor

dc



Saskatchewan
Municipal Affairs,
Culture and Housing

Municipal Services Division

Protection Services Branch
Boiler & Pressure Vessel Safety
330 - 1855 Victoria Avenue
Regina, Saskatchewan
S4P 3V7

PLEASE DO NOT SEND REMITTANCE
WITHOUT A COPY OF THIS INVOICE
WHICH IS DUE WITHIN 30 DAYS.

TEL : (306)787-4490 / 787-4514
FAX : (306)787-9273

APPROVAL AND INVOICE

21/09/99

ABSA

#200, 4208 - 97 Street
Edmonton, Alberta T6E 5Z9

Our File 27417[0 V]

ATTENTION : Cynthia Formaniuk, Administrative Asst.

With reference to your submission respecting the registration of the item below, for legal use in the province, please note we have surveyed, approved and registered this design as noted.

MANUFACTURER :	Enerflex Manufacturing	
ITEM :	DRAWING NUMBER :	CRN :
Fuel Gas Scrubber	C1972C Rev 1	L7030.23
REGISTRATION FEE: \$60.00	(CANADIAN FUNDS ONLY)	

We wish to point out that every vessel must be constructed strictly in accordance with the registered design.

In addition to stamping every vessel with the registration number given above and as required in CSA Code B51, a Manufacturer's Data Report must be forwarded to this office immediately at the time a vessel is shipped. Such forms may be obtained upon request.

Sincerely,

John Gosselink

Design and Registration

#327 Reg. of Design

REMARKS: CRN registered under reciprocal agreement.



FARRIS PRESSURE MANAGEMENT

EDMONTON FACILITY

INSPECTION TEST REPORT

CUSTOMER: ENERFLEX SYSTEMS ORDER#: 649456 SE#: 649456-01 MetalTag: _____
 PO: 0671604

TYPE: 26HA13-120 VALVE SIZE: 2"600RFx3"150RF ORIFICE: H FactorySerial #: 498572-2-A10 CRN#: OG8442.5C

SPRING: _____

SERVICE: GAS StampSymbol: UV NB

CAPACITY: 19383 SCFM

Set Pressure	BackPressure	Diff	ColdDiff	Temp. Corr.	Temperature
<u>1270</u> PSIG	<u>0</u> PSIG	<u>1270</u> PSIG	<u>1270</u> PSIG	<u>0</u> PSIG	<u>60</u> F
<u>8757</u> KPAG	<u>0</u> KPAG	<u>8757</u> KPAG	<u>8757</u> KPAG	<u>0</u> KPAG	<u>16</u> C

MATERIAL/HEAT NUMBER ASSIGNMENT:

MTR'S REQUIRED Body y7477 Nozzle p501 InspectionRequiredBy _____
 WITNESS TEST REQUIRED Bonnet y7467 Disc 888222 _____

PERFORMANCE TEST DATA:

Test Fluid: Air Final Test Pressure: 1270 PSIG
 Waters 8757 KPAG
 Air Over Water

Upper B.D.R. Setting: N/A Notches
 Lower B.D.R. Setting: -11 Notches
 Shop Test Gauges Used: 1. 11A 2. 11B

BackPressure TEST:

Not Applicable, (Open Bonnet / Cap Design)
 120 PSIG Air

SEAT TIGHTNESS TEST: API-527

Test Fluid: Air Reg'd At: 90%
 Waters 95% Of Set Pressure
 Air Over Water

Leak Test Pressure: 1143 PSIG 7881 KPAG
 No Visible Leakage:
 LeakRate: 12 B.P.M. Final Inspection / TechTested: [Signature]
 DateCompleted: 7/5/2006

FOR WITNESS TESTING ONLY

Tested By: _____ Date: _____
 Customer Witness: _____ Farris Witness: _____



FARRIS PRESSURE MANAGEMENT

EDMONTON FACILITY

INSPECTION TEST REPORT

CUSTOMER: ENERFLEX SYSTEMS ORDER#: 649456 SE#: 649456-02 MetalTag: _____
 PO: 0671604

TYPE: 38GC14-120 VALVE SIZE: 1.5"900RFx3"300RF ORIFICE: G FactorySerial #: 494459-2-DA CRN#: OG3308.5C

SPRING: _____

SERVICE: GAS StampSymbol: UV NB

CAPACITY: 1615 SCFM

Set Pressure	BackPressure	Diff	ColdDiff	Temp. Corr.	Temperature
<u>1650</u> PSIG	<u>0</u> PSIG	<u>1650</u> PSIG	<u>1650</u> PSIG	<u>0</u> PSIG	<u>60</u> F
<u>11377</u> KPAG	<u>0</u> KPAG	<u>11377</u> KPAG	<u>11377</u> KPAG	<u>0</u> KPAG	<u>16</u> C

MATERIAL/HEAT NUMBER ASSIGNMENT:

MTR'S REQUIRED Body h23 Nozzle f30 InspectionRequiredBy _____
 WITNESS TEST REQUIRED Bonnet m9 Disc _____

PERFORMANCE TEST DATA:

Test Fluid: Air Final Test Pressure: 1650 PSIG Upper B.D.R. Setting: _____ Notches
 Waters 11377 KPAG Lower B.D.R. Setting: Fixed Notches
 Air Over Water Shop Test Gauges Used: 1. 11A 2. 11B

BackPressure TEST:

Not Applicable, (Open Bonnet / Cap Design)
 120 PSIG Air

SEAT TIGHTNESS TEST: API-527

Test Fluid: Air Reg'd At: 90% Leak Test Pressure: 1485 PSIG / 10239 KPAG
 Waters 95% Of Set Pressure No Visible Leakage: LeakRate: 0 B.P.M. Final Inspection / TechTested: J.S.
 Air Over Water DateCompleted: 4/5/2006

FOR WITNESS TESTING ONLY

Tested By: _____ Date: _____
 Customer Witness: _____ Farris Witness: _____



TEST REPORT

BRANCH:

Serial #: 236364

Work Order: 204492

Customer PO#: 0671597

Date: 6/27/2006
Facility: CALGARY
A#:
Cust. Ref.:

LSD:

Customer: Enerflex Systems Ltd.
PSV Location:
Cust Id: TAG: 060158
Valve PO: 0671597

VALVE DATA

Man.: Mercer Model: 81-17151V09G11 Serial: 236364
Conn: Threaded Inlet: 1 inch MNPT Orifice: E Outlet: 1 inch FNPT
Set Pres: 165 PSI Back Press: 0 PSI Temp: 70 Cold/Diff Set Press: 0 PSI Cap: 608 SCFM
Lift Lever: Cap Assembly: Closed Trim: Standard Code Symbol: UV CRN#: 0G8841.5C

CUSTOMER INSTRUCTIONS

Valve Instruct. Factory Set Instructions: Sold New Valve Reset Required?
RESET INFORMATION: New Pressure: New Cold/Diff Set: New Capacity:

COMPONENTS INSPECTION

Components Installed

Components Removed

New Model #: Spring #: New Inlet Size:
Trim: Standard Valve Medium: Gas / Air Temperature: 70
Disassembly: Inspection: Kelly Lyness Reassembly:

FINAL TEST:

Test Medium: Simmer: Set Pressure:
Reseat: Leakage: BPM B.P. Test: Cold/Diff Set:
Test Gauge:
Tested by:

FINAL INSPECTION:

SEAL Installed: End Protectors Installed: Painted: Palletized: Ship Container: Flex Gaskets Supplied:
Final Inspection: Kelly Lyness Customer Inspection INSPECTION ID#: 6133

Comments: