J-W Power Company

District 11

Unit Number: **7351**
Type: **EA- 200-4**
Configuration: **10.75 - 5.50 - 3.63 - 1.75 X 3**
Unit Part Number: **996-00007**

J-W Power Company
District 11
HWY 322 South
PO Box 12340
Longview, TX 75607

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TECHNICAL DATA



Start – Load – Unload – Shutdown Procedures

The procedures that follow are intended to be followed in many situations where gas compressor packages are installed. The operation of gas compressor machinery and associated installations has many associated risks due to the combination of high pressures, high-speed mechanical equipment, high temperatures and in some cases harmful or lethal gases. It is impossible to cover all possible cases in the limited scope of this document as not all compressor installations are designed alike for many reasons. In all cases it is the operators responsibility to fully understand the peculiarities of each individual site with regards to piping system design, gas or gasses being compressed, machinery employed and any special local/site concerns. Although these procedures can be used for many types of machinery they are intended to cover only the starting, loading, unloading & shutdown of portable reciprocating & rotary screw type packages.

- Starting -

Things to consider before starting:

1) Was the machine last shutdown manually?

2) Did the safety panel shut the unit down?

3) Has mechanical repair work or maintenance been done since last shutdown?

4) Is this a new installation?

If the machine was last shutdown manually for no known compressor malfunction the following procedure may be used:

Basic Start Procedure

a) Close process gas inlet or “suction” block valve.
b) If the unit or site piping has a “by-pass” line with manual valve to allow pressure equalization with out the discharge of process gas to the atmosphere, open the valve.
c) If the unit is not equipped with a pressure equalization “by-pass” valve, release pressure on the process gas system of the package by opening the “blow down” valve near the final discharge flange of the gas cooler.

- Safety Note -

Wear ear protection

d) Decrease throttle or speed setting on engine driven packages. This can be accomplished in several ways depending on engine type and fuel system. The engine speed governor can be set to lower speed setting either by means of a manual lever or throttle cable knob. Some larger units with pneumatic throttle control have a speed adjustment knob that is turned counter clock wise to reduce speed. On smaller units the incoming fuel line ball valve is simply "pinched" during start to limit the furl to the engine thus reducing RPM. In any case the operator must under stand how to control speed to keep from inadvertently testing the over speed during start-up.

e) Prelube compressor if unit is equipped with manual prelube pump and no automatic prelube system. Pump until there is an indication of pressure on the system gauge or the pump becomes hard to actuate indicating a rise in lube system pressure.

f) Reset annunciator to start the 5-minute start timer. On older units with "tattletale" type safety panels, give the start timer a twist to approximately 5 minutes.

g) Reset electric fuel safety shutoff valve if unit is so equipped. Some units have oil pressure type safety shutoff valves. These valves can be manually latched in the start position or left closed so that oil pressure opens it during starting.

h) Insure all personnel are wear a unit start is going to be attempted. Allow all personnel sufficient time to take appropriate action to be safe and if necessary call off the start.

i) When starting a rotary screw package it can be advantageous to "crack" the suction block valve before attempting to start the package. The resulting pressure against the rotors can help turn them as well as push any excess oil through the compressor making it easier to turn.

j) Initiate start sequence. There are several ways to start the engines and/or electric motors used in gas compression.
Electric motor – Press start button.

Electric starter equipped gas engines – Press start button until engine "fires". Release start button.

Gas/Air starter equipped gas engines - Press start button until engine "fires". Release start button. Some units have spring-loaded ball valves to activate the starter. Activate the handle and release when the engine starts. Some units have a simple "ball valve" in the starter inlet line. Activate the handle and manually return to closed position when engine starts. In all cases be sure the starter disengages from the engine flywheel after the engine starts.

- Safety Note -

On units with high-speed vane or turbine motor type starters, it is recommended that the starting personnel position be well away from the starter motor. Any gas type starter must have the exhaust vented well away from the engine to reduce the

chance of fire or explosion. Never smoke or intentionally create sparks around an active gas compressor package, especially during the start sequence.

Newer large Caterpillar powered packages – Rotate switch on the Engine Supervisory System panel to the start position. The prelube/start sequence will be automatic with the fuel shutoff valve opening at the appropriate time. Starting should be automatic.

Ajax units with "high pressure to power piston" type start systems – **This unique type of starting system requires on-site training and can be very dangerous if not accomplished correctly.** The basic procedure is to close the start system vent valve and open the starting cam/valve box inlet ball valve. The engine should begin to rotate in a **clock-wise direction**. As the engine gains speed the start ball valve is momentarily closed allowing the combustion chambers to "lean out" and "fire". The main fuel manual valve can then be slowly opened to sustain engine RPM. Open the start system vent valve. If the engine does not roll when the start valve is opened the crankshaft may be in a "top/bottom dead center" position not allowing the pressure to push the power piston(s) and thus rotate the crankshaft. Generally if the flywheel key is **exactly** in the 9:00 or 3:00 o'clock position the engine will not roll. In this situation the flywheel must be rotated a few degrees (20 to 30) off of top/bottom dead center using the start system bleed valves or a suitable bar in the flywheel. This procedure is known as flywheel "spotting". Spotting the flywheel using the bleed valves on a multi-cylinder Ajax is best left to on site training by a knowledgeable operator. Spotting the flywheel using a bar can be very dangerous and must be approached with caution. Close the starting system ball valve and upstream isolation valve. Open the start system vent valve. Disable the ignition system. Roll the flywheel 20 to 30 degrees off top/bottom dead center. Stow flywheel bar. Replace flywheel guard (if opened). Enable ignition. Open start system supply valve. Attempt to start engine as described earlier.

k) Be sure engine and compressor lube oil pressures are appropriate – If unit is started "cold" the oil pressures will likely be higher than after unit rises to operating temperature. Generally do not operate in any case at less than 20 PSI. Most low pressure "kill" points are set at 35 PSI with a few at 30 PSI. Caterpillar G-342 engines usually run about 30 to 35 PSI. Ajax units are of the "splash" lube type system. During warm-up run at least 250 RPM to insure adequate oil distribution.

l) It is good practice to close the start system supply valve after a successful start is made.

m) Allow unit to approach operating temperature – On water-cooled engines the engine jacket water temperature should be allowed to rise to 120 to 140 degs. F before loading. Ajax units may not reach 120 degs. during warm-up, but should be at least warm to the touch on the power cylinders and around the engine and compressor crosshead slides.

- Note -

During warm-up it may be necessary to either lower the process gas low pressure "kill" points on the safety panel switch gauges or repeatedly reset the safety panel start timer. If the timer is reset several times be absolutely sure the oil pressures are constantly checked as there will be no low pressure protection while the timer is active.

n) Increase engine speed to desired operating speed – The unit is now ready to be loaded when the start timer has expired.

- Starting What IF's -

If the machine was last shutdown by the safety panel – The reason for shut down must be considered. There are only a few situations in which a unit may be restarted, loaded and put "on-line" without contacting a service technician. 1) Low suction pressure – Field/process conditions and suction pressure control valve operation must be considered. 2) High discharge pressure – Field, pipeline & process conditions must be considered. 3) High engine jacket water temperature – On HOT summer days, if the cooling system is full of coolant the unit can be restarted after it has sufficiently cooled. 4) Engine, Compressor & Cooler vibration – Possibly only immediately after a hailstorm has passed by. **For any other shutdown reasons contact the party responsible for machine maintenance before attempting a restart.**

If mechanical repair work or maintenance been done since last shutdown - A service technician (preferably the one that did the repair) should be on site for the start and load process. If the process gas system has been open to the atmosphere it must be purged.

If the installation is new - A service technician should be on site for the start and load process. The process gas system has been open to the atmosphere and it must be purged.

- Loading -

1) Slowly open suction block valve

2) As pressure rises slowly close manual "by pass" valve if so equipped.

3) If “blow down” valve is open, close it slowly after allowing enough time to pass (approximately 10 to 15 seconds) to insure any air/gas mixture has been purged from the system.

4) Watch the process gas pressure and temperature gauges to insure they are responding according to application. Typically if the compressor cylinder discharge temperatures are less than 300 degs. the pressures will be in acceptable range if the package has been applied correctly. On a rotary screw package, if the compressor gas/oil discharge temperature is greater than 220 degs. call the appropriate service technician.

5) Reset any safety panel pressure or temperature gauge “kill” points.

6) Watch the machine run loaded until all pressures and temperatures have stabilized within appropriate ranges. Call the responsible service technician with any questions. When in doubt, ASK.

7) Walk around the machine once to notice any abnormal fluid or gas leaks.

8) The machine should be ready for unattended operation.

- **Unload** -

1) Slowly open “Bypass valve” if so equipped.

2) Close suction block valve.

3) Slowly open final stage “blow- down” valve. If unit is equipped with a “bypass valve” the “blow down “ valve can be left shut.

- **Stop** -

1) Allow unit to run 3 to 5 minuets to allow engine and compressor temperatures to somewhat equalize. Electric motor driven units may be shut down immediately.

2) Shut fuel supply valve or press stop on annunciator or switch stop/run switch in panel to off.

- **Safety Note** -

If at any time the operator believes the unit to be unsafe to operate for any reason, he or she has the responsibility to call the responsible service technician. The operator has the right to follow any and all lockout tag-out procedures as necessary.

335-10874
REV 01
DATE 3/8/96
APPROVED DKL

J-W POWER COMPANY
P.O. BOX 12340
LONGVIEW, TEXAS 75607
Compressor Manufacture Center
(903) 643-3413

The use of a start-up strainer is strongly recommended on all J-W Operating compression units. A start-up strainer with at least 40 mesh screen and 200% open area should be installed before the suction scrubber. The strainer is for start-up only, and should be removed as soon as practical. After being removed, they can be cleaned and re-used on other compressor units at start-up.

J-W Power will have in stock or can readily fabricate a start-up strainer spool for use on this unit. Please contact the parts department for cost and availability.

UNIT START-UP EVALUATION FORM

PLEASE PRINT

Unit: _____ **Type:** _____ **Unit Start-up Date:** _____

District: _____ **Location:** _____ **Customer:** _____

(PLEASE CIRCLE ONE)

1) Were there any items short, missing or damaged on unit — Yes ☐ No ☐
If marked yes, please explain:

_____

_____

2) Were there any complications @ start-up in regard to design, Packaging or performance:
If yes, please explain: — Yes ☐ No ☐

_____

_____

_____

_____

3) Were there any leaks, i.e.: oil, antifreeze, gas, etc. — Yes ☐ No ☐
If yes, please explain:

_____

_____

4) Please rate the overall appearance of this unit regarding quality of workmanship, paint, decals, etc.
Comments:

Best……Worst
1 2 3 4 5

_____

_____

5) Are there any recommendations you may have for future builds of this type:

_____

_____

Date Report Completed: _____ **By:** _____
(Please print)

Call Back Phone Number(s): _____

* Please make any additional comments on back if not enough space above *
** Please return in postage-paid envelope to J-W Mfg - Longview **

PRODUCT IDENTIFICATION CONTROL SHEET

Unit Number: 7351

Unit Work Order Number: 134769

Unit Part Number: 996-00007

Type: EA- 200-4

Configuration: 10.75 - 5.50 - 3.63 - 1.75 X 3

Unit Height: 10' 8" Unit Width: 8' 6" Unit Length: 12' 8"

Unit Weight: 14500 lbs

Product Description Manufacturer	J-W Part Number Model Number	Serial Number Quantity

MOTOR

MAIN ELECTRIC MOTOR TECO	825-00161 EP2004	VB.AC168093-4 1

COUPLING

DRIVE COUPLING TB WOODS	250-02829 GCH 40-35	N/A 1
COUPLING DRAWING T B WOODS	335-28371 N/A	REV 00 1

COMPRESSOR

COMPRESSOR FRAME ASSY ARIEL	896-00910 JGQ/2	F-53162 1
1ST STAGE CYLINDER ARIEL	850-00619 10.75 X 3 P-HE TDM 225# MAWP	C-189414 1
2ND STAGE CYLINDER ARIEL	850-00618 5.50 X 3 P-CE TDM 525# MAWP	C-189423 1
3RD STAGE CYLINDER ARIEL	850-00609 3.63 X 3 SG-CE TDM 2550# MAWP	C-189419 1
4TH STAGE CYLINDER ARIEL	850-00466 1.75 X 3 SG-FS-HE TDM 6100# MAWP	C-189410 1

COMPRESSOR PRELUBE PUMP	766-00243	16E019-A07-001
PARKER	1HP MTR W/.5" GP	1

COOLER

COOLER	329-01115	8009072-1002
SUPER RADIATOR COILS	B83-11083	1

COOLER DRAWING	335-22834	REV 09
SUPER RADIATOR COILS	N/A	1

COOLER FAN MOTOR	825-00193	1033105268
TECO	10HP 900 RPM TEFC 284T	1

COMPRESSOR OIL COOLER	329-01127	N/A
THERMAL	M-30	1

PRESSURE VESSELS

1ST INTERSTAGE PROCESS GAS FILTER	252-01289	N/A
PARKER	HS8S-100WSN	1

2ND INTERSTAGE PROCESS GAS FILTER	252-01248	N/A
FINITE	JS4C-WSN	1

3RD INTERSTAGE PROCESS GAS FILTER	252-01248	N/A
FINITE	JS4C-WSN	1

DISCHARGE PROCESS GAS FILTER	252-01238	N/A
FINITE	JS4C-10CN	1

FINAL PROCESS GAS FILTER	252-01237	N/A
FINITE	JS4C-4CN	1

BLOWDOWN TANK	330-02029	C9105 NB 8095
J-W POWER COMPANY	28 300#V	1

PANEL

CONTROL PANEL J-W POWER COMPANY	328-00820 UL NNNY	N/A 1
PANEL DRAWING J-W POWER COMPANY	335-29548 UL NNNY	REV 01 1
MOTOR CONTROL PANEL MOTION	328-00633 48 X 36 X 16 460V	N/A 1
MOTOR CONTROL PANEL DRAWING J-W POWER COMPANY	335-25174 N/A	REV 07 1
MOTOR STARTER DRAWING J-W POWER COMPANY	335-25245 N/A	REV 03 1
MOTOR STARTER DRAWING J-W POWER COMPANY	335-26558 N/A	REV 00 1

INSTRUMENTS

INSTRUMENT GAS RELIEF VALVE MERCER	635-03133 91-06D51V06I1 SET @ 120#	N/A 1
1ST STAGE PRESSURE SAFETY VALVE MERCER	635-03008 91-62D61T07I1 SET @ 225#	1266902 1
2ND STAGE PRESSURE SAFETY VALVE MERCER	635-03012 91-62C61T09C1 SET @ 525#	1266906 1
3RD STAGE PRESSURE SAFETY VALVE MERCER	635-03019 91-62C61P13C1 SET @ 2000#	1266910 1
4TH STAGE PRESSURE SAFETY VALVE MERCER	635-03024 91-62C61P5641 SET @ 5000#	127066 1
RELIEF VALVE CNTRL DV	635-00803 ST25-150	N/A 1
BLOWDOWN PRESSURE SAFETY VALVE MERCER	635-03010 91-62E61T11I1 SET @ 300#	1266903 1
BLOWDOWN LEVEL SWITCH MURPHY	712-01056 MLS-020	50003943415 1

OIL PRESSURE RELIEF VALVE FULFLO	635-03196 VJ-5R/HS/US	N/A 1
OIL PRESSURE RELIEF VALVE CNTRLDV	635-03541 ST25-1A050	N/A 1
LOAD SOLENOID VA ASCO	635-01727 EF8320G184	N/A 2
SUCTION SOLENOID VA ASCO	635-01727 EF8320G184	N/A 2
COALESCING FILTER DUMP VALVE OASIS	635-03260 BV7044S6SDDN0124	N/A 2
SUCTION CHECK VALVE CRANE	635-02812 4G15SPF-201	N/A 1
DISCHARGE CHECK VALVE SWAGELOK	635-03587 C146-2	N/A 1
VIBRATION TRANSMITTER METRIX	581-00573 ST5484E-132-114-02	N/A 2
ISOLATION VALVE GATOR	635-01454 1F-LN270CS	N/A 1
PROXIMITY SWITCH WHITLOCK	271-08204 A-18255	28294 2
COMPRESSOR OIL THERMOSTAT VALVE FPE	635-02173 A1110-170	N/A 1
COMPRESSOR OIL CHECK VALVE CRANE	635-01103 76E	N/A 1
COMPRESSOR OIL CHECK VALVE NIBCO	635-00621 T413B100	N/A 1
1ST INTERSTAGE PRESSURE TRANSDUCER ENOVATIO	712-01166 PXT-KM-600	N/A 1
2ND INTERSTAGE PRESSURE TRANSDUCER ENOVATIO	712-01167 PXT-KM-1000	N/A 1

3RD INTERSTAGE PRESSURE TRANSDUCER ENOVATIO	712-01169 PXT-KM-3000	N/A 1
DISCHARGE PRESSURE TRANSDUCER ENOVATIO	712-01170 PXT-KM-6000	N/A 1
BLOWDOWN TRANSDUCER ENOVATIO	712-01166 PXT-KM-600	N/A 1
COMPRESSOR OIL LEVEL CONTROLLER KENCO	593-00334 KLCE-12	09-07-16-038 1
COMPRESSOR OIL PRESSURE TRANSDUCER ENOVATIO	712-01164 PXT-KM-200	N/A 1
SUCTION REGULATOR FISHER	626-00734 627 DI .50 ORF 15-40# SPR	R055637541 1
THERMOCOUPLE WEED	612-00047 3352A-KU-Z180	N/A 2
THERMOCOUPLE WEED	612-00200 W/DRNWIRE	N/A 3

ACCESSORIES

SUCTION VALVE VELAN/BETTIS	635-02811 4VELF01402BET0950MTG, & MTG	N/A 1
DISCHARGE VALVE OASIS	635-03258 BV706-4S6ADDN-1000	N/A 1
AUXILIARY SUCTION VALVE QUADRANT	635-02751 ZNIPV10	N/A 1
BY PASS VALVE QUADRANT	635-03129 ZNIPV10	N/A 1
METHANE DETECTOR SEC	581-00618 490000001004L12	14736 1
OIL HEATER WATLOW	370-00099 BHN717N13C-32	81613H26 1

SOFT START WEG	700-01871 SSW070255T5SZSSW07	1026130701 1

REFERENCE DRAWINGS

PLAN AND ELEVATION J-W POWER COMPANY	335-29521 INSTALLATION DRAWING	REV 00 1
OIL TRIM J-W POWER COMPANY	335-26472 N/A	REV 03 1
PROCESS FLOW J-W POWER COMPANY	335-26022 N/A	REV 05 1
INSTRUMENT GAS TRIM DRAWING J-W POWER COMPANY	335-25689 N/A	REV 05 1
INTERCONNECT DRAWING J-W POWER COMPANY	335-26130 UCP>MCP	REV 01 1

CONSUMABLES

COALESING FILTER ELEMENT FINITE	252-01247 100WS25-187 X 1	N/A 1
CPRSR FRAME OIL FILTER ELEMENT ARIEL	271-06730 A-0661	N/A 1
PROCESS GAS FILTER ELEMENT PARKER	252-01193 KIT F/ JN4C-4CN	N/A 1
PROCESS GAS FILTER ELEMENT PARKER	252-01194 KIT F/ JN4C-10CN	N/A 1
PROCESS GAS FILTER ELEMENT FINITE	252-01252 WSJCK	N/A 2
FUSES GOULD	700-00175 GAB-5	N/A 3
FUSES LITTLEMA	700-00349 ATDR30	N/A 6

FUSES GOULD	700-00631 GAB-10	N/A 4

FUSES BUSS	700-00758 ABC-3 250V	N/A 7

FUSES GOULD	700-01326 GAB-1/4	N/A 6

FUSES FERRAZ S	700-01726 A6T500 500AMP	N/A 0

ORING VITON	285-00228 228 VITON 90 DUROMETER	N/A 2

VARIOUS HOSES PARKER	685-00556 801-16-BLK-RL	N/A 3.5

CNG TESTING CHECKLIST LOAD/ NO LOAD

W/O 134769 UNIT 7351 DATE 1-4-17

THIS PORTION OF PROCEDURE IS FOR A NO-LOAD TEST

1. Record serial numbers on 99.20.1 report on all equipment required for test. Ma.
2. Ensure relief valve protection of systems and confirm set pressures. Ma
3. Add proper amount of preservative to the compressor crankcase and lube box. Ma
4. Visually inspect all piping/tubing for missing plugs or loose fittings/nuts. Ma
5. Power up control panel by wiring in 120v ac to proper terminals. Ma
6. Ensure correct panel program is installed. Ma
7. Set temperature offsets on centurion controllers. Ma
8. On plc controlled units, set up compressor geometry and check set points. \
9. Connect potentiometer test panel to the high, mid, low, direct fill and slow fill to appropriate analog inputs in the unit control panel if applicable. \
10. Install appropriate blind flange on gas inlet of unit for test. Ma
11. Plug discharge tubing fitting on gas outlet using appropriate plug. Ma
12. Close instrument supply line ball valve to packing drain drip tank. Ma
13. Close the blow down valve on the process gas. (final stage) Ma
14. Apply instrument supply to unit through "IA" customer connection. Ma
15. Verify instrument supply transducer range where applicable. Ma
16. Set instrument supply pressure switch to 60 psi and tag if applicable. Ma
17. Check all manual forcing to the following valves if applicable: Suction block, auxiliary suction, drain/load, high bank actuator*, mid bank actuator*, low bank actuator* and slow fill actuator*. (*verify output is energized in the unit control panel for these.) Ma
18. Verify fail position of all control valves. Ma
19. Close needle valves on all process pressure lines to transducers. Ma
20. Make sure blow down tank drain and vent are closed. Ma
21. While suction block valve is open, apply shop air (110 psi) to unit through the gas inlet. Ma
22. Check entire process system for leaks using approved water soap mixture. Ma
23. Verify all transducer ranges per process trim drawing, make sure transducer ranges on dwg make sense. Ma
24. Open lines to panel transducers one at a time and verify they read 110 psi. Ma
25. Check packing / distance piece drains for excessive blowby. Ma
26. Bleed air from process system. Ma
27. Remove air test flange from gas inlet and discharge plug. Ma
28. Open instrument air supply line ball valve to packing drain drip tank with vent closed and check for leaks. Ma
29. While panel is unplugged and safe, wire unit control panel to the motor control panel per correct interconnect drawing. Ma
30. Make sure cooler fan blades will rotate by hand without obstruction. Ma
31. Wire main, cooler, pre-lube motors and heater to the motor control panel per correct interconnect drawing WLM
32. Remove shim pack from coupling on the motor side. \

33. Wire the motor control panel to the 480v source while power is locked out and safe. WLH
34. Install any **temporary** jumpers (Long & orange) needed to clear fire loop or remote ESD faults. **NO OTHER JUMPERS TO BE INSTALLED DURING FULL-LOAD TEST** MA
35. Power up the unit control panel. MA
36. Verify that the ESD circuit is functional and interrupts 120v power to motor control panel when tripped. WLH
37. Set up the main motor, cooler and prelube starter parameters MA
38. Make sure all oil drain valves are closed and all hoses/tubing installed properly. WLH
39. Check oil level controller height. WLH
40. Fill compressor crankcase with correct oil. (oil used Karus 827) WLH
41. Put safety barricade tape or chain around any area where panels are not able to be closed and high voltage will be present. WLH
42. Turn on power to the motor control panel following safe practices. (ARC FLASH HAZARD) WLH
43. Manually force pre-lube motor and cooler motor to verify rotation and correct if necessary by phase change following lock out-tag out procedures. WLH
44. Force the pre-lube motor on, bleed air from high point vent on cooler and fill compressor to center of sight glass. WLH
45. Set the oil relief valve on the pre-lube system to required set-point on oil trim drawing. WLH
46. Verify heater functionality WLH
47. Manually force / bump the main motor. If rotation is backwards, correct by phase change following safe lock out tag out procedures. WLH
48. Disable manual forcing and lock out 480v power. WLH
49. While power is still locked out, reinstall coupling shim pack. —
50. Run unit in manual mode and test all end devices for shutdown in test mode. This includes vibration switches, high blow-down level, low oil level and low instrument supply. MA
51. Verify all event faults if applicable. MA
52. Verify methane detector output calibration and shutdown. MA
53. Apply proper amount of preservative into gas inlet with atomizer sprayer. MA
54. Test lube no-flow switch by removing and waiting for panel to show no flow alarm/SD. MA
55. Adjust lube rate to normal if applicable. MA
56. If applicable, verify 1st stage bypass is operating properly. (Fail open and closes after running. May vary depending on type of unit control.) MA
57. Run unit for 10-15 minutes and look for leaks and abnormal vibrations and noises. MA
58. Using the potentiometer test panel, adjust all storage and direct fill pressures to 4000 psi. \
59. Place unit in auto, it should be ready but not start. Lower high bank pressure slowly below the high bank start pressure. The unit should go through a normal start sequence. \
60. Slowly raise the high bank pressure above the high bank full set-point. The unit should go through a normal cool-down stop sequence. \
61. Verify high pressure shutdowns by raising the bank and direct fill / slow fill pressure above shutdown set-point. \

This concludes a No-load test. Full-load test will commence on page 3

THIS PORTION OF THE PROCEDURE IS FOR A LOAD TEST

62. Install all components of load test loop per test schematic including booster compressor if applicable. _____
63. Verify all MAWP of components and set pressures of relief valves. _____
64. With test loop purged and all leaks found, identify all valves and note their function and desired positions for each of the tests to be performed per the test schematic. _____
65. If applicable, run booster compressor unloaded until warm then assuring all air is purged, load unit and fill volume tanks to desired pressure. _____
66. If applicable, set control valve to maintain desired discharge pressure in volume tanks if needed, If not needed, unload and shut off booster compressor. _____
67. Set desired suction pressure to unit with the control valve. _____
68. Manually force the suction block valve open to pressurize and purge air from process system and check for leaks. _____
69. Place control panel into auto operation. _____
70. Lower high bank start pressure potentiometer to start unit if applicable _____
71. Check suction and blow-down tank valves for proper operation. _____
72. Load unit and ensure all actuated valves operate correctly. _____
73. With unit loaded adjust control valve to desired discharge pressure. _____
74. Load steps and leak checks: _____
    0-500
    500-1000
    1000-1500
    1500-3000
    3000-4150
75. Set blow-down tank regulator anytime during the load steps. _____
76. Re-start unit after reaching max discharge pressure. _____
77. Verify blow-down tank pressure equalizes to suction pressure within 90 seconds after load valves close. _____
78. Ensure local gauge pressures and transducer pressures read equal. _____
79. Check for unusual or extreme vibration under load. _____
80. Minimum of 1hr at max discharge pressure
    (3 sets of flow/temp/press readings: at start, at 30 min then at 60 min) _____
81. Re-check all flange bolts for tightness after load run. _____

END OF PROCEDURE

CNG TESTING CHECKLIST LOAD/ NO LOAD

READINGS

Compressor oil pressure	67
Compressor oil temp.	93
Compressor vibration	.211
Unit on blocks?	Yes / (No)
Cooler vibration	.091
Lube rate (seconds)	43
Decibel level / distance	90 dB @ 15'
Enclosure on?	Yes / (No)
Main motor amps	112 / 112 / 109
Cooler motor amps	~~8.6~~ 13.9 / 14.2 / 14.6
Cooler motor volts	284 / 285 / 285

Matt G — 1-4-17

TESTING TECHNICIAN — DATE

CNG TESTING CHECKLIST LOAD/ NO LOAD

READINGS

W/O #	134769
UNIT #	7351
UNIT TYPE	EA-200
DATE:	1-4-17

TIME:				
	Run 1	Run 2	Run 3	Run 4
Suction pressure				
1st stage pressure				
2nd stage pressure				
3rd stage pressure				
4th stage pressure				
5th stage pressure				
After cooler pressure				
Compressor oil pressure				
Compressor oil temp				
Suction temp				
1st stage discharge temp				
2nd stage suction temp				
2nd stage discharge temp				
3rd stage suction temp				
3rd stage discharge temp				
4th stage suction temp				
4th stage discharge temp				
5th stage suction temp				
5th stage discharge temp				
Final after cooler temp				
Main motor Amp	/ /	/ /	/ /	/ /
Main motor Volt	/ /	/ /	/ /	/ /
Cooler motor Amp	/ /	/ /	/ /	/ /
Cooler motor Volt	/ /	/ /	/ /	/ /
Pre-lube pump Amp	/ /	/ /	/ /	/ /
Pre-Lube pump Volts	/ /	/ /	/ /	/ /
Lube rate cycle time				
Cooler vibration level				
Main motor vibration level				
Decibel level / Distance				
Calculated capacity (SCFM)				
Actual capacity (SCFM)				
Actual capacity (MCFPD)				
Orifice size				

EVENT FAULT LIST

1	AL:	SD:	DESCRIPTION:
2		✓	LO CPRSR OIL LEVEL
3		✓	HI BLDWN TNK LEVEL
4		✓	LUBRICATOR NO-FLOW
5		✓	LOW / HIGH COMP OIL PRESS
6		✓	HIGH METHANE DETECTOR
7		✓	LOW INSTRUMENT AIR PRESS
8		✓	HI CPRSR VIB
9		✓	HI CLR VIB
10		✓	TC/OC OIL TEMP
11		✓	TC/OC SUC TEMP
12		✓	TC/OC 1st STG TEMP
13		✓	TC/OC 2nd STG TEMP
14		✓	TC/OC 3rd STG TEMP
15		✓	TC/OC 4th STG TEMP
16		✓	TC/OC FINAL DIS TEMP
17			HIGH THROW #1 ROD LOAD – COMPRESSION
18			HIGH THROW #2 ROD LOAD – COMPRESSION
19			HIGH THROW #1 ROD LOAD – TENSION
20			HIGH THROW #2 ROD LOAD – TENSION
21			HIGH THROW #1 ROD LOAD – TOTAL
22			HIGH THROW #2 ROD LOAD – TOTAL
23			RECIP COMP LOW / HIGH SUCTION PRESS
24			RECIP COMP LOW / HIGH 1ST STAGE DSCH PRESS
25			RECIP COMP LOW / HIGH 2ND STAGE DSCH PRESS
26			RECIP COMP LOW / HIGH 3RD STAGE DSCH PRESS
27			RECIP COMP LOW / HIGH 4TH STAGE DSCH PRESS
28			RECIP COMP LOW / HIGH BLOWDN TANK PRESS
29			HIGH BANK PRESS HIGH
30			MID BANK PRESS HIGH
31			LOW BANK PRESS HIGH
32			HIGH DIRECT FILL PRESS
33			LOW / HIGH SLOW FILL PRESS
34			HIGH DISPENSER #1 GAS FLOW
35			HIGH DISPENSER #2 GAS FLOW
36			HIGH DISPENSER #3 GAS FLOW
37			HIGH DISPENSER #4 GAS FLOW
38			HIGH DISPENSER #5 GAS FLOW
39			HIGH SLOW FILL PRESS
40			RECIP COMP HIGH OIL TEMP

CNG TESTING CHECKLIST LOAD/ NO LOAD

41			RECIP COMP HIGH SUCTION TEMP
42			RECIP COMP HIGH 1ST STAGE DSCH TEMP
43			RECIP COMP HIGH 2ND STAGE DSCH TEMP
44			RECIP COMP HIGH 3RD STAGE DSCH TEMP
45			RECIP COMP HIGH 4TH STAGE DSCH TEMP
46			RECIP COMP HIGH FINAL DSCH TEMP
47			HIGH AMBIENT TEMP
48			LOW / HIGH DIRECT FILL PRESS
49			LOW / HIGH SLOW FILL PRESS
50			DISPENSER #1 GAS FLOW XMIT FAIL
51			DISPENSER #2 GAS FLOW XMIT FAIL
52			DISPENSER #3 GAS FLOW XMIT FAIL
53			DISPENSER #4 GAS FLOW XMIT FAIL
54			DISPENSER #5 GAS FLOW XMIT FAIL
55			LOST XMT / FAIL OIL PRES
56			LOST XMT / FAIL SUC PRES
57			LOST XMT / FAIL 1st STG PRES
58			LOST XMT / FAIL 2nd STG PRES
59			LOST XMT / FAIL 3rd STG PRES
60			LOST XMT / FAIL 4th STG PRES
61			LOST XMT / FAIL STORAGE PRES
62			LOST XMT / FAIL CPRSR VIB
63			LOST XMT / FAIL CLR VIB
64			LOST XMT / FAIL METH DET
65			LOST XMT / FAIL BLDWN TNK PRES
66			LOST XMT / FAIL DIRECT FILL PRES
67			LOST XMT / FAIL HIGH BANK PRES
68			LOST XMT / FAIL MID BANK PRES
69			LOST XMT / FAIL LOW BANK PRES
70			PRLB MTR RUN FAIL
71			MAIN MTR RUN FAIL
72			RECIP COMP UNLOAD FAIL STOP
73			RECIP COMP LOAD / LUBE PULSE PERMISSIVE FAILURE
74			PRLB PRES FAILURE
75			SOFT START FAULT
76			LOST M MTR RUN FDBK
77			CONTROL MODE – OFF
78			Local Mode
79			RECIP ESD CONDTION EXISTS
80			FIRE LOOP ESD

007-00814 -- KIT CONVERSION UNIT 7351TO PLC & GAS ACTUATED

Seq Nbr	Component	Description		Qty Per	UM
0	005-00950	KIT INST AIR TO INST GAS	CONVERSION CNG OPTION C	1.00	EA
0	328-00680	PANEL MURPHY CENTURION	CNG UCP *	-1.00	EA
0	328-00753	PANEL PLC UNIT CNG	UL NNNY	1.00	EA
0	332-01801	SUPPORT PANEL	PLC MOUNT ON UNIT	1.00	EA
0	335-29521	EA- 200-4 UNIT #7351		1.00	D
0	700-00938	BODY CND .75 F35 LB	RGD/IMC W/COVER&GASKET*	4.00	EA
0	700-02150	GROUND LUG 6-350	BLACKBURN ADR35-21	3.00	EA
0	700-02242	HUB 0.75 MYERS	CS	8.00	EA
0	700-10201	NIP .75 CLOSE	GALV CND	12.00	EA
0	700-11530	CND .75 RIGID GALV	*	40.00	FT
0	730-00210	CONSUMABLE BOM @ 4%		49.70	EA
0	731-00000	FREIGHT BOM @ 5%		62.12	EA
0	990-00099	HONEYMOON KIT CNG ELECTR	PANELS 328-00496 & 00606	1.00	EA
0	990-00100	HONEYMOON KIT CNG ELECTR	PANELS 328-00680 & 00681	-1.00	EA

SERVICE BULLETINS



J-W POWER COMPANY
DISTRICT 11
P.O. BOX 12340
LONGVIEW, TEXAS 75607

(903) 643-3413
Compressor Manufacturing Center FAX (903) 643-3586

SERVICE BULLETINS

J-W Service Bulletins are constantly in the process of being updated. These Bulletins contain important information for maintenance, service and operation of our equipment.

Please contact a J-W Service Supervisor for a current copy of the Service Bulletin Manual or contact the Media Department at:

J-W Power Company
P.O. Box 12340
Longview, TX 75607

903-643-3413
903-643-3586 (Fax)

Service Bulletin

Bulletin No. 12.1-001
REV 01……3-13-03*

SUBJECT

Major Components' Warranty Start-up

It has become imperative that we maintain consistency when submitting start-up documentation for major components (engines, electric motors, compressors, etc.) in order to take full advantage of the entire warranty period allowed. In an effort to achieve this task, we will begin including in each control panel of a unit, a postage paid self addressed envelope with the appropriate start-up documents, whether it be Caterpillar, Waukesha, Arrow, Ariel, Gardner Denver, Sullair, etc. We ask that you fill out form(s) where applicable and maintain a copy for your records in case envelope is lost in route back to Dist.11 for some reason. Please note for postage purposes, only return forms required to be filled out, not the service bulletins so weight of envelope does not exceed postage stamp limit. Once Dist. 11 receives this information it will be checked for accuracy and then submitted to appropriate manufacturer for warranty period initiation.

Ref: Service Bulletin No. 3.2-003 Ariel Frame Start-up's
Service Bulletin No. 1.3-025 Caterpillar Delivery Inspection and Warranty Validation Procedure

***** This Service Bulletin was initially in Section 11 General as 11.4-002. Content is still the same.

Service Bulletin

Bulletin No. 3.2-003
Rev 02……. 2/15/05

SUBJECT

Ariel Frame Start-up's

Due to recent failures on J-W packages involving an Ariel compressor, it has been decided that it become mandatory to complete Ariel's "Start-Up Check List ER-10.4.0" that is supplied with each new frame. Ariel as a company has been lenient on us in the past in the absence of this requirement, but the time has come to fulfill this obligation.

Completion of this data will be advantageous in situations of catastrophic failures that require Ariel assistance in failure analysis and/or warranty. It will help assist them in determination of cause and will also save time from having to go and locate this information.

Effective immediately, the required checklist will be placed in the control panel of each applicable unit along with a postage paid envelope, which is to be mailed back to Dist.11 Attn. QC Dept. Dist.11 will fill out a portion of the form regarding general information prior to shipping from Longview. Dist.11 will also include in the panel a copy of the Alignment Record as recorded during fabrication and Test Cell Documentation with compressor clearances, to be used as a reference only. The operating district will be required to complete the remainder of the list. As a supplement to this or any other package built by J-W, a Unit Start-up Evaluation Form will now come with each unit as well to ascertain feedback from the field level. Your suggestions and comments are welcomed and will be evaluated for further action(s), if required.

Again, it is very beneficial as a company that we complete this documentation mandated by Ariel Corp. Furthermore, in cases of Ariel compressor failures, it is extremely important to contact the J-W Technical Services Group and/or Dist.11 as soon as possible if the frame is within the warranty period***** in order for contact to be made with Ariel giving them the option to either come out on site and physically inspect damages incurred prior to repairing (or) for guidance on proper warranty protocol. It has been indicated that Ariel can be on site within a 24hr time period if deemed necessary. Please keep in mind, if Ariel comes out on site and it's determined not to be a warrantable issue, they could invoice J-W for travel expenses, etc.

*** Frames shipped from Ariel after 1-1-03 have a 72 month warranty if Ariel OEM replacement parts are used. Frames shipped prior to this have a 36 month warranty. See Ariel's limited warranty policy for details.**

Service Bulletin

Bulletin No. 11.1-004
REV 00.....6-06-05
REV 01.....8-15-07

SUBJECT

Recommended Maintenance Intervals for Ariel Reciprocating Compressors

Attached is Ariel's published document ER-8.2 of their Recommended Maintenance Intervals on their reciprocating compressors. Please assure this information is made aware to necessary personnel and that the guidelines are being followed and understood. This information will be updated as often as Ariel updates it. If there is ever any doubt of latest release of this document, feel free to contact Dist. 11 for confirmation.

RECOMMENDED MAINTENANCE INTERVALS - RECIPROCATING COMPRESSORS

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.

Daily

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 Ariel Technical Manual, Fastener Torque Tightening Values or Toolbox Torque Chart, ER-63. After the first week or 150 hours, repeat this fastener torque check.

8	**At Monthly + para. 2. At 6-Months/8. + frame top mounting surface flatness tol. check. At Yearly, delete 8. & move 9. to 6-Mo. Re-numbered as required. Delete footnotes & move up into text.**	6	013013	9-8-05			
		5	012786	4-13-05			
		4	011765	2-6-04			
		3	ECN7924	--	8	014236	3-19-07
REV	**DESCRIPTION**	2	ECN7228	--	7	013283	1-16-06
		REV	**EC**	**DATE**	**REV**	**EC**	**DATE**

If bearing temperatures increase or a visual inspection of the crankcase indicates bearing wear, check main, connecting rod and crankshaft-thrust bearing clearances. Replace affected bearings if clearances are out of tolerances. See the Ariel Technical Manual for instructions and clearance tolerances.

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.

Monthly (in addition to Daily Requirements)

After running a new compressor (or after a re-location, re-configuring or major overhaul) for the first month or 650 hours, shutdown, vent gas system and check fastener torque on gas nozzle flanges, valve caps, cylinder heads and compressor rod packing flanges. Reference Ariel Technical Manual, Fastener Torque Tightening Values or Toolbox Torque Chart, ER-63. 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.

1. Check and confirm safety shutdown functions.
2. Take a frame oil sample and send to a reputable lubricant laboratory for analysis. See the Ariel Packager's Standards or Technical Manual Lube Section for a listing of what an oil analysis should provide. If the oil analysis results indicate, change oil. If an oil analysis indicates lead, tin or copper particles in the oil, check main, connecting rod and crankshaft-thrust bearing clearances. If bearing clearances

are outside of the limits, replace the affected bearings. See the Ariel Technical Manual for instructions and clearance tolerances.

Every 6 Months or 4000 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 Ariel Technical Manual, Lube Section for value.
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 is 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. Inspect for frame twist or bending to be sure the main bearing bores are in alignment. Check frame top cover mounting surface flatness tolerance (reference Ariel document ER-82), or for 2-throw and JGH:E:K:T/4 or smaller frames a soft foot check may be used. For soft foot check, more than 0.002 inch (0.05 mm) pull down requires re-shimming.
9. Realign if necessary to hold coupling hot alignment within 0.005 inch (0.13 mm) TIR.
10. Check cylinders for the proper lubrication rates. Reference Ariel Technical Manual, Lube Section for a practical indication using the paper test method.

Yearly or 8000 Hours (plus Daily/Monthly/6 Months)

1. Check main, connecting rod, and crankshaft-thrust bearing clearances with a pry bar and dial indicator. See the Ariel Technical Manual for instructions and clearance tolerances. Any time bearing clearances are outside the limits, 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 Ariel Technical Manual, Clearances Table, replace the affected parts.
3. Inspect valves for broken plates and loose center bolts, replace broken parts and tighten center bolts. Reference Ariel Technical Manual, 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, efficiency can be affected and/or rapid ring wear can result, 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 Ariel Technical Manual, Clearance Tables.
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.
8. Check and re-calibrate all temperature and pressure gauges.
9. Check and record compressor rod run out.
10. Grease VVCP stem threads at grease fitting, with 2 to 3 pumps of multi-purpose grease using a standard hand pump grease gun.
11. Clean crankcase breather filter.
12. Adjust drive chains.
13. Pressure test distribution blocks.
14. Check gas nozzle flange, valve cap, cylinder heads, 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.
15. 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.



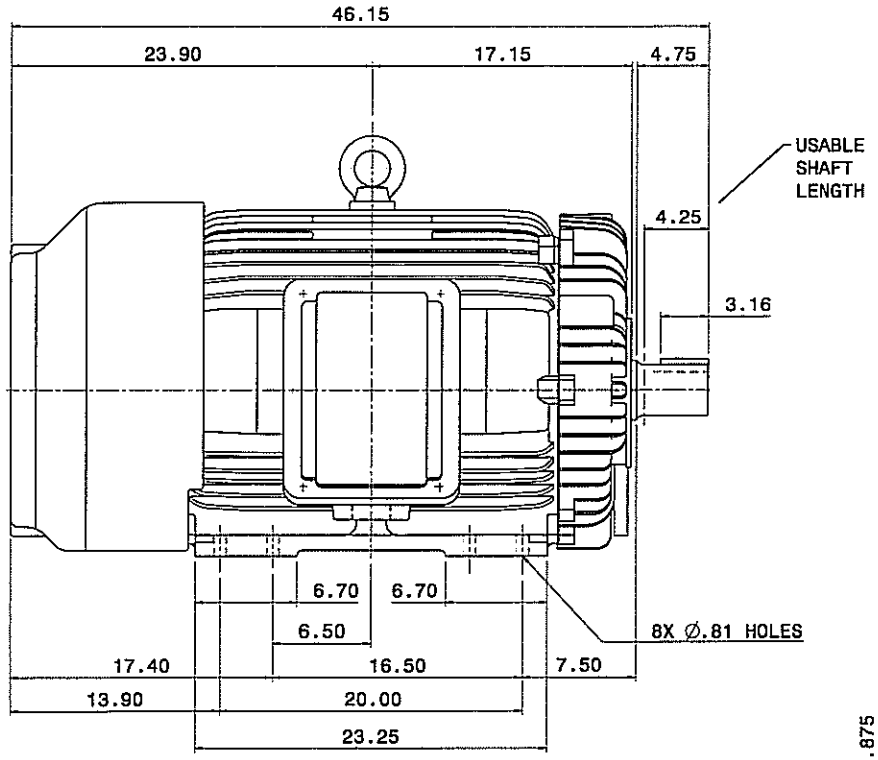
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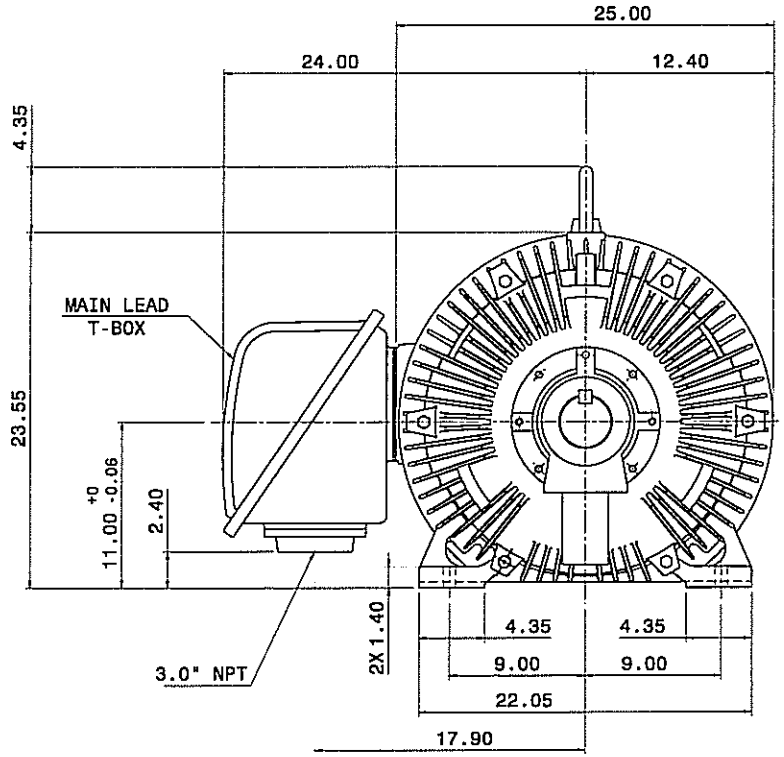
MOTOR

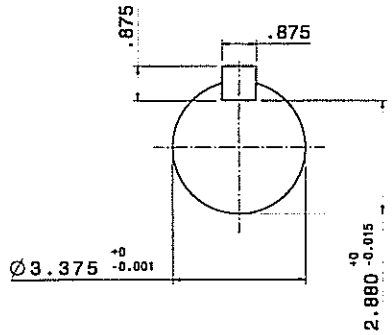


CATALOG #	TYPE	FRAME	OUTPUT HP	OUTPUT kW	POLE	SYN. SPEED R.P.M.	VOLTAGE V.	Hz.	TIME RATING	INSULATION CLASS	SERVICE FACTOR	BEARINGS DE	BEARINGS NDE	WEIGHT LBS
EP2004	AEHH8N	447T	200	149.2	4	1800	460	60	CONT.	F	1.15	6320C3	6316C3	~~2450~~ 2106#

TOTALLY ENCLOSED FAN-COOLED TYPE. SQUIRREL CAGE ROTOR







Tag: 825-00161

J-W P/N 825-00161
J-W DWG NO. 335-24736
REV.02 24JUL14
SHEET 1 OF 4

NOTES:

1. DIMENSIONS IN INCH.
2. ENCLOSURE: IP54.
3. FOR DIRECT FLEXIBLE COUPLING.

REV. DATA		
	TECO Westinghouse	REV NO 01
	3-PHASE INDUCTION MOTOR OUTLINE DIMENSIONS	DWG NO. EP2004-M10
REF:	DWN T. FELPS 070513	APPD S. GROHOSKY 070513
	TECO-WESTINGHOUSE MOTOR COMPANY	ROUND ROCK, TEXAS USA

TECO Westinghouse

ISSUED	PERFORMANCE DATA	ENCLOSURE
12/27/2013	3-PHASE INDUCTION MOTOR	TEFC
TYPE		CATALOG#
AEHH8N		EP2004

NAMEPLATE INFORMATION

OUTPUT HP	OUTPUT KW	POLE	FRAME SIZE	VOLTAGE	HZ	RATED AMBIENT	INS. CLASS	NEMA DESIGN	TIME RATING	SERVICE FACTOR
200	149.2	4	447T	460	60	40°C	F	B	CONT.	1.15

VARIABLE FREQUENCY DRIVE SERVICE

VARIABLE TORQUE			
HZ	HP	RPM	TORQUE (lb-ft)
3~60	0.025~200	90~1800	1.458~588

OHMS/PHASE EQUIVALENT WYE CIRCUIT (AT RATED OPERATING TEMPERATURE 25°C)				
R1	R2	X1	X2	X_m
0.0248	0.0232	0.219	0.442	10.3

CONSTANT TORQUE				CONSTANT HORSEPOWER			
HZ	HP	RPM	TORQUE (lb-ft)	HZ	HP	RPM	TORQUE (lb-ft)
6~60	20~200	180~1800	588	60~90	200	1800-2700	588~392

TYPICAL PERFORMANCE

FULL LOAD RPM	EFFICIENCY				POWER FACTOR			SOUND PRESSURE LEVEL @ 3 FT Db(A)
	FULL LOAD		3/4 LOAD %	1/2 LOAD %	FULL LOAD %	3/4 LOAD %	1/2 LOAD %	
	MIN.%	NOM.%						
1786	95.4	96.2	95.8	95	84.5	82.5	78.5	81

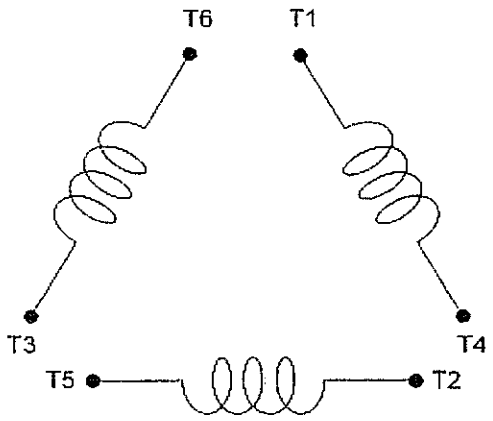
CURRENTS			NEMA KVA CODE LETTER	SAFE STALL TIME IN SECONDS	
NO LOAD	FULL LOAD	LOCKED ROTOR		COLD	HOT
AT 460 VOLT	AT 460 VOLT	AT 460 VOLT			
46.4	230	1450	G	19	13

TORQUE				INERTIA			ACCEL TIME (DOL)		ALLOWABLE STARTS PER HOUR	
FULL LOAD (lb-ft)	LOCKED ROTOR %FLT	PULL UP %FLT	BREAK DOWN %FLT	ROTOR WR^2 ($lb\text{-}ft^2$)	NEMA LOAD WK^2 ($lb\text{-}ft^2$)	MAX ALLOWABLE WK^2 ($lb\text{-}ft^2$)	NEMA LOAD WK^2 Sec	MAX ALLOWABLE WK^2 Sec	COLD	HOT
588.00	120	95	210	73.5	831	1662	5.52	10.59	2	1

APPROVED:	M. PRATER	DRAWING NO.	31057EP2004	REVISION:	0

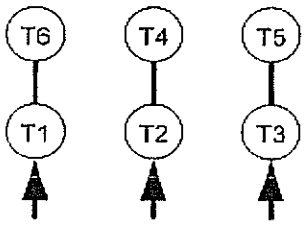
J-W P/N 825-00161
J-W DWG NO. 335-24736 REV.02 24JUL14
SHEET 2 OF 4

DATE: November 10, 2005	CONNECTION DIAGRAM	CATALOG NO.: EP2004



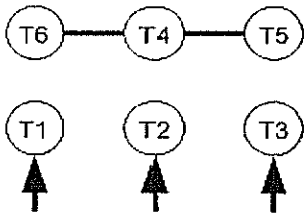
SCHEMATIC - Δ / Y CONNECTION

ACROSS THE LINE CONNECTION

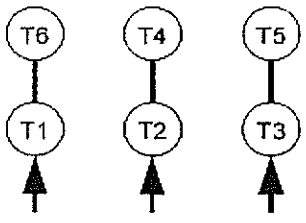


460 VOLT CONNECTION

WYE START-DELTA RUN CONNECTION



LINE
460 VOLT START



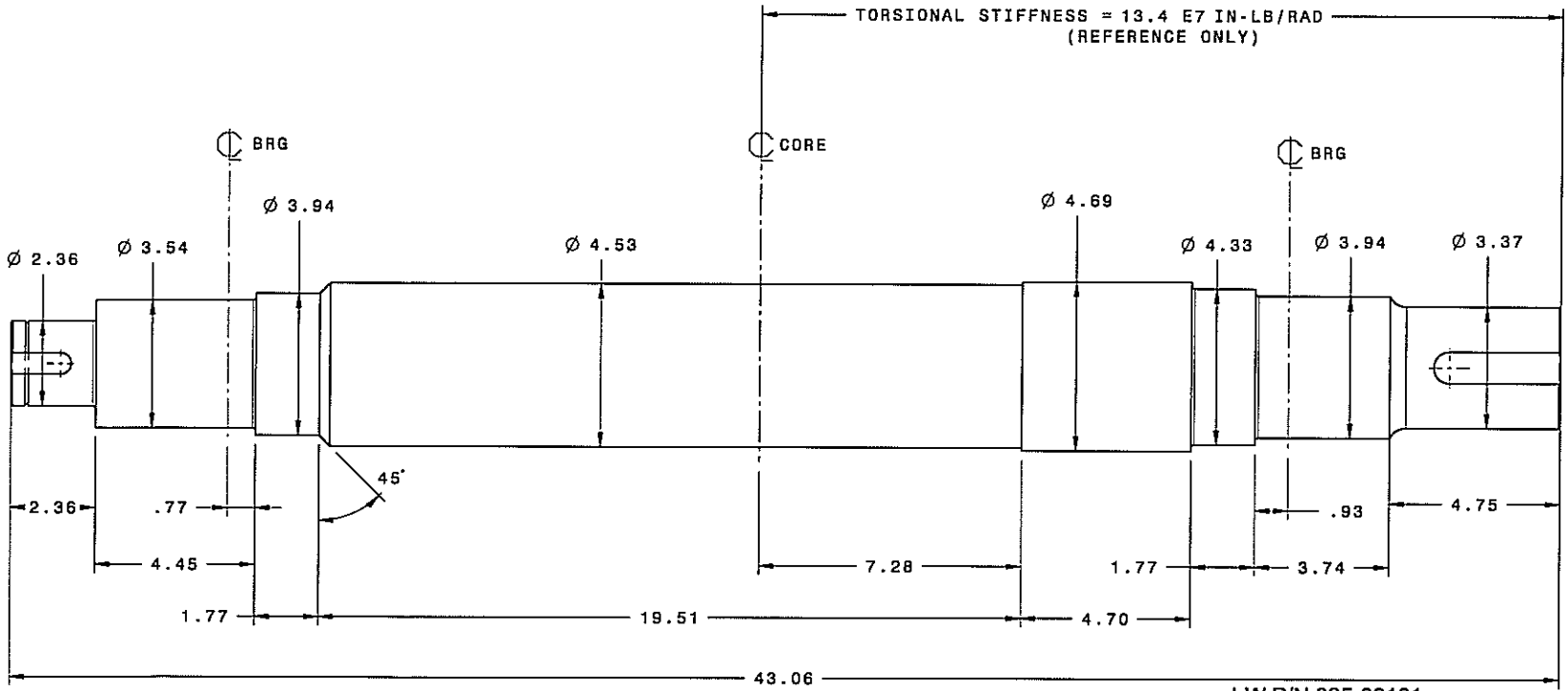
LINE
460 VOLT RUN

TECO Westinghouse

DWG NO. **DAC-1545-3**

MASS - ELASTIC DATA
SHAFT MATERIAL - HOT ROLLED STEEL JIS-G-4051-S45C
SHAFT MODULUS OF RIGIDITY = 11,500,000 PSI
SHAFT ULTIMATE TENSILE STRENGTH = 82,000 PSI
SHAFT TENSILE YIELD STRENGTH = 44,830 PSI

REVISION HISTORY				
ZONE	REV	DESCRIPTION	DATE	APPROVED



J-W P/N 825-00161
J-W DWG NO. 335-24736 REV.02 24JUL14
SHEET 4 OF 4

FOR APPROVAL

PLEASE CONFIRM OR COMMENT, AND RETURN WITHIN 10 BUSINESS DAYS. OTHERWISE THESE DRAWINGS WILL BE DEEMED AS CERTIFIED AND APPROVED.

APPROVED BY:_____

INERTIA
TOTAL ROTOR = 73.5 LB-FT^2
SHAFT = 2.67 LB-FT^2

WEIGHT
TOTAL ROTOR = 735.0 LB
SHAFT = 167.7 LB

CERTIFIED
TECO-Westinghouse MOTOR COMPANY

DRAFTER	felpsty	DATE 20130617
ENGINEER	felpsty	DATE 20130617
REF	ref	

TECO-Westinghouse Motor Company
5100 North IH-35
Round Rock, TX 78681

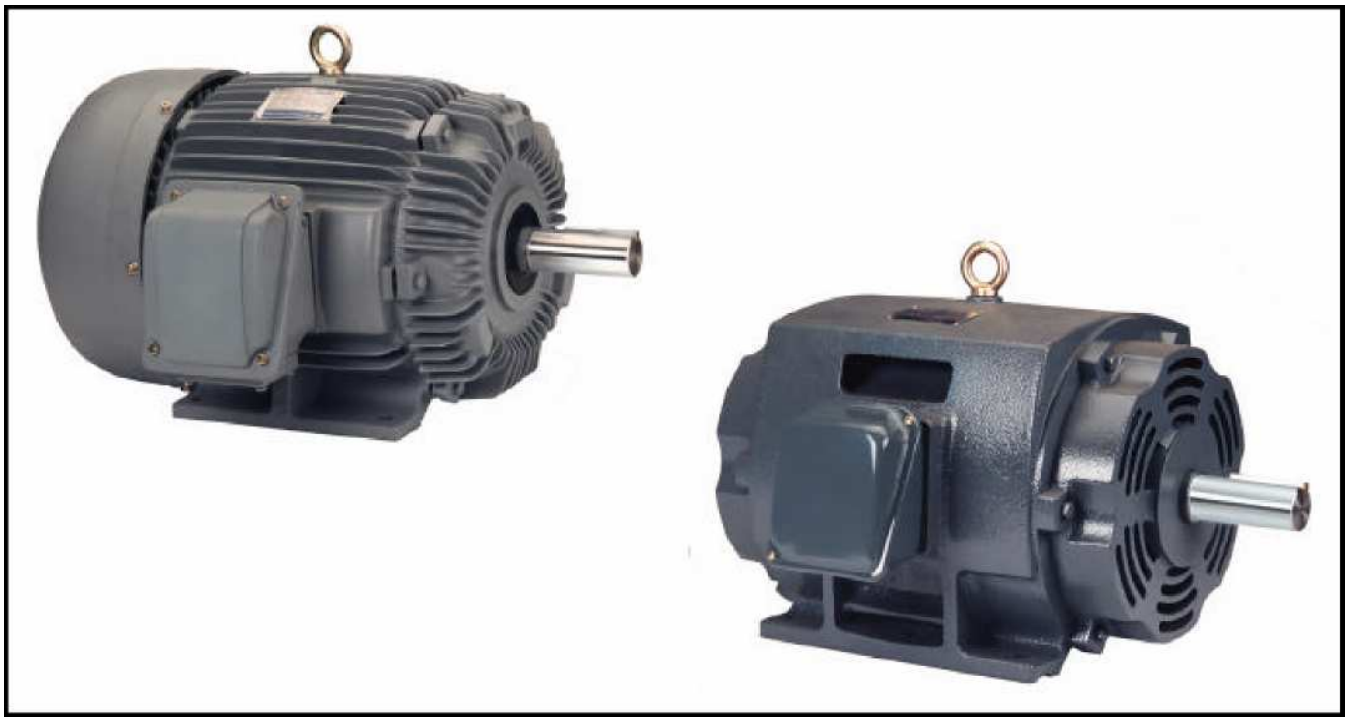
DRAWING TITLE
SHAFT PROFILE
T-FRAME AEHH8N, 200 HP, 1800 RPM

SIZE	CAGE CODE	DRAWING NUMBER	REV
B		MD05069	01

SCALE: NTS SHEET 1/1

INSTALLATION AND MAINTENANCE INSTRUCTIONS FOR THREE PHASE INDUCTION MOTORS

Frames 56 and 143T - 449TZ



5100 North IH 35 Round Rock, Texas 78681

RECEIVING

1. Check nameplate data.
2. Check whether any damage has occurred during transportation.
3. After removal of shaft clamp, turn shaft by hand to check that it turns freely.
4. If motor is to be reshipped (alone or installed to another piece of equipment) the shaft must again be clamped to prevent axial movement.
   Note: Remove the bearing clamp before turning the shaft on 284T-449TZ frame motors.

WARNING
THE FOLLOWING SAFETY PRECAUTIONS MUST BE OBSERVED:

1. Electric rotating machinery and high voltage can cause serious or fatal injury if improperly installed, operated or maintained. Responsible personnel should be familiarized with NEMA MG-1; Safety Standards for Construction and Guide Selection. Installation and Use of Electric Motors and Generators; National Electric Code and all local safety requirements.
2. When servicing, all power sources to the motor and to the accessory devices should be de-energized and disconnected and all rotating parts should be at standstill.
3. Lifting means, when supplied, are intended for lifting the motor only. When two lifting devices are supplied with the motor a dual chain must be used.
4. Suitable protection must be used when working near machinery with high noise levels.
5. Safeguard or protective devices must not be by-passed or rendered inoperative.
6. The frame of this machine must be grounded in accordance with the National Electric Code and applicable local codes.
7. A suitable enclosure should be provided to prevent access to the motor by other than authorized personnel. Extra caution should be observed around motors that are automatically or have automatic re-setting relays as they may restart unexpectedly.
8. Shaft key must be fully captive or removed before motor is started.
9. Provide proper safeguards for personnel against possible failure of motor-mounted brake, particularly on applications involving overhauling loads.
10. Explosion proof motors are constructed to comply with the label service procedure manual, repair of these motors must be made by TECO-Westinghouse Motor Company or U/L listed service center in order to maintain U/L listing.

LOCATION

1. Drip-proof motors are intended for use where atmosphere is relatively clean, dry, well ventilated and non-corrosive.
2. Totally enclosed motors may be installed where dirt, moisture, or dust are present and in outdoor locations.
3. Explosion-proof motors are built for use in hazardous locations as indicated by Underwriters' label on the motor.
4. Chemical duty enclosed motors are designed for installation in high corrosion or excessive moisture locations.

   Note: in all cases, no surrounding structure should obstruct normal flow or ventilating air through or over the motor.

MOUNTING

1. Mount motor securely on a firm, flat base. All ball bearing normal thrust motors up to and including 256T frame size may be side-wall or ceiling mounted; all others check nearest TECO-Westinghouse office for mounting recommendations.
2. Align motor accurately, using a flexible coupling if possible. For drive recommendations, consult with drive or equipment manufacturer, or TECO-Westinghouse.
3. Mounting bolts must be carefully tightened to prevent changes in alignment and possible damage to the equipment. The recommended tightening torque's for medium carbon steel bolts, identified by three radial lines at 120 degrees on the head, are:

Bolt Size	Recommended Torque (Ft-lb.)	
	Minimum	Maximum
2/8	25	37
1/2	60	90
5/8	120	180
3/4	210	320

4. V-belts Sheave Pitch Diameters should not be less than those shown in Table 1 (NEMA recommended values)
5. Tighten belts only enough to prevent slippage. Belt speed should not exceed 5000 ft. per min.

TABLE 1. V-Belt Sheave Pitch Diameters (MG1-14.42)

Frame Number	Horsepower at Synchronous Speed, RPM				V-Belt Sheave			
					Conventional A, B, C, D AND E		Narrow 3V, 5V, AND 8V	
	3600	1800	1200	900	Minimum Pitch Diameter Inches	*Maximum Width Inches	Minimum Outside Diameter Inches	**Maximum Width Inches
143T	1.5	1	.75	.5	2.2	4.25	2.2	2.25
145T	2-3	1.5-2	1	.75	2.4	4.25	2.4	2.25
182T	3	3	1.5	1	2.4	5.25	2.4	2.75
182T	5	...	...	...	2.6	5.25	2.4	2.75
184T	...	...	2	1.5	2.4	5.25	2.4	2.75
184T	5	...	...	...	2.6	5.25	2.4	2.75
184T	7.5	5	...	...	3.0	5.25	3.0	2.75
213T	7.5-10	7.5	3	2	3.0	6.5	3.0	3.375
215T	10	...	5	3	3.0	6.5	3.0	3.375
215T	15	10	...	...	3.8	6.5	3.8	3.375
254T	15	...	7.5	5	3.8	7.75	3.8	4
254T	20	15	...	...	4.4	7.75	4.4	4
256T	20-25	...	10	7.5	4.4	7.75	4.4	4
256T	...	20	...	...	4.6	7.75	4.4	4
284T	...	...	15	10	4.6	9	4.4	4.625
284T	...	25	...	...	5.0	9	4.4	4.625
286T	...	30	20	15	5.4	9	5.2	4.625

TABLE 1. V-Belt Sheave Pitch Diameters (MG1-14.42)

Frame Number	Horsepower at Synchronous Speed, RPM				V-Belt Sheave			
					Conventional A, B, C, D AND E		Narrow 3V, 5V, AND 8V	
	3600	1800	1200	900	Minimum Pitch Diameter Inches	*Maximum Width Inches	Minimum Outside Diameter Inches	**Maximum Width Inches
324T	...	40	25	20	6.0	10.25	6.0	5.25
326T	...	50	30	25	6.8	10.25	6.8	5.25
364T	...	...	40	30	6.8	11.5	6.8	5
364T	...	60	...	...	7.4	11.5	7.4	5.785
365T	...	...	50	40	8.2	11.5	8.2	5.785
365T	...	75	...	...	9.0	11.5	8.6	5.785
404T	...	...	60	...	9.0	14.25	8.0	7.25
404T	...	...	...	50	9.0	14.25	8.4	7.25
404T	...	100	...	...	10.0	14.25	8.6	7.25
405T	...	...	75	60	10.0	14.25	10.0	7.25
405T	...	100	...	...	10.0	14.25	8.6	7.25
405T	...	125	...	...	11.5	14.25	10.5	7.25
444T	...	...	100	...	11.0	16.75	10.0	8.5
444T	...	...	...	75	10.5	16.75	9.5	8.5
444T	...	125	...	...	11.0	16.75	9.5	8.5
444T	...	150	...	...	...	16.75	10.5	8.5
445T	...	...	125	...	12.5	16.75	12.0	8.5
445T	...	...	...	100	12.5	16.75	12.0	8.5
445T	...	150	...	...	...	16.75	10.5	8.5

*****Max. Sheave width = 2(N-W) - .25

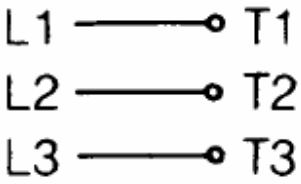
**Max Sheave width = N-W

***Sheave ratios grater than 5:1 and center-to-center distance less than the diameter of the large sheave should be referred to TECO-Westinghouse.

POWER SUPPLY & CONNECTIONS

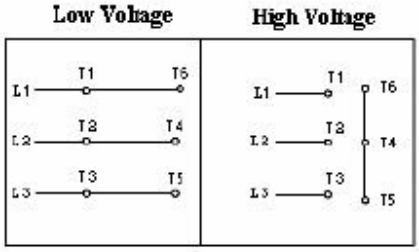
1. Wiring of motor and control, overload protection and grounding should be in accordance with National Electrical Code and all local safety requirements.
2. Nameplate voltage and frequency should agree with power supply. Motor will operate satisfactorily on line voltage within ±10% of nameplate voltage; or frequency with ±5% and with a combined variation not to exceed ±10%. 230-volt motors can be used on 208-volt network systems, but with slightly modified performance characteristics as shown on the nameplate.
3. Dual voltage and single voltage motors can be connected for the desired voltage by following connection diagram shown on the nameplate or inside of the conduit box.
4. All Explosion Proof motors have Temperature Limiting Devices in the motor enclosure to prevent excessive external surface temperature of the motor in accordance with U/L standards. Terminals of thermal protectors (P1 & P2) should be connected to the motor control equipment, according to the connection diagram inside of the conduit box.
5. Standard connection diagram for three phase, not thermally protected, dual rotation motors are shown in diagrams A through E. **(Note: To change rotation, Interchange any two line leads)**

A. 3 Lead, Single Voltage

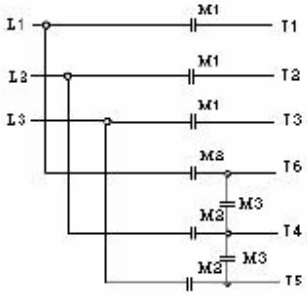


B. 6 Lead, Dual Voltage & Voltage Ration 1 to 3

B-1 Across the Line Start & Run



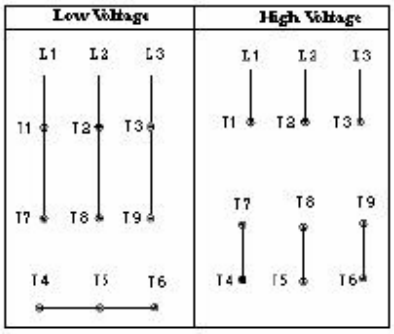
B-2 Wye Start & Delta Run
(Low Voltage only)



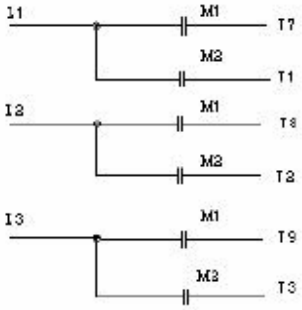
	START	RUN
M1	CLOSE	CLOSE
M2	OPEN	CLOSE
M3	CLOSE	OPEN

C. 9 Leads; Dual Voltage & Voltage Ratio 1 to 2, Wye Connected

C-1 Across the Line Start & Run



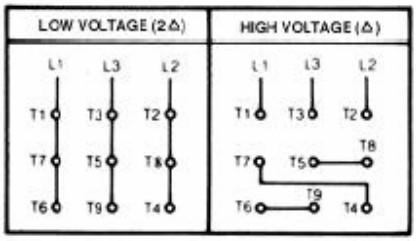
C-2 Part Winding Start
(Low Voltage only)



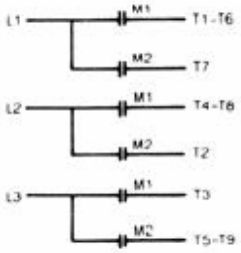
	START	RUN
M1	CLOSE	CLOSE
M2	OPEN	CLOSE
Tie Together	(T4-T5-T6)	

D. 9 Leads; Dual Voltage & Voltage Ration 1 to 2, Delta Connected

D-1 Across the Line Start & Run



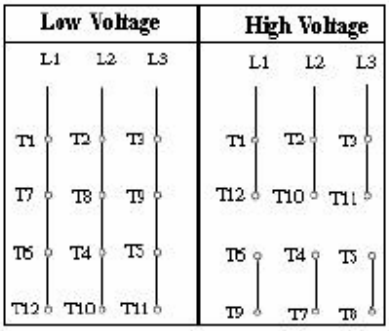
D-2 Part Winding Start
(Low Voltage only)



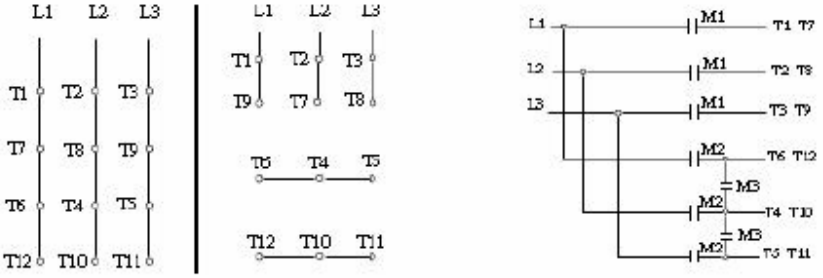
	START	RUN
M1	CLOSE	CLOSE
M2	OPEN	CLOSE

E. 12 Leads, Dual Voltage

E-1 Across the Line Start & Run

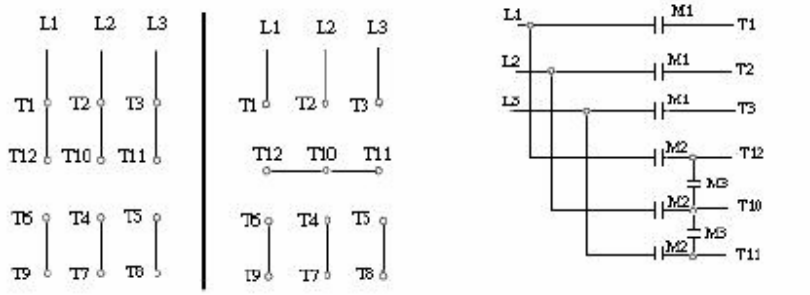


E-2-1 Wye Start & Delta Run (Low Voltage only)



	START	RUN
M1	CLOSE	CLOSE
M2	OPEN	CLOSE
M3	CLOSE	OPEN

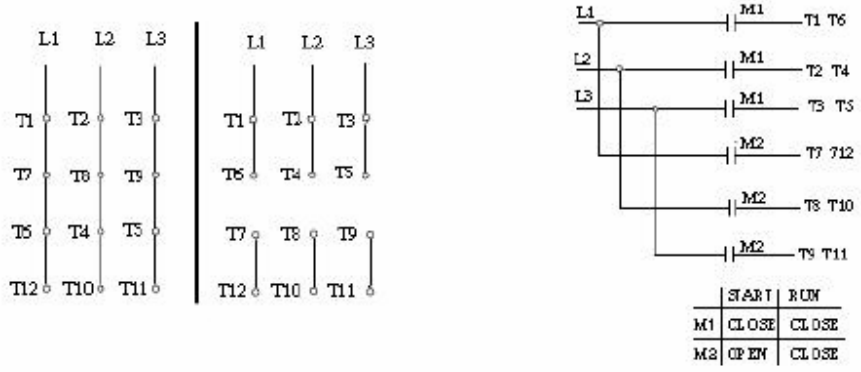
E-2-2 Wye Start & Delta Run (High Voltage only)



	START	RUN
M1	CLOSE	CLOSE
M2	OPEN	CLOSE
M3	CLOSE	OPEN

Tie Together (T4-T7); (T5-T8); (T6-T9)

E-3 Part Winding Start (Low Voltage only)



*Important: For Part Winding Start, M2 contactor should be closed within two (2) seconds after M1 contactor is closed.
Only 4 pole and above (e.g., 6P, 8P...) motors are satisfactory for Part Winding Start at low voltage.

START UP

1. Disconnect load and start motor. Check direction of rotation. If rotation must be changed, ALLOW THE MOTOR TO STOP COMPLETLEY. Interchange any two leads of a three-phase motor.
2. Connect load. The motor should start quickly and run smoothly. If no, shut power off at once. Recheck the assembly including all connections before restarting.
3. If excessive vibration is noted, check for loose mounting bolts too flexible motor support structure or transmitted vibration from adjacent machinery. Periodic vibration checks should be made; foundations often settle.
4. Operate under load for short period of time and check operating current against nameplate.

TESTING

If the motor has been in storage for an extensive period or has been subjected to adverse moisture conditions, it is best to check the insulation resistance of the stator winding with a megometer. Depending on the length and conditions of storage it may be necessary to regrease or change rusted bearings.
If the resistance is lower than one megohm the windings should be dried in one of the following two ways:

1. Bake in oven at temperatures not exceeding 194°F until insulation resistance becomes constant.
2. With rotor locked, apply low voltage and gradually increase the current through windings until temperature measured with a thermometer reaches 194°F. Do not exceed this temperature.

MAINTENANCE

INSPECTION

Inspect motor at regular intervals. Keep motor clean and ventilation openings clear.

LUBRICATION

1. Frame 143T-256T: Double shielded and pre-lubricated ball-bearing motors without grease fittings and don't need re-lubrication, except on MAX-E1® and MAX-E2® products which have re-greasable features.
2. Frames 280TS, 320-449TZ(TS): Motors having grease fittings and grease discharge devices at brackets. Motors are shipped with grease for initial running. It is necessary to re-lubricate anti-friction bearing motors periodically, depending on size and type of service. See Table 2 to provide maximum bearing life. Excessive or too frequent lubrication may damage the motor.

TABLE 2

Horsepower	Standard Conditions	Severe Conditions	Extreme Conditions
1 Thru 30 Hp, 1800 rpm and below	7 years	3 years	180 days
40 Thru 75 Hp, 1800 rpm and below	210 days	70 days	30 days
100 Thru 150 Hp, 1800 rpm and below	90 days	30 days	15 days
1 Thru 20 Hp, 3600 rpm	5 years	2 years	90 days
25 Thru 75 Hp, 3600 rpm	180 days	60 days	30 days
100 Thru 150 Hp, 3600 rpm	90 days	30 days	15 days

Note:

A. Standard conditions: 8 hours operation per day, normal or light loading, clear and 40°C ambient conditions.
B. Severe conditions: 24-hour operation per day or light shock loading, vibration or in dirty or dusty conditions.
C. Extreme conditions: With heavy shock loading or vibration or dusty conditions.
D. For double shielded bearings, above data (lubrication frequency) means that the bearing must be replaced.

3. Be sure fittings are clean and free from dirt. Using a low-pressure grease gun, pump in the recommended grease until new grease appears at grease discharge hole.
4. Use the POLYUREA grease unless special grease is specified on the nameplate.
5. If re-lubrication is to be performed with the motor running, stay clear of rotating parts. After re-greasing, allow the motor to run for ten to thirty minutes.

RENEWAL PARTS

1. Use only genuine TECO-Westinghouse renewal parts or as recommended by TECO-Westinghouse Motor Company.
2. When you order renewal parts please specify complete information to TECO-Westinghouse office/agent such as type, frame no., poles, horsepower, voltage, series no., quantity, etc.

FOR FURTHER INFORMATION PLEASE CONTACT

TECO-WESTINGHOUSE MOTOR COMPANY

Round Rock, TX **800-873-8326**

COUPLING



J-W POWER COMPANY
MACHINE ALIGNMENT RECORD

W/O #: 134769 TYPE EA-200-4 UNIT # 7351

CONDITION OF UNIT: NEW X REBUILD

MANUFACTURER DATA

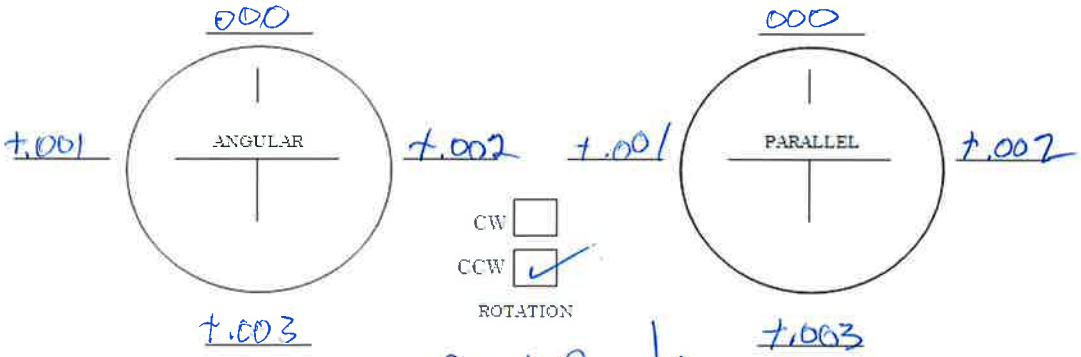
	PART #	MFR	TYPE	SERIAL #
PRIME MOVER	825-00161	Teco	TEFC 447T	VBAC168093-4
COMPRESSOR	896-00910	Ariel	JGQ/2	F53162
COUPLING	250-02829	TB Woods	GCH 40-35	N/A

ASSEMBLED TOLERANCES	TOTAL INDICATOR READING (T.I.R.)		END PLAY (FLOAT / THRUST)		COUPLING LOCKNUT TORQUE FT.LBS	ADAPTOR PLATE	COMPRESSION RING	COMPRESSION RING
	ANG. (FACE)	PARA. (RIM/OD)	PRIME MOVER	CPRSR		BOLT SIZE	BOLT SIZE	BOLT SIZE
						-	13mm	17mm
						TORQUE	TORQUE	TORQUE
*MFR / J-W REQT	.005	.005	0	.0035-.011	75	-	22	44
FINAL READING	.003	.003	.0	.007	75	-	22	44

* range where applicable

SHAFT OD ACTUAL		HUB ID ACTUAL * Note if had to be honed		CPRSR / X-HD SUPPORT/ PRIME MOVER TIE DOWN NUT TORQUE FT. LBS.			
COMPRESSOR	2.6247	COMPRESSOR	2.6260		COMPRESSOR	X-HD SUPPORT	PRIME MOVER
PRIME MOVER	3.375	PRIME MOVER	3.3755	REQT	100	90	150
				ACTUAL	100	90	150
				STUD/BOLT SIZE	5/8	5/8	5/8

NOTE: ALIGNMENT INDICATING BRACKETS MOUNTED AS SHOWN IN THE FOLLOWING/ATTACHED PICTURE.



ALIGNMENT COMPLETED BY _____ MILLWRIGHT 11/30/2016 Date

FINAL READINGS OBSERVED BY _____ Q.A. INSPECTOR 11/30/2016 Date

PACKAGE SHI_ LAYOUT DETAIL

	—	—		—	
SHIM	SHIM	SHIM	SHIM	SHIM	SHIM
	.002	.002	.258	—	.242
SOFT FT	SOFT FT	SOFT FT	SOFT FT	SOFT FT	SOFT FT
	COMPRESSOR			**PRIME MOVER**	
	.003	.0025		—	
SOFT FT	SOFT FT	SOFT FT	SOFT FT	SOFT FT	SOFT FT
	—	—	.258	—	.242
SHIM	SHIM	SHIM	SHIM	SHIM	SHIM

- 10.75 - 5.50

Cylinder Bore & Type

Preload - / - - / -

Total Shim / .006 / .004

O Throw #4 O

O Throw #2 O

O Throw #3 O

O Throw #1 O

Preload - / - - / -

Total Shim / .006 / .007

- 3.63 - 1.75

Cylinder Bore & Type

*Soft foot Verified by:

11/30/2016
DATE

134769
WORK ORDER #

EA-200-4
UNIT TYPE

7351
UNIT #

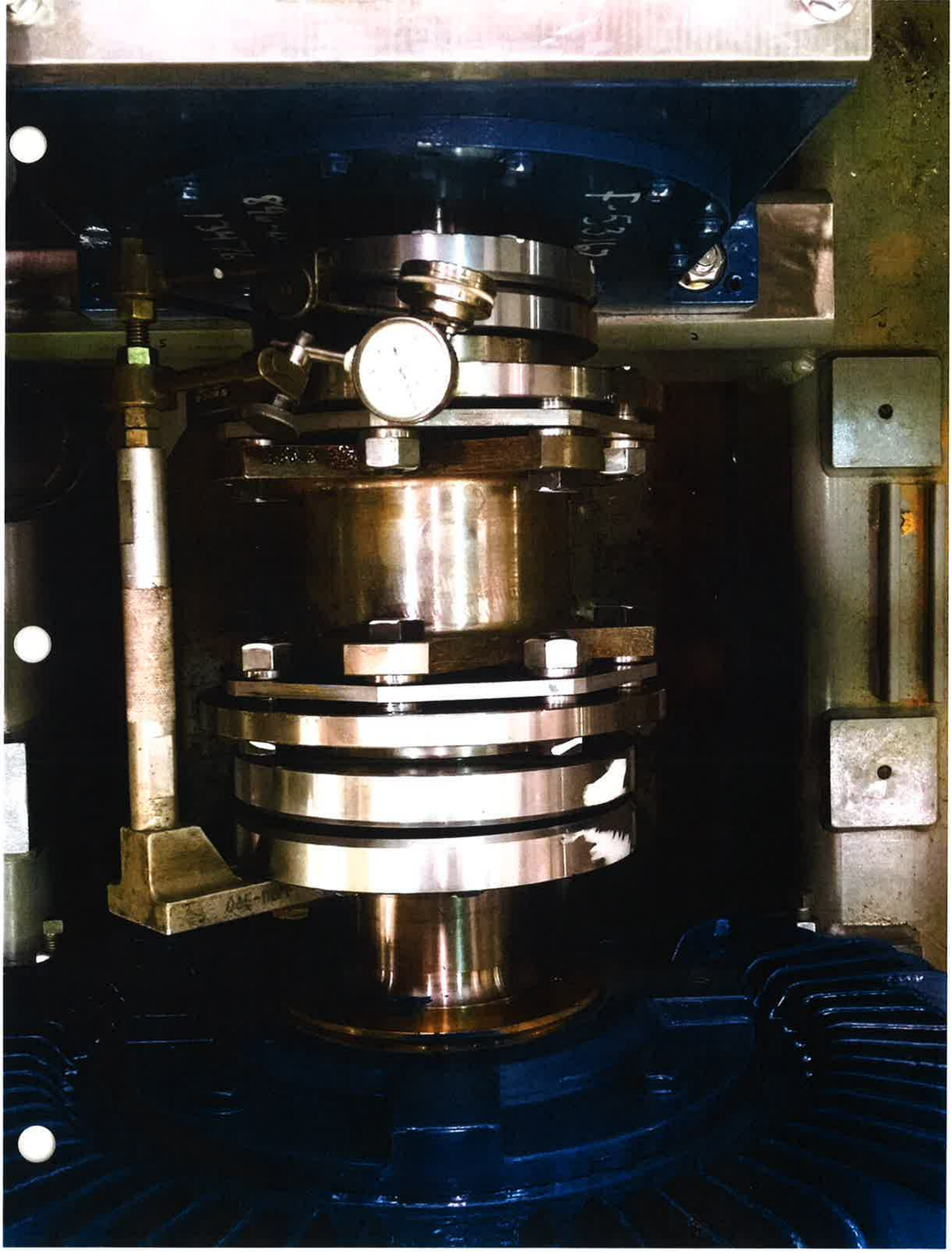
VB.AC168093-4
PRIME MOVER S/N

E-53162
COMPRESSOR S/N

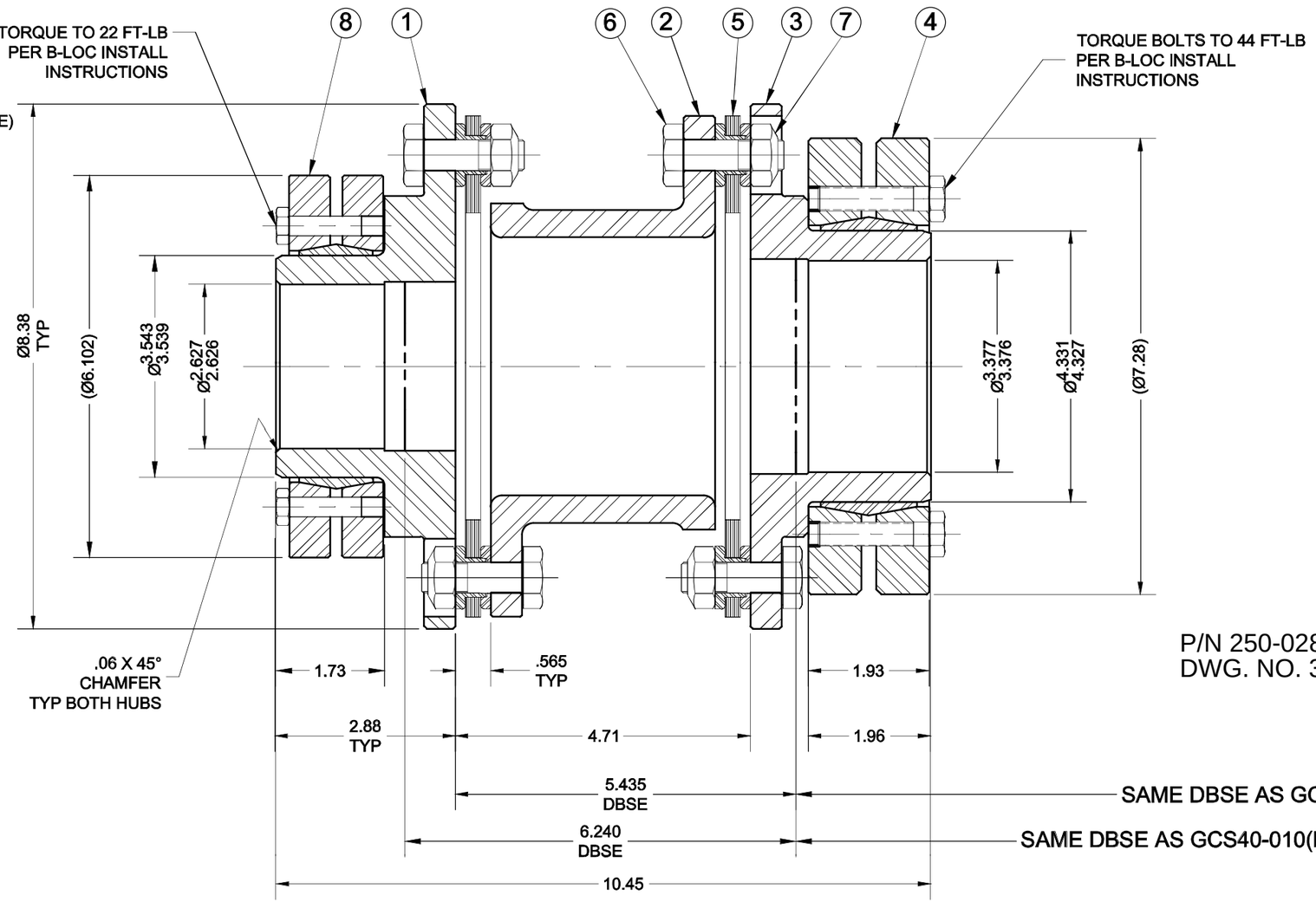
N/A
ADJUSTABLE CHOCK P/N

MILLWRIGHT

QUALITY ASSURANCE



NOTES:
1. COUPLING RATINGS:
   1.1. RATED TORQUE: 40,000 LB*IN
   1.2. PEAK TORQUE: 46,000 LB*IN (LIMITED BY 90-10 SD)
   1.3. RATED MISALIGHTMENT:
      1.3.1. ANGULAR: 0.3° PER PACK
      1.3.2. AXIAL: ±.06"
2. TORQUE NUT, ITEM⑦, 75 FT-LBS (USING COMMERCIALLY AVAILABLE ANTI-SEEZE)



P/N 250-02829
DWG. NO. 335-28371

Kt= 11.81 x 10^6 LB*IN/RAD INCLUDES 1/3 SHAFT PENETRATION FACTOR PER AGMA 9004-A99.

*© T.B. WOOD'S INCORPORATED. THIS DRAWING CONTAINS PROPRIETARY INFORMATION AND SHALL NOT BE USED OR REPRODUCED WITHOUT WRITTEN CONSENT OR APPROVAL FROM TB WOOD'S INCORPORATED.

ITEM	DESCRIPTION	P/N	QTY.	MATERIAL
8	ESD TLK-090 1.75X6.10	YLTLK-M090	1	VARIOUS
7	NUT GC40 1/2-20UNF 2B	GC40-6N	16	ALLOY STEEL
6	BOLT GC40 1/2-20UNF	GC40-6H	16	ALLOY STEEL
5	DISC PACK GC40 SS	GC40-5	2	CARBON STEEL
4	ESD TLK-110 2.24X7.28	YLTLK-M110	1	VARIOUS
3	HUB GC40 3.376/3.375 110-10	GC40-3-05-003	1	4140 STEEL
2	SPY GC40-35 L=3.58 DUCTIL	GC40-2-35	1	DUCTILE IRON
1	HUB GC40 2.627/2.626 90-10	GC40-3-05-007	1	4140 STEEL
0	CPL GCH40-35 2.6ESDX3.38SD	GCH40-35-003	p	VARIOUS

REVISIONS	ECN NO.	BY	CKD BY	DATE
F				
E				
D				
C				
B				
A ORIGINAL RELEASE		TLR	MJD	02/26 16

THIRD ANGLE PROJECTION

CUSTOMER: JW POWER
CUST. P/N: 250-02829
DRAWN: TLR DATE: 02/26/16
APPRVD: TDL DATE: 02/26/16
SHEET: 1 OF 1 SCALE: 1/1

TB WOOD'S INCORPORATED
MECHANICAL DIVISION

DESCRIPTION: CPL GCH40-35 2.63SDX3.38SD
COMP.: ASSEMBLY

WR2-LBS. IN²:	PART NO.:	
453	GCH40-35-003	
FINISH WT.-LBS.:	DRAWING NUMBER:	REV. LEVEL:
58.9	GCH4035003	A

SD INSTALLATION AND REMOVAL INSTRUCTIONS FOR B-LOC® SHRINK DISCS

B-LOC® Shrink Discs provide a high capacity, zero-backlash shaft/hub or coupling connection by means of a mechanical interference fit. Please follow these INSTALLATION AND REMOVAL INSTRUCTIONS carefully to ensure proper performance of this ***B-LOC***® unit.

ⓘ WARNING ⓘ

When installing or removing ***B-LOC***® products, always adhere to the following safety standards:

1. Be sure that the system is de-energized using proper lockout tagout procedures.
2. Wear proper personal protective equipment.

INSTALLATION

(Refer to Figure 1)

B-LOC® Shrink Discs are supplied ready for installation. However, prior to tightening of locking screws it is necessary to remove wooden spacers that may have been used during shipping.

Important: Never tighten locking screws before shaft installation, as inner ring of Shrink Disc and/or hub can be permanently contracted even at relatively low tightening torques.

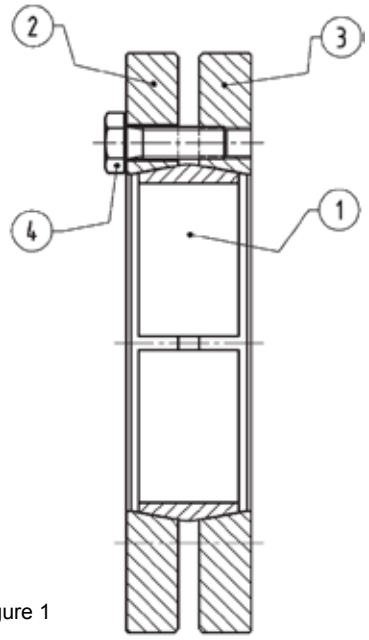


Figure 1

1. Clean hub O.D. and Shrink Disc bore. Lightly lubricate hub O.D. using an ordinary machine oil before assembling Shrink Disc on hub.
2. Carefully clean shaft and hub bore of any lubricant using a non-petroleum based solvent prior to mounting hub onto shaft. ***This step is critical, as any lubricant on the shaft/hub bore interface will greatly reduce the torque transmitting capacity of a B-LOC® Shrink Disc connection.***
3. After confirming correct position of hub and Shrink Disc, hand-tighten three (3) or four (4) equally spaced locking screws and make sure that outer collars of Shrink Disc are parallel. Hand-tighten remaining locking screws.
4. Use torque wrench and set it approximately 5% higher than specified tightening torque (M_a). Tighten locking screws in either a clockwise or counterclockwise sequence, using approx. 1/4 (i.e., 90°) turns (even if initially some locking screws require a very low tightening torque to achieve 1/4 turns) for several passes until 1/4 turns can no longer be achieved.
5. Continue to apply overtorque for 1 to 2 more passes. This is required to compensate for a system-related relaxation of locking screws since tightening of a given screw will always relax adjacent screws. Without over torquing, an infinite number of passes would be needed to reach specified tightening torque.
6. Reset torque wrench to specified torque (M_a) and check all locking screws. No screw should turn at this point, otherwise repeat Steps 5 and 6.

REMOVAL

(Refer to Figure 2)

Prior to initiating the following removal procedure, check to ensure that no torque or thrust loads are acting on the Shrink Disc, shaft or any mounted components.

1. Loosen all locking screws in several stages by using approx. 1/2 (i.e., 180°) turns, following either a clockwise or counterclockwise sequence, until Shrink Disc can be moved on hub. The Shrink Disc, hub and shaft will return to their original clearance fits.

ⓘ WARNING ⓘ

DO NOT completely remove locking screws before outer collars are disengaged from inner ring. A sudden release of the outer collars involves high separating forces and could result in permanent injury or death. Be certain that outer collars are disengaged from inner ring before completely removing locking screws.

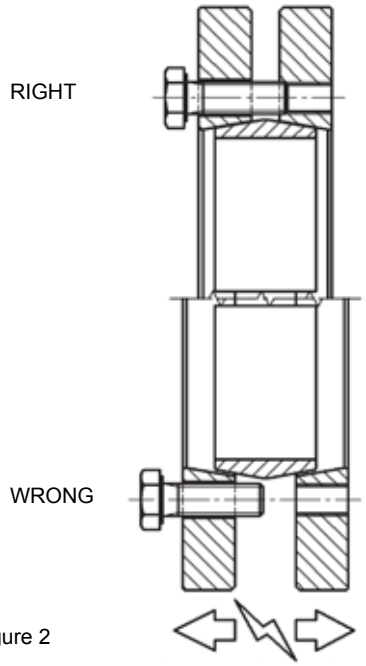


Figure 2

REINSTALLATION OF SHRINK DISCS

In relatively clean operating conditions, Shrink Discs can be re-used without prior cleaning. Shrink Discs used under severe conditions, however, require thorough cleaning and re-lubrication with Dow Corning® Molykote® G-Rapid Plus Paste or equivalent.

LOCKING SCREW SIZES AND SPECIFIED TIGHTENING TORQUE M_a

Screw Size	M5	M6	M8	M10	M12	M16	M20	M24	M27
Tightening Torque M_a (ft lb)	3.6	8.7	22	44	74	185	362	620	922
Wrench Size Across Flats (mm)	8	10	13	17	19	24	30	36	41

Fenner Drives®
www.fennerdrives.com

For technical assistance, please call +1-717-665-2421

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GCF/GCH Series Flexible Disc Couplings

Installation Instructions

Form 607



TB Wood's®
Incorporated

An **Altra Industrial Motion** Company

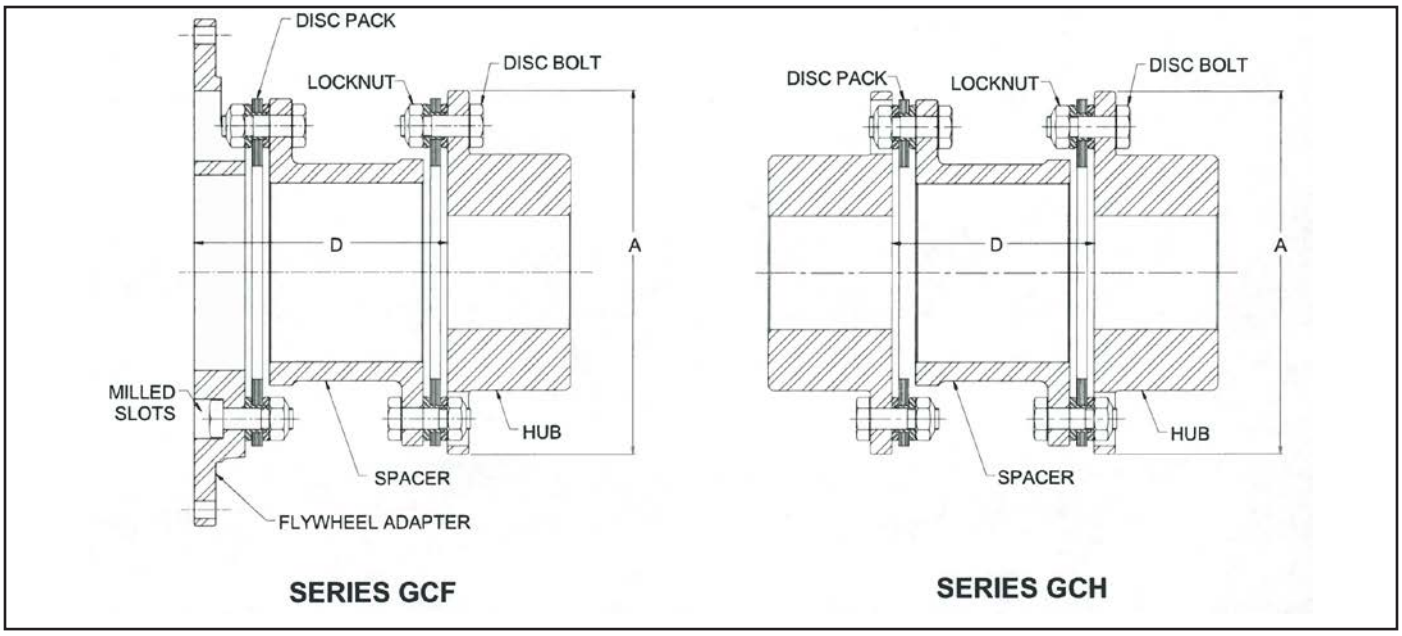


FIG.1: COUPLING NOMENCLATURE

ASSEMBLY & ALIGNMENT

1. Clean and inspect hub bore(s) and shaft ends. Remove any nicks or burrs with a stone. For tapered shafts, check contact with machinists' bluing. For straight shafts, measure shaft and bore diameters to confirm proper fit.

2. Fit key(s) to hub and shaft if applicable. Installed keys must fit snugly on the sides and have a small clearance over the top.

3. Arrange an axial stop bar or collar to stop the hub at the desired position.

4. Heat hub uniformly to required temperature to allow installation on shaft. Use of open flame is not recommended, to avoid localized overheating and damage to hubs. If a torch must be used, use a large rosebud tip and be careful to maintain even heat distribution. See graph on page 4.

   CAUTION: Do not exceed 550° F. , to avoid damage to hub.

5. Quickly slide the expanded hub into position against the prearranged axial stop, and allow to cool.

6. (GCF only) Install disc bolts in flywheel adapter with heads in milled slots, and bolt adapter to flywheel. Torque interface bolts to value specified in Table 3, or as otherwise directed by the equipment supplier.

7. Move the equipment into place. Distance 'D' between shaft ends and/or flange face should match the target dimension within +/-25% of the coupling's axial capacity. Generally speaking the axial error at installation should not be visible to the naked eye- see Figure 2. See Table 1 or the assembly drawing for dimensions.

8. Alignment can be performed using laser equipment if available, or with dial indicators as described following. Attach a dial indicator's base to one hub or the flywheel adapter, and indicate a point on the other hub flange's outside diameter. See Figure 3.

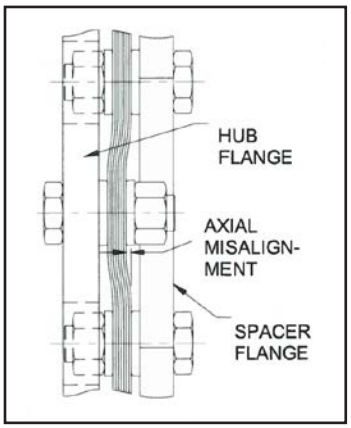


FIG.2: EXCESSIVE AXIAL MISALIGNMENT AT INSTALLATION

TABLE 1: DIMENSIONS & CAPACITIES

COUPLING SIZE	LEGACY COUPLING SIZE	'A' DIA. (INCHES)	SPACER 'D' DIMENSION (INCHES)			COUPLING AXIAL CAPACITY (INCHES)	INSTALLATION MISALIGNMENT LIMIT (INCHES T.I.R.)
			SPACER	GCF	GCH		
340	40	8.38	31	5.31	4.14	±.06	.007
			35	5.88	4.71		
412	120	11.00	42	7.14	5.57	±.08	.009
			45	7.64	6.07		
			50	8.76	7.19		
424	240 / 300	15.00	55	9.89	7.45	±.10	.013
			60	10.89	8.45		
456	560 / 640	18.00	70	12.44	9.63	±.12	.016
			75	13.51	10.70		
511	1100 / 1200	22.00	80	14.76	11.39	±.14	.019
			85	15.76	12.39		
			92	17.26	13.89		

9. Rotate only the rotor on which the indicator's base is mounted and read rim runout. T.I. R. readings should not exceed the values shown in Table 1.
10. Reposition the indicator tip to indicate a point on the opposing hub's flange face near the OD, and repeat step #10 to read face runout. T. I. R. readings should not exceed the values in Table 1. Align equipment as needed to ensure that rim and face readings are both within the alignment limit.
11. Install a disc pack on adapter or first hub. Review figure 1 to confirm proper bolt orientation. For couplings with two hubs, install the four disc bolts which connect the pack to the first hub. Coat all bolt threads and nut faces with anti-seize thread compound.

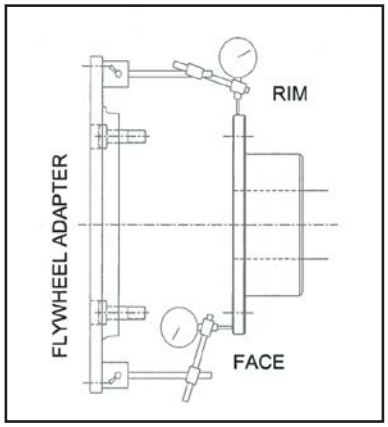


FIG.3: DIAL INDICATOR MOUNTING FOR RIM & FACE READINGS

12. Bring spacer into position and install the other four bolts and nuts at the first end, oriented as shown in Figure 1. Continue to support spacer to prevent damage to the disc pack.
13. Install second disc pack and all remaining bolts and nuts as shown in Figure 1. Read the following sections before tightening bolts.

A WORD ABOUT BOLT TIGHTENING

Proper bolt tightening is crucial to obtain the preloads needed for proper coupling performance.

a) Lubricate threads and nut faces with anti-seize thread compound before assembly.

b) In general, rotating the nut while holding the bolt is preferred, but in some cases, the reverse may be necessary.

c) Methods of obtaining proper bolt preload-listed in order of accuracy:

1) Measure actual bolt stretch
2) Uses Supernuts (see page 4)
3) Torque wrench
4) Turn of the Nut

TABLE 2: DISC BOLT TIGHTENING DATA

COUPLING SIZE	LEGACY COUPLING SIZE	DISC BOLT THREAD SIZE	SOCKET WRENCH SIZE (INCHES)	BOLT STRETCH (INCHES)	NUT TORQUE (FT - LB)	TURN OF THE NUT (DEGREES)
340	40	1/2-20	7/8	.004	75	33
412	120	3/4-16	1 1/4	.006	250	37
424	240 / 300	1-14	1 5/8	.009	450	45
456	560 / 640	1 1/4-12	2	.0105	1095	51
511	1100 / 1200	1 1/2-12	2 3/8	.013	1640	61

14. When clearance permits, best preload accuracy is obtained by measuring bolt stretch directly with a micrometer. Table 2 lists the target stretch in inches. If this is not practical, obtain a suitable torque wrench and "crow's foot" attachment to facilitate bolt torqueing. See Table 2 for required wrench sizes.

15. If a torque wrench, micrometer, or a Supernut cannot be used, use the "turn-of-the-nut" values from Table 2, measured in degrees from the point where the nut is seated against its mating flange with .1 (one-tenth) of its target tightening torque (for example 110 ft-lb on GCF456).

16. Tighten all bolts to the specified tightening torques.

TABLE 3: FLYWHEEL BOLT TIGHTENING DATA

BOLT SIZE & THREAD	THREAD COEFFICIENT 'C'	SOCKET WRENCH SIZE (INCHES)	BOLT TIGHTENING TORQUE (FT - LB)
3/8-16	.18	9/16	36
1/2-13	.16	3/4	80
5/8-11	.15	15/16	147
3/4-10	.14	1 1/8	246
7/8-9	.13	1 5/16	377
1-8	.13	1 1/2	541

DATA SUPPLIED FOR REFERENCE ONLY! Engine manufacturer or packager is responsible for specifying and/or supplying fasteners and locking method. These values apply for coarse thread cadmium plated Grade 8 bolts lubricated with oil and tightened to 70% of yield strength

SUPERNUT TIGHTENING TORQUES

Supernuts are an available option which greatly eases the task of obtaining proper preload in large fasteners. They must be installed with the included hardened washer, and the jackbolts MUST be properly lubricated on their threads and tips using their special grease. Values shown apply when using standard Superbolt ® “JL-G” grease.

DISC BOLT THREAD SIZE	“CY” SERIES SUPERNUT JACKBOLTS		
	THREAD SIZE	WRENCH SIZE INCHES	TIGHTENING TORQUE FT-LB
1-14	5/16	1/4	34
1 1/4-12			63
1 1/2-12	3/8	5/16	83
1 3/4-12			84

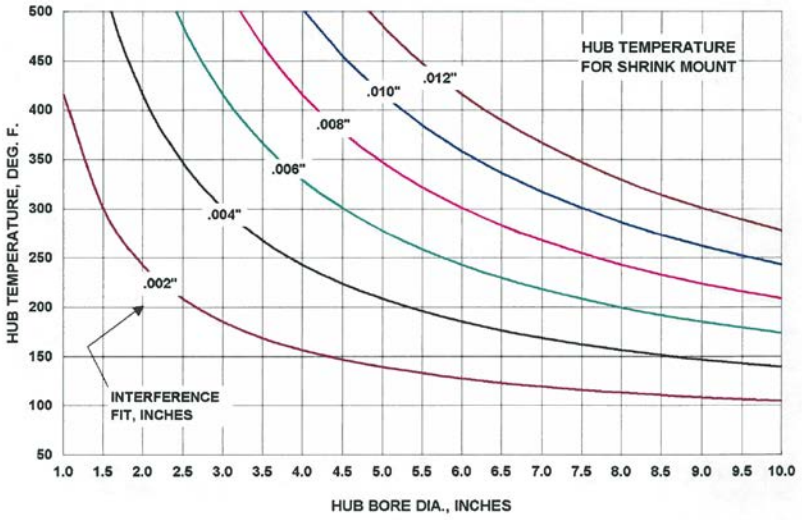
SUPERBOLT is a registered trademark of Superbolt Inc., Carnegie, PA USA

HUB SHRINK FIT TEMPERATURES

DATA SUPPLIED FOR REFERENCE ONLY! Installer must ensure that proper procedures and values are used.

Graph assumes steel hub material and 70° F. ambient temperature, and includes a 10% safety margin. For example, for 6” bore and .008” interference, heating the hub from 70° to 300° will expand the hub by .0088”.

Do not exceed the interference specified on the assembly drawing to avoid overstressing the hub.



Altra Industrial Motion

All Customer Service phone numbers shown in bold

Electromagnetic Clutches and Brakes

Warner Electric
Electromagnetic Clutches and Brakes
New Hartford, CT - USA
1-800-825-6544
For application assistance: 1-800-825-9050

Saint Barthélémy d'Anjou, France
+33 (0)2 41 21 24 24

Precision Electric Coils and Electromagnetic Clutches and Brakes
Columbia City, IN - USA
1-260-244-6183

Matrix International
Electromagnetic Clutches and Brakes, Pressure Operated Clutches and Brakes
Brechin, Scotland
+44 (0) 1356 602000
New Hartford, CT - USA
1-800-825-6544

Inertia Dynamics
Spring Set Brakes; Power On and Wrap Spring Clutch/Brakes
New Hartford, CT - USA
1-800-800-6445

Linear Products

Warner Linear
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Gear Couplings
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Bibby Turboflex
Disc, Gear, Grid Couplings, Overload Clutches
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Boksburg, South Africa
+27(0) 11 918 4270

TB Wood's
Elastomeric Couplings
Chambersburg, PA - USA
1-888-829-6637– Press #5
For application assistance: 1-888-829-6637 – Press #7

General Purpose Disc Couplings
San Marcos, TX - USA
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Universal Joints, Drive Shafts, Mill Gear Couplings
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Hertford, England
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Chambersburg, PA - USA
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Lamiflex Couplings
Flexible Couplings, Bearing Isolators, and Coupling Guards
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Pneumatic Clutches and Brakes
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Bedford, England
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Twiflex Limited
Caliper Brakes and Thrusters
Twickenham, England
+44 (0) 20 8894 1161

Industrial Clutch
Pneumatic and Oil Immersed Clutches and Brakes
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Svendborg Brakes
Industrial Brakes and Brake Systems
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Gearing

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For application assistance: 1-800-816-5608

Bauer Gear Motor
Geared Motors
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Somerset, NJ - USA
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Nuttall Gear and Delroyd Worm Gear
Worm Gear and Helical Speed Reducers
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1-716-298-4100

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Formsprag Clutch
Overrunning Clutches and Holdbacks
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1-800-348-0881– Press #1
For application assistance: 1-800-348-0881 – Press #2

Marland Clutch
Roller Ramp and Sprag Type Overrunning Clutches and Backstops
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Stieber Clutch
Overrunning Clutches and Holdbacks
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Form 607 8/14 Printed in USA

COMPRESSOR



Ariel Frame Data Sheet

Model: JGQ/2 **Stroke: 3.00 in** **Class: (JGQ)**

Frame:

Number of Throws:	2
Rated Power:	280.0 BHP
Frame Friction Power:	6.00 BHP
Cyl Friction Factor:	0.95
Guide Type:	Integral

Speed Ratings:

Rated Piston Speed @ RPM:	900.0 FPM
Maximum Speed:	1800.00 RPM
Minimum Speed:	900.00 RPM

Frame Dimensions:

Center Line Height:	9.25 in
Max. Overall Height:	17.00 in
Max. Overall Width with Cylinders: (Std Guide, widest dbl. Cyl, No HEH devices)	83.00 in
Length:	34.00 in

Internal Gas Rod Loads:

Total:	20000 lbf
Compression:	11000 lbf
Tension:	10000 lbf
Single Acting Tension:	10000 lbf

Weights:

Avg. Weight without Cylinders:	900.00 lbs
Maximum Recip:	103.20 lbs
Maximum Imbalance:	1.00 lbs
Crankshaft:	100.00 lbs
Connecting Rod:	14.40 lbs
Pin Assembly:	4.87 lbs
Stub Shaft:	0.50 lbs

Component Dimensions:

Piston Rod Diameter:	1.125 in
Connecting Rod Center Distance:	8.250 in
Crankshaft Pin Diameter:	3.000 in
Crankshaft Journal Diameter:	3.250 in
Main Bearing Width:	2.000 in

Lubrication:

Oil Pump Flow Rate:	5.0 GPM
Oil Sump Capacity:	2.5 gal
Oil Heat Rejection:	16800.0 BTU/h

Material Specifications:

		Ariel Spec	(Reference)
Crankcase:	Gray Iron	12G	(ASTM A48 Class 30)
Crosshead Guide:	Gray Iron	12G	(ASTM A48 Class 30)
Crankshaft:	Forged Carbon Steel	11N	(ASTM A668 Class DH/AISI 1045)
Connecting Rod:	Forged Carbon Steel	18N	(ASTM A521 Class AC or CG/AISI 1045)
Main Bearing:	Tri-metal		(Tri-metal)
Thrust Bearing:	Tri-metal		(Tri-metal)
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)

Ariel Cylinder Data Sheet

Model: 10-3/4P-HE **Bore: 10.750in** **MAWP: 225.0 psig**

Flange: 3"- 300 FF | Stroke: 3.00 in | Rated Speed: 1800 RPM | Cyl Assembly Wt: 535.00 lbs | Piston/Rod Std Wt: 17.50 lbs

Pressure Ratings:

MAWP: 225.0 psig RDP: 200.0 psig HTP: 337.5 psig

NACE MAWP: 1.0 psig - NACE derating only if shipped prior to 19-Jul-2002.

Piston and Velocity Data:	HE	CE	Total
Piston Rod Diameter, in	n/a	1.125	
Piston Area, in2	90.76	89.77	
Piston Displacement at 1800 RPM, CFM	283.63		
API Suct Valve Velocity at 1800 RPM, FPM	9357.40		

Clearance:		w/Vlvs	w/Vlvs
Normal Clearance, % (in3)	4.05 (11.020)	13.48	
Non-Std Clearance, % (in3)	0.00 (0.000)		

Spacer Data:	Suction	Discharge	Suction	Discharge
Spacers (Maximum)	1	1		
Spacer Clearance, % (in3)	0.00 (34.000)			

Cylinder ADJ Equivalent Area, in2 15.000 21.000

Valve Data:	HE Suction	CE	HE Discharge	CE
Num valves/Corner:	1		1	
Nominal Diameter,in:	12.32		12.32	
Model:	147CT		256CES	
Clearance,% (in3):	9.44 (25.691)		0.00 (0.000)	
Lift,in (Area,in2):	0.087 (8.730)		0.059 (6.929)	
Adj Equivalent,in2:	10.144		9.336	
Plate Material:	PC (PEEK Carbon)		PC (PEEK Carbon)	
Seat Material:	AISI 416 (Mart 400 Series)		AISI 416 (Mart 400 Series)	
Guard Material:	AISI 416 (Mart 400 Series)		AISI 416 (Mart 400 Series)	
Spring Material(s):	SS 17 - 7PH		SS 17 - 7PH	
Bolt Material:	AISI 416 (Mart 400 Series)		AISI 416 (Mart 400 Series)	

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
NO POCKETS											

Fixed Volume Clearance Pockets:

	---------- Pocket 1 ----------				---------- Pocket 2 ----------				---------- Pocket 3 ----------			
	------- Min -------		----- Pocket -----		------- Min -------		----- Pocket -----		------- Min -------		----- Pocket -----	
	in3	%	in3	%	in3	%	in3	%	in3	%	in3	%
Selected	0.00	0.00	11.30	4.15	0.00	0.00	22.70	8.34	0.00	0.00	34.00	12.49

Material Specifications:		**Ariel Spec**	**(Reference)**
Body:	Ductile Iron	17D	(ASTM A536 Grade 80-55-06)
Piston:	Ductile Iron	10D	(ASTM A536 Grade 80-55-06)
Piston Rod:	Alloy Steel	13C	(AISI 4100 Series)
Piston Ring:	GMFTFE		(Glass Moly Filled Teflon)
Piston Wear Band:	N/A		(N/A)
Rod Packing Case:		()	
Rod Packing Rings:		()	
Stress Bolt:	Grade 8		(Grade 8)

Ariel Cylinder Data Sheet

Model: 5-1/2P-CE | **Bore: 5.500in** | **MAWP: 525.0 psig**

Flange: 2"- 300 FF | Stroke: 3.00 in | Rated Speed: 1800 RPM | Cyl Assembly Wt: 320.00 lbs | Piston/Rod Std Wt: 16.00 lbs

Pressure Ratings:

MAWP: 525.0 psig | RDP: 477.3 psig | HTP: 787.5 psig

NACE MAWP: 1.0 psig - NACE derating only if shipped prior to 19-Jul-2002.

Piston and Velocity Data:	HE	CE	Total
Piston Rod Diameter, in	n/a	1.125	
Piston Area, in2	23.76	22.76	
Piston Displacement at 1800 RPM, CFM		71.14	
API Suct Valve Velocity at 1800 RPM, FPM		7845.42	

Clearance:	w/Vlvs		w/Vlvs
Normal Clearance, % (in3)		12.78 (8.731)	19.26
Non-Std Clearance, % (in3)		0.00 (0.000)	

Spacer Data:	Suction	Discharge	Suction	Discharge
Spacers (Maximum)			1	1
Spacer Clearance, % (in3)			4.70 (3.210)	

Cylinder ADJ Equivalent Area, in2	3.767	5.182

Valve Data:	HE Suction	CE Suction	HE Discharge	CE Discharge
Num valves/Corner:		1		1
Nominal Diameter,in:		3.58		3.58
Model:		79CRE		79CRE
Clearance,% (in3):		2.86 (1.950)		3.62 (2.470)
Lift,in (Area,in2):		0.063 (2.611)		0.055 (2.285)
Adj Equivalent,in2:		3.017		2.809
Plate Material:		NYX (Low Temp Nylon X)		MTX (Med Temp Nylon X)
Seat Material:		AISI 416 (Mart 400 Series)		AISI 416 (Mart 400 Series)
Guard Material:		AISI 416 (Mart 400 Series)		AISI 416 (Mart 400 Series)
Spring Material(s):		SS 17 - 7PH		SS 17 - 7PH
Bolt Material:		AISI 416 (Mart 400 Series)		AISI 416 (Mart 400 Series)

Material Specifications:		**Ariel Spec**	**(Reference)**
Body:	Ductile Iron	17D	(ASTM A536 Grade 80-55-06)
Piston:	Ductile Iron	10D	(ASTM A536 Grade 80-55-06)
Piston Rod:	Alloy Steel	13C	(AISI 4100 Series)
Piston Ring:	GMFTFE		(Glass Moly Filled Teflon)
Piston Wear Band:	N/A		(N/A)
Rod Packing Case:	Gray Iron		(ASTM A278 Class 30)
Rod Packing Rings:	CFTFE		(Carbon Filled Teflon)
Stress Bolt:	Grade 8		(Grade 8)

Ariel Cylinder Data Sheet

Model: 3-5/8SG-CE **Bore: 3.625in** **MAWP: 2550.0 psig**

Flange: 1-1/2"- 1500 FF
Stroke: 3.00 in
Rated Speed: 1800 RPM
Cyl Assembly Wt: 440.00 lbs
Piston/Rod Std Wt: 14.50 lbs

Pressure Ratings:
MAWP: 2550.0 psig RDP: 2318.2 psig HTP: 3825.0 psig

Piston and Velocity Data:	HE	CE	Total
Piston Rod Diameter, in	n/a	1.125	
Piston Area, in2	10.32	9.33	
Piston Displacement at 1800 RPM, CFM		29.15	
API Suct Valve Velocity at 1800 RPM, FPM		6554.65	

Clearance:	w/Vlvs	w/Vlvs
Normal Clearance, % (in3)	15.08 (4.220)	22.22
Non-Std Clearance, % (in3)	0.00 (0.000)	

Spacer Data:	Suction	Discharge
Spacers (Maximum)	0	0
Spacer Clearance, % (in3)	8.10 (2.267)	

Cylinder ADJ Equivalent Area, in2	2.115	1.950

Valve Data:	HE Suction	CE Suction	HE Discharge	CE Discharge
Num valves/Corner:		1		1
Nominal Diameter,in:		2.49		2.49
Model:		52RX		52RX
Clearance,% (in3):		2.49 (0.698)		4.65 (1.300)
Lift,in (Area,in2):		0.071 (1.281)		0.063 (1.138)
Adj Equivalent,in2:		1.388		1.314
Plate Material:		NYX (Low Temp Nylon X)		MTX (Med Temp Nylon X)
Seat Material:		AISI 416 (Mart 400 Series)		AISI 416 (Mart 400 Series)
Guard Material:		AISI 416 (Mart 400 Series)		AISI 416 (Mart 400 Series)
Spring Material(s):		UHB716		UHB716
Bolt Material:		AISI 416 (Mart 400 Series)		AISI 416 (Mart 400 Series)

Material Specifications:

		Ariel Spec	**(Reference)**
Body:	Ductile Iron	17D	(ASTM A536 Grade 80-55-06)
Piston:	Alloy Steel	13C	(AISI 4100 Series)
Piston Rod:	Alloy Steel	13C	(AISI 4100 Series)
Piston Ring:	GMFTFE		(Glass Moly Filled Teflon)
Piston Wear Band:	N/A		(N/A)
Rod Packing Case:	Gray Iron		(ASTM A278 Class 30)
Rod Packing Rings:	CFTFE		(Carbon Filled Teflon)
Stress Bolt:	Grade 8		(Grade 8)

Ariel Cylinder Data Sheet

Model: 1-3/4SG-FS-HE **Bore: 1.750in** **MAWP: 6100.0 psig**

Flange: 1" SAE threaded
Stroke: 3.00 in
Rated Speed: 1800 RPM
Cyl Assembly Wt: 260.00 lbs
Piston/Rod Std Wt: 3.90 lbs

Pressure Ratings:
MAWP: 6100.0 psig RDP: 5545.5 psig HTP: 9150.0 psig

Piston and Velocity Data:	HE	CE	Total
Piston Rod Diameter, in	n/a	1.125	
Piston Area, in2	2.41	1.41	
Piston Displacement at 1800 RPM, CFM	7.52		
API Suct Valve Velocity at 1800 RPM, FPM	2586.32		

Clearance:		w/Vlvs	w/Vlvs
Normal Clearance, % (in3)	4.22 (0.305)	24.32	
Non-Std Clearance, % (in3)	0.00 (0.000)		

Spacer Data:	Suction	Discharge	Suction	Discharge
Spacers (Maximum)	0	0		
Spacer Clearance, % (in3)	12.93 (0.933)			

Cylinder ADJ Equivalent Area, in2 2.135 2.393

Valve Data:	HE Suction	CE	HE Discharge	CE
Num valves/Corner:	1		1	
Nominal Diameter,in:	3.78		3.78	
Model:	78CD		35CD10	
Clearance,% (in3):	20.09 (1.450)		0.00 (0.000)	
Lift,in (Area,in2):	0.047 (0.837)		0.047 (0.315)	
Adj Equivalent,in2:	0.870		0.449	
Plate Material:	AISI 410 (Mart. 400 Series)		AISI 410 (Mart. 400 Series)	
Seat Material:	AISI 416 (Mart 400 Series)		AISI 416 (Mart 400 Series)	
Guard Material:	AISI 416 (Mart 400 Series)		AISI 416 (Mart 400 Series)	
Spring Material(s):	UHB716		UHB716	
Bolt Material:	AISI 416 (Mart 400 Series)		AISI 416 (Mart 400 Series)	

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

NO POCKETS

Fixed Volume Clearance Pockets:

---------- Pocket 1 ----------				---------- Pocket 2 ----------				---------- Pocket 3 ----------			
------- Min -------		----- Pocket -----		------- Min -------		----- Pocket -----		------- Min -------		----- Pocket -----	
in3	%	in3	%	in3	%	in3	%	in3	%	in3	%

NO POCKETS

Material Specifications:		**Ariel Spec**	**(Reference)**
Body:	Forged Alloy Steel	16N	(ASTM A668 Class J/AISI 4140, 22 Rc)
Piston:	Alloy Steel	13C	(AISI 4100 Series)
Piston Rod:	Alloy Steel	13C	(AISI 4100 Series)
Piston Ring:	PEEK		(PEEK)
Piston Wear Band:	CFTFE		(Carbon Filled Teflon)
Rod Packing Case:		()	
Rod Packing Rings:		()	
Stress Bolt:	Grade 8		(Grade 8)

Compressor Data:

Elevation,ft:	2000.00	Barmtr,psia:	13.651	Ambient,°F:	100.00
Frame:	JGQ/2	Stroke, in:	3.00	Rod Dia, in:	1.125
Max RL Tot, lbf:	20000	Max RL Tens, lbf:	10000	Max RL Comp, lbf:	11000
Rated RPM:	1800	Rated BHP:	280.0	Rated PS FPM:	900.0
Calc RPM:	1775.0	BHP:	151	Calc PS FPM:	887.5

Driver Data:

Type:	Electric
Mfg:	TECO or equa
Model:	447T Frame
BHP:	200
Avail:	200

Services	**Service 1**			
Gas Model	VMG			
Stage Data:	**1 (SG)**	**2**	**3**	**4**
Target Flow, MMSCFD	0.000	0.000	0.000	0.000
Flow Calc, MMSCFD	0.446	0.446	0.444	0.443
BHP per Stage	40.2	32.4	36.0	36.7
Specific Gravity	0.6100	0.6102	0.5953	0.5934
Ratio of Sp Ht (N)	1.2545	1.2533	1.2704	1.2797
Comp Suct (Zs)	0.9953	0.9858	0.9593	0.8726
Comp Disch (Zd)	0.9934	0.9831	0.9634	1.0206
Pres Suct Line, psig	13.00	N/A	N/A	N/A
Pres Suct Flg, psig	13.00	93.36	295.06	1092.26
Pres Disch Flg, psig	96.24	301.99	1104.77	4545.14
Pres Disch Line, psig	N/A	N/A	N/A	4500.00
Pres Ratio F/F	4.124	2.950	3.623	4.122
Temp Suct, °F	80.00	126.90	115.30	111.20
Temp Clr Disch, °F	126.90	115.30	111.20	107.30
Cylinder Data:	**Throw 2**	**Throw 2**	**Throw 1**	**Throw 1**
Cyl Model	10-3/4P-HE	5-1/2P-CE	3-5/8SG-CE	1-3/4SG-FS-HE
Cyl Bore, in	10.750	5.500	3.625	1.750
Cyl RDP (API), psig	200.0	477.3	2318.2	5545.5
Cyl MAWP, psig	225.0	525.0	2550.0	6100.0
Cyl Action	HE	CE	CE	HE
Cyl Disp, CFM	279.7	70.2	28.7	7.4
Pres Suct Intl, psig	10.83	85.26	279.09	1084.98
Temp Suct Intl, °F	89	132	121	116
Pres Disch Intl, psig	105.34	324.88	1169.10	4634.87
Temp Disch Intl, °F	297	299	322	330
HE Suct Gas Vel, FPM	9586	N/A	N/A	2650
HE Disch Gas Vel, FPM	9442	N/A	N/A	4836
HE Spcrs Used/Max	0/3	N/A	N/A	N/A
HE Vol Pkt Avail, %	No Pkt	N/A	N/A	No Pkt
Vol Pkt Used, %	No Pkt	N/A %	N/A %	No Pkt
HE Min Clr, %	13.48	N/A	N/A	24.32
HE Total Clr, %	13.48	N/A	N/A	24.32
CE Suct Gas Vel, FPM	N/A	9546	7807	N/A
CE Disch Gas Vel, FPM	N/A	8807	7978	N/A
CE Spcrs Used/Max	N/A	0/2	N/A	N/A
CE Min Clr, %	N/A	19.08	21.98	N/A
CE Total Clr, %	N/A	19.08	21.98	N/A
Suct Vol Eff HE/CE, %	63.1/N/A	N/A/67.5	N/A/54.2	52.9/N/A
Disch Event HE/CE, ms	4.7/N/A	N/A/6.5	N/A/5.4	4.3/N/A
Suct Pseudo-Q HE/CE	9.0/N/A	N/A/8.3	N/A/6.2	0.9/N/A
Gas Rod Ld Comp, %	61.4 C	61.4 C	98.9 C	98.9 C
Gas Rod Ld Tens, %	72.8 T	72.8 T	59.6 T	59.6 T
Gas Rod Ld Total, %	70.2	70.2	84.2	84.2
Xhd Pin Deg/%Rvrsl lbf	126/58.8	126/58.8	113/31.2	113/31.2
Flow Calc, MMSCFD	0.446	0.446	0.444	0.443
Cyl BHP	40.2	32.4	36.0	36.7

Valve Part Numbers as Ordered
1st Stage Suction: B-7242-GG
1st Stage Discharge: B-7242-GGD

2nd Stage Suction: B-5091-CC
2nd Stage Discharge: B-5092-ZM

3rd Stage Suction: B-4087-AA
3rd Stage Discharge: B-3712-ZN

4th Stage Suction: B-1788-E
4th Stage Discharge: B-1788-ED

Compressor Data:

Elevation,ft:	2000.00	Barmtr,psia:	13.651	Ambient,°F:	100.00
Frame:	JGQ/2	Stroke, in:	3.00	Rod Dia, in:	1.125
Max RL Tot, lbf:	20000	Max RL Tens, lbf:	10000	Max RL Comp, lbf:	11000
Rated RPM:	1800	Rated BHP:	280.0	Rated PS FPM:	900.0
Calc RPM:	1775.0	BHP:	160	Calc PS FPM:	887.5

Driver Data:

Type:	Electric
Mfg:	TECO or equa
Model:	447T Frame
BHP:	200
Avail:	200

Services	**Service 1**			
Gas Model	VMG			
Stage Data:	**1 (SG)**	**2**	**3**	**4**
Target Flow, MMSCFD	0.000	0.000	0.000	0.000
Flow Calc, MMSCFD	0.481	0.481	0.479	0.479
BHP per Stage	43.2	34.6	38.2	38.5
Specific Gravity	0.6100	0.6102	0.5971	0.5965
Ratio of Sp Ht (N)	1.2546	1.2537	1.2706	1.2788
Comp Suct (Zs)	0.9949	0.9848	0.9567	0.8674
Comp Disch (Zd)	0.9929	0.9819	0.9612	1.0175
Pres Suct Line, psig	15.00	N/A	N/A	N/A
Pres Suct Flg, psig	15.00	100.77	312.15	1130.44
Pres Disch Flg, psig	103.82	319.35	1143.18	4545.14
Pres Disch Line, psig	N/A	N/A	N/A	4500.00
Pres Ratio F/F	4.100	2.910	3.551	3.985
Temp Suct, °F	80.00	126.90	115.30	111.20
Temp Clr Disch, °F	126.90	115.30	111.20	107.30
Cylinder Data:	**Throw 2**	**Throw 2**	**Throw 1**	**Throw 1**
Cyl Model	10-3/4P-HE	5-1/2P-CE	3-5/8SG-CE	1-3/4SG-FS-HE
Cyl Bore, in	10.750	5.500	3.625	1.750
Cyl RDP (API), psig	200.0	477.3	2318.2	5545.5
Cyl MAWP, psig	225.0	525.0	2550.0	6100.0
Cyl Action	HE	CE	CE	HE
Cyl Disp, CFM	279.7	70.2	28.7	7.4
Pres Suct Intl, psig	12.66	92.11	295.20	1122.82
Temp Suct Intl, °F	89	132	121	116
Pres Disch Intl, psig	113.56	343.57	1210.35	4636.38
Temp Disch Intl, °F	296	297	319	323
HE Suct Gas Vel, FPM	9586	N/A	N/A	2650
HE Disch Gas Vel, FPM	9442	N/A	N/A	4836
HE Spcrs Used/Max	0/3	N/A	N/A	N/A
HE Vol Pkt Avail, %	No Pkt	N/A	N/A	No Pkt
Vol Pkt Used, %	No Pkt	N/A %	N/A %	No Pkt
HE Min Clr, %	13.48	N/A	N/A	24.32
HE Total Clr, %	13.48	N/A	N/A	24.32
CE Suct Gas Vel, FPM	N/A	9546	7807	N/A
CE Disch Gas Vel, FPM	N/A	8807	7978	N/A
CE Spcrs Used/Max	N/A	0/2	N/A	N/A
CE Min Clr, %	N/A	19.08	21.98	N/A
CE Total Clr, %	N/A	19.08	21.98	N/A
Suct Vol Eff HE/CE, %	63.4/N/A	N/A/68.1	N/A/55.3	55.0/N/A
Disch Event HE/CE, ms	4.7/N/A	N/A/6.6	N/A/5.4	4.4/N/A
Suct Pseudo-Q HE/CE	9.0/N/A	N/A/8.3	N/A/6.2	0.9/N/A
Gas Rod Ld Comp, %	65.5 C	65.5 C	98.8 C	98.8 C
Gas Rod Ld Tens, %	76.8 T	76.8 T	61.2 T	61.2 T
Gas Rod Ld Total, %	74.4	74.4	84.9	84.9
Xhd Pin Deg/%Rvrsl lbf	127/68.0	127/68.0	128/33.6	128/33.6
Flow Calc, MMSCFD	0.481	0.481	0.479	0.479
Cyl BHP	43.2	34.6	38.2	38.5

Valve Part Numbers as Ordered
1st Stage Suction: B-7242-GG
1st Stage Discharge: B-7242-GGD

2nd Stage Suction: B-5091-CC
2nd Stage Discharge: B-5092-ZM

3rd Stage Suction: B-4087-AA
3rd Stage Discharge: B-3712-ZN

4th Stage Suction: B-1788-E
4th Stage Discharge: B-1788-ED

Compressor Data:

Elevation,ft:	2000.00	Barmtr,psia:	13.651	Ambient,°F:	100.00
Frame:	JGQ/2	Stroke, in:	3.00	Rod Dia, in:	1.125
Max RL Tot, lbf:	20000	Max RL Tens, lbf:	10000	Max RL Comp, lbf:	11000
Rated RPM:	1800	Rated BHP:	280.0	Rated PS FPM:	900.0
Calc RPM:	1775.0	BHP:	182	Calc PS FPM:	887.5

Driver Data:

Type:	Electric
Mfg:	TECO or equa
Model:	447T Frame
BHP:	200
Avail:	200

Services	**Service 1**			
Gas Model	VMG			
Stage Data:	**1 (SG)**	**2**	**3**	**4**
Target Flow, MMSCFD	0.000	0.000	0.000	0.000
Flow Calc, MMSCFD	0.570	0.570	0.568	0.568
BHP per Stage	50.8	39.9	43.6	42.3
Specific Gravity	0.6100	0.6102	0.5987	0.5987
Ratio of Sp Ht (N)	1.2552	1.2549	1.2722	1.2786
Comp Suct (Zs)	0.9940	0.9824	0.9514	0.8593
Comp Disch (Zd)	0.9917	0.9795	0.9577	1.0125
Pres Suct Line, psig	20.00	N/A	N/A	N/A
Pres Suct Flg, psig	20.00	119.38	354.69	1227.00
Pres Disch Flg, psig	122.81	362.49	1240.26	4545.14
Pres Disch Line, psig	N/A	N/A	N/A	4500.00
Pres Ratio F/F	4.055	2.827	3.404	3.675
Temp Suct, °F	80.00	127.90	116.10	111.90
Temp Clr Disch, °F	127.90	116.10	111.90	107.90
Cylinder Data:	**Throw 2**	**Throw 2**	**Throw 1**	**Throw 1**
Cyl Model	10-3/4P-HE	5-1/2P-CE	3-5/8SG-CE	1-3/4SG-FS-HE
Cyl Bore, in	10.750	5.500	3.625	1.750
Cyl RDP (API), psig	200.0	477.3	2318.2	5545.5
Cyl MAWP, psig	225.0	525.0	2550.0	6100.0
Cyl Action	HE	CE	CE	HE
Cyl Disp, CFM	279.7	70.2	28.7	7.4
Pres Suct Intl, psig	17.25	109.29	335.39	1218.64
Temp Suct Intl, °F	89	133	121	117
Pres Disch Intl, psig	134.16	390.01	1313.99	4638.75
Temp Disch Intl, °F	294	295	314	310
HE Suct Gas Vel, FPM	9586	N/A	N/A	2650
HE Disch Gas Vel, FPM	9442	N/A	N/A	4836
HE Spcrs Used/Max	0/3	N/A	N/A	N/A
HE Vol Pkt Avail, %	No Pkt	N/A	N/A	No Pkt
Vol Pkt Used, %	No Pkt	N/A %	N/A %	No Pkt
HE Min Clr, %	13.48	N/A	N/A	24.32
HE Total Clr, %	13.48	N/A	N/A	24.32
CE Suct Gas Vel, FPM	N/A	9546	7807	N/A
CE Disch Gas Vel, FPM	N/A	8807	7978	N/A
CE Spcrs Used/Max	N/A	0/2	N/A	N/A
CE Min Clr, %	N/A	19.08	21.98	N/A
CE Total Clr, %	N/A	19.08	21.98	N/A
Suct Vol Eff HE/CE, %	63.8/N/A	N/A/69.3	N/A/57.7	59.6/N/A
Disch Event HE/CE, ms	4.8/N/A	N/A/6.8	N/A/5.7	4.8/N/A
Suct Pseudo-Q HE/CE	9.0/N/A	N/A/8.3	N/A/6.3	0.9/N/A
Gas Rod Ld Comp, %	75.9 C	75.9 C	98.5 C	98.5 C
Gas Rod Ld Tens, %	86.5 T	86.5 T	65.2 T	65.2 T
Gas Rod Ld Total, %	85.0	85.0	86.8	86.8
Xhd Pin Deg/%Rvrsl lbf	131/78.1	131/78.1	155/39.4	155/39.4
Flow Calc, MMSCFD	0.570	0.570	0.568	0.568
Cyl BHP	50.8	39.9	43.6	42.3

Valve Part Numbers as Ordered
1st Stage Suction: B-7242-GG
1st Stage Discharge: B-7242-GGD

2nd Stage Suction: B-5091-CC
2nd Stage Discharge: B-5092-ZM

3rd Stage Suction: B-4087-AA
3rd Stage Discharge: B-3712-ZN

4th Stage Suction: B-1788-E
4th Stage Discharge: B-1788-ED

Compressor Data:

Elevation,ft:	2000.00	Barmtr,psia:	13.651	Ambient,°F:	100.00
Frame:	JGQ/2	Stroke, in:	3.00	Rod Dia, in:	1.125
Max RL Tot, lbf:	20000	Max RL Tens, lbf:	10000	Max RL Comp, lbf:	11000
Rated RPM:	1800	Rated BHP:	280.0	Rated PS FPM:	900.0
Calc RPM:	1775.0	BHP:	200	Calc PS FPM:	887.5

Driver Data:

Type:	Electric
Mfg:	TECO or equa
Model:	447T Frame
BHP:	200
Avail:	200

Services	**Service 1**			
Gas Model	VMG			
Stage Data:	**1 (SG)**	**2**	**3**	**4**
Target Flow, MMSCFD	0.000	0.000	0.000	0.000
Flow Calc, MMSCFD	0.642	0.642	0.639	0.639
BHP per Stage	56.8	44.0	47.8	45.0
Specific Gravity	0.6100	0.6099	0.6011	0.6011
Ratio of Sp Ht (N)	1.2559	1.2563	1.2733	1.2781
Comp Suct (Zs)	0.9933	0.9806	0.9469	0.8529
Comp Disch (Zd)	0.9908	0.9776	0.9548	1.0085
Pres Suct Line, psig	24.00	N/A	N/A	N/A
Pres Suct Flg, psig	24.00	134.14	388.37	1303.14
Pres Disch Flg, psig	137.87	396.62	1316.78	4545.14
Pres Disch Line, psig	N/A	N/A	N/A	4500.00
Pres Ratio F/F	4.024	2.776	3.309	3.462
Temp Suct, °F	80.00	127.90	116.10	111.90
Temp Clr Disch, °F	127.90	116.10	111.90	107.90
Cylinder Data:	**Throw 2**	**Throw 2**	**Throw 1**	**Throw 1**
Cyl Model	10-3/4P-HE	5-1/2P-CE	3-5/8SG-CE	1-3/4SG-FS-HE
Cyl Bore, in	10.750	5.500	3.625	1.750
Cyl RDP (API), psig	200.0	477.3	2318.2	5545.5
Cyl MAWP, psig	225.0	525.0	2550.0	6100.0
Cyl Action	HE	CE	CE	HE
Cyl Disp, CFM	279.7	70.2	28.7	7.4
Pres Suct Intl, psig	20.93	122.92	367.12	1294.16
Temp Suct Intl, °F	89	133	121	116
Pres Disch Intl, psig	150.49	426.77	1395.96	4640.81
Temp Disch Intl, °F	294	293	310	300
HE Suct Gas Vel, FPM	9586	N/A	N/A	2650
HE Disch Gas Vel, FPM	9442	N/A	N/A	4836
HE Spcrs Used/Max	0/3	N/A	N/A	N/A
HE Vol Pkt Avail, %	No Pkt	N/A	N/A	No Pkt
Vol Pkt Used, %	No Pkt	N/A %	N/A %	No Pkt
HE Min Clr, %	13.48	N/A	N/A	24.32
HE Total Clr, %	13.48	N/A	N/A	24.32
CE Suct Gas Vel, FPM	N/A	9546	7807	N/A
CE Disch Gas Vel, FPM	N/A	8807	7978	N/A
CE Spcrs Used/Max	N/A	0/2	N/A	N/A
CE Min Clr, %	N/A	19.08	21.98	N/A
CE Total Clr, %	N/A	19.08	21.98	N/A
Suct Vol Eff HE/CE, %	64.2/N/A	N/A/70.0	N/A/59.3	62.7/N/A
Disch Event HE/CE, ms	4.8/N/A	N/A/6.9	N/A/5.8	5.1/N/A
Suct Pseudo-Q HE/CE	9.0/N/A	N/A/8.3	N/A/6.3	0.9/N/A
Gas Rod Ld Comp, %	84.1 C	84.1 C	98.3 C	98.3 C
Gas Rod Ld Tens, %	94.2 T	94.2 T	68.3 T	68.3 T
Gas Rod Ld Total, %	93.4	93.4	88.2	88.2
Xhd Pin Deg/%Rvrsl lbf	148/82.9	148/82.9	159/43.4	159/43.4
Flow Calc, MMSCFD	0.642	0.642	0.639	0.639
Cyl BHP	56.8	44.0	47.8	45.0

Valve Part Numbers as Ordered
1st Stage Suction: B-7242-GG
1st Stage Discharge: B-7242-GGD

2nd Stage Suction: B-5091-CC
2nd Stage Discharge: B-5092-ZM

3rd Stage Suction: B-4087-AA
3rd Stage Discharge: B-3712-ZN

4th Stage Suction: B-1788-E
4th Stage Discharge: B-1788-ED

Compressor Data:

Elevation,ft:	2000.00	Barmtr,psia:	13.651	Ambient,°F:	100.00
Frame:	JGQ/2	Stroke, in:	3.00	Rod Dia, in:	1.125
Max RL Tot, lbf:	20000	Max RL Tens, lbf:	10000	Max RL Comp, lbf:	11000
Rated RPM:	1800	Rated BHP:	280.0	Rated PS FPM:	900.0
Calc RPM:	1775.0	BHP:	185	Calc PS FPM:	887.5

Driver Data:

Type:	Electric
Mfg:	TECO or equa
Model:	447T Frame
BHP:	200
Avail:	200

Services	**Service 1**			
Gas Model	VMG			
Stage Data:	**1 (SG)**	**2**	**3**	**4**
Target Flow, MMSCFD	0.000	0.000	0.000	0.000
Flow Calc, MMSCFD	0.592	0.592	0.590	0.590
BHP per Stage	49.7	41.2	44.9	43.2
Specific Gravity	0.6100	0.6099	0.6015	0.6015
Ratio of Sp Ht (N)	1.2568	1.2556	1.2720	1.2779
Comp Suct (Zs)	0.9933	0.9819	0.9497	0.8566
Comp Disch (Zd)	0.9909	0.9790	0.9564	1.0110
Pres Suct Line, psig	24.00	N/A	N/A	N/A
Pres Suct Flg, psig	24.00	123.96	365.26	1250.28
Pres Disch Flg, psig	127.70	373.51	1263.92	4545.14
Pres Disch Line, psig	N/A	N/A	N/A	4500.00
Pres Ratio F/F	3.754	2.813	3.372	3.607
Temp Suct, °F	80.00	127.90	116.10	111.90
Temp Clr Disch, °F	127.90	116.10	111.90	107.90
Cylinder Data:	**Throw 2**	**Throw 2**	**Throw 1**	**Throw 1**
Cyl Model	10-3/4P-HE	5-1/2P-CE	3-5/8SG-CE	1-3/4SG-FS-HE
Cyl Bore, in	10.750	5.500	3.625	1.750
Cyl RDP (API), psig	200.0	477.3	2318.2	5545.5
Cyl MAWP, psig	225.0	525.0	2550.0	6100.0
Cyl Action	HE	CE	CE	HE
Cyl Disp, CFM	279.7	70.2	28.7	7.4
Pres Suct Intl, psig	20.92	113.53	345.28	1241.69
Temp Suct Intl, °F	88	133	121	116
Pres Disch Intl, psig	139.63	401.85	1339.65	4639.77
Temp Disch Intl, °F	283	295	312	306
HE Suct Gas Vel, FPM	9586	N/A	N/A	2650
HE Disch Gas Vel, FPM	9442	N/A	N/A	4836
HE Spcrs Used/Max	1/3	N/A	N/A	N/A
HE Vol Pkt Avail, %	No Pkt	N/A	N/A	No Pkt
Vol Pkt Used, %	No Pkt	N/A %	N/A %	No Pkt
HE Min Clr, %	13.48	N/A	N/A	24.32
HE Total Clr, %	17.63	N/A	N/A	24.32
CE Suct Gas Vel, FPM	N/A	9546	7807	N/A
CE Disch Gas Vel, FPM	N/A	8807	7978	N/A
CE Spcrs Used/Max	N/A	0/2	N/A	N/A
CE Min Clr, %	N/A	19.08	21.98	N/A
CE Total Clr, %	N/A	19.08	21.98	N/A
Suct Vol Eff HE/CE, %	59.2/N/A	N/A/69.5	N/A/58.2	60.6/N/A
Disch Event HE/CE, ms	4.7/N/A	N/A/6.8	N/A/5.7	4.9/N/A
Suct Pseudo-Q HE/CE	9.0/N/A	N/A/8.3	N/A/6.3	0.9/N/A
Gas Rod Ld Comp, %	77.1 C	77.1 C	98.5 C	98.5 C
Gas Rod Ld Tens, %	88.6 T	88.6 T	66.2 T	66.2 T
Gas Rod Ld Total, %	86.7	86.7	87.2	87.2
Xhd Pin Deg/%Rvrsl lbf	133/75.5	133/75.5	156/40.9	156/40.9
Flow Calc, MMSCFD	0.592	0.592	0.590	0.590
Cyl BHP	49.7	41.2	44.9	43.2

Valve Part Numbers as Ordered
1st Stage Suction: B-7242-GG
1st Stage Discharge: B-7242-GGD

2nd Stage Suction: B-5091-CC
2nd Stage Discharge: B-5092-ZM

3rd Stage Suction: B-4087-AA
3rd Stage Discharge: B-3712-ZN

4th Stage Suction: B-1788-E
4th Stage Discharge: B-1788-ED

Compressor Data:

Elevation,ft:	2000.00	Barmtr,psia:	13.651	Ambient,°F:	100.00
Frame:	JGQ/2	Stroke, in:	3.00	Rod Dia, in:	1.125
Max RL Tot, lbf:	20000	Max RL Tens, lbf:	10000	Max RL Comp, lbf:	11000
Rated RPM:	1800	Rated BHP:	280.0	Rated PS FPM:	900.0
Calc RPM:	1775.0	BHP:	189	Calc PS FPM:	887.5

Driver Data:

Type:	Electric
Mfg:	TECO or equa
Model:	447T Frame
BHP:	200
Avail:	200

Services	**Service 1**			
Gas Model	VMG			
Stage Data:	**1 (SG)**	**2**	**3**	**4**
Target Flow, MMSCFD	0.000	0.000	0.000	0.000
Flow Calc, MMSCFD	0.607	0.607	0.605	0.605
BHP per Stage	51.1	42.2	45.9	43.8
Specific Gravity	0.6100	0.6095	0.6008	0.6008
Ratio of Sp Ht (N)	1.2568	1.2552	1.2717	1.2775
Comp Suct (Zs)	0.9931	0.9816	0.9494	0.8570
Comp Disch (Zd)	0.9906	0.9787	0.9566	1.0108
Pres Suct Line, psig	25.00	N/A	N/A	N/A
Pres Suct Flg, psig	25.00	127.73	374.18	1271.60
Pres Disch Flg, psig	131.54	382.54	1285.33	4545.14
Pres Disch Line, psig	N/A	N/A	N/A	4500.00
Pres Ratio F/F	3.756	2.802	3.349	3.547
Temp Suct, °F	80.00	130.00	118.50	114.00
Temp Clr Disch, °F	130.00	118.50	114.00	109.40
Cylinder Data:	**Throw 2**	**Throw 2**	**Throw 1**	**Throw 1**
Cyl Model	10-3/4P-HE	5-1/2P-CE	3-5/8SG-CE	1-3/4SG-FS-HE
Cyl Bore, in	10.750	5.500	3.625	1.750
Cyl RDP (API), psig	200.0	477.3	2318.2	5545.5
Cyl MAWP, psig	225.0	525.0	2550.0	6100.0
Cyl Action	HE	CE	CE	HE
Cyl Disp, CFM	279.7	70.2	28.7	7.4
Pres Suct Intl, psig	21.84	117.05	353.83	1262.91
Temp Suct Intl, °F	88	135	124	119
Pres Disch Intl, psig	143.79	411.46	1362.05	4639.72
Temp Disch Intl, °F	283	296	314	306
HE Suct Gas Vel, FPM	9586	N/A	N/A	2650
HE Disch Gas Vel, FPM	9442	N/A	N/A	4836
HE Spcrs Used/Max	1/3	N/A	N/A	N/A
HE Vol Pkt Avail, %	No Pkt	N/A	N/A	No Pkt
Vol Pkt Used, %	No Pkt	N/A %	N/A %	No Pkt
HE Min Clr, %	13.48	N/A	N/A	24.32
HE Total Clr, %	17.63	N/A	N/A	24.32
CE Suct Gas Vel, FPM	N/A	9546	7807	N/A
CE Disch Gas Vel, FPM	N/A	8807	7978	N/A
CE Spcrs Used/Max	N/A	0/2	N/A	N/A
CE Min Clr, %	N/A	19.08	21.98	N/A
CE Total Clr, %	N/A	19.08	21.98	N/A
Suct Vol Eff HE/CE, %	59.2/N/A	N/A/69.6	N/A/58.6	61.4/N/A
Disch Event HE/CE, ms	4.7/N/A	N/A/6.8	N/A/5.8	5.0/N/A
Suct Pseudo-Q HE/CE	9.0/N/A	N/A/8.3	N/A/6.3	0.9/N/A
Gas Rod Ld Comp, %	79.2 C	79.2 C	98.4 C	98.4 C
Gas Rod Ld Tens, %	90.6 T	90.6 T	67.0 T	67.0 T
Gas Rod Ld Total, %	88.9	88.9	87.6	87.6
Xhd Pin Deg/%Rvrsl lbf	137/76.1	137/76.1	157/42.0	157/42.0
Flow Calc, MMSCFD	0.607	0.607	0.605	0.605
Cyl BHP	51.1	42.2	45.9	43.8

Valve Part Numbers as Ordered
1st Stage Suction: B-7242-GG
1st Stage Discharge: B-7242-GGD

2nd Stage Suction: B-5091-CC
2nd Stage Discharge: B-5092-ZM

3rd Stage Suction: B-4087-AA
3rd Stage Discharge: B-3712-ZN

4th Stage Suction: B-1788-E
4th Stage Discharge: B-1788-ED

Compressor Data:

Elevation,ft:	2000.00	Barmtr,psia:	13.651	Ambient,°F:	100.00
Frame:	JGQ/2	Stroke, in:	3.00	Rod Dia, in:	1.125
Max RL Tot, lbf:	20000	Max RL Tens, lbf:	10000	Max RL Comp, lbf:	11000
Rated RPM:	1800	Rated BHP:	280.0	Rated PS FPM:	900.0
Calc RPM:	1775.0	BHP:	197	Calc PS FPM:	887.5

Driver Data:

Type:	Electric
Mfg:	TECO or equa
Model:	447T Frame
BHP:	200
Avail:	200

Services	**Service 1**			
Gas Model	VMG			
Stage Data:	**1 (SG)**	**2**	**3**	**4**
Target Flow, MMSCFD	0.000	0.000	0.000	0.000
Flow Calc, MMSCFD	0.641	0.641	0.639	0.639
BHP per Stage	53.7	44.2	47.9	45.0
Specific Gravity	0.6100	0.6099	0.6019	0.6019
Ratio of Sp Ht (N)	1.2571	1.2559	1.2724	1.2775
Comp Suct (Zs)	0.9928	0.9808	0.9473	0.8541
Comp Disch (Zd)	0.9902	0.9779	0.9554	1.0089
Pres Suct Line, psig	27.00	N/A	N/A	N/A
Pres Suct Flg, psig	27.00	134.62	389.85	1307.13
Pres Disch Flg, psig	138.58	398.42	1321.04	4545.14
Pres Disch Line, psig	N/A	N/A	N/A	4500.00
Pres Ratio F/F	3.745	2.779	3.308	3.452
Temp Suct, °F	80.00	130.00	118.50	114.00
Temp Clr Disch, °F	130.00	118.50	114.00	109.40
Cylinder Data:	**Throw 2**	**Throw 2**	**Throw 1**	**Throw 1**
Cyl Model	10-3/4P-HE	5-1/2P-CE	3-5/8SG-CE	1-3/4SG-FS-HE
Cyl Bore, in	10.750	5.500	3.625	1.750
Cyl RDP (API), psig	200.0	477.3	2318.2	5545.5
Cyl MAWP, psig	225.0	525.0	2550.0	6100.0
Cyl Action	HE	CE	CE	HE
Cyl Disp, CFM	279.7	70.2	28.7	7.4
Pres Suct Intl, psig	23.68	123.40	368.59	1298.16
Temp Suct Intl, °F	88	135	124	118
Pres Disch Intl, psig	151.44	428.59	1400.27	4640.65
Temp Disch Intl, °F	283	295	312	301
HE Suct Gas Vel, FPM	9586	N/A	N/A	2650
HE Disch Gas Vel, FPM	9442	N/A	N/A	4836
HE Spcrs Used/Max	1/3	N/A	N/A	N/A
HE Vol Pkt Avail, %	No Pkt	N/A	N/A	No Pkt
Vol Pkt Used, %	No Pkt	N/A %	N/A %	No Pkt
HE Min Clr, %	13.48	N/A	N/A	24.32
HE Total Clr, %	17.63	N/A	N/A	24.32
CE Suct Gas Vel, FPM	N/A	9546	7807	N/A
CE Disch Gas Vel, FPM	N/A	8807	7978	N/A
CE Spcrs Used/Max	N/A	0/2	N/A	N/A
CE Min Clr, %	N/A	19.08	21.98	N/A
CE Total Clr, %	N/A	19.08	21.98	N/A
Suct Vol Eff HE/CE, %	59.3/N/A	N/A/70.0	N/A/59.3	62.8/N/A
Disch Event HE/CE, ms	4.7/N/A	N/A/6.9	N/A/5.8	5.1/N/A
Suct Pseudo-Q HE/CE	9.0/N/A	N/A/8.3	N/A/6.3	0.9/N/A
Gas Rod Ld Comp, %	83.0 C	83.0 C	98.3 C	98.3 C
Gas Rod Ld Tens, %	94.2 T	94.2 T	68.5 T	68.5 T
Gas Rod Ld Total, %	92.7	92.7	88.3	88.3
Xhd Pin Deg/%Rvrsl lbf	147/78.4	147/78.4	159/43.6	159/43.6
Flow Calc, MMSCFD	0.641	0.641	0.639	0.639
Cyl BHP	53.7	44.2	47.9	45.0

Valve Part Numbers as Ordered
1st Stage Suction: B-7242-GG
1st Stage Discharge: B-7242-GGD

2nd Stage Suction: B-5091-CC
2nd Stage Discharge: B-5092-ZM

3rd Stage Suction: B-4087-AA
3rd Stage Discharge: B-3712-ZN

4th Stage Suction: B-1788-E
4th Stage Discharge: B-1788-ED

Compressor Data:

Elevation,ft:	2000.00	Barmtr,psia:	13.651	Ambient,°F:	100.00
Frame:	JGQ/2	Stroke, in:	3.00	Rod Dia, in:	1.125
Max RL Tot, lbf:	20000	Max RL Tens, lbf:	10000	Max RL Comp, lbf:	11000
Rated RPM:	1800	Rated BHP:	280.0	Rated PS FPM:	900.0
Calc RPM:	1775.0	BHP:	184	Calc PS FPM:	887.5

Driver Data:

Type:	Electric
Mfg:	TECO or equa
Model:	447T Frame
BHP:	200
Avail:	200

Services	**Service 1**			
Gas Model	VMG			
Stage Data:	**1 (SG)**	**2**	**3**	**4**
Target Flow, MMSCFD	0.000	0.000	0.000	0.000
Flow Calc, MMSCFD	0.595	0.595	0.594	0.594
BHP per Stage	47.5	41.5	45.2	43.4
Specific Gravity	0.6100	0.6099	0.6023	0.6023
Ratio of Sp Ht (N)	1.2579	1.2552	1.2713	1.2773
Comp Suct (Zs)	0.9928	0.9819	0.9499	0.8574
Comp Disch (Zd)	0.9903	0.9791	0.9568	1.0112
Pres Suct Line, psig	27.00	N/A	N/A	N/A
Pres Suct Flg, psig	27.00	125.26	368.58	1258.42
Pres Disch Flg, psig	129.22	377.14	1272.33	4545.14
Pres Disch Line, psig	N/A	N/A	N/A	4500.00
Pres Ratio F/F	3.515	2.813	3.364	3.584
Temp Suct, °F	80.00	130.00	118.50	114.00
Temp Clr Disch, °F	130.00	118.50	114.00	109.40
Cylinder Data:	**Throw 2**	**Throw 2**	**Throw 1**	**Throw 1**
Cyl Model	10-3/4P-HE	5-1/2P-CE	3-5/8SG-CE	1-3/4SG-FS-HE
Cyl Bore, in	10.750	5.500	3.625	1.750
Cyl RDP (API), psig	200.0	477.3	2318.2	5545.5
Cyl MAWP, psig	225.0	525.0	2550.0	6100.0
Cyl Action	HE	CE	CE	HE
Cyl Disp, CFM	279.7	70.2	28.7	7.4
Pres Suct Intl, psig	23.67	114.77	348.48	1249.81
Temp Suct Intl, °F	88	135	124	119
Pres Disch Intl, psig	141.44	405.67	1348.40	4639.71
Temp Disch Intl, °F	274	297	314	308
HE Suct Gas Vel, FPM	9586	N/A	N/A	2650
HE Disch Gas Vel, FPM	9442	N/A	N/A	4836
HE Spcrs Used/Max	1/3	N/A	N/A	N/A
HE Vol Pkt Avail, %	No Pkt	N/A	N/A	No Pkt
Vol Pkt Used, %	No Pkt	N/A %	N/A %	No Pkt
HE Min Clr, %	13.48	N/A	N/A	24.32
HE Total Clr, %	21.82	N/A	N/A	24.32
CE Suct Gas Vel, FPM	N/A	9546	7807	N/A
CE Disch Gas Vel, FPM	N/A	8807	7978	N/A
CE Spcrs Used/Max	N/A	0/2	N/A	N/A
CE Min Clr, %	N/A	19.08	21.98	N/A
CE Total Clr, %	N/A	19.08	21.98	N/A
Suct Vol Eff HE/CE, %	55.1/N/A	N/A/69.5	N/A/58.3	60.8/N/A
Disch Event HE/CE, ms	4.7/N/A	N/A/6.8	N/A/5.7	4.9/N/A
Suct Pseudo-Q HE/CE	9.0/N/A	N/A/8.3	N/A/6.3	0.9/N/A
Gas Rod Ld Comp, %	76.5 C	76.5 C	98.4 C	98.4 C
Gas Rod Ld Tens, %	89.0 T	89.0 T	66.5 T	66.5 T
Gas Rod Ld Total, %	86.6	86.6	87.4	87.4
Xhd Pin Deg/%Rvrsl lbf	131/71.4	131/71.4	156/41.3	156/41.3
Flow Calc, MMSCFD	0.595	0.595	0.594	0.594
Cyl BHP	47.5	41.5	45.2	43.4

Valve Part Numbers as Ordered
1st Stage Suction: B-7242-GG
1st Stage Discharge: B-7242-GGD

2nd Stage Suction: B-5091-CC
2nd Stage Discharge: B-5092-ZM

3rd Stage Suction: B-4087-AA
3rd Stage Discharge: B-3712-ZN

4th Stage Suction: B-1788-E
4th Stage Discharge: B-1788-ED

Compressor Data:

Elevation,ft:	2000.00	Barmtr,psia:	13.651	Ambient,°F:	100.00
Frame:	JGQ/2	Stroke, in:	3.00	Rod Dia, in:	1.125
Max RL Tot, lbf:	20000	Max RL Tens, lbf:	10000	Max RL Comp, lbf:	11000
Rated RPM:	1800	Rated BHP:	280.0	Rated PS FPM:	900.0
Calc RPM:	1775.0	BHP:	194	Calc PS FPM:	887.5

Driver Data:

Type:	Electric
Mfg:	TECO or equa
Model:	447T Frame
BHP:	200
Avail:	200

Services	**Service 1**			
Gas Model	VMG			
Stage Data:	**1 (SG)**	**2**	**3**	**4**
Target Flow, MMSCFD	0.000	0.000	0.000	0.000
Flow Calc, MMSCFD	0.640	0.640	0.638	0.638
BHP per Stage	51.0	44.3	48.0	45.0
Specific Gravity	0.6100	0.6099	0.6016	0.6016
Ratio of Sp Ht (N)	1.2574	1.2546	1.2710	1.2764
Comp Suct (Zs)	0.9922	0.9808	0.9478	0.8554
Comp Disch (Zd)	0.9895	0.9779	0.9560	1.0096
Pres Suct Line, psig	30.00	N/A	N/A	N/A
Pres Suct Flg, psig	30.00	135.27	391.75	1311.61
Pres Disch Flg, psig	139.44	400.63	1325.77	4545.14
Pres Disch Line, psig	N/A	N/A	N/A	4500.00
Pres Ratio F/F	3.507	2.782	3.304	3.440
Temp Suct, °F	80.00	132.20	121.40	116.20
Temp Clr Disch, °F	132.20	121.40	116.20	111.30
Cylinder Data:	**Throw 2**	**Throw 2**	**Throw 1**	**Throw 1**
Cyl Model	10-3/4P-HE	5-1/2P-CE	3-5/8SG-CE	1-3/4SG-FS-HE
Cyl Bore, in	10.750	5.500	3.625	1.750
Cyl RDP (API), psig	200.0	477.3	2318.2	5545.5
Cyl MAWP, psig	225.0	525.0	2550.0	6100.0
Cyl Action	HE	CE	CE	HE
Cyl Disp, CFM	279.7	70.2	28.7	7.4
Pres Suct Intl, psig	26.43	124.05	370.52	1302.66
Temp Suct Intl, °F	88	137	127	121
Pres Disch Intl, psig	152.57	430.88	1404.92	4640.33
Temp Disch Intl, °F	273	298	315	303
HE Suct Gas Vel, FPM	9586	N/A	N/A	2650
HE Disch Gas Vel, FPM	9442	N/A	N/A	4836
HE Spcrs Used/Max	1/3	N/A	N/A	N/A
HE Vol Pkt Avail, %	No Pkt	N/A	N/A	No Pkt
Vol Pkt Used, %	No Pkt	N/A %	N/A %	No Pkt
HE Min Clr, %	13.48	N/A	N/A	24.32
HE Total Clr, %	21.82	N/A	N/A	24.32
CE Suct Gas Vel, FPM	N/A	9546	7807	N/A
CE Disch Gas Vel, FPM	N/A	8807	7978	N/A
CE Spcrs Used/Max	N/A	0/2	N/A	N/A
CE Min Clr, %	N/A	19.08	21.98	N/A
CE Total Clr, %	N/A	19.08	21.98	N/A
Suct Vol Eff HE/CE, %	55.2/N/A	N/A/69.9	N/A/59.3	62.9/N/A
Disch Event HE/CE, ms	4.7/N/A	N/A/6.9	N/A/5.8	5.1/N/A
Suct Pseudo-Q HE/CE	9.0/N/A	N/A/8.3	N/A/6.3	0.9/N/A
Gas Rod Ld Comp, %	81.9 C	81.9 C	98.2 C	98.2 C
Gas Rod Ld Tens, %	94.2 T	94.2 T	68.7 T	68.7 T
Gas Rod Ld Total, %	92.2	92.2	88.4	88.4
Xhd Pin Deg/%Rvrsl lbf	147/74.0	147/74.0	159/43.8	159/43.8
Flow Calc, MMSCFD	0.640	0.640	0.638	0.638
Cyl BHP	51.0	44.3	48.0	45.0

Valve Part Numbers as Ordered
1st Stage Suction: B-7242-GG
1st Stage Discharge: B-7242-GGD

2nd Stage Suction: B-5091-CC
2nd Stage Discharge: B-5092-ZM

3rd Stage Suction: B-4087-AA
3rd Stage Discharge: B-3712-ZN

4th Stage Suction: B-1788-E
4th Stage Discharge: B-1788-ED

Compressor Data:

Elevation,ft:	2000.00	Barmtr,psia:	13.651	Ambient,°F:	100.00
Frame:	JGQ/2	Stroke, in:	3.00	Rod Dia, in:	1.125
Max RL Tot, lbf:	20000	Max RL Tens, lbf:	10000	Max RL Comp, lbf:	11000
Rated RPM:	1800	Rated BHP:	280.0	Rated PS FPM:	900.0
Calc RPM:	1775.0	BHP:	198	Calc PS FPM:	887.5

Driver Data:

Type:	Electric
Mfg:	TECO or equa
Model:	447T Frame
BHP:	200
Avail:	200

Services	**Service 1**			
Gas Model	VMG			
Stage Data:	**1 (SG)**	**2**	**3**	**4**
Target Flow, MMSCFD	0.000	0.000	0.000	0.000
Flow Calc, MMSCFD	0.656	0.656	0.654	0.654
BHP per Stage	52.2	45.2	49.0	45.6
Specific Gravity	0.6100	0.6102	0.6023	0.6023
Ratio of Sp Ht (N)	1.2575	1.2548	1.2712	1.2763
Comp Suct (Zs)	0.9920	0.9804	0.9469	0.8539
Comp Disch (Zd)	0.9893	0.9775	0.9554	1.0086
Pres Suct Line, psig	31.00	N/A	N/A	N/A
Pres Suct Flg, psig	31.00	138.50	399.10	1328.15
Pres Disch Flg, psig	142.75	408.08	1342.38	4545.14
Pres Disch Line, psig	N/A	N/A	N/A	4500.00
Pres Ratio F/F	3.503	2.772	3.285	3.398
Temp Suct, °F	80.00	132.20	121.40	116.20
Temp Clr Disch, °F	132.20	121.40	116.20	111.30
Cylinder Data:	**Throw 2**	**Throw 2**	**Throw 1**	**Throw 1**
Cyl Model	10-3/4P-HE	5-1/2P-CE	3-5/8SG-CE	1-3/4SG-FS-HE
Cyl Bore, in	10.750	5.500	3.625	1.750
Cyl RDP (API), psig	200.0	477.3	2318.2	5545.5
Cyl MAWP, psig	225.0	525.0	2550.0	6100.0
Cyl Action	HE	CE	CE	HE
Cyl Disp, CFM	279.7	70.2	28.7	7.4
Pres Suct Intl, psig	27.34	127.03	377.43	1319.06
Temp Suct Intl, °F	88	137	127	121
Pres Disch Intl, psig	156.17	438.92	1422.75	4640.80
Temp Disch Intl, °F	273	297	314	301
HE Suct Gas Vel, FPM	9586	N/A	N/A	2650
HE Disch Gas Vel, FPM	9442	N/A	N/A	4836
HE Spcrs Used/Max	1/3	N/A	N/A	N/A
HE Vol Pkt Avail, %	No Pkt	N/A	N/A	No Pkt
Vol Pkt Used, %	No Pkt	N/A %	N/A %	No Pkt
HE Min Clr, %	13.48	N/A	N/A	24.32
HE Total Clr, %	21.82	N/A	N/A	24.32
CE Suct Gas Vel, FPM	N/A	9546	7807	N/A
CE Disch Gas Vel, FPM	N/A	8807	7978	N/A
CE Spcrs Used/Max	N/A	0/2	N/A	N/A
CE Min Clr, %	N/A	19.08	21.98	N/A
CE Total Clr, %	N/A	19.08	21.98	N/A
Suct Vol Eff HE/CE, %	55.2/N/A	N/A/70.1	N/A/59.6	63.5/N/A
Disch Event HE/CE, ms	4.7/N/A	N/A/6.9	N/A/5.9	5.2/N/A
Suct Pseudo-Q HE/CE	9.0/N/A	N/A/8.3	N/A/6.3	0.9/N/A
Gas Rod Ld Comp, %	83.7 C	83.7 C	98.2 C	98.2 C
Gas Rod Ld Tens, %	95.9 T	95.9 T	69.4 T	69.4 T
Gas Rod Ld Total, %	94.0	94.0	88.7	88.7
Xhd Pin Deg/%Rvrsl lbf	148/75.2	148/75.2	160/44.8	160/44.8
Flow Calc, MMSCFD	0.656	0.656	0.654	0.654
Cyl BHP	52.2	45.2	49.0	45.6

Valve Part Numbers as Ordered
1st Stage Suction: B-7242-GG
1st Stage Discharge: B-7242-GGD

2nd Stage Suction: B-5091-CC
2nd Stage Discharge: B-5092-ZM

3rd Stage Suction: B-4087-AA
3rd Stage Discharge: B-3712-ZN

4th Stage Suction: B-1788-E
4th Stage Discharge: B-1788-ED

Compressor Data:

Elevation,ft:	2000.00	Barmtr,psia:	13.651	Ambient,°F:	100.00		
Frame:	JGQ/2	Stroke, in:	3.00	Rod Dia, in:	1.125		
Max RL Tot, lbf:	20000	Max RL Tens, lbf:	10000	Max RL Comp, lbf:	11000		
Rated RPM:	1800	Rated BHP:	280.0	Rated PS FPM:	900.0		
Calc RPM:	1775.0	BHP:	186	Calc PS FPM:	887.5		

Driver Data:

Type:	Electric
Mfg:	TECO or equa
Model:	447T Frame
BHP:	200
Avail:	200

Services	**Service 1**			
Gas Model	VMG			
Stage Data:	**1 (SG)**	**2**	**3**	**4**
Target Flow, MMSCFD	0.000	0.000	0.000	0.000
Flow Calc, MMSCFD	0.614	0.614	0.612	0.612
BHP per Stage	46.6	42.8	46.5	44.1
Specific Gravity	0.6100	0.6102	0.6027	0.6027
Ratio of Sp Ht (N)	1.2582	1.2541	1.2701	1.2760
Comp Suct (Zs)	0.9920	0.9815	0.9492	0.8569
Comp Disch (Zd)	0.9894	0.9786	0.9566	1.0107
Pres Suct Line, psig	31.00	N/A	N/A	N/A
Pres Suct Flg, psig	31.00	129.82	379.37	1282.93
Pres Disch Flg, psig	134.07	388.34	1297.16	4545.14
Pres Disch Line, psig	N/A	N/A	N/A	4500.00
Pres Ratio F/F	3.308	2.802	3.335	3.516
Temp Suct, °F	80.00	132.20	121.40	116.20
Temp Clr Disch, °F	132.20	121.40	116.20	111.30
Cylinder Data:	**Throw 2**	**Throw 2**	**Throw 1**	**Throw 1**
Cyl Model	10-3/4P-HE	5-1/2P-CE	3-5/8SG-CE	1-3/4SG-FS-HE
Cyl Bore, in	10.750	5.500	3.625	1.750
Cyl RDP (API), psig	200.0	477.3	2318.2	5545.5
Cyl MAWP, psig	225.0	525.0	2550.0	6100.0
Cyl Action	HE	CE	CE	HE
Cyl Disp, CFM	279.7	70.2	28.7	7.4
Pres Suct Intl, psig	27.34	119.01	358.77	1274.17
Temp Suct Intl, °F	88	137	127	121
Pres Disch Intl, psig	146.89	417.66	1374.62	4639.97
Temp Disch Intl, °F	265	298	316	307
HE Suct Gas Vel, FPM	9586	N/A	N/A	2650
HE Disch Gas Vel, FPM	9442	N/A	N/A	4836
HE Spcrs Used/Max	1/3	N/A	N/A	N/A
HE Vol Pkt Avail, %	No Pkt	N/A	N/A	No Pkt
Vol Pkt Used, %	No Pkt	N/A %	N/A %	No Pkt
HE Min Clr, %	13.48	N/A	N/A	24.32
HE Total Clr, %	25.97	N/A	N/A	24.32
CE Suct Gas Vel, FPM	N/A	9546	7807	N/A
CE Disch Gas Vel, FPM	N/A	8807	7978	N/A
CE Spcrs Used/Max	N/A	0/2	N/A	N/A
CE Min Clr, %	N/A	19.08	21.98	N/A
CE Total Clr, %	N/A	19.08	21.98	N/A
Suct Vol Eff HE/CE, %	51.7/N/A	N/A/69.6	N/A/58.7	61.7/N/A
Disch Event HE/CE, ms	4.6/N/A	N/A/6.8	N/A/5.8	5.0/N/A
Suct Pseudo-Q HE/CE	9.0/N/A	N/A/8.2	N/A/6.3	0.9/N/A
Gas Rod Ld Comp, %	77.7 C	77.7 C	98.3 C	98.3 C
Gas Rod Ld Tens, %	91.0 T	91.0 T	67.5 T	67.5 T
Gas Rod Ld Total, %	88.2	88.2	87.8	87.8
Xhd Pin Deg/%Rvrsl lbf	132/68.6	132/68.6	158/42.6	158/42.6
Flow Calc, MMSCFD	0.614	0.614	0.612	0.612
Cyl BHP	46.6	42.8	46.5	44.1

Valve Part Numbers as Ordered
1st Stage Suction: B-7242-GG
1st Stage Discharge: B-7242-GGD

2nd Stage Suction: B-5091-CC
2nd Stage Discharge: B-5092-ZM

3rd Stage Suction: B-4087-AA
3rd Stage Discharge: B-3712-ZN

4th Stage Suction: B-1788-E
4th Stage Discharge: B-1788-ED

Compressor Data:

Elevation,ft:	2000.00	Barmtr,psia:	13.651	Ambient,°F:	100.00
Frame:	JGQ/2	Stroke, in:	3.00	Rod Dia, in:	1.125
Max RL Tot, lbf:	20000	Max RL Tens, lbf:	10000	Max RL Comp, lbf:	11000
Rated RPM:	1800	Rated BHP:	280.0	Rated PS FPM:	900.0
Calc RPM:	1775.0	BHP:	199	Calc PS FPM:	887.5

Driver Data:

Type:	Electric
Mfg:	TECO or equa
Model:	447T Frame
BHP:	200
Avail:	200

Services	**Service 1**			
Gas Model	VMG			
Stage Data:	**1 (SG)**	**2**	**3**	**4**
Target Flow, MMSCFD	0.000	0.000	0.000	0.000
Flow Calc, MMSCFD	0.672	0.672	0.670	0.670
BHP per Stage	50.9	46.3	50.0	46.1
Specific Gravity	0.6100	0.6101	0.6024	0.6024
Ratio of Sp Ht (N)	1.2587	1.2548	1.2712	1.2760
Comp Suct (Zs)	0.9913	0.9801	0.9463	0.8539
Comp Disch (Zd)	0.9885	0.9772	0.9553	1.0082
Pres Suct Line, psig	35.00	N/A	N/A	N/A
Pres Suct Flg, psig	35.00	142.26	407.87	1349.03
Pres Disch Flg, psig	146.79	417.24	1363.57	4545.14
Pres Disch Line, psig	N/A	N/A	N/A	4500.00
Pres Ratio F/F	3.298	2.764	3.267	3.345
Temp Suct, °F	80.00	133.50	122.90	117.70
Temp Clr Disch, °F	133.50	122.90	117.70	112.60
Cylinder Data:	**Throw 2**	**Throw 2**	**Throw 1**	**Throw 1**
Cyl Model	10-3/4P-HE	5-1/2P-CE	3-5/8SG-CE	1-3/4SG-FS-HE
Cyl Bore, in	10.750	5.500	3.625	1.750
Cyl RDP (API), psig	200.0	477.3	2318.2	5545.5
Cyl MAWP, psig	225.0	525.0	2550.0	6100.0
Cyl Action	HE	CE	CE	HE
Cyl Disp, CFM	279.7	70.2	28.7	7.4
Pres Suct Intl, psig	31.01	130.52	385.78	1339.81
Temp Suct Intl, °F	88	139	128	122
Pres Disch Intl, psig	160.72	448.70	1445.11	4640.96
Temp Disch Intl, °F	265	298	315	300
HE Suct Gas Vel, FPM	9586	N/A	N/A	2650
HE Disch Gas Vel, FPM	9442	N/A	N/A	4836
HE Spcrs Used/Max	1/3	N/A	N/A	N/A
HE Vol Pkt Avail, %	No Pkt	N/A	N/A	No Pkt
Vol Pkt Used, %	No Pkt	N/A %	N/A %	No Pkt
HE Min Clr, %	13.48	N/A	N/A	24.32
HE Total Clr, %	25.97	N/A	N/A	24.32
CE Suct Gas Vel, FPM	N/A	9546	7807	N/A
CE Disch Gas Vel, FPM	N/A	8807	7978	N/A
CE Spcrs Used/Max	N/A	0/2	N/A	N/A
CE Min Clr, %	N/A	19.08	21.98	N/A
CE Total Clr, %	N/A	19.08	21.98	N/A
Suct Vol Eff HE/CE, %	51.9/N/A	N/A/70.2	N/A/59.9	64.2/N/A
Disch Event HE/CE, ms	4.6/N/A	N/A/6.9	N/A/5.9	5.3/N/A
Suct Pseudo-Q HE/CE	9.0/N/A	N/A/8.2	N/A/6.3	0.9/N/A
Gas Rod Ld Comp, %	84.3 C	84.3 C	98.1 C	98.1 C
Gas Rod Ld Tens, %	97.4 T	97.4 T	70.3 T	70.3 T
Gas Rod Ld Total, %	95.1	95.1	89.1	89.1
Xhd Pin Deg/%Rvrsl lbf	149/72.7	149/72.7	160/45.5	160/45.5
Flow Calc, MMSCFD	0.672	0.672	0.670	0.670
Cyl BHP	50.9	46.3	50.0	46.1

Valve Part Numbers as Ordered
1st Stage Suction: B-7242-GG
1st Stage Discharge: B-7242-GGD

2nd Stage Suction: B-5091-CC
2nd Stage Discharge: B-5092-ZM

3rd Stage Suction: B-4087-AA
3rd Stage Discharge: B-3712-ZN

4th Stage Suction: B-1788-E
4th Stage Discharge: B-1788-ED

Compressor Data:

Elevation,ft:	2000.00	Barmtr,psia:	13.651	Ambient,°F:	100.00
Frame:	JGQ/2	Stroke, in:	3.00	Rod Dia, in:	1.125
Max RL Tot, lbf:	20000	Max RL Tens, lbf:	10000	Max RL Comp, lbf:	11000
Rated RPM:	1800	Rated BHP:	280.0	Rated PS FPM:	900.0
Calc RPM:	1775.0	BHP:	188	Calc PS FPM:	887.5

Driver Data:

Type:	Electric
Mfg:	TECO or equa
Model:	447T Frame
BHP:	200
Avail:	200

Services	**Service 1**			
Gas Model	VMG			
Stage Data:	**1 (SG)**	**2**	**3**	**4**
Target Flow, MMSCFD	0.000	0.000	0.000	0.000
Flow Calc, MMSCFD	0.633	0.633	0.631	0.631
BHP per Stage	45.9	44.0	47.7	44.8
Specific Gravity	0.6100	0.6101	0.6028	0.6028
Ratio of Sp Ht (N)	1.2594	1.2542	1.2702	1.2758
Comp Suct (Zs)	0.9913	0.9811	0.9484	0.8565
Comp Disch (Zd)	0.9885	0.9783	0.9564	1.0101
Pres Suct Line, psig	35.00	N/A	N/A	N/A
Pres Suct Flg, psig	35.00	134.12	389.39	1306.60
Pres Disch Flg, psig	138.65	398.76	1321.14	4545.14
Pres Disch Line, psig	N/A	N/A	N/A	4500.00
Pres Ratio F/F	3.131	2.791	3.312	3.453
Temp Suct, °F	80.00	133.50	122.90	117.70
Temp Clr Disch, °F	133.50	122.90	117.70	112.60
Cylinder Data:	**Throw 2**	**Throw 2**	**Throw 1**	**Throw 1**
Cyl Model	10-3/4P-HE	5-1/2P-CE	3-5/8SG-CE	1-3/4SG-FS-HE
Cyl Bore, in	10.750	5.500	3.625	1.750
Cyl RDP (API), psig	200.0	477.3	2318.2	5545.5
Cyl MAWP, psig	225.0	525.0	2550.0	6100.0
Cyl Action	HE	CE	CE	HE
Cyl Disp, CFM	279.7	70.2	28.7	7.4
Pres Suct Intl, psig	31.01	123.01	368.30	1297.70
Temp Suct Intl, °F	87	139	128	122
Pres Disch Intl, psig	152.02	428.80	1399.96	4640.19
Temp Disch Intl, °F	257	300	317	305
HE Suct Gas Vel, FPM	9586	N/A	N/A	2650
HE Disch Gas Vel, FPM	9442	N/A	N/A	4836
HE Spcrs Used/Max	2/3	N/A	N/A	N/A
HE Vol Pkt Avail, %	No Pkt	N/A	N/A	No Pkt
Vol Pkt Used, %	No Pkt	N/A %	N/A %	No Pkt
HE Min Clr, %	13.48	N/A	N/A	24.32
HE Total Clr, %	30.12	N/A	N/A	24.32
CE Suct Gas Vel, FPM	N/A	9546	7807	N/A
CE Disch Gas Vel, FPM	N/A	8807	7978	N/A
CE Spcrs Used/Max	N/A	0/2	N/A	N/A
CE Min Clr, %	N/A	19.08	21.98	N/A
CE Total Clr, %	N/A	19.08	21.98	N/A
Suct Vol Eff HE/CE, %	48.9/N/A	N/A/69.8	N/A/59.1	62.6/N/A
Disch Event HE/CE, ms	4.6/N/A	N/A/6.8	N/A/5.8	5.1/N/A
Suct Pseudo-Q HE/CE	9.0/N/A	N/A/8.2	N/A/6.3	0.9/N/A
Gas Rod Ld Comp, %	78.7 C	78.7 C	98.3 C	98.3 C
Gas Rod Ld Tens, %	92.9 T	92.9 T	68.5 T	68.5 T
Gas Rod Ld Total, %	89.7	89.7	88.3	88.3
Xhd Pin Deg/%Rvrsl lbf	132/66.1	132/66.1	158/43.3	158/43.3
Flow Calc, MMSCFD	0.633	0.633	0.631	0.631
Cyl BHP	45.9	44.0	47.7	44.8

Valve Part Numbers as Ordered
1st Stage Suction: B-7242-GG
1st Stage Discharge: B-7242-GGD

2nd Stage Suction: B-5091-CC
2nd Stage Discharge: B-5092-ZM

3rd Stage Suction: B-4087-AA
3rd Stage Discharge: B-3712-ZN

4th Stage Suction: B-1788-E
4th Stage Discharge: B-1788-ED

Compressor Data:

Elevation,ft:	2000.00	Barmtr,psia:	13.651	Ambient,°F:	100.00
Frame:	JGQ/2	Stroke, in:	3.00	Rod Dia, in:	1.125
Max RL Tot, lbf:	20000	Max RL Tens, lbf:	10000	Max RL Comp, lbf:	11000
Rated RPM:	1800	Rated BHP:	280.0	Rated PS FPM:	900.0
Calc RPM:	1775.0	BHP:	198	Calc PS FPM:	887.5

Driver Data:

Type:	Electric
Mfg:	TECO or equa
Model:	447T Frame
BHP:	200
Avail:	200

Services	**Service 1**			
Gas Model	VMG			
Stage Data:	**1 (SG)**	**2**	**3**	**4**
Target Flow, MMSCFD	0.000	0.000	0.000	0.000
Flow Calc, MMSCFD	0.676	0.676	0.675	0.675
BHP per Stage	48.9	46.5	50.3	46.3
Specific Gravity	0.6100	0.6099	0.6049	0.6049
Ratio of Sp Ht (N)	1.2603	1.2560	1.2711	1.2758
Comp Suct (Zs)	0.9909	0.9799	0.9457	0.8527
Comp Disch (Zd)	0.9880	0.9770	0.9548	1.0076
Pres Suct Line, psig	38.00	N/A	N/A	N/A
Pres Suct Flg, psig	38.00	142.68	409.65	1352.48
Pres Disch Flg, psig	147.42	419.31	1367.24	4545.14
Pres Disch Line, psig	N/A	N/A	N/A	4500.00
Pres Ratio F/F	3.118	2.769	3.262	3.337
Temp Suct, °F	80.00	131.30	122.30	117.20
Temp Clr Disch, °F	131.30	122.30	117.20	112.10
Cylinder Data:	**Throw 2**	**Throw 2**	**Throw 1**	**Throw 1**
Cyl Model	10-3/4P-HE	5-1/2P-CE	3-5/8SG-CE	1-3/4SG-FS-HE
Cyl Bore, in	10.750	5.500	3.625	1.750
Cyl RDP (API), psig	200.0	477.3	2318.2	5545.5
Cyl MAWP, psig	225.0	525.0	2550.0	6100.0
Cyl Action	HE	CE	CE	HE
Cyl Disp, CFM	279.7	70.2	28.7	7.4
Pres Suct Intl, psig	33.76	130.87	387.34	1343.19
Temp Suct Intl, °F	87	136	128	121
Pres Disch Intl, psig	161.56	450.99	1449.48	4641.56
Temp Disch Intl, °F	257	297	314	299
HE Suct Gas Vel, FPM	9586	N/A	N/A	2650
HE Disch Gas Vel, FPM	9442	N/A	N/A	4836
HE Spcrs Used/Max	2/3	N/A	N/A	N/A
HE Vol Pkt Avail, %	No Pkt	N/A	N/A	No Pkt
Vol Pkt Used, %	No Pkt	N/A %	N/A %	No Pkt
HE Min Clr, %	13.48	N/A	N/A	24.32
HE Total Clr, %	30.12	N/A	N/A	24.32
CE Suct Gas Vel, FPM	N/A	9546	7807	N/A
CE Disch Gas Vel, FPM	N/A	8807	7978	N/A
CE Spcrs Used/Max	N/A	0/2	N/A	N/A
CE Min Clr, %	N/A	19.08	21.98	N/A
CE Total Clr, %	N/A	19.08	21.98	N/A
Suct Vol Eff HE/CE, %	49.2/N/A	N/A/70.1	N/A/60.0	64.4/N/A
Disch Event HE/CE, ms	4.6/N/A	N/A/6.9	N/A/5.9	5.3/N/A
Suct Pseudo-Q HE/CE	9.0/N/A	N/A/8.3	N/A/6.3	0.9/N/A
Gas Rod Ld Comp, %	83.1 C	83.1 C	98.1 C	98.1 C
Gas Rod Ld Tens, %	97.5 T	97.5 T	70.5 T	70.5 T
Gas Rod Ld Total, %	94.4	94.4	89.2	89.2
Xhd Pin Deg/%Rvrsl lbf	147/68.5	147/68.5	160/45.6	160/45.6
Flow Calc, MMSCFD	0.676	0.676	0.675	0.675
Cyl BHP	48.9	46.5	50.3	46.3

Valve Part Numbers as Ordered
1st Stage Suction: B-7242-GG
1st Stage Discharge: B-7242-GGD

2nd Stage Suction: B-5091-CC
2nd Stage Discharge: B-5092-ZM

3rd Stage Suction: B-4087-AA
3rd Stage Discharge: B-3712-ZN

4th Stage Suction: B-1788-E
4th Stage Discharge: B-1788-ED

Compressor Data:

Elevation,ft:	2000.00	Barmtr,psia:	13.651	Ambient,°F:	100.00		
Frame:	JGQ/2	Stroke, in:	3.00	Rod Dia, in:	1.125		
Max RL Tot, lbf:	20000	Max RL Tens, lbf:	10000	Max RL Comp, lbf:	11000		
Rated RPM:	1800	Rated BHP:	280.0	Rated PS FPM:	900.0		
Calc RPM:	1775.0	BHP:	188	Calc PS FPM:	887.5		

Driver Data:

Type:	Electric
Mfg:	TECO or equa
Model:	447T Frame
BHP:	200
Avail:	200

Services	**Service 1**			
Gas Model	VMG			
Stage Data:	**1 (SG)**	**2**	**3**	**4**
Target Flow, MMSCFD	0.000	0.000	0.000	0.000
Flow Calc, MMSCFD	0.640	0.640	0.638	0.638
BHP per Stage	44.3	44.4	48.1	45.1
Specific Gravity	0.6100	0.6099	0.6052	0.6052
Ratio of Sp Ht (N)	1.2609	1.2554	1.2702	1.2757
Comp Suct (Zs)	0.9909	0.9808	0.9477	0.8553
Comp Disch (Zd)	0.9881	0.9780	0.9558	1.0094
Pres Suct Line, psig	38.00	N/A	N/A	N/A
Pres Suct Flg, psig	38.00	135.16	392.50	1313.17
Pres Disch Flg, psig	139.89	402.16	1327.94	4545.14
Pres Disch Line, psig	N/A	N/A	N/A	4500.00
Pres Ratio F/F	2.973	2.794	3.303	3.436
Temp Suct, °F	80.00	131.30	122.30	117.20
Temp Clr Disch, °F	131.30	122.30	117.20	112.10
Cylinder Data:	**Throw 2**	**Throw 2**	**Throw 1**	**Throw 1**
Cyl Model	10-3/4P-HE	5-1/2P-CE	3-5/8SG-CE	1-3/4SG-FS-HE
Cyl Bore, in	10.750	5.500	3.625	1.750
Cyl RDP (API), psig	200.0	477.3	2318.2	5545.5
Cyl MAWP, psig	225.0	525.0	2550.0	6100.0
Cyl Action	HE	CE	CE	HE
Cyl Disp, CFM	279.7	70.2	28.7	7.4
Pres Suct Intl, psig	33.76	123.93	371.13	1304.17
Temp Suct Intl, °F	87	136	128	122
Pres Disch Intl, psig	153.50	432.51	1407.63	4640.82
Temp Disch Intl, °F	250	298	316	304
HE Suct Gas Vel, FPM	9586	N/A	N/A	2650
HE Disch Gas Vel, FPM	9442	N/A	N/A	4836
HE Spcrs Used/Max	2/3	N/A	N/A	N/A
HE Vol Pkt Avail, %	No Pkt	N/A	N/A	No Pkt
Vol Pkt Used, %	No Pkt	N/A %	N/A %	No Pkt
HE Min Clr, %	13.48	N/A	N/A	24.32
HE Total Clr, %	34.31	N/A	N/A	24.32
CE Suct Gas Vel, FPM	N/A	9546	7807	N/A
CE Disch Gas Vel, FPM	N/A	8807	7978	N/A
CE Spcrs Used/Max	N/A	0/2	N/A	N/A
CE Min Clr, %	N/A	19.08	21.98	N/A
CE Total Clr, %	N/A	19.08	21.98	N/A
Suct Vol Eff HE/CE, %	46.5/N/A	N/A/69.8	N/A/59.3	62.9/N/A
Disch Event HE/CE, ms	4.6/N/A	N/A/6.8	N/A/5.8	5.1/N/A
Suct Pseudo-Q HE/CE	8.9/N/A	N/A/8.3	N/A/6.3	0.9/N/A
Gas Rod Ld Comp, %	77.9 C	77.9 C	98.2 C	98.2 C
Gas Rod Ld Tens, %	93.3 T	93.3 T	68.9 T	68.9 T
Gas Rod Ld Total, %	89.5	89.5	88.5	88.5
Xhd Pin Deg/%Rvrsl lbf	132/61.8	132/61.8	160/43.8	160/43.8
Flow Calc, MMSCFD	0.640	0.640	0.638	0.638
Cyl BHP	44.3	44.4	48.1	45.1

Valve Part Numbers as Ordered
1st Stage Suction: B-7242-GG
1st Stage Discharge: B-7242-GGD

2nd Stage Suction: B-5091-CC
2nd Stage Discharge: B-5092-ZM

3rd Stage Suction: B-4087-AA
3rd Stage Discharge: B-3712-ZN

4th Stage Suction: B-1788-E
4th Stage Discharge: B-1788-ED

Compressor Data:

Elevation,ft:	2000.00	Barmtr,psia:	13.651	Ambient,°F:	100.00
Frame:	JGQ/2	Stroke, in:	3.00	Rod Dia, in:	1.125
Max RL Tot, lbf:	20000	Max RL Tens, lbf:	10000	Max RL Comp, lbf:	11000
Rated RPM:	1800	Rated BHP:	280.0	Rated PS FPM:	900.0
Calc RPM:	1775.0	BHP:	194	Calc PS FPM:	887.5

Driver Data:

Type:	Electric
Mfg:	TECO or equa
Model:	447T Frame
BHP:	200
Avail:	200

Services	**Service 1**			
Gas Model	VMG			
Stage Data:	**1 (SG)**	**2**	**3**	**4**
Target Flow, MMSCFD	0.000	0.000	0.000	0.000
Flow Calc, MMSCFD	0.666	0.666	0.665	0.665
BHP per Stage	46.1	46.0	49.7	46.0
Specific Gravity	0.6100	0.6095	0.6058	0.6058
Ratio of Sp Ht (N)	1.2614	1.2561	1.2707	1.2756
Comp Suct (Zs)	0.9905	0.9802	0.9461	0.8530
Comp Disch (Zd)	0.9877	0.9773	0.9548	1.0079
Pres Suct Line, psig	40.00	N/A	N/A	N/A
Pres Suct Flg, psig	40.00	140.71	405.21	1341.96
Pres Disch Flg, psig	145.59	415.05	1356.86	4545.14
Pres Disch Line, psig	N/A	N/A	N/A	4500.00
Pres Ratio F/F	2.968	2.777	3.272	3.363
Temp Suct, °F	80.00	131.30	122.30	117.20
Temp Clr Disch, °F	131.30	122.30	117.20	112.10
Cylinder Data:	**Throw 2**	**Throw 2**	**Throw 1**	**Throw 1**
Cyl Model	10-3/4P-HE	5-1/2P-CE	3-5/8SG-CE	1-3/4SG-FS-HE
Cyl Bore, in	10.750	5.500	3.625	1.750
Cyl RDP (API), psig	200.0	477.3	2318.2	5545.5
Cyl MAWP, psig	225.0	525.0	2550.0	6100.0
Cyl Action	HE	CE	CE	HE
Cyl Disp, CFM	279.7	70.2	28.7	7.4
Pres Suct Intl, psig	35.59	129.06	383.11	1332.72
Temp Suct Intl, °F	87	136	128	121
Pres Disch Intl, psig	159.70	446.37	1438.56	4641.53
Temp Disch Intl, °F	250	297	315	300
HE Suct Gas Vel, FPM	9586	N/A	N/A	2650
HE Disch Gas Vel, FPM	9442	N/A	N/A	4836
HE Spcrs Used/Max	2/3	N/A	N/A	N/A
HE Vol Pkt Avail, %	No Pkt	N/A	N/A	No Pkt
Vol Pkt Used, %	No Pkt	N/A %	N/A %	No Pkt
HE Min Clr, %	13.48	N/A	N/A	24.32
HE Total Clr, %	34.31	N/A	N/A	24.32
CE Suct Gas Vel, FPM	N/A	9546	7807	N/A
CE Disch Gas Vel, FPM	N/A	8807	7978	N/A
CE Spcrs Used/Max	N/A	0/2	N/A	N/A
CE Min Clr, %	N/A	19.08	21.98	N/A
CE Total Clr, %	N/A	19.08	21.98	N/A
Suct Vol Eff HE/CE, %	46.6/N/A	N/A/70.0	N/A/59.8	64.0/N/A
Disch Event HE/CE, ms	4.6/N/A	N/A/6.9	N/A/5.9	5.2/N/A
Suct Pseudo-Q HE/CE	8.9/N/A	N/A/8.3	N/A/6.3	0.9/N/A
Gas Rod Ld Comp, %	80.7 C	80.7 C	98.2 C	98.2 C
Gas Rod Ld Tens, %	96.1 T	96.1 T	70.0 T	70.0 T
Gas Rod Ld Total, %	92.4	92.4	89.0	89.0
Xhd Pin Deg/%Rvrsl lbf	135/63.6	135/63.6	160/45.6	160/45.6
Flow Calc, MMSCFD	0.666	0.666	0.665	0.665
Cyl BHP	46.1	46.0	49.7	46.0

Valve Part Numbers as Ordered
1st Stage Suction: B-7242-GG
1st Stage Discharge: B-7242-GGD

2nd Stage Suction: B-5091-CC
2nd Stage Discharge: B-5092-ZM

3rd Stage Suction: B-4087-AA
3rd Stage Discharge: B-3712-ZN

4th Stage Suction: B-1788-E
4th Stage Discharge: B-1788-ED

Compressor Data:

Elevation,ft:	2000.00	Barmtr,psia:	13.651	Ambient,°F:	100.00
Frame:	JGQ/2	Stroke, in:	3.00	Rod Dia, in:	1.125
Max RL Tot, lbf:	20000	Max RL Tens, lbf:	10000	Max RL Comp, lbf:	11000
Rated RPM:	1800	Rated BHP:	280.0	Rated PS FPM:	900.0
Calc RPM:	1775.0	BHP:	199	Calc PS FPM:	887.5

Driver Data:

Type:	Electric
Mfg:	TECO or equa
Model:	447T Frame
BHP:	200
Avail:	200

Services	**Service 1**			
Gas Model	VMG			
Stage Data:	**1 (SG)**	**2**	**3**	**4**
Target Flow, MMSCFD	0.000	0.000	0.000	0.000
Flow Calc, MMSCFD	0.693	0.693	0.692	0.692
BHP per Stage	47.9	47.5	51.2	46.8
Specific Gravity	0.6100	0.6098	0.6047	0.6047
Ratio of Sp Ht (N)	1.2609	1.2558	1.2711	1.2754
Comp Suct (Zs)	0.9901	0.9794	0.9446	0.8512
Comp Disch (Zd)	0.9872	0.9765	0.9541	1.0068
Pres Suct Line, psig	42.00	N/A	N/A	N/A
Pres Suct Flg, psig	42.00	146.20	417.52	1370.08
Pres Disch Flg, psig	151.20	427.52	1385.12	4545.14
Pres Disch Line, psig	N/A	N/A	N/A	4500.00
Pres Ratio F/F	2.962	2.760	3.244	3.295
Temp Suct, °F	80.00	131.30	122.30	117.20
Temp Clr Disch, °F	131.30	122.30	117.20	112.10
Cylinder Data:	**Throw 2**	**Throw 2**	**Throw 1**	**Throw 1**
Cyl Model	10-3/4P-HE	5-1/2P-CE	3-5/8SG-CE	1-3/4SG-FS-HE
Cyl Bore, in	10.750	5.500	3.625	1.750
Cyl RDP (API), psig	200.0	477.3	2318.2	5545.5
Cyl MAWP, psig	225.0	525.0	2550.0	6100.0
Cyl Action	HE	CE	CE	HE
Cyl Disp, CFM	279.7	70.2	28.7	7.4
Pres Suct Intl, psig	37.43	134.12	394.77	1360.65
Temp Suct Intl, °F	87	136	128	121
Pres Disch Intl, psig	165.84	459.84	1468.56	4641.92
Temp Disch Intl, °F	249	296	313	297
HE Suct Gas Vel, FPM	9586	N/A	N/A	2650
HE Disch Gas Vel, FPM	9442	N/A	N/A	4836
HE Spcrs Used/Max	2/3	N/A	N/A	N/A
HE Vol Pkt Avail, %	No Pkt	N/A	N/A	No Pkt
Vol Pkt Used, %	No Pkt	N/A %	N/A %	No Pkt
HE Min Clr, %	13.48	N/A	N/A	24.32
HE Total Clr, %	34.31	N/A	N/A	24.32
CE Suct Gas Vel, FPM	N/A	9546	7807	N/A
CE Disch Gas Vel, FPM	N/A	8807	7978	N/A
CE Spcrs Used/Max	N/A	0/2	N/A	N/A
CE Min Clr, %	N/A	19.08	21.98	N/A
CE Total Clr, %	N/A	19.08	21.98	N/A
Suct Vol Eff HE/CE, %	46.7/N/A	N/A/70.3	N/A/60.3	65.0/N/A
Disch Event HE/CE, ms	4.6/N/A	N/A/6.9	N/A/5.9	5.3/N/A
Suct Pseudo-Q HE/CE	8.9/N/A	N/A/8.3	N/A/6.3	0.9/N/A
Gas Rod Ld Comp, %	83.5 C	83.5 C	98.1 C	98.1 C
Gas Rod Ld Tens, %	98.8 T	98.8 T	71.2 T	71.2 T
Gas Rod Ld Total, %	95.3	95.3	89.5	89.5
Xhd Pin Deg/%Rvrsl lbf	148/65.6	148/65.6	162/46.4	162/46.4
Flow Calc, MMSCFD	0.693	0.693	0.692	0.692
Cyl BHP	47.9	47.5	51.2	46.8

Valve Part Numbers as Ordered
1st Stage Suction: B-7242-GG
1st Stage Discharge: B-7242-GGD

2nd Stage Suction: B-5091-CC
2nd Stage Discharge: B-5092-ZM

3rd Stage Suction: B-4087-AA
3rd Stage Discharge: B-3712-ZN

4th Stage Suction: B-1788-E
4th Stage Discharge: B-1788-ED

Compressor Data:

Elevation,ft:	2000.00	Barmtr,psia:	13.651	Ambient,°F:	100.00
Frame:	JGQ/2	Stroke, in:	3.00	Rod Dia, in:	1.125
Max RL Tot, lbf:	20000	Max RL Tens, lbf:	10000	Max RL Comp, lbf:	11000
Rated RPM:	1800	Rated BHP:	280.0	Rated PS FPM:	900.0
Calc RPM:	1775.0	BHP:	190	Calc PS FPM:	887.5

Driver Data:

Type:	Electric
Mfg:	TECO or equa
Model:	447T Frame
BHP:	200
Avail:	200

Services	**Service 1**			
Gas Model	VMG			
Stage Data:	**1 (SG)**	**2**	**3**	**4**
Target Flow, MMSCFD	0.000	0.000	0.000	0.000
Flow Calc, MMSCFD	0.659	0.659	0.658	0.658
BHP per Stage	43.8	45.5	49.2	45.7
Specific Gravity	0.6100	0.6098	0.6050	0.6050
Ratio of Sp Ht (N)	1.2614	1.2553	1.2703	1.2753
Comp Suct (Zs)	0.9901	0.9803	0.9465	0.8535
Comp Disch (Zd)	0.9873	0.9774	0.9550	1.0084
Pres Suct Line, psig	42.00	N/A	N/A	N/A
Pres Suct Flg, psig	42.00	139.19	401.57	1333.48
Pres Disch Flg, psig	144.19	411.57	1348.52	4545.14
Pres Disch Line, psig	N/A	N/A	N/A	4500.00
Pres Ratio F/F	2.836	2.782	3.281	3.384
Temp Suct, °F	80.00	131.30	122.30	117.20
Temp Clr Disch, °F	131.30	122.30	117.20	112.10
Cylinder Data:	**Throw 2**	**Throw 2**	**Throw 1**	**Throw 1**
Cyl Model	10-3/4P-HE	5-1/2P-CE	3-5/8SG-CE	1-3/4SG-FS-HE
Cyl Bore, in	10.750	5.500	3.625	1.750
Cyl RDP (API), psig	200.0	477.3	2318.2	5545.5
Cyl MAWP, psig	225.0	525.0	2550.0	6100.0
Cyl Action	HE	CE	CE	HE
Cyl Disp, CFM	279.7	70.2	28.7	7.4
Pres Suct Intl, psig	37.42	127.65	379.70	1324.32
Temp Suct Intl, °F	87	136	128	122
Pres Disch Intl, psig	158.32	442.65	1429.59	4641.24
Temp Disch Intl, °F	243	297	315	301
HE Suct Gas Vel, FPM	9586	N/A	N/A	2650
HE Disch Gas Vel, FPM	9442	N/A	N/A	4836
HE Spcrs Used/Max	3/3	N/A	N/A	N/A
HE Vol Pkt Avail, %	No Pkt	N/A	N/A	No Pkt
Vol Pkt Used, %	No Pkt	N/A %	N/A %	No Pkt
HE Min Clr, %	13.48	N/A	N/A	24.32
HE Total Clr, %	38.46	N/A	N/A	24.32
CE Suct Gas Vel, FPM	N/A	9546	7807	N/A
CE Disch Gas Vel, FPM	N/A	8807	7978	N/A
CE Spcrs Used/Max	N/A	0/2	N/A	N/A
CE Min Clr, %	N/A	19.08	21.98	N/A
CE Total Clr, %	N/A	19.08	21.98	N/A
Suct Vol Eff HE/CE, %	44.4/N/A	N/A/69.9	N/A/59.6	63.7/N/A
Disch Event HE/CE, ms	4.6/N/A	N/A/6.9	N/A/5.9	5.2/N/A
Suct Pseudo-Q HE/CE	8.9/N/A	N/A/8.3	N/A/6.3	0.9/N/A
Gas Rod Ld Comp, %	78.6 C	78.6 C	98.2 C	98.2 C
Gas Rod Ld Tens, %	94.9 T	94.9 T	69.7 T	69.7 T
Gas Rod Ld Total, %	90.7	90.7	88.8	88.8
Xhd Pin Deg/%Rvrsl lbf	131/59.8	131/59.8	160/45.3	160/45.3
Flow Calc, MMSCFD	0.659	0.659	0.658	0.658
Cyl BHP	43.8	45.5	49.2	45.7

Valve Part Numbers as Ordered
1st Stage Suction: B-7242-GG
1st Stage Discharge: B-7242-GGD

2nd Stage Suction: B-5091-CC
2nd Stage Discharge: B-5092-ZM

3rd Stage Suction: B-4087-AA
3rd Stage Discharge: B-3712-ZN

4th Stage Suction: B-1788-E
4th Stage Discharge: B-1788-ED

Compressor Data:

Elevation,ft:	2000.00	Barmtr,psia:	13.651	Ambient,°F:	100.00		
Frame:	JGQ/2	Stroke, in:	3.00	Rod Dia, in:	1.125		
Max RL Tot, lbf:	20000	Max RL Tens, lbf:	10000	Max RL Comp, lbf:	11000		
Rated RPM:	1800	Rated BHP:	280.0	Rated PS FPM:	900.0		
Calc RPM:	1775.0	BHP:	198	Calc PS FPM:	887.5		

Driver Data:

Type:	Electric
Mfg:	TECO or equa
Model:	447T Frame
BHP:	200
Avail:	200

Services	**Service 1**			
Gas Model	VMG			
Stage Data:	**1 (SG)**	**2**	**3**	**4**
Target Flow, MMSCFD	0.000	0.000	0.000	0.000
Flow Calc, MMSCFD	0.697	0.697	0.696	0.696
BHP per Stage	46.2	47.8	51.6	47.0
Specific Gravity	0.6100	0.6100	0.6070	0.6070
Ratio of Sp Ht (N)	1.2617	1.2556	1.2700	1.2744
Comp Suct (Zs)	0.9896	0.9794	0.9444	0.8512
Comp Disch (Zd)	0.9866	0.9765	0.9539	1.0065
Pres Suct Line, psig	45.00	N/A	N/A	N/A
Pres Suct Flg, psig	45.00	147.43	420.95	1378.02
Pres Disch Flg, psig	152.43	430.95	1393.26	4545.14
Pres Disch Line, psig	N/A	N/A	N/A	4500.00
Pres Ratio F/F	2.832	2.760	3.237	3.276
Temp Suct, °F	80.00	132.60	124.10	118.90
Temp Clr Disch, °F	132.60	124.10	118.90	113.50
Cylinder Data:	**Throw 2**	**Throw 2**	**Throw 1**	**Throw 1**
Cyl Model	10-3/4P-HE	5-1/2P-CE	3-5/8SG-CE	1-3/4SG-FS-HE
Cyl Bore, in	10.750	5.500	3.625	1.750
Cyl RDP (API), psig	200.0	477.3	2318.2	5545.5
Cyl MAWP, psig	225.0	525.0	2550.0	6100.0
Cyl Action	HE	CE	CE	HE
Cyl Disp, CFM	279.7	70.2	28.7	7.4
Pres Suct Intl, psig	40.17	135.28	398.00	1368.53
Temp Suct Intl, °F	87	138	129	123
Pres Disch Intl, psig	167.32	463.47	1477.37	4642.22
Temp Disch Intl, °F	243	297	315	297
HE Suct Gas Vel, FPM	9586	N/A	N/A	2650
HE Disch Gas Vel, FPM	9442	N/A	N/A	4836
HE Spcrs Used/Max	3/3	N/A	N/A	N/A
HE Vol Pkt Avail, %	No Pkt	N/A	N/A	No Pkt
Vol Pkt Used, %	No Pkt	N/A %	N/A %	No Pkt
HE Min Clr, %	13.48	N/A	N/A	24.32
HE Total Clr, %	38.46	N/A	N/A	24.32
CE Suct Gas Vel, FPM	N/A	9546	7807	N/A
CE Disch Gas Vel, FPM	N/A	8807	7978	N/A
CE Spcrs Used/Max	N/A	0/2	N/A	N/A
CE Min Clr, %	N/A	19.08	21.98	N/A
CE Total Clr, %	N/A	19.08	21.98	N/A
Suct Vol Eff HE/CE, %	44.6/N/A	N/A/70.2	N/A/60.3	65.3/N/A
Disch Event HE/CE, ms	4.6/N/A	N/A/6.9	N/A/5.9	5.4/N/A
Suct Pseudo-Q HE/CE	8.9/N/A	N/A/8.3	N/A/6.3	0.9/N/A
Gas Rod Ld Comp, %	82.7 C	82.7 C	98.1 C	98.1 C
Gas Rod Ld Tens, %	99.2 T	99.2 T	71.6 T	71.6 T
Gas Rod Ld Total, %	95.1	95.1	89.7	89.7
Xhd Pin Deg/%Rvrsl lbf	146/62.6	146/62.6	162/46.7	162/46.7
Flow Calc, MMSCFD	0.697	0.697	0.696	0.696
Cyl BHP	46.2	47.8	51.6	47.0

Valve Part Numbers as Ordered
1st Stage Suction: B-7242-GG
1st Stage Discharge: B-7242-GGD

2nd Stage Suction: B-5091-CC
2nd Stage Discharge: B-5092-ZM

3rd Stage Suction: B-4087-AA
3rd Stage Discharge: B-3712-ZN

4th Stage Suction: B-1788-E
4th Stage Discharge: B-1788-ED

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Fastener Torques for Reciprocating Compressors

This document lists fastener lubrication and torque requirements for proper assembly of current production Ariel reciprocating compressors (JG:M:P:N:Q:A:R:J:H:E:K:T:C:D:F and KBB:V:Z:U). For models not referenced in this document, see the appropriate ER-96.2.x series document or technical manual. For older units with lower specified torque values, do not assume higher values without consulting the packager and/or Ariel. See technical manual for specific torque information and detailed assembly procedures.

- Use only Ariel specified fasteners tightened to the correct torque.
- Connecting rod, valve cap, and suction/discharge nozzle (Ariel supplied flange) fasteners are modified to prevent fatigue; do not replace them with standard cap screws. For questions about replacing other fasteners with standard cap screws, contact your packager or Ariel.
- Clean and de-burr all threads.
- Do not use molybdenum disulfide lubricants.

TABLE 1 Fastener Thread & Seating Surface Lubrication

NOTE: Lubricate all fasteners both under the head and on the threads.	
Application	**Lubricant**
• **Frame:** tie bars, KBB:V:Z:U main bearing cap, jack screws, KBZ:U guide support stud (both ends) • **Steel Cylinders:** valve cap, cylinder mounting flange to cylinder body, packing, crank end and head end head, gas passage • **Pistons:** piston nuts, set screws (except B:V), piston collar, crosshead threads, B:V piston studs • All stainless steel fasteners	Never-Seez Regular Grade
Fasteners specified with Loctite on threads	Use Loctite only with no additional lube
Connecting rod fasteners	Lubriplate 630
All other fasteners	Mineral oil (ISO 100-150)

- Do not use Never-Seez for fastener lubrication unless specified or excessive stresses may result with specified torques. See TABLE 1.
- Use anti-seize lubricants sparingly; excessive amounts cause oil analysis to indicate contamination and may unnecessarily increase maintenance costs.
- Re-preserve any fasteners subject to corrosion after installation.



Hex Head Grade 5 | Hex Head Grade 8 | Hex Head Grade 9 | Hex Socket Head Grade 8 | 12 Point Grade 8 | 12 Point Grade B7M | 12 Point Grade 5 | 12 Point Stainless 17-4PH | 12 Point Metric Class 8.8

FIGURE 1 Bolt Head Grade and Material Identification

CAUTION: To replace a fastener, see parts list for fastener grade and part number. Do not use a lesser or greater material grade. Use Ariel parts to replace special fasteners and fasteners with reduced body diameter for fatigue resistance. Do not torque fasteners with compressor running or pressurized. Read technical manual safety warnings.

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REV	DESCRIPTION	REV	EC	DATE	REV	EC	DATE
35	Primary changes: removed all references to non-current production equipment, corrected several metric torque values. See EC for details.	34	019466	4-15-14			
		33	018978	9-3-13			
		32	018774	4-23-13			
		31	018282	2-11-13			
		30	018165	8-6-12	35	019888	1-15-15

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Recommendations for Torque Accuracy

1. Qualified personnel must use a properly calibrated torque wrench to correctly torque fasteners.
2. Determine torque wrench accuracy range. Most torque wrenches are not accurate over their entire range.
3. Clean and de-burr all threads before assembly.
4. Tighten all multi-bolt assemblies in steps (optional for Grade 5 cap screws). Snug opposing pairs of cap screws until all are snug. Next, tighten each cap screw to 25% of full torque in the same pattern. Repeat this step for 50%, 75%, and 100% of full torque. For main bearing stud nuts and connecting rod bolts, repeat the 100% step to verify proper pre-torque of fasteners prior to the final partial turn.
5. Always apply a steady slow force to a torque wrench, and stop immediately when the wrench clicks; do not jerk it. Jerking a torque wrench may apply up to one and a half times the torque setting.
6. Perform final tightening with a torque wrench. Do not tighten fasteners with a ratchet or impact wrench, and then "check" the torque with a torque wrench.
7. Do not double tap a torque wrench; it increases the set torque significantly.
8. When checking the torque of a tightened fastener, set torque wrench to required torque, then apply a slow steady force until the wrench clicks.
9. When finished, reset torque wrench to its lowest setting to relax the spring and help retain accuracy. A torque wrench left in a high setting stresses the spring and decreases accuracy with time.
10. Do not break fasteners loose with a torque wrench; it may overload the wrench and/or destroy calibration.
11. To determine the torque wrench setting when using a torque multiplier on larger fasteners, divide the desired fastener torque by the multiplier actual mechanical advantage, not the design mechanical advantage. Example: An X4 torque multiplier, model TD-1000 has a design mechanical advantage of 4.0, but an actual mechanical advantage of 3.6.
12. For hard to access fasteners requiring a boxed end or crow's foot adapter with a torque wrench, the torque setting is not the actual torque applied to the fastener, unless the adapter is 90° to the torque wrench. The ratio of actual fastener torque (Ta) with the torque setting (Tw) is a function of the length the adapter adds to the torque wrench (A), and the location of the applied force.

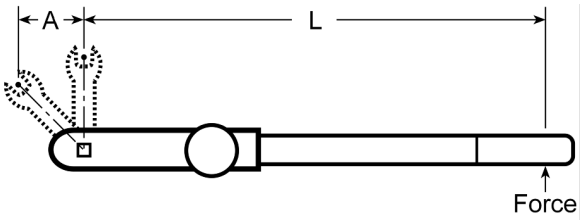


FIGURE 2 Torque Wrench with Angled Adapter

Tw = Ta x [L ÷ (L + A)]

Tw = Torque wrench setting, lb x ft or N·m.
Ta = 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 = Wrench length added by adapter, ft or m (measured through end of adapter on a line parallel to the center line of the wrench).

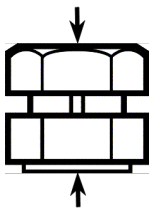
NOTE: Lb x In ÷ 12 = Lb x Ft

13. When studs are specified for cylinder applications, tighten nuts to the same values as cap screws in similar applications.
14. Install pipe threads and main cap plugs using Loctite 577 thread sealant. Synthetic oils may require Loctite 545 and Loctite Activator 7649 (N).

These are general guidelines for proper torque wrench use. Call a torque wrench dealer for details.

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TABLE 2 Hoerbiger Valve Assembly Fastener Torques

Fastener	Nominal Size Inch - TPI	Type	Torque LB x FT (N·m), unless specified
Center Cap Screw[a] US Bolt 316 Stainless Steel, Grade B8M, NACE 6 Chandler Products Grade 5	5/16 - 24	12 Point - Steel Grade 5 Material Parts: SPL3 & 4	12 (16)
	3/8 - 24		21 (28)
	7/16 - 20		30 (40)
	5/16 - 24	12 Point - Steel Grade 5 Material Parts: SPL or 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		16 (22)
	7/16 - 20		24 (33)
Peripheral Cap Screw	#10 - 32	Hex Socket Head	25 lb x in. (2.8)
	#12 - 28		43 lb x in. (4.9)
	1/4 - 20		110 lb x in. (12)
	5/16 - 18		176 lb x in. (20)
	3/8 - 16		21 (28)
Single-piece Lock Nuts (Microlok, JL-Nut, Spiralok, Greer)	See Table 4 or 5, Column 40.		
Center Stud Drake 2-Piece Beam Lock Nut **Top Half**  **Bottom Half**	**Inch - TPI**	**Bottom Half Torque** LB x FT (N·m), unless specified	**Top Half Torque** LB x FT (N·m), unless specified
	1/4 - 28	103 lb x in. (12)	66 lb x in. (7.5)
	5/16 - 24	120 lb x in. (14)	66 lb x in. (7.5)
	3/8 - 24	16 (22)	96 lb x in. (11)
	1/2 - 20	36 (49)[b]	20 (27)
	5/8 - 18	73 (99)	40 (54)
	3/4 - 16	130 (175)	70 (95)
	7/8 - 14	210 (285)	115 (155)

a. Center cap screw valve assemblies have Spiralock® (SPL) threads to prevent loosening. See bottom of valve assembly for SPL material parts number (3, 4, 5 or 6) and select proper torque from the table. Lubricate both threads and seating surfaces with a petroleum type lubricant ONLY. If using older valve assemblies not covered in the table, see the original torque chart provided in the compressor tool box, or contact Ariel for instructions. Spiralock® threads cannot be dressed with a standard tap. Clean center cap screws in valve assemblies not marked SPL with Loctite safety solvent and lock them with one or two drops of Loctite #272 thread locking compound. DO NOT use petroleum lubricants.

b. Use 29 (39) for 1/2 - 20 bottom half Drake lock nut with non-metallic valve plates in liftwasher valves.

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TABLE 3 Torques for Specific Applications Use with Table 4 and Table 5.

APPLICATION	COLUMN
• Crosshead Guide to Frame/Cylinder/Working Cover • KBB:V:Z:U Crosshead Guide to Frame to Spacer Bar or to Extension Piece • Cylinder Mounting Flange to Forged Steel Cylinder - 12 Point or Nut	55
Crosshead Guide Support to Guide - Hex Cap Screw Grade 9 / Head End Cylinder Support to Cylinder – Grade 8	50
KBZ:U Crosshead Guide Support to Guide - Cap Nut	45
• Crosshead Pin Thru Bolt - Hex Nylon Insert Lock Nut • Auxiliary End Damper/Sprocket Adapter to Crankshaft - Grade 9 or 12 Point Cap Screw • Auxiliary End Spacer/Sprocket Adapter to Crankshaft - Grade 9 or 12 Point Cap Screw • Auxiliary End Sprocket Adapter to Crankshaft - Grade 9 or 12 Point Cap Screw • Crankshaft Vibration Detuner Donut – 12 Point Cap Screw	60
Crankshaft Nut Plate/Oil Slinger (E:K:T/6, KBB:V) - Hex Cap Screw Grade 9 or 12 Point	45
Distance Piece to Class 11JG Cylinder - Socket Head Cap Screw	50
Distance Piece to Crosshead Guide - 12 Point Cap Screw	65
Distribution Block Divider Valve - Socket Head Cap Screw	55
Distribution Block Tie Rod - Hex Nut	50
Dog Point Studs, Seating (except for KBB:V stud to piston rod, 1-1/8 - 12, use 50 Lb x Ft)	25[a]
External-Thrust Bearing Adapter to Crankshaft - 12 Point Cap Screw	65
Idler Sprocket Thru Bolt – Prevailing Lock Nut or Hex Lock Nut (Drill & Pin)	40
Lifting Bracket to Frame - 12 Point Cap Screw	45
Piston Rod Oil Slinger Bolt-Locknut	70
Rod Catcher to Packing - 12 Point Cap Screw	50
Rod Packing - 12 Point Cap Screw or Nut[b]	40
Roller Thrust Bearing Retainer Clamp Bolt - Ariel Design	45
Frame to Spacer Bar - 12 Point/Hex Grade 8/9 Cap Screw (except for KBB:V:Z:U Crosshead Guide to Frame to Spacer Bar use Column 55)	45
Tandem Cylinder to Cylinder - Hex Cap Screw Grade 8/9 or 12 Point or Nut	50
Hex Cap Screw Grade 8/9 or 12 Point or Nut flange to cylinder fasteners: • Valve Cap • Gas Passage Cap • Cylinder Head • Vent Cap • Unloader • Ariel Supplied Special Flange to Cylinder NOTE: For “Peanut” dual nozzle special flanges to cylinder, use Column 60. For other gas nozzle flange types, see Packager’s instructions.	45
Unloader Actuator to Valve Cap - Hex Cap Screw, Grade 8	55
KBB:V:Z:U Sole Plate Pull-up Bolts - Sole plate to guide foot or sole plate to frame foot	45
Valve Cap Seal Keeper - Cap Screw	50

a. In valve cap assemblies with a spring-energized seal, install longer studs with loctite 242.

b. Repeat the final torque for rod packing bolts until they no longer turn before the torque wrench clicks.

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TABLE 4 Bolting Torques by Size, U.S. Units - Shaded Blocks = LB x IN; White Blocks = LB x FT

Size Inch-TPI	COL. 25	COL. 30	COL. 35	COL. 40	COL. 45	COL. 50	COL. 55	COL. 60	COL. 65	COL. 70	COL. 80
#10 - 24	12	14	17	19	21	24	26	28	31	33	38
#10 - 32	14	17	20	22	25	28	31	34	36	39	45
1/4 - 20	29	34	40	46	52	57	63	69	74	80	92
1/4 - 28	34	41	48	54	61	68	75	82	88	95	109
5/16 - 18	60	72	84	96	108	120	132	144	156	168	192
5/16 - 24	68	82	96	109	123	136	150	164	177	192	18
3/8 - 16	107	128	150	171	193	18	20	21	23	25	29
3/8 - 24	125	150	175	17	19	21	23	25	27	29	33
7/16 - 14	172	17	20	23	26	29	31	34	37	40	46
7/16 - 20	197	20	23	26	30	33	36	39	43	46	53
1/2 - 13	22	26	31	35	40	44	48	53	57	62	70
1/2 - 20	26	31	36	41	46	51	56	61	66	71	82
9/16 - 12	32	38	45	51	57	64	70	76	83	89	100
9/16 - 18	36	44	51	58	66	73	80	87	95	100	115
5/8 - 11	44	53	62	70	Note a	88	97	105	115	125	140
5/8 - 18	51	62	72	82	92	105	115	125	135	145	165
3/4 - 10	79	94	110	125	140	160	175	190	205	220	250
3/4 - 16	90	110	125	145	160	180	200	215	235	250	290
7/8 - 9	130	150	180	205	230	255	280	305	330	355	410
7/8 - 12	140	165	195	220	250	280	305	330	360	390	445
7/8 - 14	145	170	200	230	260	290	315	345	375	400	460
1” - 8	200	230	270	305	345	380	420	460	500	535	610
1” - 12	200	255	300	340	385	425	470	510	555	600	680
1” - 14	200	265	310	350	395	440	485	530	570	615	705
1-1/8 - 7	200	325	380	430	485	540	595	650	700	755	865
1-1/8 - 12	Note b	375	435	500	560	620	685	740	810	870	995
1-1/4 - 7	200	460	540	615	690	770	845	920	1000	1070	1230
1-1/4 - 12	200	520	610	700	780	870	955	1040	1130	1220	1390
1-3/8 - 6	200	600	700	800	900	1000	1100	1200	1300	1400	1600
1-3/8 - 8	200	650	760	870	980	1090	1200	1300	1410	1520	1740
1-3/8 - 12	200	705	820	940	1060	1170	1290	1410	1530	1640	1880
1-1/2 - 6	200	800	935	1070	1200	1340	1470	1610	1740	1870	2140
1-1/2 - 12	200	925	1080	1230	1390	1540	1700	1850	2010	2160	2470
1-5/8 - 12	200	1190	1390	1590	1780	1980	2180	2380	2580	2780	3170
1-3/4 - 5	200	1260	1470	1680	1900	2110	2320	2530	2740	2950	3370
1-3/4 - 8	200	1410	1650	1880	2120	2360	2590	2830	3060	3300	3770
1-3/4 - 12	200	1500	1750	2000	2250	2500	2750	3000	3250	3500	4000
2 - 12	200	2270	2650	3030	3400	3780	4160	4540	4920	5300	6050
2-1/4 - 8	200	3120	3650	4170	4690	5210	5730	6250	6770	7290	8330

a. See ER-112 for 3-bolt valve cap fasteners on 20-1/8, 22, 24-1/8, & 26-1/2 CDZU class cylinders, else use 79 lb-ft.

b. 200 lb-ft, except for KBB:V stud to piston rod, use 50 lb-ft.

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TABLE 5 Bolting Torques by Size, Metric Units - N•m

Size Inch-TPI	COL. 25	COL. 30	COL. 35	COL. 40	COL. 45	COL. 50	COL. 55	COL. 60	COL. 65	COL. 70	COL. 80
#10 - 24	1.4	1.6	1.9	2.1	2.4	2.7	2.9	3.2	3.5	3.7	4.3
#10 - 32	1.6	1.9	2.3	2.5	2.8	3.2	3.5	3.8	4.1	4.4	5.1
1/4 - 20	3.3	3.8	4.5	5.2	5.9	6.4	7.1	7.8	8.4	9.0	10
1/4 - 28	3.8	4.6	5.4	6.1	6.9	7.7	8.5	9.3	9.9	11	12
5/16 - 18	6.8	8.1	9.5	11	12	14	15	16	18	19	22
5/16 - 24	7.7	9.3	11	12	14	15	17	19	20	22	24
3/8 - 16	12	15	17	19	22	24	27	28	31	34	39
3/8 - 24	14	17	20	23	25	28	31	34	37	39	45
7/16 - 14	19	23	27	31	35	39	42	47	50	54	62
7/16 - 20	22	27	31	35	40	45	49	54	58	62	71
1/2 - 13	30	35	42	48	54	60	65	71	77	83	95
1/2 - 20	35	42	49	55	62	69	76	83	90	97	110
9/16 - 12	43	52	60	69	77	86	95	105	110	120	140
9/16 - 18	49	60	69	79	90	99	108	120	130	140	155
5/8 - 11	60	71	83	95	Note a	120	130	140	155	170	190
5/8 - 18	69	83	97	110	125	140	155	170	180	195	225
3/4 - 10	105	130	150	170	190	215	235	255	275	300	340
3/4 - 16	120	150	170	195	215	245	270	295	315	340	390
7/8 - 9	175	205	245	275	310	345	380	415	450	480	550
7/8 - 12	190	225	265	300	340	380	415	450	490	525	600
7/8 - 14	195	235	270	310	350	390	425	465	505	545	620
1” - 8	270	310	360	415	465	515	570	620	675	725	825
1” - 12	270	345	405	460	520	580	635	695	750	810	925
1” - 14	270	355	415	475	535	595	660	715	775	830	955
1-1/8 - 7	270	440	515	585	660	730	805	880	950	1030	1170
1-1/8 - 12	Note b	505	590	675	760	845	930	1010	1100	1180	1350
1-1/4 - 7	270	620	730	830	935	1040	1150	1250	1360	1450	1670
1-1/4 - 12	270	705	825	950	1060	1180	1290	1410	1530	1650	1880
1-3/8 - 6	270	810	950	1090	1220	1360	1500	1630	1770	1900	2170
1-3/8 - 8	270	880	1030	1180	1330	1470	1630	1770	1910	2060	2360
1-3/8 - 12	270	955	1110	1270	1430	1590	1750	1910	2070	2230	2550
1-1/2 - 6	270	1090	1270	1450	1630	1810	2000	2180	2360	2540	2900
1-1/2 - 12	270	1260	1460	1670	1880	2090	2300	2510	2720	2930	3350
1-5/8 - 12	270	1610	1880	2150	2420	2690	2960	3230	3490	3760	4300
1-3/4 - 5	270	1710	2000	2280	2570	2850	3140	3430	3710	4000	4570
1-3/4 - 8	270	1910	2240	2550	2870	3190	3510	3830	4150	4470	5110
1-3/4 - 12	270	2030	2370	2710	3050	3390	3720	4060	4400	4740	5420
2 - 12	270	3080	3590	4100	4620	5130	5640	6150	6670	7180	8200
2-1/4 - 8	270	4240	4940	5650	6350	7060	7760	8470	9180	9880	11300

a. See ER-112 for 3-bolt valve cap fasteners on 20-1/8, 22, 24-1/8, & 26-1/2 CDZU class cylinders, else use 105 N•m.

b. 270 N•m, except for KBB:V stud to piston rod, use 68 N•m.

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TABLE 6 Assembled Component Bolt Torques

Compressor Model	Nom. Size inch-TPI	Torque Lb x Ft (N•m)
Main Bearing Cap - 12-Point Cap Screw or Nut		
JG:A:M:N:P:Q	1/2 - 13	58 (79)
JGR:J	5/8 - 11	97 (130)
JGH:E:K:T	7/8 - 9	280 (380)
JGC:D:F	1-1/8 - 7	540 (730)
KBB:V:Z:U	1-3/8 - 6	350 (475) + 60°[a]
Connecting Rod Cap - Modified Cap Screw		
JGM:P	1/2 - 13	58 (79)
JG:A:N:Q	1/2 - 20	67 (91)
JGR	5/8 - 18	123 (167)
JGJ	3/4 - 16	215 (295)
JGH	7/8 - 14	80 (108) + 90°[b]
JGH[c], JGE:K:T	1" - 14	90 (120) + 90°[b]
JGC:D	1-1/8 - 12	See Ariel CTB-132
JGF	1-1/8 - 12	165 (224) + 110°
KBB:V:Z:U	1-3/8 - 12	350 (475) + 110°[a]

a. Use Ariel bearing cap hydraulic torque tool B-4180 KBZ:U and B-4472 for KBB:V.
b. Use Ariel turn indicator, B-1495
c. Steel JGH connecting rods.

Compressor Model	Nom. Size inch-TPI	Torque Lb x Ft (N•m)
Piston Nut - Ariel Design Nut		
JG:A:M:N:P:Q	7/8 - 12	220 (300)[d]
KBB:V	1-1/8 - 12	620 (845)
JGR:J	1-1/4 - 12	700 (950)[d]
JGH:E:K:T	1-5/8 - 12	1590 (2150)[d, f]
JGC:D:F	2 - 12	3970 (5380)[d, g]
KBZ:U	2-1/4 - 12	8700 psig (600 barg) & 30 (40) on pinion drive[d, e]
Main Drive Coupling/Flywheel/Drive Adapter to Crankshaft Flange or Flywheel Hub 12 Point or Hex Head Cap Screw		
N/A	3/4 - 16	250 (340)
	1" - 8	460 (620)
	1" - 14	530 (715)
	1-1/8 - 12	740 (1010)
	1-1/4 - 12	1040 (1410)

d. Tighten, loosen, then re-tighten.
e. Use Ariel piston rod hydraulic torque tool A-19040.
f. Or use 3500 psig (241 barg) hydraulic pressure and 50 (68) torque on pinion drive with separately purchased piston rod hydraulic tensioning tool (B-6911).
g. Or use 5400 psig (372 barg) hydraulic pressure and 100 (140) torque on pinion drive with separately purchased piston rod hydraulic tensioning tool (B-6911).

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TABLE 7 Miscellaneous Torques

Fastener		Torque LB x FT (N·m), unless specified
Compressor to Skid Hold Down Bolts		See packager instructions & ER-26 in Ariel Packager Standards.
JG:A:M:N:P:Q Fan Shaft to Crankshaft		250 (340), 3 times; loosen to hand tight between each tightening.
JGJ Fan Shaft to Crankshaft: 3/8 - 24 TPI		25 (34)
Fenner Drives	P/N A-7352	100 (140)
	P/N A-11560	200 Lb x In (23)
Crosshead Balance Nut	Small Frames	Slugging Method
	JGH:E:K:T	3500 psig (241 barg) on tool A-8906 or slugging method
	JGC:D:F	3500 psig (241 barg) on tool A-19513 or slugging method
	KBZ:U	2000 psig (138 barg) on tool A-7417
	KBB:V	2800 psig (193 barg) on tool A-7417
Force Feed Lubricator Hex Jam Nut	1"-14 TPI	75 (100)
	1-1/2-12 TPI	112 (152)
Force Feed Lubricator Bearing Housing 1-3/8-20 Left Hand		70 (95) use A-8158 Spanner Wrench
Force Feed Lubricator Pump Mounting 1/4-20 TPI Grade 5 Cap Screw		50 Lb x In (5.6)
Grade 5 Hex Cap Screw		Up to 40 (54), i.e. hand wrench tight
Rupture Disk Blow-Out Hex Fitting Cap (1/4 Nom. Tube)		40 Lb x In (4.5)
Viscous Damper Filler Pipe Plug (1/8 NPT)		30 (40)
Eccentric Vernier Cap: Hex Cap Screw Grade 8/9		Up to 40 (54), i.e. hand wrench tight
Packing Tie Rod Nut	#10 - 24	20 Lb x In (2.3)
	1/4 - 20 TPI	72 Lb x In (8.1)
JGH/4 2-Piece Crankshaft Flange: 7/8-14 TPI		Torque to 315 (425), loosen, then re-torque to 280 (380)[a]
Valve Cap Assembly - Cap Nut		Up to 40 (54), i.e. hand wrench tight
Shipping Cover Cap Screw or Nut	1/2 - 13 TPI	22 (30)
	7/8 - 9 TPI	70 (95)
	1" - 8 TPI	120 (165)
	1-1/8 - 7 TPI	190 (255)
	1-1/8 - 12 TPI	
	1-3/8 - 12 TPI	

a. Torque opposing pairs of fasteners incrementally until all reach full torque.

ARIEL CUSTOMER TECHNICAL BULLETINS



J-W POWER COMPANY
DISTRICT 11

FOR INTER-OFFICE CORRESPONDENCE

June 30, 2006

FROM: Media Department

TO: Whom it may concern

SUBJECT: Ariel Technical Bulletins

Ariel Technical Bulletins are no longer included in Unit Manuals. This information can be found in the J-W Service Bulletin Manual. A print copy of the Service Bulletin Manual has been shipped to all field offices and electronic copies are available on CD-ROM.

If you have any questions, please feel free to contact:

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Maintenance and Repair Manual

For JGM:P:N:Q Heavy Duty Balanced Opposed Reciprocating Compressors



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REV: 10/14

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General Safety for Reciprocating Compressors

CAUTION: Gas compressor packages are complicated and dangerous to those unfamiliar with their operation. Only properly trained personnel should operate or maintain this equipment. Before starting:

- **Carefully study start-up and shut-down information for both package and compressor. DO NOT attempt to start-up compressor without referring to the Start-Up Checklist in the appropriate Ariel Maintenance and Repair Manual and the Packager's Operating Manual.**
- **Sufficiently purge the compressor of any explosive mixture before loading. A gas/air mixture under pressure can explode and cause severe injury or death!**
- **Follow in detail all start-up requirements for the other package components.**



When the symbol to the right appears on a compressor or control panel, consult the appropriate Ariel Maintenance and Repair Manual for specific information before proceeding. The Maintenance and Repair Manual applies to current design and build; it may not apply to equipment built prior to the date on the front cover and is subject to change without notice. For questions of compressor safety, operation, maintenance, or repair, contact your packager or Ariel.

CAUTION: Severe personal injury and property damage can result if the compressor is not completely vented before loosening bolts on flanges, heads, valve caps, or packing. Consult the appropriate Ariel Maintenance and Repair Manual before performing any maintenance.

CAUTION: Noise generated by reciprocating machinery may damage hearing. See Packager information for specific recommendations. Wear hearing protection during compressor operation.

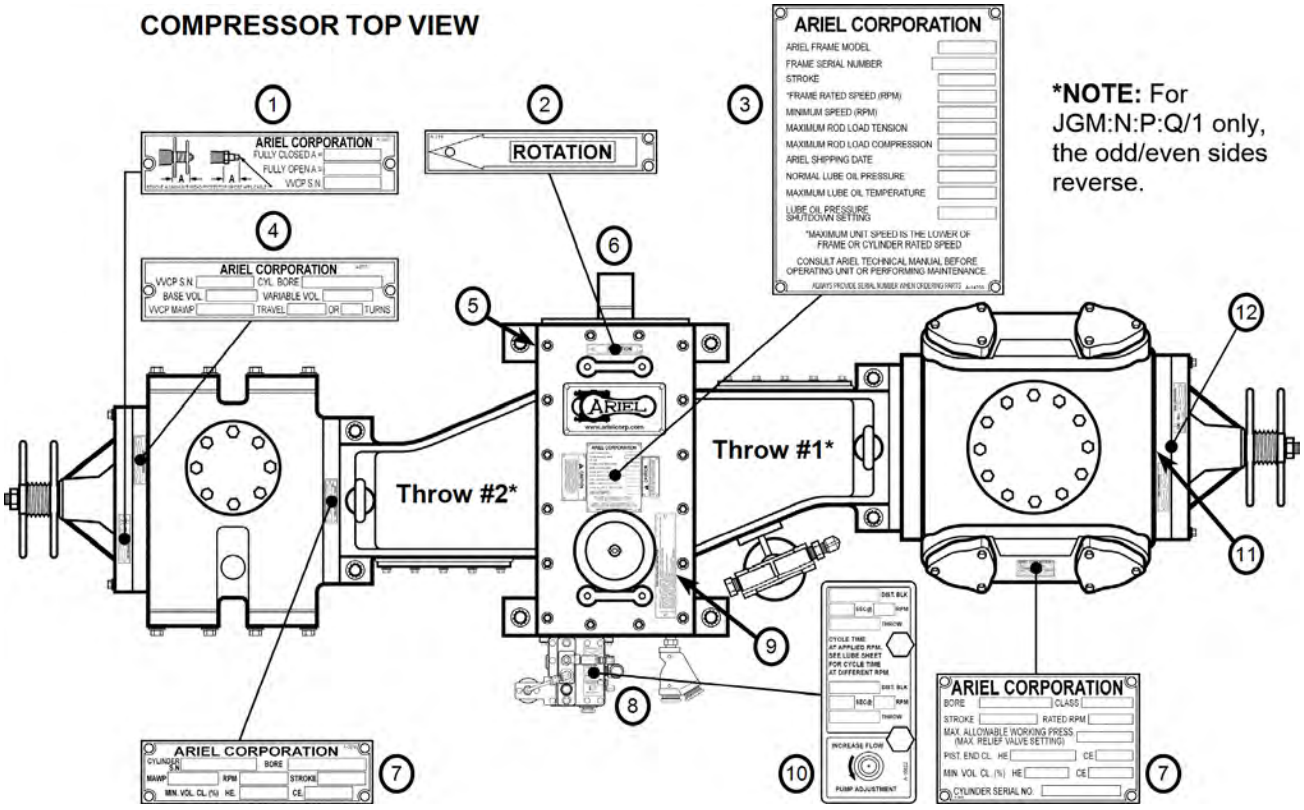
CAUTION: Where applicable, compressor installation must conform to Zone 1 requirements. A Zone 1 environment requires installation of proper intrinsically safe or equivalent protection to fulfill electrical requirements.

CAUTION: Hot gas temperatures (especially the cylinder discharge), 190°F (88°C) oil, and high friction areas. Wear proper protection. Shut down unit and allow to cool before maintaining these areas.

CAUTION: Suction or discharge valves installed in improper locations may result in severe personal injury and property damage.

Throw and Data Plate Locations

When contacting Ariel with compressor questions, know throw locations and information on data plates fastened to the machine. This data helps Ariel representatives answer quickly and accurately. Contact Ariel for replacement if any data plates are missing.



1. VVCP Dimension Plate
2. Rotation Direction Plate
3. Compressor Data Plate
4. VVCP Data Plate
5. Mechanical Inspector Plate and Frame Serial Number Stamp
6. Compressor Drive End
7. Cylinder Data Plate (see #11)
8. Compressor Auxiliary End
9. Oil Filter Change Instruction Plate
10. Force Feed Lubricator Data Plate
11. Cylinder Serial Number, MAWP, and Hydrotest Stamp (requires head removal to view)
12. VVCP Hydrotest Stamp

FIGURE i-1 Integral Guide Compressor Throw and Data Plate Locations - Typical

Other Ariel Resources

Ariel Website

Visit www.arielcorp.com to view and print the latest documentation, such as:

- **Customer Technical Bulletins** (CTB's) provide important information on changes, corrections, or additions to Ariel products or services. Read these bulletins before operating or servicing equipment.
- **Engineering References** (ER's) provide standard procedures and other useful information for operation, maintenance, or repair of Ariel compressors or components. Read and follow these procedures for long and trouble-free service from your Ariel compressor.
- **Maintenance and Repair Manuals** provide detailed maintenance and repair information on specific Ariel compressor models.
- **Packager Standards** provide detailed requirements and recommendations on the installation of an Ariel compressor.
- **Application Manual** provides detailed information on the use of Ariel compressors in different applications.

Ariel Technical and Service Schools

Ariel schedules several in-plant schools each year, which include classroom and hands-on training. Ariel also sends representatives to provide customized training on location. Contact Ariel for details.

Ariel Contact Information

<table>
<tr><th>Contact</th><th>Telephone</th><th>Fax</th><th>E-Mail</th></tr>
<tr><td>Ariel Response Center</td><td rowspan="3">888-397-7766
(toll free USA & Canada) or
740-397-3602 (International)</td><td>740-397-1060</td><td>arc@arielcorp.com</td></tr>
<tr><td>Spare Parts</td><td>740-393-5054</td><td>spareparts@arielcorp.com</td></tr>
<tr><td>Order Entry</td><td>740-397-3856</td><td>--</td></tr>
<tr><td>Ariel World HQ</td><td rowspan="2">740-397-0311</td><td rowspan="2">740-397-3856</td><td>info@arielcorp.com</td></tr>
<tr><td>Technical Services</td><td>fieldservice@arielcorp.com</td></tr>
<tr><td colspan="4">Website: www.arielcorp.com</td></tr>
</table>

Ariel Response Center Technicians or Switchboard Operators answer telephones during Ariel business hours, Eastern Time - USA or after hours by voice mail. Contact an authorized distributor to purchase Ariel parts. Always provide Ariel equipment serial number(s) to order spare parts. The after-hours Telephone Emergency System works as follows:

1. Follow automated instructions to Technical Services Emergency Assistance or Spare Parts Emergency Service. Calls are answered by voice mail.
2. Leave a message: caller name and telephone number, serial number of equipment in question (frame, cylinder, unloader), and a brief description of the emergency.
3. Your voice mail routes to an on-call representative who responds as soon as possible.

Section 1 - Tools

Ariel Optional Furnished Tools

Ariel offers an optional tool kit with every compressor. For JGM:P:N:Q compressors, it contains the tools shown below, which are specifically designed for use on Ariel units. Clean all tools before use and verify full tool engagement with the part being removed or installed. If the Tool Kit is missing or if a single tool is missing, worn, or broken, call your distributor. Do not use worn or broken tools, or substitutes for Ariel furnished tools. See Parts List for individual tool part numbers.

1. Tool Box
2. Crank End Clearance Setting Tool (included only for 2-3/4M, 3M, 2-3/4P-CE, and 3-1/4P-CE class cylinders)
3. 3/8" Allen wrench (2 provided)
4. 5/16" Allen wrench (3 provided)
5. 1/4" Allen wrench (3 provided)
6. 3/16" Allen wrench (5 provided)
7. 5/32" Allen wrench (5 provided)
8. 9/64" Allen wrench
9. 1/8" Allen wrench (10 provided)
10. 3/32" Allen wrench (10 provided)
11. 1/4" x 3/8" UNF Valve Tool
12. 5/16" x 1/2" UNF Valve Tool
13. 2-Inch Open End Wrench
14. 3/4" Peg Wrench
15. Crank End Clearance Setting Tool (included only for 2-1/4P-CE class cylinders
16. Ariel Bore & Thread Gauge
17. Piston Turning Tool for 9/16" socket (included only for small tandem cylinders)
18. Piston Rod Entering Sleeve
19. Piston Nut Spanner
20. Ariel ER-63 Fastener Torque Chart (not shown)

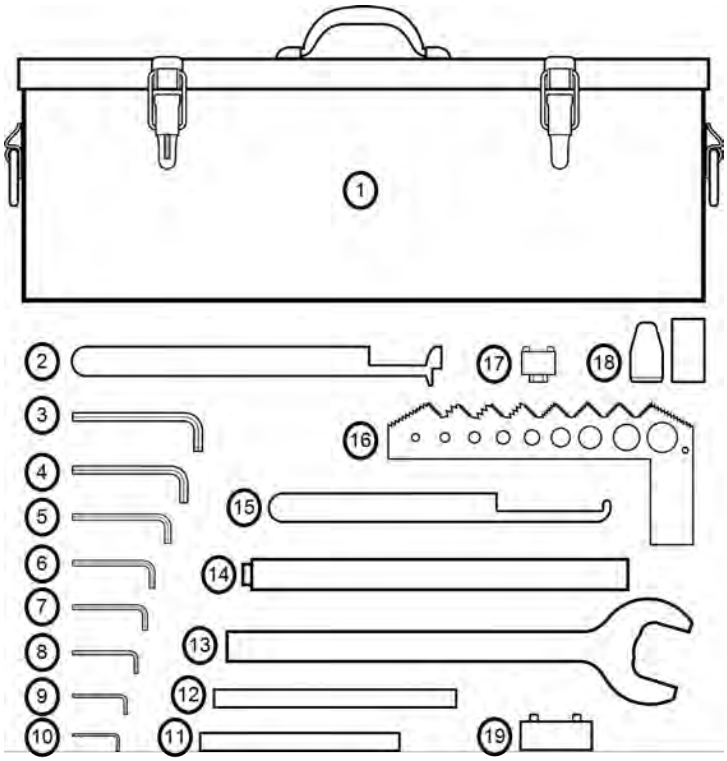


FIGURE 1-1 Optional Furnished Tools for JGM:P:N:Q Compressors

Ariel Separately Purchased Tools

1. Piston Rod Entering Sleeve (applies only to cylinders with part number less than D-4500 and bore size of 2-3/4", 3", or 3-3/8")
2. Force Feed Lubricator Bearing Housing Spanner Wrench
3. Piston and Rod Clamping Fixture
4. Force Feed Lube Hand Purge Pump

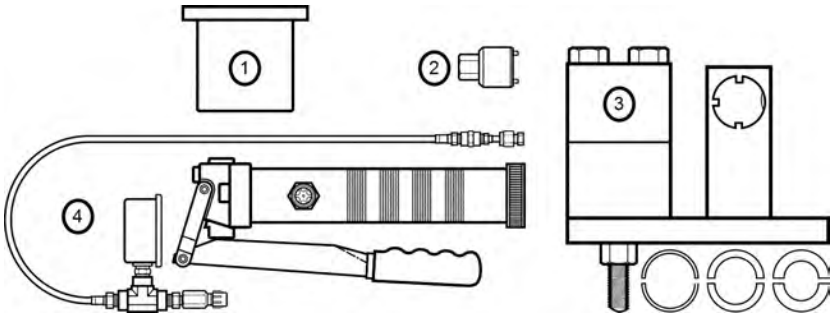


FIGURE 1-2 Ariel Separately Purchased Tools for JGM:P:N:Q Compressors

Ariel Separately Purchased Tool Kits

1. **Ariel SAE Hand Measurement Tool Kit**
   - **a.** .0005” needle type dial indicator.
   - **b.** .001” 1-inch travel dial indicator.
   - **c.** Magnet base for dial indicator.
   - **d.** 3/8” drive calibrated torque wrench, 40 to 200 in x lbs.
   - **e.** 1/2” drive calibrated torque wrench, 50 to 250 ft x lbs.
   - **f.** 3/4” drive calibrated torque wrench, 120 to 600 ft x lbs.
2. **Ariel SAE Hand Tool Kit**
   - **a.** 15-piece combination open/box end wrench set, 5/16” through 1-1/4”.
   - **b.** 8-piece slot and Phillips screwdriver set.
   - **c.** 3/8" square drive wrench set, including:
     - 12-piece, 12-point socket set, 5/16” through 1”.
     - 7” ratchet.
     - Speed handle.
     - Extensions, 1-1/2”, 3”, 6”, and 12”.
     - Ball type universal joint.
     - 3/8” to 1/2" drive adapter.
     - 1/4” hex key socket.
     - 8-1/2” breaker bar.
   - **d.** 1/2" square drive wrench set, including:
     - 14-piece, 12-point socket set, 7/16” through 1-1/4” with clip rail.
     - Extensions, 1-1/2”, 5”, and 10”.
     - Drive adapters: 1/2” to 3/8" and 1/2” to 3/4".
     - 1-1/4” open end crow’s foot adapter.
     - 10-1/4” ratchet.
     - Speed handle.
     - Ball type universal joint.
     - 18” breaker bar.
     - 1/2” and 5/8” hex key sockets.
   - **e.** 3/4" square drive wrench set, including:
     - 18-piece, 12-point socket set, 3/4” through 2”.
     - Extensions, 3-1/2”, 8”, and 16”.
     - Drive adapters: 3/4” to 1/2", 3/4” to 1", and 1” to 3/4"
     - 24” ratchet.
     - 22” breaker bar.
   - **f.** Adjustable wrenches: 12" and 18".
   - **g.** Dead blow semi-soft faced hammers: 3 lb. and 6 lb.
   - **h.** 3/4” x 36” pry bar.
   - **i.** 12” long feeler gage set.
   - **j.** 12” machinist scale with .01” increments.
   - **k.** 13-piece Allen wrench set, .050 - 3/8”.

Recommended Tools

Ariel compressor maintenance and repair normally requires only Ariel furnished tools and separately purchased tools and tool kits. However, Ariel also recommends purchasing the additional tools below. Contact Ariel for questions about tools for Ariel units.

1. 12-point box end torque adapter extension wrench set.
2. Tape measure.
3. Flashlight.
4. Small mirror on a flexible extension rod.
5. Small magnet on a flexible extension rod.
6. Electric and/or pneumatic drill.
7. Twist drill set.
8. Torque multiplier.

Section 2 - Instrumentation

Several optional instruments can aid in the operation of an Ariel compressor. Through the data they provide, some instruments can help decrease maintenance costs and downtime, and help diagnose lubrication and other types of problems. The use of “alarm” instead of “shutdown” for any minimum instrumentation requirement may result in equipment damage.

NOTE: Ariel recommends the use of shipboard or armored cabling as opposed to wiring in conduit to minimize nuisance shutdowns due to wire chafing and shorts. Cable in cable trays also facilitates maintenance access.

CAUTION: DO NOT drill holes in cylinders or other pressure containing components for any purpose. Epoxy-mounted clamps (to bare metal) for wiring and tubing are a suitable alternative. See Ariel ER-89.10.

CAUTION: 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 reduce electronic equipment life and void the warranty.

To protect electronic equipment prior to any arc welding (including repair welding), disconnect all electrical connections including ground, and remove batteries, or completely remove the electronic equipment 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.

TABLE 2-1 Required Instrumentation Summary

INSTRUMENT	SUPPLIER	SETTING/REQUIREMENT
Frame Oil System (see Section 3)		
Oil Pressure	PKGR	
• Start Permissive with Prelube Pump		30 psig (2.1 barg) for 2 minutes
• Run Permissive		45 psig (3.1 barg) within 10 seconds of start
• Alarm		50 psig (3.4 barg)
• Shutdown		45 psig (3.1 barg)
Oil Filter Differential	Ariel	
• JGC:D:F/2 and smaller		Change at 10 psi (0.7 bar) or 4000 hours
• JGC:D:F/4 and larger		Change at 15 psi (1.0 bar) or 4000 hours
Oil Temperature	PKGR	
• Minimum, start up		See for max. oil viscosity based on frame size.
• Minimum, to load		See for max. oil viscosity based on frame size.
• Minimum, operating		150°F (66°C)
• Maximum, shutdown		190°F (88°C)
Crankcase Level	PKGR	1/2 to 2/3 sight glass level
• Low Level Shutdown		1/4 sight glass level
Main Bearing Temp.	**Ariel**	**(Standard on B:V:Z:U. Recommended, but optional on JG:A:R:J:H:E:K:T:C:D:F)**
• Alarm		+20°F (12°C) above normal not to exceed 220°F (104°C)
• Shutdown		+30°F (18°C) above normal not to exceed 230°F (110°C)
• Differential Alarm		20°F (12°C)
• Differential Shutdown		30°F (18°C)
Packing Case Temp.	**Ariel**	**(Optional)**
• Alarm		+20°F (12°C) above normal
• Shutdown		+30°F (18°C) above normal
Packing Case Vent	**PKGR**	**(Optional)**
• Vent Flow Alarm		2 - 4 scfm (per throw)
• Vent Flow Shutdown		> 4 scfm (per throw)
Scrubber Liquid Level	**PKGR**	
• High Liquid Level Control		
• High Liquid Level Shutdown		
Gas Conditions	**PKGR**	
• Inlet Temperature Indicator, each cylinder		
• Inlet Pressure Indicator, each stage		
• Discharge Pressure Indicator, each cylinder		
• Discharge Temperature Indicator, each cylinder		
• High Discharge Temperature Shutdown, each cylinder		10% above normal[a] (Not to exceed the maximum temperatures below)
• Lubricated Cylinders		350°F (177°C)
• Non-Lube/PRC Cylinders		325°F (163°C)

INSTRUMENT	SUPPLIER	SETTING/REQUIREMENT				
• Hydrogen Rich > 50% < 0.41 Specific Gravity		300°F (149°C)				
• Air		Not to exceed autoignition temperature of cylinder lubricant at discharge pressure				
• Relief Valve Setting above normal operating pressure (not to exceed MAWP)		Up to 150: 15 psig (1.0 barg)	to 2500: 10%	to 3500: 8%	to 5000: 6%	Over 5000: As agreed
		See ER-56.04.				
Cylinder Rod Load Protection	**PKGR**					
High Vibration Shutdown	**PKGR**	As close to normal level as practical. See "Vibration Protection" in ER-56.07.				
Overspeed	**PKGR**	10% over rated speed for shutdown				

a. Example: Normal Discharge Temp. = 270°F; Shutdown Setting = 270 x 1.1 = 297°F.

Notes

1. Install the compressor frame low lube oil pressure shutdown set to stop the unit if oil pressure downstream of the filter falls below 45 psig (3.1 barg). Compressor operation for only a few seconds without oil pressure causes major damage. Normal oil pressure is about 60 psig (4.1 barg) at full rated speed and normal operating temperature. The low oil pressure shutdown must activate after oil pressure exceeds 45 psig (3.1 barg) at start-up. Ariel provides a 1/4 inch tubing fitting to connect the low lube oil pressure shutdown and ties a tag to this connection before each compressor ships. Do not operate the compressor for prolonged periods at less than 50 psig (3.4 barg) oil pressure.
2. Automated pre-lube systems require a start permissive to sense minimum required pressure/time at the oil gallery inlet. See “Compressor Pre-lube System” on page 3-16. The unit must shut down if the system fails to achieve 45 psig (3.1 barg) oil pressure within 10 seconds after crankshaft starts to turn.
3. Mount overhead lube oil supply tanks high enough to provide oil flow to the level control at all ambient temperatures.
4. On multi-nozzle cylinders, Ariel strongly recommends a temperature device in both discharge nozzles.
5. Install the high lube oil inlet temperature shutdown at the filter inlet connection.
6. At a minimum, install one vibration shutdown for two and four throw frames and two for six throw frames. Mount vibration devices near the top of the frame with the sensitive axis parallel to the piston rod axis.
7. Install all safety shutdowns, controls, instrumentation, ignition systems, electrical devices, and high temperature piping (gas discharge and engine exhaust) in accordance with good engineering practice and applicable codes for the area classification at the end user location. Ensure compatibility of all systems for area classification.
8. If packing vent temperature is monitored, alarm and shutdown set points should be confirmed through vent flow rates.

Digital No-Flow Timer (DNFT)

CAUTION: See arc welding caution on page 2-1.

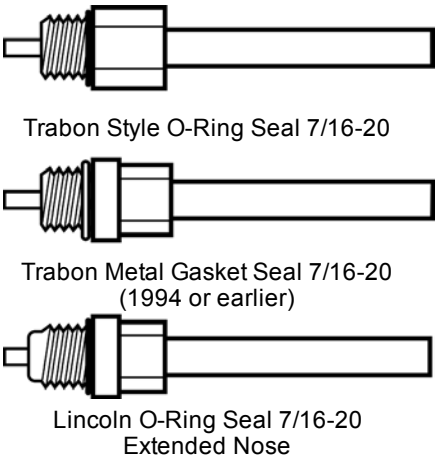
A DNFT is a totally enclosed electronic device, combining the latest technology in microprocessor and transistor components to detect slow-flow and no-flow of divider block lubrication systems. The DNFT uses an oscillating crystal to accurately monitor the lubrication system cycle time to enable precision timed shutdown capability. The magnet assembly and control housing mount directly to a divider valve. Lubricant flow through a divider valve assembly forces the piston to cycle back and forth causing a lateral movement of the DNFT magnet linked to the piston. The DNFT microprocessor monitors piston movement and resets the timer, lights the light emitting diode (LED), and allows the unit to continue operation, indicating one complete cycle of the lubrication system. If the microprocessor fails to receive this cycle within a predetermined time, a shutdown occurs. The DNFT automatically resets the alarm circuit when normal divider valve operation resumes.

DNFTs utilize an LED to indicate each cycle of the divider valve, which allows easy adjustment and monitoring of lubrication rates. Programmable models display total pints, cycle time of divider valve, total cycles of divider valve, or pints per day pump flow rate on a liquid crystal display and operators can adjust alarm time from 20 to 255 seconds.

DNFT Installation

1. Loosen the Allen set screws on the DNFT and remove magnet housing. Do not remove magnet, spring, or spacer from magnet housing.
2. Remove piston enclosure plug from end of desired divider valve. The DNFT installs on any of the divider valves of the divider block. The DNFT requires the correct magnet assembly to match the divider valve manufacturer.

   NOTE: Do not install a DNFT on Lincoln divider valves with cycle indicator pins.
3. If applicable, verify o-ring or metal gasket is in place on magnet housing. Thread magnet housing into end of divider valve. Torque to 15 lbs x ft maximum.
4. Slide DNFT all the way onto hex of magnet housing. Torque Allen set screws on hex of magnet housing to 25 lbs x inch, maximum.



Trabon Style O-Ring Seal 7/16-20

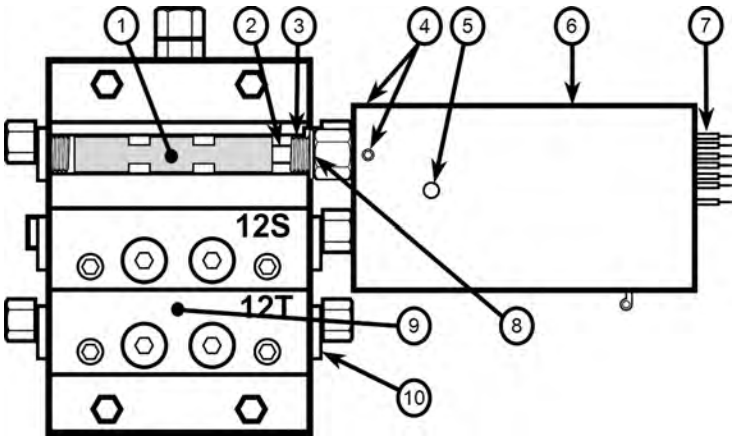
Trabon Metal Gasket Seal 7/16-20 (1994 or earlier)

Lincoln O-Ring Seal 7/16-20 Extended Nose

FIGURE 2-1 Typical DNFT Magnet Assemblies

5. The LED on the DNFT indicates each divider valve cycle to allow lubricator pump adjustment for Ariel recommended cycle time and oil consumption. If the LED fails to blink during compressor operation or by manually pumping oil into the divider valve, then the DNFT requires adjustment.
6. The divider valve must cycle during DNFT adjustment. To cycle it, either run the compressor or manually pump oil through the distribution block with a purge gun.

7. To adjust, slide DNFT all the way onto hex of magnet housing. Tighten Allen set screws to 25 lbs x inch maximum. A blinking LED indicates correct adjustment. If the LED fails to blink with divider valve cycling, slide DNFT back on the hex of the magnet housing in 1/16" increments until it does.
8. Make all conduit and connections appropriate for area classification. Support conduit and fittings to avoid bending the magnet housing.
9. After DNFT installation and before compressor start-up, purge all air from divider block lubrication system with a purge gun.



1. Divider Valve Piston
2. Magnet
3. Magnet Housing
4. Set Screws (2)
5. LED
6. Control Housing
7. Wire Leads
8. O-Ring
9. Divider Valve
10. Piston Enclosure Plug

FIGURE 2-2 Typical DNFT Installation

NOTE: When installing multiple DNFTs, wire each to a separate alarm circuit of the control panel, annunciator, or PLC to simplify lubrication system and DNFT troubleshooting. Always secure green ground wire to "earth ground" in the control panel. Do not ground to electrical conduit. Improper grounding can result in unreliable monitor operation.

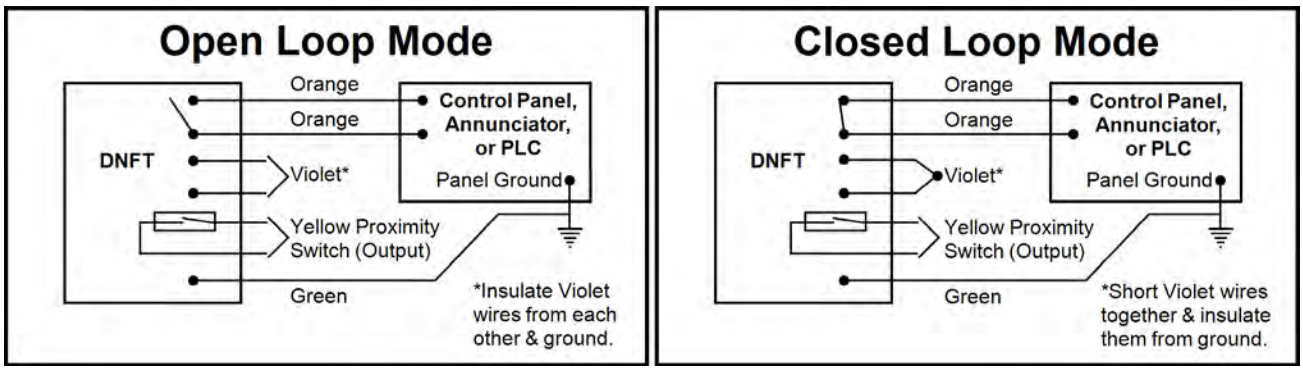


FIGURE 2-3 A-10754 Programmable DNFT Wiring Connections for Unit in Operation

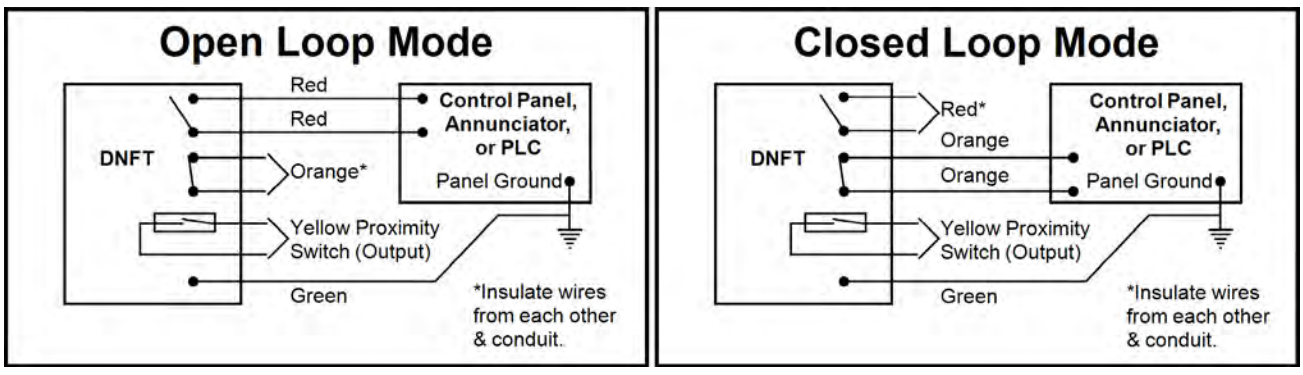


FIGURE 2-4 A-10753 and A-10772 DNFT Wiring Connections for Unit in Operation

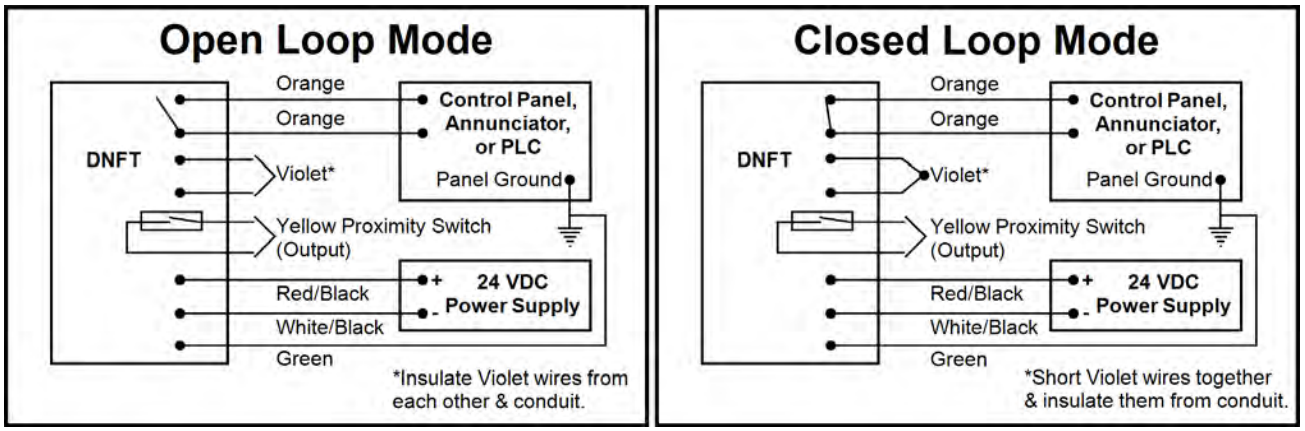


FIGURE 2-5 A-20513 24 VDC Programmable DNFT Wiring Connections for Unit in Operation

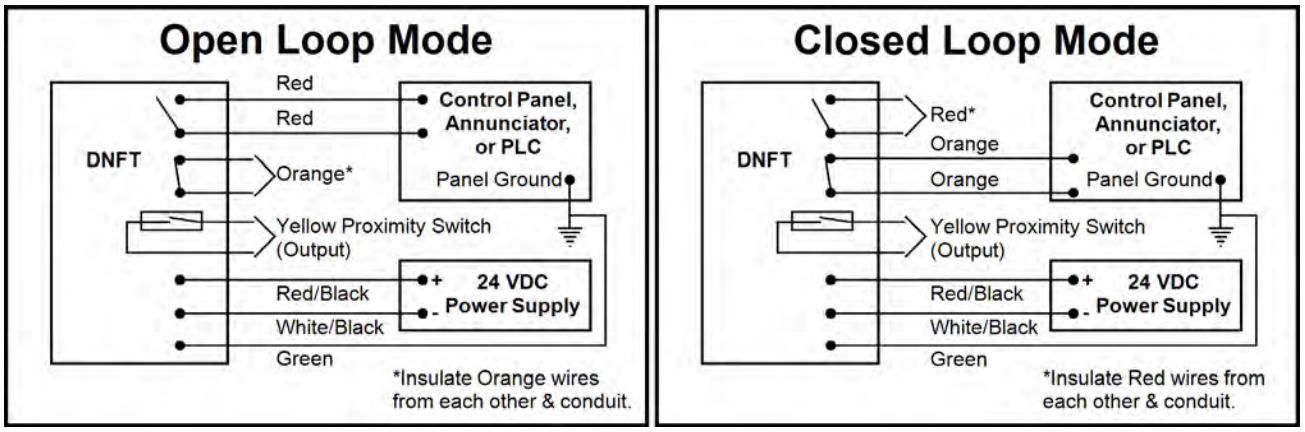


FIGURE 2-6 A-20514 24 VDC DNFT Wiring Connections for Unit in Operation

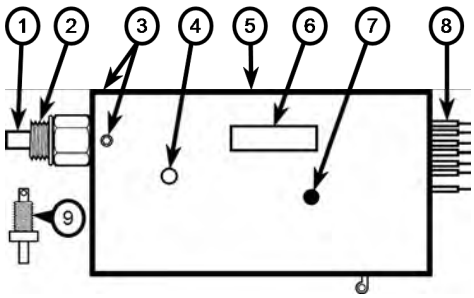
Programmable DNFTs

Programmable DNFTs come with a small liquid crystal display (LCD) screen to display total divider valve cycles (Mode 1), cycle time of divider valve in seconds (Mode 2), total pints of oil used (Mode 3), or pump flow rate in pints per day (Mode 4). Operators can also adjust alarm time in Mode 1.

CAUTION: Program DNFT before installing it on a divider valve. DO NOT insert programming magnet into 1/8" recessed opening while the compressor is operating; it causes the DNFT to shut down the compressor. Programming modes cannot be changed while the compressor is operating. To program a DNFT, first remove it from the divider valve.

To program:

1. Insert the programming magnet into the 1/8" recessed opening on the face of the DNFT. The current programming



1. Magnet
2. Magnet Housing
3. Allen Set Screws
4. LED
5. Control Housing
6. LCD
7. 1/8" recessed opening for programming magnet
8. Wire Leads
9. Programming Magnet

FIGURE 2-7 Typical Programmable DNFT

mode (1, 2, 3, or 4) immediately displays on the LCD followed by "0" 2 seconds later. "0" indicates the current mode is ready for programming.

2. If the desired programming mode does not display, remove and re-insert the programming magnet into the recessed opening until it does. Leave the programming magnet in the recessed opening when the desired programming mode displays.
3. Select one of the programming modes below:
   a. **Mode 1 - LCD displays total divider valve cycles; program alarm time.**
      - To set alarm time, press and release the spring-loaded magnet assembly until the desired alarm time in seconds displays on the LCD. Set alarm time from a minimum of 20 seconds to a maximum of 255 seconds. If not set, device defaults to 120 seconds.
      - Remove programming magnet. DNFT displays total divider valve cycles if left in this mode and alarm time is now set.
   b. **Mode 2 - LCD displays cycle time of divider valve in seconds.**
      - Remove programming magnet when Mode 2 displays. LCD counts each divider valve cycle in seconds, counting up from zero until the divider valve completes one full cycle. When divider valve completes one full cycle, the LCD resets to zero and repeats the count until another cycle is completed. The LED blinks in all modes to indicate each divider valve cycle. This blink enables the operator to set pump flow rate.
   c. **Mode 3 - LCD displays total pints used; program divider valve total.**
      - To set divider valve total, add the sizes of the divider valve sections on which the DNFT will be installed. Example: 24 + 24 + 24 = 72.
      - Press and release the spring-loaded magnet until the divider valve total displays on the LCD. Maximum value: 120. If not set, device defaults to zero and prevents Mode 4 flow rate display.
      - Remove programming magnet. The DNFT displays total pints on the LCD if left in this mode.
   d. **Mode 4 - LCD displays pump flow rate in pints per day.**
      - Remove programming magnet with Mode 4 displays. LCD displays pump flow rate in pints per day based upon the divider valve total set in Mode 3. Mode 4 requires a minimum 4 second cycle time.

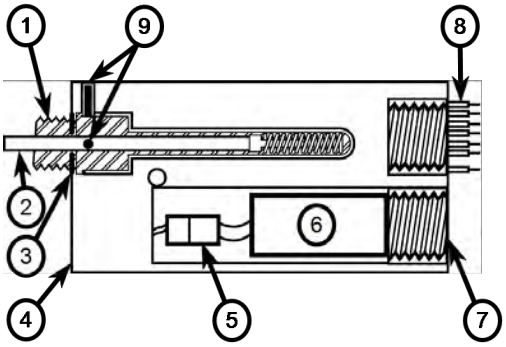
The DNFT stores all programmed information until the operator inserts the programming magnet into the recessed opening, selects Mode 1 or Mode 3, and presses the spring loaded magnet assembly. This action resets the unit to zero and allows entry of a new value.

NOTE: Power interruption to the DNFT requires reprogramming Mode 1 and Mode 3.

DNFT Battery Replacement

The DNFT operates on a field-replaceable lithium battery that should last six to ten years. If battery voltage drops below normal operating levels, the DNFT shuts down and the compressor cannot be restarted until the battery is replaced.

CAUTION: Do not open a DNFT in an explosive gas atmosphere.



1. Magnet Housing
2. Magnet
3. O-Ring
4. Control Housing
5. Polarized Connector
6. Field Replaceable Battery
7. 1/2" Pipe Plug
8. #22 AWG 18" (0.46 m) Leads
9. Allen Set Screws

FIGURE 2-8 Typical Digital No-Flow Timer Switch (DNFT)

1. Shut down compressor.
2. Disconnect DNFT wiring
3. Use 1/8 inch Allen wrench to loosen Allen set screws and remove control housing to a safe atmosphere.
4. Use 3/8 inch ratchet wrench to remove pipe plug.
5. Remove battery and disconnect from polarized connector.
6. Connect new battery to polarized connector.
7. Insert new battery and reinstall pipe plug.
8. Place DNFT control housing on the magnet housing in its original position and tighten set screws. Reattach wiring and conduit.
9. Programmable DNFTs require reprogramming of the alarm time (Mode 1) and divider valve total (Mode 3) after a power interruption. See programming section of this document.
10. To verify DNFT operation, pre-lube the system and check for LED blink.

Troubleshooting DNFT's

NOTE: When installing multiple DNFTs, wire each to a separate alarm circuit of the control panel, annunciator, or PLC to simplify lubrication system and DNFT troubleshooting.

Problem	Possible Cause	Solution	
LED does not blink and control panel indicates lube no-flow. (see also Erratic Shutdown)	Improperly adjusted DNFT.	Loosen set screws, slide DNFT all the way onto hex of magnet housing and torque to 25 lbs x inch max. **(Do not over tighten)**. Either pump clean oil through lubrication system with a purge gun or run the compressor to cycle the divider valve. If necessary, slide DNFT back in 1/16" increments until LED blinks with each divider valve cycle.	
	Broken spring or magnet in magnet housing.	Loosen set screws, remove DNFT from magnet housing. Remove magnet housing from divider valve. Remove magnet, spring, and spacer and check for damage. Replace damaged components. Re-install magnet housing on divider valve and DNFT on magnet housing. If necessary, adjust DNFT, check for LED blink. Purge air from system with purge gun.	
	Low battery voltage.	Remove battery from DNFT and test it. Replace battery with a factory recommended replacement lithium battery if voltage is below 2.5 volts.	
	Bent magnet housing.	Loosen set screws, remove DNFT from magnet housing. Check for damaged or bent magnet housing. Remove magnet assembly from divider valve. Replace magnet housing, magnet, spring, and spacer. Re-install new magnet housing on divider valve and DNFT on magnet housing. If necessary, adjust DNFT, check for LED blink. Purge air from system with purge gun.	
Rupture disc blows and divider valve seizes after DNFT installation.	Wrong magnet housing installed on divider valve.	Loosen set screws and remove DNFT from magnet housing. Check for correct magnet housing for divider valve manufacturer. Remove and replace with correct magnet housing. Re-install DNFT on new magnet housing. If necessary adjust DNFT, check for LED blink. Purge air from system with purge gun.	
	Air or debris in divider valve assembly.	Check system pressure to verify oil flows to divider valves. If needed, install pressure gauge to monitor lubrication system operation: • Loosen outlet plugs in front of valve blocks. Purge lubrication system with a purge gun until clean, clear, air-free oil flows from plugs. • Loosen, but do not remove, each piston enclosure plug individually to purge air from behind piston. Tighten all divider valve plugs. Adjust DNFT. **To ensure proper lubrication system operation, all tubing and components MUST be filled with oil and free of air before start-up.**	
Erratic shutdown or LED blink.	Faulty wiring from DNFT to control panel or air in system (see above for air in system).	A-10753 A-10772 A-20513	• **Normally Open** - Attach ohmmeter to red wires. Should read 10 megaohms in operation and less than 10 ohms in alarm. • **Normally Closed** - Attach ohmmeter to orange wires. Should read less than 10 ohms in operation and infinity in alarm.
		A-10754 A-20514	• **Normally Open** - Attach ohmmeter to orange wires; insulate violet wires from each other. Should read 10 ohms or less in alarm. • **Normally Closed** - Attach ohmmeter to orange wires. Short violet wires together. Should read infinity in alarm.
	Faulty lube pump.	Check system pressure to verify oil flows to pump and divider valves. If needed, install pressure gauge to monitor lubrication system operation. Check gauge to verify pump builds sufficient pressure to inject oil into cylinder. Do not remove tubing from check valve and pump oil to atmosphere to check oil flow into cylinder. Replace pump.	

Proximity Switch A-18255

CAUTION: See arc welding caution on page 2-1.

A proximity switch installs into a divider valve in place of a piston end plug and can be used to actuate any device. It consists of a reed switch and a magnet. When installed, the magnet rests against the divider valve piston and parallel to the reed switch. With every divider valve cycle, the piston moves the magnet, which opens and closes the reed switch contacts.

The time for the proximity switch to repeat a contact transition (ex. from open to closed) is known as the cycle time of the divider valve assembly. The proximity switch must work with a PLC or some other counter/timer device to produce a shutdown. See "Instrumentation" in the Ariel Packager Standards for interpretation of proximity switch pulse output.

Proximity Switch Installation

1. Loosen the Allen set screws on the proximity switch housing and remove magnet housing. Do not remove magnet, spring, or spacer from magnet housing.
2. Remove piston enclosure plug from end of desired divider valve. The proximity switch installs on any of the divider valves of the divider block. The proximity switch requires the correct magnet assembly to match the divider valve manufacturer.

   NOTE: Do not install a proximity switch on Lincoln divider valves with cycle indicator pins.
3. If applicable, verify o-ring or metal gasket is in place on magnet housing. Thread magnet housing into end of divider valve. Torque to 15 lbs x ft maximum.
4. Slide proximity switch all the way onto hex of magnet housing. Torque Allen set screws on hex of magnet housing to 25 lbs x inch, maximum.

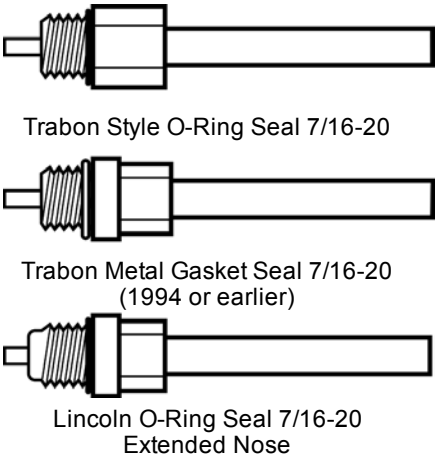
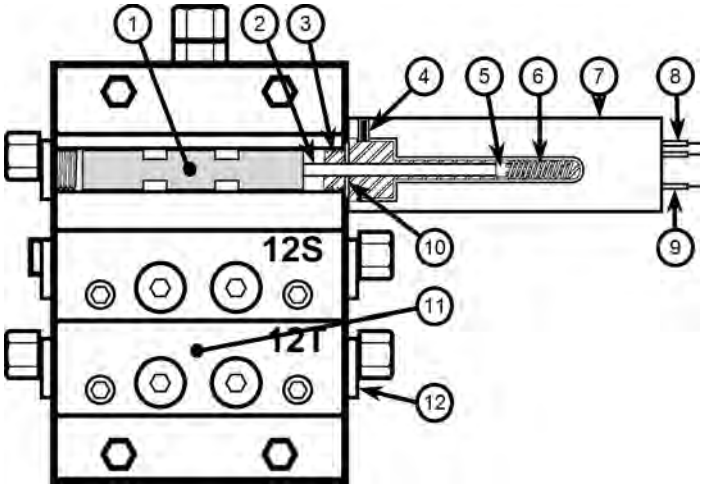


FIGURE 2-9 Typical Magnet Assemblies

5. Connect an ohm meter across the two yellow switch leads exiting the proximity switch housing.

6. The divider valve must cycle during proximity switch adjustment. To cycle it, either run the compressor or manually pump oil through the distribution block with a purge gun.
7. To adjust, slide proximity switch all the way onto hex of magnet housing. Tighten Allen set screws to 25 lbs x inch maximum. The ohm meter showing the switch changing state as the divider valve cycles indicates correct adjustment. If the switch state fails to change, slide proximity switch back on the hex of the magnet housing in 1/16" increments until it does.
8. Make all conduit and connections appropriate for area classification. Support conduit and fittings to avoid bending the magnet housing.
9. After proximity switch installation and before compressor start-up, purge all air from divider block lubrication system with a purge gun.



1. Divider Valve Piston
2. Magnet
3. Magnet Housing
4. Allen Set Screw (2)
5. Spacer
6. Spring
7. Switch Housing
8. Wire Leads (yellow)
9. Ground Wire (green)
10. O-Ring
11. Divider Valve
12. Piston End Plug

FIGURE 2-10 Typ. Proximity Switch Installation

NOTE: When installing multiple proximity switchs, wire each to a separate alarm circuit of the control panel, annunciator, or PLC to simplify lubrication system and proximity switch troubleshooting. Always secure green ground wire to "earth ground" in the control panel. Do not ground to electrical conduit. Improper grounding can result in unreliable monitor operation.

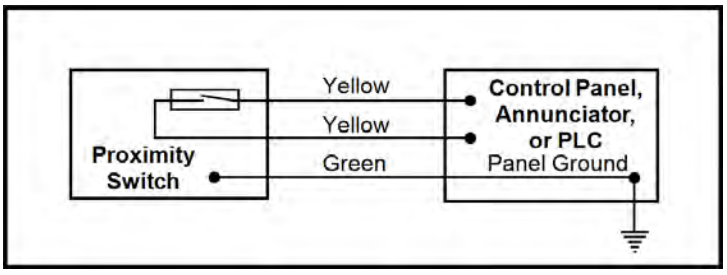


FIGURE 2-11 A-18255 Proximity Switch Wiring Connections for Unit in Operation

Troubleshooting Proximity Switches

NOTE: When installing multiple proximity switches, wire each to a separate circuit in the control panel, annunciator, or PLC to simplify lubrication system and proximity switch troubleshooting.

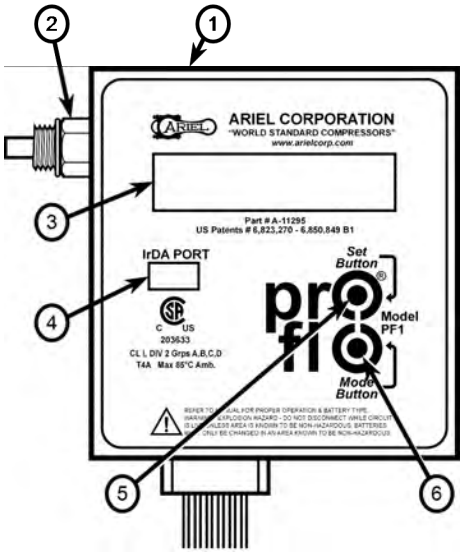
Problem	Possible Cause	Solution
Switch does not cycle and control panel indicates lube no-flow. (see also Erratic Operation)	Improperly adjusted proximity switch.	Loosen set screws, slide proximity switch all the way onto hex of magnet housing and torque to 25 lbs x inch max. **(Do not over tighten)**. Either pump clean oil through lubrication system with a purge gun or run the compressor to cycle the divider valve. If necessary, slide proximity switch back in 1/16“ increments until the switch opens/closes with each divider valve cycle.
	Broken spring or magnet in magnet housing.	Loosen set screws, remove proximity switch from magnet housing. Remove magnet housing from divider valve. Remove magnet, spring, and spacer and check for damage. Replace damaged components. Re-install magnet housing on divider valve and proximity switch on magnet housing. If necessary, adjust proximity switch and test switch functionality. Purge air from system with purge gun.
	Bent magnet housing.	Loosen set screws, remove proximity switch from magnet housing. Check for damaged or bent magnet housing. Remove magnet assembly from divider valve. Replace magnet housing, magnet, spring, and spacer. Re-install new magnet housing on divider valve and proximity switch on magnet housing. If necessary, adjust proximity switch and test switch functionality. Purge air from system with purge gun.
Rupture disc blows and divider valve seizes after proximity switch installation.	Wrong magnet housing installed on divider valve.	Loosen set screws and remove proximity switch from magnet housing. Check for correct magnet housing for divider valve manufacturer. Remove and replace with correct magnet housing. Re-install proximity switch on new magnet housing. If necessary adjust proximity switch and test switch functionality. Purge air from system with purge gun.
	Air or debris in divider valve assembly.	Check system pressure to verify oil flows to divider valves. If needed, install pressure gauge to monitor lubrication system operation: • Loosen outlet plugs in front of valve blocks. Purge lubrication system with a purge gun until clean, clear, air-free oil flows from plugs. • Loosen, but do not remove, each piston enclosure plug individually to purge air from behind piston. Tighten all divider valve plugs. Adjust proximity switch. **To ensure proper lubrication system operation, all tubing and components MUST be filled with oil and free of air before start-up.**
Erratic Operation.	Faulty wiring from proximity switch to control panel or air in system (see above for air in system).	Check electrical wiring and connections for damage or poor contact. See FIGURE 2-11.
	Faulty lube pump.	Check system pressure to verify oil flows to pump and divider valves. If needed, install pressure gauge to monitor lubrication system operation. Check gauge to verify pump builds sufficient pressure to inject oil into cylinder. Do not remove tubing from check valve and pump oil to atmosphere to check oil flow into cylinder. Replace pump.

Proflo Lubricator Fluid-Flow Monitor/No-Flow Timer Switch

CAUTION: See arc welding caution on page 2-1.

The battery-powered, programmable **Proflo** is an electronic microprocessor-based switch that senses slow-flow or no-flow conditions in the compressor cylinder force feed lubrication system to facilitate alarm and/or shutdown. It eases force feed lube system operation by accurately monitoring cycle time and system performance. Operators use this information to optimize force feed lube and reduce operating costs.

The Proflo monitor works through a magnetic pin that cycles back and forth as the divider valve piston moves. The magnetic pin housing normally threads into the divider valve. The monitor box housing slides onto the pin housing and two hex-socket set screws hold it in place. The liquid crystal display (LCD) indicates:



1. Hex-Socket Set Screws (2)
2. Magnetic Pin Housing (attaches to divider valve)
3. Liquid Crystal Display (LCD)
4. Infrared Wireless Connection IrDA Port (to download data to a hand-held computer)
5. Set Button
6. Mode Button

FIGURE 2-12 Proflo Electronic Lubricator Fluid Flow Monitor and No-Flow Timer Switch

1. Total operating time of the force feed lube system in hours.
2. "Average", "Last" and "Current" cycle time of the divider valve in seconds.
3. Total divider valve cycles.
4. Remaining battery life in percent.
5. Alarm set time for no-flow indication (programmable from 30 to 240 seconds).
6. Alarm wiring mode: Normally Open or Normally Closed.

Proflo electronics come with reverse polarity protection/correction that automatically corrects a reverse polarity output connection on both pulse and alarm outputs.

Normally Open and Normally Closed Definition

Most electrical components define Normally Open (NO) and Normally Closed (NC) operation as the default state or “on the shelf” state. Example: A NO solenoid valve is open when the coil is not energized, and closed when the coil is energized. A NC solenoid valve is closed when the coil is not energized, and open when the coil is energized. This is not true of DNFT or Proflo electrical contacts. Both the DNFT and Proflo switch contacts are defined as switch states after the divider valve cycles.

NO = Normally Open when running; switch is open while the divider valve cycles. This is non-fail-safe operation. If a wire falls off while the unit runs, the control system will not alarm/shutdown.

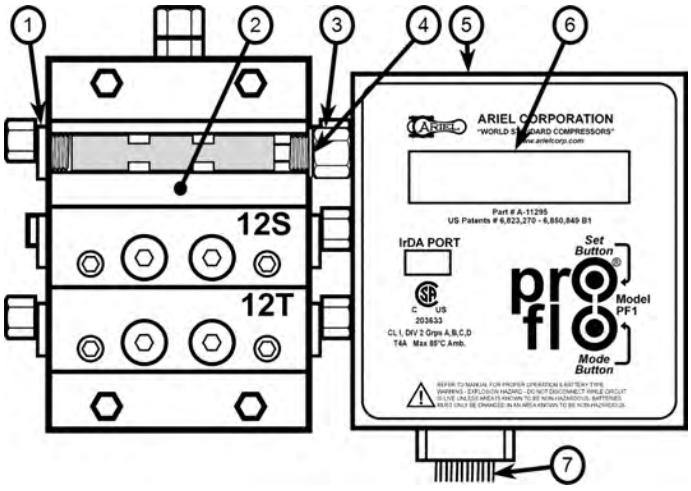
NC= Normally Closed when running; switch is closed while the divider valve cycles. This is fail-safe operation. If a wire falls off while the unit runs, the control system will alarm/shutdown.

Ariel recommends NC operation. The Proflo is pre-programmed for NC operation.

Proflo Installation

1. Loosen the two hex-socket set screws on top of Proflo case and remove magnet housing. Do not remove magnet, spring, and spacer from magnet housing.
2. Remove end plug from desired divider valve. The Proflo installs on either side of any divider valve, but requires the correct magnet housing for each divider valve manufacturer (Trabon, Lincoln)

   NOTE: Do not install the Proflo on any divider valves with cycle indicator pins.
3. Verify O-ring is in place on Proflo magnet housing. Screw magnet housing into end of divider valve. Torque magnet housing to 15 foot-pounds max.
4. Slide Proflo all the way onto magnet housing. Torque set screws to 15 inch-pounds max. **DO NOT** over tighten set screws.



1. End Plug
2. Divider Valve
3. Magnet Housing
4. O-Ring
5. Hex-Socket Set Screws (2)
6. LCD Display
7. Wire Leads

FIGURE 2-13 Typical Proflo Installation

5. The Proflo LCD indicates cycle time. Verify correct operation by pumping oil through the divider valve assembly. The LCD enables the operator to adjust the lubricator pump for correct cycle time. The force feed lubricator data plate on the lubricator box indicates either normal and break-in cycle times at maximum rated speed, or normal cycle time for applied speed. Use break-in cycle times only for the first 200 hours of operation before changing to the normal cycle time. If unable to determine cycle time, contact the Ariel Response Center.
6. All conduit and connections should be appropriate for area classification. Use flexible conduit to ease installation. Support conduit and fittings to minimize vibration.
7. After Proflo installation or performance of any maintenance on the lube system, compressor cylinders, or packing, **pre-lube the complete system with a purge gun to purge air from the divider valves and all components BEFORE COMPRESSOR START-UP.**

Proflo Button Operation

1. Push SET button to clear ALARM. When the LCD displays **LAST**and **AVG**, the alarm output contact enters the “as running” state; set operation to **NC** to close the output alarm contact. **LAST** is the last divider valve cycle time in seconds. **AVG** is the average time of the last six (6) divider valve cycles in seconds.
2. Push MODE button; the LCD displays **NOW**, which is current divider valve cycle time in seconds. This mode allows operators to accurately change cycle time by adjusting the force feed lubricator pump. The force feed lubricator data plate on the lubricator box indicates either normal and break-in cycle times at maximum rated speed, or normal cycle time for applied speed. Use break-in cycle times only for the first 200 hours of operation before changing to the normal cycle time. Compressor speed is directly proportional to cycle time; at 50% rated speed, the lube cycle time doubles (see lube sheets in the Ariel Parts Book for table of speeds vs. cycle times). If unable to determine cycle time, contact the Ariel Response Center.

3. Push MODE button again; the LCD displays **RUN TIME**, which is the total run time of the lube system in hours since the last reset.
4. Push MODE button a third time; the LCD displays **CYCLE TOTAL**, which is the total divider valve cycles since the last reset. Test Proflo for reliability if **CYCLE TOTAL** displays over two million.
5. Push MODE button a fourth time; the LCD displays **BATTERY - PCNT**, which indicates percentage of remaining battery life. If battery voltage drops below safe operating levels the monitor enters ALARM mode.
6. The display mode changes to ALARM when an alarm is triggered. The display defaults to **LAST** and **AVG** while the divider valve cycles. To set alarm time and mode:
   a. Push SET.
   b. Push MODE six times until LCD displays **SETUP?**.
   c. Push SET. The LCD displays **SET ALARM TIME**.
   d. Push SET again to display current alarm time.
   e. Push and release SET button to change alarm-shutdown from 30 to 240 seconds in 5 second increments. Ariel typically sets it to 120 seconds. **Ariel recommends setting alarm time to 2 times normal cycle time rounded up to the nearest 5 seconds. Minimum: 30 seconds; maximum 180 seconds.** Find normal cycle time on the force feed lubricator data plate.
   f. Push MODE two more times to scroll the LCD to **SET ALARM MODE**, which configures the control system to shutdown the compressor for a no-flow indication. Push SET to toggle from N/O (normally open) or N/C (normally closed). **Ariel recommends N/C operation.** After setting wiring mode, either push MODE two times or simply wait 30 seconds to return to the **LAST** and **AVG** display. The Proflo records any setup changes to the EEPROM.

Display Errors

ALARM - Displays when divider valves are not cycling. Programmed divider valve cycle time has expired. **ALARM** flashes every 2 seconds during compressor shutdown.To clear alarm, press SET. Alarm will clear and again indicate cycle time upon compressor re-start.

OVERLOAD - Indicates a wiring short or circuit switching of too large a load. To correct this, check wiring insulation for bare wires touching ground or each other. Insulate unused wires or re-terminate wires. Self-resetting fuses on the inputs protect Proflo electronics; they auto reset 45 seconds after fixing a short.

LOW BATT - Indicates 20% remaining battery life. At 10% remaining battery life, the Proflo shuts down the compressor and flashes **ALARM** and **LOW BATT** until batteries are replaced. See battery replacement procedure below.

RESET X - Indicates an internal Proflo fault. No alarm displays; the Proflo still counts divider valve cycles and controls inputs and outputs. While the divider valve cycles, the Proflo counts pulses and measures time between divider valve cycles. At 30-minute intervals, the processor writes data stored in memory to on-board EEPROMS. If there is a problem with this, the Proflo issues a Reset error.

1. **RESET 1** - Proflo processor unable to determine if the EEPROM contains valid configuration information. Reset 1 usually occurs after a RESET 3 occurs. Upon reboot, the Proflo loses stored and configuration data; programmed information must be re-entered.
2. **RESET 2** - Proflo processor unable to determine storage of any data or location for next data. Upon reboot, the Proflo loses stored data, but retains configuration data; programmed information need not be re-entered.
3. **RESET 3** - Internal Proflo fault. The Proflo processor tried and failed three resets. The most likely cause is failure to write to the EEPROM. To try to correct the problem:

a. Remove Proflo batteries.

b. Press SET button for 45 seconds to discharge internal capacitors and ensure a complete reset.

c. Re-insert batteries to reboot the Proflo.

- If the error was a one-time problem, the Proflo reboots as normal.
- If diagnostics detect an error on reboot, the Proflo displays a constant RESET error again. Replace the Proflo and contact Ariel. Sometimes on reboot, the Proflo flashes RESET. This is normal.

NOTE: Moisture on Proflo circuitry causes most reset errors. Several design precautions keep moisture from the circuit board:

- **The Proflo housing is completely sealed in a low humidity room.**
- **There is a desiccant pack in the circuit board chamber.**
- **The circuit boards have a protective conformal coating.**

Proflo Battery Replacement

The Proflo formerly used alkaline batteries. Sometimes, alkaline batteries leak, release acid, and corrode the battery compartment, and their service potential diminishes at extreme temperatures. The Proflo now uses Lithium batteries, which provide superior leakage resistance, greater service advantage at temperature extremes, and longer shelf and service life. Ariel highly recommends AA Energizer Lithium/FeS_2, model L91 batteries to reduce maintenance costs. This is a true Lithium battery, unlike several other brands.

While not recommended, use replacement alkaline batteries only when Lithium batteries are unavailable. Component damage due to battery leakage is not normally covered under warranty. Front cover removal voids the warranty, except on older Proflo monitors made prior to 3/2003 where batteries may be located under the front cover.

CAUTION: EXPLOSION HAZARD! Disconnect/lockout electrical power to control circuits before battery cover removal. Power connected to the Proflo presents a potential of fire, electrical shock, personal injury, or death. Change batteries only in a non-hazardous area. Earlier Proflo models use a front battery access cover while later models use a rear access cover to reduce potential risk. Disconnect power to Proflo to replace batteries regardless of battery access location

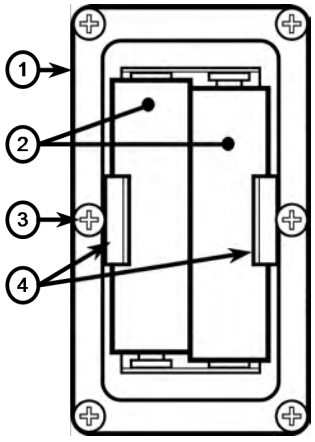
1. Remove the six battery cover screws.

2. Remove battery cover and gasket.

3. Remove old batteries. Remove plastic protective sleeves from old batteries. Save the sleeves and discard the old batteries in a responsible manner.

4. Press SET for 45-60 seconds without batteries installed to dissipate stored energy and allow the battery display to update immediately after new battery installation. This step is optional; the monitor automatically updates the battery display within 30 minutes of operation.

5. The outer cover of batteries is the positive terminal; verify it is unscratched. If a scratched outer cover touches the metal battery holder, the battery depletes very quickly and the Proflo displays **LOW**



1. Battery compartment cover with gasket
2. AA Energizer lithium L91 batteries with plastic sleeves
3. Battery cover screw
4. Battery clips

FIGURE 2-14 Proflo Rear Battery Compartment

BATT. It is possible for one battery to completely deplete and the other to reverse polarity. Replace with new unscratched batteries if this occurs.

6. Slide the plastic protective sleeves onto the new batteries and insert new batteries into the battery holder. The plastic sleeves and the gasket on the bottom of the cover ensure a tight battery fit. Compressor vibration can cause premature failure in batteries not installed tightly. Verify the batteries are installed with correct negative/positive orientation. Do not scratch or damage new battery outer covers during installation.
7. Re-assemble cover, gasket, and screws. The cover holes align with the six monitor body holes in only one direction; verify correct installation. Installing the cover upside down results in stripped screw threads and compromises the battery compartment seal. Do not over-tighten the screws. Replace lost cover screws with 4-40 x 3/16 in. pan head machine screws.
8. Press SET once, then press MODE until the LCD displays **BATTERY**. If stored energy was dissipated (see step 4), the monitor checks battery voltage, resets, and displays remaining battery power. The monitor automatically searches for battery voltage at the next 30 minute read/write interval and updates to the new battery power percentage. All trending and configuration data store in the Proflo EEPROM. Battery failure or replacement causes no memory loss.

Proflo Jr. No-Flow Switch

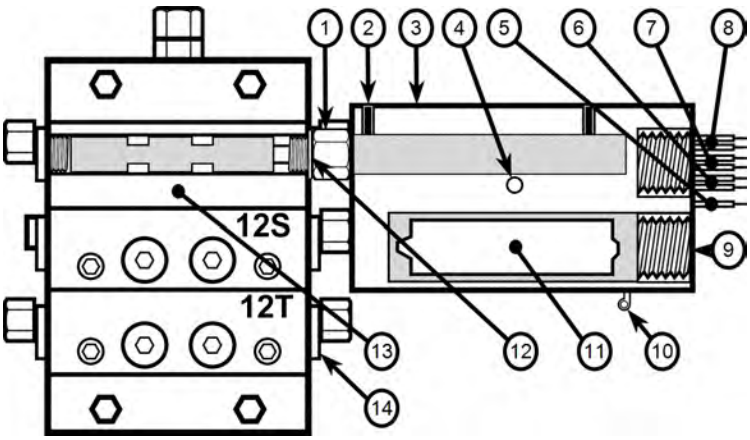
CAUTION: See arc welding caution on page 2-1.

Proflo Jr. Installation

CAUTION: Explosion hazard - no user serviceable parts. Do not disconnect wiring while circuit is live. Complete all field wiring in accordance with local codes pertaining to potentially explosive atmospheres. Do not open battery compartment in areas known to contain explosive gases.

1. Loosen the two Allen head set screws on top of Proflo Jr. case and remove magnet housing. Do not remove magnet, spring, and spacer from magnet housing.
2. Remove piston end plug from desired divider valve. The Proflo Jr. installs on either side of any divider valve, but requires the correct magnet housing for each divider valve manufacturer.

   NOTE: Do not install the Proflo Jr. on any divider valves with cycle indicator pins.
3. Verify O-ring is in place on magnet housing. Thread magnet housing into end of divider valve. Torque magnet housing to 15 foot-pounds maximum.

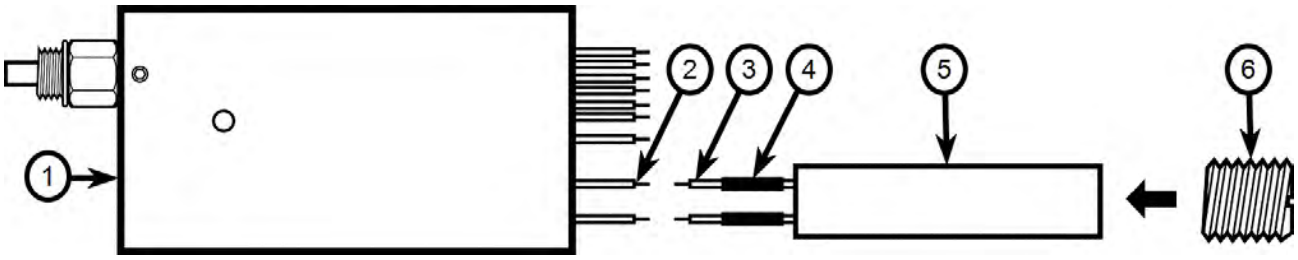


1. Magnet Housing
2. O-Ring
3. Allen Head Set Screw (2)
4. Proflo Jr. Case
5. LED
6. Red Wire Leads (2)
7. Orange Wire Leads (2)
8. Yellow Wire Leads (2)
9. Green Wire Lead (1)
10. Battery Plug
11. Grounding Lug
12. Battery
13. Divider Valve
14. End Plug

FIGURE 2-15 Typical Proflo Jr. Installation

4. Slide Proflo Jr. all the way onto magnet housing. Torque Allen head set screws to 15 inch-pounds maximum. **DO NOT** over-tighten set screws.
5. The LED on the Proflo Jr. indicates one complete cycle of the divider valve system. Verify correct operation by pumping oil through the divider valve assembly. The force feed lubricator data plate on the lubricator box indicates either normal and break-in cycle times at maximum rated speed, or normal cycle time for applied speed. Use break-in cycle times only for the first 200 hours of operation before changing to the normal cycle time. If unable to determine cycle time, contact the Ariel Response Center.
6. Lincoln divider valves may require adjustment to the Proflo Jr. by sliding it back about 1/8" on the magnet housing until the LED flashes. All conduit and connections should be appropriate for area classification. Use flexible conduit to ease installation. Support conduit and fittings to minimize vibration.
7. After Proflo Jr. installation or performance of any maintenance on the lube system, compressor cylinders, or packing, **pre-lube the complete system with a purge gun to purge air from the divider valves and all components BEFORE COMPRESSOR START-UP.**

Proflo Jr. Battery Replacement



1. Proflo Jr.
2. Proflo Jr. Battery Wires
3. Replacement Battery Wires
4. Heat Shrink Sleeves
5. Replacement Battery
6. Pipe Plug

FIGURE 2-16 Proflo Jr. Battery Replacement

If battery voltage drops below normal operating levels, the Proflo Jr. shuts down and the compressor cannot be re-started until the battery is replaced. The Battery Replacement Kit contains one battery assembly with heat shrink.

CAUTION: Do not open the Proflo Jr. in an explosive gas atmosphere.

1. Remove the large silver pipe plug. A large flat bit is required to break the pipe plug free.
2. Plug removal exposes the old battery. Grab the heatshrink on the battery with needle nose pliers and pull the battery out of the housing. Untwist the red and black Proflo Jr. wires.
3. Cut the Proflo Jr. wires free from the old battery as close to the battery as possible.
4. Remove about 3/8 in. of insulation from the ends of the Proflo Jr. wires.
5. Remove about 3/8 in. of insulation from the ends of the replacement battery wires.
6. Slide heat shrink sleeves over the replacement battery wires.
7. Solder the bare ends of the replacement battery wires to the bare ends of the Proflo Jr. wires. Match red to red and black to black.
8. Slide heat shrink sleeves over the soldered wire ends and shrink using a heat gun.
9. Twist battery wires 4 – 5 turns and slide the battery into the Proflo Jr. compartment.
10. Thread the pipe plug back into the Proflo Jr. until the plug top is flush with the case.

Section 3 - Maintenance

Ariel compressors, like all industrial equipment, require maintenance. The severity of compressor service directly influences the frequency and amount of maintenance needed. Below are recommended intervals for inspections and replacements to help determine appropriate intervals for a given compressor application. Careful documentation of inspection results is critical to establish whether recommended intervals are adequate or require more or less frequency.

NOTE: For intermittent duty service, see ER-8.2.2.

As part of your maintenance program, Ariel recommends:

- Consistent adherence to safety policies, procedures, and equipment warning labels.
- Daily operational checks.
- Routine trending and review of operational parameters.
- Routine oil analysis and trending.
- Detailed records of all maintenance.
- To avoid contamination, keep all covers in place where access is not required. Use lint free cloths or paper towels during internal maintenance.

CAUTION: Gas compressors are complicated and dangerous pieces of equipment. Only trained operators and mechanics familiar with unit operation should attempt any maintenance. Read and thoroughly understand the appropriate manual and always wear appropriate personal protection equipment during maintenance.

Never adjust any fastener torques while the unit is operating or pressurized.

To reduce the risk of serious personal injury or death, verify driver or compressor cylinder gas pressure cannot turn compressor crankshaft during maintenance. For engine-driven compressors, either remove the center coupling or lock the flywheel; for electric motor-driven compressors, either detach the driver from the compressor or lock out the driver switch gear. Before any maintenance or component removal, relieve all pressure from compressor cylinders. See packager information to completely vent the system or call the packager for assistance. After maintenance, purge the entire system with gas prior to operation to avoid a potentially explosive air/gas mixture.

Initial Maintenance

Comply with Ariel Packager Standards and the compressor Start Up Check List. Adhere to all items before and after start-up. After running a new, relocated, reconfigured, or overhauled compressor for 24 hours, shut down, vent the gas system, and perform the following maintenance:

1. Perform a hot coupling alignment check within 30 minutes of shutdown; bar driver shaft to packager recommendations.

   To ensure parallel and concentric drive train alignment, position connected equipment so total indicator reading (TIR) is as close to zero as possible on the coupling hub faces and outside diameters at normal operating temperature. Do not exceed 0.005 inches (0.13 mm) on the face and outside diameter, except for outside diameters above 17 in. (43 cm) where the angular face TIR limit is 0° 1' (0.0167°). See FIGURE 3-1

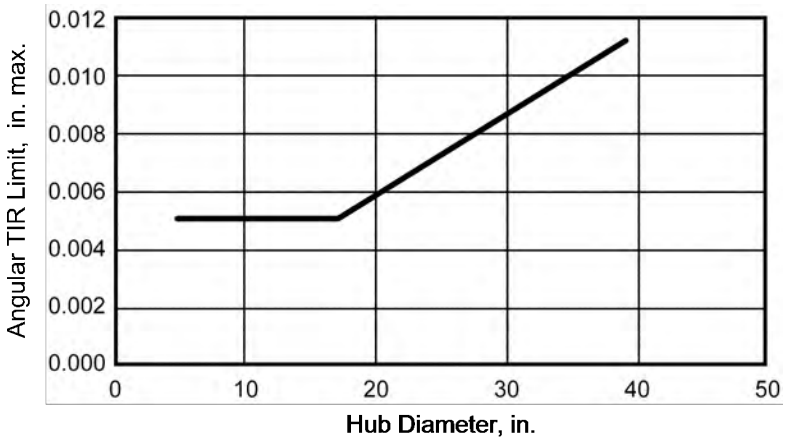


FIGURE 3-1 Angular Coupling-Hub Face Alignment TIR Limits

   - Hub O.D. > 17 in. x 0.00029 = angular coupling-hub face TIR, in. max.
   - Hub O.D. > 43 cm x 0.0029 = angular coupling-hub face TIR, mm max.)

   Center the coupling between the driver and compressor so it does not thrust or force the crankshaft against either thrust face.

   For cold alignment, account for the difference in thermal growth height between the compressor and driver. The compressor centerline height change for JGM:P:N:Q compressors is 0.006 in. (0.15 mm) based on 6.5 x 10^{-6}/°F (11.7 x 10^{-6}/°C) and a differential temperature of 100°F (55.6°C). Obtain driver thermal growth predictions from the driver manufacturer.

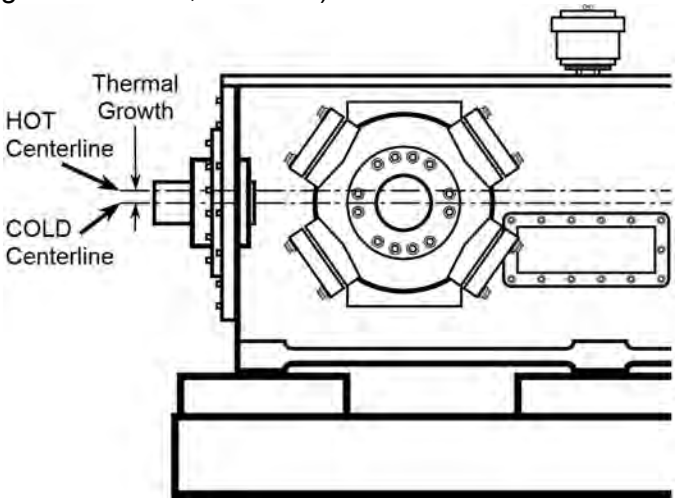


FIGURE 3-2 Thermal Growth

2. At hot alignment check, adjust discharge bottle supports and head end supports, if applicable.

   NOTE: To avoid cylinder distortion, lift discharge bottles only 0.003 to 0.005 inch using the supports.

3. Check fastener torque on gas nozzle flanges, valve caps, cylinder heads, piston rod packing flanges, crosshead guide hold down, and crosshead guide to frame bolting, if applicable. See TABLE A-3 in Appendix A for correct torques.

4. Repeat torque check after 750 hours. If loosening persists, consult your packager. Recheck fasteners found loose in any of these intervals after an additional 750 hours. If loosening continues, contact your package supplier immediately.

Daily Maintenance

1. Log and trend the following:
   - Operating RPM, gas pressure and temperatures - determine if the unit is operating within design parameters and expectations.

     NOTE: Verify high and low pressure shutdowns are set as close as practical to normal operating conditions. Set points must protect the machine from exceeding compressor limits.
   - Bearing temperatures - if the unit is equipped with main bearing temperature sensors.
   - Frame oil pressure - at operating temperature (190°F (88°C) max. inlet oil temperature), it should be 50 to 60 psig (3.5 to 4.2 barg) at the filter gauges. If pressure falls below 50 psig, shut down the compressor then determine and correct the cause.
   - Frame inlet oil temperature.
   - Oil filter differential pressure - differential pressure exceeding the filter change value indicates a need for a filter change. See filter information plate on top cover or "Oil Filter" on page 3-15 for procedure.
2. Check frame oil level. It should be about mid-level in the sight glass and free of foam when running. If not, determine and correct the cause. Do not overfill. Check oil makeup tank for sufficient oil supply. For dry sump frames, check the package sump oil level. Do not add oil to the crankcase through the breather hole while the unit runs. This causes oil foaming and unnecessary no-flow shutdowns in the force feed lubrication system.
3. Check force feed lubricator box oil level. It should be full to the overflow line.
4. Log and trend packing vent temperature and check crosshead guide vents for leakage.
5. If applicable, check suction valve unloader actuator vents for leakage.
6. If applicable, check clearance pocket vents for leakage.
7. Verify the high discharge gas temperature shutdown is set to within 10% or as close as practical above the normal operating discharge temperature. Do not exceed the maximum discharge temperature shutdown setting for the application.
8. Log and trend valve cap temperatures.
9. Check lubricator block cycle time. See lubricator box data plate for correct cycle time. Contaminated gas may require a shorter cycle time. Check lube sheet for units not running at rated speed.
10. Check for gas, oil, and coolant leaks.

CAUTION: Do not attempt to repair leaks while the unit is operating or pressurized.

11. Check for unusual noises or vibrations.
12. See packager documentation for additional recommended checks, i.e. scrubber liquid levels, dump valve operation, cooler louver positions, etc.

Monthly Maintenance

1. Perform all Daily maintenance.
2. Verify safety shutdown functionality.
3. Sample frame oil and send it to a reputable lubricant lab for analysis. See ER-56.06 for a list of what an oil analysis should provide. If analysis results indicate increasing levels of lead, tin, or copper particles in the oil, shut down unit. Remove frame top cover and crosshead guide side covers.

Visually inspect for debris. Do not disassemble further without good reason. If debris indicates, replace affected parts, then change oil, oil filter, and clean the strainer with a suitable solvent.

4. Check and log cylinder clearance devices in use and their settings.

Six-Month (4,000-Hour) Maintenance

1. Perform all Daily and Monthly maintenance.
2. Shut down unit and allow sufficient time for components to cool.
3. Drain and replace force feed lubricator box oil.
4. Clean sintered element in the small oil filter on the force feed lubrication system now or at every main oil filter change. Use a suitable solvent.
5. Change oil filter. See top cover filter information plate or “Oil Filter” on page 3-15 for procedure).

   NOTE: On replaceable element style filters, drain the canister completely before removing the element.

   NOTE: Replaceable filter elements have a finite shelf life. Check the "Install by" date on the filter element before installation. Inspect elements for cleanliness and damage. Do not install dirty or damaged elements.
6. Change oil. Extremely dirty environments, oil supplier recommendations, or oil analysis may dictate a different oil change interval. Follow these steps:
   a. Drain oil from frame, associated piping, and oil cooler.
   b. Clean oil strainer with a suitable solvent. In dry sump applications, the strainer is located at the oil reservoir.
   c. Remove frame top cover and crosshead guide side covers. Visually inspect for debris. Do not disassemble further without good reason. If debris indicates, replace affected parts, then change the oil filter and clean the strainer with a suitable solvent.
   d. Refill frame with fresh, clean oil.
7. Check cylinder lubrication. See “Cylinder Lubrication Paper Test” on page 3-29 for procedure.
8. Re-tighten hold down fasteners to proper torque. Inspect for frame twist or bending to verify main bearing bore alignment. See Ariel document ER-82 for flatness and soft foot requirements.
9. Perform a coupling alignment (see "Initial Maintenance" above).

One-Year (8,000-Hour) Maintenance

1. Perform all Daily, Monthly, and Six-Month maintenance.
2. Grease VVCP stem threads at grease fitting, with 2 to 3 pumps of multi-purpose grease using a standard hand pump grease gun. Turn VVCP adjustment handle all the way in and all the way out to lubricate the threads. Measure or count turns to return the handle to its original position.
3. Open force feed lubricator box and visually inspect pump followers, cams, and gears for wear.
4. Pressure test distribution blocks. See “Divider Valve Bypass Pressure Test” on page 3-21 for procedure.
5. Measure, log, and trend the following:
   - Main bearing, connecting rod bearing, and crankshaft jack and thrust clearances. See page 4-34 and page 4-39

   NOTE: Clearance trends along with oil analysis and crankcase visual inspection can indicate the need for bearing replacement. Contact Ariel for original assembly clearances.

- Crosshead to guide clearances.
- Piston rod run out. See “Piston Rod Runout” on page 4-16

If any of the above items are outside limits listed in Appendix B, replace the affected parts.

6. Remove valves and valve gaskets:
   a. Visually inspect valve pockets for damage. Verify all old valve seat gaskets are removed.
   b. Have a qualified valve repair shop disassemble, visually inspect, and refurbish the valves where needed. Provide the valve repair shop an Ariel torque chart and valve service guide.
   c. Visually inspect cylinder gas passages and clean them of all debris.
7. If applicable, visually inspect suction valve unloader actuator stems for damage or wear. Visually inspect stem seals for damage or wear and confirm that the actuator moves freely.
8. If applicable, visually inspect pneumatic clearance pockets for damage or wear (seating surface and stems/stem seals). Confirm that actuator moves freely.
9. Inspect cylinder bores for damage or wear. Replace the cylinder body or restore the bore if any of the following conditions exist:
   - Bore surface blemishes or gouges.
   - Bore out of round more than 0.001 inch per inch of bore diameter (0.001 mm/mm) or tapered.
10. Inspect piston rings and wearband:
    a. Measure and log piston ring condition, end gap, and side clearance.
    b. Replace rings that are damaged or outside limits listed in Appendix B .
    c. When replacing rings, re-measure and log ring side clearance to check for groove wear.
    d. Measure and log radial projection of wear band.
11. Inspect piston rods for damage and excessive wear. Replace rod if any of these conditions exist:
    - Gouges or scratches on the rod.
    - Under size more than 0.005 inch (0.13 mm).
    - Out of round more than 0.001 inch (0.03 mm) per inch of rod diameter.
    - Tapered more than 0.002 inch (0.05 mm) per inch of rod diameter.
12. Rebuild piston rod pressure packing cases. See “Piston Rod Packing” on page 4-19 for procedure.
13. Re-install valves, retainers, and valve caps using new valve gaskets and valve cap o-rings/seals. Use proper installation techniques and torque procedures for valve caps.
14. Check and re-calibrate all required instrumentation.
15. Clean crankcase breather filter with suitable solvent.
16. Check and, if needed, adjust drive chains. See “Chain Adjustment” on page 4-45 for procedure.
17. If the compressor is equipped with crankcase over-pressure relief valves, visually inspect and exercise valves to manufacturer recommendations.
18. Check fastener torques of gas nozzle flange, valve cap, piston 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.

Two-Year (16,000-Hour) Maintenance

1. Perform all Daily, Monthly, Six-Month, and One-Year maintenance.
2. Rebuild oil wiper cases.

3. If applicable, use new piston and stem seals to rebuild actuators on suction valve unloaders and fixed volume pneumatic pockets. Replace piston stem assemblies where stem is damaged or worn.
4. Check auxiliary end chain drive for undercut sprocket teeth and chain for excessive stretching. Replace as required.

Three-Year (24,000-Hour) Maintenance

1. Perform all Daily, Monthly, Six-Month, and One-Year maintenance.
2. Replace non-ELP connecting rod bearings for JGE:T:C:D:F:U:Z:B:V and KBB:V models. See "Connecting Rods" on page 4-29 and "Crankshaft" on page 4-37.

   NOTE: Main and connecting rod bearing wear and replacement intervals are heavily dependent on many factors including speed, load, oil temperature, oil cleanliness, and oil quality. Depending on the severity of service, the bearing maintenance interval may be longer or shorter.

Four-Year (32,000-Hour) Maintenance

1. Perform all Daily, Monthly, Six-Month, One-Year, and Two-Year maintenance.
2. Remove crosshead pins. Measure and log crosshead pin to crosshead pin bore and connecting rod bushing bore clearances. Check the crosshead pin end caps and through bolt for wear. Replace if needed.
3. Check for bushing wear in the auxiliary end drive chain tightener.
4. Check for ring groove wear in pistons.

Six-Year (48,000-Hour) Maintenance

1. Perform all Daily, Monthly, Six-Month, One-Year, Two-Year, and Three-Year maintenance.
2. Replace lubricator distribution blocks.
3. Replace crosshead and connecting rod bushings. See "Crossheads" on page 4-25 and "Connecting Rods" on page 4-29.
4. Replace connecting rod bearings. See "Connecting Rods" on page 4-29.
5. Replace main bearings. See "Crankshaft" on page 4-37.

Frame Oil

There are several oil specifications, maintenance procedures, and operating conditions which affect oil performance. For optimal performance, ensure the oil meets the specifications below and is suitable for the given application, and diligently complete maintenance procedures.

Viscosity

For cold ambient temperatures, design the oil system so the unit may safely start with adequate oil flow to the journal bearings. Successful operation may require temperature controlled cooler by-pass valves, oil heaters, cooler louvers, and even buildings.

The minimum allowable viscosity of the oil entering the frame is 16 cSt. Typically, this is the viscosity of ISO 150 grade oil at about 190°F (88°C).

TABLE 3-1 Oil Viscosity Requirements, cSt

Frame	Max. Viscosity to START	Max Viscosity to LOAD	Max Viscosity into Compressor at Operating Temp.	Min Viscosity into Compressor at Operating Temp.
JGH:E:K:T & smaller	3,300	1,000	60	16
JGC:D:F	2,000	1,000		
JGZ:U, KBZ:U:B:V	2,000	350		

Oil Pressure

The factory sets normal pressure on the discharge side of the oil filter at 60 psig (4.1 barg) for compressors tested mechanically complete (inspector tag displayed). If factory tested as mechanically incomplete (no inspector tag), the packager sets normal oil pressure at initial start-up to 60 psig (4.1 barg) at the lower of the frame or cylinder rated speed, or driver speed at normal operating temperature.

Ariel uses the pump safety relief or separate lube oil pressure regulating valve to regulate pressure into the compressor. If oil pressure into the compressor at minimum operating speed and normal operating temperature does not read about 60 psig (4.1 barg), adjust the pump safety relief or separate lube oil pressure regulating valve. With compressor running at minimum rated speed, turn the adjustment screw clockwise to increase oil pressure, or counter-clockwise to decrease it.

The compressor requires a 45 psig (3.1 barg) low oil pressure shutdown for protection.

NOTE: If oil pressure drops below 50 PSIG (3.4 barg) when crankshaft speed equals or exceeds minimum rated operating speed, find the cause and correct it.

Oil Temperature

Maintain frame inlet oil temperature as close to 170°F (77°C) as possible. Minimum lube oil operating temperature is 150°F (66°C) to drive off water vapor. Maximum allowable oil temperature into the compressor frame is 190°F (88°C). Higher temperatures increase the oxidation rate of oil. Every 18°F (10°C) within the operating range doubles the oxidation rate of oil.

For proper operation of the thermostatic control valve, the maximum differential pressure between the hot oil supply line and the cooled oil return line is 10 psid (0.7 bard).

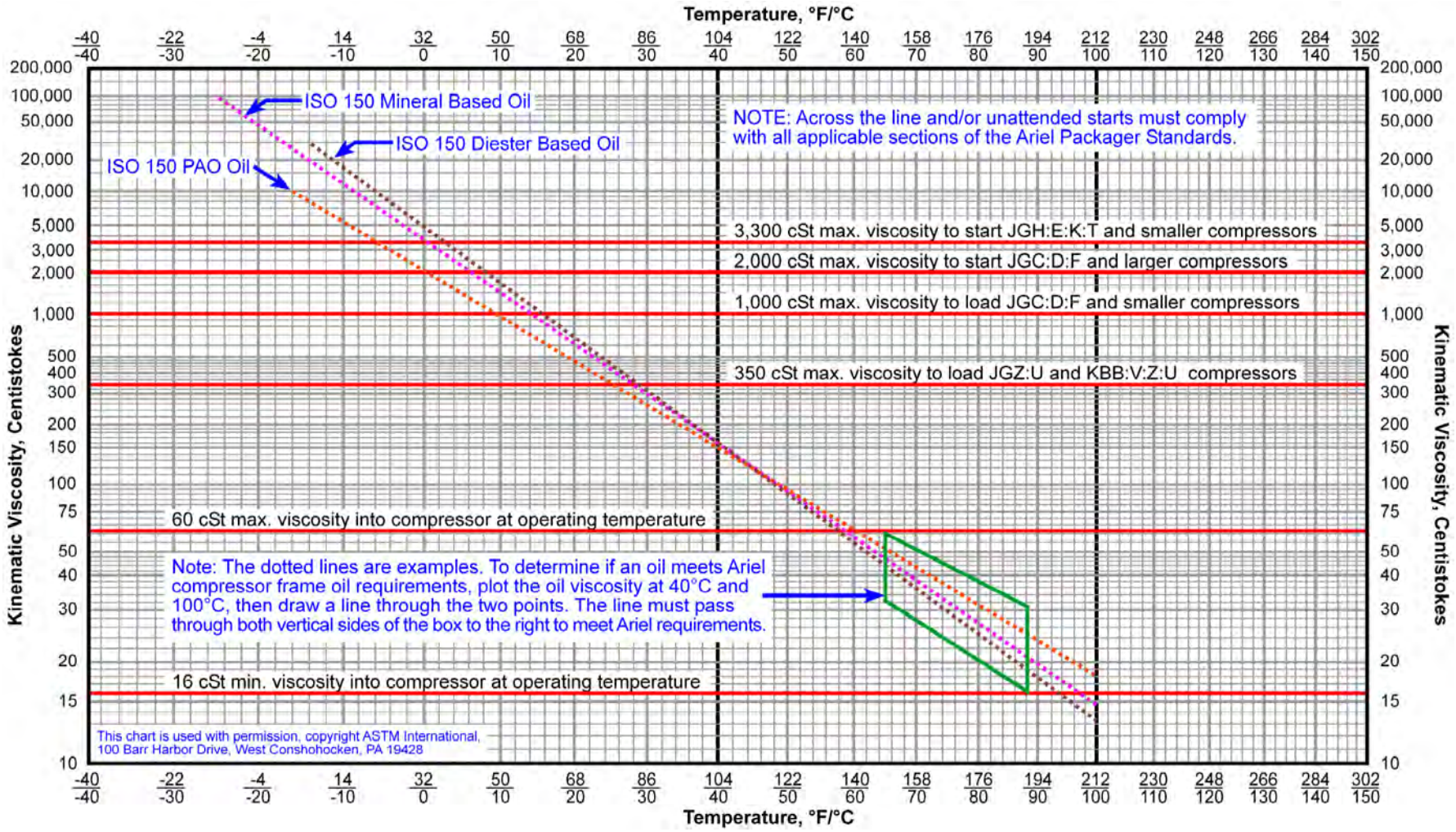


FIGURE 3-3 Viscosity vs. Temperature Graph of Different Lubricants

Oil Maintenance

An oil analysis program is the most effective way to determine frame oil change intervals. Consistent oil analysis can identify when to change oil on the basis of need rather than a scheduled interval. Depending on service, oil analysis can significantly extend oil change intervals.

Install a sampling point between the oil pump and filter at an easily accessible location. Minimize dirt or debris that can collect around it. Use a needle valve to better control pressurized oil flow.

Collect and analyze oil samples to verify suitability for continued service. Oil analysis should include:

- Viscosity testing at 104°F (40°C) and 212°F (100°C). This verifies that oil has not mixed with cylinder oils or process gas.
- Particle counting to the latest version of ISO 4406.
- Spectroscopy to determine wear metals, contaminants, and additives.
- FTIR (Fourier Transform Infrared Spectroscopy) to check for oxidation, water or coolant contamination, and additive depletion. This is more important if the sump oil is not consumed by the force feed system.

Oil System Cleanliness

Clean the compressor frame oil piping system and components of all foreign matter such as sand, rust, mill scale, metal chips, weld spatter, grease, and paint. Use proper cleaning procedures with proper cleaners, acids, and/or mechanical cleaning to meet cleanliness requirements. Ariel recommends flushing all oil-piping systems with an electric or pneumatic driven pump and filtered, clean production oil. Ariel thoroughly cleans all compressor frame cavities prior to assembly and test runs compressors with a filtered closed loop lube system.

NOTE: Ariel recommends not disturbing lube oil piping downstream of the installed oil filter. Contaminants that enter this piping or open ports flush into the bearings causing catastrophic damage. To remove or alter piping, cover the inlets to the oil gallery, the ends of the piping, and the filter outlet so no contaminants enter. Before reinstallation, chemical and mechanical cleaning is required. Flush the pipe in accordance with Ariel cleanliness requirements (see TABLE 3-2).

Prior to start-up, flush all compressors installed with an electric or pneumatic powered pre-lube pump and less than 50 feet (15 m) of oil piping as outlined below. Include cooler oil passages in the flushing loop. While oil systems for compressors without an electric or pneumatic powered pre-lube pump and less than 50 feet (15 m) of oil piping must be clean, oil flushing is desirable, but not required.

For all compressors with oil piping systems 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 (see TABLE 3-2), prior to start-up.

1. Prior to assembling lube oil piping, remove scale, weld slag, rust and any other matter that could contaminate lube oil. Confirm:
   - Complete and closed lube oil system.
   - Crankcase filled to the correct level with appropriate oil.
   - Proper and correctly installed lube oil filters.
   - Operational and viewable oil pressure transducer or gauge, oil filter differential-pressure transducers or gauges, and oil temperature RTD or indicator.
2. Start pre-lube pump. Record oil pressure, oil filter differential-pressure, and oil temperature. Minimum oil pressure is 30 psig (2.1 barg) for effective flushing. Do not exceed 90 psig (6.2 barg).

3. Flush continuously for one hour. Oil filter differential-pressure must not increase more than 10% of measured oil pressure into the filter. Record the oil pressure, oil filter differential pressure, and oil temperature every 15 minutes. Oil temperature increases of more than 10°F (5.5°C) during an hour of flushing invalidate the system cleanliness test, due to oil viscosity change.
4. After one hour of pre-lube flushing, if differential pressure or temperature increases exceed the limits above, continue flushing. If the lube oil filter differential pressure exceeds change filter limits, stop the pre-lube pump and change the oil filter. To ensure system cleanliness, re-set time and continue flushing until the compressor achieves a continuous hour of flushing within differential pressure and temperature increase limits.

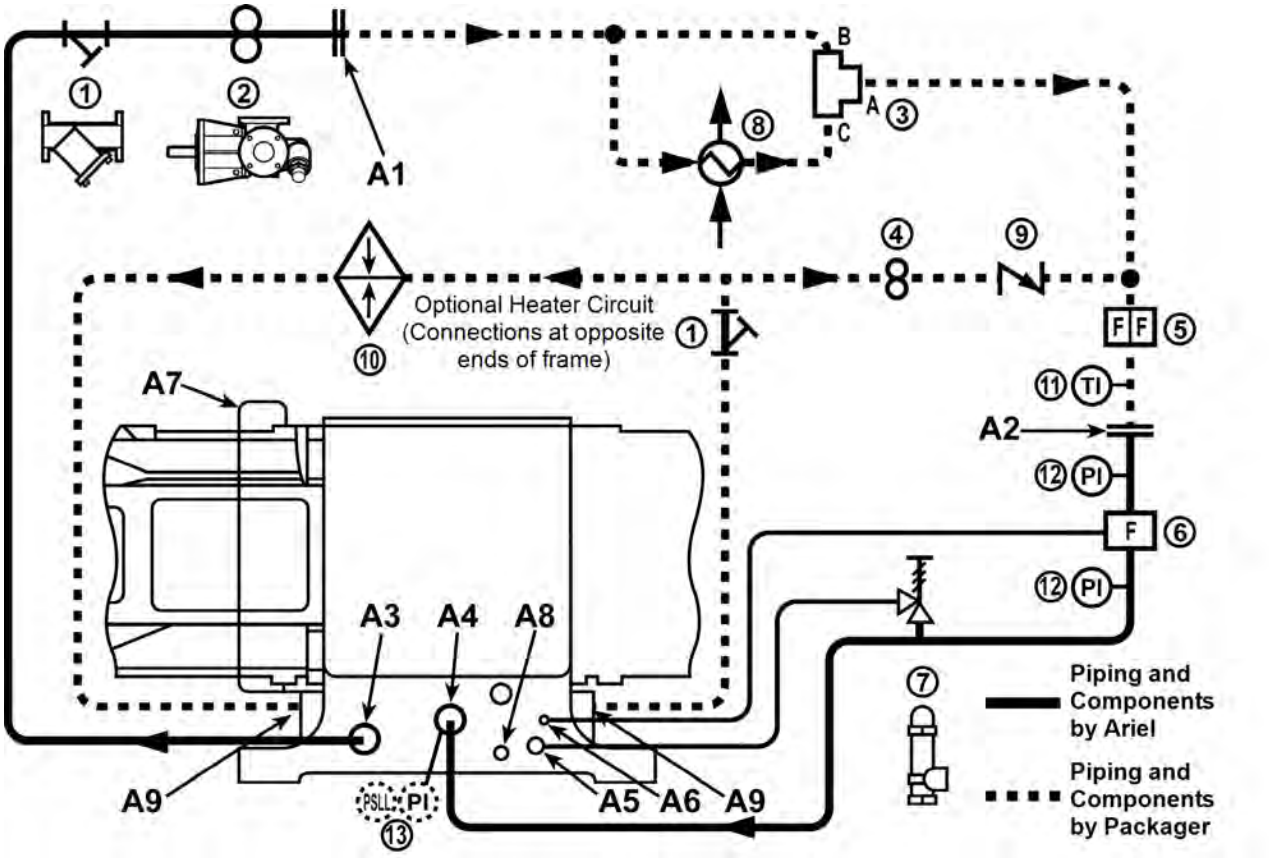
See ISO-4406 "International Standard - Hydraulic fluid power - Fluids - Method for coding level of contamination by solid particles" and/or NAS-1638 "National Aerospace Standard, Aerospace Industries Association of America, Inc. - Cleanliness Requirements for Parts Used in Hydraulic Systems" for complete information. Use a competent oil lab for sample testing.

TABLE 3-2 Oil Flush Cleanliness Requirements

ISO-4406 GRADE 13/10/9		
Grade Requirement	**Particle Size um/ml Oil Sample**	**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 um/100ml Oil Sample	**Grade 5 Maximum Particles Allowed**
5 to 15	8,000
15 to 25	1,424
25 to 50	253
50 to 100	45
Over 100	8

Frame Oil System Components



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 crankshaft main bearings, connecting rod bearings, crosshead pins, and bushings.
A5 Pressure regulating valve return connection to oil sump, when applicable.
A6 Filter vent return connection to oil sump, when applicable on some models.
A7 Oil tubing connections from frame gallery tube to top and bottom of 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 (with safety relief valve for pressure regulation, or in models with a separate regulating valve (6), for relief).
3. Thermostatic control valve, 170°F (77°C) nominal rating - required (purchase separately from Ariel).
4. Pre-lube oil pump - required (shown with oil heating circuit, when applicable).
5. Optional duplex oil filter.
6. Oil filter.
7. Pressure regulating valve with overflow return to oil sump, when applicable.
8. Oil cooler - required.
9. Check valve.
10. Heater (when applicable).
11. Temperature indicator.
12. Pressure indicator.
13. Pressure indicator/shutdown connection.

FIGURE 3-4 Standard Frame Lube Oil Schematic

Oil Strainer

An oil strainer installed upstream of the pump prevents debris from entering the pump and damaging it. Ariel supplies a 30 mesh (595 microns) strainer on all JGM:P:N:Q compressors. It is located on the

auxiliary end of the crankcase below oil level. Remove the strainer basket and wash it in an appropriate solvent whenever lubricating oil is changed.

Oil Pump & Regulating Valve

The oil pump constantly supplies oil to all journal bearings, bushings, and crosshead sliding surfaces. The crankshaft drives it by a chain and sprocket to provide adequate oil flow to bearings when the compressor operates at the minimum speed rating (typically half of maximum rated speed).

JGM:P:N:Q compressors maintain oil pressure with a spring-loaded safety relief valve within the pump head. To adjust, remove the dust cap to expose the safety relief valve adjustment screw.

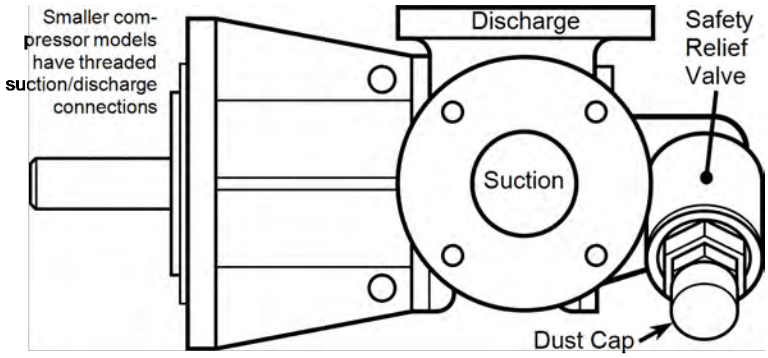


FIGURE 3-5 Typical Lube Oil Pump

When installing a new oil pump on a compressor or after maintenance on an existing oil pump, Ariel recommends priming the pump (wetting the gears with oil) before start-up to ensure proper operation.

Oil Cooler

An oil cooler is required to remove heat from the frame lube oil.When sizing an oil cooler, consider temperature and flow rate of both cooling medium and lube oil. Insufficient cooling water flow rate is the primary cause of high oil temperatures. Mount cooler as close to the compressor as possible with piping of adequate size to minimize pressure drop of both lube oil and cooling medium.

The Application Manual lists required cooling water temperature and flow rate to properly cool oil with Ariel supplied coolers. The Ariel Performance Program lists oil heat rejection data for each frame in the frame details section (contact Ariel for details).

Flushing to Change to a PAG Lubricant

Recommended Flushing Oil

The preferred flushing oil is soluble in both the original oil and PAG lubricant. A linear diester is preferred, such as Shell Corena DE 150 or Mobil Rarus 829. If this is unavailable, use the desired PAG lubricant fill oil as the initial flushing oil.

Flushing Procedure

Below is a general flushing procedure recommended to change from mineral or PAO oils to a synthetic PAG lubricant.

1. Drain old oil from frame while the oil is still warm.
2. Drain all supply and return lines upstream of the frame lube oil filter, filter housing (if applicable), coolers, and other peripheral equipment in the lubricant supply loop.
3. Remove standing oil in the frame and guide compartment low points. Remove as much oil as possible with a vacuum hose. If heavy deposits are visible, remove them as best as possible by hand using clean, dry, lint-free rags.
4. Replace all oil filters.

5. Remove and either clean or replace the Y-strainer element.
6. Reconnect oil piping and install drain plug in frame.
7. Connect a diaphragm pump upstream of the frame mounted oil filter.
8. Feed the diaphragm pump flushing oil (see "Recommended Flushing Oil") from a clean reservoir and prime the lube oil system. Prime until old oil is purged from oil passages and flushing oil steadily flows from all bearings and crosshead bushings.
9. Drain frame. Remove standing oil in the frame and guide compartment low points. Remove as much oil as possible with a vacuum hose.
10. Remove diaphragm pump.
11. Install drain plug in frame.
12. Refill the frame with flushing oil (see "Recommended Flushing Oil").
13. Circulate flushing oil for at least four hours, and up to 24 hours if needed, to loosen all debris and existing deposits. Monitor lube oil filter differential pressure during flushing. The filter may need to be taken off line or changed several times during flushing, as loosened deposits tend to plug the filter quickly.
14. Drain the first flushing oil from the frame while the oil is still warm. Take care to also drain all supply and return lines, filter housing, and other peripheral equipment in the lubricant supply loop. If standing oil remains in the frame, remove as much as possible with a vacuum hose.
15. Refill the frame with the PAG lubricant of the recommended viscosity for the application. At this time, as much as 2-3% of the initial oil may still remain in the system. Circulate this fill for at least four hours and up to 24 hours if possible. Replace filters as needed.

    NOTE: If the PAG lubricant is clear and bright after circulating and no debris or emulsion is visible, it may be possible to skip the final steps and simply begin normal operation. However, a second flush is preferred (see steps 16 and 17).
16. Drain second flushing (PAG lubricant) oil from the frame while the oil is still warm.
17. Refill frame with PAG lubricant of the recommended viscosity and circulate for at least four hours. At this point, the initial oil remaining in the system should be less than 0.5%. Sample the oil and examine it for any emulsion or debris. If the oil is clear and bright (a slight haze is acceptable), then continue normal operation and top off as needed. If significant emulsion or debris remains, then conduct one more drain and flush.

If the frame uses the same oil as the force-feed cylinder lubrication system, the overflow line on the lubricator box can remain attached to the frame auxiliary end cover. If the frame oil and cylinder oil are incompatible or of different ISO grades, disconnect overflow line on the lubricator box (see "Independent Oil Supply"). Fill the force-feed lubricator box with the same oil used to lubricate the compressor cylinders/packings. To change the lubricator box lubricant from a mineral oil or synthetic PAO lubricant to a PAG synthetic lubricant:

1. Drain old oil from lubricator box.
2. Rinse lubricator box with flushing oil (see "Recommended Flushing Oil").
3. Fill lubricator box with PAG lubricant to be used for the cylinders.

Flushing the Force Feed Lubrication System

Common Oil Supply

1. If installed, drain the sintered filter and clean the element with solvent.
2. Drain the lube line upstream of the force feed pump inlet.

3. Drain tubing/manifold feeding the force feed pump(s).
4. Remove the purge/vent connection on the outlet of each force feed pump.
5. Use a purge gun filled with clean/filtered flushing oil (see Note) to prime each force feed pump by forcing oil through the pump inlet and out the purge/vent connection.
6. Reconnect the purge gun to the force feed pump purge/vent outlet connection. If pumps are paired together at their outlets, close one of the purge/vent connections.
7. For the zone fed by the force feed pump being primed, disconnect lube lines at the inlet of the double-ball check valves.
8. Place paper towels or suitable collection containers beneath each disconnected lube line to catch flushing oil during priming.
9. Prime flushing oil from the force feed pump purge/vent connection to downstream tubing, divider blocks, and check valves.
10. Prime until no air bubbles appear in the flushing oil at all disconnected lube lines in the zone.
11. Reconnect lube lines to double ball check valves in the primed zone.
12. Continue to prime 2 floz of oil per throw through the primed zone.
13. Repeat steps 6 thru 12 for remaining zones.

Independent Oil Supply

1. If installed, drain the sintered filter and clean the element with solvent.
2. Drain daytank, oil filter, and lube lines upstream of the force feed pump inlet. Oil trapped in piping will need vacuumed out or flushing oil can be pumped through these lines to displace the old oil.
3. Drain tubing/manifold feeding the force feed pump(s).
4. Remove the purge/vent connection on the outlet of each force feed pump.
5. Use a purge gun filled with clean/filtered flushing oil (See Note#1) to prime each force feed pump by forcing oil through the pump inlet and out the purge/vent connection.
6. Reconnect the purge gun to the force feed pump purge/vent outlet connection. If pumps are paired together at their outlets, close one of the purge/vent connections.
7. For the zone fed by the force feed pump being primed, disconnect lube lines at the inlet of the double-ball check valves.
8. Place paper towels or suitable collection containers beneath each disconnected lube line to catch flushing oil during priming.
9. Prime flushing oil from the force feed pump purge/vent connection to downstream tubing, divider blocks, and check valves.
10. Prime until no air bubbles appear in the flushing oil at all disconnected lube lines in the zone.
11. Reconnect lube lines to double ball check valves in the primed zone.
12. Continue to prime 2 floz of flushing oil per throw through the primed zone.
13. Disconnect the purge gun and install cap for purge/vent connection.
14. Repeat steps 6 thru 12 for remaining zones.
15. Install a new oil filter.
16. Reconnect lube lines between daytank and pump inlets.
17. Place a collection container beneath the disconnected lube line near the force feed pump inlet connection.

18. Add enough flushing oil to the daytank to prime the system up to the disconnected line in step 17.

19. Collect oil until no air bubbles appear in the flushing oil.

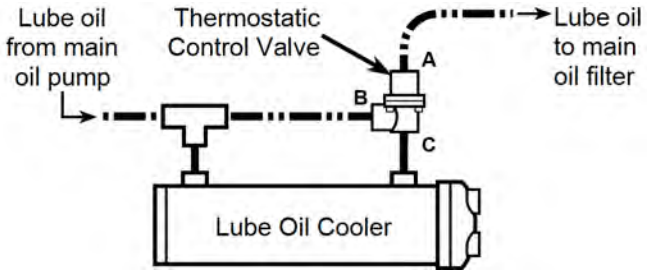
20. Reconnect feed line to force feed pump.

21. Bleed trapped air by loosening tube connections nearest each pump inlet.

Oil Temperature Control Valve

The lube oil system requires a thermostatic valve to control compressor oil temperature. A thermostatic valve is a three-way valve with a temperature sensitive element. As the oil heats, the sensing element opens the third port in the valve.

Ariel recommends a thermostatic valve with a 170°F (77°C) element. Install the valve in mixing mode to more directly control oil temperature into the frame (see FIGURE 3-6).



Thermostatic control valve configuration may vary from this schematic depending on valve size. Valve connections A-B-C are marked on the valve.

FIGURE 3-6 Thermostatic Valve in Mixing Mode

Oil Filter

All compressor frames require oil filters to remove particle contamination that can damage equipment and oil. Contaminants that damage equipment include wear particles from equipment , airborne particles such as dust or sand, and particulates in new oil. Contaminants that damage oil include oxidized oil components and air bubbles.

- Ariel filters are not designed for reverse flow often caused by pumping oil out of the compressor through the filter. This can invert and tear the filter media, sending dirty oil to crankshaft bearings.
- With canister style filters, always drain oil filter housing before element removal or dirty oil will be sent to crankshaft bearings.
- Ariel cartridge filters have a 24 month shelf life from the date of manufacture, and an install-by date is stamped on the top of each filter. Discard any filter exceeding the install-by date.

JGM:N:P:Q compressors ship with simplex, spin-on, non-bypassing, resin-impregnated filters as standard. Spin-on filters carry a 5 micron nominal and 17 micron absolute rating. The Beta ratings are ß5 = 2 and ß17 = 75. Many spin-on filters fit an Ariel compressor, but very few meet filtration ratings of Ariel filters. Do not use after-market filters.

Pressure gauges monitor pressure drop across the filter. High differential pressure indicates a plugged filter. Ariel recommends lube oil filter replacement every 6 months, or 4000 hours, or when oil filter differential pressure at normal operating temperature reaches 10 psid (0.7 bard), whichever comes first. On start-up, differential pressure may exceed the filter replacement limit until the oil reaches operating temperature. On the same schedule, or with every main oil filter change, clean the sintered element in the small oil filter of the force feed lubricator.

Simplex Spin-on Filter Replacement

NOTE: Replace oil filters only with Ariel approved filters.

1. Remove old filter, clean filter base surfaces, and verify old gasket is removed.

2. Inspect new filter for damage or debris. Do not install damaged or dirty filters. **Never operate a unit with a damaged or leaking oil filter.**

3. Apply clean oil to the filter gasket and thread the filter with gasket onto the base.

4. Tighten the filter one turn after the filter gasket contacts the base.

5. Use the compressor pre-lube pump to fill the oil filter with oil and purge air from the oil system. Manually filling the filter with oil can introduce debris on the clean side of the filter. This debris can damage the compressor to the point of catastrophic bearing failure.
6. After starting the unit, check for leaks, and retighten if necessary.

Compressor Pre-lube System

Ariel compressors must be pre-lubed anytime the crankshaft is turned and prior to starting. Ariel strongly recommends an automated pre-lube system to extend driveline component life.

Ariel requires automated pre-lube systems for compressors that meet any of the following criteria:

- Electric motor driven compressors.
- Unattended-start compressors, regardless of driver type.
- Compressor models JGC:D:F:Z:U:B:V and KBZ:U:B:V.

See FIGURE 3-4 for pre-lube circuit design.

NOTE: The pre-lube return into the frame must be upstream of the oil filter.

For on-demand compressor applications, the pre-lube pump can circulate oil continuously through the bearings while on standby.

Ariel requirements are based on a pre-lube pump sized for 25% of frame oil pump flow to ensure oil flow to bearings, bushings, and oil-filled clearances prior to turning or start-up (see the Ariel Performance Program for frame oil pump flow rates).

Pre-lube pressure shall be 30 psig (2.1 barg) at the oil gallery for a minimum of 2 minutes prior to turning or starting.

NOTE: A 10 to 15 minute pre-lube is required after:

- Any major drive line maintenance
- The main lube oil system is drained
- Oil filter replacement

Instrumentation: Automated pre-lube systems require a start permissive logic and instrumentation to satisfy the minimum required pressure and duration at the oil gallery inlet.

It is highly recommended that the compressor low oil pressure shutdown be Class B. Inhibited time shall be no longer than 10 seconds after idle speed is achieved on gas engines or start initiation for electric motors.

If the compressor fails to achieve 45 psig (3.1 barg) oil pressure within 10 seconds after reaching engine idle speed or electric motor start initiation, ensure shutdown and correct the cause. Repeat pre-lube before each start attempt.

NOTE: If a compressor fails to start or shuts down at start-up due to low oil pressure, DO NOT re-start until the cause is corrected.

Oil Heaters

The compressor may need a frame oil heater to meet allowable oil viscosity requirements at start-up (see TABLE 3-1). One possible heating mode maintains the compressor frame at a minimum temperature so the compressor can start immediately if needed. Multiply 0.0086 kW/ºF (0.0155 kW/ºC) by the differential between target oil temperature and ambient temperature to obtain the kilowatt rating for a heater.

Another mode heats oil from ambient to a minimum temperature prior to starting (see). Multiply 0.0275 kW-h/ºF (0.0495 kW-h/ºC) by the rise in oil temperature and divide by target hours to obtain the kilowatt rating for a heater.

Ariel recommends circulation heaters for all units. Heated oil should circulate through the filter, bearings, and crossheads as well as the sump.

All Ariel compressors have at least one heater connection; four and six throw frames have two. Maximum allowable watt density for an immersion heater is 15 W/in^2 (2.3 W/cm^2). This limit prevents oil coking on the heater element, which reduces heater efficiency and contaminates remaining oil.

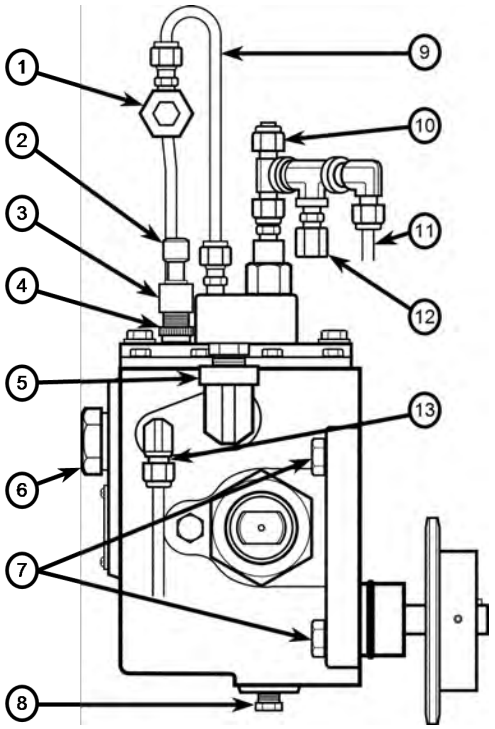
Force Feed Lubrication System Components

The cylinder lubrication system injects lubrication into cylinder bores and packings. The system consists of an oil supply, an oil filter, a force feed lubricator pump, divider blocks, pressure indicators, check valves, and flow monitoring shutdown devices. The system is progressive; each piston in the divider block must complete a cycle before the system cycles again. This type of system offers better lubrication precision and eases monitoring.

Force Feed Lubricator

The force feed lubrication system oils the compressor cylinders and piston rod packings. Oil flows 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 lubrication system, or from an overhead tank. Filtered oil flows to a header and to pumps on the force feed lubricator.

A self-contained oil reservoir oils the force feed lubricator worm gear and cam. The force feed lubricator sight glass shows the reservoir oil level.



1. Inlet Header
2. Priming Stem
3. Pump Plunger Stroke Adjustment Screw
4. Lock Nut
5. Lubricator Oil Fill Connection
6. Sight Glass
7. Mounting Flange Capscrews (4)
8. Drain Plug
9. Pump Inlet from Header
10. Priming Pump Connection
11. Pump Outlet to Distribution Block
12. Rupture Disk Assembly
13. Lubricator Overflow

FIGURE 3-7 Typical Force Feed Lubricator

Priming the Pump

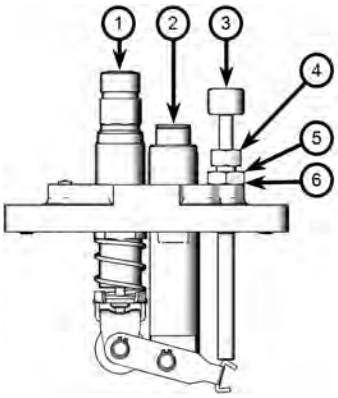


FIGURE 3-8 Pump Priming and Adjustment

Use filtered oil when priming the pump and force feed system (minimum 5 micron nominal filter). Refer to Figure 2 during priming.

1. Remove and discard the plastic plugs in the pump inlet and outlet.
2. Apply thread sealant (user supplied) to inlet and outlet line fittings.
3. Install the inlet and outlet fittings on the pump.
4. Connect the inlet line to the inlet fitting.
5. Introduce oil into the inlet line. If installed, open oil supply valve (located upstream from pump).
6. Wipe the pump priming stem clean and lubricate with oil.
7. Manually prime pump by depressing the pump priming stem repeatedly until clean, air-free oil flows from the outlet fitting.
8. Connect outlet line to outlet fitting.
9. Manually prime pump using pump priming stem until clean, air-free oil flows from the outlet line.
10. Connect the outlet line to the lube point.
11. After startup, adjust individual pumps to meet required flow rates. See "Pump Adjustment".

Pump Adjustment

The flow adjustment screw controls pump flow rate; turning it changes the length of the piston stroke which changes the pump discharge volume. Refer to Figure 2 during adjustment.

1. Loosen the flow adjustment screw locknut.
2. Lubricate the A-9065 o-ring beneath the adjustment screw locknut with oil.
3. Turn the flow adjustment screw. Counterclockwise increases flow and decreases cycle time; clockwise decreases flow and increases cycle time.
4. Check force feed lubricator data plate or Ariel lube sheets for correct cycle time. Adjust flow until desired cycle time is achieved with the force feed system operating.
5. Repeat Steps 2 and 3 as needed.
6. After adjustment to the proper cycle time, tighten the adjustment screw locknut.

NOTE: Inconsistent flow can occur if pump stroke is set below 20% of maximum stroke.

NOTE: A dust seal inside the flow adjustment screw holds the priming stem stationary during operation.

Force Feed Lube Blow-Out Fittings, Rupture Disks, and Tubing

Force feed lube pump discharge lines require blow-out fittings and the properly rated rupture disk installed. The disk color should show at the fitting blow-out hole. A system blockage causes pressure build-up that ruptures the disk. Venting the system through the blow-out disk causes the no-flow shutdown switch to shut down the compressor.

TABLE 3-3 Blow-Out Fittings, Replacement Rupture Disks, & Tubing

Blow-out Fitting Ariel P/N	Replacement Rupture Disk			Standard Tubing		
	Rating psig (barg)	Ariel P/N	Color	Size in. (mm)	Rating psig (barg)	Ariel P/N
A-0080	3250 (224)	A-0124	Purple	1/4 x 0.035 (6.4 x 0.9) wall	5100 (352)	PT0200CB (304 SS)
A-3531	3700 (255)	A-3536	Yellow			
A-3532	4600 (317)	A-3537	Red			
A-3533	5500 (379)	A-3538	Orange	1/4 x 0.065 (6.4 x 1.7) wall	10,200 (703)	PT0201CD (316 SS)
A-3534	6400 (441)	A-3539	Pink			
A-3535	7300 (503)	A-3540	Blue			

Ariel force feed lube blow-out fitting rupture disks are color-coded to identify rupture pressure ratings. Some disks come with half the finished face coated. If the disk color coating is less than half the face surface, the color may not show through the small centered blow-out hole when installed in the blow-out fitting. When this happens, a visual inspection for color coding may not indicate the correct disk is installed, and fitting disassembly is required to confirm the proper disk installation. To correct this issue in the future, the finished face of rupture disks supplied to Ariel after March 2005 are completely coated with color. Disks need not be replaced because of this change and existing disk stock may be used-up.

CAUTION: Use a mirror to inspect rupture disk color if force feed lube system is pressurized. A rupturing disk or high pressure oil can potentially cause personal injury.

Use a rupture disk that matches the blow-out fitting type and application pressure. Generally, use a rupture disk rated about 1000 psig (70 barg) greater than the highest MAWP cylinder. When installing a rupture disk, tighten the blow-out hex fitting cap to 40 lb. x in. (4.5 N•m) torque. Do not over tighten cap or blow-out pressure may decrease, which may increase nuisance shutdowns.

For all tubing downstream from a force feed pump on a pump circuit rated 5500 psig (380 barg) or greater (orange, pink, and blue disks), that circuits with any cylinders greater than 3600 psig MAWP (248 barg), use ¼-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 compressors, Ariel provides ¼-inch x 0.065 (6.4 x 1.7 mm) tubing regardless of rupture disk or cylinder ratings.

Distribution Blocks

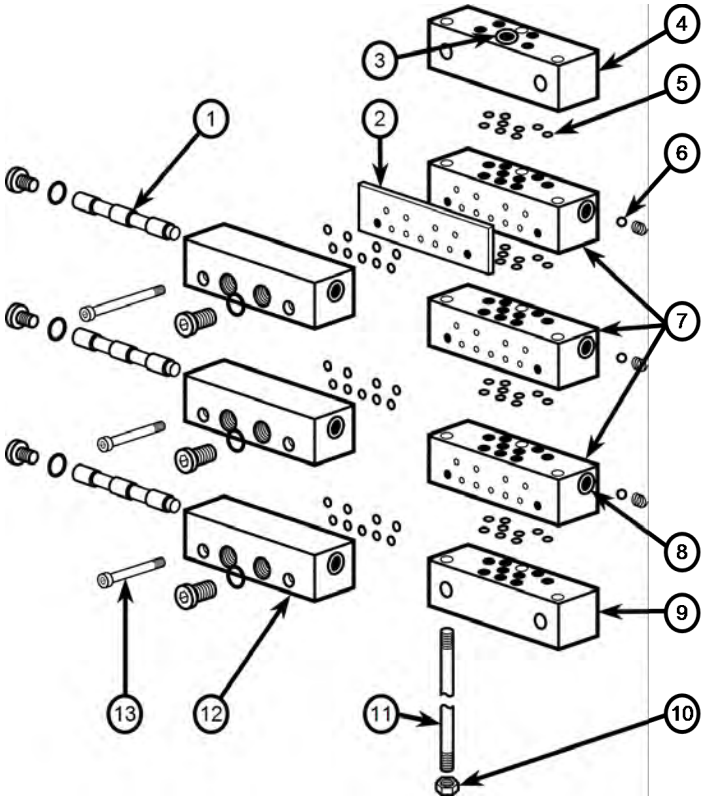
Distribution blocks consist of three to seven divider valves and an optional bypass block fastened to a segmented baseplate. Viton O-rings (90 Durometer) seal between the divider valves and baseplate and between baseplate segments. Check valves are installed at all lube port outlets.

Divider valves contain metering pistons that discharge a predetermined amount of oil with each cycle in a single line, progressive lubrication system.

NOTE: Pistons are matched to a specific divider valve. Do not try to place a different piston into a divider valve.

Single or twin valves may be externally singled or cross-ported. Plug unused outlets when singling or cross-porting.

Bypass blocks can replace a divider valve section to eliminate the lubrication points. Plug both outlets below the bypass block. A bypass block can mount in any baseplate location, but it requires at least three working divider valves in the block assembly (i.e. bypass blocks cannot be used on 3-section baseplates).



1. Piston
2. Crossport Plate
3. Inlet Port
4. Inlet Block
5. O-Rings
6. Check Valve
7. Intermediate Blocks
8. Outlet Port (correct position is off-center toward inlet block)
9. End Block
10. Tie Rod Nut
11. Tie Rod
12. Divider Valve
13. Valve Screw

FIGURE 3-9 Typical Distribution Block

The baseplate contains the divider valve inlet and outlet connections, interrelated passageways, and built-in check valves. All lubricant piping to and from the distribution block connects to the baseplate. The baseplate consists of one inlet block, three to seven intermediate blocks, one end block, and three tie rods. The number of baseplate intermediate blocks determines the number of divider valves allowed. Each distribution block requires a minimum of three divider valves.

Distribution Block Assembly

NOTE: See specific frame Parts Book for available divider valve assembly drawings, parts lists, and repair kits.

1. Thread three tie rods into inlet block until the ends flush with the top surface of the block.
2. Slide Intermediate blocks onto tie rods. Verify all o-rings are installed and discharge ports are off center toward the inlet block.
3. Slide end block onto tie rods.
4. Lay base plate assembly on a flat surface. Use "Recommendations for Torque Accuracy" to tighten the tie rod nuts to the correct torque listed in TABLE A-3.
5. Mount the divider valves with o-rings onto the base plate. Use "Recommendations for Torque Accuracy" to tighten the tie rod nuts to the correct torque listed in TABLE A-3.

Divider Valve Bypass Pressure Test

Lubricant can leak (by-pass) from a divider valve when the divider valve piston becomes worn. Pressure test or replace all divider valves every twelve months. Testing verifies the piston fits tightly enough in the divider valve bore for adequate pressure to force oil into the injection point. **The supplier pressure tests all new Ariel divider valves.**

To test distribution blocks for valve by-passing requires a manual purge gun with a pressure gauge capable of developing 5000 psig (350 barg). Ariel offers an optional force feed lubrication hand purge gun with a pressure gauge (see Section 1). Pressure test each divider valve one at a time, complete with pin indicators installed.

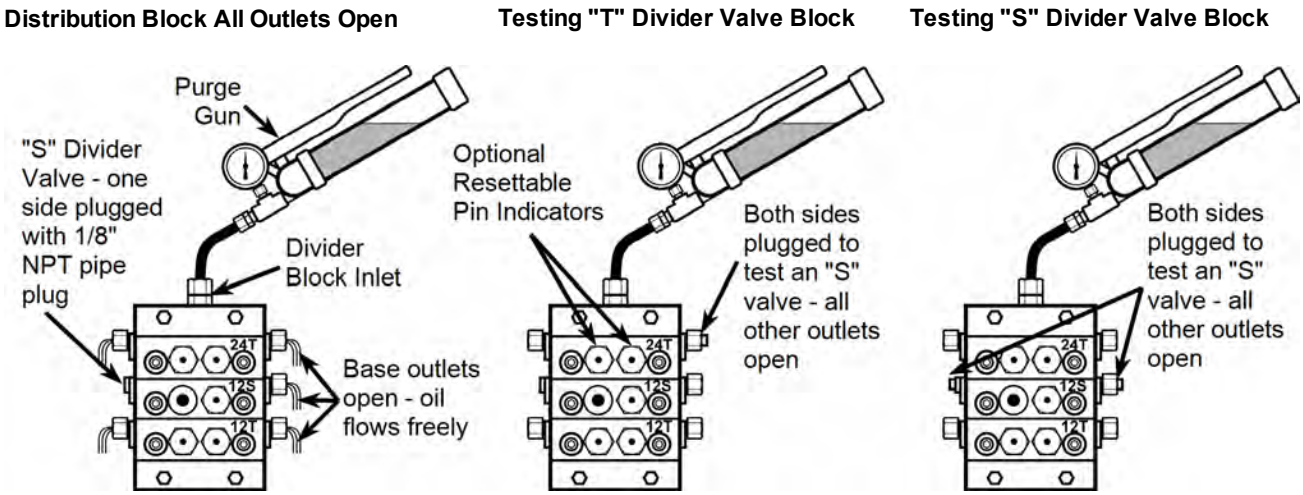


FIGURE 3-10 Pressure Testing Divider Valves

1. For new divider valves, verify working piston section fastener torque is 75 lb-in. Loosen the section fasteners, then step-torque them first to 40 lb-in, and then to 75 lb-in. Used divider valves can be tested “as is”, with approximate section fastener torque verified after testing.
2. Place the distribution block in an open container with all base outlets open. Connect purge gun filled with room temperature (65°F) 10 wt. (ISO 32) mineral oil to the divider block inlet. Pump the purge gun to purge air from the divider block assembly. Verify that oil flows freely from all outlets (see FIGURE 3-10 “Divider Block All Outlets Open”).

   Testing with 10 wt. mineral oil at 65°F simulates divider block operation at 120°F with 40 wt. (ISO 150) mineral oil. If 10 wt. mineral oil is unavailable, use 40 wt. (ISO 150); however, the pressure test will be less sensitive in detecting a bypassing divider valve.
3. The divider block assembly should cycle at less than 300 psi while purging at a steady rate. Cycle pressures above 300 psi indicate inhibited piston movement, possibly caused by the piston rubbing the bore, oil contamination, part geometry, or bore distortion due to over-tightening the section fastners. If re-torquing the valve section fails to improve cycle pressure, replace the divider valve section. Do not attempt to alter the piston/bore fit by polishing components.
4. For divider valves stamped with a “T” (for “twin”), use a 1/8 inch pipe or tubing plug to plug only one base outlet when testing that side of the piston, and leave all other outlets open. Plug and test each base outlet of divider valves stamped with a “T” one side at a time. See FIGURE 3-10 “Testing ‘T’ Divider Valve”. Individual testing of each outlet ensures both sides of the piston build adequate pressure. For all divider valves stamped with an “S” on the front (for “single”), leave the one side plugged and plug the other outlet as well to test both sides of the piston for by-passing simultaneously. See FIGURE 3-10 “Testing ‘S’ Divider Valve”.

5. Pump the purge gun until the pressure gauge indicates 3000 psi. Hold this pressure for 5 seconds, then increase it to 3500 psi. Stop pumping at 3500 psi.
6. Start timer and monitor the pressure drop from 3500 psi for 30 seconds. Check discharge outlet(s) plug(s) to confirm no external leaks. Also check o-rings for external leakage. If the valve bypasses rapidly, repeat the test to ensure the bypass wasn't due to trapped air. New valves should not exceed a 400 psi pressure drop in 30 seconds. Used valves should not exceed 1000 psi pressure drop in 30 seconds. If pressure drops exceed these limits, the divider valve fails the test.
7. Repeat Steps 4 thru 6 for the remaining outlets on the divider block assembly.

NOTE: Test distribution blocks at higher pressures if the application dictates higher system operating pressure.

If a divider valve fails, replace it. Discard worn divider valves. If the tested valve passes the test, relieve the pressure, move the plug to the next outlet, and repeat the test for all divider valves. When all divider valves either pass this pressure test or are replaced, reassemble the distribution block, purge it with the proper force feed lubricant, and put it into service.

This distribution block pressure test procedure is not infallible. Ariel recommends periodic tests for proper cylinder bore lubrication rates and/or aftermarket devices that measure flow.

Balance Valves

Install balance valves on low-pressure lube lines to artificially increase lube line pressure and reduce differential pressure between lube points downstream of a divider block. Important considerations:

- Set and maintain balance valves downstream of a divider block within 500 psi (3400kPa) of each other or less. The closer the balance valve set pressures, the more reliable the system.
- Avoid situations in which the balance valve set pressure is the greatest contributor of pressure to the divider block immediately upstream.
- With a balanced divider block, the upstream divider block pressure gauge should exhibit no erratic needle movement as the divider block cycles.

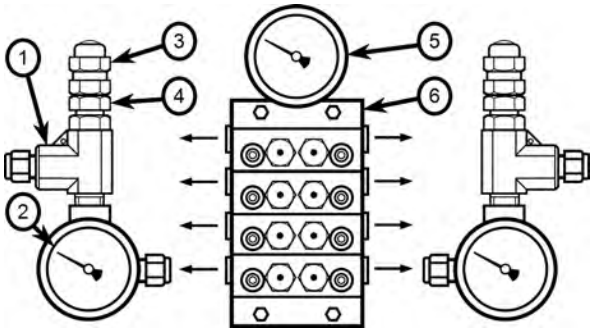
To maintain the force feed lube system, record the maximum injection pressure indicated at each divider block gauge, balance valve set pressures, and divider block cycle time at least once a day for each zone in the system. See Appendix E.

Do not adjust balance valves prior to operating the unit. Verify the tightness of all fittings and fix any known leaks. To remove any trapped air or gas in the force feed lube system, use a high-pressure hand purge pump and the same oil recommended for the cylinder application to purge it. DO NOT USE ANY OTHER FLUIDS FOR PURGING! Call the Ariel Response Center for details about purchasing a hand purge pump. To prepare for balance valve adjustment:

1. Start the compressor and bring the cylinders up to normal operating pressure.
2. Allow operating pressures to stabilize.
3. See the cylinder lube sheets for balance valve locations and proper spring type for each device.

Adjustment of Balance Valves Fed by a Divider Block

1. Select one divider block that feeds one or more balance valves nearest the compressor cylinder/packing.
2. For each balance valve downstream of the selected divider block, loosen the balance valve lock nut and rotate the adjustment cap counter-clockwise until the cap is loose. Some residual pressure may remain on the balance valve gauge.
3. Monitor the selected divider block gauge for one minute and record the minimum and maximum pressures in Appendix E.
4. Calculate the balance valve set pressure by multiplying the maximum recorded pressure by 0.85.



1. Balance Valve
2. Balance Valve Pressure Gauge
3. Adjustment Cap
4. Lock Nut
5. Divider Block Pressure Gauge
6. Divider Block

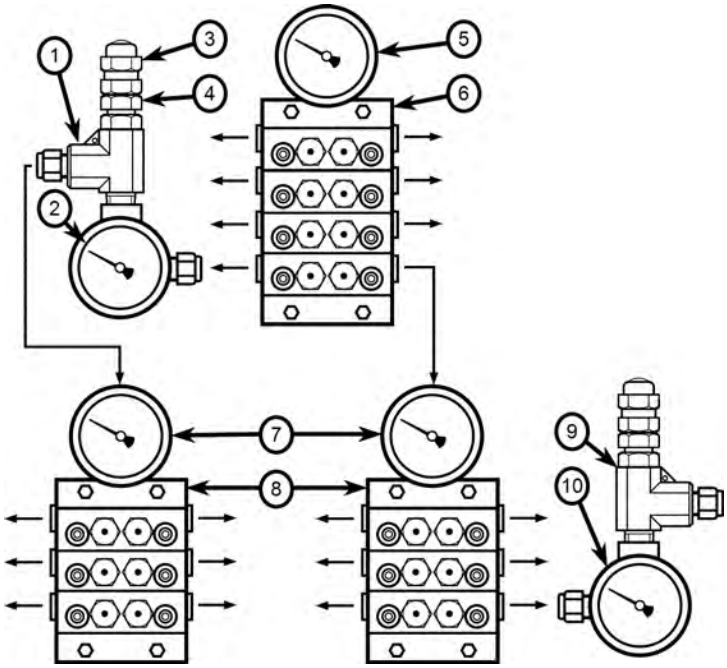
FIGURE 3-11 Balance Valves Fed by Divider Block

5. Set balance valve(s) downstream of the selected divider block to the pressure calculated in step 4 by rotating the adjustment cap clockwise to increase pressure. Set pressure within ±50 psi of the calculated value.
6. Monitor the divider block gauge for one minute and record the minimum and maximum pressures in Appendix E. The difference between the minimum and maximum should not exceed 1200 psig. If it does, repeat steps 2 through 6.
7. Tighten the balance valve lock nut. DO NOT lockwire the adjustment cap.
8. Repeat steps 2 through 7 for any remaining divider block that feeds one or more balance valves nearest the compressor cylinder/packing.
9. After setting all balance valves in the force feed system, operate the system for 4 to 6 hours, then repeat step 6 for each divider block.

Adjustment of Balance Valves Fed by Primary/Secondary Divider Blocks

NOTE: Set secondary balance valves before setting primary balance valves. If the system contains no secondary balance valves downstream of a secondary divider block, proceed to step 4.

1. Select one secondary divider block that feeds one or more secondary balance valves nearest the compressor cylinder/packing.
2. For the selected secondary divider block and secondary balance valves, perform steps 2 through 7 in "Adjustment of Balance Valves Fed by a Divider Block" above.
3. Repeat steps 1 and 2 for any remaining secondary divider blocks that feed one or more secondary balance valves nearest the compressor cylinder/packing.
4. Select one primary divider block that feeds one or more primary balance valves located prior to a secondary divider block or lube point.
5. For the selected primary divider block and balance valves, perform steps 2 through 7 in "Adjustment of Balance Valves Fed by a Divider Block" above.



1. Primary Balance Valve
2. Primary Balance Valve Pressure Gauge
3. Adjustment Cap
4. Lock Nut
5. Primary Divider Block Pressure Gauge
6. Primary Divider Block
7. Secondary Divider Block Pressure Gauge
8. Secondary Divider Block
9. Secondary Balance Valve
10. Secondary Balance Valve Pressure Gauge

FIGURE 3-12 Primary/Secondary Divider Block System

6. Repeat steps 4 and 5 for any remaining primary divider block that feeds one or more balance valves located prior to a secondary divider block or lube point.
7. After setting all balance valves in the force feed system, operate the system for 4 to 6 hours, then repeat steps 3 through 7 in "Adjustment of Balance Valves Fed by a Divider Block" above for each primary or secondary divider block.

Subsequent Compressor Start-Up

1. Verify tightness of all fittings and fix any known leaks. Purge force feed lube system.
2. If the force feed lube system has been disassembled or parts replaced since the last startup, purge the force feed lube system with a high-pressure hand purge pump. When purging the system, use the same oil that is recommended for the cylinder application, to remove any trapped air or gas in the system. DO NOT USE ANY OTHER FLUIDS FOR PURGING! Call the Ariel Response Center for details about purchasing a hand purge pump.
3. Start the compressor and bring up to normal operating pressure.

4. Operate the unit for 2 to 3 hours to allow the operating pressures to stabilize. DO NOT adjust the balancing valves immediately after startup. It is possible that some lube point injection pressures will fluctuate after a short period of run time and the system pressures will stabilize as components increase in temperature.
5. See the cylinder lube sheets for balance valve locations and proper spring type for each device.

TABLE 3-4 Ariel Balance Valve Part Numbers

Description	Ariel Part Number
Balance Valve without Spring	CA-8005
Balance Valve Springs	See ER-57.1
Balance Valve Seal Repair Kit	A-8005-K
Balance Valve Plug	A-10330
Pressure Gauges	See ER-57.1

6. Select one divider block that feeds one or more balance valves.
7. Monitor the selected divider block gauge for one minute and record the minimum and maximum pressures in Appendix E.
8. See "Balance Valves" if any of the conditions below occur:
   a. The difference between the maximum and minimum recorded divider block pressures exceeds 1200 psig.
   b. The maximum recorded balance valve pressure exceeds 85% of the maximum recorded divider block pressure.
   c. The divider block gauge exhibits erratic needle movement as the divider block cycles.

DO NOT RUN UNIT WITH LEAKING BALANCE VALVES. Ariel offers a balance valve seal repair kit - **Part No. A-8005-K**.

To maintain the force feed lube system, record maximum injection pressure indicated at the divider block gauge, balance valve set pressure, and divider block cycle time at least once a day for each zone in the lube system.

Force Feed System Design & Operating Parameters

To optimize force-feed lubrication system operation, Ariel uses these general guidelines:

1. Maintain lube ratios within prescribed limits and cycle times as low as possible (normally 10 sec minimum) to lubricate each point as frequently as possible.
2. Multiple pumps with manifolding ensure 150% of the normal lubrication rate during break-in.
3. Do not operate pumps below 20% of full stroke or they become inconsistent. Full stroke is 0.438 inch; 20% of full stroke is 0.088 inch.
4. In some applications, a single divider section delivers lubrication to both a packing and a cylinder to optimize lubrication system operation. In some applications, cross-ported divider valves deliver the proper proportion of lubricant to a given point.

5. During operation, verify oil fills the lubricator reservoir sight glass at least half way, but does not exceed two-thirds. See specific packager data to determine normal operating conditions, cylinder working pressures, and rated speed. Reservoir oil lubricates the worm gear and cam; it does not flow through the system. The reservoir also catches lube pump overflow. Add oil only if needed to raise reservoir oil level. See TABLE 3-5.
6. Ariel fills the force feed system with mineral oil. If tubing is missing, or if the system is drained, fill and prime the system through a 1/8 inch plug on the discharge end of the lubricator pump.

TABLE 3-5 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)

7. Prime the force feed lubrication system with a proper priming pump just prior to starting the compressor (see Section 1 for pump illustration). Use clean force feed lubricating oil of same type and grade as used in service. Do not use any other fluid type or grade to prime.
8. For recently overhauled units, adjust lubricator for maximum delivery. Loosen adjusting screw locknut. Turn plunger stroke adjustment screw to the full up position. Tighten adjusting screw locknut. Set proper feed rate after the machine starts.
9. When two or more pumps are manifolded to feed one distribution block, adjust them equally. Start with pumps wide open, and adjust them together so that when break-in cycle time is set, the pumps stroke about the same. After break-in period, adjust the pumps in the same manner, provided the final pump stroke is not too short. Try to keep the stroke greater than 20% of maximum; a shorter stroke produces unreliable pump output. If needed, close one pump to stop its flow and open the other(s) to make the “normal” cycle time, and maintain a stroke greater than 20% in the functioning pump(s).

Common Oil Supply

FIGURE 3-13 shows the force feed lube system installation when compressor frame lube oil is also used for cylinder and packing lubrication.

1. Frame Oil Gallery
2. Single Ball Check Valve
3. Sintered Bronze Filter
4. Force Feed Lubricator Pump
5. Rupture Disk
6. Pressure Gauge
7. Divider Valves/Distribution Block
8. Fluid Flow Monitor No-Flow Timer Shutdown Switch
9. Double Ball Check Valve
10. Top Cylinder Injection Point
11. Bottom Cylinder Injection Point
12. Packing Injection Point

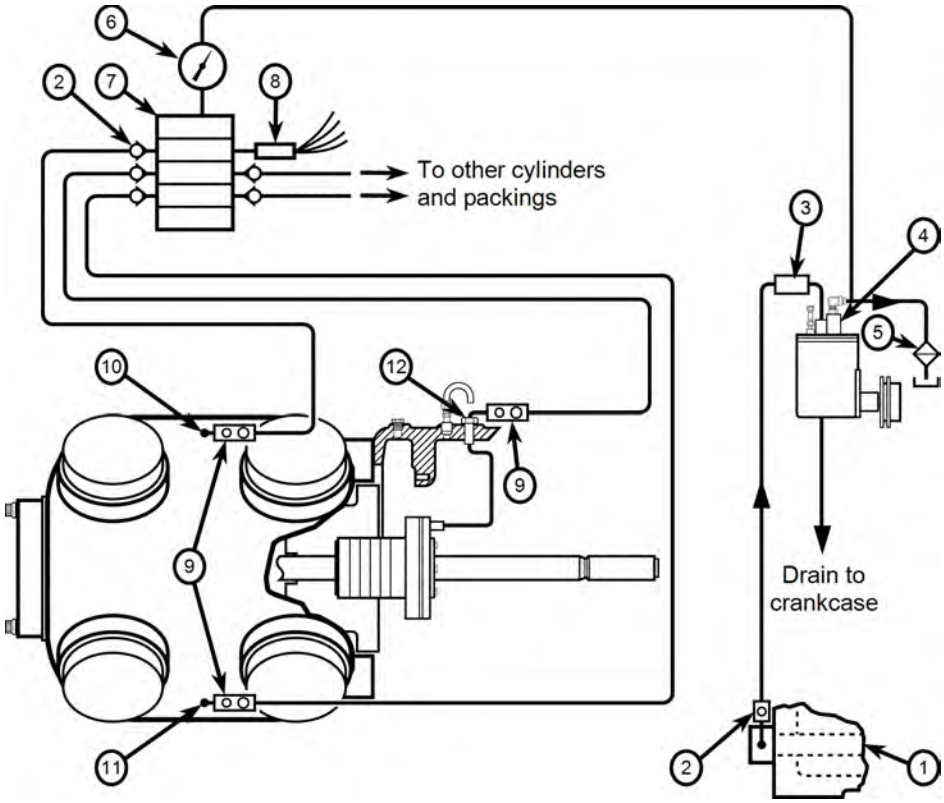


FIGURE 3-13 Force Feed Lubrication System Common Oil Supply

Independent Oil Supply

When cylinders and packing require oil different from frame oil, the force feed lubricator system requires an independent oil supply system (see FIGURE 3-14). An elevated tank supplies pressurized lubricator oil.

To prevent force feed oil from contaminating compressor frame oil, disconnect lubricator box overflow tubing from the compressor frame and direct it to an appropriate drain system.

Independent force feed lube systems require oil with a viscosity below 1100 cSt at the lubricator pump inlet. Possible measures to ensure the force feed pump is fed with oil during the suction stroke:

- Increase pipe and fitting size from tank to force feed pump.
- Heat the oil.
- Pressurize the supply tank.

1. Oil Supply Tank
2. Oil Filter
3. System Inlet 1/4-inch NPT (female) customer connection
4. Sintered Bronze Filter
5. Force Feed Lubricator Pump
6. Blow-Out Disc
7. Pressure Gauge
8. Divider Valves Distribution Block
9. Fluid Flow Monitor No-Flow Timer Shutdown Switch

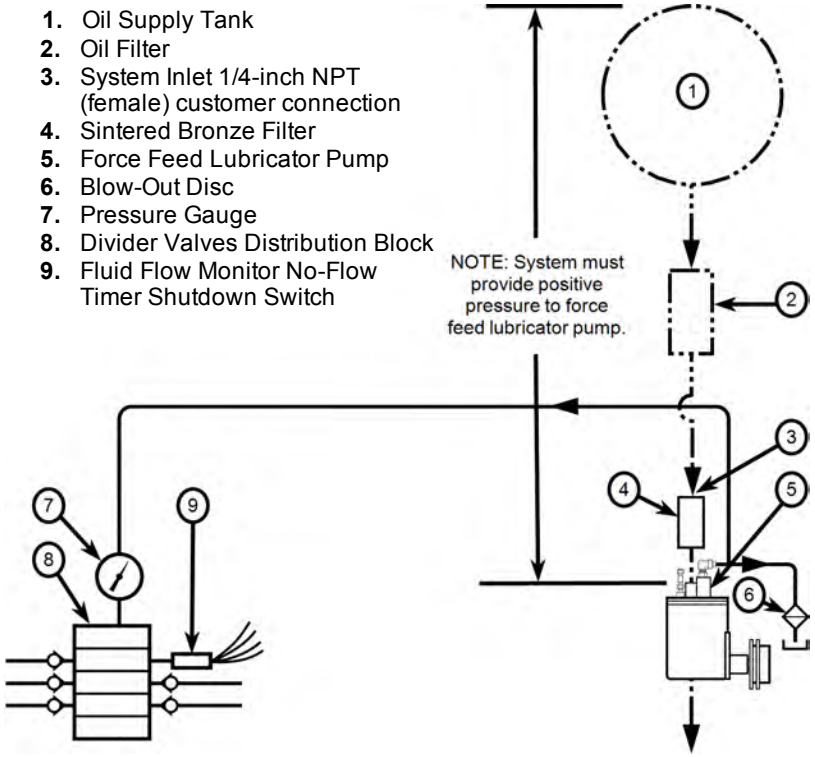


FIGURE 3-14 Force Feed Lubrication System Independent Oil Supply

Force Feed Lubrication Conditions

CAUTION: To prevent personal injury, verify driver or compressor cylinder gas pressure cannot turn compressor crankshaft during maintenance: on engine-driven compressors, either remove the center coupling or lock the flywheel; on electric motor-driven compressors, either detach the driver from the compressor or lock out the driver switch gear.

Before any maintenance or component removal, relieve all pressure from compressor cylinders. See Packager's instructions to completely vent the system. After maintenance, purge the entire system with gas prior to operation to avoid a potentially explosive air/gas mixture.

Lubricator Cycle Time

Lubricant flow rates are measured in seconds per cycle of the distribution block. The calculated break-in and normal cycle times are stamped on the lubricator box data plate. These cycle times are calculated based on the gas analysis, operating conditions, and applied speed specified in the compressor order. If gas conditions were not supplied with the compressor order, the data plate/lube sheet rates default to clean, dry, 0.65 specific gravity, sweet gas and cylinder MAWP. If the applied speed is not specified, the cycle time is based on maximum rated speed of the frame or cylinders, whichever is less. The lube sheets in the Ariel Parts Book state gas conditions and list the base rate multiplier at each lube point.

Break-in Rate - Set the break-in lube rate about twice the recommended daily rate (150% minimum); i.e. set the break-in cycle time about half the normal cycle time (67% max.) to increase lube rate. Maintain break-in rate for 200 hours of operation for new equipment, or when replacing packing and/or piston rings. Contact Ariel if existing pump is incapable of minimum flow rate required.

Lube Rate and Speed - Recommended lube rates for break-in or normal operation, in seconds per cycle, are calculated at the frame rated speed (RPM) stamped on the frame data plate or the cylinder rated RPM stamped on the cylinder data plate, whichever is lower. Lube rate reduces with speed, (as compressor actual running speed decreases, cycle time increases to reduce lube rate):

$(RPM_{max} \div RPM_{actual})$ x cycle time seconds from lube plate = cycle time seconds at actual running speed.

Or see the Ariel Parts Book Lubrication Sheets for the Cycle Time (seconds) vs. RPM (compressor speed) table at various running speeds at stated gas operating conditions and lubricant.

Adjusting the cycle time changes the lubrication rate for all the compressor cylinders and packings supplied by a particular pump. To change the lubrication rate for only one cylinder or packing requires individual divider valve changes. Contact your packager or Ariel for information.

To set proper force-feed lubricator pump flow rate, read or measure the cycle time from the installed device. For a magnetic cycle indicator assembly, time the cycle from initial indicator pin movement at the fully retracted position to the time when the pin returns to the fully retracted position and just begins initial movement out again. Adjust the lubricator pump to provide the required cycle time.

NOTE: Pump output can become inconsistent if the flow rate is set too low.

Changes in operating conditions (such as gas properties or pressures, temperatures, flow requirements, or cylinder re-configuration) require lubrication rate re-calculation and possible force-feed lubrication system alteration. Consult the Ariel Packager Standards, the Packager, and/or Ariel.

Under/Over Lube

Under lubrication causes extremely rapid breakdown of piston and packing ring materials. Black, gummy deposits in the distance piece, packing case, cylinder, and valves indicate under lubrication. When symptoms indicate under lubrication:

- Verify proper operation of force feed lubricator pumps.
- Confirm distribution block cycle time matches the lube sheet or force feed lubricator data plate.
- Verify all tubing and fitting tightness; check for leakage. Check fittings inside cylinder gas passages.
- Pressure test or replace divider valves to ensure they do not bypass.

Over lubrication can result in excessive oil carryover into the gas stream, and increased valve and gas passage deposits. Valve plate breakage and packing failure may also indicate over-lubrication.

Cylinder Lubrication Paper Test

1. Remove head end head and position piston for the desired cylinder at inner dead center.
2. Using light pressure, wipe the cylinder bore with two layers of regular unwaxed cigarette paper together. Begin at the top and wipe downward about 20° along the bore circumference. The paper against the bore surface should be stained (wetted with oil), but the second paper should not be soaked through.
3. Repeat the test at both sides of the bore at about 90° from the top, using two clean papers for each side. Paper against the bore surface not stained through may indicate under-lubrication; both papers stained through may indicate over-lubrication. In either case, Ariel normally recommends changing lubrication rate accordingly and repeating all paper tests until passed.
4. Repeat this procedure for all cylinders. If the test indicates a lubrication rate reduction or increase for a cylinder, change in 5% increments by adjusting cycle time at the force feed lube pump (see “Pump Adjustment” on page 3-18). Repeat oil film testing, for affected cylinders, after 24 hours of operation.

NOTE: The paper test indicates only oil film quantity. Aftermarket devices exist that measure flow. Neither method indicates viscosity quality. Oils diluted with water, hydrocarbons, or other constituents may ostensibly produce an adequate film or flow, but dilution may reduce load-carrying capability below requirements.

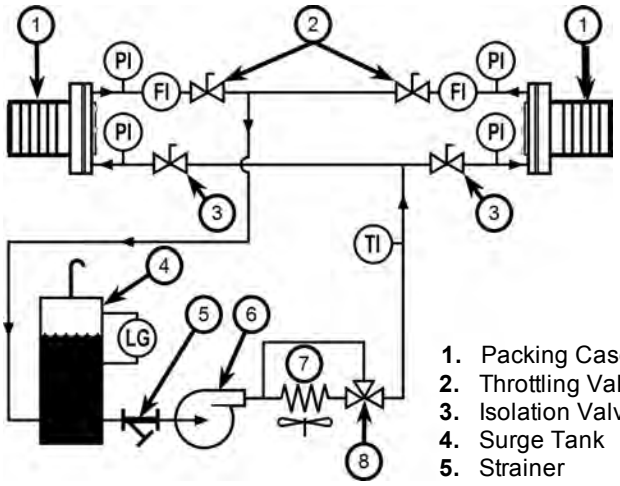
Coolant System Requirements

Coolant flow = number of packing cases x 1 US gallon per minute (gpm), 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 solution of 50/50 treated water/glycol solution. See FIGURE 3-15.

Example: JGK/2 with 2.0 inch (50.8 mm) diameter piston rod.

2 packing cases x 1 gpm per inch of rod diameter x 2.0 inch rod diameter = 4 gpm
(2 packing cases x 0.149 l/min per mm of rod diameter x 50.8 mm rod diameter = 15.2 l/min)

Cooler size = number of cases x 70 BTU/minute/inch of rod diameter (number of cases x 0.05 kW/mm of rod diameter). The pressure drop across each case must exceed 30 psi (2.1 bar). Coolant into the packing must not exceed 130°F maximum (54°C max.). Lower coolant temperature increases heat transfer to the coolant and is better in high-pressure applications.



PI = Pressure Indicator
TI = Temperature Indicator
FI = Flow Indicator
LG = Level Gauge

1. Packing Case
2. Throttling Valve
3. Isolation Valve
4. Surge Tank
5. Strainer
6. Water Pump
7. Cooler
8. Thermostatic Valve

FIGURE 3-15 Typical Packing Cooling System

Section 4 Part Replacement

Major frame assembly components include the crankcase, crankshaft and bearings, connecting rods, chain drive system, crossheads and guides, and distance pieces. Removable end covers, an aluminum top cover, and crosshead guide side covers provide easy access to internal components.

Part replacement requires absolute cleanliness; use lint-free wiping cloths. When not working on a frame with access covers removed, cover it to protect the interior from dust. Protect removed components from corrosion and falling objects that might mar or chip running surfaces.

When dismantling the machine, carefully inspect gaskets at non-pressure locations. If damaged, replace them. Replace gaskets at pressure locations. Always apply an anti-seize lubricant to both sides of gaskets to ease future removal. For major overhauls, drain and flush the crankcase.

If replacing a connecting rod assembly, piston, piston and rod assembly, crosshead-balance nuts, or crosshead, weigh component parts and compare to the Compressor Balancing Record included in the parts manual with each compressor. If there are weight changes, recalculate opposing throw reciprocating weight differential. See "Opposed Throw - Reciprocating Weight Balancing".

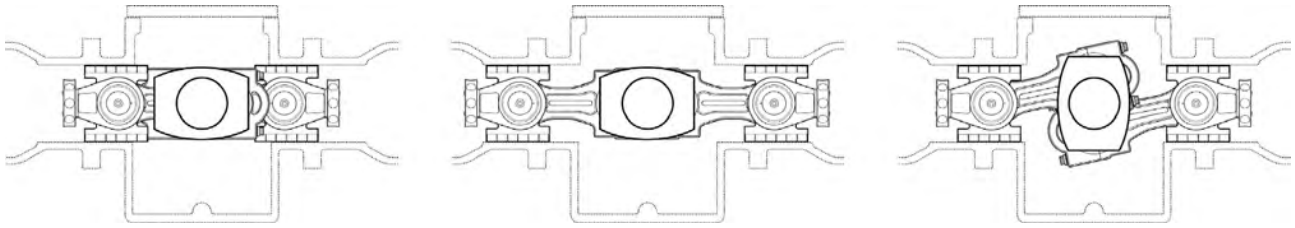
CAUTION: Gas compressors are complicated and dangerous pieces of equipment. Only trained operators and mechanics familiar with unit operation should attempt any maintenance. Read and thoroughly understand the appropriate manual and always wear appropriate personal protection equipment during maintenance.

Never adjust any fastener torques while the unit is operating or pressurized.

To reduce the risk of serious personal injury or death, verify driver or compressor cylinder gas pressure cannot turn compressor crankshaft during maintenance. For engine-driven compressors, either remove the center coupling or lock the flywheel; for electric motor-driven compressors, either detach the driver from the compressor or lock out the driver switch gear. Before any maintenance or component removal, relieve all pressure from compressor cylinders. See packager information to completely vent the system or call the packager for assistance. After maintenance, purge the entire system with gas prior to operation to avoid a potentially explosive air/gas mixture.

Positioning a Throw

Component replacement often requires manually turning the crankshaft to position a throw in one of two positions: inner dead center or outer dead center. During normal operation, crossheads slide back and forth in the crosshead guides. In the inner dead center position, the crossheads slide toward the crankcase as far as possible. In the outer dead center position, the crossheads slide away from the crankcase as far as possible (see figure below). Some procedures require a dial indicator with magnetic base to locate the precise inner or outer dead center. At other times, a procedure may require turning the crankshaft so a throw occupies its highest or lowest position. In the figure below, the throw on the left is in its highest position and the throw on the right is in its lowest position.



Inner Dead Center Position | Outer Dead Center Position | Highest/Lowest Throw Position

FIGURE 4-1 Throw Positioning

Variable Volume Clearance Pocket (VVCP)

A VVCP changes the clearance volume of the head end of a cylinder. The amount of clearance depends on the position of the clearance pocket piston. Users turn the piston/stem assembly counterclockwise to increase clearance, and clockwise to decrease it. In the event that gas begins to leak from the VVCP vent, replace the V-packing or seal within the VVCP.

VVCP Removal

CAUTION: Completely vent the cylinder before VVCP removal. Attempting to remove the VVCP without venting results in possible equipment damage, personal injury, or death.

1. Cylinder
2. Eyebolt
3. Packing Vent
4. Locking Handle
5. Adjustment Handle
6. Flange Bolts
7. Bellows Thread Protector
8. Piston Stem
9. Metal Thread Protector
10. Adjustment Locknut

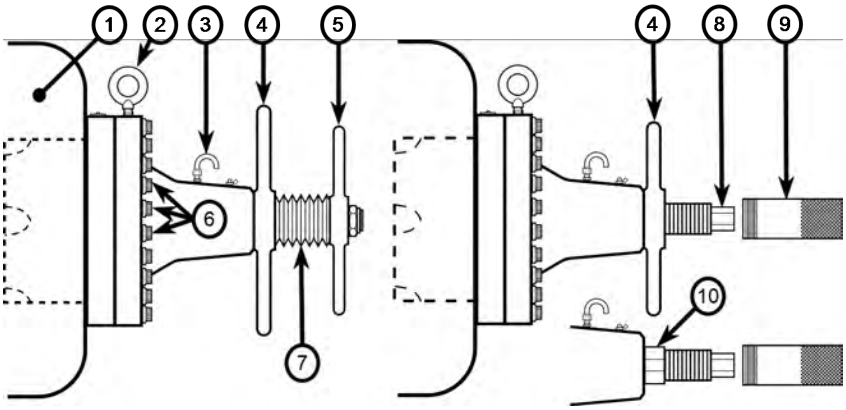


FIGURE 4-2 Typical VVCP with Bellows or Metal Thread Protector

1. **For VVCP with a bellows thread protector:** After venting the cylinder, loosen the locking handle so the adjustment handle can turn freely. Turn the adjustment handle.

   For VVCP with a metal thread protector: After venting the cylinder, unscrew the metal thread protector. Loosen the locking handle or adjustment locknut so the piston stem can turn freely. With a wrench, turn the piston stem.

   CAUTION: A hard to turn adjustment handle or piston stem indicates pressurized gas trapped within the VVCP. See VVCP Disassembly caution below.

2. Tighten the locking handle or adjustment locknut.
3. Disconnect the packing vent.
4. Remove plastic plug from eyebolt hole and thread an eyebolt into the eyebolt hole.
5. Slide a crane hook through the eyebolt and remove slack from the crane chain.
6. Remove all flange bolts and slide the VVCP out from the cylinder. The Ariel Performance Program contains approximate VVCP weights.
7. Discard the head gasket and transport the VVCP to a suitable work area for disassembly.

VVCP Disassembly

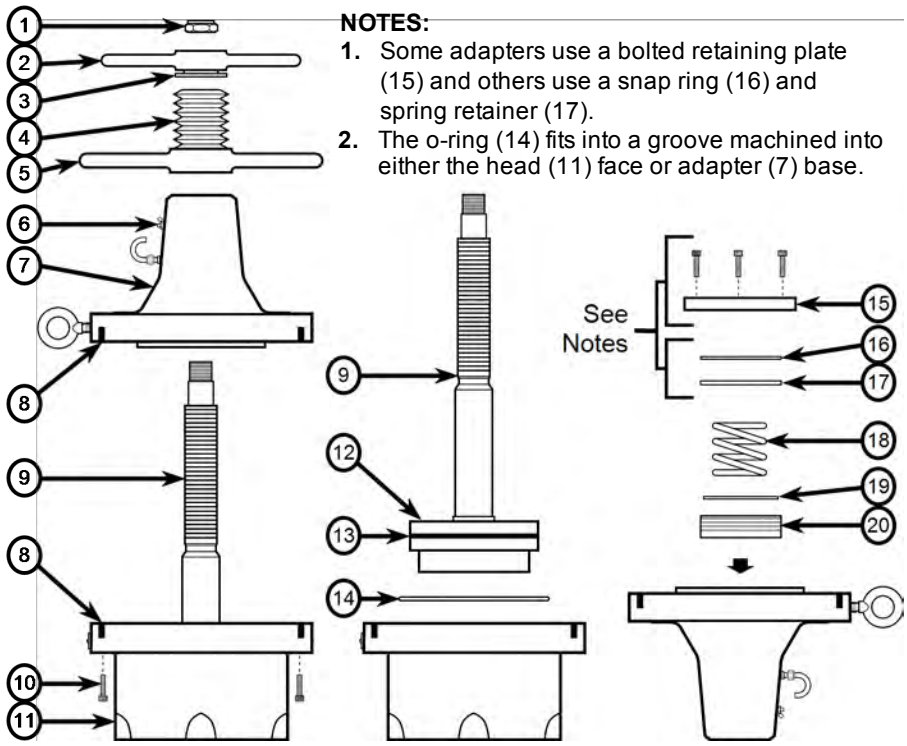
The VVCP piston ring is not gas-tight to allow a nearly balanced gas pressure, which eases VVCP adjustment with the cylinder pressurized. Gas pressure behind the VVCP piston normally vents when the cylinder vents. Process debris or rust around the piston ring can form a seal that traps gas within the VVCP assembly, sometimes at substantial pressure.

CAUTION: Trapped gas pressure can present a personal safety hazard when servicing the VVCP. Work in a well-ventilated, non-sparking area, particularly with sour gas applications. Do not breathe gas emission from VVCP when venting trapped gas.

1. Place the VVCP on a table, adapter up.

NOTE: Steps 2-4 apply only to VVCP's with a bellows thread protector.

2. The bellows thread protector grips a lip on the adjustment handle. Use pliers to pull the bellows from the adjustment handle lip. Do not tear the bellows.
3. Remove locknut.
4. Remove adjustment handle. The adjustment handle is a tapered fit onto the piston stem; use a hammer or puller to break the fit.
5. Thread the locking handle or adjustment locknut off of the piston stem. Leave the bellows thread protector attached to the locking handle, if applicable.



NOTES:
1. Some adapters use a bolted retaining plate (15) and others use a snap ring (16) and spring retainer (17).
2. The o-ring (14) fits into a groove machined into either the head (11) face or adapter (7) base.

1. Locknut
2. Adjustment Handle
3. Adjustment Handle Lip
4. Bellows Thread Protector
5. Locking Handle
6. Grease Fitting
7. Adapter
8. Match Mark
9. Piston Stem
10. Socket Head Bolt
11. Head
12. Piston
13. Piston Ring
14. O-Ring
15. Retaining Plate
16. Snap Ring
17. Spring Retainer
18. Compression Spring
19. Backup Ring
20. V-Packing or Seal

FIGURE 4-3 VVCP Disassembly/Assembly

6. Depending on size, a VVCP may have two to four socket head bolts. Use a marker to draw match marks on the side of the VVCP where the adapter and head join at each socket head bolt location. Loosen the socket head bolts evenly and incrementally to release any potentially high-pressure gas. **Do not breathe gas emission from VVCP.**
7. Remove socket head bolts and turn the adapter counterclockwise to thread it off of the piston stem. Place adapter base up next to the head.
8. Remove the piston stem and piston assembly from the head. The piston stem and piston are permanently joined; do not attempt to disassemble them.
9. Remove the piston ring from the piston.
10. Depending on VVCP size, Ariel machines a groove for the O-ring into either the face of the head or the base of the adapter. Remove and discard the O-ring.
11. Some adapters use a bolted retaining plate while others use a snap ring and spring retainer:
    a. **Retaining Plate** - Remove retaining plate bolts and retaining plate.

b. Snap Ring and Spring Retainer

- Thread a nut onto a threaded rod that is a few inches longer than the height of the adapter.
- Slide a washer wider than the main bore of the adapter down to the nut.
- Insert the threaded rod end with no nut into the main bore of the adapter until it protrudes from the base of the adapter.
- Slide a washer wide enough to overlap the spring retainer but less wide than the snap ring onto the threaded rod protruding from the base.
- Thread a nut onto the threaded rod protruding from the base. Tighten the nut until the compression spring compresses enough to separate the spring retainer from the snap ring.
- Use snap ring pliers to remove snap ring.
- Remove the nut from the threaded rod, then remove the threaded rod and washers from the main bore of the adapter.

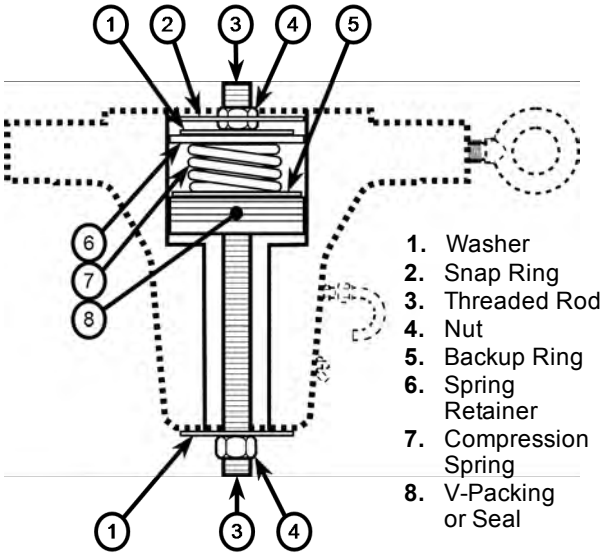


FIGURE 4-4 Spring Compression for Snap Ring Removal

12. Remove spring retainer, compression spring, and backup ring from the adapter counterbore.

13. Remove V-packing or seal from adapter counterbore. Find a strong, foot-long metal 3/16 inch rod or pipe and bend about .75 inch at 90°. Insert the rod into the adapter counterbore and slide the .75 inch beneath the V-packing or seal. Pull up on the rod or pipe to pull the V-packing or seal from the adapter counterbore.

VVCP Reassembly

Clean all VVCP parts of all debris, rust, etc. Replace parts if excessively worn or damaged. Replace V-packing or seal if excessive gas leakage occurs at the packing vent. See FIGURE 4-3 and FIGURE 4-4.

1. With face up, place the head on a table. With base facing up, place the adapter beside the head.

2. Depending on VVCP size, Ariel machines a groove for the O-ring into either the face of the head or the base of adapter. Oil and insert a new O-ring into O-ring groove.

3. Install the piston ring onto the piston.

4. Oil the head cavity walls, then insert piston stem and piston assembly into the head cavity.

5. Oil the adapter counterbore walls and insert V-packing or seal. The V-packing or seal consists of five partitions; insert V-packing or seal into the counterbore with the thickest partition down and the thinnest partition up. Use a solid cylinder of wood or metal as a ram and tap the V-packing or seal two or three times into the counterbore to ensure proper seating.

6. Insert backup ring into adapter counterbore.

7. Insert compression spring into adapter counterbore.

8. Place spring retainer on top of the compression spring.

9. Some adapters use a bolted retaining plate while others use a snap ring and spring retainer:

a. **Retaining Plate** - Place the retaining plate on top of the spring retainer and press down to compress the compression spring. thread retaining plate bolts through the retaining plate and into the Adapter base. Tighten the retaining plate bolts hand tight.

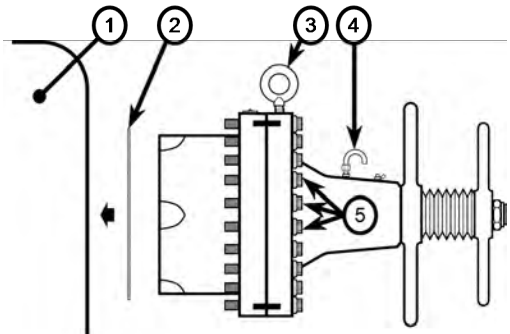
b. **Snap Ring and Spring Retainer**

- Compress the compression spring (see FIGURE 4-4).
- Use snap ring pliers to install the snap ring above the spring retainer.
- Remove the nut from the threaded rod, then remove the threaded rod and washers from the main bore of the adapter.

10. Grease piston stem threads and thread adapter clockwise onto piston stem. Thread adapter as far as possible on the piston stem, then turn the adapter counter-clockwise to align the socket head bolt match marks on the adapter base with the match marks on the head.
11. Install the socket head bolts. Tighten socket head bolts hand tight.
12. Thread locking handle or adjustment locknut onto the piston stem, but do not lock it. For VVCP with bellows thread protector, thread the locking handle with the protector facing up.
13. For VVCP with an adjustment handle, slide the adjustment handle onto the piston stem and use a hammer to pound it down evenly onto the tapered fit.
14. Use the adjustment handle or piston stem hex to turn the piston stem counter-clockwise to tighten the seal between the adapter and head, then lock the locking handle or adjustment locknut.
15. For VVCP with an adjustment handle, thread the locknut onto the piston stem. While the torque for the locknut is not critical, tighten it enough to prevent adjustment handle from loosening.
16. **Bellows thread protector:** Slide thread protector bellows onto the adjustment handle lip and verify that it grips securely.
    Metal thread protection: Thread protector over the piston stem.
17. Torque socket head bolts. See Appendix A for proper torque value and torque procedure.
18. Apply 3-4 pumps of all-purpose petroleum grease with a grease gun at the grease fitting.

VVCP Installation

1. Slide a crane hook through the VVCP eyebolt and move the VVCP to the cylinder.
2. Apply an anti-sieze lubricant to both the new head gasket and the cylinder seating surface. Stick the new head gasket to the cylinder seating surface.
3. Slide the VVCP into the cylinder and align the adapter flange bolt holes with the cylinder bolt holes.
4. Lubricate flange bolt threads and seating surfaces with petroleum type lubricant and install bolting. See Appendix A for proper torque value and torque procedure.
5. Reconnect packing vent. To install a new VVCP, re-set crank end/head end feeler clearances with VVCP completely closed and check total piston end clearance. See Appendix B in Appendix B .



1. Cylinder
2. Head Gasket
3. Eyebolt
4. Packing Vent
5. Flange Bolts

FIGURE 4-5 VVCP Installation

VVCP Adjustment

Users may change VVCP clearance volume with the compressor running or stopped. The expected change in compressor flow and absorbed power depends on compression ratio and properties of the

compressed gas. Consult packager instructions regarding where to set the VVCP. Also see the VVCP data sheet in the Ariel Maintenance and Repair Manual Parts Book. To open VVCP to a desired percentage:

1. **For VVCP with a bellows thread protector:** Loosen the locking handle so the adjustment handle can turn freely.

   For VVCP with a metal thread protector: Unscrew the metal thread protector. Loosen the locking handle or adjustment locknut so the piston stem can turn freely.
2. Find the VVCP dimension plate.
3. Subtract the fully closed dimension from the fully open dimension. The Ariel Performance program also lists these dimensions if the VVCP dimension plate is missing.
4. Multiply the step 3 result by the desired percentage expressed as a decimal.
5. Add the step 4 result to the fully closed dimension.
6. Turn the adjustment handle or piston stem until the measurement from the base of the locking handle or adjustment locknut, when locked, to the top of the adjustment handle or piston stem equals the step 5 result.



FIGURE 4-6 VVCP Dimension Plate

Compressor Valves - Removal and Installation

Most compressor valves use non-metallic plates. Before servicing any valve, see the correct valve assembly drawing, parts list, and service literature in the Parts Book. The cylinder cover sheet in the Parts Book lists the valve originally supplied with each cylinder. Changes in operating pressures, temperatures, RPM, or gas composition may require alternate valve configuration including springing and lift. Contact your Packager and/or Ariel for help in valve selection.

CAUTION: Gas compressors are complicated and dangerous pieces of equipment. Only trained operators and mechanics familiar with unit operation should attempt any maintenance. Read and thoroughly understand the appropriate manual and always wear appropriate personal protection equipment during maintenance.

Never adjust any fastener torques while the unit is operating or pressurized.

To reduce the risk of serious personal injury or death, verify driver or compressor cylinder gas pressure cannot turn compressor crankshaft during maintenance. For engine-driven compressors, either remove the center coupling or lock the flywheel; for electric motor-driven compressors, either detach the driver from the compressor or lock out the driver switch gear. Before any maintenance or component removal, relieve all pressure from compressor cylinders. See packager information to completely vent the system or call the packager for assistance. After maintenance, purge the entire system with gas prior to operation to avoid a potentially explosive air/gas mixture.

Required Tools and Materials

- Appropriate Ariel parts list
- Appropriate Ariel Maintenance and Repair manual
- Calibrated torque wrench with the appropriate range for target values
- Regular grade Never Seez (for forged steel cylinders) or ISO 150 mineral oil (for cast iron cylinders)
- Appropriate personal protection equipment

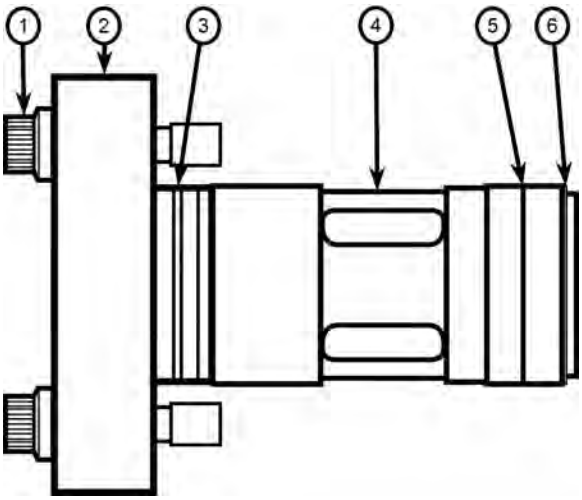
- Bottle brush
- Pressurized liquid solvent
- Valve Tool

Valve Cap Removal

Valve Caps on Cast Iron Cylinders or High-Pressure Caps without Spring Energized Seals

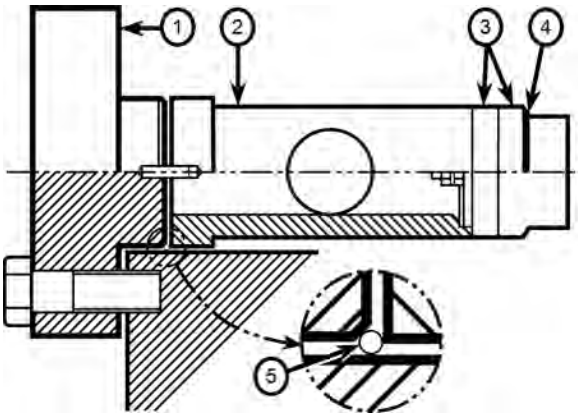
1. Slightly loosen all cap screws in steps and evenly on a valve cap; the cap should stay in its original position. If it pushes outward, **STOP!** Completely vent the cylinder. See Caution above.
2. After the above safety checks and with cap screws still in place but loosened, pry the valve cap out until the o-ring clears the cylinder to confirm proper cylinder venting. Use a pair of pry bars or screwdrivers, one on each side of the cap, to pry it out.
3. Remove cap screws and valve cap. Take care to prevent damage to fastener threads.

CAUTION: Valve cap, retainer, and valve may fall out of bottom pockets if not supported. Support them after cap screw removal to prevent personal injury.



1. Cap Screw
2. Valve Cap
3. O-Ring
4. Valve Retainer
5. Valve Assembly
6. Valve Seat Gasket

FIGURE 4-7 Valve Cap Assembly for Cast Iron Cylinder

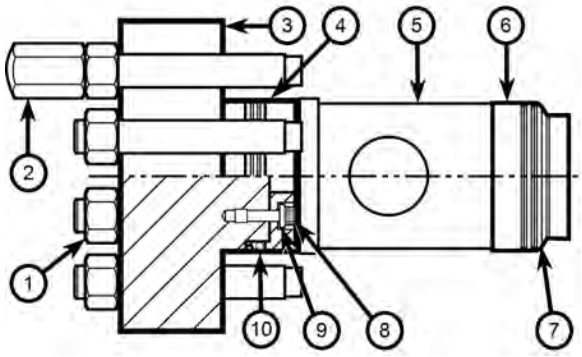


1. Valve Cap
2. Valve Retainer
3. Valve Assembly
4. Valve Seat Gasket
5. Metallic Wire Gasket

FIGURE 4-8 High-Pressure Valve Cap Assembly without Spring Energized Seal

Valve Cap with Spring Energized Seal

1. Remove cap nuts from long studs.
2. Slightly loosen all hex nuts on each valve cap in steps and evenly. With all the nuts loose, the cap should stay in its original position. If it pushes out of its own accord, STOP! Completely vent the cylinder. See Caution above.
3. After the above safety checks and with hex nuts still in place but loosened, remove hex nuts from short studs.
4. Evenly back off hex nuts on long studs while pulling the valve cap from the cylinder. Use a pair of pry bars or screwdrivers, one on each side of the cap, to pry it out. Ensure the spring energized seal completely disengages from the cylinder before removing the hex nuts from long studs.



1. Hex Nut
2. Cap Nut
3. Valve Cap
4. Seal Keeper
5. Retainer
6. Valve
7. Valve Gasket
8. Keeper Bolt
9. 2-Piece Wedge Lock Washer
10. Spring Energized Seal

FIGURE 4-9 High-Pressure Valve Cap Assembly with Spring Energized Seal

NOTE: Long studs are assembled with thread locker to eliminate the possibility of the studs backing out of the cylinder while the hex nut is removed.

5. Remove long stud hex nuts and valve cap.
6. Inspect seal for damage. If undamaged, the spring energized seal is re-usable.

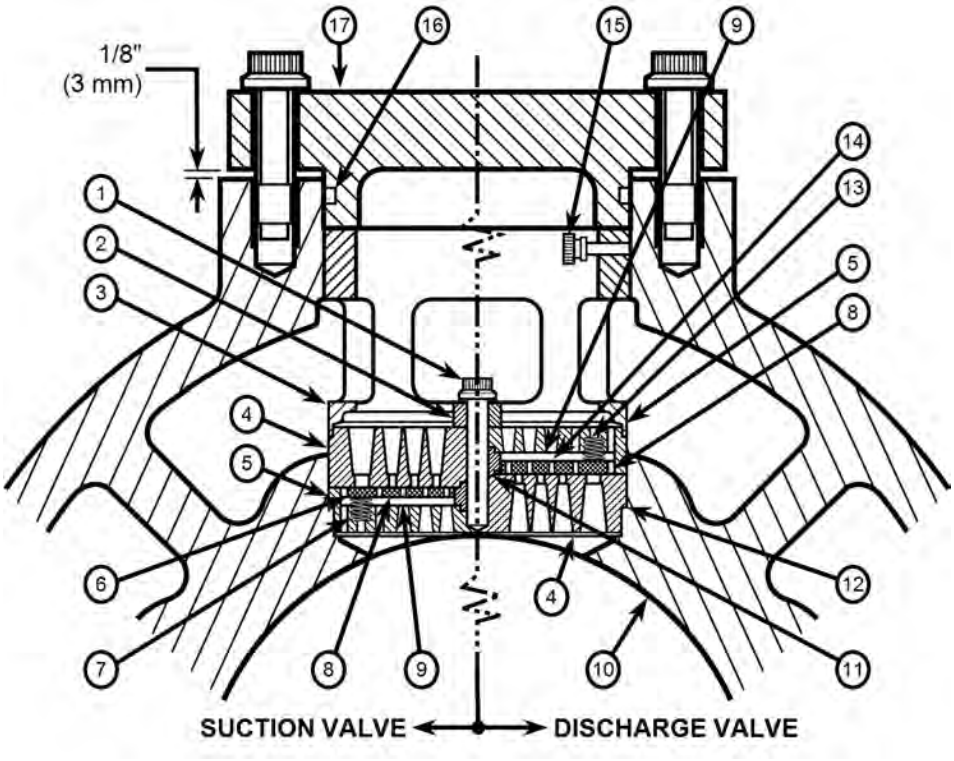
CAUTION: Valve cap, retainer, and/or valve may fall out of bottom pockets if not supported. Support them carefully after removing hex nuts to prevent personal injury.

Valve Removal

1. With the valve cap removed and the valve retainer still in place, thread a valve tool over the valve center bolt. See Section 1 .
2. It may be necessary to loosen the plastic thumb screws in the valve retainers. In some cylinder classes, the discharge valve retainer is held in place with an o-ring - simply pull the retainer out to remove it.
3. For high pressure applications that use a metallic wire gasket seal under the valve cap, the cylinder vents upon loosening the cap screws. Use the valve tool to unseat the metallic wire gasket.
4. Pull out the valve and retainer together.
5. Head end tandem cylinders may require removal of suction and discharge piping and the cylinder head to access the concentric valve. A concentric valve combines suction and discharge valves in one assembly.
6. In most cases, the flat metal gasket remains 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. Use a small magnet on a flexible extension rod to remove gasket from cylinder. For optimum sealing, replace valve seat gaskets anytime a valve is removed from a cylinder of a unit that has been in service.

Valve Installation

1. Coat a new valve seat gasket with Never Seez. Either insert it into the valve pocket or stick it on the valve. In either case, do not allow the gasket to fall into the gas passage. For optimum sealing, replace valve seat gaskets anytime a valve is removed from a cylinder, if the unit has been in service.
2. Install suction valves only in suction pockets and discharge valves only in discharge pockets. The valve pockets have identification plates. Install all valves with valve fastener(s) positioned away from the cylinder bore. If a valve is not marked for suction or discharge, manually depress the valve plate to verify the type. Preferably, use a tool softer than the valve plate material or exercise care to prevent damage to the plate. A suction valve plate may be depressed only from the valve fastener (bolting) side of the valve; a discharge valve plate may be depressed only from the side of the valve that faces the cylinder bore.



1. 12-Point Capscrew (Center Bolt)
2. Threaded Washer
3. Valve Retainer
4. Seat
5. Guard
6. Suction Valve Plate
7. Suction Valve Spring
8. Cushion Plate
9. Wafer Spring
10. Cylinder Bore
11. Guide Ring
12. Valve Seat Gasket
13. Discharge Valve Spring
14. Discharge Valve Plate
15. Plastic Retainer-Keeper (Thumbscrew)
16. Valve Cap O-Ring
17. Valve Cap

FIGURE 4-10 Typical Valve Assemblies

3. Use the valve tool to insert the valve and retainer into the pocket together (see Section 1). Verify the valve seats properly in the pocket. When installed correctly, the valve rotates freely by hand.
4. Plastic thumbscrews hold valve retainers in position in bottom valve pockets. Tighten these screws just enough to provide friction so retainers and valves in bottom pockets will not fall out during valve cap installation.
5. Lubricate a new o-ring with oil and install it in the groove on the valve cap nose. Some high pressure cylinders use a soft metallic wire gasket or spring-energized seal in lieu of the o-ring. Continue to "Valve Cap Installation".

Valve Cap Installation

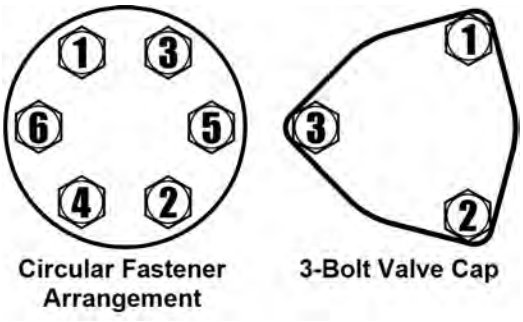
Depending on the application, Ariel compressor cylinders utilize different styles of valve caps. Cast iron cylinders utilize valve caps in which an O-ring on the valve cap seals gas within the cylinder. Forged steel cylinders utilize a valve cap with either a spring-energized seal or a round metallic gasket to seal gas within the cylinder. The valve cap presses the round gasket into a triangular cross section during the torque procedure.

It is critical to torque the valve cap following the torque procedure below. Valve cap bolt failures can occur if the cap is torqued improperly. Draw bolting to full torque in even, gradual steps, without bias on one bolt or cocking the valve cap in the bore. Such bias or cocking can unevenly crush the gasket, which may cause leakage and/or bolt failure.

Ensure all threads are clean and free of debris or burrs. Use a bottle brush and pressurized liquid solvent to clean threaded holes thoroughly. Avoid sending debris into cylinder gas passage. Bolts should thread into hole and bottom out on the valve cap by hand without resistance or use of a wrench. If bolts do not thread into hole freely contact ARC for thread repair instructions.

Torque

See Appendix A for information on torque accuracy. For fasteners in a circular arrangement, torque in a crisscross order. For 3-bolt valve caps, make multiple passes using the following pattern: 123, 231, 312 (see figure to the right). Initially torque fasteners to 25% of final torque, then torque them up to 100% in 25% increments.



Fastener joints with wire gaskets (pressure packing, and some forged steel valve caps) require multiple rounds of torque after reaching 100% of final torque to properly seat and crush the gasket. Continue in a crisscross pattern until no turns on the bolts are observed.

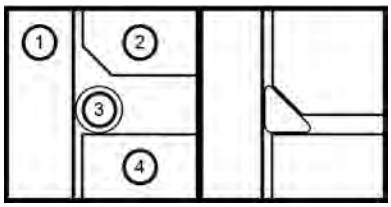
Proper tensioning of gas containment fasteners is critical to ensure safe and reliable operation.

CAUTION: Severe personal injury and property damage may result from improperly torqued valve cap bolts. See Appendix A for correct torque and detailed recommendations.

Valve Caps on Cast Iron Cylinders or High-Pressure Caps without Spring Energized Seals

1. Install valve assembly (and high clearance spacer, if applicable), with the valve seat gasket and valve retainer in the valve pocket. See “Valve Installation” on page 4-9.
2. **For high-pressure valve caps only:** Place a new, round, metallic wire gasket. Always use a new wire gasket when installing a high-pressure valve cap; gaskets are not re-useable.
3. Oil and install a new o-ring on the valve cap. Install the valve cap.
4. For standard fasteners, lubricate threads and bolt seating surfaces with mineral oil. For stainless steel fasteners, lubricate threads and bolt seating surfaces with Never Seez regular grade. Do not use Never Seez on standard fasteners. See Appendix Afor correct valve cap bolt torque. See "Torque" above.

   NOTE: For high-pressure applications, the valve cap joint design requires pressing a round metallic wire gasket into a triangular cross section. This requires multiple passes in a crisscross pattern with the torque wrench. See "Torque" above.



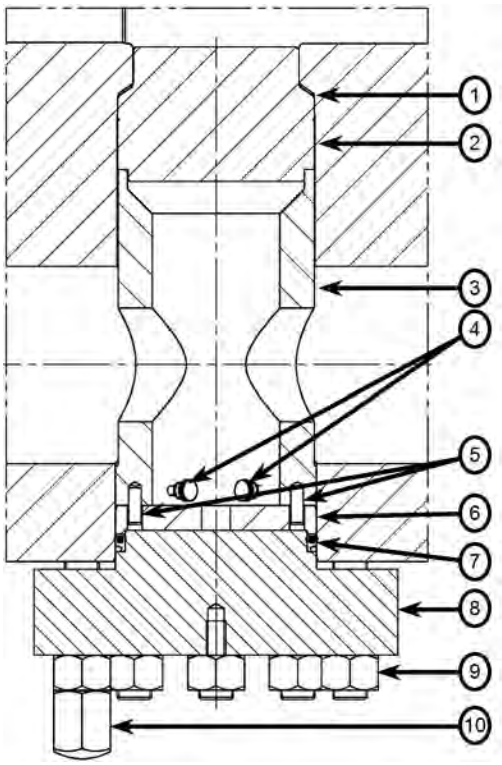
1. Cylinder
2. Valve Cap
3. Metallic Wire Gasket
4. Valve Retainer

FIGURE 4-11 Gasket Crush

Valve Caps with Spring Energized Seals

1. Install valve assembly with valve seat gasket and valve retainer in the valve pocket. See “Valve Installation” on page 4-9.
2. Inspect and lightly lubricate spring energized seal with petroleum oil.
3. Install the valve cap. Align valve cap roll pins so they are parallel with the main bore of the cylinder. This aligns the retainer openings with the cylinder gas passage. Be careful not to gouge the bore, or distort or damage the gasket. Tighten thumb screws, if applicable.
4. Liberally coat the valve cap stud threads and hex nut seating surface or cap screw threads and under the head with Never-Seez.
5. Install valve cap so the roll pins engage the clearance slots in the retainer.
6. See Appendix A for correct valve cap fastener torque. See "Torque" above for torque procedure.
7. Continue to torque the valve cap at 100% torque value until no bolt movement is observed. Even minute bolt movement warrants another pass around the valve cap in a crisscross pattern.

   NOTE: The valve cap joint design requires pressing a round metallic wire gasket into a triangular cross section (see FIGURE 4-11). This requires multiple passes in a crisscross pattern with the torque wrench. See "Torque" above.
8. Tighten cap nuts on long studs, hand wrench tight.



1. Valve Gasket
2. Valve
3. Retainer (openings aligned with gas passage)
4. Thumb Screws
5. Roll Pins
6. Seal Keeper
7. Spring Energized Seal
8. Valve Cap
9. Hex nut
10. Cap Nut

FIGURE 4-12 High-Pressure Valve Cap Assembly with Spring-Energized Seal

Gas Containment Fastener Torque Checks

Per Ariel ER-10.4.x series (start-up checklists) and ER-8.x series (Recommended Maintenance Intervals), Ariel recommends checking all gas containment fastener torques by the schedule below and including this schedule in your computerized maintenance management system (CMMS):

- Prior to start-up
- 24 hours after start-up
- 750 hours after start-up
- Every 8,000 hours after start-up

Per ER-8.2, re-check any fasteners found loose in any of these intervals after an additional 750 hours. If loosening continues, contact your packager immediately.

Piston and Rod

CAUTION: To prevent personal injury, verify neither driver nor compressor cylinder gas pressure can turn the crankshaft during maintenance: on engine-driven compressors, either remove the center coupling or lock the flywheel; on electric motor-driven compressors, either detach the driver from the compressor or lock out the driver switch gear.

Before any maintenance or component removal, relieve all pressure from compressor cylinders. See packager information to completely vent the system or call the packager for assistance. Before removing a cylinder head, back off all cap screws 1/8 inch (3 mm). Verify the head is loose and the cylinder is completely vented.

Piston and Rod Removal

NOTE: See Section 1 for illustrations of tools mentioned below. For non-lube cylinders, see "Component Cleaning & Thread Lube for Non-Lube Compressor Cylinders" on page 4-46.

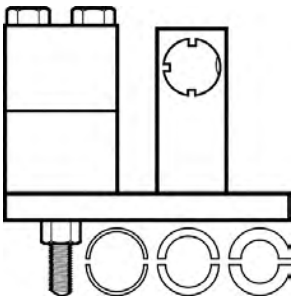
1. Loosen cylinder head bolts. Remove cylinder head and all crosshead guide side covers.
2. Move crosshead to inner dead center. Back off, but do not remove, the crosshead balance nut set screws. Loosen crosshead balance nut with the special slugging wrench. Use the open end wrench for hex nuts, the peg wrench for round nuts, or use the separately purchased hydraulic crosshead balance nut torque tool.
3. In tandem cylinders where the outboard cylinder bore is smaller than the inboard bore, remove the outboard cylinder. Support such cylinders during removal and installation, to avoid excessive weight on the piston and rod assembly that may bend them.
4. Move crosshead to outer dead center. If the piston uses a wear band, measure piston to cylinder clearance at bottom of piston with a feeler gauge. See Appendix B for tolerances. If out of tolerance, replace the wearband.
5. Use the piston nut spanner to turn the piston and rod assembly out of the crosshead. The two dowels on the tool fit the piston nut holes. Remove the crosshead nut from the piston rod.
6. Use the piston rod entering sleeve to slide the piston rod through the wiper and packing. With extreme care, slowly slide piston rod through packing so as not to damage wiper or packing rings.
7. For one-piece piston rings, slide the piston rod assembly from the cylinder, then carefully remove the piston rings. For two-piece piston rings (in high pressure applications), slide the piston rod assembly out of cylinder until a fraction of the first ring clears the cylinder. Hold the first ring in the piston groove by hand, or use a band for larger sizes, until the ring clears the cylinder, then carefully remove the ring. This prevents the ring from popping out of the groove and causing damage to the ring. Remove succeeding two-piece rings and wear band in the same way. Handle all piston rings carefully with clean tools and hands to protect them from nicks, marring, and bending. Despite their toughness in service, some rings made of PEAK are fragile when removed.
8. The weight of the piston rod is stamped on its head. Support the piston either manually or with a crane as appropriate as it slides from the cylinder bore. The piston rod must remain parallel with the bore until it leaves the bore completely. Take care not to ding any surfaces.

Piston and Rod Manual 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.

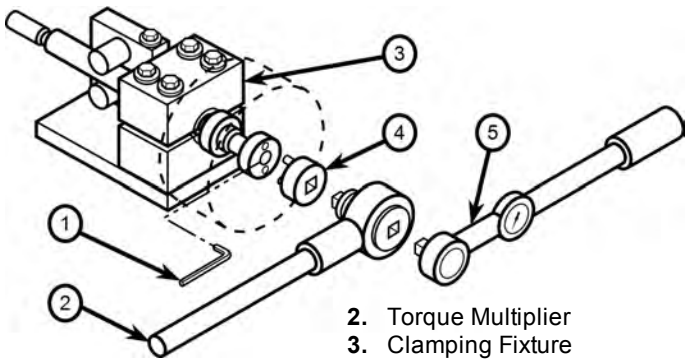
NOTE: Ariel offers a clamping fixture for 1.125 to 2 inches (29 to 51 mm) diameter piston rods.

1. Securely bolt the clamping fixture to a base to prevent it from turning with the piston rod. Place it at a convenient height of about three feet (0.9 m).
2. Verify that the clamping fixture saddle where the clamping ring seats, the clamping ring, and the piston rod are clean, dry, and free of any oil. Even a small amount of oil can cause the piston rod to turn in the fixture during torquing, and a small amount of debris clamped under high force can damage a piston rod.
3. Clamp the piston and rod assembly in an appropriate clamping fixture using the appropriate clamping ring for the rod size. Torque the four fixture cap screws to 344 lb x ft (466 N•m) to prevent the rod from turning. The fixture properly holds the piston rod to prevent damage to the parts and promote safety during disassembly and reassembly.



Nom. Piston Rod Diameter Inches (mm)	Clamping Force Required Ton (kN)
1.125 (29)	8.67 (19.3)
1.5 (38)	20.4 (45.4)
2 (51)	35 (78)

FIGURE 4-13 Clamping Fixture with Clamping Rings (Ariel P/N D-0961) and Required Clamping Force



1. Allen Wrench (for piston nut setscrews)
2. Torque Multiplier
3. Clamping Fixture
4. Spanner (bolts to piston nut)
5. Torque Wrench

FIGURE 4-14 Piston and Rod Clamping Fixture

4. Remove the setscrews from the piston nut. Use an Allen wrench to force them out by turning them past the small lip formed by staking.
5. Remove piston nut using piston nut spanner.
6. After piston nut removal, slip the piston and collar off the end of the piston rod.

Piston and Rod Manual Reassembly

1. Clean all piston and rod assembly parts thoroughly. Verify piston is internally clean and dry.

   NOTE: Any reassembly of used parts requires re-cleaning and re-lubrication of threads and seating surfaces.

2. Inspect collar (or collar area on rod, when collar is integral and not separable),piston, and piston nut for nicks, burrs or scratches. Replace if surfaces are damaged, worn, or galled. Inspect piston ring grooves. If damaged or ring groove width is out of tolerance replace the piston (see Appendix B for tolerances). Dress surfaces with a fine grit stone as required. Fit collar and nut into piston to verify the outside diameter fits and turns freely by hand in the piston.

3. Inspect piston rod threads and collar shoulder. Clean, de-burr, and lubricate threads. Install collar and nut onto piston rod to verify inside diameter fits and rotates freely. Tighten piston nut until piston threads protrude to verify freedom of thread engagement. Remove nut and collar. ee for torque to seat studs.
4. Verify the clamping fixture saddle where the clamping ring seats, the clamping ring, and the piston rod are clean, dry, and free of any oil. Even a small amount of oil can cause the piston rod to turn in the fixture during torquing, and a small amount of debris clamped under high force can damage a piston rod.
5. Clamp piston and rod assembly in an appropriate clamping fixture using the appropriate clamping ring for the rod size. Clamp it as close to the collar as possible without fixture interference with the piston.
6. Apply a thin coat of Never-Seez Regular Grade to piston rod shoulder, rod collar locating band, and collar face in contact with piston, then slide collar onto rod.
7. Apply a thin coat of Never-Seez Regular Grade to piston rod threads at the piston end, then slide piston onto rod and collar.

   NOTE: If one end of the piston is machined 0.002 inch (0.05 mm) undersize across a 3/4 inch (20 mm) wide band (for manufacturing purposes) and the piston has the same number of piston ring grooves on each side, assemble with the undersize band toward the head end. For pistons with a different number of piston ring grooves on each side, assemble with the side of fewer piston ring grooves toward the head end. See
8. Apply a thin coat of Never-Seez Regular Grade to piston nut threads and piston mating face. Install nut and hand tighten to make up the piston rod assembly.
9. Torque piston nut to the torque listed in Appendix A , using the piston nut spanner and clamping fixture. A torque multiplier may be necessary to achieve required torque. Loosen the piston nut without disassembling and re-tighten to required torque. Repeating the torque properly seats components and enhances the integrity of the assembly.

   TABLE 4-1 Required Piston Nut Torque

Frame	Piston Nut Size Inch x TPI	Torque lb x ft (N•m)	Torque Spanner Part No.
JG:A:M:P:N:Q	7/8 - 12	222 (300)	A-0279
KBB:V	1-1/8 - 12	620 (895)	A-7721
JGR:J	1-1/4 - 12	695 (940)	A-0424
JGH:E:K:T	1-5/8 - 12	1590 (2160)	B-1410

   NOTE: To calculate torque wrench setting when using a torque multiplier, divide desired fastener torque by the multiplier actual mechanical advantage, not design mechanical advantage. Example: A multiplier with a design mechanical advantage of 4.0, but an actual mechanical advantage of 3.6 requires 442 lbx ft (599 N•m) of applied torque to achieve a 1590 lbx ft (2156 N•m) torque.
10. After tightening, the piston rod should not protrude more than 0.010 inch (0.25 mm) past the piston face. If it does, contact your packager and/or Ariel.
11. Apply a thin coat of Never-Seez Regular Grade to two new Allen set screws. To install a set screw, tighten it 15° past the Allen wrench yield point. Discard the deformed Allen wrench and use a new Allen wrench to tighten the other set screw in the same way. If Allen wrenches are unavailable, use the torques in TABLE 4-2.

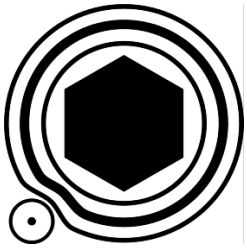


FIGURE 4-15 Staking a Set Screw

TABLE 4-2 Set Screw Torque, lb x in (N•m)

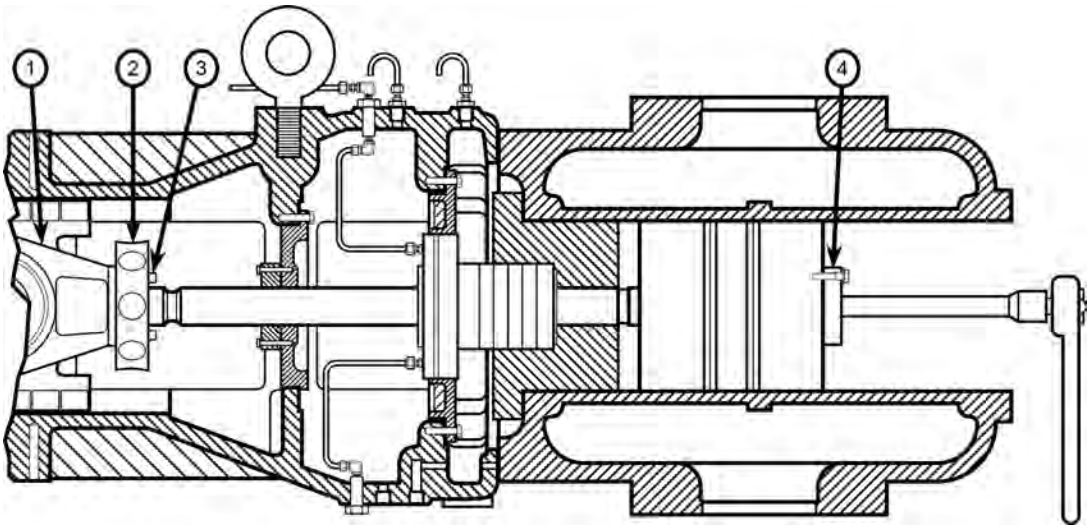
Size	Torque
#10-32	36 (4.07)
1/4 - 28	87 (9.83)
5/16 - 24	165 (18.64)
3/8 - 24	288 (32.54)

12. Use a punch within 1/16 inch (1.5 mm) of set screw threads to deform the threads and stake set screws in place.
13. Use a calibrated scale to weigh piston rod assembly with piston rings and wear band. Stamp weight on piston head end. Flatten any raised lips to avoid clearance measurement errors. Record weight for future reference. See “Opposed Throw - Reciprocating Weight Balancing” on page C-3

Piston and Rod Installation

1. Install piston rings in cylinder main bore without piston to measure end gaps. Ariel recommends replacing piston rings when the end gap equals three times its original specification. See Appendix B for specification.
2. Use cylinder and packing oil to lubricate the piston rings and ring grooves. Install rings on the piston with ring gaps staggered.
   a. For cylinders requiring two-piece piston rings, verify that they are a set by the match marks. Two-piece rings use dots as match marks -verify the dots face the pressure side of cylinder. Do not use two piston rings of the same match marks on the same bore size on a unit.
   b. For all other rings, see "Piston Rings" below.
3. Use the piston rod entry sleeve to slide piston rod with piston rings and wear band into cylinder bore. Damage to the packing rings is possible if an entry sleeve is not used.
4. Position the crankshaft so the crosshead is leveled in dead center position. For crankshafts with round webs, use a dial indicator to determine dead center position.
5. Lubricate the piston rod and crosshead threads with Never-Seez Regular Grade. Spin the balance nut onto the piston rod. Turn the piston rod into the crosshead. Visually center the packing flange around the piston rod and torque packing bolts per Appendix A.
6. Set piston end clearance (see Appendix B):
   a. Using the piston turning tool, turn the piston rod into the crosshead.
   b. Place a feeler gauge equal to the crank end clearance required in the crank end top valve pocket between the piston and the head on cylinder.
   c. Snug piston against the feeler gauge so the feeler gauge cannot be pulled out.
   d. Snug the crosshead nut against the crosshead.
   e. Tighten the crosshead nut by the slugging method or by hydraulic torquing device. See Maintenance and Repair manual for hydraulic torquing device.
7. See “Crosshead Installation” on page 4-27 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.

CAUTION: Ariel recommends leaving distance piece covers off after any piston rod or rod packing ring maintenance. Verify no ignition sources exist in the area, pressurize the unit, and check for gas leaks before distance piece cover installation. This protects against crosshead guide over-pressure and possible ignition due to incorrect installation of packing case or components. When checking for leaks, take proper precautions in process gas applications, such as H_2S.



1. Crosshead
2. Crosshead Nut
3. Set Screw
4. Piston Nut Spanner

FIGURE 4-16 Typical Piston and Rod Installation

Piston Rod Runout

Check piston rod run out after new unit installation, unit relocation, or maintenance that may affect rod run out.

Verify proper shimming of crosshead guides to level. Verify the crossheads directly contact the bottom of the crosshead guide. A 0.0015 inch (0.04 mm) feeler stock should not insert more than 1/2 inch (13 mm) at all four corners of the crosshead.

Position the stem of a 0.0001 inch (0.001 mm) increment calibrated dial indicator against the piston rod, close to the packing case. Set indicator to zero with piston toward the crank end. Take readings in both vertical and horizontal directions. When measuring vertical rod movement, record upward movement as positive and downward movement as negative. When measuring horizontal rod movement, record movement toward the auxiliary end of the frame as positive and movement toward the drive end of the frame as negative. Copy TABLE 4-4 below to record readings. Rotate crankshaft manually and record readings at mid-stroke and with piston at the head end. Compare readings to TABLE 4-3.

TABLE 4-3 Max. Piston Rod Runout Readings

Direction	Inch (mm)
Vertical	0.002 (0.051)
Horizontal	0.001 (0.025)

TABLE 4-4 Piston Rod Run Out @ 0°, Inches

Run Out Measurement		Throw 1	Throw 2	Throw 3	Throw 4	Throw 5	Throw 6
Vertical (0°)	Piston @ CE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	Mid-Stroke						
	Piston @ HE						
Horizontal (0°)	Piston @ CE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	Mid-Stroke						
	Piston @ HE						

If a vertical reading is greater than the maximum acceptable, use this procedure to determine acceptability: Break the balance nut loose. Looking from the head end, turn the piston 90º to the left, and re-torque the balance nut. Record both vertical and horizontal (90º) readings in the table below. If readings are 0.0003 inch or less than the original (0º) run out readings above, the rod is acceptable - break the balance nut loose. Re-set C.E. clearance and re-torque the balance nut. If rod run out is greater than 0.0003 inch more than the original (0°) reading above, contact Ariel.

TABLE 4-5 Alternate Piston Rod Run Out @ 90°, Inches

Run Out Measurement		Throw 1	Throw 2	Throw 3	Throw 4	Throw 5	Throw 6
Vertical (90°)	Piston @ CE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	Mid-Stroke						
	Piston @ HE						
Horizontal (90°)	Piston @ CE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	Mid-Stroke						
	Piston @ HE						
Vertical Run Out Difference[a]							
Horizontal Run Out Difference[a]							

a. Piston @ H.E. 0° - 90°.

Piston Rings

Most cylinders use one-piece angle-cut filled PTFE piston rings. High-pressure cylinders use two-piece thermoplastic rings.

Ariel recommends replacing rings when the end gap increases to three times the new dimension. To measure end gaps, insert rings in the cylinders without pistons (see Appendix B for new and maximum end gap dimensions).

Seal-Joint Piston Rings

Seal-joint piston rings are standard for tandem compressor cylinders and optional for double acting cylinders. Seal-joint rings provide a better seal for light gases and leakage minimization. Seal-joint piston rings are directional and require correct installation.

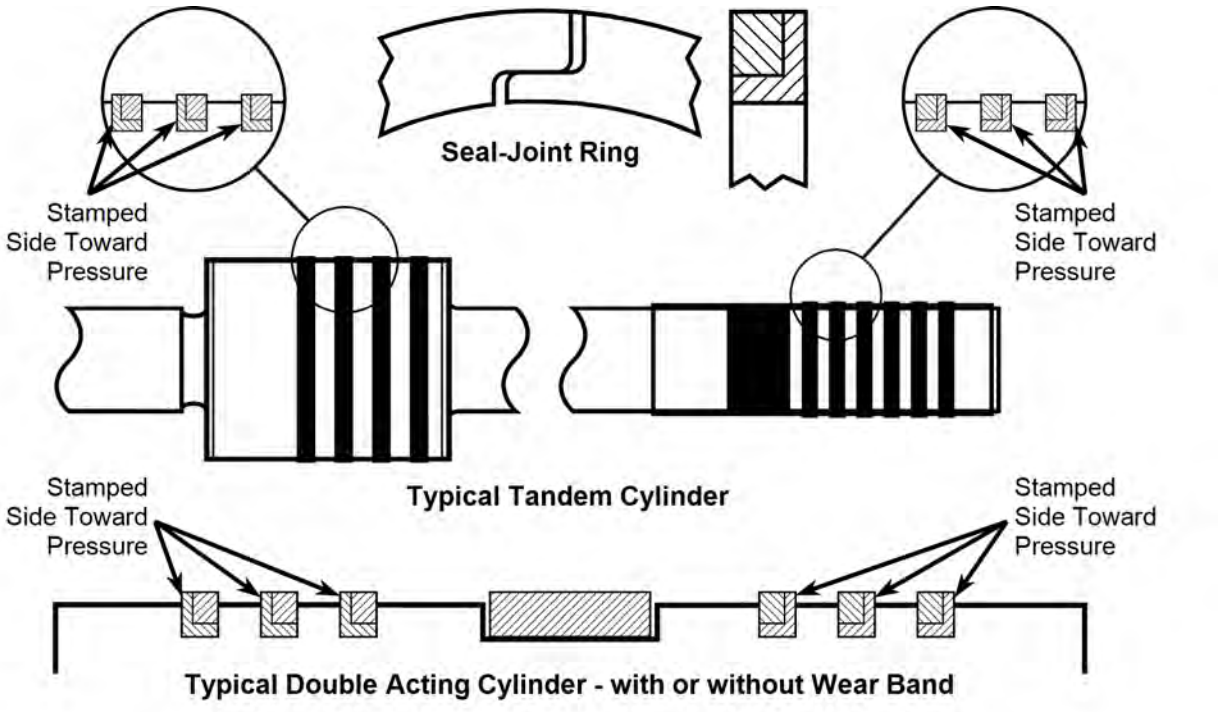
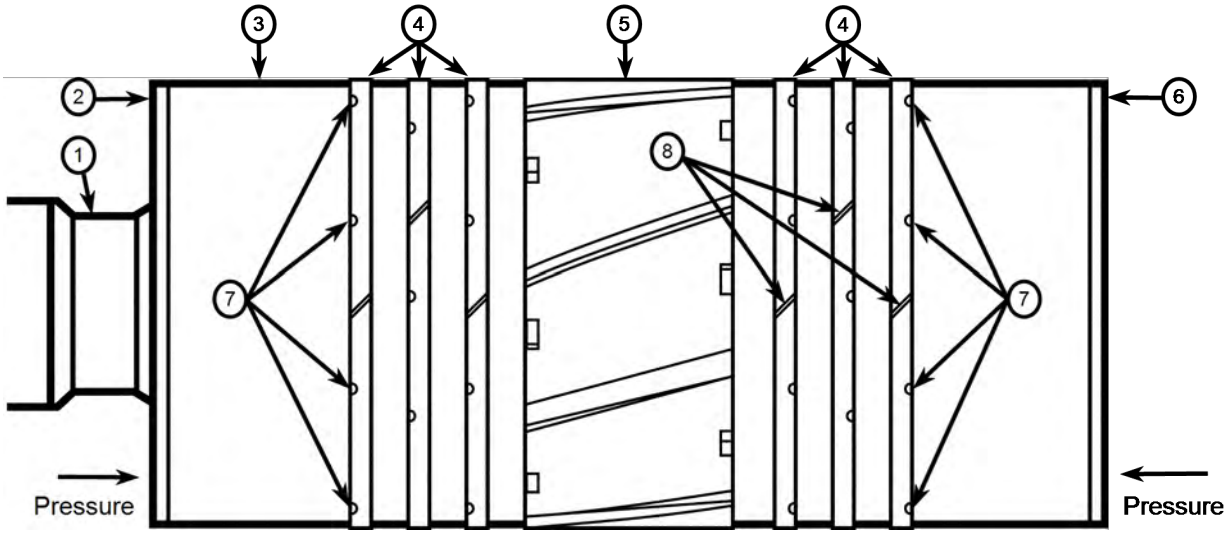


Рис. 4-17 Seal-Joint Piston Ring Installation Orientation

High-Pressure Face-Cut Piston Rings

Face-cut piston rings are typically used in cylinders with 2500 psi MAWP or higher, and generally with notched and fluted wear bands. The rings install with the face cuts toward the highest pressure, or toward the nearest head. Gas pressure in the wear band area escapes past the piston rings via the face cuts during the suction stroke to prevent loading the wear band and increase service life. Also, do not align the ring end gaps; stagger them to minimize gas leakage.



1. Piston Rod **2.** Crank End **3.** Piston **4.** Piston Rings **5.** Wear Band **6.** Head End **7.** Notches **8.** Staggered End Gaps

FIGURE 4-18 High-Pressure Face-Cut Piston Ring Orientation

Three-Piece Piston Rings

This ring style consists of two “outer” rings installed over an “inner” ring. The inner ring rests in the bottom of the piston ring groove. The inner ring and one outer ring have face cuts that install facing the highest pressure or toward the nearest head (see FIGURE 4-19). Install three-piece ring sets with the end gaps staggered to prevent leakage.

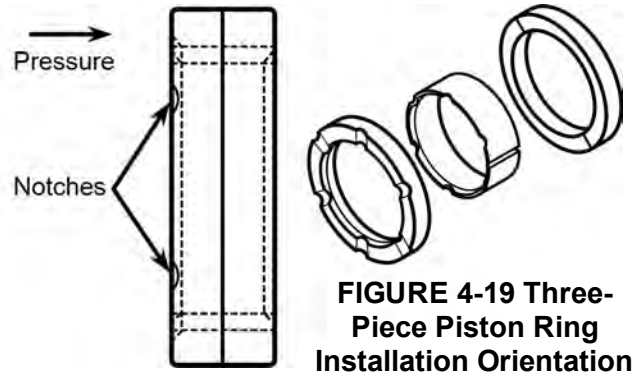


FIGURE 4-19 Three-Piece Piston Ring Installation Orientation

Wear Bands

Most pistons use a single, one-piece angle-cut filled Teflon wear band. High-pressure cylinders use two-piece thermoplastic wear bands (see FIGURE 4-18).

Since wear bands do not work as sealing rings, end gap is not critical. Wear band projection beyond the outer piston diameter is important. To check wear band projection, measure piston to cylinder bore clearance at the bottom of the bore. There is no need to remove the piston from the cylinder. Replace wear band before it wears enough to allow the piston to touch the cylinder bore. Install wear bands in the same way as piston rings, above.

Piston Rod Packing

The piston rod packing prevents gas from entering the crosshead guide. Piston rod rings within the packing wear over time and need replacement.

Piston Rod Packing Removal

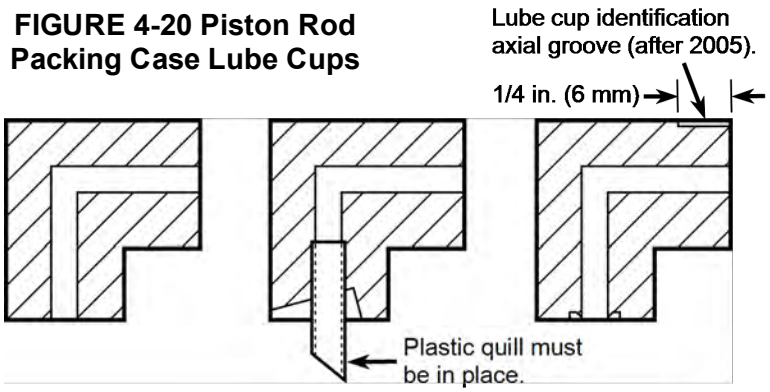
1. Remove piston and piston rod. See “Piston and Rod Removal” on page 4-12.
2. Remove packing diaphragm (if applicable) and oil wiper packing.
3. Disconnect all tubing and instrumentation (if applicable) from packing flange. Remove the twelve-point cap screws that hold the pressure packing gland to the crank end of the cylinder/head.
4. Do not remove the small nuts from the studs. They hold the packing case together for removal as an assembly.
5. Pull entire pressure packing out into the crosshead guide, then through the large side opening of the guide. Take pressure packing to a clean place for disassembly.
6. Set 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 unequally spaced to prevent misalignment of the stack of parts. Remove the nuts and unstack the pressure packing. Replace these nuts each time the pressure packing is serviced.
7. To check ring wear, place assembled rings (note match-marks) on the piston rod. Check end gap clearance. If the ends butt, or nearly butt, replace the rings. See “Types of Piston Rod Packing Rings” on page 4-21 for correct ring orientation.
8. Carefully file any fins or wire edges on the rings to square all matching edges.
9. Pry loose the metal gasket on the end cup with a sharp awl. Do not scratch the sides of the gasket groove.
10. Before reassembly, clean all parts thoroughly.

Piston Rod Packing Reassembly

1. Refer to the pressure packing assembly in your parts book. Ariel supplies parts books with each unit. Contact your distributor to obtain a parts book. Each pressure packing re-build kit includes a pressure packing assembly drawing.
2. Take care not to scratch mating surfaces of the cups. Cup surfaces must be clean and dry for re-assembly.
3. To install a new set of rod rings in an existing packing case, inspect case parts for wear. Cups should be smooth and flat on the back side where the rod rings must seal. If cups or grooves are concave or tapered, regrind or relap them. Contact Ariel for appropriate rework thickness dimensions. It is rarely necessary to alter the crosshead side of cups, but if necessary, take care not to destroy the correct side clearance for the renewal rings.

   NOTE: If premature wear is suspected, see "Force Feed Lubrication Conditions" on page 3-28.
4. Before a packing case installation, disassemble and thoroughly clean it in an appropriate solvent for the intended service.
5. Verify the proper position of each rod ring and cup and, unless non-lube, coat rings liberally with new, clean lubricant before reassembly. Use only the same lubricant in the force feed lube system. If non-lube, see "Component Cleaning & Thread Lube for Non-Lube Compressor Cylinders" on page 4-46. Ensure tie studs are completely threaded into the end cup. Examine all parts for unusual nicks or burrs which may interfere with the free floating of the rod ring in the cups. Take particular care with rod rings made of soft materials, such as bronze or TFE. It is extremely important to handle and install wiper rings to prevent damage to the scraping edges.

FIGURE 4-20 Piston Rod Packing Case Lube Cups



Original Lube Cup Style | **High-Pressure Plastic Quill Oil-Drip Lube Cup** | **Grooved Oil-Drip Lube Cup (All after 2005)**

6. Lay out parts on a work bench for progressive installation, with each part 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 unequally spaced to prevent misalignment of the stack of parts. Note that all rod ring segments are carefully lettered; assemble them accordingly. This is most important for proper sealing. Center side-loaded WAT and AL rings prior to tightening tie stud nuts. Install tie nuts and tighten to the torques in Appendix A. Manually verify all rings move freely, radially, in their grooves. Side-loaded rings are snug, but should still move manually. Center these rings.
7. For new installations, carefully clean all accumulated dirt in the lines and compressor. Any foreign material lodges in the packing and becomes destructively abrasive.
8. Prior to packing case installation, inspect end cup gasket for nicks and damage that may cause leakage. If in doubt, replace the gasket. Verify the gasket surface in the packing counter bore on the crank end of the cylinder/head is clean and not scratched.
9. Reinstall complete packing case assembly with oil supply point on top. Use rod packing bolts to pull packing into place.
10. Reinstall packing diaphragm (if applicable) and wiper packing.

11. Reinstall piston and rod. See "Piston and Rod Installation" on page 4-15.

12. After tightening the crosshead nut, tighten rod packing bolts evenly to the recommended torque in Appendix A. This procedure squares the pressure packing on its nose gasket. To align the packing, use feelers to maintain a uniform clearance all around between the case bore and the rod. Rod packing bolt tightening on high pressure cylinders requires a torque multiplier.

NOTE: Repeat final torque for rod packing bolts until the bolts no longer turn. Re-check torque on these fasteners at the next service interval.

13. Retighten tie stud nuts. Reinstall tubing connections and instruments (if applicable). Take care not to cross-thread tubing nuts. Tubing nuts must be tight.

NOTE: After pressure packing installation, see "Force Feed Lubricator" on page 3-17 to prime the force feed lube system and obtain recommended lubrication rates for new machine break-in. Repeat priming each time a compressor is started because oil lines may bleed during down time. Break-in lube rates are approximately twice the normal rates, or half the normal indicator pin cycle time.

CAUTION: Ariel recommends leaving distance piece covers off after any piston rod or rod packing ring maintenance. Verify no ignition sources exist in the area, pressurize the unit, and check for gas leaks before distance piece cover installation. This protects against crosshead guide over-pressure and possible ignition due to incorrect installation of packing case or components. When checking for leaks, take proper precautions in process gas applications, such as H_2S.

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, the force feed lube oils the top of the ring set at a very low rate because this ring set is not subject to cylinder pressures and temperatures. The end-to-end seal in the cup and the low lube rate of AL ring sets, ensures newly installed rings 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 rod installation. Use only the same lubricant in the force feed lube system. If non-lube, see "Component Cleaning & Thread Lube for Non-Lube Compressor Cylinders" on page 4-46.

Types of Piston Rod Packing Rings

There are several types of piston rod packing rings depending on the application. Below are those used in Ariel JGM:P:N:Q compressors.

"P" Pressure Breaker

This single ring is cut radially into three equal segments. It breaks down or slows gas flow without sealing it completely. Total end gap installed is 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. To maintain end gap, adjust ring gap or replace ring.

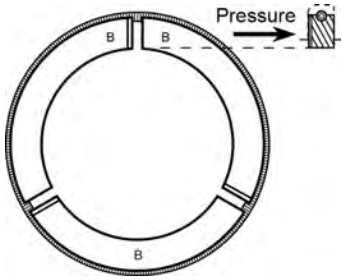


FIGURE 4-21 "P" Pressure Breaker

"UP" Pressure Breaker

This single solid ring breaks down or slows gas flow without sealing it completely.

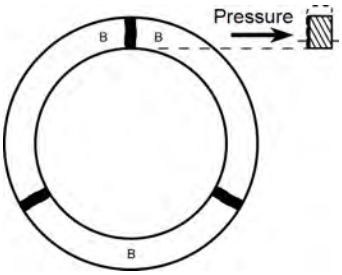


FIGURE 4-22 "UP" Pressure Breaker

"P1U" Pressure Breaker

This two-ring set allows controlled leakage in one direction only and installs 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 solid and has a bore larger than the rod diameter. Total end gap installed is 0.040 to 0.046 in. (1.0 to 1.2 mm) for PEEK, and 0.020 to 0.026 in. (0.5 to .07 mm) for Bronze, and Cast Iron. Maintain end gap by adjusting ring gap or replacing the ring.

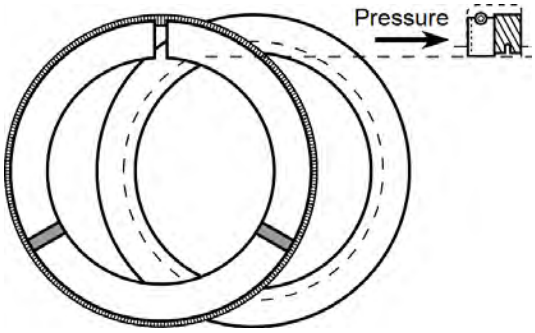


FIGURE 4-23 "P1U" Pressure Breaker

"BTR" Single-Acting Seal Set

This three-ring set seals in one direction only. The first ring (pressure side) is radially cut. The second ring is tangentially step cut and made of the same material as the first ring. These two rings are doweled to stagger the cuts from one ring to the other. 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. Maintain end gap by adjusting ring gap or replacing the ring. The third ring is called a back-up ring. It is radially cut and has a bore larger than the rod diameter. This allows the radial joints to form a tight gas seal. This ring needs no dowel.

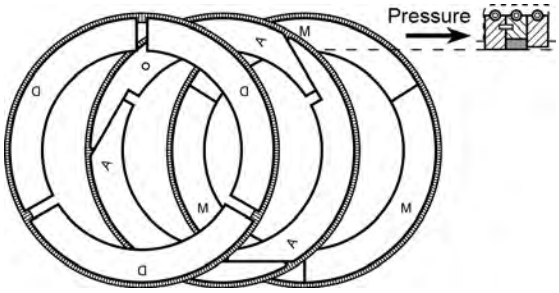


FIGURE 4-24 "BTR" Single-Acting Seal Set

"BD" Double-Acting Seal Set

This two-ring set consists of tangentially step cut rings doweled to stagger the tangential cuts from one ring to the other. 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. Maintain end gap by adjusting ring gap or replacing the ring. This double acting set seals in either direction. In cylinders operating near atmospheric pressure, it prevents air from entering the cylinder. Install with the match mark letters facing the pressure.

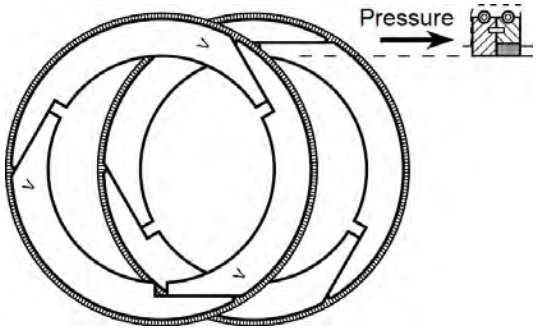


FIGURE 4-25 "BD" Double-Acting Seal Set

"WAT" Double-Acting Seal Set

In this three-ring Teflon set, the first two rings (pressure side) are radially cut; the third is tangentially step cut. The last two rings are doweled to stagger the cuts from one ring to the other. Total end gap installed is 3/16 to 7/32 in. (4.8 to 5.6 mm). Maintain end gap by adjusting 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. Use this ring set primarily for low pressure applications. WAT rings must be centered when installed in the packing case.

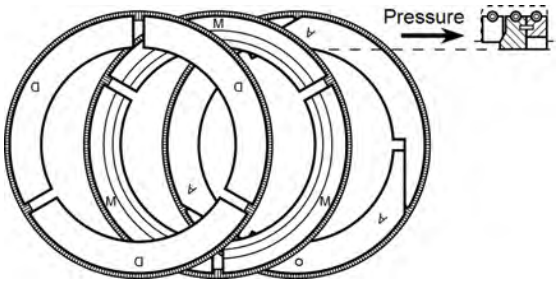


FIGURE 4-26 "WAT" Double-Acting Seal Set

"AL" Double-Acting Seal Set

This five-ring Teflon set functions like a double-ended "WAT" ring set. Total end gap installed is 3/16 to 7/32 in. (4.8 to 5.6 mm). Maintain end gap by adjusting ring gap or replacing the ring. It totally blocks leakage in a groove supplied with low-pressure fluid. AL rings must be centered when installed in the packing case.

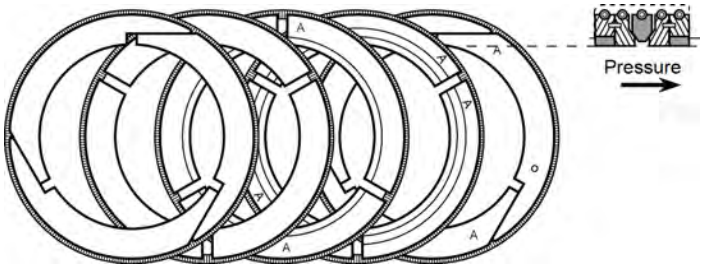


FIGURE 4-27 "AL" Double-Acting Seal Set

"BTU" Single-Acting Seal Set

This three-ring set seals in one direction only. The first ring (pressure side) is radially cut; the second is tangentially step cut. These first two rings are doweled to stagger the cuts from one ring to the other. The third ring is called a back-up ring. It is solid, with a bore larger than the rod diameter, allowing radial joints to form a tight gas seal. 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. Maintain end gap by adjusting ring gap or replacing ring.

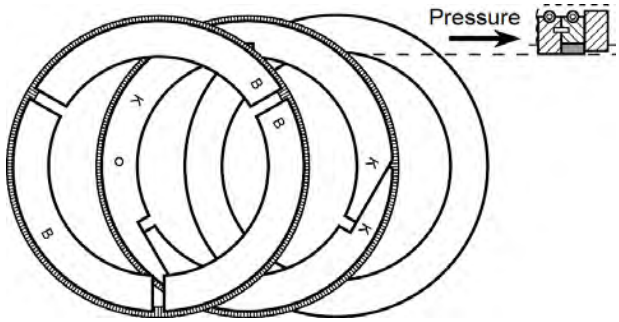


FIGURE 4-28 "BTU" Single-Acting Seal Set

"BTUU" Single-Acting Seal Set

This four-ring set seals in one direction only. The first ring (pressure side) is radially cut; the second is tangentially step cut. These rings are doweled to stagger the cuts from one ring to the other. The third and fourth rings are solid and have bores larger than the rod diameter, allowing the radial joints of the sealing rings to form a tight gas seal. 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. Maintain end gap by adjusting ring gap or replacing the ring.

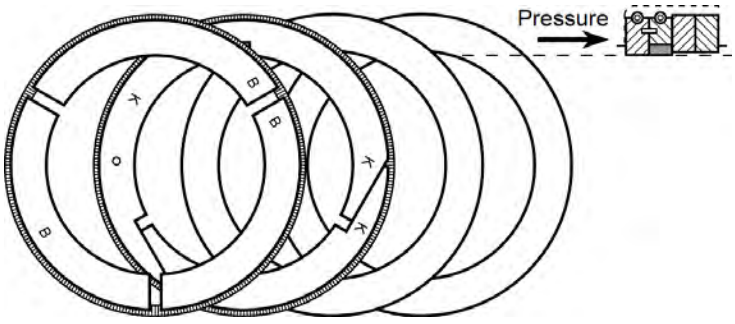


FIGURE 4-29 "BTUU" Single-Acting Seal Set

"CU" Single-Acting Seal Set

This three-ring set seals in one direction only. The first ring (pressure side) is radially cut. The second ring is tangentially cut. The first two rings are doweled to stagger the cuts from one ring to the other. The third ring is called a back-up ring. It is solid and has a bore larger than the rod diameter. 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. Maintain end gap by adjusting ring gap or replacing the ring.

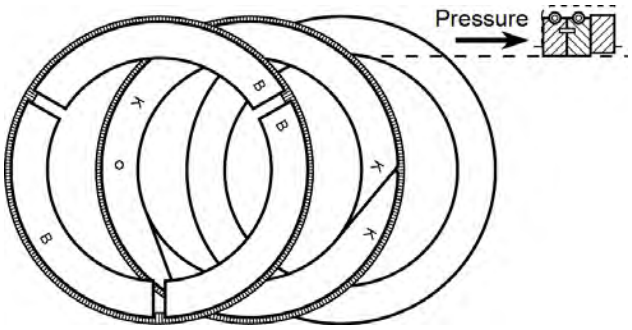


FIGURE 4-30 "CU" Single-Acting Seal Set

"STU" Single-Acting Seal Set

This three-ring set seals in one direction only. The first ring (pressure side) is solid, with radial groves on the pressure side. The second ring is tangentially cut. The third ring is solid.

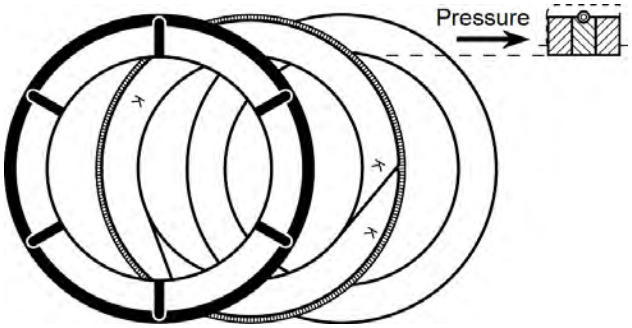


FIGURE 4-31 "STU" Single-Acting Seal Set

"CR" Single-Acting Seal Set

This three-ring set seals in one direction only. The first ring (pressure side) is radially cut. The second ring is tangentially cut. The first two rings are doweled to stagger the cuts from one ring to the other. The third ring is called a back-up ring. It is radially cut and has a bore larger than the rod diameter to allow the radial joints to form a tight gas seal. 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. Maintain end gap by adjusting ring gap or replacing the ring.

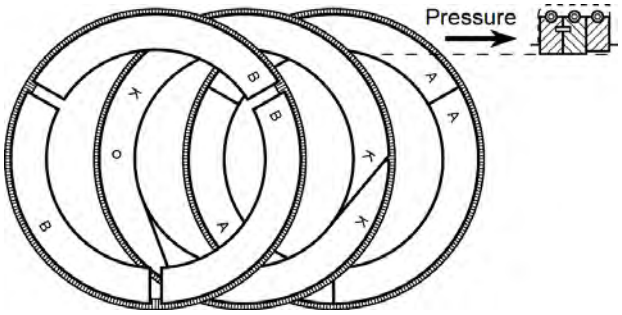


FIGURE 4-32 "CR" Single-Acting Seal Set

"RTV" Oil Wiper Set

This three-ring set are doweled to stagger the end gaps from one ring to the other. The first ring (toward oil side) is PEEK and tangentially step cut with radial drains. The center ring is also PEEK and radially cut with axially loaded inside diameter groove and radial holes. The third ring is teflon and tangentially step cut. The total end gap for all three rings installed is 0.062 to 0.093 in. (1.6 to 2.4 mm). Maintain the end gap by replacing the ring.

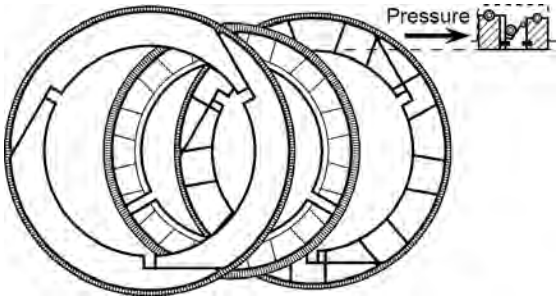


FIGURE 4-33 "RTV" Oil Wiper Set

"3RWS" Oil Wiper Set

The three cast iron rings in this set are radially cut and doweled to stagger the cuts from one ring to the other. They 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. Total end gap installed is 3/16 to 7/32 in. (4.8 to 5.6 mm). Maintain end gap by adjusting ring gap or replacing the ring.

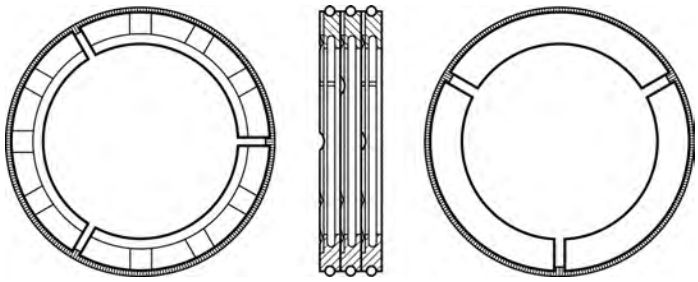


FIGURE 4-34 "3RWS" Oil Wiper Set

Arrangement of Piston Rod Packing Rings

Ariel supplies packings in five pressure ranges. The figure to the right shows the general arrangement of the oil supply, seal ring, and vent locations. The type of rings used depends on the pressure application.

A separate diaphragm in the crosshead guide carries the oil wiper rings and one seal ring set.

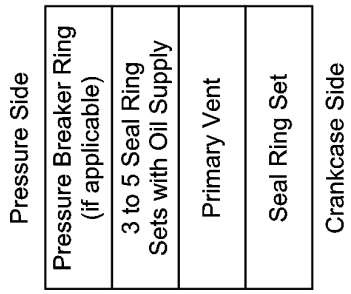


FIGURE 4-35 Piston Rod Packing Ring Arrangement

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 consists of 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 to provide a strong, slick material to reduce friction and wear.

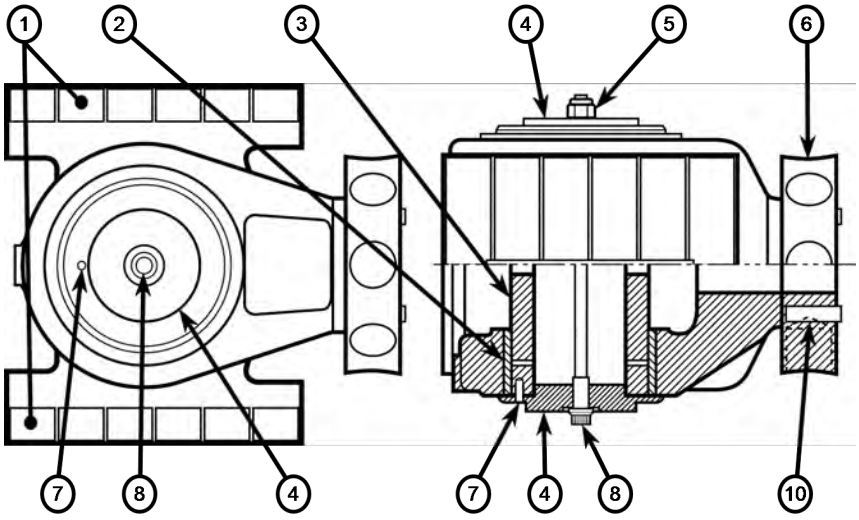
Crossheads

CAUTION: Before removing a cylinder head, back off all cap screws 1/8 inch (3 mm). Verify the head is loose and the cylinder is completely vented. Crossheads are heavy. Handle with care to avoid personal injury. The balance sheet that comes in the manual with each compressor lists each crosshead weight.

Crosshead Removal

NOTE: See Section 1 for illustrations of tools mentioned below.

1. Remove crosshead guide side covers and (head end) cylinder head or unloader.
2. Move crosshead to its inner dead center position. Back off, but do not remove, the crosshead nut set screws.
3. Loosen crosshead nut with the special slugging peg or open end wrench, depending on nut type. Or use separately purchased hydraulic crosshead nut torque tool.



1. Shoe Area
2. Bushing
3. Crosshead Pin
4. End Plate
5. Thru Bolt Lock Nut
6. Crosshead Nut
7. Roll Pin
8. Thru Bolt
9. Set Screw (loosen before turning nut)

FIGURE 4-36 Typical Crosshead

4. Use the piston nut spanner to thread the piston rod out of the crosshead. The two dowels on the spanner fit holes in the piston nut. Thread the crosshead nut off the piston rod. Push the rod end forward to the edge of the packing to provide clearance for crosshead removal.
5. With crosshead in its outer dead center position, remove crosshead pin thru-bolt, lock nut, end-plates and pin. Discard old lock nut.
6. Turn crankshaft to its inner dead center position. Move crosshead to its outer dead center position, free of the connecting rod. Support connecting rod so it does not drop and damage the crosshead guide surface.
7. Remove oil wiper packing from crosshead guide diaphragm.
8. Install crosshead installation/removal tool.
9. Push crosshead onto crosshead installation/removal tool and rotate crosshead 90°.
10. Slide a 3/16 inch (5 mm) thick plate into the gap between the crosshead and crosshead guide (see FIGURE 4-38).
11. Remove diaphragm from crosshead guide and slide crosshead out of crosshead guide onto the plate.
12. Check crosshead pin to bushing clearance (see Appendix B in Appendix B). Determine pin wear by inspection.
13. Replace pin, if necessary. To replace bushings, hacksaw or file to within 1/32 inches (1 mm) of their thickness, then drift them out.

14. New bushing installation requires a press. To install a bushing in the crosshead, cool the bushing in 95% alcohol with dry ice solution. Leave the bushing 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 protection. Alcohol is flammable; use it only in open air or well-ventilated buildings. Avoid sparks and open flame. Avoid alcohol vapors which may cause injury to nose and eye tissue. Do not return solution to a closed container until it reaches room temperature or container may explode.

NOTE: Directly support the crosshead side receiving the new bushing to prevent the press from possibly crushing the crosshead (see FIGURE 4-37). Thoroughly clean bushing and crosshead to prevent dirt accumulation between bushing and crosshead bore.

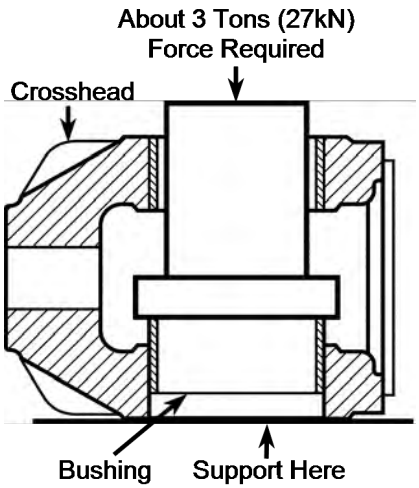


FIGURE 4-37 Crosshead Bushing Replacement

15. Inspect shoe surfaces; there should be no wear whatsoever.

Crosshead Installation

NOTE: Return crossheads 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 crosshead on its side (see FIGURE 4-38). Oil crosshead and guide surfaces.

2. Mount Crosshead Installation Tool onto crosshead guide diaphragm and oil tool bearing surfaces (see FIGURE 4-38). With tool mounted on diaphragm, install diaphragm into crosshead guide. Slide crosshead onto tool.

NOTE: Long two-compartment crosshead guides supplied prior to 11/08 require a crosshead installation tool with a smaller pilot diameter. Contact Ariel for the proper tool.

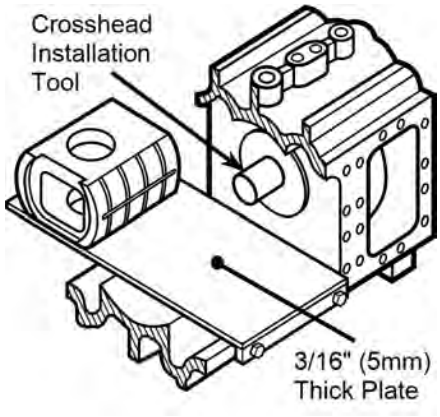


FIGURE 4-38 Crosshead Installation

3. Remove 3/16 inch (5 mm) thick plate. Rotate crosshead 90°. Slide crosshead into guide and off of the installation tool. Verify it does not become cocked. If crosshead becomes wedged, do not force it. Ease it off and start again. Be careful not to damage crosshead shoe surface during installation.

4. Remove crosshead installation tool and reinstall wiper packing.

5. Lift crosshead end of connecting rod and turn crankshaft to its outer dead center position to locate the connecting rod in position and insert crosshead pin. Use crosshead pin alignment tool on the opposite side of the crosshead to assist pin insertion. Oil crosshead pin and alignment tool prior to installation. Install crosshead pin end-plates, thru-bolt, and a new lock nut. Tighten thru-bolt and lock nut to the torque listed in Appendix A . (TIP: If pin insertion is difficult, chill it first.)
6. Lubricate piston rod threads with Never-Seez regular grade. Re-thread crosshead-balance nut onto piston rod; allow enough clearance to attach rod to crosshead. Position setscrew cup points on crosshead side of nut.

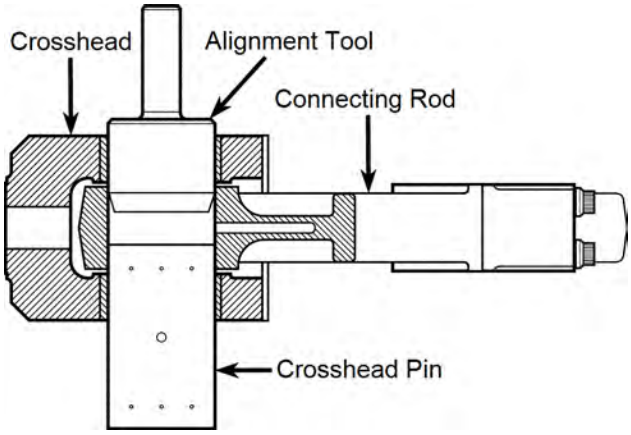


FIGURE 4-39 Typical Crosshead Alignment Tool

7. Position crankshaft at inner dead center position of throw. Use a dial indicator with a magnetic base to indicate crosshead location when finding exact inner and outer dead center positions.

   NOTE: At this point, set piston end clearance or serious damage may occur. See required piston crank end clearance on cylinder data plate or Appendix B .

8. Insert a feeler gage, equal to the required crank end clearance, through an open valve pocket. For 13 in. (330 mm) and larger cylinders, insert feeler gage through a bottom valve pocket. Tighten the piston rod into the crosshead until piston is tight against the feeler gage, and the feeler gage cannot be removed manually.
9. Tighten crosshead-balance nut in one of two ways:
   a. Strike the special slugging peg or open end wrench with a dead blow semi-soft faced hammer until an audible difference can be heard or the wrench “bounces” indicating a tight nut. Some mechanics obtain desired tightness in 3 to 4 strikes; others may require more.

b. Use a separately purchased crosshead-balance nut hydraulic torque tool and hand pump kit. See Appendix A for the hydraulic pressure to apply to the torque tool. When initially installing the tool, position the spanner wrench adapter open area toward the spanner wrench as shown in FIGURE 4-40. Apply hydraulic pressure to the ram to tighten the crosshead-balance nut. When the ram ends its travel, release 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. During tightening, if the adapter open area turns 90° before the 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.

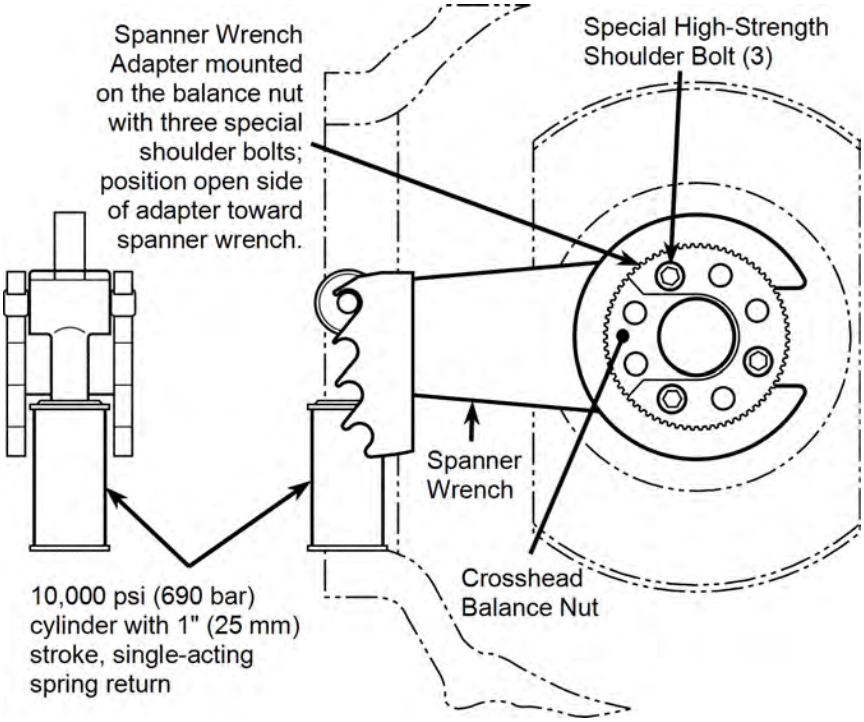


FIGURE 4-40 Typical Crosshead Balance Nut Hydraulic Torque Tool - Tightening Position

CAUTION: Do not allow open areas of spanner wrench and adapter to overlap, as the spanner wrench can be sprung. If the wrench becomes sprung, destroy and replace it.

When nut is tight, remove feeler gage. Verify removal of all tools from cylinder and crosshead.

10. With the head end head or unloader properly installed (closed position) and fasteners tightened, rotate crankshaft 180° to outer dead center position of throw. Remove a top head end valve. Determine required piston head end clearance limits from cylinder data plate or Appendix B . Measure head end clearance at the top of the head end. Using feeler gages through the open valve pocket, check head end clearance. Determine if measured clearance is within tolerance. Tighten the crosshead-balance nut set screws. Re-install valve assemblies and properly tighten fasteners. See “Valve Installation” on page 4-9.

11. Check piston rod runout and crosshead clearances upon re-assembly, any time a piston rod is removed. See “Piston Rod Runout” on page 4-16 for crosshead clearances.

12. Replace crosshead guide side covers and gaskets, tighten all cap screws hand wrench tight. Lubricate both sides of cover gaskets with anti-seize lubricant or multi-purpose grease to ease future removal.

Connecting Rods

A connecting rod assembly consists of a rod with bushing, a rod cap, rod cap bolts (4), and two half bearing shells. The bearing shells join together to form the connecting rod bearing.

Connecting Rod Removal

1. Remove top cover from crankcase and side covers from crosshead guides.
2. Remove the middle frame spacer bar of the three over the desired pair of throws. Spacer bars fit snugly, but should remove manually without hammering. They should not fall out. If fit is too loose or tight contact your packager or Ariel before proceeding.
3. Move throw to outer dead center position.
4. Remove lock nut, bolt, end plates, and crosshead pin from crosshead. Discard old lock nut.
5. Remove crosshead as described in "Crosshead Removal" on page 4-26.
6. Support connecting rod so it does not drop and damage the crosshead guide, then turn the crankshaft until the throw is at its highest point. Loosen all the rod cap bolts part way. Using the connecting rod cap removal tool (see Section 1), jack against the bolt heads to pull the rod cap free from the dowels. Remove the top two rod cap bolts and the rod bearing cap. The bottom two bolts remain in the cap during cap removal.

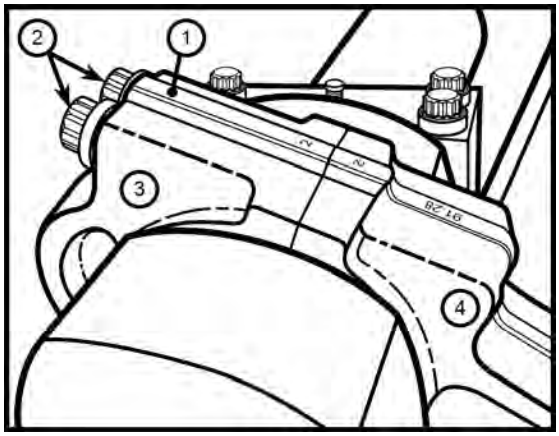
   NOTE: Do not pry or chisel to separate cap from rod; it damages the connecting rod.
7. Half of the bearing shell comes out with the cap. Slide out the other half from the rod.
8. Turn crankshaft until rod can be removed through the crosshead guide side cover openings.
9. After removing connecting rod(s), protect crank pins from nicks or scratches.

   NOTE: To remove all connecting rods, remove the crankshaft before rod removal. Detach all connecting rods from the crankshaft and retract them into the crosshead guides before crankshaft removal.

To prevent personal injury, verify neither driver nor compressor cylinder gas pressure can turn the compressor crankshaft during maintenance. Follow appropriate lock out procedures. Before any maintenance or component removal, relieve all pressure from compressor cylinders. See packager information to completely vent the system or call the packager for assistance. After maintenance, purge the entire system with gas prior to operation to avoid a potentially explosive air/gas mixture.

Connecting Rod Bearing Removal

1. Remove frame top cover and all crosshead guide covers.
2. If replacing main and rod bearings, remove all spacer bars. Spacer bars fit snugly, but should slide out by hand without hammering. They should not fall out. If fit is too loose or tight, contact your packager or Ariel before proceeding.
3. Rotate the crankshaft to approximately 45º (see FIGURE 4-42).
4. Loosen all the conn rod bolts approximately 1/8 in. (3.2 mm).



1. Top Face
2. Conn Rod Bolts

FIGURE 4-41 Rod/Rod Cap Separation

5. Pry the crosshead toward the cylinder until it bottoms out. Work the rod cap away from the rod as evenly as possible. Separating the two parts unevenly may break the rod cap dowels or cause them to bind in the rod dowel holes. If the two parts of the con rod do not separate easily by hand, loosen all bolts an additional 1/8 in. (3.2 mm) and pry the crosshead again.

   NOTE: Do not pry or chisel to separate cap from rod; it damages the connecting rod and can break the alignment dowel pins.

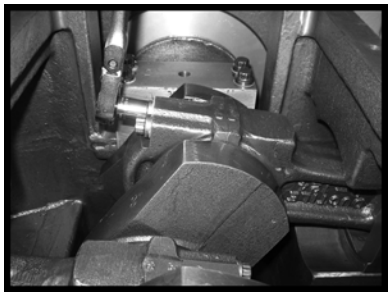


FIGURE 4-42 Crank Rotation

6. Remove all bolts from the cap first, and then remove the cap. Lift the cap while holding the bearing in the cap because oil causes the bearing to stick to the crankshaft pin. **Do not remove the cap with bolts in place.**
7. Support the rod by hand while another person rotates the crank away from the rod. When the connecting rod is clear of the crankshaft, rest it on the crosshead guide slide.
8. Rotate the crank to inner dead center and remove the connecting rod bearing.
9. After removing bearings, clean any coking or debris from both the rod and rod cap surfaces with a non-metallic Scotch-Brite or similar scouring pad and solvent.Check for raised edges on machined surfaces. All surfaces should be as clean and dry as possible.

Connecting Rod Bearing Installation

1. Check new bearing shells for 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. Fit the tab of a new, dry half bearing shell into the rod notch.

   NOTE: Where bearings are identified with an ink pictograph, connecting rod bearings and main bearings are not interchangeable. DO NOT put main bearings in a connecting rod. Do not mix part numbers on an individual main or connecting rod. Both bearing half shells must have the same part number.

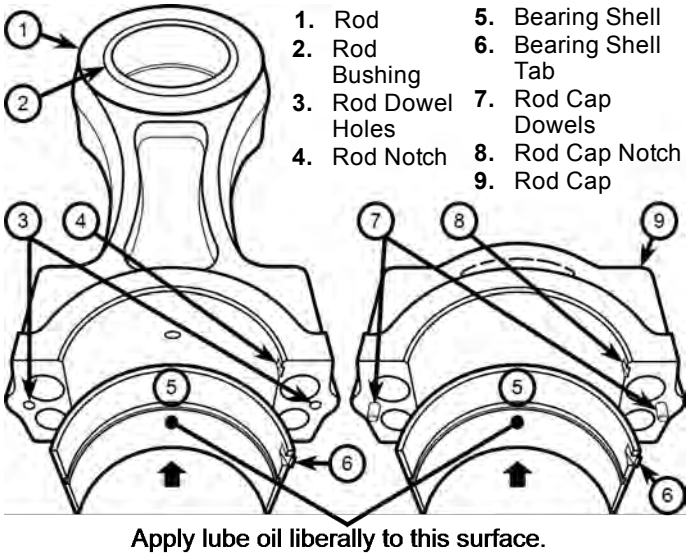


FIGURE 4-43 Connecting Rod Bearing Installation

2. Thoroughly inspect the crank pin for dings and scratches. If needed, use an Arkansas stone to dress dings and scratches (Norton Hard Translucent Arkansas Stone, 3” x 1/2” x 1/2”, product number HF-43). Lightly slide the stone around the circumference of the crank pin surface to remove any high spots; do not slide it back and forth over the length of the crank pin. After dressing, ensure the crank pin is clean and dry. If the crank is scored around the circumference, use 600 grit emery cloth to remove high spots.
3. Apply clean, new lube oil liberally to the crank pin.
4. Fit the tab of the other bearing shell into the rod cap notch.
5. Attach the rod cap to the rod:

a. Support the connecting rod by hand while another person rotates the crank towards the rod. Stop rotating the crank at about a 45º angle (see FIGURE 4-44).

b. Keep supporting the connecting rod by hand while the second person pries the crosshead towards the crank until the rod bottoms out on the crankshaft.

c. Carefully lower the connecting rod cap **(WITHOUT BOLTS!)** onto the crank pin. Verify rod bolts are undamaged and free of dirt. Lubricate them per , then place all four bolts into the rod cap.

NOTE: Ariel stamps throw numbers on all rod caps and rods. Install a rod cap in the correct throw location with the stamped numbers facing up.

d. After ensuring the rod cap seats properly on the rod, tighten all conn rod bolts to the torque listed in .

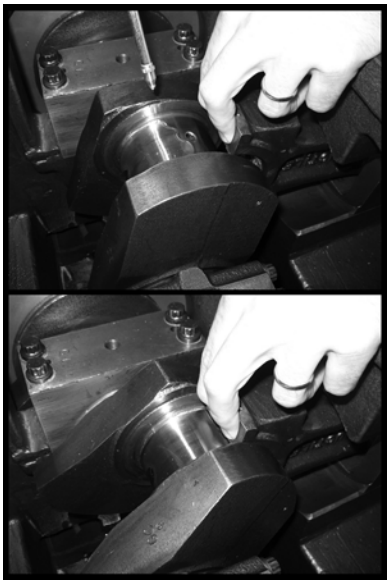


FIGURE 4-44 Attaching Rod to Crankshaft

6. Repeat steps 1-5 for all remaining connecting rods.
7. Measure each connecting rod bearing jack and thrust clearance as detailed in this document. If clearance readings are not within Appendix B tolerances, contact your packager or Ariel before proceeding.

NOTE: If replacing main bearings, continue to "Main Bearing Removal". If not replacing main bearings, continue to Step 8.

8. Install spacer bars so the match mark is up and next to the spacer bar boss with the same mark. Tighten all spacer-bar cap screws to the torque listed in .
9. Account for all tools, equipment, supplies, and parts to ensure none are left inside the crankcase.
10. Examine top cover and side cover gaskets. If there is doubt about their condition, replace them. Apply Never-seez Regular Grade to both sides of the gasket to ease future removal. Replace top cover and crosshead guide covers. Tighten all cap screws hand wrench tight.
11. Reverse lockout procedures.
12. After replacing bearings, thoroughly pre-lube compressor to ensure bearing lubrication and to help remove foreign materials from the lube system.
13. Run the compressor according to the time intervals listed on the form in Appendix D. After each run, shut down and remove the frame top cover. Measure main and connecting rod bearing cap temperatures with a hand held thermocouple probe or infrared thermometer and record them on a copy of the form in Appendix D. Complete the form and email or fax it to Ariel Field Service.

Connecting Rod Bushing Removal and Installation

1. Check crosshead pin to bushing clearance (see Appendix B in Appendix B). Determine pin wear by inspection. Replace pin, if necessary.
2. To replace a bushing, file or hacksaw the existing bushing 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. **DO NOT file or saw into the connecting rod; any bore damage renders the rod useless and requires rod replacement.**
3. Use a hydraulic press in a qualified machine shop to install the new bushing. Do not hammer bushing into place; it will distort the bushing bore.

4. Before installation, cool new bushing in a 95% alcohol and dry ice solution. Leave bushing in solution long enough to reach the solution temperature, about -110°F (-80°C).
5. Position connecting rod on the press table so the chamfered edge of the rod bushing bore is on top. Align bushing oil hole with connecting rod oil passage (if applicable) before pressing bushing in. The bushing has an annular groove around its outside diameter aligned with the oil hole; if the bushing shifts in the connecting rod during operation, oil still travels to the bushing inside diameter and to the crosshead pin. However, a new bushing installation should cover no more than 1/3 of the rod oil passage hole.

CAUTION: Do not touch cold surfaces without proper protection. Alcohol is flammable; use it only in open air or well-ventilated buildings. Avoid sparks and open flame. Avoid alcohol vapors which may cause injury to nose and eye tissue. Do not return solution to a closed container until it reaches room temperature or container may explode.

NOTE: Thoroughly clean bushing and connecting rod to prevent dirt accumulation between them. Immediately assemble them so the bushing does not warm and stick before it is in place. If the bushing sticks, remove it by notching as in step 2 above.

Connecting Rod Installation

1. To install a new connecting rod, stamp match mark numbers matching the throw location on the tops of the connecting rod and bearing cap (with notches up). See FIGURE 4-45.
2. Check new bearing shells for 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 rod notch. With the crankcase top cover off, turn the throw to inner dead center position and slide the rod into the crosshead guide space. Oil crankshaft crank pin bearing surfaces with new clean lubricating oil, the same type used in the frame, before connecting rod cap installation.

   NOTE: Connecting rod bearings and main bearings are not interchangeable. Connecting rod bearings have a narrower groove or no groove at all. DO NOT put main bearings in connecting rod bearing locations.

   NOTE: Caps and rods are numbered by throw beginning with number one at the drive end. For throw numbering sequence, see . Always install rods with numbers up. Protect crank pin at all times.
3. Fit connecting rod to crank pin and turn to the highest position. Position cap, with a new half bearing shell properly located in the notch, and the bolts. Snug all bolts; do not tighten them to full torque.
4. Reconnect rod and crosshead with pin. Install end plates, thru-bolt, and new lock nut. Tighten lock nut to the torque listed in TABLE A-3.

5. Follow the torquing procedure in "Recommendations for Torque Accuracy" to tighten connecting rod cap screws to the recommended torque in TABLE A-3.
6. Measure each connecting rod bearing to crankshaft jack clearance and connecting rod thrust (side) clearance (see "Connecting Rod Bearing Vertical Jack Clearance Measurement" and "Connecting Rod Thrust (Side) Clearance Measurement" below). Record measurements on a copy of the form in Appendix D. If measurements are out of tolerance after installing new bearings, contact your packager or Ariel before proceeding

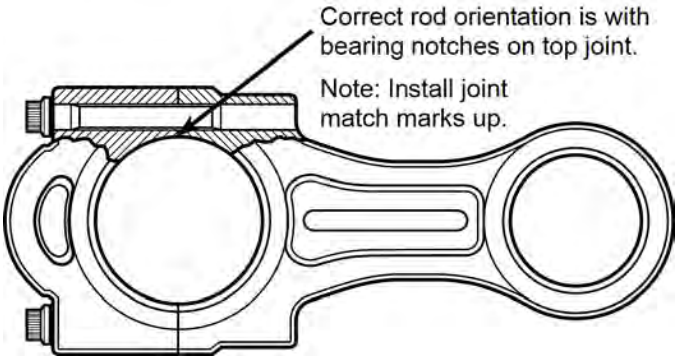


FIGURE 4-45 Typical Connecting Rod

7. Reinstall spacer bars. All spacer bars are match-marked for proper location; reinstall them in their original location. Tighten all spacer bar bolts to the torque listed in TABLE A-3.
8. Examine top cover and side cover gaskets. If there is doubt about their condition, replace them. Lubricate both sides of cover gaskets with anti-sieze lubricant or multi-purpose grease to ease future removal. Replace top cover and crosshead guide cover. Tighten all capscrews hand wrench tight.

Connecting Rod Bearing Vertical Jack Clearance Measurement

1. Turn the crankshaft pin of the desired throw to its highest position. For JGH:E:K:T:C:D:F:Z:U:B:V and KBZ:U:B:V models, thread an eye bolt into the connecting rod (see FIGURE 4-46).
2. Attach the magnetic base of a needle dial indicator to the crankshaft web adjacent to the connecting rod. Place the point of the dial indicator against the top of the connecting rod near the center of the cap seam.
3. Zero the dial indicator. Insert a pry bar into the eye bolt and pry against the frame to force the connecting rod up until the dial indicator needle stops moving. For JG:A:M:N:P:Q:R:J:W models, pry against the top conn rod bolts. While maintaining upward pressure, note the reading.
4. Release upward pressure and push downward on the rod until the indicator reads zero again. If a zero reading cannot be obtained, zero the indicator again and repeat steps 3 and 4. Repeat the measurement process until the measurement returns to zero twice in a row to verify accuracy.
5. Repeat measurement process for every rod. If a reading is outside Appendix B tolerances, contact your packager or Ariel.

NOTE: Remove eye bolts, magnetic bases, dial indicators, and pry bars after measurement.



Dial indicator magnetic stand placement on top of crankshaft web, and pry bar inserted into eye bolt.

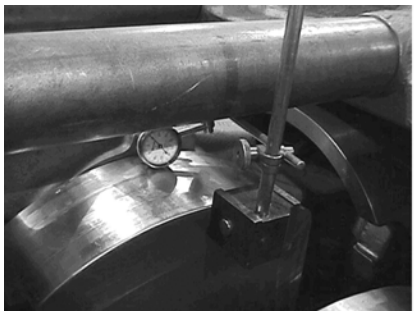
Use pry bar to check jack clearance.

FIGURE 4-46 Typical Connecting Rod Vertical Jack Clearance Measurement

Connecting Rod Thrust (Side) Clearance Measurement

1. Turn the crankshaft pin of the desired throw to its highest position.
2. Attach the magnetic base of a button dial indicator to the side of the crankshaft web adjacent to the connecting rod. Place the button of the dial indicator against the thrust surface of the connecting rod (see FIGURE 4-47).
3. Use a pry bar to pry against the crankshaft web and thrust the connecting rod tight toward the dial indicator (do not pry on rod cap). Release pressure and zero the dial indicator.
4. Thrust the connecting rod tight in the opposite direction until the dial indicator needle stops moving. Release pressure and note reading. Repeat steps 3 and 4 to verify measurement accuracy.
5. Repeat the measurement process for every rod. If a reading is outside Appendix B tolerances, contact your packager or Ariel.

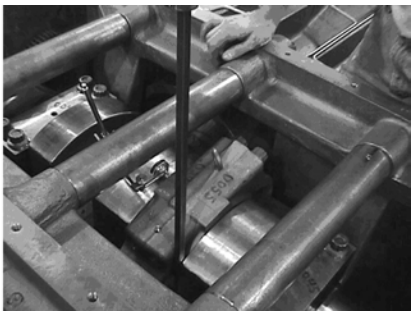
   NOTE: Remove magnetic bases, dial indicators, and pry bars after measurement.



Dial indicator magnetic stand placement.



Dial indicator button placement.



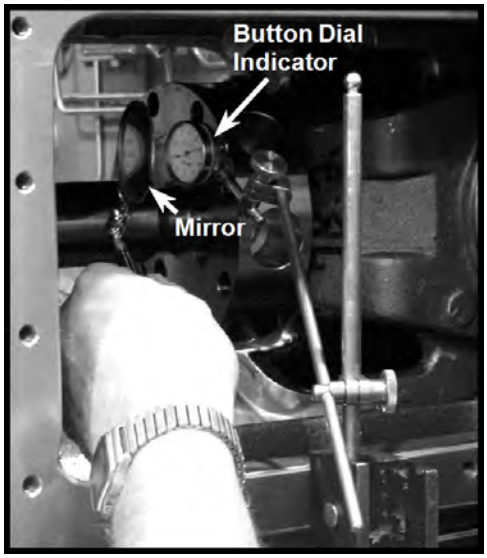
Thrust rod tight toward and away from dial indicator.

FIGURE 4-47 Typical Connecting Rod Thrust (Side) Clearance Measurement

Measuring Head End Clearance for Forged Steel Tandem Cylinders with Concentric Valves

CAUTION: Completely vent compressor to relieve ALL gas pressure and remove coupling spacer prior to removing access covers for compressor internal maintenance. For electric drive motors, lock out the breaker. Failure to follow these steps can result in serious personal injury or death.

1. Set crank end piston clearance to the proper feeler gauge specification stamped on the cylinder data plate or printed in the Ariel Technical manual.
2. With head end components removed, position the piston for the desired cylinder at outer dead center. Position a dial indicator to index off of the crosshead or crosshead nut outer face, with the cylinder near to outer dead center. Manually turn crankshaft to find the 0.010 inch (0.25 mm) position, before and after outer dead center. Then turn crankshaft to position piston at outer dead center (see picture to the right).



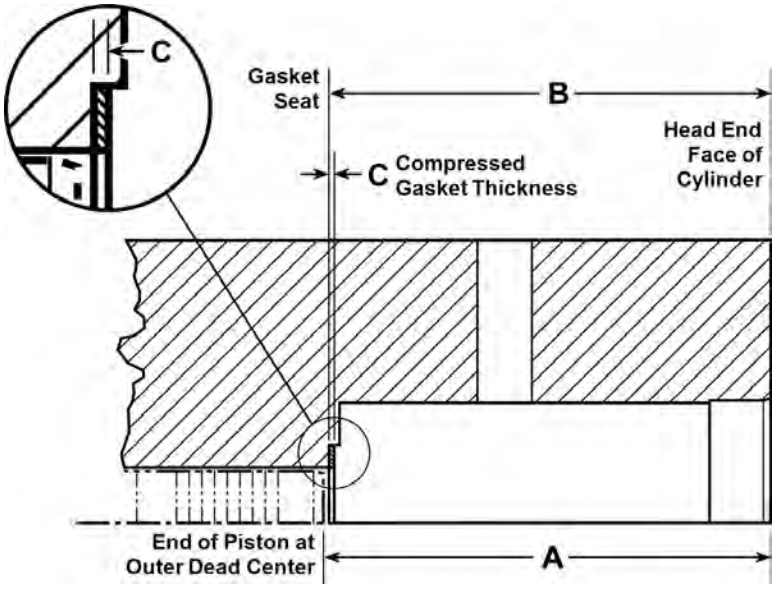
3. **Dimension A:** Measure from cylinder head end to piston head end to the nearest thousandth inch and record. See illustration on the following page.
4. **Dimension B:** With gasket removed, measure from head end cylinder face to the gasket seat and record.
5. **Dimension C:** Use **0.055 inch (1.40 mm)** for nominal 0.060 inch (1.52 mm) thick steel gasket and record.
6. Calculate Head End Clearance:
   A - B + C = Head End Clearance

   A _____

   - B _____

   + C 0.055 (1.40 mm)

   = _____



7. Compare calculated head end piston clearance to clearance tolerances stamped on the cylinder data plate or printed in the Ariel Technical manual. **If tolerances are unavailable or if calculated clearance is outside tolerance, contact your packager or Ariel before proceeding.**
8. Measure head end piston clearance prior to new start up, as required by recommended maintenance intervals in Section 3 , or after installation, removal, or replacement of any one of the following:

   • Crankshaft • Crosshead Guide • Either Tandem Cylinder Body
   • Connecting Rod • Piston and/or Piston Rod • Crosshead and/or Crosshead Nut

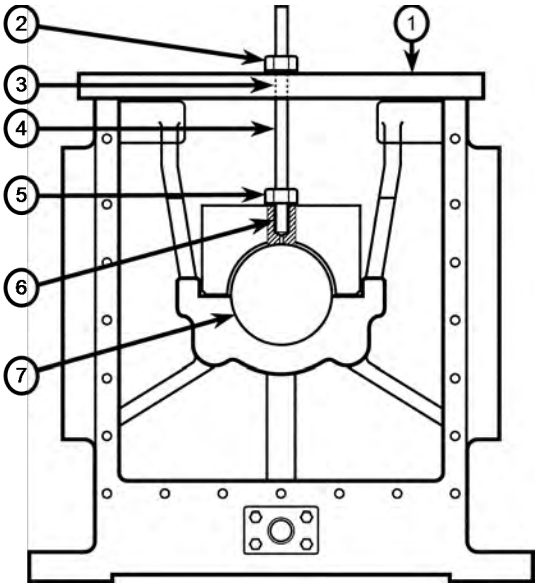
9. Re-assemble all components according to the Ariel Maintenance and Repair Manual supplied with your compressor. Verify installation of all gaskets and manually bar over the compressor to confirm the crankshaft rotates freely.

Crankshaft

The crankshaft is the heart of the compressor. With proper maintenance, it should provide years of trouble-free service.

Crankshaft Removal

1. Remove coupling disk pack. Remove coupling hub. It may be necessary to heat the hub to remove it; wear insulated gloves. If the hub is not removed, the drive end cover cannot be removed and must lift out with the crankshaft.
2. Remove top cover, spacer bars, and drive end cover. TIP: If spacer bar bolts are difficult to loosen, use a 12-point hammer wrench.
3. Do not damage the sharp corners on each end of the crankcase top. They form a junction between the end covers, top cover, and base; keep them sharp and unmarred to prevent oil leaks.
4. Detach connecting rods and move them to their full outer position.
5. Remove chain eccentric adjustment capscrews. Turn the eccentric to loosen the chain and slip it off the crankshaft sprocket.
6. Remove capscrews from main bearing caps. Pull caps straight up to prevent damage to the dowel fit. If cap is tight, use a bearing cap puller as illustrated.
7. Before removing the crankshaft, prepare wooden saddles with sides high enough to prevent the webs or oil slinger from touching the floor to store the crankshaft during maintenance - even if for only a short time. Also, protect the crankshaft from above so dropped tools or equipment cannot mar pin and journal surfaces.



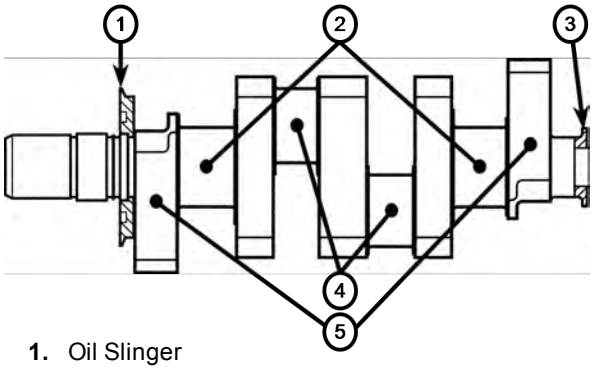
1. 20.5 in. (52 cm) Steel Bar
2. 5/8-11 UNC Nut (turn to jack bearing cap straight up)
3. 11/16 in. (18 mm) Hole (drill)
4. 11 in. (28 cm) x 5/8-11 UNC Threaded Rod
5. 5/8-11 UNC Lock Nut
6. 5/8-11 UNC Puller Hole
7. Crankshaft

FIGURE 4-48 Main Bearing Cap Puller

8. Turn the crankshaft so that sling lifting points are above the shaft center of gravity to prevent rotation when lifted. Lift straight up with the crankshaft ends parallel to the frame. The crankshaft weight requires two men and a crane or lift to safely remove it. Use appropriate sized nylon slings to prevent marring the crankshaft running surface.

CAUTION: Lifting the crankcase may cause the shaft to bind and damage it.

NOTE: Lower half bearing shells sometimes stick to the shaft journals. After lifting the shaft about ¼ inch (6mm) clear of the



1. Oil Slinger
2. Main Bearing Journals
3. Chain Sprocket
4. Crank Pins
5. Counterweights

FIGURE 4-49 Typical Crankshaft

saddles, verify the lower half bearing shells remain on the saddles. If not, tap them back onto the saddles before lifting the shaft further.

9. While one person raises the crane 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 on the shaft end to keep the crankshaft level. Wear clean gloves for a good grip, to avoid cuts from the slinger, and to avoid marring the running surface. As the shaft slowly raises, lift the drive and auxiliary ends at the same rate. Carefully guide the crankshaft to avoid marring its surfaces.

Oil Slinger Replacement

CAUTION: Do not touch hot surfaces without proper protection.

Although the slinger should last indefinitely with proper care, it may become nicked. To replace it:

1. Suspend the crankshaft as detailed in "Crankshaft Removal" and heat the slinger until it glows yellow (about 400°F or 204°C). When it expands, it should fall off by itself.
2. Slide a minimum ½-inch (13mm) diameter rod through the new slinger. Do not mar slinger surfaces, and be careful of its sharp outer edge. Suspend the slinger and heat it with a small torch. When it glows yellow (about 400°F or 204°C), slip it over the drive end of the crankshaft. Hold the slinger in place with high temperature gloves or two pieces of clean wood. Rotate it slightly to ensure squareness, until it cools enough to shrink onto the crankshaft.

Main Bearing Removal

1. Remove top cover and spacer bars. If spacer bar bolts are difficult to loosen, use a 12-point slugging wrench and hammer. Spacer bars fit snugly, but should slide out by hand without hammering. They should not fall out. If fit is too loose or tight contact your packager or Ariel before proceeding.
2. Remove main (journal) bearing cap screws. Pull caps straight up to prevent damage to the dowel fit. If cap is tight, use a bearing cap puller (see FIGURE 4-50). Remove shells from main bearing caps.

1. Puller Nut - turn to pull bearing cap straight up.
2. Rectangular Steel Bar Clearance Hole: 5/8 in. (15 mm) Length:16 in. (40 mm)
3. Drill Hole
4. Threaded Rod Nominal Size: 1/2 in. - 13 Length:10 in. (25 mm)
5. Lock Nut
6. Puller Hole
7. Crankshaft

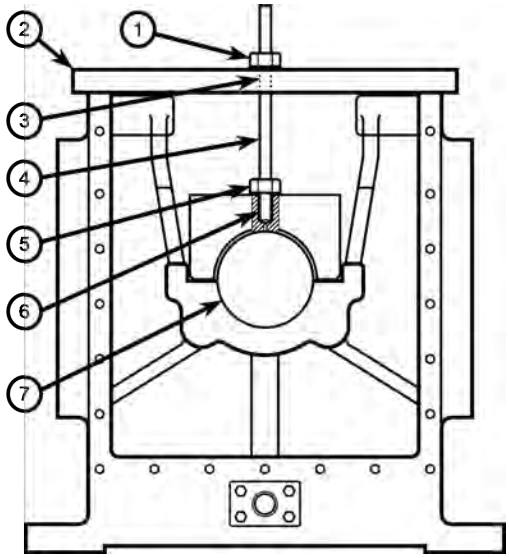


FIGURE 4-50 Main Bearing Cap Puller

3. Remove main journal bearing shells from under the crankshaft one at a time. If needed, attach clean nylon straps around the crankshaft and lift it 0.003 - 0.005 inch to lessen weight on the bearings and allow easier removal. To remove, rotate shell under the crankshaft tab side out first, by pushing or tapping with a non-metallic tool on the opposite split face side. Do not damage crankshaft bearing surfaces. Replace with new bearing shell, before rotating out the next main bearing shell.
4. Clean any coking or debris from both the saddle and main bearing cap surfaces and check for raised edges on machined surfaces. Verify all surfaces are as clean and dry as possible. Verify no bolting is damaged.

Main Bearing Installation

1. Check new bearing shells for damage, scratches, burrs, and loose material at the tab. **DO NOT RUB BEARING SURFACE WITH FINGERNAIL.** Keep the backs of shells dry and clean; installation requires perfectly clean bearing shells. Install bearing shells in caps, and frame journals, properly located in the tab notch, (rotate in the un-tabbed end first).

   JM:N:P:Q units use a thrust bearing, where the thrust plate is integral to one bearing shell, and the other shell has no thrust plate. Install the bearing shell with the integral thrust plate into the #1 main bearing cap.

   NOTE: Where bearings are identified with an ink pictograph, main and connecting rod bearings are not interchangeable. Do not put connecting rod bearings in main bearing locations. Do not mix part numbers on an individual main or connecting rod. Both bearing half shells must have the same part number.

2. Apply a liberal amount of clean, new lube oil to crankshaft bearing surfaces.
3. Main bearing caps have position match-marks corresponding with frame spacer bars and spacer bar bosses. Install main bearing caps with new bearing shells in their correct locations. Seat the cap by tapping it with the handle of a hammer or screwdriver. It is a machined fit, not a press fit, and the cap should not rock in the jaw fit when it seats. Do not use bolting to force the cap to seat. Snug the cap screws. Starting at the thrust end, use the torque procedure in the technical manual to tighten the main bearing cap bolts to the torque listed in Appendix A .
4. Verify proper alignment of main bearing cap dowels with the holes in the crankcase base. A set screw on top of each dowel prevents it from backing out.
5. Check crankshaft journal bearing jack (at each bearing) and crankshaft thrust clearances to values in Appendix B (see procedure below). Record readings on a copy of the form in Appendix D. If readings are out of tolerance after new bearing installation, contact your packager or Ariel before proceeding.
6. Install spacer bars so the match mark is up and next to the spacer bar boss with the same mark. Tighten all spacer-bar cap screws to the torque listed in Appendix A .
7. Account for all tools, equipment, supplies, and parts to ensure none are left inside the crankcase. Reinstall gaskets and top cover(s). Tighten cover bolts hand wrench tight.
8. Reverse lockout procedures.
9. After replacing bearings, pre-lube compressor for 10-15 minutes at 30 psi to ensure bearing lubrication and to help remove foreign materials from the lube system.
10. Run the compressor according to the time intervals listed on the form in Appendix D. After each run, shut down and remove the frame top cover. Measure main and connecting rod bearing cap temperatures with a hand held thermocouple probe or infrared thermometer and record them on a copy of the form in Appendix D. Complete the form and email or fax it to Ariel Field Service.

Main Bearing Vertical Jack Clearance Measurement

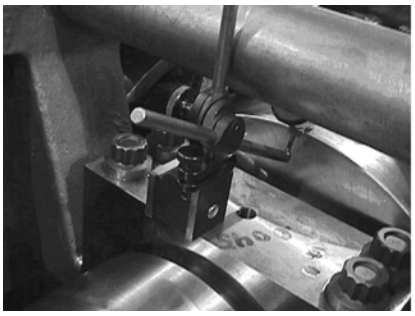
1. Turn the crankshaft until the web adjacent to the desired main bearing is vertical (see FIGURE 4-51).
2. Loop a lifting strap around the crankshaft web adjacent to the main bearing and attach the strap to a crane.

   NOTE: If the crane does not have a fine adjustment, attach a chain hoist to the crane lifting hook to prevent excessive force on the crankshaft and crane.

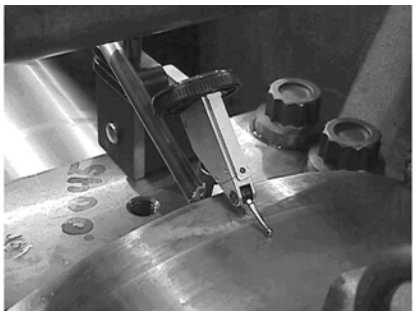
3. Attach the magnetic base of a needle dial indicator to the top of the main bearing cap. Place the point of the dial indicator against the top of the adjacent web and zero it.

4. GENTLY lift crankshaft. The dial indicator needle moves steadily until the crane/hoist overcomes crankshaft oil stiction, at which point the needle jumps a little. Stop lifting immediately at this point, and note the reading.
5. Release crane/hoist pressure and repeat step 4 to verify the measurement.
6. Repeat the measurement process for each main bearing. If a reading is outside Appendix B tolerances, contact your packager or Ariel.

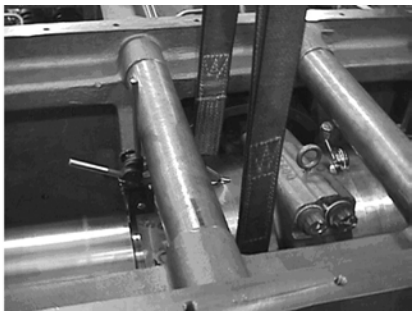
   NOTE: Remove magnetic bases, dial indicators, and lifting strap after measurement.



Dial Indicator magnetic stand placement on top of a main bearing cap.



Needle-type dial Indicator placement on top of adjacent crankshaft web.



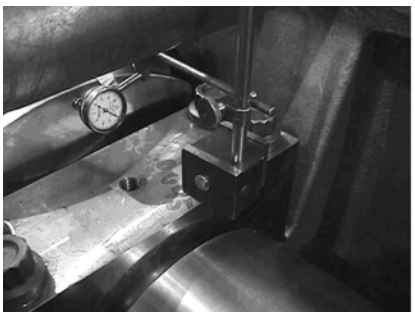
Place lifting strap around crankshaft web - attach strap to a crane.

FIGURE 4-51 Typical Crankshaft Journal Bearing Vertical Jack Clearance Measurement

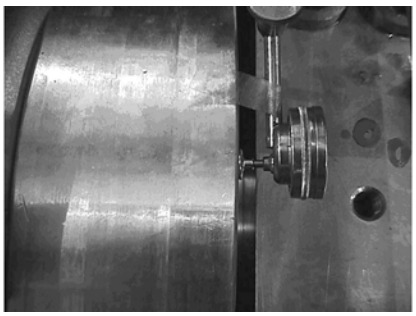
Crankshaft Thrust (End) Clearance Measurement

1. Attach the magnetic base of a button dial indicator to the top of a main bearing cap. Place the button of the dial indicator against the side of the adjacent crankshaft web (see FIGURE 4-52).
2. Use a pry bar to pry against the compressor frame and thrust the crankshaft tight toward the dial indicator. Release pressure and zero the dial indicator.
3. Thrust the crankshaft tight in the opposite direction until the dial indicator needle stops moving, then release pressure. Note reading. Repeat steps 2 and 3 to verify measurement accuracy.
4. If the measurement is outside Appendix B tolerances, contact your packager or Ariel.

   NOTE: Remove magnetic bases, dial indicators, and pry bar after measurement.



Dial Indicator magnetic stand placement on top of a main bearing cap.



Button-type dial Indicator placement against the side of crankshaft web.



Pry against compressor frame to thrust crankshaft back and forth.

FIGURE 4-52 Typical Crankshaft Thrust Clearance Measurement

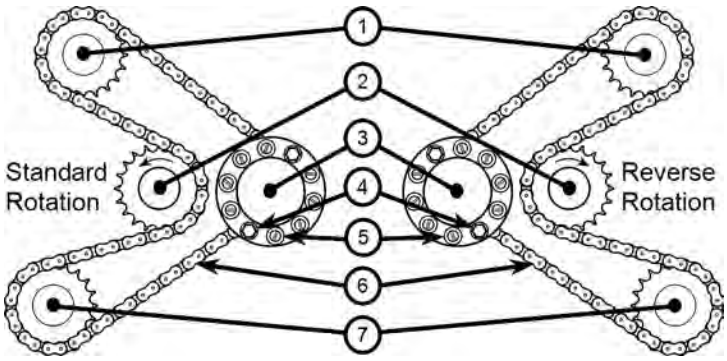
Crankshaft Installation

1. Verify correct new main bearing half shells positioned in the frame saddles, absolute cleanness, and bearing surfaces lubricated with clean crankcase oil.

2. Move connecting rods to full outer position. If the piston rods are still attached to the crossheads, the heads and wiper packing gland may need repositioned so the rods clear the crankshaft. While the crankshaft lowers very slowly into the crankcase (suspended by a crane with a clean nylon sling), one man wearing clean gloves should grasp the drive end and slowly maneuver the drive end and auxiliary end straight down into the crankcase. Both drive end and auxiliary end journals should touch the bottom bearing shells at the same time.
3. When the crankshaft rests on the bottom bearing shells, lubricate upper crankshaft pin bearing surfaces with new clean crankcase oil and install bearing caps (with their correct bearing half shells in place) with the cap screws lightly snugged. See "Recommendations for Torque Accuracy" and TABLE A-3 in Appendix A to tighten the bolts to the correct torque. Bearing caps are match-marked to correspond with the spacer bar and spacer bar bosses on the frame.
4. Verify bearing cap dowel alignment with crankcase base holes. A set screw on top of each dowel prevents it from backing out.
5. Before connecting rod installation, measure each crankshaft journal bearing jack clearance with a dial indicator (see procedure on page 4-39 and allowable clearances in Appendix B in Appendix B).
6. Reattach connecting rods (See "Connecting Rod Installation" on page 4-33), packing diaphragms, and unloaders/head end heads.
7. Reinstall chain drive. (See "Chain Drive System" on page 4-41).
8. Replace spacer bars. Locate spacer bar match mark. Install spacer bar so the match mark is up and next to the spacer bar boss with the same marking.
9. Lubricate both sides of cover gaskets with anti-sieze lubricant or multi-purpose grease to ease future removal. Install new end cover gaskets. With a knife, trim excess from new end cover gaskets flush to the base after re-bolting end covers.
10. Examine top cover gasket. If there is doubt about its condition, install a new gasket. Reinstall top cover. Reinstall coupling hub (if removed) and the coupling disk pack to coupling manufacturer instructions.

Chain Drive System

The chain drive system is crankshaft-driven at the auxiliary end of the frame. For JGM:P:N:Q compressors, a single chain runs the lube oil pump and force feed lubricator. An idler sprocket attached to the eccentric adjustment cap controls chain tightness. The chain dips into the crankcase oil for constant lubrication. In dry sump applications, an oil sprayer lubricates the chain.



1. Force Feed Lubricator Sprocket
2. Crankshaft Sprocket
3. Eccentric Adjustment
4. Cap Screw
5. Dust Plug
6. Chain
7. Oil Pump Sprocket

FIGURE 4-53 JGM:P:N:Q Chain Drive Systems

Chain and Sprocket Replacement

Replace chain(s) if elongation exceeds 0.084 inches (2.13 mm) over a 10 pitch length. Measure the section of chain with vernier calipers while it is stretched tight in position in the compressor. Add a measurement outside the rollers at 10 pitches (X) to a measurement between the inside of the same rollers (Y), and then divide by two. Replace the chain if the result exceeds 3.834 inches (97.4 mm)

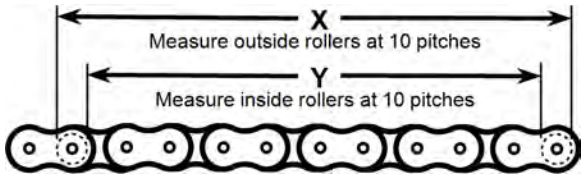
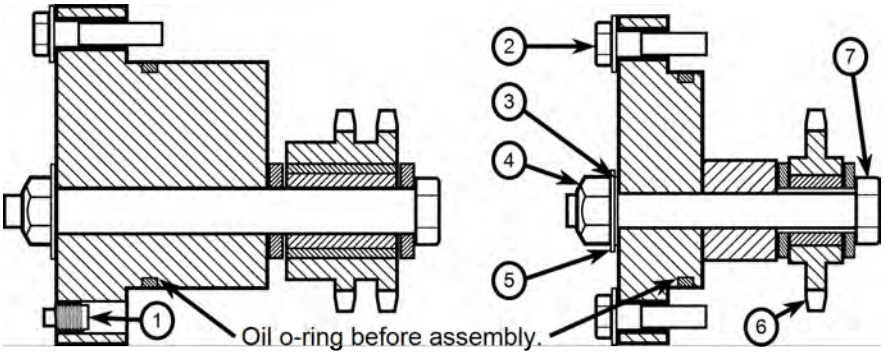


FIGURE 4-54 Measuring to Check Chain Elongation

Replace sprockets showing any undercutting or other damage.

Chain Idler Sprocket Replacement (Eccentric Adjustment Caps)

1. Chain idler sprocket location varies for standard versus reverse rotation.
2. Remove frame top cover.
3. Remove all dust plugs from the eccentric cap and all cap screws holding the eccentric cap to the end cover. Rotate eccentric cap to loosen chain for removal. Drop the chain off the idler sprocket and remove entire assembly from the end cover.



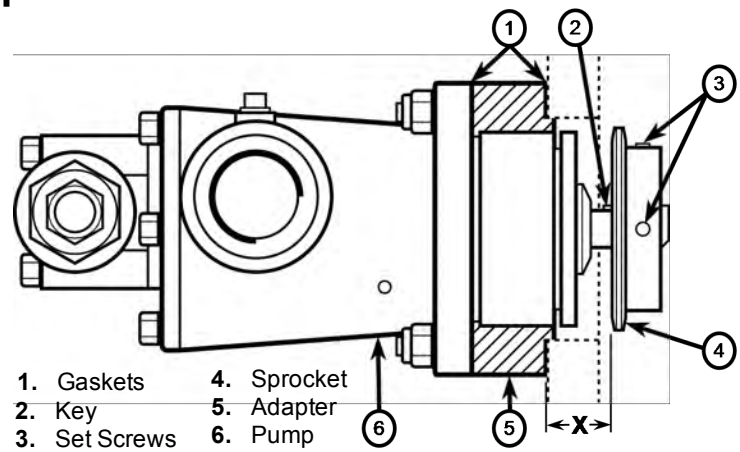
1. Dust Plug
2. Cap Screw
3. Stat-O-Seal
4. Self-Lock Nut
5. Washer
6. Sprocket
7. Thru Bolt

FIGURE 4-55 Typical Chain Idler Sprockets (Eccentrics)

4. Remove and discard lock nut, hex cap screw, stat-o-seal washer, and cap O-ring.
5. Reassemble new cap screw, stat-o-seal washer, sprocket, and lock nut. Tighten idler lock nut to recommended torque in Appendix A .
6. Apply oil and install a new O-ring. Install assembly and chain.
7. Take care when measuring and adjusting the force feed idler sprocket; it is thinner than the force feed lubricator and drive sprockets. To center the idler sprockets in the chain, subtract the force feed idler sprocket thickness from the drive sprocket thickness and divide the difference by 2. Add this value to the measurement from the inside face of the auxiliary end cover to the outside face of the force feed idler sprocket. Adjust driven sprockets to the drive sprocket measurements, aligned within 1/32 inch (1 mm). Non-alignment may require disassembly and shimming eccentrics.
8. Adjust chain according to “Chain Adjustment” on page 4-45.

Lube Oil Pump Sprocket Replacement

1. Remove all pump piping. Remove fasteners from pump mounting flange. After chain removal, the pump with sprocket comes free through the end cover hole.
2. To position the new sprocket, use a machinist rule to measure the exact distance from sprocket drive face to pump mounting flange face (X). 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 the shaft.



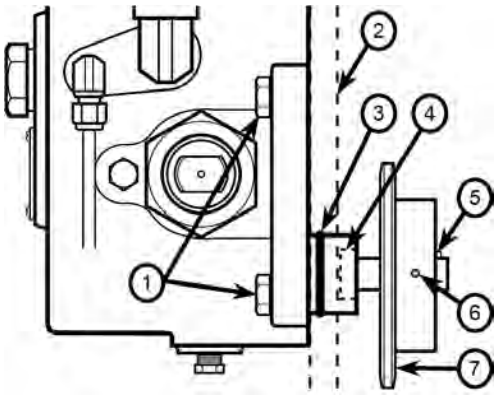
1. Gaskets
2. Key
3. Set Screws
4. Sprocket
5. Adapter
6. Pump

FIGURE 4-56 Typical Lube Oil Pump Chain Sprocket

4. Remove the key from the shaft and file the shaft to smooth burrs raised by the set screw cup point.
5. Install a new key (see build book for type and dimensions). First verify it fits into the new sprocket. If too thick, polish the key with emery cloth on a flat surface until it easily slides into the notch. The top edge may also require a little filing.
6. Install new sprocket to the original measurement between the sprocket drive face and the pump mounting flange face. When in position, tighten set screws.
7. Lubricate both sides of cover gaskets with anti-seize lubricant or multi-purpose grease to ease future removal. Install new end cover gaskets.
8. Reinstall pump onto end cover. Using a straight edge, to within 1/32 inch (1 mm), check alignment to crankshaft drive sprocket with crankshaft centered in end play. If misaligned, adjust sprocket position as needed.
9. Adjust chain according to “Chain Adjustment” on page 4-45.
10. Reinstall all piping to pump.

Force Feed Lubricator Chain Sprocket Replacement

1. With a good machinist rule, measure exact distance from inside face of auxiliary end cover to near face of lubricator sprocket. Note measurement for proper positioning of new sprocket. Remove chain.
2. Remove sprocket set screw and sprocket. Detach all tubing to lubricator.
3. Remove mounting bracket cap screws and lubricator.
4. With the lubricator on the bench, remove key from shaft and file shaft to remove burrs raised by set screw cup point. Oil and install a new O-ring.
5. Dig out the shaft oil seal with an awl and install a new one.
6. Install a new key. Verify it fits into the new sprocket (see build book for key type and dimensions). If too thick, polish it with emery cloth on a flat surface until it easily slides into the notch. The top edge may also require a little filing.
7. After new key installation, verify the new sprocket fits, oil the new O-ring, and remount lubricator to the end cover.



1. Mounting Bracket Cap Screws (4)
2. Auxiliary End Cover
3. O-Ring
4. Shaft Oil Seal
5. Key
6. Set Screw
7. Sprocket

FIGURE 4-57 Force Feed Lubricator Chain Sprocket

8. Slide new sprocket onto the shaft and set to dimension measured in step 2. Tighten set screw.
9. Using a straight edge, to within 1/32 inch (1 mm), check alignment to crankshaft drive sprocket with crankshaft centered in end play. When aligning this sprocket with the idler sprocket, take into account that the idler sprocket is thinner than the other sprockets. If misaligned, adjust sprocket position as needed.
10. Install chain and adjust according to "Chain Adjustment" on page 4-45.
11. Re-attach all tubing to lubricator.

Crankshaft Chain Sprocket Replacement

CAUTION: Do not touch hot surfaces without proper protection.

Examine the sprocket carefully for wear; sprockets operating for five years or more may require replacement. To replace a worn sprocket:

1. Drill a hole in the sprocket hub parallel to the shaft centerline and big enough to remove most of the hub cross section (see figure to the right). Multiple smaller holes may be required. **DO NOT** touch shaft with drill. Mark the drill with tape to avoid drilling through the sprocket and into the crankshaft face. The hole relieves most of the shrink, and a few radial strikes with a hammer and chisel opens the sprocket enough for easy removal.
2. Suspend the sprocket with a wire and heat it with a small torch to about 400°F (204°C), then slip it over the auxiliary end of the crankshaft. Hold the sprocket in place and rotate it slightly to ensure squareness until it cools enough to shrink onto the crankshaft.

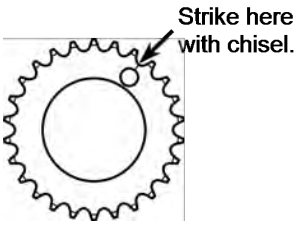


FIGURE 4-58 Chain Sprocket Removal

Chain Adjustment

1. Roll the crankshaft to the tightest position of the chain. This prevents snugging 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. Use a tape measure to measure the longest most easily accessible span from sprocket center to sprocket center, where the deflection will be gauged. Determine allowable deflection limits for the measured span as defined by the shaded area in FIGURE 4-60.

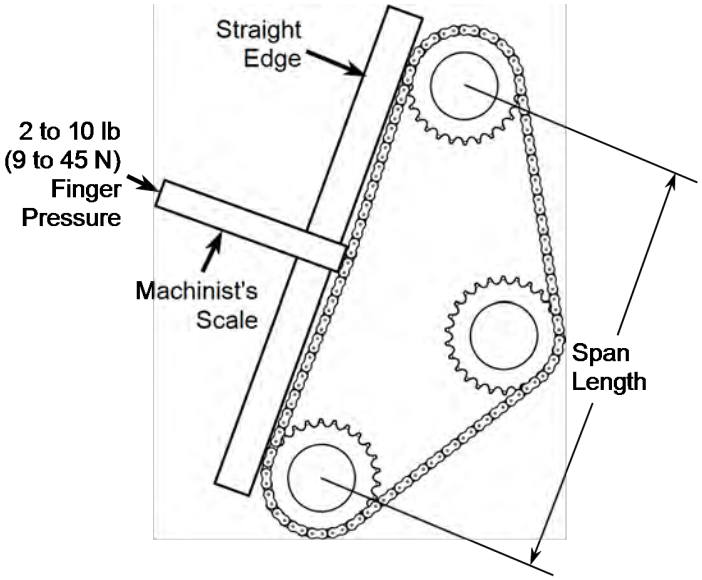


FIGURE 4-59 Chain Deflection Measurement

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.
4. If adjustment is required, remove the cap screws and plastic plugs from the eccentric cap. Rotate the cap clockwise to line up the first two new cap screw holes. If this tightens the chain too much, turn the cap counterclockwise for a different hole alignment.
5. Replace and tighten the two cap screws hand wrench tight. **CAUTION: Over tightening may result in bent shafts.**
6. Roll crankshaft to check tightness in several positions. At its tightest position, the chain should deflect within the shaded limits in the figure below. Replace plastic caps to keep holes clean.

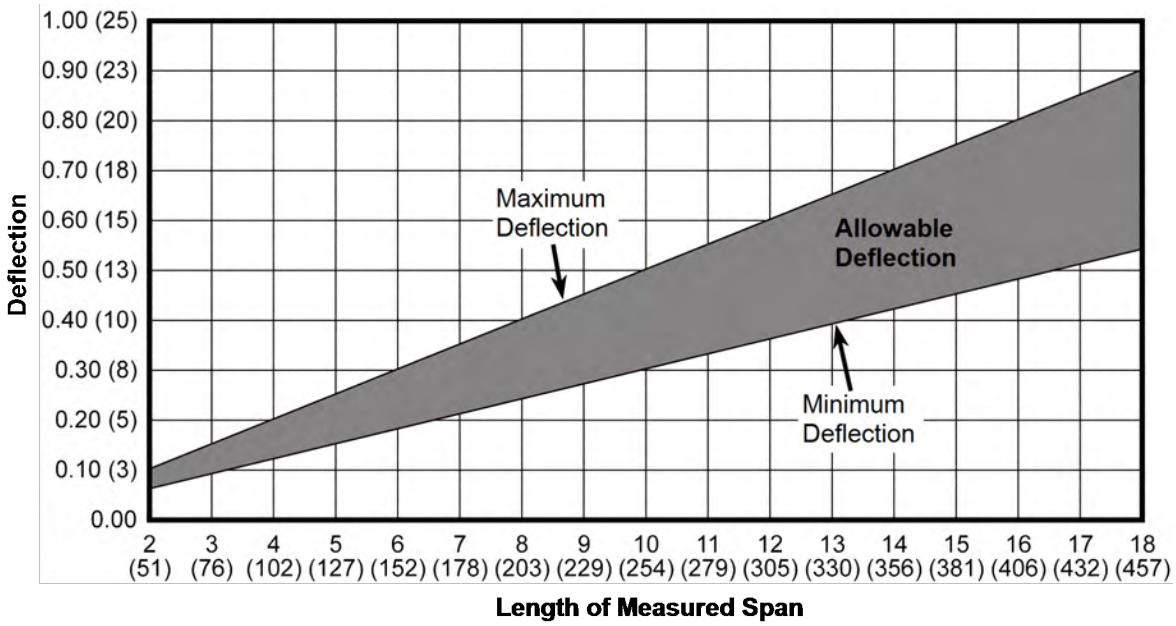


FIGURE 4-60 Allowable Chain Deflection, Inches (mm)

Component Cleaning & Thread Lube for Non-Lube Compressor Cylinders

Ariel cleans and protects complete non-lube cylinders to non-lube service requirements. Clean all internal parts shipped loose, contaminated internal surfaces, and repair parts prior to installation, to extend the life of rings and non-lube compressors.

Clean cylinder bore thoroughly with denatured alcohol until a clean, alcohol-soaked, white paper towel removes no more 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 cylinder seating surfaces to seal O-rings.

CAUTION: Denatured alcohol presents health and safety hazards. It contains methyl alcohol and is poisonous if ingested. Avoid eye and skin contact. 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. Properly handle and dispose of materials resulting from clean-up. See manufacturer's material safety data sheets for more details.

Do not use any lubricants or anti-seize compounds on parts that may contact the gas stream.

Use very small amounts of Never-Seez regular grade on nut and collar when assembling piston assembly. Thoroughly clean piston (especially the ring grooves) with denatured alcohol until a clean, alcohol-soaked towel removes no more debris.

Disassemble packing case. Wipe all surfaces clean with denatured alcohol. Re-assemble. Handle cleaned parts with new or clean "rubber" or new white cotton gloves.

Before piston rod installation, wipe it with denatured alcohol. Be careful not to leave fingerprints on the rod before it contacts the packing rings. Wipe the rod with denatured alcohol after installation.

Clean the head end head or unloader components with denatured alcohol. Use minimal amounts of oil for the bolt-holes to ensure oil does not run into the cylinder. Also install the head end steel gasket without Never-Seez.

Disassemble and clean the valves with denatured alcohol, then re-assemble, wipe them again, and install. Clean retainers and high clearance assemblies with denatured alcohol. Use only a thin film of oil for the valve cap O-rings and bolt-holes.

Assemble cleaned parts immediately to avoid contamination and corrosion. If cylinder will not commence immediate service, contact Ariel for preservation instructions to ER-34.

Section 5 - Start Up

The checklist below contains all the checks, verifications, and instructions necessary to start smaller Ariel reciprocating compressor models. Use it as guide when restarting the compressor after a shutdown.

Warranty Notification - Installation List Data and Start Up Check Lists for Reciprocating Compressors JG:A:M:P:N:Q:R:J:H:E:K:T:C:D:F

The following forms are designed to ensure a successful start-up of smaller Ariel reciprocating compressor models. Ariel warranty coverage requires these completed forms sent to:

Administrative Assistant - Sales, Ariel Corporation
35 Blackjack Road • Mount Vernon, Ohio 43050 USA
Phone: 740-397-0311 • FAX: 740-397-3856

Warranty Notification - Installation List Data

Date:_____ Name: _____

☐ Unassigned ☐ Resale ☐ Direct Sale ☐ Lease-Purchase ☐ Rental/Lease Unit

Compressor Frame

Frame Model:_____ Frame Serial #:_____

Frame Lubricant Make and Grade:_____

Package Startup Date:_____

Distributor/Fabricator

Company:_____ Name:_____

Address:_____

City:_____ State:_____ Zip:_____ Country:_____

Fabricator Unit Number:_____

Application

☐ Air/Nitrogen ☐ CNG/GNC ☐ FPSO ☐ Gathering ☐ Fuel Gas Booster

☐ Refrigeration ☐ Pipeline ☐ PRC ☐ Injection ☐ Storage/Withdrawal ☐ Miscellaneous

Elevation:_____

H_2S%:_____ CO_2%:_____ Specific Gravity:_____ Non-Lube: ☐ Yes ☐ No

Unit Location

Customer Name:_____

Project/Lease Name: _____

Closest Town:_____ State:_____ Country:_____ Offshore: ☐ Yes ☐ No

Directions to Location or GPS:_____

_____

_____

_____

Customer Contact Person:_____ Contact Phone:_____

Contact Email:_____ OK to contact: ☐ Yes ☐ No

Driver

Driver Manufacturer:_____ Driver Model:_____

Driver Type:_____ Applied RPM:_____ Name Plate HP (kW):_____

Coupling Manufacturer:_____ Coupling Model:_____

Compressor Cylinders and Operating Conditions

Cylinder Class	Stage Number	Throw Number	Serial Number	Bore Dia. In. (mm)	Inlet Temp. °F (°C)	Inlet Pres. psig (barg)	Disc. Temp °F (°C)	Disc. Pres. psig (barg)
_____	_____	_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____	_____	_____

Cylinder Lubricant Make and Grade:_____

Documentation and Accessories

Check all items included in the shipment:

Maintenance and Repair Manual	☐ Yes	☐ No	Recommended Spares List	☐ Yes	☐ No
Start-Up Spare Parts	☐ Yes	☐ No	Unit Start and Stop Procedures	☐ Yes	☐ No
Toolbox w/Ariel Tools	☐ Yes	☐ No	Toolbox with Hydraulic Tools (optional)	☐ Yes	☐ No
Unit Parts List	☐ Yes	☐ No	Toolbox with SAE Hand Tools (optional)	☐ Yes	☐ No

Commissioning Agent

Name:_____ Company:_____

Address:_____

City:_____ State:_____ Zip:_____ Country:_____

Phone:_____ Email:_____

START-UP CHECK LIST - ITEMS TO CHECK IN THE FIELD AT COMMISSIONING		
Description	**Date Checked**	**Date Verified**
1. Check and verify the top cover data plate of the compressor frame for compressor design limitations such as rod load, maximum and minimum speed, and maximum lube oil temperature.	Commissioning Agent: _____	Distributor: _____
2. Check and verify the availability of correct start-up spares, hand tools, special tools, compressor parts list and drawings, and technical manuals at installation.	Commissioning Agent: _____	Distributor: _____
3. Check and verify the Ariel lube sheet and Lubrication Specification matches the recommended oil grade and viscosity for the service.	Commissioning Agent: _____	Distributor: _____
4. Check and verify all lube oil piping cleanliness per Ariel lubrication specifications (see "Oil System Cleanliness" on page 3-9).	Commissioning Agent: _____	Distributor: _____
5. Verify lube oil storage and supply line cleanliness per "Oil System Cleanliness" on page 3-9). Verify crankcase oil supply isolation valve is open.	Commissioning Agent: _____	Distributor: _____
6. Verify pre-lube piping cleanliness per "Oil System Cleanliness" on page 3-9) and correct circuit operation.	Commissioning Agent: _____	Distributor: _____
7. Verify there is an oil cooler and high temperature shutdown for the oil into the compressor frame.	Commissioning Agent: _____	Distributor: _____
8. Verify whether the temperature control valve installation is blending or diverting (blending preferred). _____ _____	Commissioning Agent: _____	Distributor: _____
9. Check compressor crankcase oil level controller for proper installation, operation, levelness, and venting.	Commissioning Agent: _____	Distributor: _____
10. If applicable, check cooling water circuit cleanliness for the oil cooler and cooled packing per Maintenance and Repair Manual. Verify correct routing and test pump rotation. Set pressure appropriately per Maintenance and Repair Manual and leak test.	Commissioning Agent: _____	Distributor: _____
11. Verify correct filter element installation. Prime the oil filter element and all lube oil piping with oil.	Commissioning Agent: _____	Distributor: _____
12. Verify proper compressor crankcase oil level before starting (about 7/8 full in site glass).	Commissioning Agent: _____	Distributor: _____
13. Verify correct installation of a low oil pressure shutdown tubed to the downstream side of the oil filter.	Commissioning Agent: _____	Distributor: _____
14. Operate pre-lube system.	Commissioning Agent: _____	Distributor: _____
15. OPTIONAL STEP: Record "out of plane" readings (pre-grout) - see Appendix G - ER-82. _____ _____ _____ _____ _____ _____ **Drive End** _____ _____ _____ _____ _____ _____ **Auxiliary End**		
	Commissioning Agent: _____	Distributor: _____

START-UP CHECK LIST - ITEMS TO CHECK IN THE FIELD AT COMMISSIONING		
Description	**Date Checked**	**Date Verified**
16. Record soft foot readings. Over 0.002 inches (0.05 mm) pull-down on any frame foot requires correction. _____ _____ _____ _____ _____ _____ **Drive End** _____ _____ _____ _____ _____ _____ **Auxiliary End**	Commissioning Agent: _____	Distributor: _____
17. Check crosshead guide shimming for correct pre-load and hold down bolt torque.	Commissioning Agent: _____	Distributor: _____
18. Record piston end clearances with feeler gages (see Maintenance and Repair Manual, Appendix B). **Throw** 1 2 3 4 5 6 **Head End** _____ _____ _____ _____ _____ _____ **Crank End** _____ _____ _____ _____ _____ _____		
NOTE: Pre-lube compressor before turning crankshaft.	Commissioning Agent: _____	Distributor: _____
19. Measure and record rod run out (see Maintenance and Repair Manual for maximum acceptable readings). **Throw** 1 2 3 4 5 6 **Vertical:** **Piston @ CE** _____ _____ _____ _____ _____ _____ **Mid-Stroke** _____ _____ _____ _____ _____ _____ **Piston @ HE** _____ _____ _____ _____ _____ _____ **Horizontal:** **Piston @ CE** _____ _____ _____ _____ _____ _____ **Mid-Stroke** _____ _____ _____ _____ _____ _____ **Piston @ HE** _____ _____ _____ _____ _____ _____		
NOTE: Pre-lube compressor before turning crankshaft.	Commissioning Agent: _____	Distributor: _____

START-UP CHECK LIST - ITEMS TO CHECK IN THE FIELD AT COMMISSIONING		
Description	**Date Checked**	**Date Verified**
20. Measure crosshead clearances with cylinders mounted. To check top, insert 0.5 inch (12.7 mm) wide feelers from one side edge across to the opposite side, at both ends. See Maintenance and Repair Manual, Appendix B for limits. To check bottom, insert a 0.0015 inch (0.038 mm) feeler at the four corners; feeler should insert no more than 0.50 (13 mm). Record values: **Throw** **Top Min.** **Top Max.** **Bottom Max. (Corners)** **1** _____ _____ _____ **2** _____ _____ _____ **3** _____ _____ _____ **4** _____ _____ _____ **5** _____ _____ _____ **6** _____ _____ _____	Commissioning Agent: _____	Distributor: _____
21. For electric motor drivers, check and verify the motor shaft is set at its magnetic center before positioning axial clearance. With the coupling disconnected, check and verify driver rotation matches the compressor rotation arrow.	Commissioning Agent: _____	Distributor: _____
22. Check coupling bolt torque to coupling manufacturer recommendations.	Commissioning Agent: _____	Distributor: _____
23. Check and verify compressor to driver alignment (installed on site, cold). Record dial indicator readings in inches (mm) at the 3, 6, 9 and 12 o'clock positions or attach alignment tool print-out.  If using a laser alignment tool, make a print out and attach it to this document.	Commissioning Agent: _____	Distributor: _____
24. Check and verify compressor crankshaft thrust clearance. The shaft should remain stationary after thrusting each direction (see Appendix B). _____ _____	Commissioning Agent: _____	Distributor: _____

START-UP CHECK LIST - PROCESS PIPING VENTS AND DRAINS		
Description	**Date Checked**	**Date Verified**
1. Verify the bottle and process pipe installation contains no bolt bound flanges or elevation differences that may stress the compressor cylinders	Commissioning Agent: _____	Distributor: _____
2. Verify cold adjustment of any bottle or cylinder supports.	Commissioning Agent: _____	Distributor: _____
3. Verify correct inlet screen orientation in process piping.	Commissioning Agent: _____	Distributor: _____
4. Check and verify vents and drains of the primary and secondary packing-case and the crosshead distance piece are open and tubed to a safe atmosphere.	Commissioning Agent: _____	Distributor: _____
5. Check and verify safety relief valve installation to protect cylinders, piping, and cooler for each compression stage.	Commissioning Agent: _____	Distributor: _____
6. Record method of suction pressure control and valve size. _____ _____	Commissioning Agent: _____	Distributor: _____
7. Check and verify crankcase breather element is open to atmosphere and clean.	Commissioning Agent: _____	Distributor: _____
8. Check and verify torque to spec on all gas containment and other fasteners where loosening may result in a safety hazard or equipment failure including: gas nozzle flanges, valve caps, cylinder heads, compressor rod packing, and crosshead guide support. See Appendix A .	Commissioning Agent: _____	Distributor: _____

START-UP CHECK LIST - INSTRUMENTATION		
Description	**Date Checked**	**Date Verified**
1. Check and verify the set point for the high compressor oil temperature shutdown at 190°F (88°C) maximum.	Commissioning Agent: _____	Distributor: _____
2. Check and verify proper vibration shutdown installation and operation. Record alarm and shut down settings. _____ _____ _____	Commissioning Agent: _____	Distributor: _____
3. Verify operation of suction, inter-stage, and discharge pressure shutdowns. Record alarm and shutdown settings. _____ _____ _____	Commissioning Agent: _____	Distributor: _____
4. Check, verify, and record the over speed setting: _____	Commissioning Agent: _____	Distributor: _____

START-UP CHECK LIST - FORCE FEED LUBRICATION SYSTEM		
Description	**Date Checked**	**Date Verified**
1. Check and verify force feed lubricator box for proper oil level.	Commissioning Agent: _____	Distributor: _____
2. Prime the force feed lubrication system through the purge port at the force feed pump discharge manifold. Check and verify each tube connection for tightness.	Commissioning Agent: _____	Distributor: _____
3. Check and verify operation of force feed lubrication system no flow shutdowns.	Commissioning Agent: _____	Distributor: _____
4. Record color of force feed blow out discs (see TABLE 3-3 for disc ratings): _____	Commissioning Agent: _____	Distributor: _____
5. Check, verify, and record recommended lube feed rates from lubricator data plate or "Parts Book" Cylinder Lubrication sheet. _____	Commissioning Agent: _____	Distributor: _____

FINAL PRE-START CHECK LIST		
Description	**Date Checked**	**Date Verified**
1. Operate pre-lube system. Record pre-lube pressure:_____	Commissioning Agent: _____	Distributor: _____
2. For engine driven units, disable ignition and roll the engine with the starter to check and verify the compressor rolls freely. Check and verify oil pressure increases noticeably while rolling on the starter.	Commissioning Agent: _____	Distributor: _____
3. For electric motors, bar the compressor over manually to check and verify it rolls freely.	Commissioning Agent: _____	Distributor: _____
4. For machines compressing a combustible gas, purge the entire system including the piping, by-pass, recycle line, and compressor cylinders of all air.	Commissioning Agent: _____	Distributor: _____
5. Review start-up instructions for all other package components.	Commissioning Agent: _____	Distributor: _____
6. Complete the required review of the Start-Up and Operating Instructions for the unit with the unit operator.	Commissioning Agent: _____	Distributor: _____

INITIAL POST START-UP CHECK LIST		
Description	**Date Checked**	**Date Verified**
1. Check and verify immediate oil pressure increase. Enable oil pressure shutdown and bearing temperature shutdowns. Record initial pressure at operating speed._____ __	Commissioning Agent: _____	Distributor: _____
2. Check and verify oil filter pressure gauges. Record initial differential: _____ _	Commissioning Agent: _____	Distributor: _____
3. Check and verify the low oil pressure shutdown is active and set at 45 psig (3.1 barg).	Commissioning Agent: _____	Distributor: _____

INITIAL POST START-UP CHECK LIST		
Description	**Date Checked**	**Date Verified**
4. Check and verify lube oil pressure set at 50 to 60 psig (3.5 to 4.2 barg) at operating speed and temperature (see "Oil Pressure" on page 3-7). Record final setting:_____	Commissioning Agent: _____	Distributor: _____
5. Record oil filter maximum differential reference value listed on the compressor top cover filter data plate: _____	Commissioning Agent: _____	Distributor: _____
6. Listen and feel for any strange noises or vibration in the compressor or piping. Record any occurrences. _____ _____ _____ _____	Commissioning Agent: _____	Distributor: _____
7. Check and verify high discharge gas temperature shutdowns are set about 10% above normal operating temperature (350 °F (177 °C) maximum) and functioning.	Commissioning Agent: _____	Distributor: _____
8. Check and verify distribution block cycle time indicator and set lubricator pump for proper break-in rate.	Commissioning Agent: _____	Distributor: _____
9. Check and verify the unit and piping is free from any gas or fluid leaks. Record any occurrences. _____ _____ _____ _____	Commissioning Agent: _____	Distributor: _____
10. Check and verify scrubber high level shutdowns operation and check scrubber dumps operation and frequency.	Commissioning Agent: _____	Distributor: _____
11. Check, verify, and record tank levels that indicate the amount of liquids removed from the gas. _____	Commissioning Agent: _____	Distributor: _____
12. Check and verify piston rod packings seal properly in the primary packing vents.	Commissioning Agent: _____	Distributor: _____
13. Check and verify operation of all safety functions to ensure unit shutdown upon indication.	Commissioning Agent: _____	Distributor: _____
14. If applicable, check and verify main bearing temperatures and record. Watch for even bearing temperature increase.	Commissioning Agent: _____	Distributor: _____
15. During various operational conditions, use the Ariel performance program to check and verify operational characteristics of various load steps.	Commissioning Agent: _____	Distributor: _____

24-HOUR POST START-UP CHECK LIST		
Description	**Date Checked**	**Date Verified**
1. Record "hot" alignment readings after reaching normal operating temperatures and components become heat soaked. Shutdown and vent gas system. Within 30 minutes and while components are still hot, record dial indicator readings in inches (mm) at the 3, 6, 9 and 12 o'clock positions on lines provided below:  If using a laser alignment tool, make a print out and attach it to this document.	Commissioning Agent: _____	Distributor: _____
2. If using a discharge bottle or head end cylinder supports, adjust when components are heat soaked to ensure no excessive forces exist to cause detrimental cylinder deflection.	Commissioning Agent: _____	Distributor: _____
3. Check and verify torque on gas nozzle flange, valve cap, cylinder head, compressor rod packing flange, and guide to frame bolting.	Commissioning Agent: _____	Distributor: _____
4. Complete Ariel's "Compressor Warranty Notification - Installation List Data" (pages 5-1 and 5-2).	Commissioning Agent: _____	Distributor: _____

750-HOUR POST START-UP CHECK LIST		
Description	**Date Checked**	**Date Verified**
1. Check and verify torque on gas nozzle flange, valve cap, cylinder head, and compressor rod packing flange bolting. Re-check fasteners found loose in any of these intervals after an additional 750 hours. If loosening continues, contact your package supplier immediately.	Commissioning Agent: _____	Distributor: _____
2. Send completed form and check lists (pages 5-1 to 5-12) to Ariel as noted on page 5-1.	Commissioning Agent: _____	Distributor: _____

Section 6 - Compressor Troubleshooting

Expect minor problems during routine operation of an Ariel compressor. These troubles most often trace to liquid, dirt, improper adjustment, or operators unfamiliar with Ariel compressors. These difficulties can usually be corrected by cleaning, proper adjustment, elimination of an adverse condition, part replacement, or proper training.

Major problems usually trace to long periods of operation with unsuitable lubrication, careless operation, lack of routine maintenance, or using the compressor for purposes not intended.

Recording inter-stage pressures and temperatures on multistage units is valuable. Any variation when operating at a given load point indicates trouble in one of the stages. Normally, a decrease in inter-stage pressure indicates trouble in the lower pressure cylinder. An increase usually indicates trouble in the higher pressure cylinder. Below is a list of common problems and 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 in sight glass too high), or from vortex at strainer inlet (oil level in sight glass too low), or from leaks in pump suction line. • 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.
High/Low Suction Pressure	• Suction control valve malfunction. • Faulty pressure gauges. • Frozen/plugged inlet line. • Plugged intake screen or filter. • Scrubber dump valve stuck open. • Recycle malfunction. • Site production equipment problems.
High/Low Inter-Stage Pressure	• Faulty valves or rings. • Gas leak. • Frozen cooler section or tubing to panel. • Faulty pressure gauges. • Scrubber dump valve stuck open. • Load change.
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.
Frame Knocks	• Loose crosshead pin or pin caps. • Loose or worn main, crankpin, or crosshead bearings. • Low oil pressure. • Cold oil. • Incorrect oil.

Problem	Possible Causes
	• Knock is actually from cylinder end. • Low fluid level in damper.
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 inter-cooler piping. • Leaking discharge valves or piston rings. • High inlet temperature. • Improper lube oil and/or lube rate.
High Frame Oil Temperature	• Faulty temperature gauge. • Dirty oil filters. • High oil level. • Faulty thermostatic element. • Faulty thermostatic control valve. • Clogged or blocked oil cooler. • Binding or tightness in the compressor.
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.
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 runout. • Packing not seated or properly run in.
Drive End of Crankshaft Oil Leaks	• 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 Shutdown	• Force feed pump or lubricator block failure. • Loss of oil supply to force feed pump. • Lubricator drive failure. • Proflo not programmed correctly. • Proflo battery failure or power loss. • Loose or grounded control wiring.

Problem	Possible Causes
	• Pin assembly not completely pushed into the Proflo housing.
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 for pipe threaded connection use. • Pipe thread sealant incompatible with the synthetic oil used. • Cracked pipe or fittings.
Vibration Shutdown	• Short in wire to panel. • Incorrectly positioned vibration switch. • Loose mounting bolts. • High scrubber level (liquid carry-over). • Broken valve, piston, or piston rod. • Main drive-line or coupling failure.

Appendix A - Ariel Fasteners and Torques

This document lists fastener lubrication and torque requirements for proper assembly of current production JGM:P:N:Q reciprocating compressors. For older units with lower specified torque values, do not assume higher values without consulting the packager and/or Ariel.

- Use only Ariel specified fasteners tightened to the correct torque.
- Connecting rod, valve cap, and suction/discharge nozzle (Ariel supplied flange) fasteners are modified to prevent fatigue; do not replace them with standard cap screws. For questions about replacing other fasteners with standard cap screws, contact your packager or Ariel.
- Clean and de-burr all threads.

TABLE A-1 Fastener Thread & Seating Surface Lubrication

NOTE: Lubricate all fasteners both under the head and on the threads.	
Application	**Lubricant**
• **Frame:** jack screws • **Steel Cylinders:** valve cap, packing, crank end and head end head, gas passage • **Pistons:** piston nuts, set screws, piston collar, crosshead threads • All stainless steel fasteners	Never-Seez Regular Grade
Fasteners specified with Loctite on threads	Use Loctite only with no additional lube
Connecting rod fasteners	Lubriplate 630
All other fasteners	Mineral oil (ISO 100-150)

- Do not use Molybdenum disulfide lubricants.
- Do not use Never-Seez for fastener lubrication unless specified or excessive stresses may result with specified torques. See TABLE A-1.
- Use anti-seize lubricants sparingly; excessive amounts cause oil analysis to indicate contamination and may unnecessarily increase maintenance costs.
- Re-preserve any fasteners subject to corrosion after installation.



Hex Head Grade 5 | Hex Head Grade 8 | Hex Head Grade 9 | Hex Socket Head Grade 8 | 12 Point Grade 8 | 12 Point Grade B7M | 12 Point Grade 5 | 12 Point Stainless 17-4PH | 12 Point Metric Class 8.8

FIGURE A-1 Bolt Head Grade and Material Identification

CAUTION: To replace a fastener, see parts list for fastener grade and part number. Do not use a lesser or greater material grade. Use Ariel parts to replace special fasteners and fasteners with reduced body diameter for fatigue resistance. Do not torque fasteners with compressor running or pressurized. Read technical manual safety warnings.

Recommendations for Torque Accuracy

1. Qualified personnel must use a properly calibrated torque wrench to correctly torque fasteners.
2. Determine torque wrench accuracy range. Most torque wrenches are not accurate over their entire range.
3. Clean and de-burr all threads before assembly.
4. Tighten all multi-bolt assemblies in steps (optional for Grade 5 cap screws). Snug opposing pairs of cap screws until all are snug. Next, tighten each cap screw to 25% of full torque in the same pattern. Repeat this step for 50%, 75%, and 100% of full torque. For main bearing stud nuts and connecting rod bolts, repeat the 100% step to verify proper pre-torque of fasteners prior to the final partial turn.
5. Always apply a steady slow force to a torque wrench, and stop immediately when the wrench clicks; do not jerk it. Jerking a torque wrench may apply up to one and a half times the torque setting.
6. Perform final tightening with a torque wrench. Do not tighten fasteners with a ratchet or impact wrench, and then "check" the torque with a torque wrench.
7. Do not double tap a torque wrench; it increases the set torque significantly.
8. When checking the torque of a tightened fastener, set torque wrench to required torque, then apply a slow steady force until the wrench clicks.
9. When finished, reset torque wrench to its lowest setting to relax the spring and help retain accuracy. A torque wrench left in a high setting stresses the spring and decreases accuracy with time.
10. Do not break fasteners loose with a torque wrench; it may overload the wrench and/or destroy calibration.
11. To determine the torque wrench setting when using a torque multiplier on larger fasteners, divide the desired fastener torque by the multiplier actual mechanical advantage, not the design mechanical advantage. Example: An X4 torque multiplier, model TD-1000 has a design mechanical advantage of 4.0, but an actual mechanical advantage of 3.6.
12. For hard to access fasteners requiring a boxed end or crow's foot adapter with a torque wrench, the torque setting is not the actual torque applied to the fastener, unless the adapter is 90° to the torque wrench. The ratio of actual fastener torque (Ta) with the torque setting (Tw) is a function of the length the adapter adds to the torque wrench (A), and the location of the applied force.

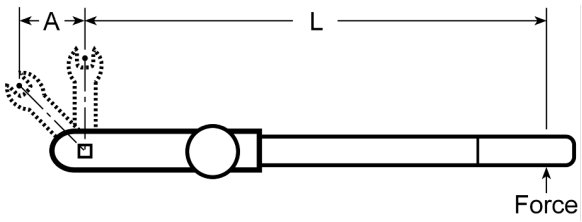


FIGURE A-2 Torque Wrench with Angled Adapter

Tw = Ta x [L ÷ (L + A)]

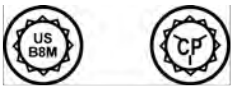
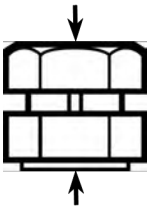
Tw = Torque wrench setting, lb x ft or N·m.
Ta = Torque required at fastener, lb x ft or N·m.
L = Length of wrench, ft or m (from square drive end to center point of force on handle).
A = Wrench length added by adapter, ft or m (measured through end of adapter on a line parallel to the center line of the wrench).

NOTE: Lb x In ÷ 12 = Lb x Ft

13. When studs are specified for cylinder applications, tighten nuts to the same values as cap screws in similar applications.
14. Install pipe threads and main cap plugs using Loctite 577 thread sealant. Synthetic oils may require Loctite 545 and Loctite Activator 7649 (N).

These are general guidelines for proper torque wrench use. Call a torque wrench dealer for details.

TABLE A-2 Hoerbiger Valve Assembly Fastener Torques

Fastener	Nominal Size Inch - TPI	Type	Torque LB x FT (N·m), unless specified
Center Cap Screw[a]  US Bolt 316 Stainless Steel, Grade B8M, NACE 6 — Chandler Products Grade 5	5/16 - 24	12 Point - Steel Grade 5 Material Parts: SPL3 & 4	12 (16)
	3/8 - 24		21 (28)
	7/16 - 20		30 (41)
	5/16 - 24	12 Point - Steel Grade 5 Material Parts: SPL or 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		16 (22)
	7/16 - 20		24 (33)
Peripheral Cap Screw	#10 - 32	Hex Socket Head	25 lb x in. (3)
	#12 - 28		43 lb x in. (5)
	1/4 - 20		110 lb x in. (12)
	5/16 - 18		176 lb x in. (20)
	3/8 - 16		21 (28)
Single-piece Lock Nuts (Microlok, JL-Nut, Spiralock®, Greer)	5/16 - 24	Lock Nut	109 lb x in. (12)
	3/8 - 24		17 (23)
	7/16 - 20		26 (36)
	1/2 - 20		41 (55)
	5/8 - 18		82 (110)
	3/4 - 16		145 (195)
	7/8 - 14		230 (310)
Center Stud Drake 2-Piece Beam Lock Nut **Top Half**  **Bottom Half**	**Inch - TPI**	**Bottom Half Torque** LB x FT (N·m), unless specified	**Top Half Torque** LB x FT (N·m), unless specified
	1/4 - 28	103 lb x in. (12)	66 lb x in. (8)
	5/16 - 24	120 lb x in. (14)	66 lb x in. (8)
	3/8 - 24	16 (22)	96 lb x in. (11)
	1/2 - 20	36 (49)[b]	20 (27)
	5/8 - 18	73 (99)	40 (54)
	3/4 - 16	130 (176)	70 (95)
	7/8 - 14	210 (285)	115 (155)

a. Center cap screw valve assemblies have Spiralock® (SPL) threads to prevent loosening. See bottom of valve assembly for SPL material parts number (3, 4, 5 or 6) and select proper torque from the table. Lubricate both threads and seating surfaces with a petroleum type lubricant ONLY. If using older valve assemblies not covered in the table, see the original torque chart provided in the compressor tool box, or contact Ariel for instructions. Spiralock® threads cannot be dressed with a standard tap. Clean center cap screws in valve assemblies not marked SPL with Loctite safety solvent and lock them with one or two drops of Loctite #272 thread locking compound. DO NOT use petroleum lubricants.

b. Use 29 (39) for 1/2 - 20 bottom half Drake lock nut with non-metallic valve plates in liftwasher valves.

TABLE A-3 JGM:P:N:Q Fastener Torques

Fastener	Nominal Size Inch - TPI	Type	Torque LB x FT (N·m), unless specified
Main Bearing Cap - Cap Screw	1/2 - 13	12 Point - Grade 8	58 (79)
Connecting Rod Cap - Cap Screw	1/2 - 13	12 Point - Grade 8 Socket Head	58 (79)
	1/2 - 20		67 (91)
Crosshead Pin Thru Bolt - Lock Nut	3/8 - 24	Hex - Flexloc	25 (34)
Frame to Cylinder; Unloader Actuator to Valve Cap - Cap Screw	1/2 - 13	12 Point or Hex Grade 8	48 (65)
Eccentric Vernier Cap - Cap Screw	5/16 - 18	Hex - Grade 8	Hand Wrench Tight
Idler Sprocket Thru Bolt - Lock Nut	1/2 - 20	Hex - Drill & Pin	41 (55)
Rod Packing - Cap Screw	1/2 - 13	12 Point - Grade 8	35 (48)
Piston Nut[a]	7/8 - 12	Ariel Design	222 (300)
Crosshead Nut	1" - 12	Ariel Design	Slugging Method
Rupture Disk - Blow-Out Fitting Cap	1/4 Nom. Tube	Hex - Tube Fitting	40 lb x in. (4.5)
Frame Foot Hold Down - Nut	5/8 - 11	Hex Nut	100[b] (130)
Crosshead Guide Foot Hold Down - Cap Screw	5/8 - 11	Hex - Grade 8 or 9	90 (120)
Cap Screw[c] • Valve Cap • Cylinder Head • Gas Passage • Unloader • Ariel supplied companion flanges	3/8 - 16	Hex Grade 8, 9, or 12 or 12 Point Grade B7M or 8	193 lb x in. (22)
	7/16 - 14		26 (35)
	9/16 - 12		57 (77)
	1/2 - 13		40 (54)
	5/8 -11		79 (105)
	3/4 - 10		140 (190)
	7/8 - 9		230 (310)
	7/8 -14		260 (350)
	1" - 8		345 (465)
	1" - 14		395 (535)
Tandem Cylinder to Cylinder - Cap Screw[b]	1/2 - 13	Hex - Grade 8 or 9 or 12 Point - Grade 8	44 (60)
	5/8 - 11		88 (120)
	3/4 - 10		160 (215)
	3/4 - 16		180 (245)
Fanshaft to Crankshaft - Central Stud	3/4 - 16	Ariel Design	250 (340)
Seating Studs in Cylinder **NOTE: In valve cap assemblies with a spring energized seal, install longer studs with Loctite 242.**	3/8 - 16	Dog Point	107 lb x in. (12)
	7/16 - 14		172 lb x in. (19)
	1/2 - 13		22 (30)
	9/16 - 12		32 (43)
	5/8 - 11		44 (60)
	5/8 - 18		51 (70)
	3/4 - 10		79 (105)
	3/4 - 16		90 (120)
	7/8 - 9		130 (170)
	1" - 8		200 (270)

Fastener	Nominal Size Inch - TPI	Type	Torque LB x FT (N·m), unless specified
Packing Tie Rod - Nut	10 - 24	Hex	20 lb x in. (2.3)
	1/4 - 20	Hex	72 lb x in. (8.1)
Distribution Block Tie Rod - Nut	1/4 - 28	Hex	68 lb x in. (7.7)
Distribution Block Divider Valve - Screw	1/4 - 28	Socket Head	75 lb x in. (8.5)
Force Feed Lubricator - Nut	1” - 14	Hex Jam Nut	75 (102)
Grade 5 - Hex Cap Screw	All	Hex - Grade 5	Hand Wrench Tight
Valve Cap Assembly - Cap Nut	All	Cap Nut	Hand Wrench Tight
Valve Cap Seal Keeper - Cap Screw	5/16 - 18	12 Point - 17-4PH	120 lb x in. (14)

a. Tighten, loosen, and re-tighten to ensure proper torque.

b. Minimum torque to stress recommended 5/8 - 11 TPI hold-down stud to 55,000 psi (380 MPa). Use studs with an ultimate strength of 100,000 psi (690 MPa) or greater. If greater, increase torque stress to about 55% of ultimate strength, as specified by packager.

c. For studs specified for cylinder applications, tighten nuts to the same torque as cap screws in similar applications.

Appendix B - Clearances

TABLE B-1 JGM:P:N:Q Main Component Clearances, in. (mm)[a]

Description	Clearance
Crankshaft Dust Seal (Feeler Gauge - Centered)	0.008 to 0.010 (0.20 to 0.25)
Crankshaft Thrust (End)	0.0035 to 0.011 (0.089 to 0.279)
Crankshaft Journal Bearing (Jack)	0.0005 to 0.0035 (0.013 to 0.089)
Connecting Rod Bearing (Jack)	0.0015 to 0.0040 (0.038 to 0.102)
Connecting Rod Thrust (Side)	0.007 to 0.016 (0.178 to 0.406)
Connecting Rod Bushing to Crosshead Pin	0.0014 to 0.0031 (0.036 to 0.079)
Crosshead Bushing to Crosshead Pin - JGN:Q	0.0014 to 0.0036 (0.036 to 0.091)
Crosshead (Bronze) to Crosshead Pin	0.0015 to 0.0025 (0.038 to 0.064)
Crosshead (Gray Iron) to Crosshead Pin - JGM:P	
Crosshead (Babbitted Ductile Iron) to Guide - JGN:Q	0.004 to 0.008 (0.10 to 0.20
Crosshead (Babbitted Bronze) to Guide	0.006 to 0.010 (0.15 to 0.25)
Crosshead (Gray Iron) to Guide - JGM:P	
Total Piston End Clearance - Double Acting[b]	0.090 to 0.145 (2.29 to 3.68)
Piston End Clearance - Crank End (Double Acting)	0.035 (0.89)
Piston End Clearance - Head End (Double Acting)	0.055 to 0.110 (1.40 to 2.79)
Total Piston End Clearance - Tandem[b]	0.090 to 0.180 (2.29 to 4.57)
Piston End Clearance - Crank End (Tandem)	0.035 (0.89)
Piston End Clearance - Head End (Tandem)	0.055 to 0.145 (1.40 to 3.68)
Maximum Fan Shaft Total Indicator Reading (TIR) Max.	0.010 (0.25)

a. Measured clearances may not agree due to oil films, wear, etc. Do not use plastigages, solder, etc.

b. If total piston end clearance (crank end + head end) is not within table tolerance, contact Packager or Ariel.

TABLE B-2 JGM:P:N:Q Side Clearances for New Conventional Piston Rings, in. (mm)

Nominal Width	Actual Groove Width	Teflon One-Piece	Bronze
3/16 (4.76)	0.187 to 0.189 (4.75 to 4.80)	0.005 to 0.009 (0.13 to 0.23)	0.004 to 0.008 (0.10 to 0.20)
1/4 (6.35)	0.250 to 0.252 (6.35 to 6.40)		
3/8 (9.53)	0.375 to 0.377 (9.53 to 9.58)	0.007 to 0.011 (0.18 to 0.28)	
3/4 (19.05)	0.750 to 0.752 (19.05 to 19.10)	0.014 to 0.019 (0.36 to 0.48)	0.006 to 0.010 (0.15 to 0.25)

TABLE B-3 JGM:P:N:Q Side Clearances for New Rider Ring Piston Rings, In. (mm)

Nominal Width	Actual Groove Width	Two-Piece
3/16 (4.76)	0.187 to 0.189 (4.75 to 4.80)	0.007 to 0.012 (0.18 to 0.30)
1/4 (6.35)	0.250 to 0.252 (6.35 to 6.40)	0.008 to 0.013 (0.20 to 0.33)
3/8 (9.53)	0.375 to 0.377 (9.53 to 9.58)	
1/2 (12.70)	0.500 to 0.502 (12.70 to 12.75)	
3/4 (19.05)	0.750 to 0.752 (19.05 to 19.10)	

TABLE B-4 JGM:P:N:Q Side Clearances for New Packing Rings, in. (mm)

Actual Groove Width	1 Ring/Groove Non-Metal Or CI	2 Rings/Groove Non-Metal or CI	3 Rings/Groove Non-Metal & CI	Bronze
0.375 to 0.377 (9.53 to 9.58)	0.011 to 0.014 (0.28 to 0.36)	0.011 to 0.015 (0.28 to 0.38)	N/A	0.006 to 0.008 (0.15 to 0.20)
0.447 to 0.449 (11.35 to 11.41)	N/A	N/A	0.013 to 0.018 (0.33 to 0.46)	
0.562 to 0.564 (14.28 to 14.33)			0.017 to 0.022 (0.43 to 0.56)	
0.936 to 0.938 (23.77 to 23.82)		Zero (0) - side loaded “AL” (5) ring type		N/A

TABLE B-5 Piston to Bore Clearance & Conventional Piston Ring End Gap, in. (mm) - M, P & SP Class Cylinders

Bore Diameter[a]	Piston to Bore Clearance	Piston Ring End Gap - TFE	
		New	Maximum
2.0625 (52)	0.007 to 0.011 (0.18 to 0.28)	0.025 to 0.030 (0.64 to 0.76)	0.120 (3.05)
2.25 (57)		0.027 to 0.032 (0.69 to 0.81)	0.128 (3.18)
2.5 (64)		0.030 to 0.036 (0.76 to 0.91)	0.144 (3.66)
2.75 (70)		0.033 to 0.040 (0.84 to 1.02)	0.160 (3.71)
3 (76)		0.036 to 0.044 (0.91 to 1.12)	0.176 (4.47)
3.25 (83)	0.009 to 0.013 (0.23 to 0.33)	0.039 to 0.047 (0.99 to 1.19)	0.188 (4.76)
3.5 (89)		0.042 to 0.052 (1.07 to 1.30)	0.208 (5.28)
3.75 (95)	0.010 to 0.014 (0.25 to 0.36)	0.046 to 0.056 (0.17 to 1.42)	0.224 (5.69)
3.875 (98)		0.047 to 0.057 (0.19 to 1.45)	0.228 (5.79)
4.125 (105)		0.049 to 0.060 (1.24 to 1.52)	0.240 (6.10)
4.375 (111)	0.011 to 0.015 (0.28 to 0.38)	0.052 to 0.064 (1.32 to 1.63)	0.255 (6.48)
4.75 (121)	0.012 to 0.017 (0.30 to 0.43)	0.057 to 0.077 (1.45 to 1.96)	0.308 (7.82)
5.125 (130)		0.061 to 0.081 (1.55 to 2.06)	0.324 (8.23)
5.5 (140)	0.013 to 0.018 (0.33 to 0.46)	0.065 to 0.085 (1.65 to 2.16)	0.340 (8.64)
5.75 (146)	0.013 to 0.018 (0.33 to 0.46)	0.068 to 0.088 (1.73 to 2.24)	0.352 (8.94)
6.125 (156)	0.014 to 0.020 (0.36 to 0.51)	0.073 to 0.093 (1.85 to 2.36)	0.372 (9.45)
6.5 (165)		0.077 to 0.097 (1.96 to 2.46)	0.388 (9.86)
7.5 (191)	0.016 to 0.022 (0.41 to 0.56)	0.089 to 0.109 (2.26 to 2.77)	0.430 (10.92)
8 (203)		0.095 to 0.115 (2.41 to 2.87)	0.460 (11.68)
8.5 (216)	0.017 to 0.023 (0.43 to 0.58)	0.102 to 0.122 (2.59 to 3.10)	0.488 (12.40)
8.875 (225)	0.018 to 0.024 (0.46 to 0.61)	0.106 to 0.126 (2.69 to 3.20)	0.504 (12.80)
10.5 (267)	0.021 to 0.027 (0.53 to 0.69)	0.125 to 0.145 (3.18 to 3.68)	0.580 (14.73)
11 (279)	0.022 to 0.028 (0.56 to 0.71)	0.131 to 0.151 (3.33 to 3.84)	0.604 (15.34)
13 (330)	0.026 to 0.032 (0.66 to 0.81)	0.155 to 0.175 (3.94 to 4.45)	0.700 (17.78)
13.5 (343)	0.027 to 0.033 (0.69 to 0.84)	0.162 to 0.182 (4.12 to 4.63)	0.728 (18.49)

a. Conventional piston rings are standard for all M, P, and SP cylinders, except for 1-3/4M-FS with bore diameters of 1.625” (41) & 1.75” (44), which use piston/rider rings. Piston/rider rings are optional for all other M, P, & SP cylinders.

TABLE B-6 Piston to Bore Clearance and Piston/Rider Ring End Gap, in. (mm) - M, P & SP Class Cylinders

Bore Diameter [a]	Piston to Bore Clearance	Piston/Rider Ring Eng Gap	
		New	Maximum
1.625 (41)	0.090 to 0.096 (2.29 to 2.44)		
1.75 (44)		0.016 to 0.032 (0.41 to 0.81)	0.128 (3.25)
2.0625 (52)		0.020 to 0.036 (0.51 to 0.91)	0.144 (3.66)
2.25 (57)			
2.5 (64)		0.044 to 0.060 (1.12 to 1.52)	0.240 (6.10)
2.75 (70)			
3 (76)			
3.25 (83)			
3.5 (89)			
3.75 (95)			
3.875 (98)		0.045 to 0.061 (1.14 to 1.55)	0.244 (6.20)
4.125 (105)		0.049 to 0.065 (1.24 to 1.65)	0.260 (6.60)
4.375 (111)		0.052 to 0.068 (1.32 to 1.73)	0.272 (6.91)
4.75 (121)		0.057 to 0.073 (1.45 to 1.85)	0.292 (7.42)
5.125 (130)		0.062 to 0.078 (1.57 to 1.98)	0.312 (7.93)
5.5 (140)		0.068 to 0.084 (1.73 to 2.13)	0.336 (8.53)
5.75 (146)		0.071 to 0.087 (1.80 to 2.21)	0.348 (8.84)
6.125 (156)		0.069 to 0.099 (1.75 to 2.51)	0.396 (10.06)
6.5 (165)		0.074 to 0.104 (1.88 to 2.64)	0.416 (10.57)
7.5 (191)		See Footnote [b]	
8 (203)			
8.5 (216)		0.114 to 0.144 (2.90 to 3.66)	0.576 (14.63)
8.875 (225)		0120 to 0.150 (3.05 to 3.81)	0.600 (15.24)
10.5 (267)		0.144 to 0.174 (3.66 to 4.42)	0.696 (17.68)
11 (279)		0.152 to 0.182 (3.86 to 4.62)	0.728 (18.49)
13 (330)		0.182 to 0.212 (4.62 to 5.39)	0.848 (21.54)
13.5 (343)		0.190 to 0.220 (4.83 to 5.59)	0.880 (22.35)

a. Conventional piston rings are standard for all M, P, and SP class cylinders, except for 1-3/4M-FS with bore diameters of 1.625 (41) and 1.75 (44) where piston/rider rings are standard. Piston/rider rings are optional for all other M, P, and SP class cylinders, except for 1-3/4SG-FS-HE which uses conventional rings and wear band.

b. 8M x 3.5 (88.9 mm) stroke & 8SP-HE, 7.5 (191) bore: New - 0.099 to 0.129 (2.51 to 3.53), Max. - 0.516 (13.11).
8M x 3 (76.2) stroke, 7.5 (191) bore: New - 0.088 to 0.118 (2.24 to 3.00), Max. - 0.472 (11.99).
8M x 3.5 (88.9) stroke & 8SP-HE, 8 (203) bore: New - 0.106 to 0.136 (2.69 to 3.43), Max. - 0.544 (14.07).
8M x 3 (76.2) stroke, 8 (203) bore: New- 0.095 to 0.125 (2.41 to 3.18), Max. - 0.500 (12.70).

TABLE B-7 Piston to Bore Clearance and Conventional Piston Ring End Gap, in. (mm) - JG and SG Class Cylinders

Bore Diameter[a]	Piston to Bore Clearance	Piston Ring End Gap - Non-Metallic	
		New	Maximum
1.25 (32)[b]	0.025 to 0.033 (0.64 to 0.84)	0.018 to 0.028 (0.46 to 0.71)	0.112 (2.85)
1.5 (38)[b]	0.030 to 0.038 (0.76 to 0.97)	0.021 to 0.031 (0.51 to 0.79)	0.124 (3.15)
1.625 (41)[b]		0.023 to 0.033 (0.58 to 0.84)	0.132 (3.35)
1.75 (44)[b]		0.025 to 0.035 (0.64 to 0.89)	0.140 (3.55)
2.75 (70)	0.009 to 0.014 (0.23 to 0.36)	0.027 to 0.033 (0.69 to 0.81)	0.132 (3.35)
3 (76)		0.030 to 0.036 (0.76 to 0.91)	0.144 (3.66)
3.375 (86)	0.010 to 0.015 (0.25 to 0.38)	0.034 to 0.041 (0.88 to 1.04)	0.164 (4.17)
3.625 (92)		0.036 to 0.044 (0.91 to 1.12)	0.176 (4.47)
3.875 (98)	0.011 to 0.016 (0.28 to 0.41)	0.039 to 0.047 (0.99 to 1.19)	0.188 (4.78)
4.125 (105)		0.041 to 0.050 (1.04 to 1.27)	0.200 (5.08)
4.75 (121)	0.012 to 0.018 (0.30 to 0.46)	0.057 to 0.077 (1.45 to 1.96)	0.308 (7.82)
5.125 (130)		0.061 to 0.081 (1.55 to 2.06)	0.324 (8.23)
6.125 (156)	0.013 to 0.019 (0.33 to 0.48)	0.073 to 0.093 (1.85 to 2.36)	0.372 (9.45)
6.5 (165)	0.014 to 0.020 (0.36 to 0.51)	0.077 to 0.097 (1.96 to 2.46)	0.388 (9.86)
7.125 (181)	0.015 to 0.021 (0.38 to 0.53)	0.085 to 0.105 (2.16 to 2.67)	0.409 (10.39)
7.5 (191)		0.089 to 0.109 (2.26 to 2.77)	0.430 (10.92)
8.5 (216)	0.017 to 0.023 (0.43 to 0.58)	0.102 to 0.122 (2.59 to 3.10)	0.488 (12.40)
8.875 (225)	0.018 to 0.024 (0.46 to 0.61)	0.106 to 0.126 (2.69 to 3.20)	0.504 (12.80)

a. Conventional piston rings are standard for JG Class Cylinders, except 2-1/2JG-FS-HE class cylinders with bore diameters of 2.25 (57mm) and 2.5 (64); 3JG-CE, 2.75 (70) and 3 (76); and 3-5/8JG-CE, 3.375 (86), and 3.625 (92), which use piston/rider rings. Piston/rider rings are optional for other JG Cylinders, except for 1-3/4JG-FS-HE which uses conventional rings and wear band.

b. This size uses conventional piston rings and wear band, see TABLE B-8 for wear band values.

TABLE B-8 New Wear Band End Gap & Radial Projection - 1-3/4JG-FS-HE and 1-3/4SG-FS-HE Class, in. (mm)

Bore Diameter	Min. End Gap	Radial Projection	Side Clearance
1.25 (32)	0.049 (1.24)	0.005 to 0.012 (0.13 to 0.30)	0.010 to 0.014 (0.25 to 0.36)
1.5 (38)	0.049 (1.24)	0.0075 to 0.0145 (0.19 to 0.37)	
1.625 (41)	0.052 (1.32)		
1.75 (44)	0.058 (1.47)		

TABLE B-9 Piston-to-Bore Clearance & Piston/Rider Ring End Gap, in. (mm) - JG and SG Class Cylinders

Bore Diameter [a]	Piston to Bore Clearance	Piston/Rider Ring End Gap	
		New	Maximum
2.25 (57)	0.090 to 0.096 (2.29 to 2.44)	0.023 to 0.039 (0.58 to 0.99)	0.156 (3.96)
2.5 (64)		0.030 to 0.046 (0.76 to 1.17)	0.184 (4.67)
2.75 (70)		0.044 to 0.060 (1.12 to 1.52)	0.240 (6.10)
3 (76)			
3.375 (86)			
3.625 (92)		0.047 to 0.063 (1.19 to 1.60)	0.252 (6.40)
3.875 (98)		0.051 to 0.067 (1.30 to 1.70)	0.268 (6.81)
4.125 (105)		0.055 to 0.071 (1.40 to 1.80)	0.284 (7.21)
4.75 (121)		0.057 to 0.073 (1.45 to 1.85)	0.292 (7.42)
5.125 (130)		0.062 to 0.078 (1.57 to 1.98)	0.312 (7.93)
6.125 (156)		0.069 to 0.099 (1.75 to 2.51)	0.396 (10.06)
6.5 (165)		0.074 to 0.104 (1.88 to 2.64)	0.416 (10.57)
7.125 (181)		0.083 to 0.113 (2.11 to 2.87)	0.452 (11.48)
7.5 (191)		0.088 to 0.118 (2.24 to 3.00)	0.472 (11.99)
8.5 (216)		0.114 to 0.144 (2.90 to 3.66)	0.576 (14.63)
8.875 (225)		0.120 to 0.150 (3.05 to 3.81)	0.600 (15.24)

a. Conventional piston rings are standard for JG class cylinders, except 2-1/2JG-FS-HE class cylinders with bore diameters of 2.25 (57mm) and 2.5 (64); 3JG-CE, 2.75 (70) & 3 (76); and 3-5/8JG-CE, 3.375 (86) & 3.625 (92), which all use piston/rider rings. Piston/rider rings are optional for other JG Cylinders, except for 1-3/4JG-FS-HE, which uses conventional rings and wear band.

Appendix C - Frame Specifications

JGM:P:N:Q Frame Specifications

For more information, see the Ariel Performance Program. Rated speeds for non-lube and lubricated process applications may vary.

TABLE C-1 JGM:P Frame Specifications

Specification	JGM/1	JGM/2	JGP/1	JGP/2
Stroke, in. (mm)	3.5 (89)		3 (76)	
Maximum Allowable Speed,[a] RPM	1500		1800	
Minimum Speed,[b] RPM	750		900	
Piston Speed,[c] FPM (m/s)	To 875 (4.5)		To 900 (4.6)	
Horsepower, hp (kW)	84 (63)	168 (125)	85 (63)	170 (127)
Maximum Length, in. (m)	37 (0.94)			
Maximum Overall Height, in. (m)	17 (0.43) to top of aluminum cover			
Maximum Width with Cylinders	See appropriate frame, guide, and cylinder outline drawings.			
Height - Bottom to Crankshaft Centerline, in. (mm)	9.250 (235)			
Approximate Weight with Cylinders	See Ariel Performance Program.			
Connecting Rod Centerline to Centerline, in. (mm)	8.250 (210)			
Sump Capacity, US gal. (L)	2.5 (9)			
Oil Pump Flow Rate,[d] GPM (L/s)	4 (0.25)		5 (0.32)	
Oil Heat Rejection BTU/hr (kW)	8400 (2.5)		16,800 (4.9)	
Piston Rod Diameter, in. (mm)	1.125 (28.6)			
Internal Rod Load - Double Acting				
Compression+Tension, lb_f (kN)	12,000 (53)			
Tension, lb_f (kN)	6000 (27)			
Compression, lb_f (kN)	7000 (31)			
Internal Rod Load - Single Acting				
Tension, lb_f (kN)	6000 (27)			

a. Maximum Allowable Speed is the highest (potential) speed at which the frame design permits continuous operation. Compressor frame data plate "Frame Rated Speed (RPM)" is application specific, and may be lower than Maximum Allowable Speed. Do not exceed the lower of frame rated speed, lowest cylinder rated (RPM), or driver rated speed.

b. Minimum Speed is the lowest frame speed needed to provide adequate oil flow to the compressor bearings.

c. Average Piston Speed is based on Maximum Allowable Speed (RPM). The cylinder data-plate rated speed (RPM) or frame rated speed may be less, resulting in a lower piston speed rating.

d. Flow rate at maximum rated speed and 180°F (82°C) oil.

TABLE C-2 JGN:Q Frame Specifications

Specification	JGN/1	JGN/2	JGQ/1	JGQ/2
Stroke, in. (mm)	3.5 (89)		3 (76)	
Maximum Allowable Speed,[a] RPM	1500		1800	
Minimum Speed,[b] RPM	750		900	
Piston Speed,[c] FPM (m/s)	To 875 (4.5)		To 900 (4.6)	
Horsepower, hp (kW)	126 (94)	252 (188)	140 (104)	280 (209)
Maximum Length, in. (m)	37 (0.94)			
Maximum Overall Height, in. (m)	17 (0.43) to top of aluminum cover			
Maximum Width with Cylinders	See appropriate frame and cylinder outline drawings.			
Height - Bottom to Crankshaft Centerline, in. (mm)	9.250 (235)			
Approx. Weight with Cylinders	See Ariel Performance Program.			
Connecting Rod Centerline to Centerline, in. (mm)	8.250 (210)			
Sump Capacity, US gallons (L)	2.5 (9)			
Oil Pump Flow Rate,[d] GPM (L/s)	4 (0.25)		5 (0.32)	
Oil Heat Rejection, BTU/hr (kW)	8400 (2.5)		16,800 (4.9)	
Piston Rod Diameter, in. (mm)	1.125 (28.6)			
Internal Rod Load - Double Acting				
Compression + Tension, lb_f (kN)	18,000 (80)		20,000 (89)	
Tension, lb_f (kN)	9000 (40)		10,000 (44)	
Compression, lb_f (kN)	10,000 (44)		11,000 (49)	
Internal Rod Load - Single Acting				
Tension, lb_f (kN)	9000 (40)		10,000 (44)	

a. Maximum Allowable Speed is the highest (potential) speed at which the frame design permits continuous operation. Compressor frame data plate "Frame Rated Speed (RPM)" is application specific, and may be lower than Maximum Allowable Speed. Do not exceed the lower of frame rated speed, lowest cylinder rated (RPM), or driver rated speed.

b. Minimum Speed is the lowest frame speed needed to provide adequate oil flow to the compressor bearings.

c. Average Piston Speed is based on Maximum Allowable Speed (RPM). The cylinder data-plate rated speed (RPM) or frame rated speed may be less, resulting in a lower piston speed rating.

d. Flow rate at maximum rated speed and 180°F (82°C) oil.

Opposed Throw - Reciprocating Weight Balancing

Ariel recommends a reciprocating weight differential between opposing throws of 1.0 pounds (0.45kg) or less for JGM:P:N:Q compressors.

To replace a connecting rod assembly, piston, piston and rod assembly, balance nuts, or crosshead, weigh component parts on a scale calibrated to 0.1 pounds (0.05 kg) and compare to the Balancing Record in the compressor Parts Book. If the weight changes, recalculate opposing throw reciprocating weight differential. If not within recommended limits, the compressor may require new balance nuts and/or crossheads.

To exchange opposing throw cylinder locations, exchange all reciprocating components to the opposite throw, except the connecting rod assemblies. Check the Balancing Record and recalculate reciprocating weight differential, including the weight of the connecting rods. If not within recommended limits, the compressor may require new crosshead balance nuts to reduce differential.

If unable to balance opposing throws within recommended limits, contact the packager or Ariel. When applying or re-applying a different cylinder to a throw, recalculate opposing throw reciprocating weight differential; new balance nuts and/or crossheads may be required. The force feed oil distribution system may also need resized. Contact the packager or the Ariel Response Center for detailed information about recommended reciprocating weight differential between opposing throws.

TABLE C-3 JGM:P:N:Q Approximate Component Weights, Lbs (Kg)

Component	Weight	Component	Weight
Main/Connecting Rod Bearing	.5 (.2)	Crosshead	See Note[a]
Top Cover	18 (8)	Crosshead Pin	4 (2)
Shaft Seal Housing	8 (2)	Lube Oil Pump	7 (3)
Crankshaft[b]	98 (44)	• Frame Assembly w/o Cylinders • VVCP • Cylinder Assembly • Piston & Rod Assembly	See Ariel Performance Program.
Main Journal Caps	6 (3)		
Connecting Rod	12.5 (6)		

a. For exact weights, see Balancing Record sheet provided by Ariel in the Parts Book for each compressor.

b. Crankshaft weight is without flywheel, vibration detuners, or damper.

Appendix D - Compressor Clearance, Oil, and Temperature Record

SERIAL NO. F-_____ MODEL _____Date _____

CRANKSHAFT THRUST (END) CLEARANCE, In. (mm)	
Crankshaft Serial Number	Thrust Clearance, In. (mm)

CONNECTING ROD THRUST (SIDE) CLEARANCE, In. (mm)					
Throw 1	Throw 2	Throw 3	Throw 4	Throw 5	Throw 6

JACK CLEARANCES, In. (mm)						
Throw #	1	2	3	4	5	6
Main Bearing						
Conn. Rod Bearing						

After new bearing installation, if measured clearances exceed tolerances of Table B-1 in Appendix B, contact your packager or Ariel before proceeding.

OIL PRESSURE AND TEMPERATURE						
Date	Time	RPM	Filter Inlet Oil Pressure psig (barg)	Filter Outlet Oil Pressure psig (barg)	Oil Temp. into Frame °F (°C)	Remarks

Throw	BEARING CAP TEMPERATURE, °F (°C), AFTER RUN TIME OF:					
	3 Minutes Idle Speed (engine, VFD) 1 Minute (single speed motor) No Gas Load		Additional 3-5 Minutes Full Speed No Gas Load		Additional 10-15 Minutes Full Speed Gas Load	
	Main	Rod	Main	Rod	Main	Rod
1						
2						
3						
4						
5						
6						

Appendix E - Balance Valve Log

TABLE E-1 Balance Valve Maintenance Log

Date	Time	Pressure Gauge Description	Div. Block Pressure		Balance Valve Set Pressure	Div. Block Cycle Time (Seconds)	Notes
			Min.	Max.			

Appendix F - ER-34.1

Cleaning, Handling, and Assembly Lubricants for Non-Lubricated Compressor Cylinders

Cleaning and handling are critical to prevent premature wear and failure of non-metallic rings and packings in non-lube compressor cylinders. Proper cleaning and handling will virtually eliminate oil and anti-seize compounds from the cylinder interior, piston rod assembly, valve and packing case areas. In non-lubricated applications, the non-metallic rings and packings transfer some material to the metallic running surfaces. This transferred film provides a "lubricated" surface that enables the compressor to function properly. The presence of oil degrades the transferred film, forming an abrasive paste that quickly wears non-metallic elements during operation. Anti-seize compounds are oil based and also contain abrasive metallic components that cause premature component wear.

This procedure applies to all non-lube compressor cylinders. Ariel cleans and protects complete non-lube cylinders to non-lube service requirements before shipping. Follow the procedure below to clean internal parts shipped loose, spare parts before installation, and contaminated surfaces during maintenance. This extends non-lube compressor component life, and ultimately, cylinder life.

Denatured alcohol presents health and safety hazards. Keep 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. Contains methyl alcohol; poisonous if ingested. Avoid eye and skin contact. Properly handle and dispose of materials resulting from clean-up. See manufacturer Material Safety Data Sheets for details.

NOTE: Clean all table surfaces and tools that will come in contact with the cylinder, cylinder components, or piston components

1. Handle all cleaned parts with new or clean "rubber" gloves or new white cotton gloves. If gloves become contaminated or dirty, dispose of them and use a new pair.
2. Clean cylinder interior surfaces thoroughly with denatured alcohol until a clean, alcohol soaked, white paper towel or lint-free rag removes no more debris. This includes all surfaces of the bore, counter bore, valve pockets, suction and discharge gas passages, nozzles, etc.
3. Lubricate the threads, bolt head, and stat-o-seal of the cylinder nozzle lube bolt with very small amounts of Never-Seez, regular grade, and ensure all mating surfaces are coated.
4. Use a small amount of Loctite 577 Pipe Sealant on male threads when installing pipe plugs.
5. Very lightly oil bolt threads and head seating surfaces for valve cap, head, and packing case mounting bolts, but prevent oil penetration into the cylinder interior.
6. Thoroughly clean piston, collar, rod, and nut with denatured alcohol until a clean, alcohol soaked paper towel or lint-free rag removes no more debris. Clean piston ring grooves and wear band grooves especially well. Clean piston rings and wear bands with denatured alcohol before assembling.
7. When assembling piston to rod, use very small amounts of Never-Seez, Regular Grade on the nut and collar, and ensure all mating surfaces are covered. Do not lube threads for the piston rod tensioner. Clean threads of hydraulic tensioner and all other tensioner surfaces that will contact the piston. Use very small amounts of Never-Seez, Regular Grade on piston nut set screws. After assembly, thoroughly wipe off all Never-Seez from the piston rod assembly exterior in the collar and nut areas with denatured alcohol until a clean, alcohol soaked, white paper towel or lint-free rag removes no more debris.

8. The manufacturer should provide packing cases cleaned, preserved, and suitable for non-lube service. Inspect packing cases for cleanliness. If they appear coated with an oil-based preservative, disassemble and clean them with denatured alcohol, then reassemble. If disassembly is required for water-cooled packing cases, re-assemble and test to Ariel Engineering Reference ER-51. Contact Ariel for latest version of ER-51.
9. Wipe down piston rod with denatured alcohol after rod installation.
10. Clean VVCP or FVCP components with denatured alcohol. Separate the unloader head from the adapter/actuator. Clean all internal surfaces with denatured alcohol including behind the unloader piston. Do not remove VVCP unloader stem seal. Clean piston ring with denatured alcohol. Do not use anti-seize compounds or oil on the steel head gaskets. Use a very thin film of oil when installing o-rings.
11. Clean crank-end head, head-end head, and steel head gaskets with denatured alcohol. Do not use anti-seize compounds or oil on the steel head gaskets. If the crank-end head uses an o-ring seal, apply a very thin film of oil to the lead-in chamfer of the cylinder seating surface to help prevent shearing of the o-ring.
12. The manufacturer should provide compressor valves cleaned, preserved, and suitable for non-lube service. Inspect valves for cleanliness. If they appear coated with an oil-based preservative, disassemble and clean them with denatured alcohol, then reassemble. If they appear clean, they require no additional cleaning provided they are sealed in their original packaging and have not been contaminated.
13. Clean valve caps, retainers, high clearance assemblies, and steel valve gaskets with denatured alcohol. Use only a very thin film of oil for valve cap o-rings. Do not use anti-seize compounds or oil on steel valve gaskets.
14. Assemble cleaned parts immediately. If cylinder will not see immediate service, see Ariel Engineering Reference ER-34 for preservation instructions. Contact Ariel for latest version of ER-34.

Do not use Ariel non-lube compressor cylinders for oxygen service.

Appendix G - ER-82

Soft Foot and Top Plane Flatness Checks for Proper Main Bearing Bore Alignment in Reciprocating Compressors

Main bearing bore alignment is critical to main bearing and crankshaft life. Ariel manufactures the top cover mounting surface of a compressor frame in close tolerance to a flat plane, to the main bearing bores, and to the bottom of the compressor feet. The main bearing bores align when frame feet are supported so the top cover mounting surface is flat and "in plane". Perform a soft foot check and top plane flatness measurement at these times:

- Setting of a new compressor (pre and post grouting).
- Commission of a compressor in the field.
- Reinstallation of a compressor.
- Relocation of a package.
- Discovery of loose hold down fasteners.
- Performance of recommended scheduled maintenance inspection every 6 months or 4000 hours.

With new unit installations, Ariel recommends checking and recording initial top plane flatness before shimming the guide feet and after initial rough coupling alignment. On compressors shipped disassembled, perform the initial check before guide and cylinder assembly installation. Shim or otherwise adjust the height to bring the top cover mounting surface within the specified plane tolerance. Record subsequent readings after complete guide and cylinder installation, and again after any vessel installation and shimming. Re-adjust height if guide, cylinder, and/or vessel installation results in frame top rail measurements out of Appendix G tolerances.

JGB:V:Z:U and KBB:V:Z:U 4 and 6-throw frames require **both** a top plane flatness **and** soft foot checks. For all other frames, the soft foot check is required; the top plane flatness measurement is optional, except for the JGI, which requires none.

Use the procedure below to properly install and periodically inspect compressor frames.

1. To check soft foot, properly install and torque compressor frame hold down bolting. Loosen each hold down bolt individually while checking the frame foot to skid deflection with a calibrated 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 on each frame-to-skid bolt. See for proper frame foot and crosshead guide bolt size and torques.
2. Remove or reposition the top cover(s) and gasket(s) to expose the frame top cover mounting surface. Verify it is clean.

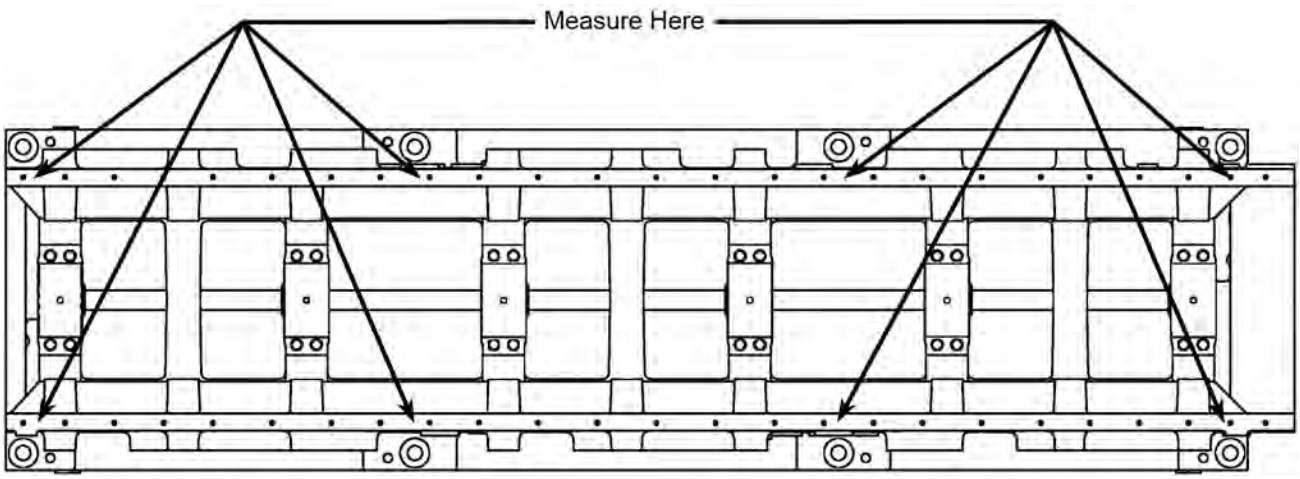
   NOTE: For KBZ:U frames only, the frame top rail has been coated with a light coat of Cortec VPCI 369 corrosion inhibitor or equivalent to protect the aluminum to cast iron joint. If the top cover is removed, clean both the top rail and the top cover and re-coat the frame top rail with a light coat of the same compound. If VPCI 369 or equivalent is not available, use marine grade grease. Apply only a light coat of the corrosion inhibitor; do not allow excess material to flow into the frame when the top cover is installed.

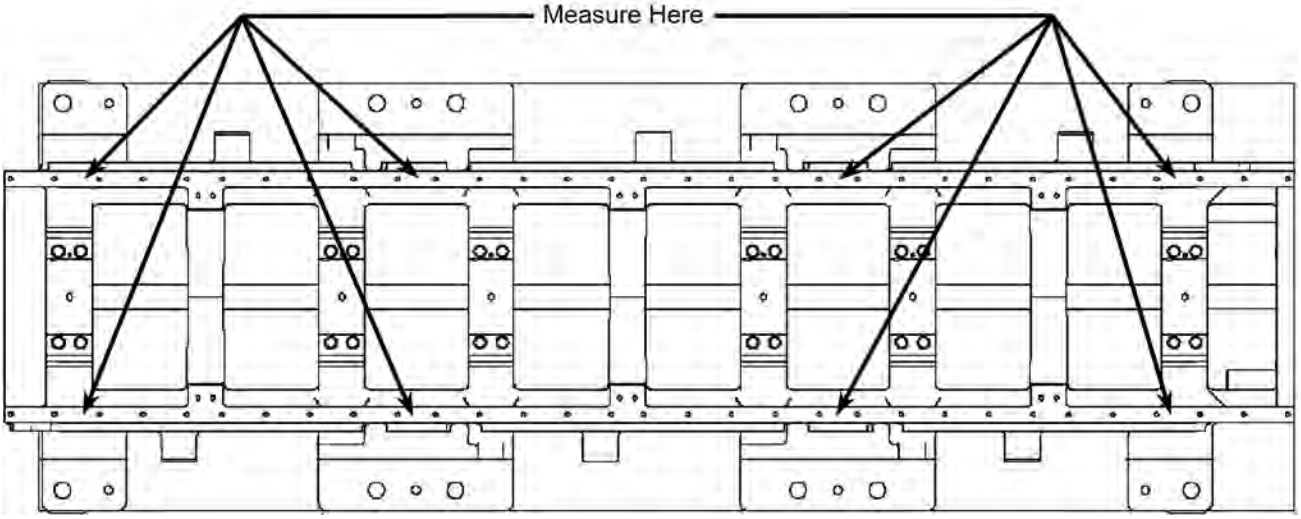
3. To check top plane flatness, use measurement equipment with a published accuracy of ±0.001 inches (0.025 mm) over the distance required to measure the entire length of both frame rails. Measure the top surface of both sides of the frame rails at each anchor bolt (see Appendix G), or between each pair of anchor bolts for frames with pairs of anchor bolts (see Appendix G). Readings between any two adjacent points must be within 0.002 in. (0.05 mm). For proper alignment, total accumulated out of plane flatness must be within Appendix G tolerances.

Compressor Frame[a]	Tolerance Inch (mm)
JGM:N:P:Q/1/2. JG:A/2/4, JGR:J/2	0.004 (0.10)
JGA/6, JGR/4, JGJ/4/6, JGH:E:K:T:C:D:F:Z:U/2/4, JGB:V/4[a],KBZ:U/2/4, KBB:V/4	0.006 (0.15)
JGE:K:T/6, JGC:D:F/6, JGZ:U/6, JGB:V/6, KBB:V:Z:U/6	0.008 (0.20)

a. Underlined frames require both soft foot and top plane flatness checks.

NOTE: If the unit will not be restarted immediately, re-preserve the unit in a manner appropriate to the time duration until restart.





VENDOR'S LITERATURE



Installing and Maintaining Cook Rod Rings and Packing Cases

CATALOG NO. 785D

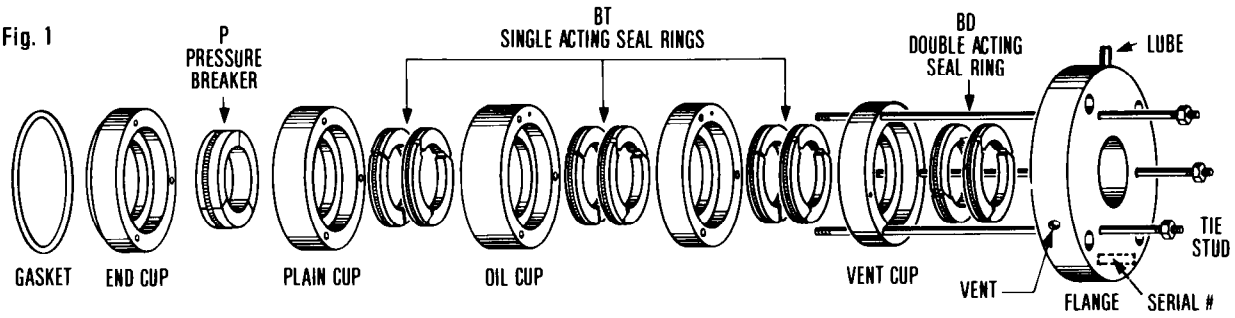
Cook's full floating rod rings are furnished in a variety of designs and materials to suit all operating conditions of reciprocating compressors and engines. It is not the purpose of this pamphlet to cover a particular design, but rather to explain the general characteristics common to most assemblies.

Figure 1 is an exploded view of a typical cup packing case with the various parts in proper order and each part named to familiarize an operator with the functions and the terms used.

Additional rod ring types can be found illustrated in Cook Catalog 785 where proper assembly and position with respect to pressure side is described. Also, refer to Cook Technical Bulletin TPB-76 for more information. It is likely that the exact rod ring, or one very similar to that in which you are interested, will be found among these illustrations.

The packing case comes assembled as it should appear on the rod and carries a six-digit serial number stamped on the face of the flange. When ordering replacement parts, this serial number should be given wherever possible.

Fig. 1



Figures 2 and 3 are common type rod rings as they appear on the rod and in their disassembled state.

Fig. 2

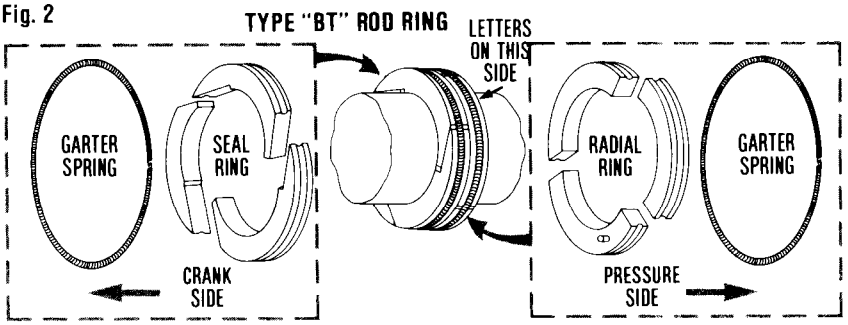
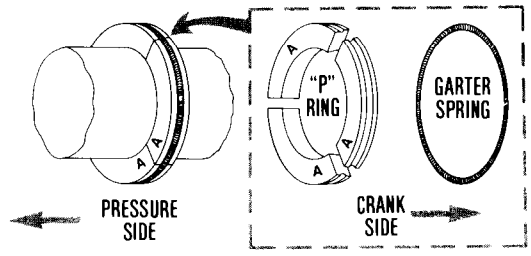


Fig. 3



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. 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. A general guide to the appropriate clearance for rod rings is shown in Table I.

TABLE I

ROD RING SIDE CLEARANCES	
ROD RING MATERIAL	**MINIMUM SIDE CLEARANCE PER INCH OF GROOVE WIDTH**
Metallic and Carbon	.015"/In
Nonmetallic Except Nylon	.030"/In
Nylon	.045"/In

NOTE: Typical Minimum Side Clearance For Metallic Wiper Rings Is .002"/Ring.

C.Lee Cook
A DOVER RESOURCES COMPANY

INSTALLATION

In most compressors, it is possible to bolt the packing case into the stuffing box after which the rod can be inserted with the aid of a bullet-nosed sleeve over its threaded end. Before a case is installed, it should always be disassembled and thoroughly cleaned in an appropriate solvent for the intended service.

Make sure that each rod ring and cup is properly positioned and that rings are liberally coated with a clean lubricant before reassembly. 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 bronzes or Tfe, and it is extremely important that wiper rings be handled and installed so as to prevent damage to the scraping edges.

Where it is necessary to install the packing case on a piece basis over the rod end, the case 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 (Fig. 2 & 3). Note that all rod ring segments are carefully lettered and must be assembled accordingly. This is most important in order to insure proper sealing. After the packing case has been assembled in the stuffing box and its tie studs tightened, the rod should be connected at the crosshead after which the packing case must be carefully aligned with the rod before bolting tightly into position. Alignment is readily accomplished by the use of feelers to maintain a uniform clearance all around between the case bore and the rod.

Connect oil and vent lines as indicated. If a packing case has two or more oil inlets, each should be connected separately to individual lubricating pump plungers because pressure differentials within the packing body would result in all lubrication going into an outer point. After all connections are made, the packing case should be flooded by hand operation of the lubricating plungers to make sure lines are not air bound.

This same operation should be repeated each time a compressor is started because oil lines may have been bled during down time.

For new installations, care must be given to the cleaning of all accumulated dirt in the lines and compressors because foreign material will lodge in the packing to become destructively abrasive.

Prior to installing the packing case into the stuffing box, 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.

LUBRICATION

All lube oil lines should be fitted with a check valve at the case inlet. The selection of a proper lubricant will depend on the service involved and a Cook field service engineer should be contacted before proceeding, especially on high-pressure work or whenever there are elements in the gas which might be destructive to ordinary lubrication.

Oil ratings will range from SAE 30 for low pressure work to SAE 60 and higher for extremely high pressure. Special inhibitors or compounded oils should be used only where necessary because of unusual conditions or as recommended by a service engineer.

During initial operation, a packing case may leak or tend to overheat. This is temporary while the rings are properly mating to the rod and case. It is advisable to break in the rings on a gradually increasing pressure scale. The amount of time required will depend on the condition involved. Additional information on break-in procedures is available in Cook Bulletin TBP-76.

VENT CONNECTIONS

Most packing cases are equipped with a vent for safety reasons. This is usually connected by a separate line to atmosphere or to some point in the system where the back pressure does not exceed 15 psi.

In all back pressure vents, a check valve should be provided so that there is no flow from the vent line to the packing case. If the vent back pressure will exceed 35 pounds, a Cook service engineer should be contacted for ring and case design recommendations.

STATIC-PAC™

When a packing case is being assembled which incorporates a Static-Pac™, the lip seal and all associated springs and O-rings must be inspected for possible damage. Cases utilizing a Static-Pac™ normally require that all cup faces be coated with a light film of sealant, such as Never-Seez, to prevent case leakage. Additional information on the operation of the Static-Pac™ is available in Catalog 785 and Bulletin 784.

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Compressor Rod Packing

Fundamentals
Materials
Lubrication
Cooling
Venting

C. Lee Cook
A DOVER RESOURCES COMPANY

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Mechanical Packing

Over a century ago, Charles Lee Cook designed the first packing to restrict the leakage of steam around the rods in steam locomotives. Today, Cook sealing devices are used in compressors, engines, pumps, valves—almost any device with a rotating or reciprocating shaft that has the potential to leak liquid or gas.

A "mechanical" packing is a seal around a shaft passing through a cylinder or pressure vessel head. It consists of one or more rings contained within a case that is typically bolted to that head. Packing rings may be used for a variety of purposes, from simply wiping oil off a shaft, to sealing an aggressive fluid at high pressure. Packing may be as basic as one ring in a case, or it may be an assembly consisting of a number of different type rings in a case that might have provision for lubrication, venting, purging, cooling or heating.

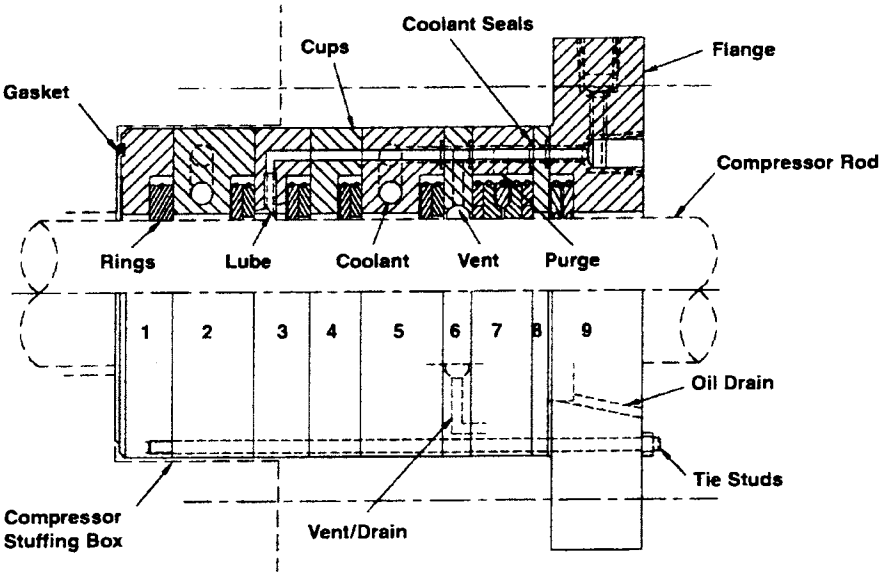
How well a packing seals is determined by how closely its shape conforms to the rod, and the dimensional accuracy of rings and sealing surfaces of the packing case. Packing life is primarily a function of the materials with which it is produced, all other factors being equal.

Cook packing is precision manufactured with surface characteristics measured in millionths of an inch. Materials are evaluated in Cook's in-house testing facility for their ability to resist wear and corrosion under the most severe conditions. Only those with a demonstrated superiority are offered as Cook materials and many formulations are proprietary, having been developed for specific applications.

The Cook Advantage is essentially the ability to design and manufacture packing components to meet modern seal requirements, and to provide materials for optimum packing life. With over a century of experience, C. Lee Cook is the recognized leader for engineered sealing devices, and countless customers have learned to... "Count on Cook When the Pressure's On!"

Figure 1

Packing Nomenclature



Compressor Packing

A typical compressor packing consists of a series of seal rings in which each ring is meant to stop or restrict the flow of gas into the distance piece. The rings are held in separate grooves or cups within a packing case. Each ring seals against the piston rod and also against the face of the packing cup at a right angle to the rod axis. The rings are free to move radially, literally "floating" within the grooves.

A basic packing arrangement consists of:

1) a pressure breaker that functions as a flow restricter (rather than a true sealing ring),
2) several seal rings that are meant to stop flow or leakage into the vent or distance piece, and
3) a vent control ring that prevents gas from leaking into the distance piece from the vent.

Even though seal rings do not provide a direct leak path, a vent to carry incidental leakage away from the packing is necessary in most applications since misalignment of the ring with the case or rod, or slight imperfections in the materials in the mating components, may allow some small volume of gas to blow-by.

Gas flow through a restriction creates a pressure drop. When there is a series of restrictions, the resultant total pressure drop can be significant. This is called the "labyrinth" effect.

Gas flow past a series of rings also creates a pressure differential, but because of the rapid rise and fall of pressure within the compressor cylinder, and because of low leakage past the rings, the "labyrinth" effect is usually negligible.

Typical pressure levels in a 5 ring case are illustrated in Figure 2. The curves represent calculated values for a new packing (which should have very small leak paths) compared to a "used" packing set. The number on each curve represents the pressure upstream of that particular ring.

The two sets of curves illustrate how the pressure drop is highest across rings nearest the pressure when the set is new. As the packing wears, the downstream rings see more and more pressure drop as the leak paths of the rings increase with age.

Figure 2

Pressure Drop Across Rings

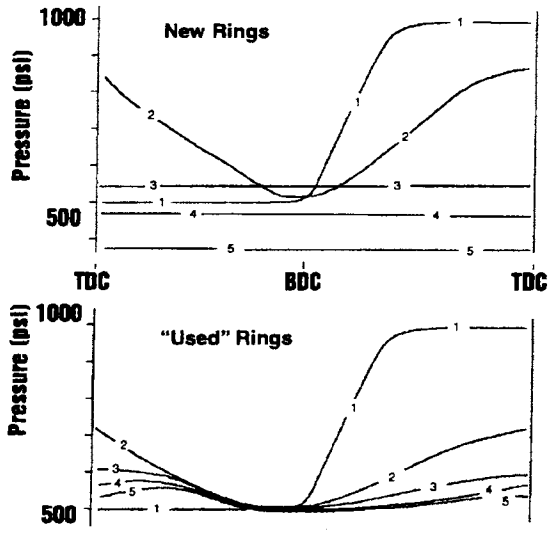
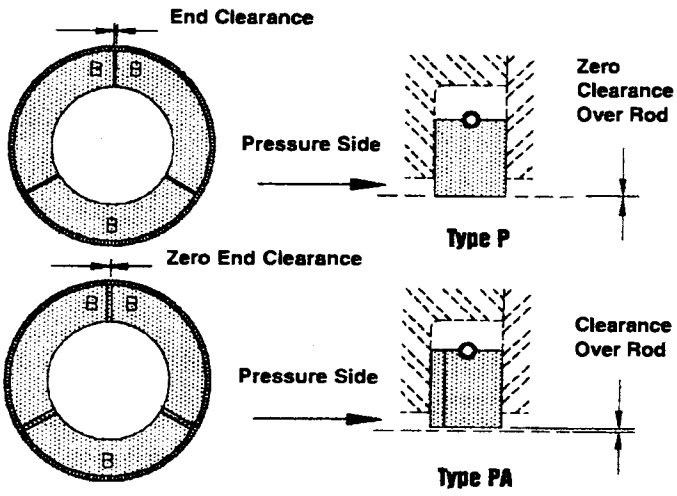


Figure 3

Pressure Breakers



The "used" packing curves are also typical of the pressure drop across a leaky new packing set. It is apparent that a "reverse" drop exists across some rings during the suction stroke; that is, gas will flow back out of the case toward the cylinder during that portion of the stroke.

The pressure drop through a series of rings is highest across the one ring that forms the best seal. In packing sets containing well-made rings which fit the rod and grooves properly, the ring nearest the cylinder will, initially, carry almost the full pressure drop. As this ring wears, or changes for any reason, the load will shift to one of the other rings, usually the next ring in line. The pressure drop may distribute across a series of rings in almost any manner.

Individual rings in a packing set wear one-at-a-time, so the number of rings in the set influences packing life but has little effect on leakage.

In a comparison of piston rings and packing rings, it should be noted that piston rings in a compressor cylinder are usually not true seal rings; that is, they have definite "open" leak paths by design. This means the pressure drop will be spread over all of the rings (they act as a labyrinth). This division of the load, plus a lower total pressure differential across the piston ring set, results in a lighter loading for piston rings when compared to packing rings.

Breaker Rings

Breaker rings, the simplest form of packing rings, are designed to restrict or control flow rather than effect a tight seal. In type P, the flow controlling orifice is the gap that is formed at the segment ends. In a type PA Breaker, the orifice is formed by clearance between the ring bore and rod. The performance of both rings is very similar. However, a type PA Breaker provides lower rod loading than a P, at the expense of a more difficult-to-control orifice area.

The most important function of Breakers is to retard rapid expansion of gas from within the packing case back into the cylinder during the suction stroke. On the intake portion of the stroke, gas contained

Figure 4

Packing Ring Type BT

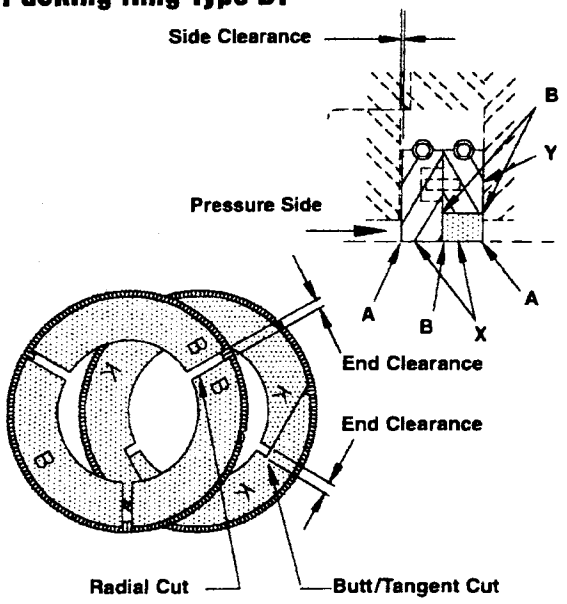
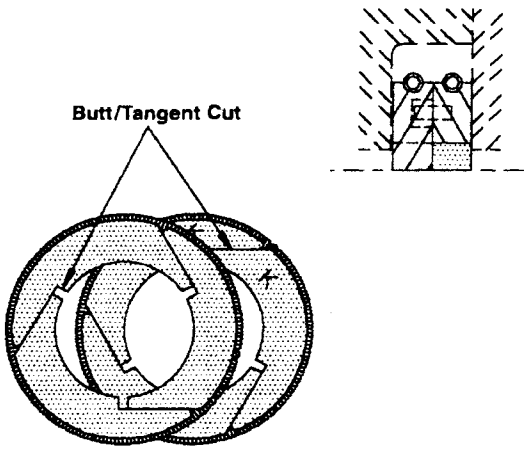


Figure 5

Packing Ring Type BD



within the packing case tends to reverse direction and flow toward the cylinder where the pressure is dropping rapidly to suction pressure levels. Without some restriction to this flow an "exploding" action of the rings may occur causing premature ring failure and damage.(Refer to Figure 15)

Pressure Breakers are not required in all packing. They are generally not needed at pressures below 300 psi and are not required when the seal rings themselves act to restrict backflow.

Pressure Breakers may be constructed with any currently available material, but those materials with a low thermal coefficient of expansion and high stiffness are preferable for a stable orifice area. Metal is usually superior to TFE in this respect; however, breakers can be made satisfactorily from some of the high strength plastics.

Packing Ring Type BT

The BT packing ring is a true sealing ring set which is made up of a radially cut ring (facing the high pressure side) and a second, butt/tangent cut ring. The individual rings are doweled together so that the inner butt cuts of the butt/tangent cut ring are offset, or staggered, to be between the radial cuts of the first ring in the pair. In this manner, gas passage by or through the ring is prevented.

In order for these rings to operate satisfactorily, it is necessary that both fit the rod perfectly ("X" in Fig. 4). They must contact each other at their mating faces and the tangent ring must lie flat against the groove surface ("Y" in Fig. 4).

In addition to this, all sealing edges must be sharp and square ("B" in Fig. 4). If these edges are beveled or rounded, they form a path for gas flow from the radial cut in the first ring to the radial portion of the cut in the butt/tangent ring. If the tangential edges are not square, they form a passage from the outside toward the radial cut at the bore. All other edges (such as point "A" in Fig. 4) are generally given small bevels to assist lubrication between the contact faces. Under ordinary circumstances, lubrication serves to help the seal function because it fills up minute crevices. This type of ring is single acting, or directional, in that it seals pressure from one side only.

Packing Ring Type BD

The BD packing ring set is "double acting", meaning it will seal pressure from either direction. It consists of two butt/tangent cut rings doweled so that the radial portion of the cuts are staggered, blocking any flow path for leakage. All of the features that are important for successful operation of the "single acting" BT ring, such as square sealing edges and proper face contact between rings, rod and cup, are also important for successful operation of the BD ring.

Common Packing Ring Features

The P, BT, and BD are the three most common types of packing rings in general use. Numerous variations of these three exist, but the principles involved are generally the same and conditions affecting proper operation are common to all types.

Packing rings are made in segments for two reasons:

1) for installation over the rod,
2) to allow free radial movement down against the rod.

Free radial movement allows for slight size variations and also provides a means to accomodate ring wear. Both spring and gas pressure loading cause rings to contract, or move radially inward, toward the rod.

All types of packing rings are manufactured with an initial "end clearance" of sufficient size that no adjustment is required throughout their useful life. When they have worn to a point where the ends butt, they should be discarded. In most rings end clearance could be adjusted to maintain the proper opening. However, it is seldom practical to rework such a ring after it has operated in a butted condition. The bore will be worn out of round, and merely recreating end clearance will not correct poor rod contact.

Ring Materials

Lubrication and gas pressure are two of the factors that influence selection of ring material. With respect to lubrication, packing may operate at conditions that vary from full or normal lubrication all the way to dry or nonlube service. Common materials used in packing fall into two categories:

1) metallic - (typically bronze, cast iron, or to a diminishing extent, babbitt) which require some lubrication but may be used at very high pressure,
2) nonmetallic - (typically carbon-graphite, TFE, or other plastics).

The important advantage of nonmetallics is their ability to run in poorly lubricated applications.

Carbon-graphites and TFE blends work well in the complete absence of lubrication, but are somewhat limited insofar as the pressure at which they can be used, due to their low strength (compared to metallics). Filled TFE blends are good to approximately 800 psi; but, with the addition of a backup, or anti-extrusion ring, can be used at much higher pressures. Carbon-graphites are moderately strong, but somewhat brittle, and therefore limited to approximately 1500 psi.

Plastic is the material of choice for rings which require a high degree of conformability. All rings must conform at their joints and around the rod in order to establish a good seal, but some types will begin to leak slightly as they wear or as they change

Figure 6

Packing Ring Type BTR

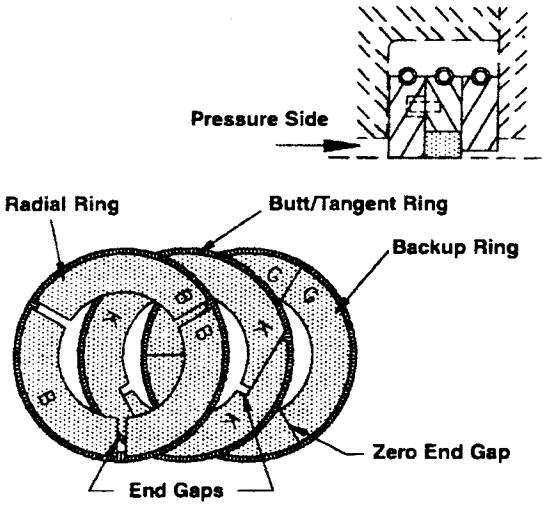
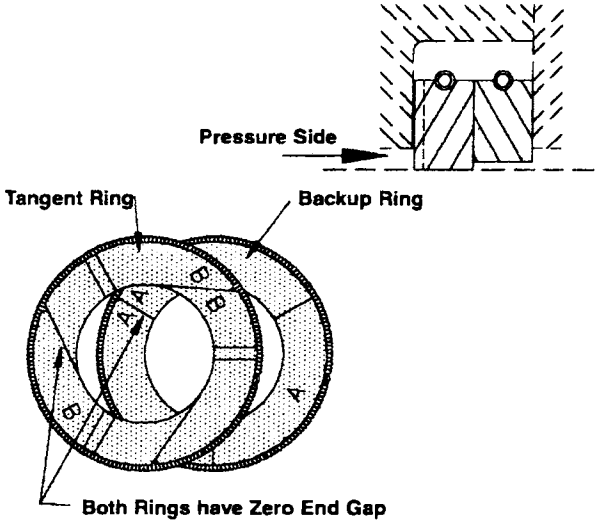


Figure 7

Packing Ring Type TR



size due to thermal expansion. With regard to sealing, a good ring material is one that is not excessively stiff relative to the pressure acting on it.

Nonmetallic materials, including the new plastics and blends with performance improving fillers, are the most commonly used materials in the manufacture of modern packing rings. Metallics are principally useful at high pressure, or as anti-extrusion rings, where strength or rigidity is an important requirement.

Lubricated, Semilubricated & Nonlubricated Packing

Packing rings made with TFE "filled" or blended with other materials (including other plastics) can now be used in many applications including those with less than full lubrication. By definition, LUBRICATED PACKING receives just the amount of lubrication required for long life. SEMILUBRICATED PACKING is that which receives either reduced lubrication through a lubricator or, in the event there is a short distance piece, minimal lubricant carry-over from the crankcase. Packing installed under these conditions is sometimes operated initially (the first 24 hours or so) with normal "force feed" lubrication. NONLUBRICATED PACKING is packing installed in systems where double distance pieces, rod oil slingers, or some other means is used to prevent any lubrication from reaching the rod rings.

TFE is the material used most often for packing installed under conditions where lubrication is impaired or less than normal. Generally, this would be in the presence of corrosives, diluting liquids, or high temperatures.

The sealing principles of all TFE ring types are virtually the same as those previously described. Due to their inherent flexibility, TFE rings have the added advantage of immediate sealing without requiring break-in.

Ring types TR and BTR are designs that include nonmetallic rings plus a rigid back-up ring.

Figure 8

Packing Ring Type C

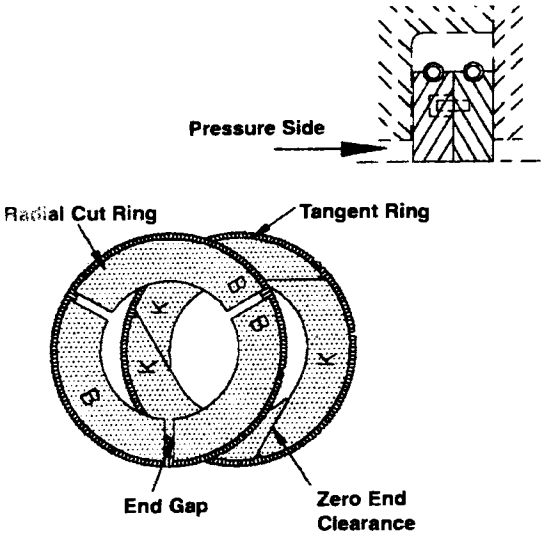
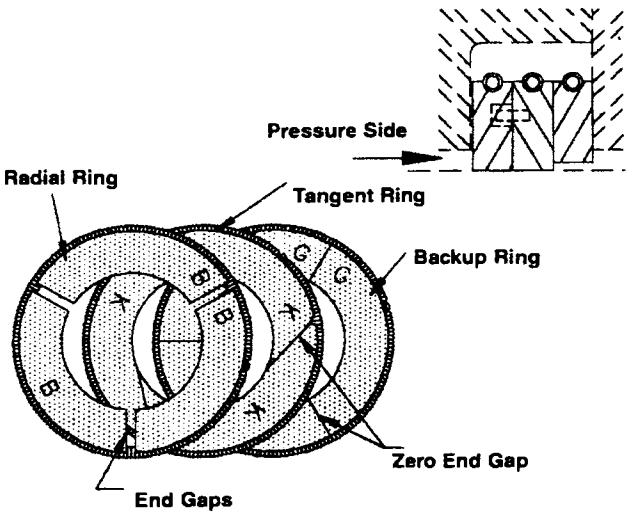


Figure 9

Packing Ring Type CR



The back-up ring is made slightly larger than the rod. It has butted ends and does not grip (or grips lightly) the rod under pressure loading. Its function is to prevent extrusion of the softer nonmetallic ring and also, when conditions warrant, to conduct heat away from the rod surface through the light contact.

Usually back-up rings are made of metal, but they can also be manufactured from strong plastics for some applications. The pressure limitation of plastic rings with metal back up has not been determined. This configuration has been used successfully up to 50,000 psi.

At pressures above 800 psi, type TR rings are the preferred alternative to the standard BT sealing ring. To obtain a better seal where there is insufficient pressure to properly actuate the TR ring, type BTR rings may be used. The BTR is limited to relatively low pressure of about 2500 psi. Above this pressure, deformation may occur intruding into the gap of the butt/tangent cut ring.

To overcome sealing problems with the TR and deformation of the BTR, a tangent cut may be combined with a radial cut ring. This is the type C, or when a backup is added, the type CR. These styles are most useful when applied above 2500 psi.

The basic TFE ring set for pressures below 800 psi consists of BT rings to seal cylinder pressure with a double-acting BD ring downstream of the vent. This arrangement is the same for nonlubricated or fully lubricated cases. When pressure exceeds 800 psi and the application is lubricated or semilubricated, the arrangement should be as follows:

1) one breaker ring type P,
2) BTR or TR rings in intermediate grooves,
3) a BD ring beyond the atmospheric vent.

Unless some special condition exists, the P and BD rings should be metal, and the BTR or TR rings a combination of metal-TFE.

The type P ring in this case will have an added function. Along with preventing backflow, garter spring breakage,

Figure 10

Packing Ring Type TU

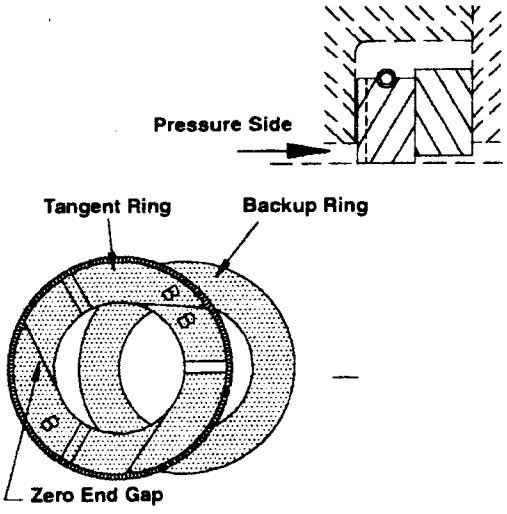
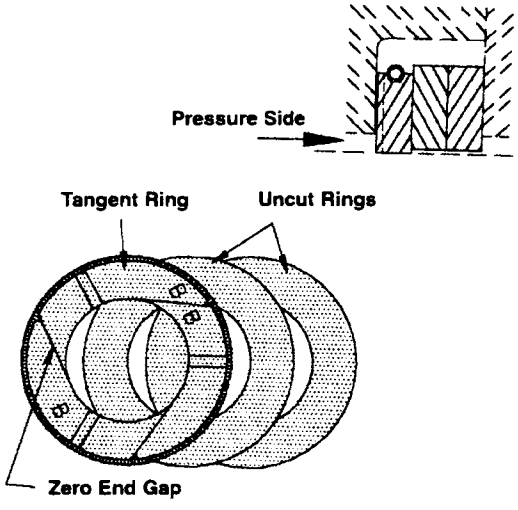


Figure 11

Packing Ring Type TUU



etc., the fact that it is in contact with the rod around the entire circumference (without heavy pressure loading) allows it to function as a means of dissipating heat. BD rings may be made of metal for this same reason.

Packing Ring Type TU

The TU ring set is essentially the same as the TR ring set, except the radially cut ring in the TR has been replaced with an uncut ring, which can be either plastic or metal.

When the stiffness of the uncut U ring is low compared to the pressure acting against the ring, it will collapse inwardly, maintaining a seal even as it wears. With the proper choice of material, the TU ring set will seal low pressure (suction), with the tangentially cut ring and high pressure (discharge) with the uncut ring. The TR ring set will function in the same manner but lacks the almost perfect seal characteristics of the uncut ring in the TU set.

An added benefit with an uncut ring is reduced contact pressure between the ring bore and the rod. Compressive stress in the ring acts counter to gas pressure against the ring's outside diameter, so there is a lower ring-to-rod loading than there would be with the tangentially cut ring.

To prevent extrusion of the soft plastic sometimes used in the U ring, an additional back-up ring can be added to form the TUU style. Typically the second U ring would be metal, or a very rigid plastic.

With proper choice of materials for the three rings in the TUU, each ring can be made to seal only over a particular pressure range. Thus wear and heat generation can be divided over individual rings to give better performance and longer life.

The difficulty of installation somewhat offsets the advantages, lower leakage and reduced wear, of the TU or TUU ring set. Uncut rings can only be installed over the rod end, and with a thread protector that is no larger than the rod diameter.

Figure 12

Packing Ring Type WB

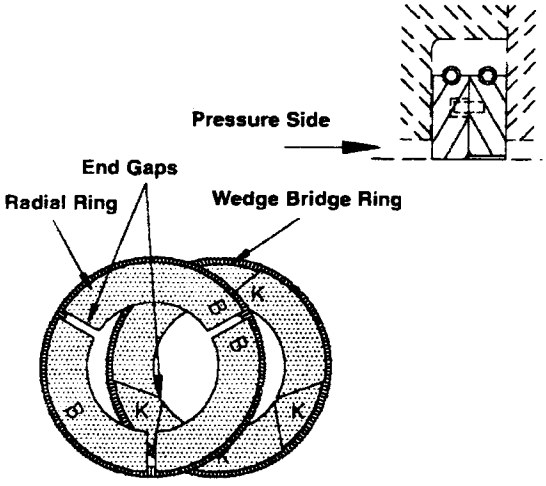
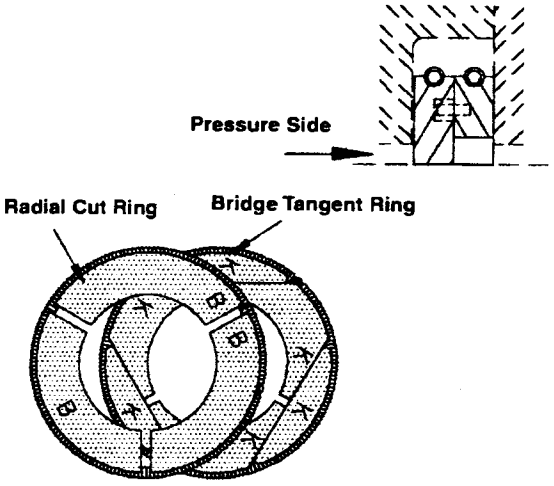


Figure 13

Packing Ring Type E



Thermal Effects

When rings expand circumferentially due to a temperature increase, there are usually leak paths created at the joints. The effect is similar whether this occurs in a true tangent-cut T ring such as the TR, or in a butt/tangent ring such as the BT. As it expands, a T ring is more likely to leak when the joint is not covered by another upstream ring (as in the type C). Contraction due to lower temperature rarely occurs, but if it does, it is much like having an undersized ring or oversized rod.

All these temperature effects can be minimized by using an upstream radially cut ring to block leak paths through the adjoining ring cut. This addition is found in the C or CR ring arrangement. These ring styles are free of unsupported areas where extrusion can occur, so they're also suitable for higher pressures and temperature than a BT or BTR.

One method to minimize the tendency toward breakage and lack of conformability of both butt/tangent and true tangent, or T rings, is to use "bridge" joints as illustrated in figures 12 and 13. The shorter, sturdier segments make the WB style suitable for service in situations where elevated temperature and pressure may cause other styles of ring to leak or break. The handling and installation of the WB or E rings may present problems due to the greater number of segments involved. As with other styles of ring, the E and WB may be used with back-up rings to prevent extrusion along the rod.

Garter Spring and Ring Breakage

Small, sometimes microscopic, leak paths occur in packing rings due to the nature of the material itself. This is the cause of the "labyrinth" effect across the rings and the penetration of gas into the space between ring grooves.

Figure 14 shows a typical compressor pressure curve which illustrates the time required to compress gas from suction pressure to discharge pressure

Figure 14

Typical Compressor Cycle

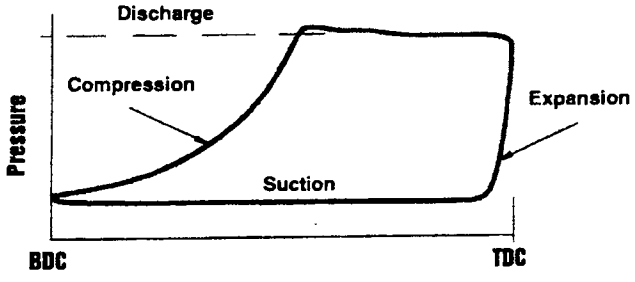
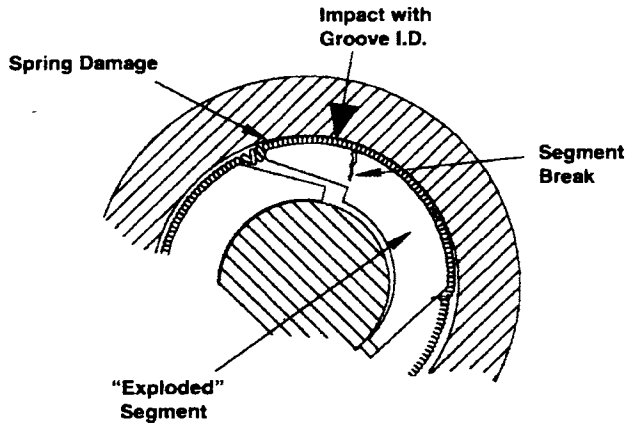


Figure 15

Effect of Backflow



is considerably longer than the expansion time from discharge to suction. It is during the compression time that gas pressure builds up within the packing assembly.

At the start of suction the time required for expansion is considerably shorter than that required for compression and gas trapped in the case tends to reverse direction and flow toward the cylinder where pressure is dropping rapidly toward suction level. This can cause an "exploding" action, particularly to tangent type rings, sometimes to the extent that they strike the inside of the groove with considerable force.

Garter spring damage and ring breakage may result. Normally the tangent lip will break at the point indicated in Figure 15.

Garter spring breakage, and ring damage due to backflow, is usually found in rings nearest the pressure side of the packing assembly. Proper application of a breaker ring is an effective preventive measure in that it's built-in orifice slows down or minimizes backflow from the case.

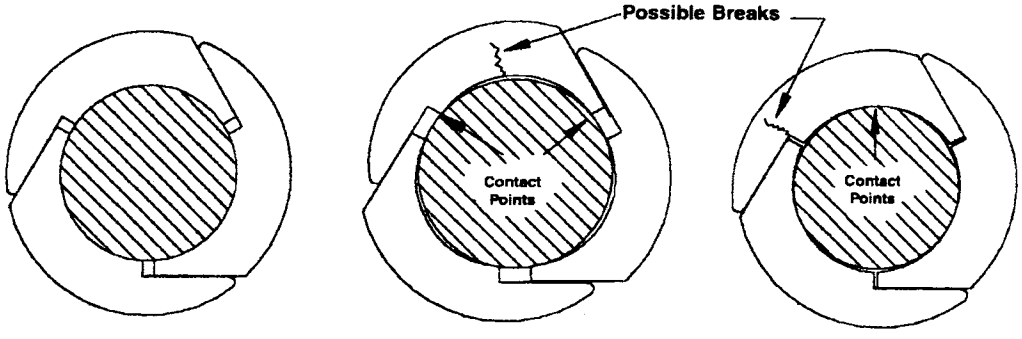
Ring breakage may also occur when ring I.D. and rod size do not match (Figure 16). Rings will make contact with the rod at the center of each segment on an undersize rod. In this circumstance, pressure tends to force the rings inward at the tangential point and the resultant flexing may cause a fatigue break from the corner where the tangent and radial cuts meet.

If undersize rings are installed on a standard rod or standard rings are installed on an oversize rod, the segments will contact the rod first at the segment ends. Pressure pulsations will then flex the entire segment. A fatigue break near the center of the segment, as indicated in Figure 16, may occur.

A tapered rod can combine the stresses of both an undersize and an oversize rod with the ring constantly adjusting to the variations. The stress conditions discussed here are most important for carbon and other materials which have low fatigue strength.

Figure 16

Misfit Rings



Proper Fit Ring | **Oversize Rod or Undersize Ring** | **Undersize Rod or Oversize Ring**

Undersize Rods

If a rod is undersize, but true in circularity and without taper, the rings still form an effective seal because bore contact will be in the center of each segment and at this point the cut in each ring is overlapped by its mate. This doesn't normally cause a problem if the amount of undersizing does not exceed .002" per inch of rod diameter. When a rod is undersize, some additional time is required for break-in before a packing will give the best seal.

Oversize Rods

When packing rings have a somewhat smaller bore than the rod diameter, the segments touch only at each end, leaving the center away from the rod. This is in line with the cut, or joint, of the mating ring so that direct passage for gas flow occurs along this line. This condition, if not severe, will also be corrected by "wear in".

One problem that may occur with either an undersized or oversized rod is that lubrication may be blown off the rubbing surfaces by the passage of gas. The subsequent "dry contact" may result in high friction, high temperature or rapid wear.

Tapered Rods

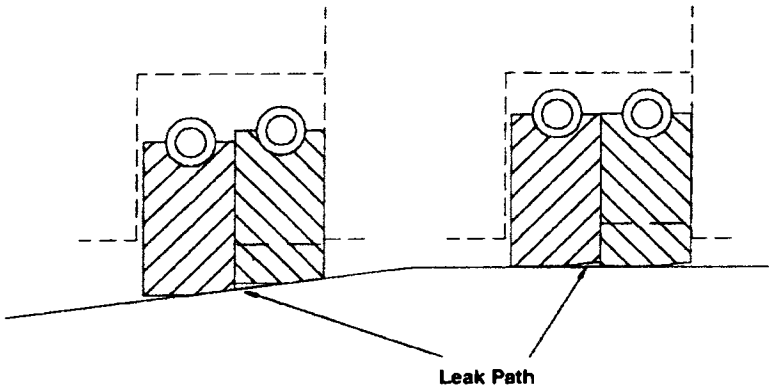
In the presence of lubricating films, which help fill (or block) very small leak paths, a packing can function adequately with some slight rod taper. Generally, taper is found at one, or both, ends of the rod, the rest of which is relatively straight. Excessive amounts of taper will destroy the seal as shown in Figure 17.

The effect of the rod passing through the packing case from the tapered to the straight portion and back, is wear at the ring's edges. This is due to the ring bearing directly on one edge while over the tapered section of rod and on the other while over the straight section. This dual edge wear leaves a gas passage along the bore from one radial cut to the other.

Tapered rods can also cause cyclic flexing of garter springs and ring segments. If this flexing is excessive, it can lead to spring and segment breakage.

Figure 17

Effect of Rod Taper



Dirt or Foreign Matter

Packing will not operate satisfactorily when excessive dirt or other foreign matter gets between the faces. This is just as destructive to packing as it would be to a bearing, or any similar rubbing surface under high load.

An effective safeguard against foreign material damaging the rings is well-fitting packing that insures low leakage. If packing is not sealing properly, it will act as a filter, catching particles in the packing case where they proceed to damage all of the parts. Under operating conditions where dirt cannot be completely removed, hardened rods, above Rc 60, should be used to minimize abrasive wear. Special wear-resistant ring materials will help reduce the effect of dirt or foreign matter. The selection of materials to use depends on the nature of the foreign matter and the operating conditions.

When dirt is present, lubrication at two or three times the normal rate may help keep the packing clean. Added oil will not only lubricate and cool the packing but assist by flushing dirt from the rings.

Rate of Leakage

Passage, or flow, of gas through a packing set depends on:

1) the amount of "misfit" in the rings and rod,
2) any disturbances in the faces, which must be in contact to properly form seals.

Under the best of circumstances, packing will weep or bleed in small amounts which cannot be detected by ordinary means. Some of this escape is caused by failure to maintain the various contacts as a result of wear or lubrication loss.

Some leakage may be due to gas being forced into the rod pores or into the lubrication film by high pressure. This small amount of gas would then escape as the rod enters a reduced pressure area. This type of leakage is quite small, almost negligible, in comparison to that caused by large imperfections in the sealing surfaces.

It is possible to manufacture packing of extreme flatness and smoothness with lapped, extra true surfaces (at added cost). This is only effective if perfect alignment and finish of the mating components is achieved and maintained. The rod surface is vital to packing performance so it must be equally smooth and true, as well.

If packing is allowed to leak excessively for a long period of time, the condition causing leakage may be difficult to correct. New rings cannot be expected to perform satisfactorily if the rod is tapered or scratched, or if the case has become damaged in like manner.

Under normal operating conditions, a period of time is required for all of the sealing surfaces to "mate" or "wear-in", after which the packing will be virtually leak-tight and remain so until normal wear or some outside influence disturbs its condition.

Break-in Procedure

Because of the great variation in operating conditions, it is difficult to outline a universal procedure for break-in. The goal is to allow the working parts to adjust and to come to a satisfactory seat without overheating or overstressing contact faces.

Overheating and high temperature can result in the failure of both the packing rings and the piston rod surface.

Gas pressure tends to increase the true area of contact between mating faces. Accordingly, the best possible break-in would be at full load under the slowest speed available so that frictional heat is not generated faster than it can be dissipated.

The amount of time needed for break-in will vary from packing to packing, depending on the pressure, speed, and lubrication. Normally, metal and other rigid materials, require approximately four hours. Some conditions, such as fully lubricated, ultra smooth surfaces may require up to several days to completely break in.

Where conditions do not permit slow speeds, such as with electric motor drives, packing can be effectively broken in by gradual load increases. This can be as little as 10-15 minute intervals, with corresponding small pressure increases. For instance, it is better to increase the pressure through a 1000 psi range using 250 psi increments at 15 minute intervals than to run a full hour with a given load and then increase a full 1000 psi for an additional hour.

The amount of lubrication applied during break-in is best determined by considering the specific operating conditions and determining exactly how the packing is reacting to the lubrication and the operating environment. Usual practice is to lubricate at 2 to 3 times the normal rate during break in. The use of special, heavy lubricants during this period is only advisable if some characteristic of the service causes a lowering of oil viscosity. Typically this would be caused by something in the gas stream or high temperatures.

It is sometimes effective to direct a small stream of lubricant on the rod immediately outside of the packing case during break-in. This not only ensures better cooling and lubrication, but also serves to carry off wear particles and other debris from the working surfaces.

Some wear products or fines are normal during break-in since the idea is to "wear off" the high spots or unevenness, promoting a good, smooth contact between mating surfaces. At no time should packing be allowed to heat to such an extent that smoke, indicating high temperature, forms.

Packing, during break-in, may exhibit alternate periods of low and high leakage, although there should be a gradual over-all reduction in leakage. If packing is allowed to leak excessively, it becomes extremely difficult, if not impossible, to maintain a proper lubricating film.

Whenever overheating or other distress signals appear, the unit should be shut down and allowed to cool, after which a restart may be undertaken. Occasionally several such restarts are necessary. Time spent in proper break-in, however, usually results in longer packing life.

TFE and similar plastics do not require a lengthy break-in due to their inherent flexibility. Full pressure can be applied after a 15-30 minute run to make sure there are no mechanical problems. However, some break-in time may still be necessary for the rod surface against which the plastic is running.

Nonlubricated Packing

Nonlubricated packing usually consists of TFE rings, or, if the operating pressure is high, TFE with back-up rings. The back-up rings, pressure breaker, and vent ring may be metal, but high strength plastics are also applied in many applications.

Most ring materials will act as abrasives when no lubrication is present. Therefore, harder rod material and a finer rod finish is required. Chrome-plated, nitrided, or tungsten carbide coated rods are the most common materials used with nonlubricated packing.

The choice of rod material, as with packing case material, may also be dictated by corrosive elements in the gas stream. Packing cases may be plated for corrosion resistance, but are more commonly made of corrosion resistant cast iron, bronze, or stainless steel.

One potential problem in nonlubricated conditions is the high frictional heat generated by the packing at the ring bore. This heat must be removed by conduction through the case or rod. Cases are normally cooled by circulating coolant through channels in the individual packing case cups. The channels can be formed internally in the cups so no O-ring seals encircling the rod are required, or cups can be made two-piece for easier disassembly and cleaning.

Almost any "heat transfer fluid" can be used as coolant, but water or water/anti-freeze mixtures are the most effective. Oil offers some advantage as far as corrosion resistance or deposit prevention, but is much less capable of carrying away heat than water.

Some compressors incorporate liquid or gas coolant circulated directly against and around the rod. When liquid is used, the problem of effectively sealing the coolant is offset by its comparatively better heat transfer properties.

Regardless of how it is achieved, keeping friction low and removing the heat generated is crucial to long life for nonlubricated packing.

Figure 18

Causes of Ring Leakage

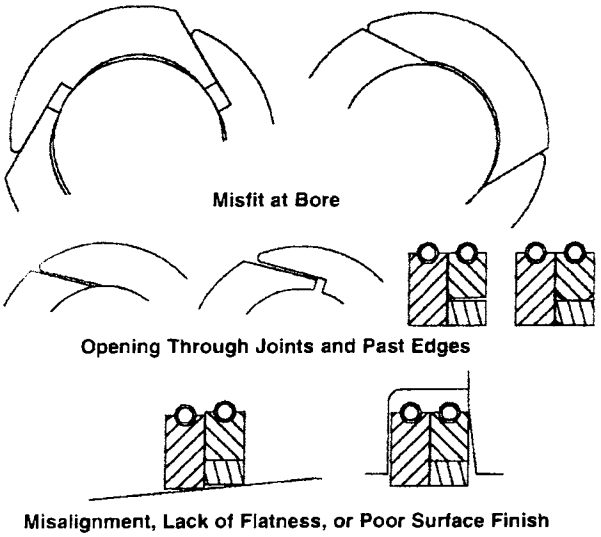
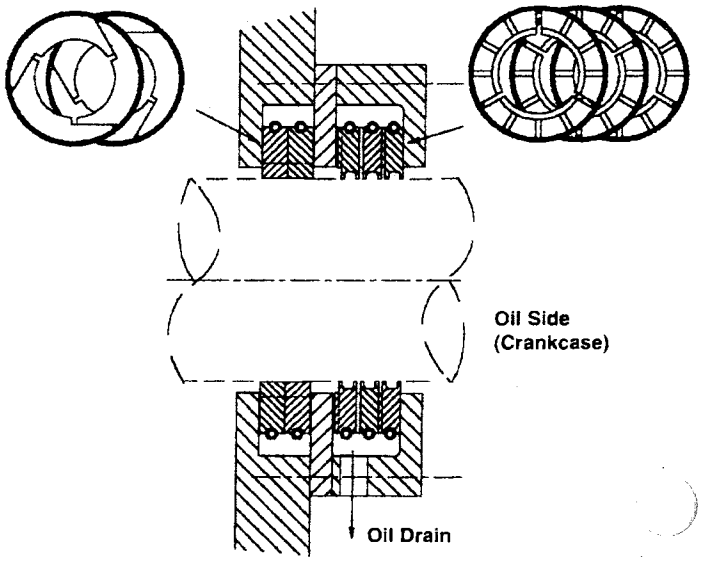


Figure 19

Typical Oil Wiper Packings



Oil Wiper Packing

The increase in nonlubricated applications and the use of incompatible oils in the same machine have created the need for greater effectiveness in crankcase oil control packing.

This need has been met by designs based on two important principles which are somewhat opposed to designs commonly in use.

The first feature, shown in Figure 19, is that the scraper ring on the dry side of the wiper groove has its drain notches facing away from the oil source. This reduces "valving" of oil into the seal ring groove because there is less surface contacting the back side of the wiper groove.

During operation, the lower part of the ring set is generally covered with a significant amount of oil which has been scraped from the piston rod surface. The oil collects on the bottom of the rings before dropping into the groove sump. This "collecting of oil" on the bottom of the rings, coupled with the flat surface of the back ring in some older styles of packing, promotes "valving" action over the division plate. The residual oil can accumulate in the normal ring side clearance where it is squeezed out at each stroke, with some of it being pumped up and over the barrier and some of it being deposited down into the sump.

The second design feature affecting oil wiper packing is the fact that the ring's flat face is installed toward the wet side of the wiper groove. There are no drain notches which would allow the oil to enter the groove in any great volume. In most old style wiper packing, the first ring is usually ventilated by notches on the front face.

In new style packing, the rings are radially cut with minimum end clearance so that oil entering the groove is reduced to that which can enter the small openings defined by the cut and the radial clearance of the case bore around the piston rod. In this manner, the normal oil return holes are not overly taxed by oil pooling or build up. Also, the oil level never reaches a point high enough to increase the valving tendency between the back ring and the division plate.

The second groove on the compressor side in the design shown in Figure 19 contains a double-acting seal ring which is independent of the wiper group. This rings function is to minimize passage of gas from the distance piece to the crankcase and also to block the slight "pumping" action of the cross-head which can push oil past the wiper.

In all cases, the condition of the piston rod is an extremely important factor for oil control. Rods which are scratched, out of round, or otherwise damaged, will not perform satisfactorily, regardless of wiper ring design.

Wiper ring material needs to be conformable in order to mate to an imperfect rod, but also be of sufficient strength to maintain a sharp wiping edge. Using nonmetallics with the right combination of flexibility and hardness has proven to be the best approach toward solving wiper problems.

There are several possible variations of ring configuration and design. The final selection of rings is a question of the specific task to be performed. Some packing is intended to repel or return oil while others are intended to collect oil and direct it to separate drains.

Compressors which use incompatible oils in the cylinder and crankcase should have auxiliary wiper assemblies built into the main compressor pressure packing. Regular distance piece

wipers under this circumstance will collect and drain only crankcase oil back into the crankcase. Extending the rod length to prevent overtravel between the crank packing and the main compressor packing is also desirable wherever maximum separation of two oils is required.

Material Selection for Compressor Packing

Selection of the most suitable material for compressor packing rings depends on the varied conditions in which they may be installed. The parameters are often interdependent, adding a degree of complexity to the decision. For instance, specific pressure limits are partially dependent on temperature, which is influenced by lubrication, which in turn, is influenced by the physical properties of the gas. The chart in Figure 20 can be used as a general guideline, but some judgment must be exercised regarding the over-all service for which the rings are intended and the suitability of the material selected.

In the Materials Selection Chart, when a material is recommended for use with a particular gas, more than just the corrosive properties of that gas are considered. In addition to any material compatibility effect, the gas may also influence lubrication. It may dilute or degrade the oil film, or products of corrosion (formed elsewhere in the system) may enter between the seal surfaces. When either occurs, the effect can be rapid abrasive wear or a rise to destructive temperatures because of high friction. The proper choice of material must be made considering its resistance to attack from components of the gas stream, and, more importantly, its wear properties when there is poor lubrication and possible abrasive solids.

Rod materials are not considered in the chart. However, material selection becomes important when lubrication is poor since the rod surface then has more influence on the wear of the ring material.

Figure 20

Material Selection Chart

■ Recommended

Ring Material	Lubrication Required			Temp Limit (°F)	Pressure Limit (PSI)	Acetylene	Air	Ammonia	Butane	Carbon Dioxide	Carbon Monoxide	Chlorine
	Normal Lube	Minimum Lube	Non Lube									
Cookroc Laminated Phenolic				350	1500							
Cook Graphitic Iron				700	Not Limited	■	■	■	■		■	
Cookmet Bronze				500	Not Limited		■		■		■	
Carbon-Graphite				750	1500	■	■	■	■	■	■	■
Babbitt				300	1500		■	■	■	■	■	
Filled Tfe Plus Metal Back-up				500	Not Limited		■	■	■	■	■	
Filled Tfe				500	700	■	■	■	■	■	■	■
Filled Polyimide				600	Not Limited	■	■		■	■		

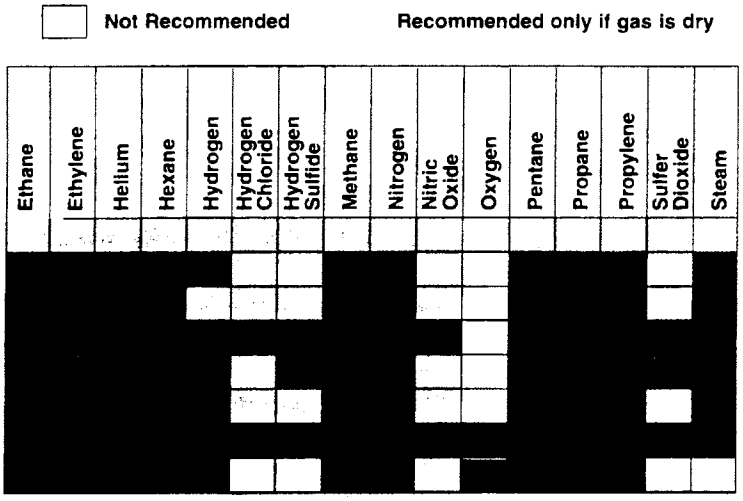
There are a few rod/ring material combinations which are incompatible. However, hardness is generally the most critical rod characteristic. Hardness can be obtained in the base material or it may be achieved as a result of a coating such as one of the metal sprays, or electroplating. For most applications, especially those at pressures above 1000 psi, through hardening or surface hardening of the base rod material is preferred. The table in Figure 21 outlines the optimum rod specifications for several different service conditions.

Lubrication

Without question, lubrication has more influence on material selection (and packing performance) than any other factor. When full lubrication is supplied to the packing, and nothing in the gas stream affects its operation, then any of the available materials will operate satisfactorily. All are capable of operating with full lubrication. When minimum lubrication is present, the choices are narrowed; and with nonlubricated service, there are even fewer choices of material.

Full lubrication, of course, means that oil of the proper viscosity is applied at the proper flow rate. Generally, viscosity for packing above 1000 psi should be between 120 and 150 SSU at 210°F, while below this pressure, viscosity down to 60 SSU at 210°F will be satisfactory.

There have been various rules or equations developed by compressor manufacturers or oil suppliers which relate the quantity of oil required for packing to the operating conditions. Contact your compressor OEM representative for specific recommendations. Some packing, obviously, will require more lubrication than others because of poor operating conditions, while others, where the service is not severe, can operate with less than this amount.



"Mini" or "minimum" lube is used to define a level of compressor lubrication which is approximately one-quarter normal. This level may vary slightly because it essentially indicates a level below which metal rings will not operate satisfactorily. The lubrication level then dictates the use of plastic rings with some self-lubricating properties: that is, a material that can operate almost without lubrication. The small amount of oil can be supplied from several sources. It can be "accidentally" carried over from the crankcase, contained in the gas stream, or it may be due to controlled feed directly to the packing case.

For pressures below 2500 psi and a "normal" length packing, one lube inlet per packing case is sufficient. Above this pressure, with oils of recommended viscosity, and with packing which does not contain a bushing, two lube points are commonly used. Where very light oils are necessary, additional lubrication points may be provided. If a bushing is present and the case is relatively long, a separate inlet may be provided for the bushing itself.

Fortunately, most large compressor cylinders are horizontal, ensuring that if oil is introduced at the top of the rod or cylinder, gravity will take care of distributing it around the circumference. A point often overlooked is that if the oil inlet is only a few degrees off top center, the upper portion of the rod may receive no oil. Gas flow and the motion of the rod distribute oil in the axial direction.

The general method for lubricating a rod is to machine a channel around the oil outlet at the packing case bore to cause oil to drop from the cup bore to the rod. Even with this feature, the oil may cling to, or creep around, the inside of the cup rather than drop onto the rod—the bottom of the rod receiving lubrication while the top remains dry. To overcome this, a small TFE quill may be inserted into the oil passage. The quill is only a few thousandths away from the rod. Instead of forming a drop, the quill provides an oil wick to the rod surface so there will be a continuous

Figure 21

Rod Specifications

Conditions	Rod Materials
Lubricated, Noncorrosive	Carbon or low alloy steel, through or surface hardened—
Below 1000 psi	R_C 25 min., 32 RMS
1000-6000 psi	R_C 40 min., 16 RMS,
Above 6000 psi	R_C 55 min., 16 RMS
Poorly Lubricated, Noncorrosive	Material as above—
Below 1000 psi	R_C 40 min., 16 RMS
1000—6000 psi	R_C 55 min., 10 RMS
Above 6000 psi	Hard coated R_C 65 min., 4-6 RMS
Corrosive	Hardness and finish as above in corrosion resistant material or coating

Type of Lubricant

"moving" film applied. This ensures that oil will be deposited directly to the top surface in a reasonably steady flow.

In all lube lines leading to packing cases, a check valve should be installed as close to the case as possible. Often gas flow and compression in an open oil passage will create considerable heat. The check valve serves to keep the volume of the open line small and, thus, minimize the heating effect within the passage. Oil channels within the packing case should be kept as small as practical, and with oil of the proper viscosity, capillary action will usually keep the lines downstream of the check valve full of oil.

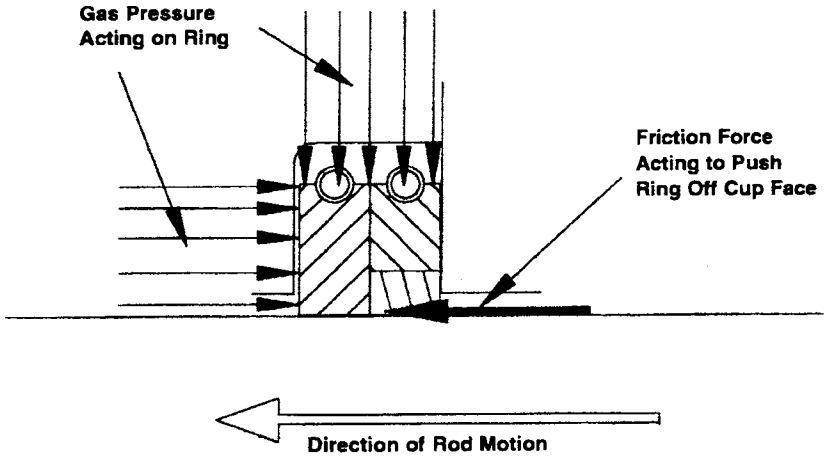
For the most part, lubrication of packing rings takes place in the "boundary" region. This is the area where an extremely thin lubricant film separates the ring bore surface from the rod. The most important factor affecting film thickness is oil viscosity. However, other properties of the oil may also affect film thickness. For example, low refined oils or ones containing oily agents or film strength improvers are best for any application where some condition of the intended service may tend to reduce viscosity. Straight mineral-based oils are adequate for dry gases at low pressures; but for gases containing liquids (water or condensed gas), compounded oils or oils with proper additives offer the best lubrication. Nearly all high speed, high pressure compressor packing will benefit from an oil containing an oxidation inhibitor and a film strength improver.

There are a large number of possible additives for modern oils, and the necessity for using an oil with any particular one is, in most cases, determined from actual field tests. Usually the choice of which oil to use is based on its compatibility with the gas stream or with other process equipment, and only rarely, if viscosity is adequate, would the oil be unsuitable for packing lubrication.

When mineral oils are unsuitable and it becomes necessary to consider synthetics, the

Figure 22

Friction Force on Ring



effect on packing performance is the same as with highly refined oils. Some of the synthetics lack the ability to lubricate well under boundary conditions. Using high viscosity oils becomes doubly important; but even at that, some synthetics will lubricate so poorly with thin films that it is necessary to consider the degree of lubrication as "minimum" and select a ring material accordingly.

There are a large number of synthetic oils and some are more effective as packing lubricants than others. Normally, the synthetics are not chosen because of their lubricating properties but because of their other advantages over mineral oils, such as temperature resistance or process compatibility. Those which offer the least friction and wear are the polyalkylene glycol oils, synthetic esters, halogenated hydrocarbons, and fluorosilicones. With these it is nearly always necessary to depart from the standard rate of application. It is necessary to increase oil feed rate and, sometimes, number of injection points in a packing case to help offset poor lubricity. With very expensive synthetics such as fluorosilicone, it is often desirable to decrease feed rates for economic reasons.

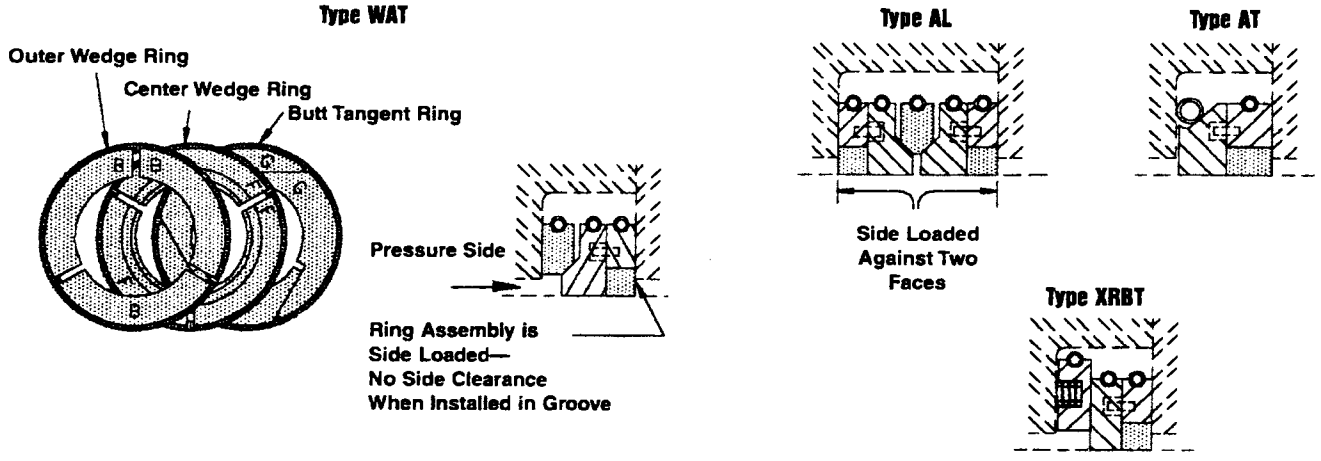
Packing Leakage Control

Relative to the potential sealing problems that may occur in high pressure compressors, the potential sealing problems in low pressure (50 psi or less) compressors may seem insignificant. Wear and packing life may not be major problems, however, obtaining a good seal between packing ring and rod, and especially between the ring and cup face, may be difficult.

There are two reasons for this. The first is because of the relative stiffness of conventional seal rings. As pressure differential increases across a ring, some of the leak paths will be decreased as the ring deforms. Obviously, using materials with low modulus of elasticity, such as plastics, will improve the seal. However, even plastics are relatively rigid when sealing against 1 or 2 psi,

Figure 23

Axially Loaded Rings



such as when suction pressure is close to atmospheric pressure.

The second reason for leakage at low pressure is loss of ring contact with the flat cup face. Figure 22 illustrates the frictional forces that may cause a rod to hold a packing ring away from the cup. The point at which this occurs depends on ring size, the coefficient of friction, and the pressure level. For "normal" size rings, approximately 50 psi differential pressure is required to hold a seal ring against the cup.

In a compressor, pressure at the packing vent is normally well under 50 psi, so good practice dictates the use of a double-acting ring to minimize leakage from the vent into the distance piece. This ring functions by forming a reasonable seal regardless of which face it rests against. However, there is an instant during stroke reversal when even the double-acting ring will leak, and in order to improve on this it is necessary to use rings which are spring loaded axially, such as in Figure 23.

The advantage of Cook axially loaded ring types such as the the AT or WAT, is the almost equal axial and radial load provided by the spring. If these loads are not equal, or very nearly equal, the ring will either "hang" in the groove and thus leak, or it will be pulled from one face to the other by the frictional force.

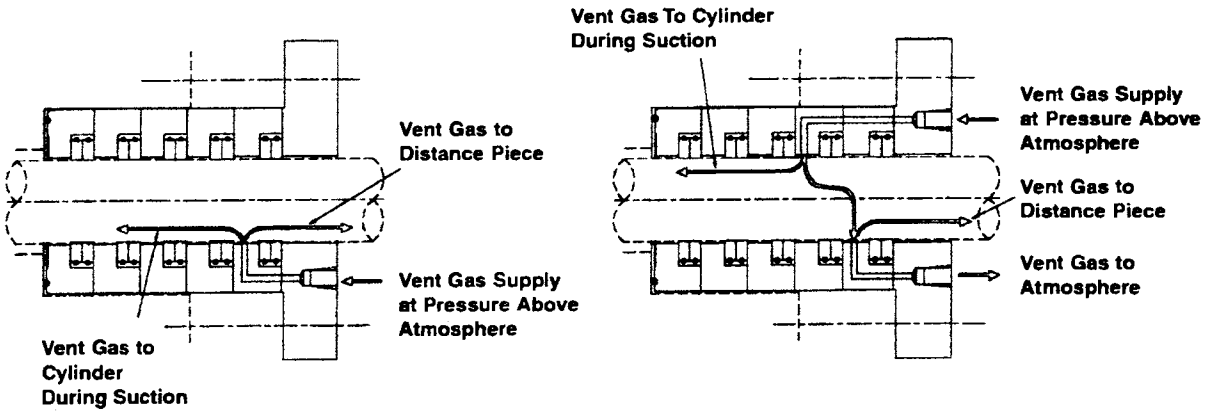
Problems Associated with Low Suction Pressure

When compressor suction pressure is below atmospheric pressure (when pressure within the cylinder falls to vacuum), air may pass back through the packing and into the cylinder. Either double-acting rings or those spring loaded against the cup face will reduce leakage, but neither will eliminate it completely due to the minor inconsistencies in the ring surfaces insufficient gas pressure to make the ring conform.

One solution is to introduce gas at low pressure at the vent, as in Figure 24A. The gas that enters the cylinder will be drawn from this vent rather than from atmosphere. The gas pressure

Figure 24

Venting



in the vent need be only a few psi above atmospheric pressure.

Loss of vent gas to the distance piece can be minimized with another lower pressure vent to atmosphere, as in Figure 24B. This more conventional arrangement will control gas leakage into the distance piece to at least the same degree as with a single atmospheric vent.

When it is impractical to use a source of gas slightly above suction pressure, then gas at full discharge pressure may be used. This will increase leakage both toward the cylinder as well as out the atmospheric vent. It also puts a higher pressure load on the ring between the vent and the distance piece, or between the two vents, and will cause more frictional heat. This can mean that for part of the stroke two rings will be loaded at high pressure, when normally only one ring will have a high differential pressure across it.

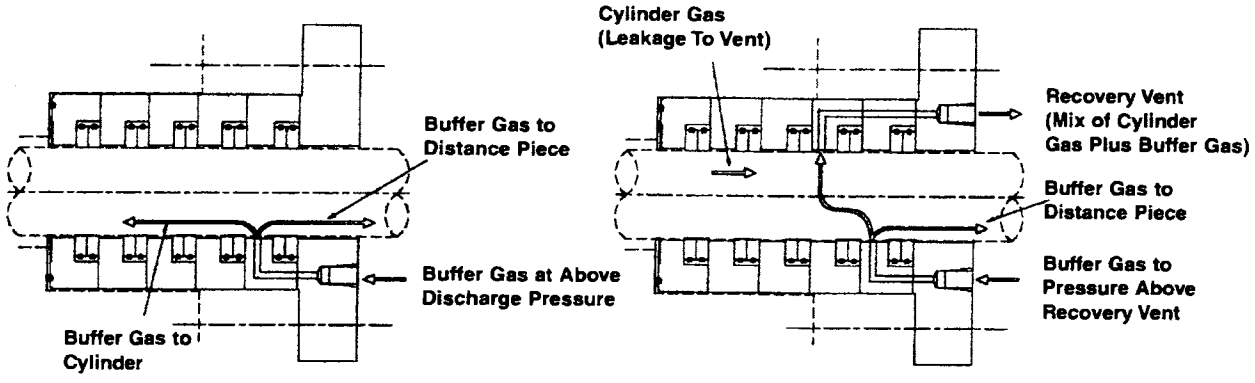
Everything discussed to this point assumes the gas used to exclude air was the same as the gas going through the compressor cylinder. There are circumstances where it is more practical to use a gas other than the process gas being compressed. The usual choice for this buffer gas is an inert gas such as nitrogen. If nitrogen is used and the pressure at the vent is less than discharge pressure, then the gas leaked into the vent or the distance piece will be a mixture of the inert gas and process gas. Of course, gas delivered from the compressor cylinder will also contain a small quantity of the inert gas.

Problems Associated with Low Leakage Requirements

In addition to low suction compressors, where entry of air should be avoided, there are a number of applications where any loss of gas to the atmosphere must be prevented. This is true for toxic or dangerous gases, very expensive gases, or in processes where it is desirable to maintain a constant quantity of gas in the system—such as within a refrigeration cycle, for example.

Figure 25

Buffered Packings



There are several methods that will accomplish the goal of minimizing leakage. One way is to use a double-vented packing, figure 25B, with buffering gas introduced at constant pressure to the outer vent instead of the inner vent. The "buffering" gas is usually inert or at least compatible with the atmosphere. Leakage from the main sealing rings flow out the inner vent in addition to some flow of buffering gas. The loss to atmosphere of the gas being compressed is zero and the mixture of the two gases from the inner vent can be recovered.

Another way to prevent leakage is much like the method used to prevent air from entering the cylinder during vacuum conditions. As illustrated in Figure 25A, a buffering gas is introduced through the packing vent at a pressure which exceeds the compressor discharge pressure. The result is a gas mixture in the cylinder as opposed to one in a recovery vent. In each of the illustrations, only one ring set is shown between the two vents and downstream of the outboard vent. Depending on the pressure levels, additional rings may be used at either of these two points.

Affect of Ring Type on Leakage Control

In each of the low pressure vent arrangements previously discussed and illustrated in Figures 24 and 25, double-acting (BD) rings are often used. When the requirements call for less leakage, one of the axially loaded type of rings would normally be substituted. Axial loaded rings are used for control of gas flow toward the cylinder, or into the vent or distance piece, as well.

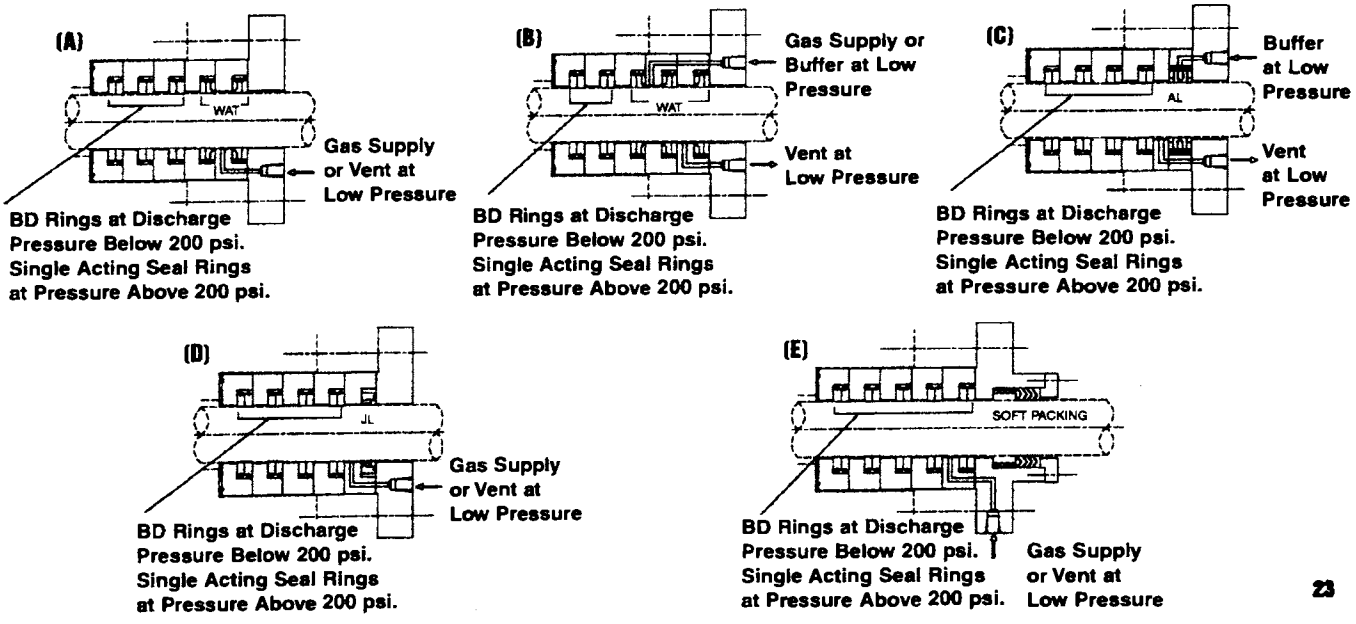
Figure 26 shows how the various ring types are installed in order to be effective seals in typical packing arrangements.

It is difficult to relate the choice of ring type to discharge pressure. However, the choice of ring type can be related to the pressure differential at a particular point in a case, and to the amount of leakage which can be tolerated.

When confronted with low pressures, the simplest control method is to use soft packing

Figure 26

Rings Used to Control Leakage At Low Pressure



or a lip seal, as illustrated in Figure 26C or D. The result will be a tighter seal than with cut rings. However, packing life may be somewhat shorter due to a limited tolerance for wear. In many reciprocating machines, lubrication is marginal, and when this is coupled with significant rod "float", there may be heavy wear in soft plastic seals. This packing arrangement, though not 100% effective, may be chosen for gases such as ammonia, propane, or methane. In general, the escape to atmosphere of these gases may be tolerated to a greater degree compared to gases like vinyl chloride or hydrogen sulfide.

The quantity of leakage with any of the ring types or with lip seals is difficult to estimate. The best that can be done is to predict a range in which the leakage quantity will most likely fall. This is normally done based on experience and empirical data for most ring types. Leakage paths through packing rings occur not by design, but due to tolerances, alignment, and various characteristics of the compressor and ring itself. Although it would appear that flow rate would be heavily dependent on pressure differential, this is not the case as rings tend to conform and effect a better seal at high pressure.

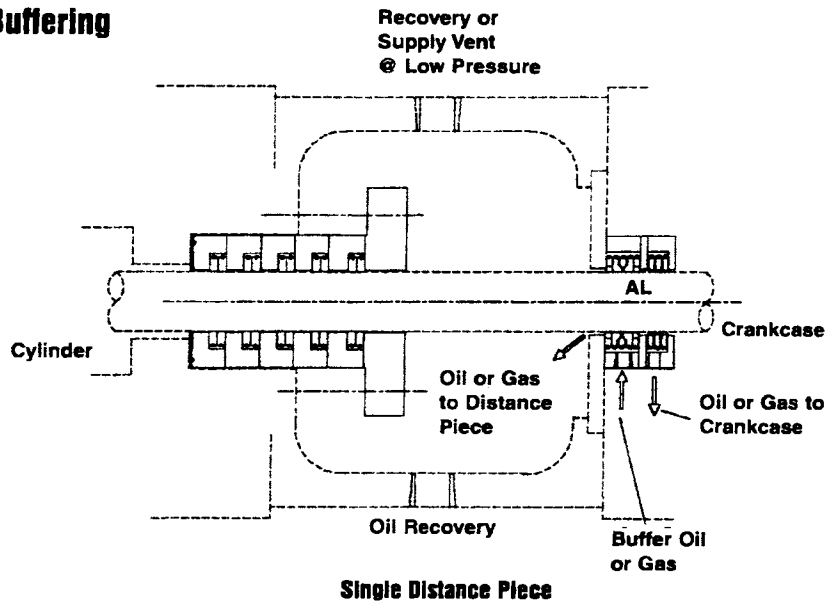
Under normal conditions and with most gases, leakage from the cylinder or through any of the vents will be on the order of 0.1 to 0.2 scfm (standard cubic feet per minute). As the factors which cause leakage progressively get worse (misalignment, dirt, poor finishes, poor lubrication, etc.), or with lighter gases such as hydrogen or helium, leakage rates can be expected to increase by 2 to 4 times. Once again, this is just a guide based on measured flow rates at various conditions. If a more accurate flow rate is required, it must be obtained by test and measurement.

Leakage Control with Distance Piece Pressure

One method to prevent both air contamination and/or gas leakage is to close, but vent the distance piece rather than

Figure 27

Distance Piece Buffering



(A)

Single Distance Piece

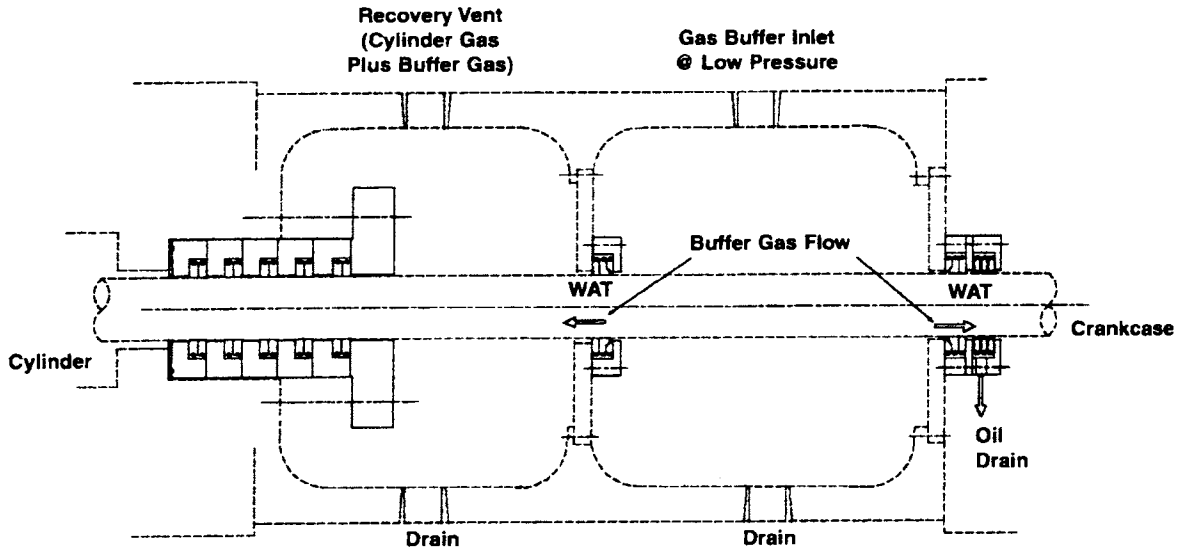
the packing case. To accomplish this, the conventional packing arrangement, less the atmospheric vent, may be used. It is also necessary to provide a positive seal for the partition packing in double distance piece machines, or for the wiper packing in a single distance piece machine. To reduce air contamination, the distance piece vent is used to supply gas, whereas when it is required to control leakage, the distance piece vent will be used to recover gas.

In either case, one type of partition or wiper packing seal arrangement is illustrated in Figure 27A. It consists of side-loaded rings between which a buffering liquid (normally oil), or more commonly buffer gas, is injected. When oil is used, it is generally taken from the crankcase. Part of the leakage past this seal goes back into the crankcase, while part must be recovered from the distance piece. In the event a buffer gas is used, it must be one that is tolerated in the crankcase and suitable for mixing with the recovered gas. When two distance pieces are used, the second one can be pressurized to serve the same function as the AL ring arrangement shown in Figure 27A.

In nearly every instance where gas is used in the distance piece to control leakage, the process pressure is very low which usually requires the use of axially loaded rings.

The methods previously described are the more common ways of controlling leakage. There are several reasons for wanting to do so including: economic, ecological, safety or to control odor. There are other methods, basically variations of those previously discussed, used for controlling leakage not only in reciprocating compressors, but in a wide variety of applications such as rotary seals, pumps, engines, "clean" rooms, and process vessels.

The basic principle remains the same in all applications: The prevention of gas flow in one direction along some particular path is accomplished by establishing pressure conditions that cause gas to flow in the opposite direction along that same path.



(B) Double Distance Piece

Static Compressor Sealing

In some applications, after a compressor stops, it is desirable to maintain pressure within the cylinder. Rod packing will generally leak slightly more when rod motion is stopped as compared to when it is moving. This is due to a number of factors; loss of oil which filled the leak paths, changes in the ring shape as the ring cools, and changes in rod alignment as the temperature changes.

To eliminate leakage through the packing rings, a product called the "Static Pac" is available in "kit" form to adapt to existing cases, or it can be supplied as part of the original design. The Static Pac is essentially an uncut, conformable ring which is forced against the rod by a piston when the compressor is stopped. Actuation occurs when pressurized gas is admitted to the piston. The piston stroke is approximately 1/4", and when actuated, wedges the seal ring inward against the rod. The shape of the seal is such that pressure from within the cylinder will cause the seal to move away from the rod when actuating pressure is lowered.

A typical packing case containing the Static Pac is illustrated in Figure 28. The minimum pressure required to actuate the Static Pac seal is one-half cylinder pressure. It is often convenient however, to use up to full cylinder pressure.

When the compressor is in operation and after it has stopped, a three way valve would be opened, admitting pressurized gas behind the internal piston. Pressure must be maintained to the Static Pac for as long as it is desirable to seal the cylinder. Deactuation would take place when the valve is opened to atmosphere, reducing pressure on the piston and allowing the springs to push the piston back away from the seal. The seal itself would then lift from the rod surface. A vent to atmosphere (or some other low pressure area) must be located downstream of the Static Pac in order for seal actuation to occur or for seal release.

The Static Pac can be adapted for pressures up to approximately 2000 psi. The seal itself is made of relatively soft synthetic rubber for pressures up to 700 psi or Teflon for pressures above that.

Leakage from a cylinder may occur through the packing case itself as well as the rings. When the Static Pac is installed, other areas for potential leakage should be checked. It may be necessary to "lap" the case mating faces or install O-rings between the individual cups. Piping, cylinder heads, and any gasketed joint are possible leak points which must be sealed if the gas is to be kept within the cylinder.

The Static Pac is excellent for overcoming the loss of gas through valves used to isolate a compressor from the pipeline. Often these valves leak and while the compressor is not operating, gas may flow through the valves, back through the cylinder and packing to atmosphere. The Static Pac will prevent this from occurring.

Possible uses for the Static Pac include any application where it is desirable to eliminate the loss of an expensive gas or to prevent an objectionable gas from escaping to atmosphere. The Static Pac may be used in conjunction with special vented or buffered packing to provide an overall seal arrangement that can achieve very close to 100% leakage control.

Compressor Barrier Fluid Systems for Fugitive Emissions Control

Although far down the list of offenders for total air pollution emissions, compressors have higher leak rates than other industrial equipment. There is no Federal regulatory limit for compressor leakage. It is indirectly established by the limit on the allowable concentration of VOC's (Volatile Organic Compounds) measured near the leak source.

Federal regulations consider 500 ppm to be "no detectable emissions". The regulations require that any compressor not in compliance with that emission level must have a barrier fluid (gas or liquid) system installed on its seal.

Barrier Systems

A "Barrier" system is one in which a non-VOC liquid, or inert gas, is forced into the seal in a direction opposite to that of the leakage. The barrier fluid or gas blocks the escape of leakage to atmosphere from the compressor seal or packing. The system can be installed in one of two ways:

1) A barrier fluid is injected to form a barrier seal between the process fluid, or gas, and atmosphere. The fluid pressure must be maintained above the pressure upstream of the seal.
2) More commonly, a barrier gas is forced against a set of "barrier seals" such as the ring sets shown in Figure 29. The barrier gas is held at a pressure exceeding pressure in the vent which normally carries leakage away from the compressor seal.

On reciprocating equipment the motion of the rod will carry fluid, usually oil, under the seal face and out to atmosphere where emissions of gas carried in the oil may be released. The oil film on the rod surface absorbs gas while in the cylinder due to the relatively high gas pressure, and then releases this gas to atmosphere when the rod moves out of the packing. On non-lube applications, gas molecules are carried out of the packing in the rod surface irregularities.

In either case, a small quantity of gas molecules may escape

Figure 28

Static Pac

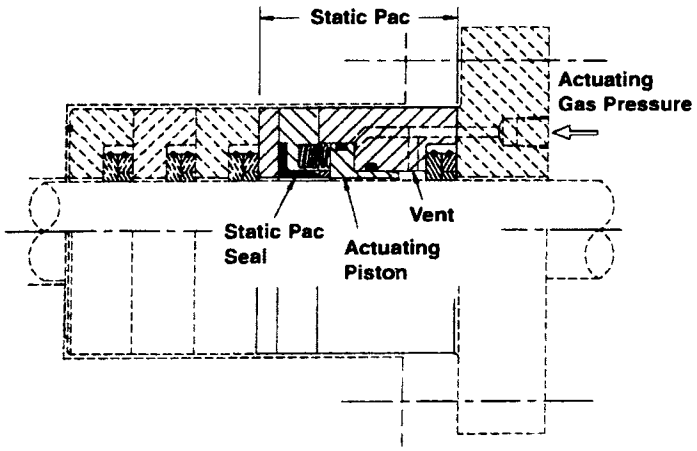
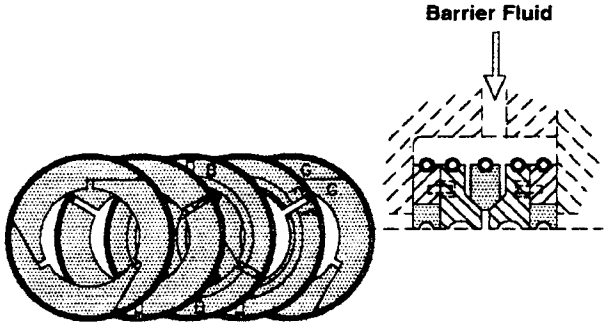


Figure 29

Barrier System Seals



TYPE ALW

the barrier seal and become fugitive emissions outside the packing flange. These may measure as much as 200 ppm but generally are much lower. Gas transported by the oil film or rod surface becomes important only when allowable emissions are near zero.

Cooling Reciprocating Compressor Packing

One of the critical, if not the most critical, factors in obtaining good service from compressor packing is proper cooling. A primary source of heat is from the work required to overcome the frictional resistance to motion of the seal rings. This is influenced by material selection, the ring dimensions, the operating characteristics of the compressor, and the conditions of the intended service.

The relation between cooling requirements and the various influencing factors is discussed here. This is intended to serve as a guide, indicating when special cooling is required, and to help in sizing the equipment needed to provide the cooling. The solutions set forth are general in nature but based on basic engineering principles and empirical data.

Low friction materials, such as TFE, carbon graphite (or compounds composed of plastics filled with TFE and carbon graphite), and other solid lubricants, have made it possible to manufacture packing and piston rings capable of satisfactory operation in a non lubricated compressor cylinder. The frictional characteristics of these materials are good, but not nearly as good as when lubrication is used. The configuration of the seal rings affects this somewhat, but even with the best designs, considerable heat due to friction is generated. Temperature is a limiting factor in the design of high speed, high pressure compressors. A point is reached where compressors fail unless the heat is conducted away from the rod or cylinder surface. Friction with the packing rings, although not the only source, is the major contributor to excess heat.

The primary purpose of cooling the packing is to remove the heat generated due to friction

Figure 30

Nomenclature

A - Area (Ft^2)

D - Rod Diameter (In)

f - Coefficient of Friction

F - Force required to move Rod against Friction (Lb)

FPM - Avg. Rod Speed (Ft/Min)

hc - Film Coefficient (BTU/Hr-Ft^2-°F)

k - Thermal Conductivity (BTU-Ft/Hr-Fx^2-°F)

n - Gas Constant

p - Gas Density (Lb/Ft^3)

Pa - Average Pressure (PSIA)

Pd - Compressor Discharge Pressure (PSIA)

Ps - Compressor Suction Pressure (PSIA)

RPM - Compressor Rotative Speed (Rev/Min)

S - Compressor Stroke Length (In)

Td - Temperature of Discharge Gas (°F)

Tr - Surface Temperature of Rod (°F)

Ts - Temperature of Suction Gas (°F)

T - Temperature Difference (°F)

u - Gas Viscosity (Lb/Hr-Ft)

V - Gas Velocity (Ft/Hr)

W - Ring Width (In)

between the seal rings and the rod. Nearly all the work done to overcome friction converts to heat at the ring and rod mating surface. This heat is transferred to the case, the gas passing through the cylinder, the distance piece, and the crankcase.

Factors affecting generation of heat, and heat flow, vary from compressor to compressor making accurate predictions of the quantities involved very difficult. A general method of calculation, coupled with certain assumptions, is a starting point that can be modified by empirical data gathered in actual field installations.

This will provide reasonably accurate results for most applications. Estimating the effect of friction is difficult in any event but especially difficult for installations with less than full lubrication.

When a compressor is lubricated and pressures are relatively low, friction loads can be estimated fairly accurately. However, at low pressures cooling is frequently not required. At higher pressures the lubricant film separating the ring and rod surfaces is, at best, partially effective and the coefficient of friction is more difficult to determine without actual operating experience and empirical data.

Examples of methods to cool cases are shown in Figure 31. Coolants in successful applications range from oil, which is circulated by convection, to special fluids chilled and pumped through the case. In some instances gas is blown through the case or over the rod for cooling.

Currently, the best available method to affect cooling is to use a case with internal cooling channels, shown in Figure 31C, which circulates water or a water anti-freeze mixture. Oil is not often recommended because it is ineffective at removing heat compared to water or water and anti-freeze.

In a packing case containing several rings, most of the pressure drop will be across one ring. For calculation purposes, the heat generated by friction can be considered to be totally from one ring carrying the entire

Figure 31

Typical Cooling Methods

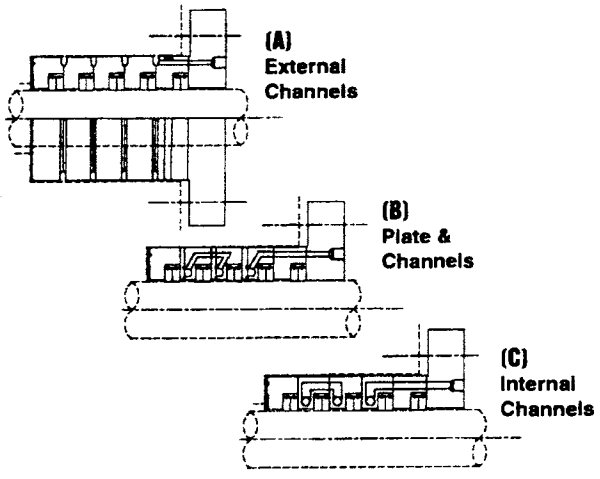
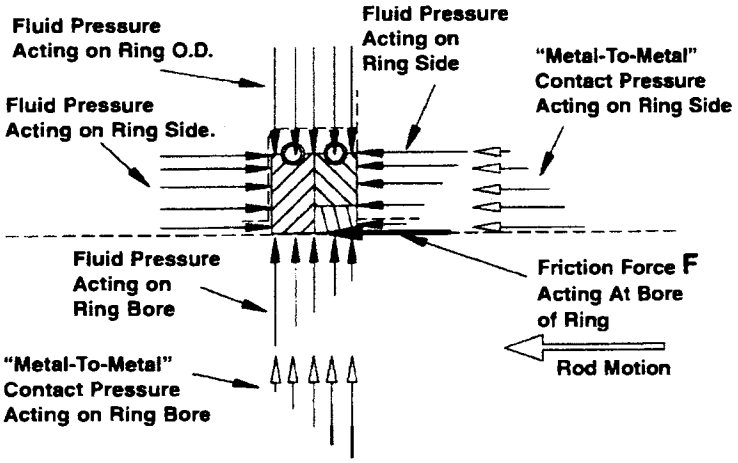


Figure 32

Pressure on Ring Faces



pressure drop. A pressure drop distributed in any manner over a complete set of rings generates essentially the same heat.

For purposes of simplifying the calculations it can be assumed that the Coefficient of Friction is independent of load and contact area. Therefore, equation (1) in Figure 33 represents the work required to overcome friction.

Obviously, the velocity of the rod is not constant throughout the stroke, but again the Coefficient of Friction can be estimated on the assumption it is independent of velocity.

As shown in equation (2), the work done can be converted to heat generated.

Figure 32 shows a cross section of a packing ring arrangement on a rod, illustrating the forces and pressure loading. Friction force is dependent on the Coefficient of Friction, the ring dimensions and the pressure acting on the ring. Reasonably accurate results can be obtained using the "mean" pressure between suction and discharge. A more accurate calculation of friction force can be made using an average pressure "Pa" for the entire cycle, from equation (3).

Typical ring configurations found in packing cases are shown in Figure 34. These can be broken down into four groups based on the load exerted against the rod. At a given pressure and total width each group exerts a different load due to the type of cut found between the ring segments. The type of cut changes pressure distribution across the bore of the ring. This applies to normally proportioned rings for the most common ring types in current use. The friction force for the various ring types is shown as related to pressure and ring dimensions.

The Coefficient of Friction normally varies between 0.01 to 0.3 in most compressors. The lower figure corresponds to a well-lubricated surface, and the higher for cases where dirt and/or abrasives are present. It may even range higher than 0.3 but, coupled with high pressure, the packing is usually unable to function and can be totally destroyed. At very high frictional resistance, it becomes nearly impossible to

Figure 33

Friction Equations

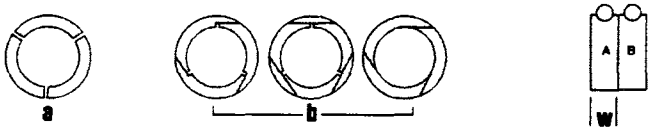
$$(1)\ \frac{\text{Work}}{\text{Revolution}} = (F)\ (2)\ (S)$$

$$(2)\ \text{BTU per minute} = \frac{(F)\ (FPM)}{777}$$

$$(3)\ Pa = \frac{\left[(Pd)\ (n)\left(\frac{Ps}{Pd}\right)^{\frac{1}{n}}\right] - (Ps)^{(2-n)}}{2(n-1)}$$

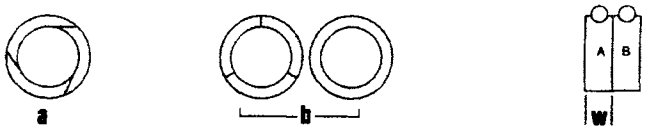
Figure 34

Friction Loads



Group A

F= (π) (f) (Pa) (W) (1.24 D + 1)



Group B

F= (π) (f) (Pa) (W) (.7 D + .5)

get rid of the heat generated or to maintain a reasonable seal.

The Coefficient of Friction for compressor packing is shown in Figure 35. The data contained in the table is a result of experience, tests and other empirical data. This information on f, along with ring dimensions, operating pressures, and rod speed can be used to calculate BTU/Min. generated by the seal rings. (From Equation 2)

In Figure 36, BTU/Min. at various products of Average Pressure times FPM are shown. Common groove widths have been chosen for purposes of illustration. For other widths, rod diameters, and intermediate values of Pa X FPM, interpolation of data in the tables may be made.

The heat generated, as mentioned earlier, is dissipated through several means. For most compressors, the two major paths are:

1) Through the case or case coolant, and
2) Through the gas flowing in the cylinder.

Heat is lost to gas passing through the cylinder when the rod, warmed by friction, moves into the cylinder and releases some of its heat to the inlet gas at suction temperature, and also during part of the stroke occurring during discharge.

There are several formulas, or empirical relationships, which could be used to describe the flow of heat from the rod into the gas, all dependent on the same factors. One which might be used is equation (4), the formula for calculating the surface coefficient for gas passing over a smooth surface.

The total heat flow, Q, into the gas, may be expressed as shown in Figure 37.

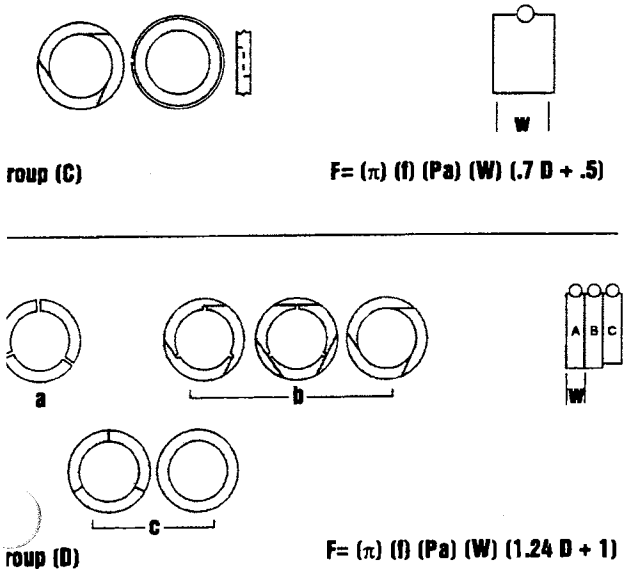
Obviously, the rod is not a flat surface with gas flowing exactly parallel to it. The gas velocity and direction of flow vary widely from point to point on the surface of the rod. The rod temperature and area of exposure are constantly changing as well. Any calculation made without taking all this into consideration is an approximation, although a useful one.

Figure 35

Coefficient of Friction

Various Products of Pa x (FPM)

Operating Conditions	Range of "f"	Suggested f to use when estimating BTU/Min
Lubricated		
Metal Rings		
Pd<2000 psi	.005 - .02	.02
Pd>2000 psi	.01 - .05	.02
Nonmetallic Rings	.01 - .1	.05
Poorly Lubricated		
Metal Rings	.1 - .2	.2
Nonmetallic Rins	.12 - .2	.2
Dirt or Solids Present	.12 - .7	.3
Non Lube		
Carbon or TFE Rings	.15 - .25	.25
Dirt or Solids Present	.15 - .7	.3
Dry Inert Gases		
Carbon Graphite Rings	.2 - .3	.3
TFE Rings	.15 - .3	.25



Relative values for most compressors can be calculated after making several approximations. The area of rod exposure can be as shown in Figure 37. The change in temperature is the difference between rod temperature and the suction gas temperature. Gas velocity can be set equal to the rod speed.

Using these assumptions, the expression for quantity of heat is shown in equation 6. If k, p, and u are obtained for the particular gas being compressed, we can assign values to everything but the rod temperature Tr.

Rod temperature is one of the conditions to be controlled with cooling. Using the maximum value of rod temperature will give the maximum heat flow, both into the gas and the case. If the value is lower, the heat transfer is lower, and the rod temperature will tend to rise. Therefore, it is logical to base heat flow predictions on maximum allowable rod temperature. In general, nonlubricated machines can run with rod temperatures as high as 250°F. In lubricated machines the limitation is approximately 150°F.

When heat flow into the gas exceeds the heat generated, no separate liquid coolant is required. Experience with compressors in the field indicates that unless the total heat to be removed from the case exceeds 20 BTU/minute per inch of rod diameter, it is not necessary to provide coolant.

Once it is established that coolant is required, it is necessary to determine required coolant temperature and amount of flow. Usually, one gallon per minute per inch of rod diameter provides sufficient velocity through most cases to ensure good heat transfer. The increased flow for larger diameter rods absorbs the increased heat generated and also compensates for larger coolant passages. Larger rod diameters generally have larger cases and thus more room for coolant passages.

It has been difficult to find a correlation between the calculated thermal resistance of a packing case and the observed heat rejection rates. Because of this, coolant temperatures are determined by first setting the temperature of the coolant as it leaves the case at about 90°F

Figure 36

Friction Force — BTU/Min.

ROD FORCE, F				
Rod Diameter	GROUP A W=3/16	GROUP A W=5/16	GROUP B W=3/16	GROUP B W=5/16
1	1.32(f)(Pa)	2.20(f)(Pa)	0.70(f)(Pa)	1.18(f)(Pa)
2	2.04(f)(Pa)	3.41(f)(Pa)	1.12(f)(Pa)	1.86(f)(Pa)
3	2.77(f)(Pa)	4.63(f)(Pa)	1.53(f)(Pa)	2.55(f)(Pa)
4	3.50(f)(Pa)	5.84(f)(Pa)	1.95(f)(Pa)	3.23(f)(Pa)
5	4.23(f)(Pa)	7.06(f)(Pa)	2.35(f)(Pa)	3.92(f)(Pa)

BTU/MIN GENERATED @ VARIOUS (Pa) (FPM) FOR GROUP A RINGS IN 3/8 WIDE GROOVE				
Rod Diameter	Pa X FPM =100,000	500,000	10^6	2 x 10^6
1	170 f	850 f	1700 f	3400 f
2	262 f	1310 f	2620 f	5240 f
3	356 f	1780 f	3560 f	7120 f
4	450 f	2250 f	4500 f	9000 f
5	544 f	2720 f	5440 f	10880 f
FOR GROUP A RINGS IN 5/8 WIDE GROOVE				
1	283 f	1415 f	2830 f	5660 f
2	439 f	2190 f	4390 f	8780 f
3	596 f	2980 f	5960 f	11920 f
4	752 f	3760 f	7520 f	15040 f
5	909 f	4540 f	9090 f	18180 f

BTU/MIN GENERATED @ VARIOUS (Pa) (FPM) FOR GROUP B RINGS IN 3/8 WIDE GROOVE				
Rod Diameter	Pa X FPM =100,000	500,000	10^6	2 x 10^6
1	90 f	450 f	900 f	1800 f
2	144 f	720 f	1440 f	2880 f
3	197 f	984 f	1970 f	3940 f
4	250 f	1250 f	2500 f	5000 f
5	302 f	1510 f	3020 f	6040 f
FOR GROUP B RINGS IN 5/8 WIDE GROOVE				
1	152 f	759 f	1520 f	3040 f
2	239 f	1195 f	2390 f	4780 f
3	328 f	1640 f	3280 f	6560 f
4	416 f	2080 f	4160 f	8320 f
5	504 f	2520 f	5040 f	10080 f

and then calculating the inlet temperature, assuming the coolant temperature will behave this way and absorb the required amount of heat.

For example: If 200 BTU's per minute are to be removed from a particular packing and circulation is two gallons (16.6 pounds) per minute of water, there is 16.6 pounds of water available to absorb the heat. 200 divided by 16.6 yields a temperature rise of 12 degrees. Subtracting this from the 90°F exit temperature, gives a maximum allowable inlet temperature to achieve this of 78°F. A definite temperature difference between the coolant and the rod is required for any given amount of heat to be conducted from the case. Using the method previously outlined, it is apparent that there are instances where rod temperatures are not equal to the 250° or 150° level for unlubricated and lubricated service.

The influence of materials on heat generation is illustrated in a general way in Figure 35. In addition to frictional properties, heat transfer characteristics also affect temperature control. These two parameters are not the only basis for choosing a material to be used for packing, as strength, resistance to the medium, cost, and wear resistance are also important. At the extremes of lubrication, choice of material is limited. With full lubrication, metals such as bronze, cast iron, or babbitt are best. Plastics such as phenolic, nylon or TFE may be used due to conditions other than heat transfer characteristics. For nonlube service, filled TFE is usually the first choice. Filled polyimides are also excellent but very costly, and some of the less expensive plastics do not have the frictional properties to allow them to be effective for nonlube service.

Between these two extremes, compressors operate in mini or semi-lube service or, as shown in Figure 35, "poorly lubricated". In this type of service it is more difficult to select the optimum material to provide the lowest operating temperature due to the overlapping performance of metals and non-metals. For example; at a certain level of lubrication, metal rings will operate at a satisfactory temperature level. However, with a

Figure 37

Heat Transfer Equations

$$(4)\ hc = .055\ k \left(\frac{Vp}{u}\right)^{.75}$$

$$(5)\ Q = \frac{(hc)\ (A)\ (\Delta T)}{60}$$

A = Area of Rod Exposure = (π) (D) (s)/2

ΔT = Temperature Difference Between Rod and Gas

$$(6)\ Q = \frac{(k)\ (D)\ (S)}{5000} \left[\frac{p\ (FPM)}{u}\right]^{.75} (Tr - Ts)$$

slight change of conditions, nonmetallic rings may perform even better. Metals conduct heat more efficiently and can run in conditions where the coefficient of friction is a bit higher, whereas nonmetallics require low friction for optimum results. The operator can enjoy the best of both by combining nonmetallic seal rings with a metallic back-up ring, which not only acts as an anti-extrusion ring but aids the nonmetallic ring by using its minimal contact with the rod to conduct heat away from the ring-rod interface.

It is often difficult to estimate cooling requirements when lubrication is poor. The best approach may be to change ring styles or materials in the event of a problem, rather than changing the existing coolant system.

Figure 38 contains two examples of calculated coolant requirements. Due to the generalizations and assumptions made in arriving at the formulas, the results are only approximations, as stated previously. However, designs often are put into practice in the field without benefit of even these rough calculations. Since many problems experienced with compressor packing stem from inadequate cooling, the approximate method outlined here should eliminate those problems.

Many machines operate under conditions that do not exactly match the assumptions or descriptions used. They have features or use materials that could change to some degree the calculated values of either heat generation or heat flow. For example; in a compressor with large clearance volume, the temperature in the cylinder may have an effect not allowed for in the calculations. Units which have short strokes will have a very limited amount of heat flow into the gas and a more concentrated input of heat to the rod than normal. A good approximation of this is to ignore the heat calculated from formula (6), and plan on removing all the excess heat through the case.

There are materials and material-lubrication combinations which provide a different coefficient of friction than found in the "Friction Versus Operating

Figure 38

Coolant Requirement Examples

Compressor and Gas Data			Calculated Values for Cooling Requirements		
	Example 1	Example 2		Example 1	Example 2
Rod Diameter	2	4	Pa	1380	4200
Pd	2000	6000	FPM	750	600
Ps	1000	3000	Pa X FPM	1.03 X 10^6	2.52 X 10^6
Td	200	220	Assumed f	.25	.02
Ts	100	100	Btu/Min.(from Fig. 36) Generated by rings	370	379
RPM	500	300	Q into Gas (from equation 6)	64	66
Stroke	9	12	Total BTU/Min. to be removed by cooling	304	313
Service	Nonlube	Lubricated	Coolant Inlet Temperature (Water out @90Fas coolant and 1 GPM/in of rod diameter	72	81
Gas Properties @ Suction	Hydrogen	Nitrogen			
n	1.4	1.4			
k	.11	.015			
p	.33	14.1			
u	.022	.044			
Ring Type	Group B	Group A			
Groove width	.375	.625			

Conditions" chart. The area designated as "poorly lubricated" is actually a broad range, and to assign one value for the Coefficient of Friction may be an oversimplification. These oversimplifications can be corrected by obtaining accurate operating results and adjusting the calculations.

Applying Packings to Liquids (Pumps)

There is little difference in cases or rings for packings applied to liquids or gases. Within the cylinder, pressure rise and fall is more rapid with liquids but this has little effect on the rings.

There is less backflow out of a pump packing case, which means pressure breakers are not normally needed as they are in a compressor. In very high pressure applications however, breaker rings may be used to achieve a labyrinth effect and thus reduce loading across individual rings.

In general, the tolerance for leakage is less with fluids than it is with gases so this dictates that low leakage rings, such as the TUU, be used. Most pumps have low suction pressure and this, together with reversal in rod direction at the start of the discharge stroke, sometimes results in slight leakage. This can be minimized by using side loaded rings, such as the TULU.

In pumps where the plunger attaches directly to the crosshead, there is little need for a case bushing, except to serve as an initial alignment aid. In those pumps where the plunger attaches to a yoke attached to drive rods, there can be greater lateral movement of the plunger, and thus the need for better bushing guidance. Cases typical of these two types of construction are shown in Figure 39.

As with compressor packings, lubrication is all important because of its effects on wear and friction. Pump packings can be pressure fed lubricant in the same manner as compressor packings. When the liquid being pumped has lubricating properties, the need for additional lubrication is less.

Cooling effect of liquid will be greater than it would be with gas so this usually eliminates the need for separate cooling through the case. Actually, some

Figure 39

Pump Packings

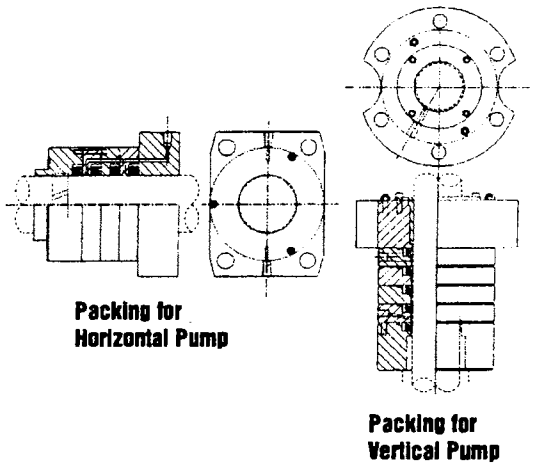
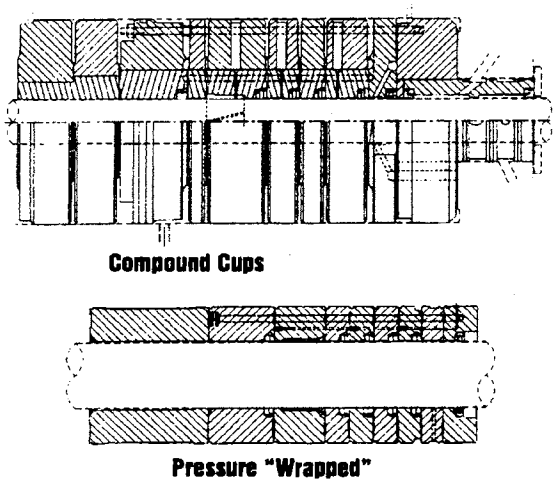


Figure 40

High Pressure Packings



pump packings require heating rather than cooling to provide better performance with viscous fluids or to overcome the low temperature effects caused by leaked liquid flashing.

Pump packings can be purged, or buffered, the same as compressor packings, normally by adding an "AL" or "ALW" outside of the vent/drain. The purging fluid can be liquid or gas. Purging at high pressure is also sometimes applied to pump packings to flush across the rod or prevent entry of solids or abrasives into the case.

High Pressure (Hyper) Packings

"Hyper" is generally taken to mean over 10,000 psi. Compressor or pump discharge may go up to 100,000 psi. At these pressure levels, fluids are usually acting very much like liquids in that compressibility is low. The type of rings used to seal these pressures are similar to those used in lower pressure compressors or pumps, but ring designs and materials must be selected to withstand high "compressive" cyclic pressures.

The problems (wear, friction and heat) caused by high contact pressure between ring and plunger are normally overcome by using ring sets that act as a laybrinth and thus reduce the pressure drop across each ring. Life of hyper packings is increased also by high lubrication rates plus, in some cases, coolant (oil) flow across the rod downstream of the packing.

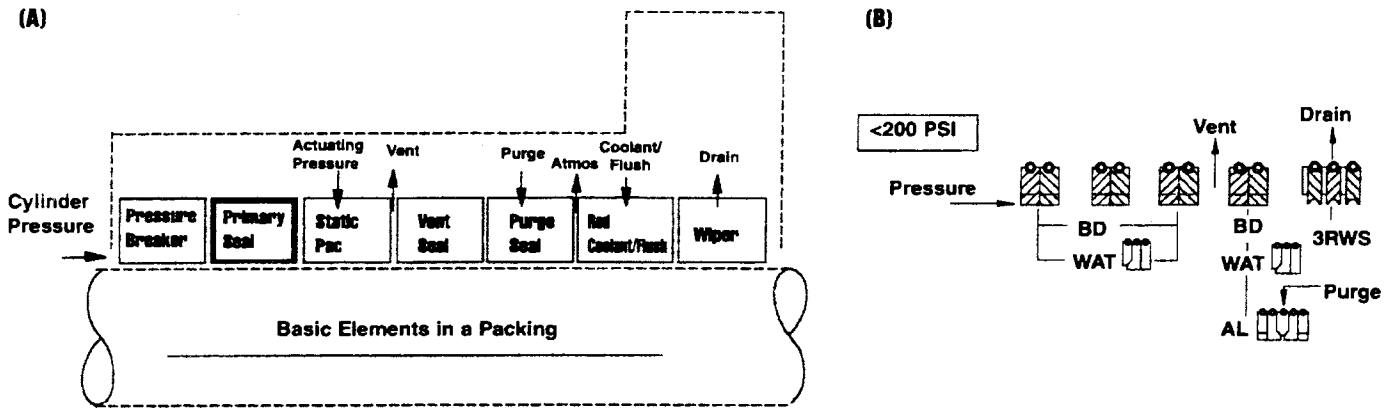
The other principle problem in hyper packings is containing very high cyclic pressure within the case, which is essentially a thick-walled pressure vessel. Particular attention has to be paid to stress concentrations, such as holes or notches, that might raise stress beyond acceptable levels. Compounding of cups, autofrettaging, or pressure loading the outside of the case are typical ways to ensure high fatigue strength in the case parts. Typical high pressure packing is shown in Figure 40.

Packing Ring Arrangements

Because of the many different ring types, there are a large number of combinations into which these can be arranged to

Figure 41

Packing Ring Arrangements



provide packings that function as intended. What is shown in Figure 41A are the basic "elements" that can be put into a set. The only necessary element is the primary seal; all the others would be optional.

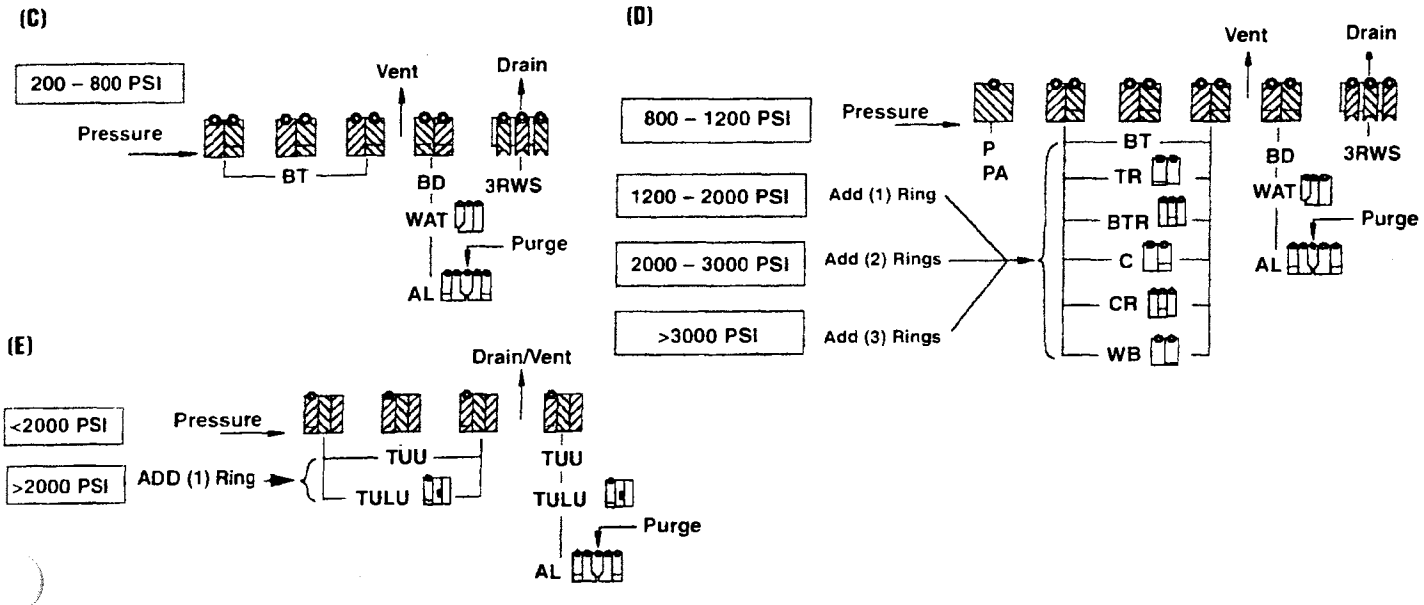
Figure 41B is a basic low pressure arrangement set up to also minimize entry of air into the cylinder. The vent seals and wiper would be optional. Not shown, but other elements that could be added, would include a Static-Pac or rod cooling. The use of all double-acting rings as primary seals should be avoided over 200 psi since these can trap pressure between them and thus increase total friction load.

Figure 41C would be the arrangement applied to moderate pressures. It might, in some cases, include a pressure breaker since this is sometimes needed above 200—300 psi. All the options mentioned with respect to a low pressure set would also apply to the moderate pressure range.

For higher pressures, options would again be the same, but a pressure breaker is nearly always needed. The different ring types in the primary seal would be chosen on the basis of lubricaton level and pressure ranges. Quantity of rings in the primary seal could vary somewhat from what is indicated in Figure 41D.

The number of rings required for any application is based more on experience that science. The number of rings shown in each arrangement simply represent what is generally applied to most modern packing.

Figure 41E represents what is currently applied to pump packings. The most common variations would be to include purging, or rod (plunger) flushing. The number of rings in the primary seal again is somewhat variable in that for all pressure ranges, the quantities would most likely vary from two to four.



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HOW PISTON RINGS AND ROD PACKING WORK – AND DON'T WORK

By Paul Hanlon

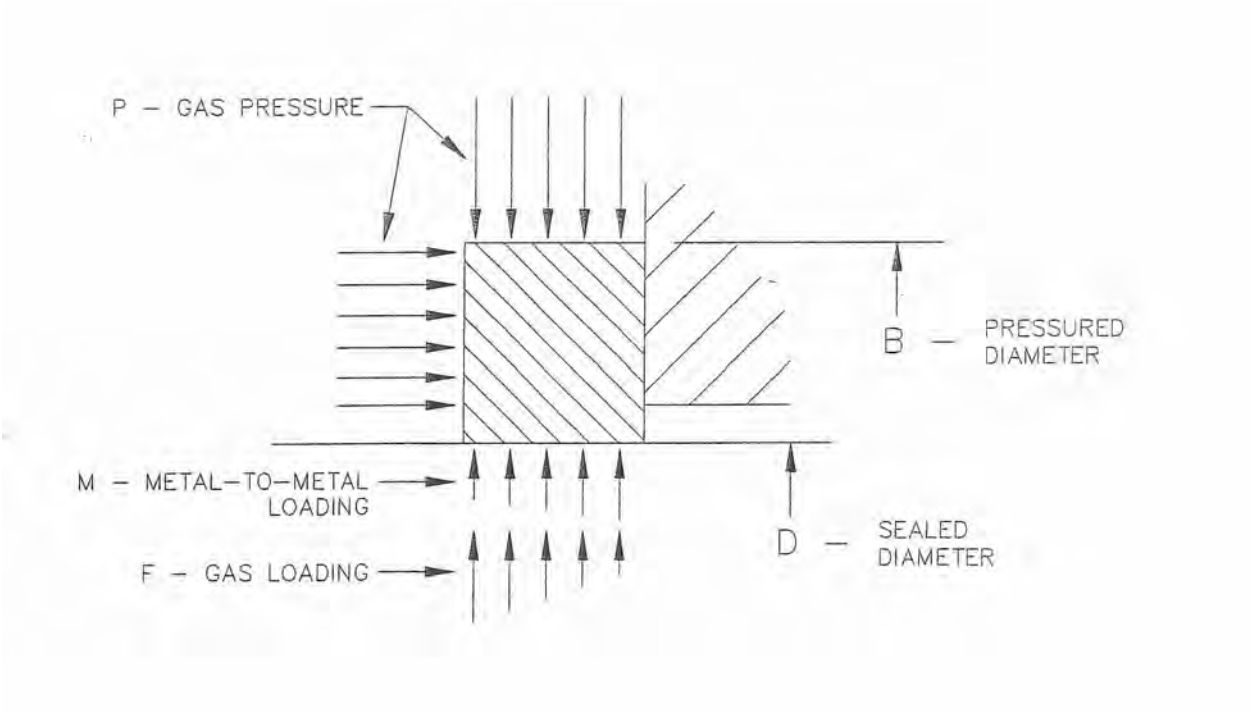
1991 Annual Gas Compressor Short Course
Norman, Oklahoma

C.Lee Cook
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Valves give problems and seal rings wear out – which pretty well covers all the troublesome things that will most likely happen to compressor cylinders. It's the rings – piston rings and packing rings – that are the subject of this paper.

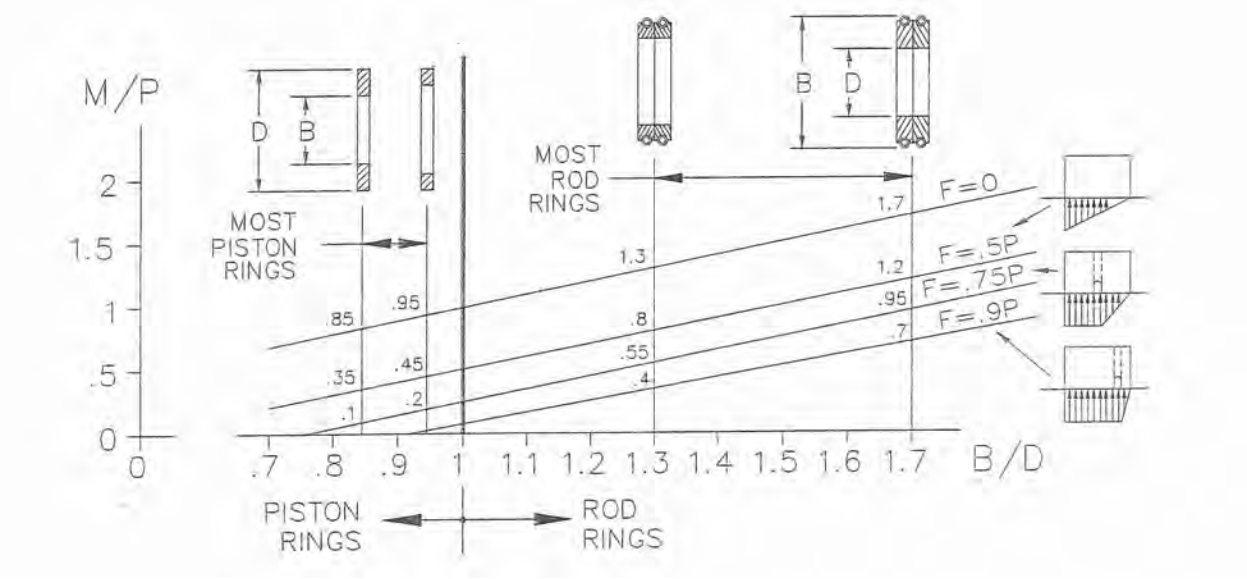
There are ways of comparing rings' dimensions and lubrication that can lead to a rough prediction of how the rings will perform. Specifically, we can look at ring loading and use this to estimate the chances of having problems in any particular compressor cylinder. Most often, "loading" is just considered to be the same as gas pressure or cylinder discharge pressure, but this really isn't the case due to a ring's shape and dimensions. As will be shown, these characteristics, plus the level of lubrication, can be expressed in terms of a "load factor" which is some multiple of the gas pressure. Rings with high load factors wouldn't be expected to last as long or be as trouble-free as those with lower factors.

Rings are basically pieces of material rubbing back and forth against another material – the cylinder or rod. As such, they should follow the rules for metals against metals or nonmetallics against metals. The rules are simple: the lighter the load, the less the wear; the better the lubrication, the less the wear. How rings function is also simple: a rectangular cross-section is pushed by pressure against the mating circular surface and at the same time against a flat piston or packing cup face. The sketch below could represent either a piston ring against a cylinder or a packing ring that seals against a rod.



Where there's a difference between piston and rod rings is in the load that the rings exert against the circular surface. This loading is caused by the gas pressure in all cases; but,

because of where the pressure acts on a ring, there can be wide variations in just how hard rings bear against the mating surface. A piston ring is essentially thin and flexible with I.D. pressure, while a rod ring is relatively stiff with pressure acting on its O.D. surface. The curves that follow show the effect of these dimensional differences on ring loading. Loading is expressed as a ratio M/P – the average metal-to-metal pressure relative to the gas pressure.



LOADING TO PRESSURE RATIO VS. RING SIZE

This indicates, for example, that typically-sized piston rings might be pushed against the cylinder with a pressure equal to only about .85 times the gas pressure; whereas, rod rings could be loaded up to 1.7 times the gas pressure. If we included the effect of gas leakage or gas pressure between the sealing surfaces, then loading will drop, as in the lower curves, to something less than the above numbers. In other words, while gas pressure acts to load a ring, the gas also gets between ring and mating surface and helps hold the ring off the surface.

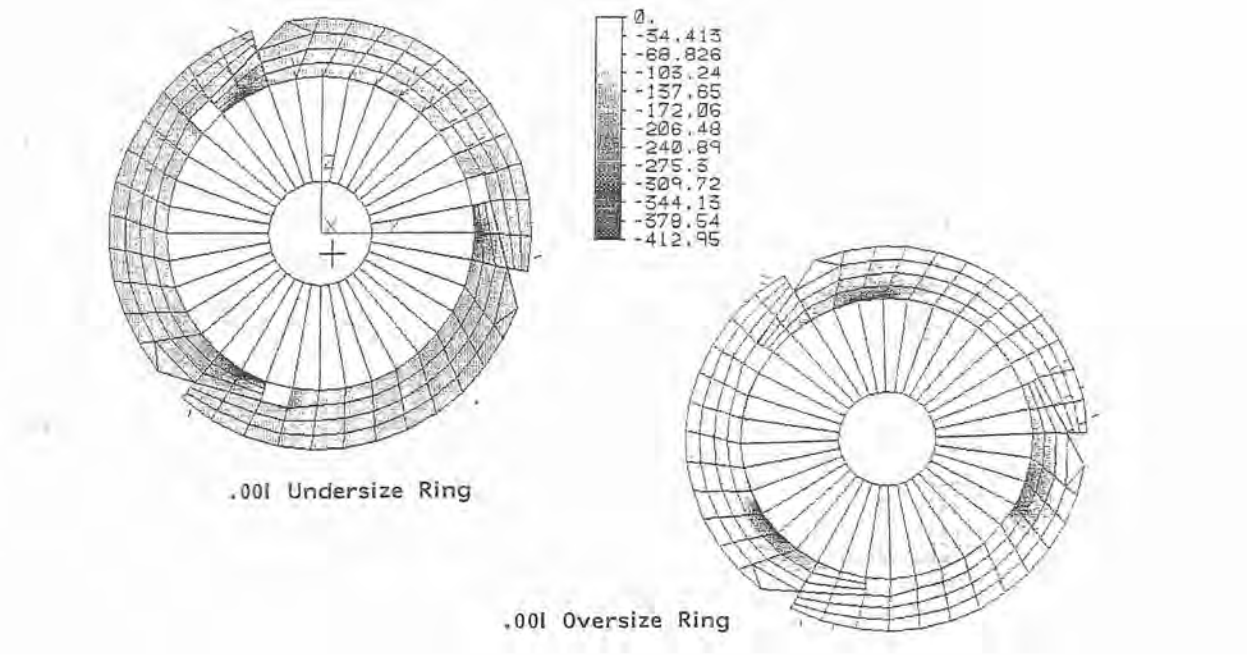
The lower curves show the effect of various pressure levels between the surfaces. Where the curves drop below M/P = 0 would indicate piston rings which aren't actuated or loaded against the cylinder at all – in other words, rings not working. Control of the gas pressure between seal surfaces is called "balancing" and is one of the ways to reduce ring loading.

LOADING VARIES AROUND A RING

The above points out one difference in piston and rod ring loading, and there's another – the effect of ring stiffness and joint construction. Most rod rings don't contact or bear evenly around their circumference because of tolerances, ring thermal expansion, and also due to the type of cut. Tangent cut rings may have particularly uneven loading under certain conditions.

The ring pictures show generally how different rings might load unevenly around their bores – one having an area where loading is increased by a factor of roughly 4. This is not the maximum that can occur since rings initially may have just point or line contact, which would raise loading even higher.

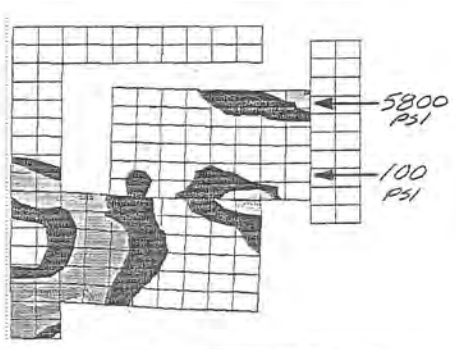
Both of these rings have B/D equal to 1.37 so their loading, if it were uniform, should be approximately 137 psi. The increased loading against the rod of either ring is a result of an over or undersize bore.



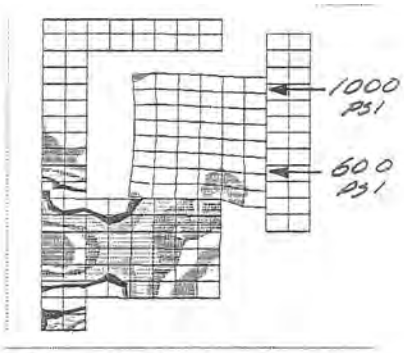
LOADING VARIES ALONG A RING

The difference in circumferential loading is partially a result of stiffness or inflexibility of the ring or ring material. Variation in loading in the axial direction, though, can be the result of either stiffness or lack of stiffness. A thin ring (narrow in width) of rigid material may "tip" and bear hard against the upstream edge. A ring made wider and of flexible (plastic) material will deform and distribute the loading more evenly over the face. A ring contacting full face in this manner also will have higher gas pressure across the surface, which acts to decrease the upstream edge loading. A rigid upper edge

bearing ring can easily be loaded at six times the gas pressure (M/P=6). The pictures below illustrate how these axial load variations might occur in piston rings.



CAST IRON RING
CAST IRON PISTON
1000 PSI
DEFLECTION SHOWN 50X



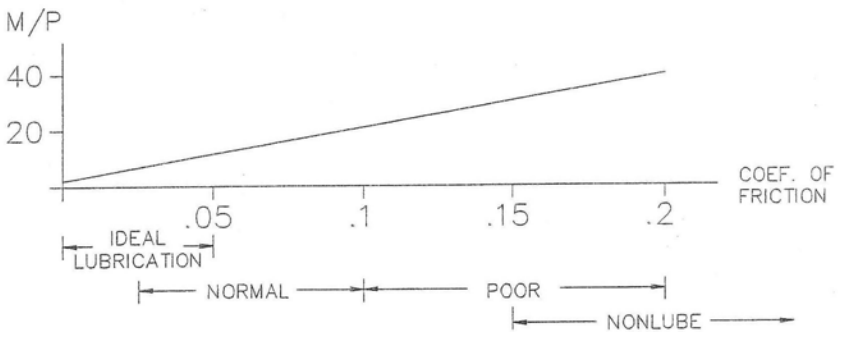
TEFLON RING
CAST IRON PISTON
1000 PSI
DEFLECTION SHOWN 5X

What these curves and pictures tell us is something about how rings work – and why they don't. It really shows that rings will have contact pressures that vary and which can be quite a bit different than the gas pressure the rings seal. If the numbers are used near their extreme, a 1000 psi cylinder with suction at 400, for example, could have piston rings loaded at roughly 240 psi (.4 x 600), while rod rings in this same cylinder might have portions of their bores at upwards of 6000 psi. This is a very big difference and points out one reason packing rings can be a problem compared to the piston rings in the same cylinder. It also illustrates how loading is influenced by shape, dimensions, and material properties, and indicates the effect could be something that takes loading from zero up to many times the gas pressure.

LUBRICATION – THE BIG FACTOR

To take into account the lubrication effect, it is necessary to consider what happens at different degrees or levels of lubrication. Lubrication at its best probably reduces the coefficient of friction down to about .005. When lubrication is very poor, the coefficient rises to about .2. Failure, wear, or even temperature rise wouldn't parallel exactly this coefficient, but will at least go along with it somewhat – probably close enough for our purposes.

The important point is that going from .005 up to .2 (40x increase) has the same frictional effect as raising the loading by a factor of 40. Comparing this to the factors for shape and dimension, it is easy to see the greater influence of lubrication on ring performance. If we "make up" a curve that turns this lubrication or friction effect into a pressure effect, it might look as below:



LUBRICATION / LOADING RELATION

This is not meant to imply the actual pressure that exists between ring and mating surface, but rather it just represents an operating condition equivalent to a particular level of lubrication.

WHAT ALL THIS MEANS —

What the lube curve suggests is that the effect of poor lube versus ideal lube is about the same as applying 30 times more gas pressure to the ring. The curve for ring dimensions implies that using a rod ring with, say, 1.7 ratio for B/D can increase loading at the bore by a factor of 1.7. If we were to look at how the dimension curve might pertain to a piston ring, then a ring with B/D of .85, for example, could be viewed as having only .85 times the gas pressure as its load against the cylinder. Rings that bear unevenly against the mating surface can have areas of very high loading – load factors of 6x or higher.

All this, then, expresses or compares ring characteristics and puts this and lubrication in terms of the gas pressure – the most common operating condition for judging just how severe the service really is. This “pressure” may really be of most value in making comparisons; that is, it should be easy to understand why a ring with load of 500 would outlast one loaded to 5,000 even though both rings were sealing the same gas pressure.

We might say, for instance, that a poorly lubricated, poorly fitting ring at 100 psi is equivalent to a lubricated, well fitting ring at 12,000 (30 x 4 x 100) psi. Only portions of the 100 psi ring would be loaded like the one at 12,000 psi, but these highly loaded areas would be where high wear or heat generation occurs, so wear or temperature in these spots might eventually cause complete ring failure. In the plastic ring segment shown, uneven loading becomes very apparent where the higher loaded portion of the ring wears away, and the material “flows” inward at this point.

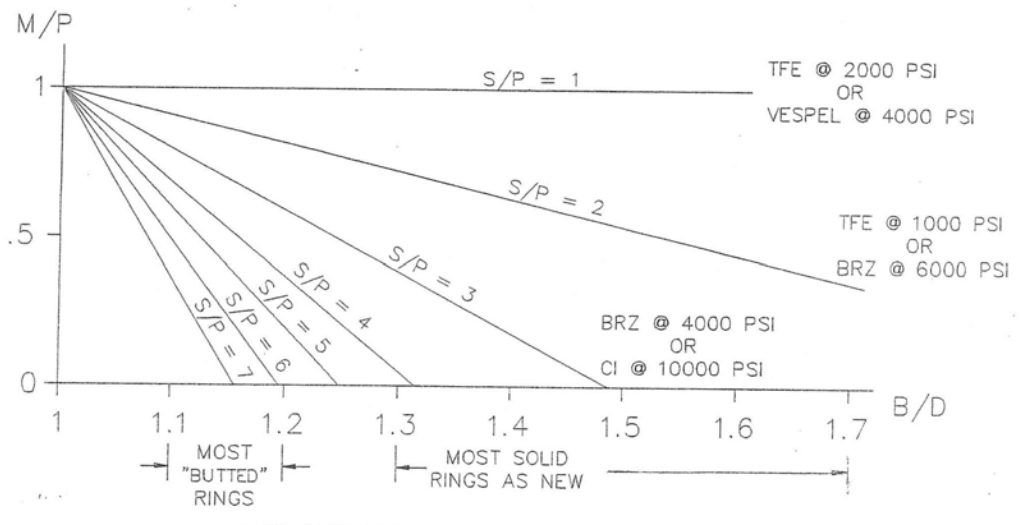


SOLID RINGS

There's another type of rod ring construction or function in which wide swings in loading may occur. This is when rings are made, or become, "solid". Backup or anti-extrusion rings start out solid or butted – with zero end clearance. Some pressure breakers are also made this way – having clearance over the rod rather than at the ends. Some seal rings are made without cuts – they must compress inward against the rod to seal. Then butt tangent rings eventually wear out and their ends butt so they, too, must at some point in their life act essentially as solid rings.

We expect different things from these basically identical rings; that is, a backup ring is supposed to have zero loading against the rod while a solid seal ring must be down against the rod if it is to seal. In the case of a pressure breaker, we would like it to just stay at a particular clearance over the rod without changing.

How solid rings react to pressure depends, for one thing, on S/P – the ratio of material strength to gas pressure. The best way to illustrate this is with more curves.



EFFECT OF MATERIAL STRENGTH ON RING TO ROD LOADING

The curves are essentially for rings after they have yielded and reached the point where stress in the ring is acting counter to the gas pressure, thus reducing loading against the rod. At this point, the load factor will be somewhere between 0 and 1. If S/P is high enough, then the ring will not yield, but it will remain up off the rod and loading will be zero.

One thing that should be pointed out is that rings begin to yield initially in the bore, so if they come into rod contact right at this time, then M/P will be higher than the curves indicate. As the ring wears and allows the entire cross-section to yield, then loading should drop to fair agreement with values shown from the curves.

How can this be used? It shows, for example, that if you want a solid ring at, say, B/D of 1.5 to act only as backup or anti-extrusion, then it must have a yield strength of over 3x the pressure. If not above this value, the backup ring will yield and load down against the rod. If you were trying to design this same ring to act as a solid <u>seal</u>, one you do want down against the rod, then S/P must be below 3 so the ring will yield. The curves also give an idea of the "balance" effect that might be achieved in a yielded ring since lower M/P ratios represent lighter rod contact.

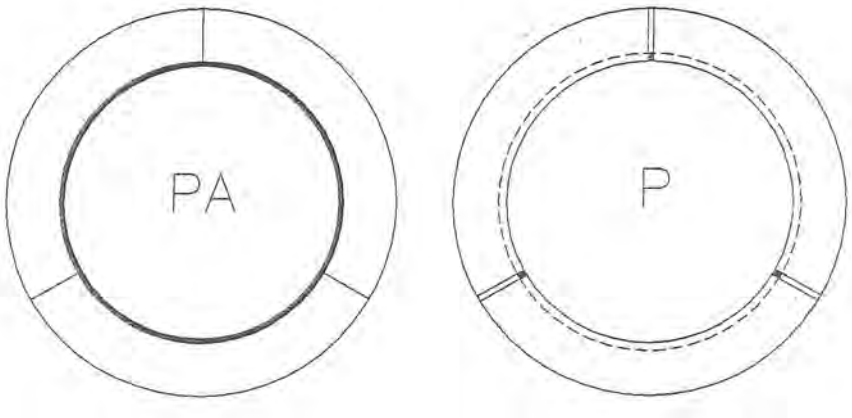
Rings may or may not yield (close inwardly) and continue to seal depending on their dimensions and the S/P ratio. The curves, however, would give an indication of what will happen in that, if M/P is up near 1, then a ring will seal fairly well but continue to wear; or, as M/P drops toward zero, then wear should fall but leakage will probably increase.

In the above, gas pressure under the rings was assumed to be zero. This would probably be true for a backup ring and might apply for some seal rings, but it will not be true for a seal ring that has butted. The easiest way to account for pressure is just to recognize that M could, in fact, be made up of gas pressure plus metal-to-metal pressure. How to take this into account is best illustrated through an example: If a bronze ring at 6000 psi butted and yielded at a B/D of about 1.1, then it should at this time come to M/P of .9. The gas at 6000 psi could be assumed to leak under the ring and create an average pressure of about 3000 psi. If we subtract this from .9 x 6000 or 5400, we are left with 2400 psi as the average metal-to-metal pressure under the ring.

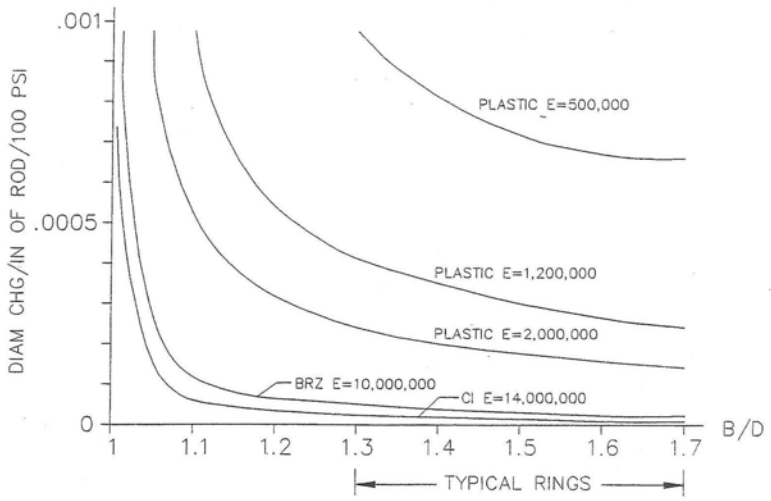
Using this same ring, we could go through a "load history" for it. It might have started out new with a ratio of O.D. to I.D. of 1.7. Ignoring the possibilities of poor fit and uneven axial loading, it would have started with a metal-to-metal loading of 1.2 x 6000 psi, or 7200 psi. When it had worn to a B/D of 1.3, its loading would have dropped to around 4800. At the moment it butted, its loading would have been around 3600. Then, after it butted and fully yielded, the average metal-to-metal pressure would have fallen to what we just calculated – 2400 psi. This final value is approximate because a butted tangent cut seal ring doesn't have a uniform cross-section, but the trend of a fall-off in loading is still evident. If nothing else, these calculations serve to show one of the reasons why problems may occur at start-up when loading on a ring is highest.

PRESSURE BREAKERS

Pressure breakers are unique in that they may or may not run against the rod. The function of this ring is to act essentially as an "orifice" ahead of the packing rings and slow down or snub the flow of gas either into or out of the rings. In doing this, a breaker will delay pressure rise at the rings during discharge or delay the rapid expansion of gas back out of the rings during suction. The orifice is controlled in the two types of breakers as illustrated:



In each ring, the dark areas indicate where the orifice is that controls the snubbing action. The type P's orifice size will remain about the same, but the PA's will change as pressure causes the ring diameter to reduce. The change in diameter will vary as pressure drop across the ring changes, and this change in diameter would follow the curve as below:



CONTRACTION OF SOLID RINGS

The curve for bronze indicates that typical size rings would change in diameter about .00002 per in. per 100 psi. If, then, we wanted a breaker for, say, 3000 psi differential, it would need to accommodate .0006 (3000/100 x .00002) decrease in bore diameter per inch of rod diameter. If the breaker is made with this clearance or slightly more, it should not contact the rod and yet it would maintain a reasonable low clearance to control flow in most applications. Materials such as cast iron will close in less than bronze while plastic (even a very stiff one) would close or change so much that it really shouldn't be considered as a suitable material for PA style breakers.

OVERCOMING HIGH LOADING

Loading, then, in rings can be anything from zero up to several thousand psi, and sometimes this can occur all in the same ring. The highly loaded areas are where problems begin in rings and usually show up as high temperature, which then causes ring distortion and leakage. Some of the ways loading can be changed are obvious, such as the effect of B/D ratio and conformability.

It is also clear that material strength or stiffness can influence loading, but these characteristics work both ways. That is, high strength and stiffness are needed for low loading in solid rings, but lower strength and stiffness would improve conformability and thus lower loading in other rings. This is, in fact, one of the reasons plastics often work

well in seal rings – the pliable nature of the material makes for a good fit, tight seal, and even loading.

Increasing the average gas pressure between seal faces (balancing) is another way to drop loading. This may carry some strength and leakage penalty along with it, but balancing can improve the life of the rings in some applications.

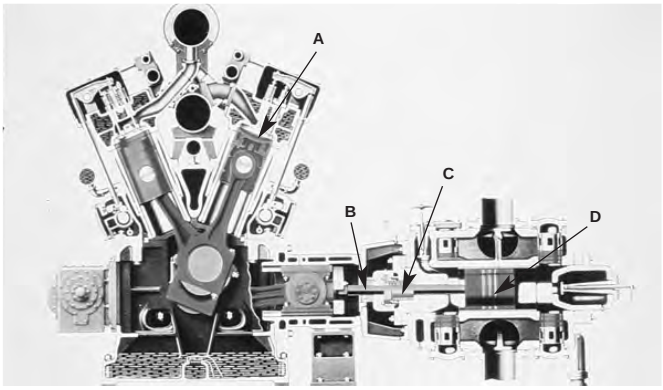
Along the same lines, dividing the pressure drop over several rings will reduce loading. This again causes some leakage penalty, but in piston rings, this is usually acceptable. Packings, however, are in general not allowed to leak, so only one ring carries almost the full pressure drop. A breaker ring can divide the loading across itself and one more ring but only if its orifice area remains relatively low. If the area reaches zero, the breaker itself will probably carry the total pressure drop.

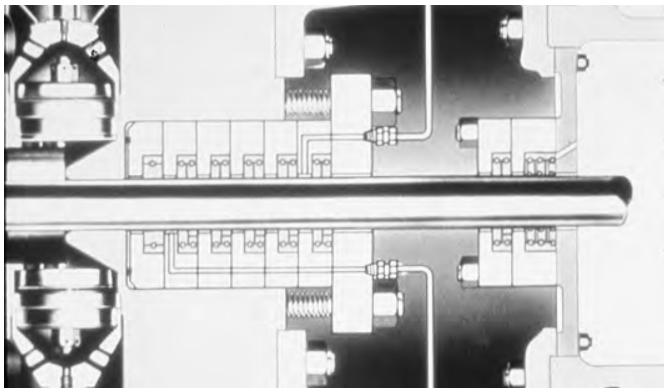
The lubrication/loading effect, which is difficult to put numbers on, can be influenced through the lubricant itself and also through the rings. Selecting lubricant compatible with the operating conditions and resistant to the gas stream through the compressor is probably the first defense against high loading. After this would be choice of a ring material that acts as its own lubricant, that is, contains a friction-reducing lubricant, which in most cases means TFE or graphite. Only so much can be done material-wise, though, because even with self-lubricating materials (primarily nonmetallics), the coefficient of friction will be up near .2. When lubrication is poor or nonexistent, then the load factor will nearly always be high.

Overview

Cook Products

- power rings for pistons on the engine (a)
- wiper rings (b)
- the packing case and rings (c)
- compressor piston rings and rider rings (d)





Packing Case Function

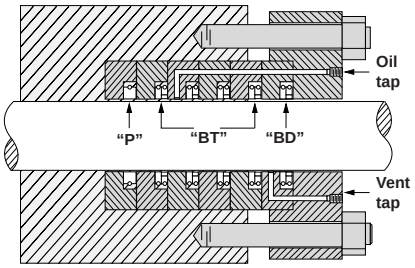
- a packing case holds rings for pr oper sealing at the compressor rod
- without a seal, gas would flow along the r od into the distance piece ar ea
- individual rings in packing cups seal ar ound the piston rod to prevent leakage
- most cases have tie studs. They ar e for alignment only and not for tightening the case

Notes

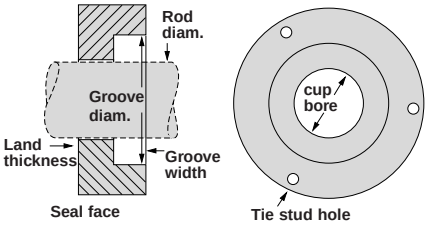
End Cup

- the first cup in a packing case is the end cup
- the end cup comes with a gasket that must seal to prevent leakage around the packing case
- end cups typically hold a pressure breaker ring

Typical Cup Type Metallic Packing



Packing Cup



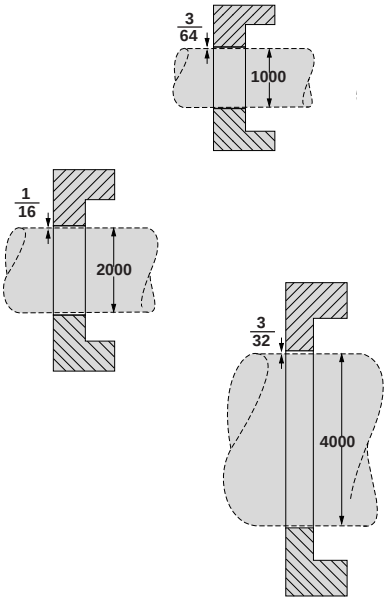
Packing Cup Wear

- wear occurs on the seal face rather than in the groove
- cup reworking is always done on the seal face
- removal of too much material from the seal face and subsequent reduction of the land thickness below that specified for the operating pressure will require cup replacement

Packing Cup Clearance

- clearance between the packing cup and rod increases as rod diameter increases

Packing Cup Clearance Over Rod

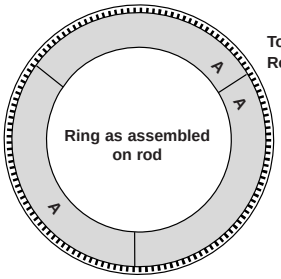


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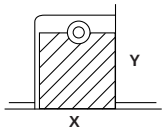
Packing Rings

"P" Pressure Breaker Ring

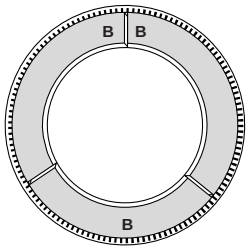
- does not seal pressure but acts as an orifice to buffer gas pressure
- can be installed with either face towards pressure
- most important function is to slow the back flow of gas back down the rod on the suction or intake stroke. Without buffering, this back flow could blow the rings off the rod damaging the garter springs and/or breaking the rings
- three cuts in the "P" ring are the flowpaths for gas
- clearance at the ring segments is necessary but should not total greater than .010" per inch of rod diameter for cast iron and bronze rings
- nylon, phenolics and PTFE's require more clearance because of thermal expansion

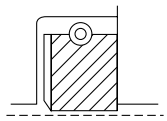


Total opening at one cut only • Rod Diameter X .010" Maximum



Double-acting ring
Either side may
face pressure





Lettered side of ring
faces pressure

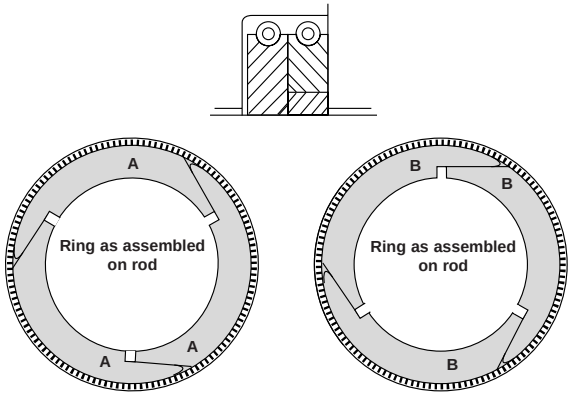
"PA" Pressure Breaker Ring

- does not seal pressure but acts as an orifice to buffer gas pressure
- installed with letters toward pressure
- one end of each segment is beveled on side facing pressure
- most important function is to slow the back flow of gas back down the rod on the suction or intake stroke. Without buffering, this back flow could blow the rings off the rod, damaging the garter springs and/or breaking the rings
- flow control is accomplished through controlled clearance between the ring I.D. and the rod
- clearance at the ring segments is zero when installed over the rod

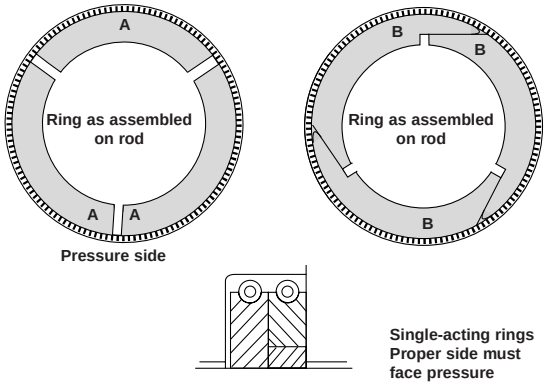
Notes

"BD" Ring

- double-acting ring generally used downstream of vent to minimize leakage into distance piece
- often used upstream of vent when suction pressure is below atmospheric. This minimizes pulling air into cylinder
- tangent cuts on this ring (and also the "BT") are "stop tangents." Rings can only close so far before they hit at the joint and can't close any further
- stop tangents enable you to install case, assembled with rings, into cylinder and then insert rod through ring using a tapered thread protector



Double-acting rings
Either side may face pressure



Single-acting rings
Proper side must face pressure

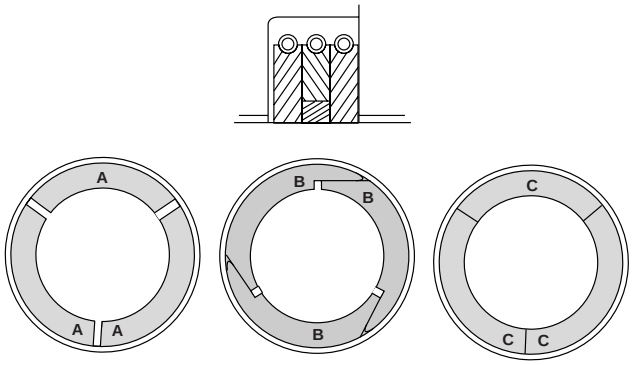
"BT" Packing Ring

- radially cut ring is installed toward the pressure side; tangentially or angle cut ring is installed on down pressure side
- letters on both rings are always to the pressure side. In assembly, match the two closest letters toward segment ends, then place the ring segment with the letter towards its center on the opposite side
- because ring cuts overlap, there is no leak path as with a "P" ring. As a result, the "BT"seals on the compression stroke but allows back flow into the cylinder on the suction stroke making it a single-acting ring
- "BT" rings are made in all materials

Notes

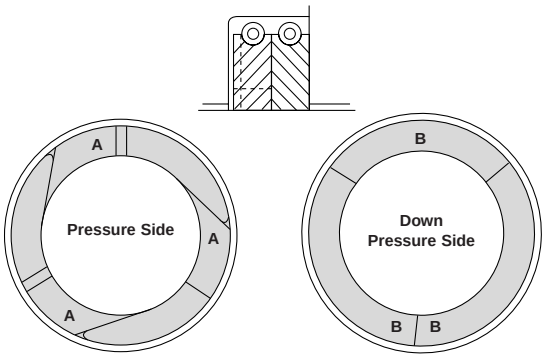
"BTR" Packing Ring

- identical to the "BT" except for a third ring on the down pressure side that prevents extrusion and removes frictional heat from the rod surface
- single-acting like the "BT" sealing on one direction
- generally the "BT" section is a non-metallic while the spacer or back-up ring is metal
- the back-up ring, while it may be metal, can be used in non-lube applications because it has clearance and rides lightly on the rod
- "BTR" rings are used generally with pressure ranging from between 700 and 1,500 psi



Pressure side

Single-acting ring



Single-action rings

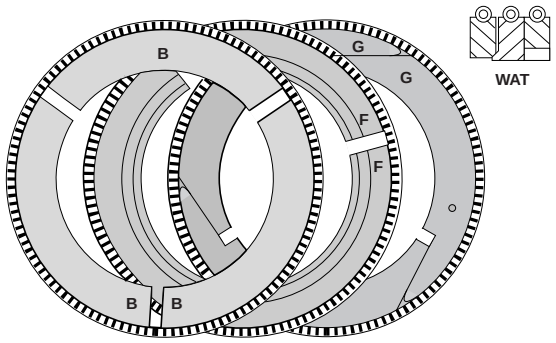
"TR" Packing Ring

- tangentially or angle cut ring is installed toward the pressure side; radially cut back-up ring is installed on down pressure side. Installation is the opposite of that for the "BT" ring
- the "TR" is not doweled
- face notches keep the "TR" ring from sealing on it's pressure side making it a single-acting ring
- the tangent cut ring is a non-metallic while the radial cut ring, which serves as an anti-extrusion ring, is generally metal or a more rigid plastic
- "TR" rings have no pressure limitation and have been used successfully in cases up to 25,000 psi

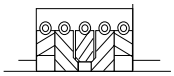
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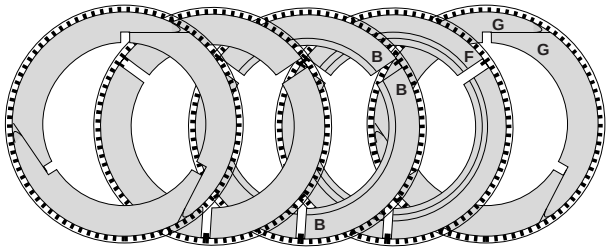
"WAT" Ring

- when used in low pressure applications, the radially cut ring is installed toward the pressure side; the last or tangentially cut ring is on the down pressure side
- when dual "WAT" rings are used in buffered applications, the radially cut rings face each other. The buffer gas is introduced between the two "WAT" rings. On the ring nearest the pressure side, the tangentially cut ring faces upstream
- "WAT" rings are made of all materials



Lettered side of each ring faces pressure





"AL" Ring

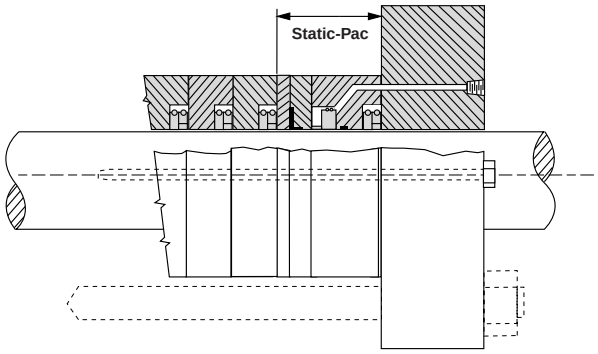
- double-acting ring used in a groove where a low-pressure medium is supplied to block leakage beyond the ring
- in assembly, match the two closest letters toward the segment end, then place the ring segment with the letters toward the center on the opposite side. The radial cut wedge rings are located in the center and the tangent cut seal rings are located outboard at each end
- used in buffer or purge applications

Notes

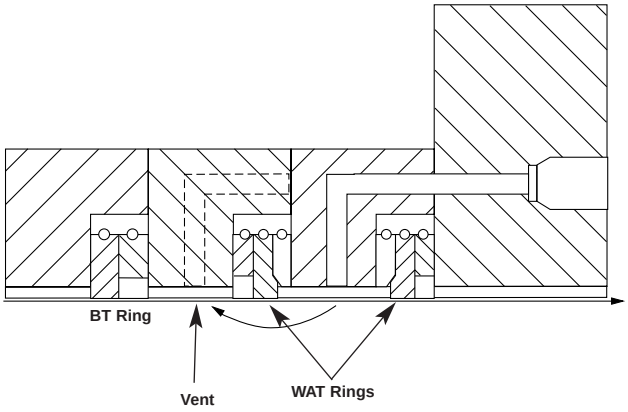
Packing Arrangements

Static-Pac

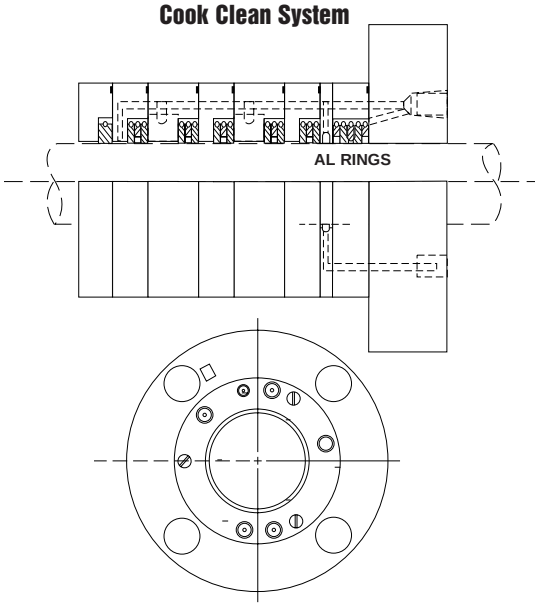
- Static-Pac seals gases when compressors are down
- when compressors shut down, pressure applied to the Static-Pac forges a lip seal inward to close around the rod
- Static-Pac can be incorporated into existing cases or made for new cases



Buffered Packing Ring Arrangement



Cook Clean System



Buffered Packing Arrangements

- confines Volatile Organic Compounds (VOC) and Volatile Hazardous Air Pollutants (VHAP) to the compressor and vent system
- a buffer or purge medium is introduced between the vent and the flange to create a barrier which inhibits gas from escaping into the distance piece. This barrier directs any leakage past the rod packing into the vent where it can be properly disposed of
- existing cases can be upgraded
- the complete “Cook Clean” system virtually eliminates emissions

Notes

Packing/Rod Maintenance

Seal Rings Required In A Packing Case

- quantity of rings shown for seal ring. To this may be added pressure breakers, vent seal ring, purge rings and wipers

2000 (+) p.s.i.	**5—7 Rings**
800—2000	**4—6 Rings**
300—800	**3—5 Rings**
Below 300	**2—4 Rings**

Break-In: Metallics/Rigid Ring Materials

250 p.s.i. to 500 p.s.i.	**(10-15 min)**
500 p.s.i. to 750 p.s.i.	**(10-15 min)**
750 p.s.i. to 1000 p.s.i.	**(10-15 min)**

Breaking In Packing Rings

- typical break-in for metal rings or hardened non-metallic is to bring pressure and/or RPM up in small increments until rings seal and run without overheating

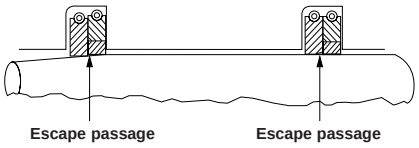
- little or no break-in is required for PTFE or soft non-metallics

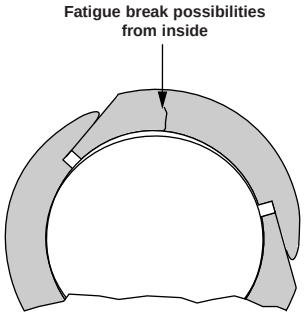
Notes

Taper Conditions

- normally found at either or both ends of the stroke
- a taper is worn in ring bore, due to contact with rod taper and also because of ring distortion,
- escape passage is created at tapered bore

Effect of Tapered Rod on Packing Ring Seal Function



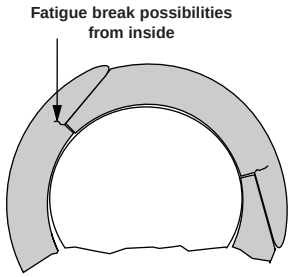


Oversized Rod

- will cause rings to make contact only at joints stressing and breaking rings in the middle of ring segments

Undersized Rod

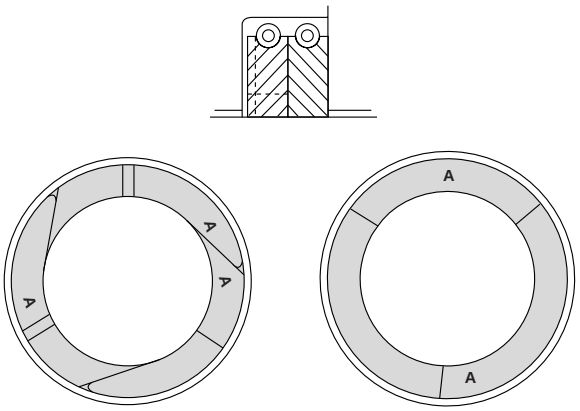
- will cause high stress and break off “ears” of ring segments



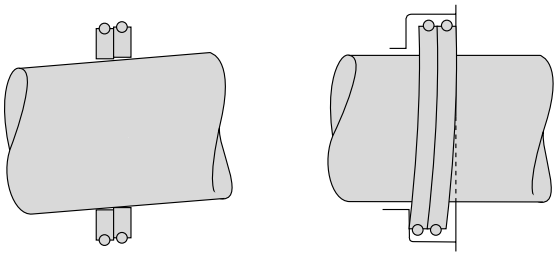
Notes

Breakage

■ is most likely on “BT” rings. If an undersized condition exists, “TR” rings should be substituted for “BT” rings



Pressure side



Rod or ring bore misalignment

Lack of flatness

Rod or Ring Bore Misalignment

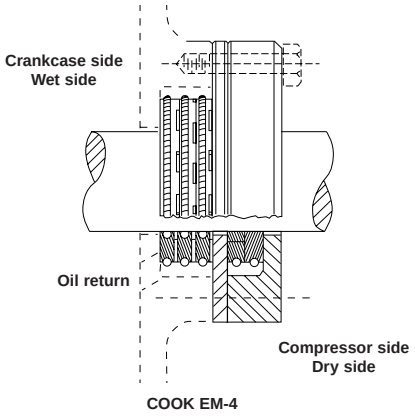
■ creates the same effect as rod taper: it wears a taper on ring bores, creating a gas leakage path. Lack of flatness creates a leak path between ring and cup

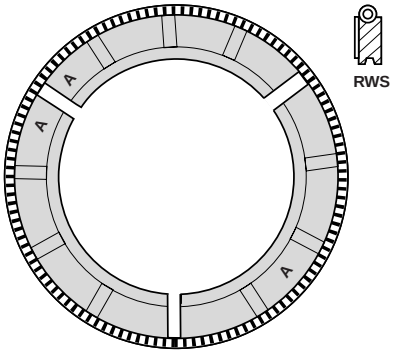
Notes

Wiper Rings

Wiper Ring Function

- wiper packing keeps oil in crank case
- sealing rings in wiper packings also minimize flow through the packing caused by “pumping” action of the crosshead



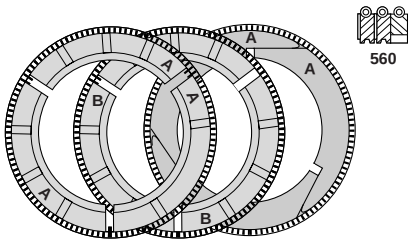


“3RWS” Wiper Ring

- “3RWS” is the basic and most commonly used wiper ring combination - its only function is to wipe the rod and drain the fluid away
- “3” indicates three “RWS” rings used together and doweled to prevent alignment of cuts

“560” Wiper Ring

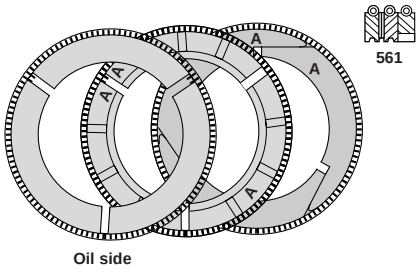
- two wiper rings and a sealing ring that combines the wiper/seal function into one groove
- rings are installed with drain notches toward oil

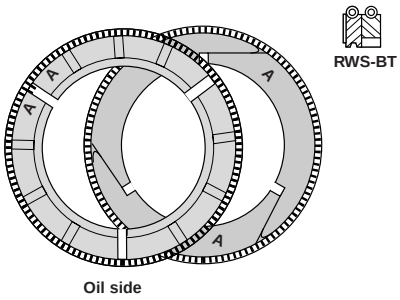


Notes

"561" Wiper Ring

- identical to "560" but with the flat face of one wiper toward oil source



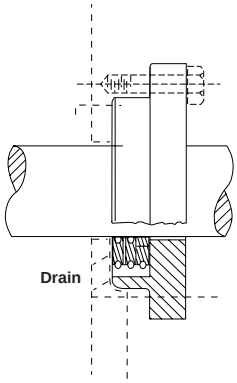


"RWS-BT" Wiper Ring

- a wiper/seal combination ring installed with drain notches facing oil

Single Groove Wiper

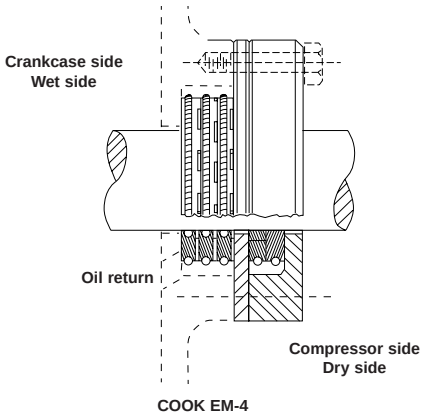
- to be used when space is at a premium and splash from crosshead is minimal



Notes

EM-4

- standard wiper ring arrangement that combines a “BD” ring and a “3RWS” ring
- one more groove can be added to create a three ring set-up with better sealing characteristics



COOK EM-4

Troubleshooting Wipers

1. check clearance
2. check rod condition
3. check cup condition
4. check drain opening
5. check ring material and style
6. check spring tension and condition

Wiper Maintenance

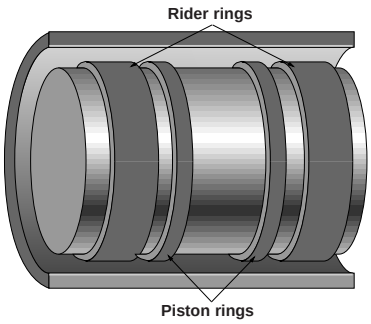
- between .006″ and .0075″ side clearance is standard in a metal three-ring wiper set-up. Most non-metallics have 50% more clearance
- oil getting into rod; scratches or gouges will be carried by the rod and escape past the wiper. Improper depth or lack of side clearance will cause rings to bind
- a stopped drain will not allow oil to flow away from the wiped surface of the rod
- everything else being o.k., ring material may need to be changed to improve a wiper’s effectiveness for wiping; conformability and weak resistance are desired

Notes

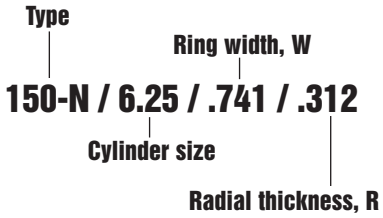
Piston Rings

Piston & Rider Rings

- piston rings stop or reduce the flow of gas between a piston and cylinder
- rider rings support and align the piston and provide a better wearing and easily renewable piston bearing surface



Piston Ring Specifications

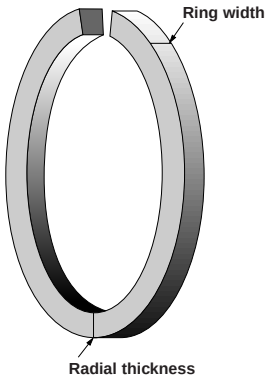


Piston Ring Specifications

- piston ring specifications indicate type of ring, cylinder size, width of ring and radial thickness

Piston Ring Nomenclature

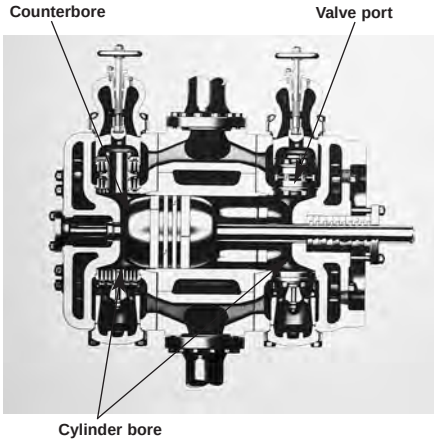
- ring width is from one edge to the other on the outside surface of the ring
- radial thickness is the distance from the inside diameter of the ring to the outside face

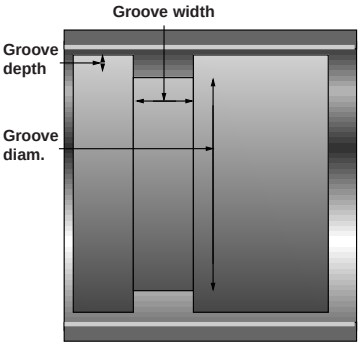


Notes

Piston/Cylinder Assembly Nomenclature

- cylinder bore is the diameter of the cylinder in which the piston will move
- the valve port areas are openings through which gas flows
- the slightly larger diameter at the end of the cylinder is referred to as the "counterbore"

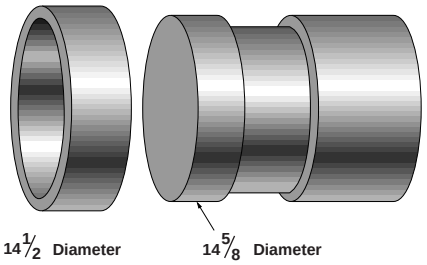




Piston Groove Nomenclature

- groove diameter is measured across bottom of groove
- groove width is the distance from one side of the groove to the other
- groove depth is the distance from the outside surface of the piston to the bottom of the piston groove

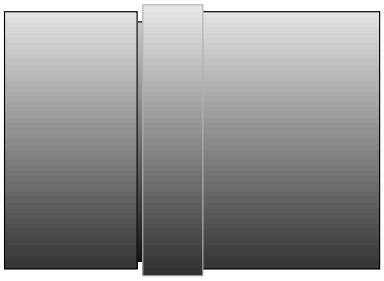
- "slip-over" diameter is the diameter of the piston ends. It is called "slip-over" because it is the diameter over which the rider must be stretched for installation into the groove

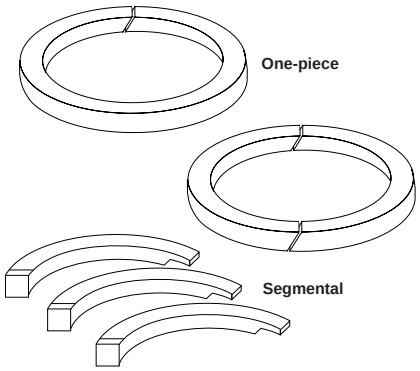


Notes

How Piston Rings Perform

- piston rings must lie flat against side of the groove to minimize the path for leakage
- piston rings have a “free” diameter larger than the cylinder bore causing rings to maintain pressure against cylinder wall to help seal at low pressure



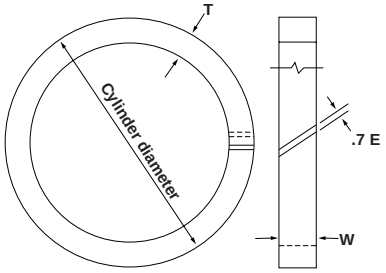


Ring Styles

- there are two basic ring types: one-piece and segmental
- all ring types are made in a variety of materials with PTFE the preferred choice for poorly lubricated applications

“101”/“101-X” Piston Rings

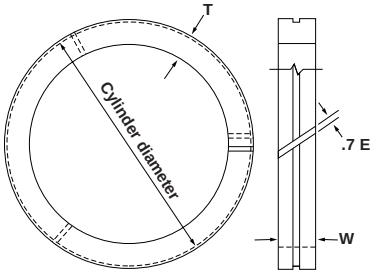
- an angle cut ring without an inner ring or expander is designated as “101”
- a ring with an expander is designated as “101-X”
- expanders are required to make a ring more conformable and to help seal at pressure below 10 psi

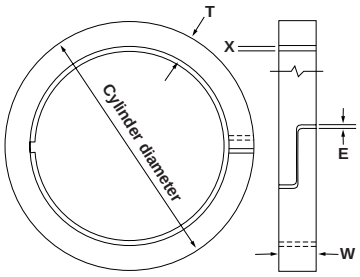


Notes

"101-GD" Piston Ring

- the "101-GD" has a grooved outside face with drilled holes in bore allowing high pressure gas into the outside groove
- the "GD" feature is used to reduce pressure loading of ring against the cylinder



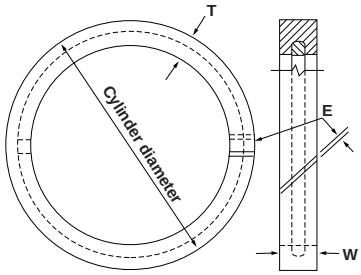


"112"/"130" Piston Ring

- "112" features a step-cut outer ring and flat inner expander for applications where low leakage is desirable
- "130" is similar to the "112" with a long flexible angle cut
- "130" is used for low temperature application and applications where a stronger joint is desirable

"401-X" Piston Ring

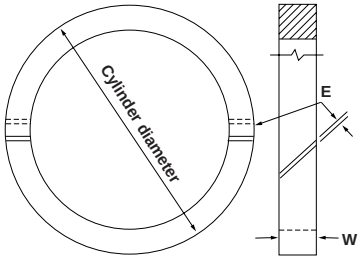
- the expander with the "401-X" is contained by the ring to prevent groove side damage in the piston
- "401-X" is used in low pressure applications

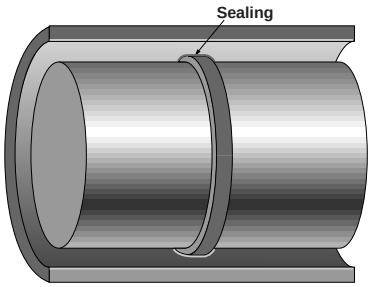


Notes

"204" Piston Ring

- two segment ring used for compressor cylinders under 18″ in diameter
- may be produced in metal as well as PFTE
- because ring is segmented, radial thickness can be heavier than normal without creating installation difficulties



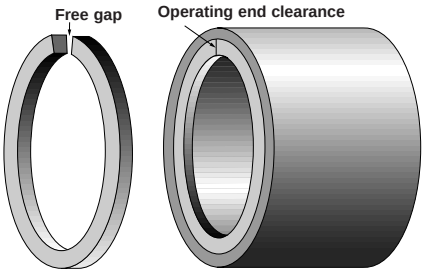


Piston Ring Sealing

- gas or other medium is forced between piston and cylinder wall
- at piston ring, sealing takes place at side of ring and cylinder bore or outer ring diameter
- outward pressure of ring against cylinder wall (caused by "free" diameter of ring being larger than cylinder bore) and gas pressure pushing ring outward against cylinder walls results in sealing

Operating End Clearance

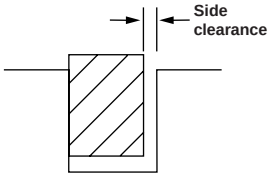
- "free" gap reduces operating end clearance once rings are snapped into grooves and piston is in cylinder
- operating end clearance applies to all ring types and will vary depending on choice of ring materials

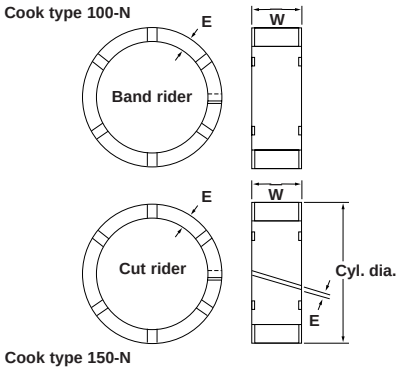


Notes

Side Clearance

- side clearance is distance between side of piston ring and groove
- side clearance will vary depending on ring material and application





Piston Rider Rings

- two basic types: "100-N" uncut band and "150-N" cut ring
- side notches on riders prevent pressure loading under the rider

Rider Width Formulas

- riders must be wide enough to provide support for piston
- where a wide groove is required more than one ring may be used per groove

Recommended Minimum Width

Non-lube: $W = \dfrac{\text{Piston Wgt.} + \frac{1}{2}\text{ Rod Wgt.}}{\text{6 X Cylinder Diameter}}$

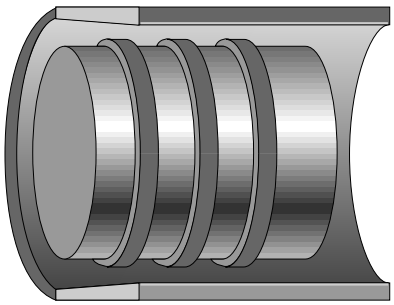
Lubricated: $W = \dfrac{\text{Piston Wgt.} + \frac{1}{2}\text{ Rod Wgt.}}{\text{20 X Cylinder Diameter}}$

Notes

Ring Installation

After Piston Rings Are Installed

- rings should be closed down to cylinder diameter either with a band around them or by a funnel-shaped entering ring used as piston enters cylinder
- piston should enter cylinder freely. Piston rings should be checked for proper clearances before installation
- when rings are entered over valve openings, thin metal strips may be used to prevent catching of rings in ports



Break-In
lube:
2-8 hrs. at low speed and/or pressure up to operating conditions

non-lube:
little or no break-in (PFTE, carbon graphite, high-strength plastics)

Break-In Of Maintained Compressor

- break-in differs for metal and non-metallic rings
- lubricated compressors should operate 2-8 hours at low speed gradually increasing up to operating conditions
- non-lube compressors using PFTE or carbon graphite require very little break-in

General Installation Guidelines

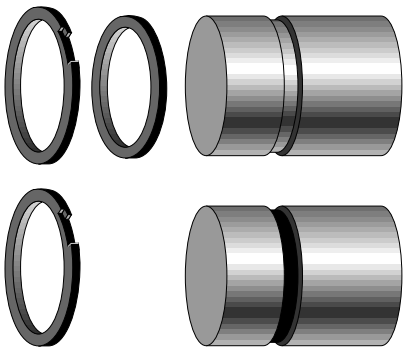
- rings should be spread no farther than necessary to prevent deformation (this is less of a concern with PFTE)
- one-piece rings should be installed with thin steel strips against piston face on opposite sides to prevent rings from catching in grooves



Notes

Installation Of Multi-Piece Rings

- with multi-piece rings like the “112”, “130” or “101-X” rings, the expander must first be slid over piston groove
- ring is then fitted into groove over its expander





Installation Of Uncut Rider Bands

- installation requires a press because ring “free” diameter is less than piston diameter
- PFTE material because of its elasticity and plastic memory allows for stretching of rider over piston diameter
- smaller uncut riders may be heated and pushed down by hand over the piston (riders should pass straight over the piston without cocking)

Installing Riders On Pistons

- PFTE riders, once installed, will shrink to a tight fit, but heat up to 350°F can be applied with a heat band to help shrink the rider back down

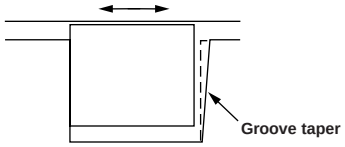


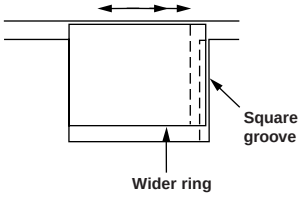
Notes

Troubleshooting

Piston Grooves

- first item for maintenance inspection is piston grooves
- because forces on a ring cause it to tilt, grooves become tapered





- new rings in tapered grooves won't seal well
- the only solution for tapered grooves is to widen them and install wider rings

End Clearance

- if end clearance has become doubled during operation, rings should be replaced
- if rings have less than minimum end clearance, ring ends may butt together due to thermal expansion, which can cause cylinder scoring and other damage
- simplest method of checking end clearance is to insert ring at most unworn section of cylinder and then try different feeler gauges to measure clearance. (When checking an angle cut, both ends of ring must be held against a flat surface such as the end of the piston or another ring)



- if clearance is less than recommended, ends should be filed down. It is better to have too much clearance than too little

Notes

Segmented Rings

- when checking end clearance with segmented rings all but one cut should be held closed and the feeler gauge inserted at open joint
- any filing to increase clearance should be done at one joint only





Cylinders

- in reboring a cylinder, the goal should be uniform diameter throughout length of cylinder
- out-of-roundness should never exceed .001″ per inch of cylinder diameter
- out-of-roundness above .001″ per inch of cylinder diameter requires cylinder to be rebored and oversized rings used
- high wear is most likely in the area of the cylinder at the end of ring travel
- all deposits should be removed from cylinder
- cylinders should be checked for cracks, scoring or metal deposits
- for quick seating of rings (especially rings or a heavier cross section or hard non-metallics or carbon) glaze busting cylinders will enhance sealing



Notes

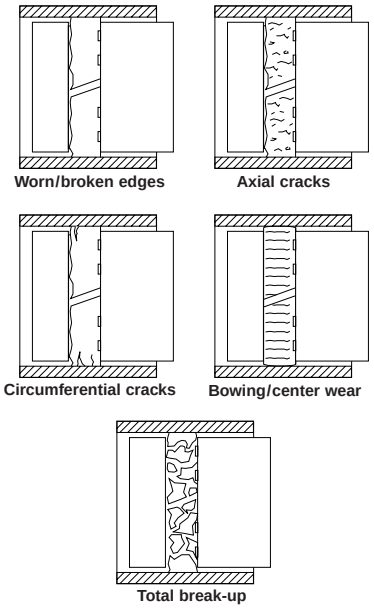
Rider Rings And Bands

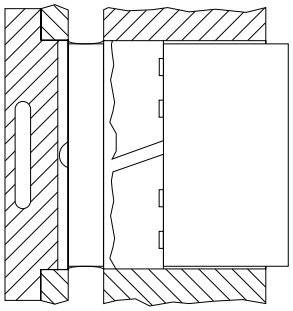
Rider Rings And Bands

- damage includes: worn or broken edges; circumferential cracks or holes blown through ring; radial cracks or splits; bowing and center wear; total break-up of rider

- damage results from rider functioning like a piston ring...becoming pressure loaded

- solution to pressure loading is cutting of relief notches or drilling holes in the rider (care should be taken with cutting notches or holes not to sacrifice bearing support)





150-N Rider

- if tips are broken off, rider is traveling out over a valve port area

- rider type “100-N” should be substituted for “150-N” if this condition exists

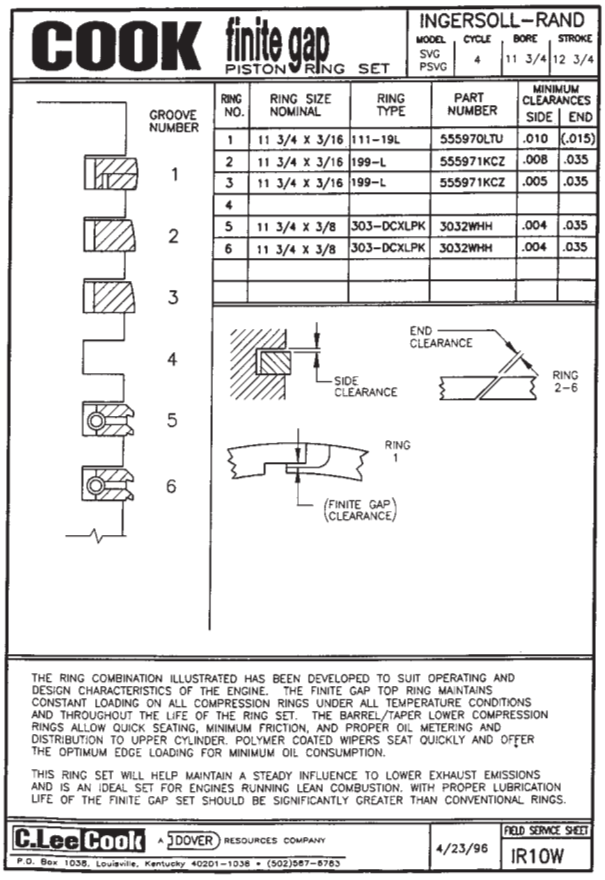
Notes

Power Rings

Field Service Sheets

- for most every engine type there is a field service set-up sheet recommending a ring set-up

- set-ups for special conditions (an oil hog, for example) can also be developed



COOK finite gap PISTON RING SET

INGERSOLL–RAND

MODEL	CYCLE	BORE	STROKE
SVG PSVG	4	11 3/4	12 3/4

RING NO.	RING SIZE NOMINAL	RING TYPE	PART NUMBER	MINIMUM CLEARANCES SIDE	END
1	11 3/4 X 3/16	111–19L	555970LTU	.010	(.015)
2	11 3/4 X 3/16	199–L	555971KCZ	.008	.035
3	11 3/4 X 3/16	199–L	555971KCZ	.005	.035
4					
5	11 3/4 X 3/8	303–DCXLPK	3032WHH	.004	.035
6	11 3/4 X 3/8	303–DCXLPK	3032WHH	.004	.035

THE RING COMBINATION ILLUSTRATED HAS BEEN DEVELOPED TO SUIT OPERATING AND DESIGN CHARACTERISTICS OF THE ENGINE. THE FINITE GAP TOP RING MAINTAINS CONSTANT LOADING ON ALL COMPRESSION RINGS UNDER ALL TEMPERATURE CONDITIONS AND THROUGHOUT THE LIFE OF THE RING SET. THE BARREL/TAPER LOWER COMPRESSION RINGS ALLOW QUICK SEATING, MINIMUM FRICTION, AND PROPER OIL METERING AND DISTRIBUTION TO UPPER CYLINDER. POLYMER COATED WIPERS SEAT QUICKLY AND OFFER THE OPTIMUM EDGE LOADING FOR MINIMUM OIL CONSUMPTION.

THIS RING SET WILL HELP MAINTAIN A STEADY INFLUENCE TO LOWER EXHAUST EMISSIONS AND IS AN IDEAL SET FOR ENGINES RUNNING LEAN COMBUSTION. WITH PROPER LUBRICATION LIFE OF THE FINITE GAP SET SHOULD BE SIGNIFICANTLY GREATER THAN CONVENTIONAL RINGS.

C.Lee Cook A DOVER RESOURCES COMPANY
P.O. Box 1038, Louisville, Kentucky 40201–1038 • (502)587–6763

4/23/96

FIELD SERVICE SHEET IR10W

Notes

Power Rings

- engine power rings are made in several configurations

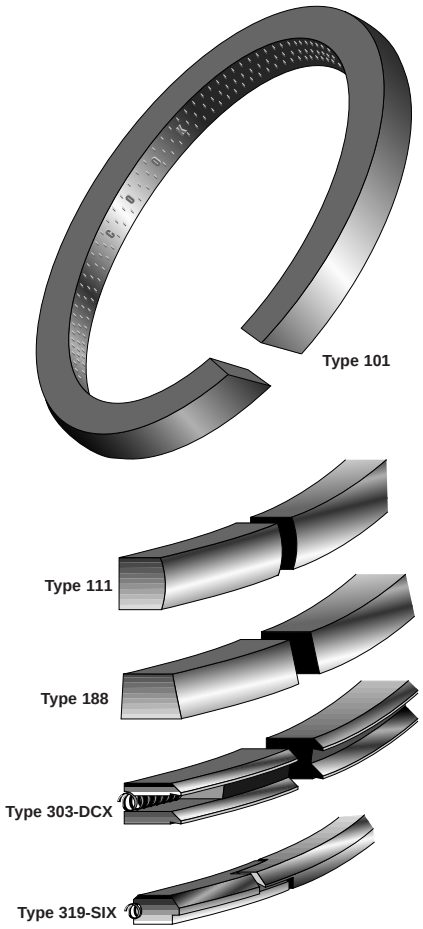
- 101 is angle cut, Type 111 has a cr owned outer face for quick sealing. Type 188 is taper faced and used for lower compr ession grooves

- features may be added to these basic ring types and can be machined shapes and/or coatings of chrome, molybdenum and phosphate—designed by letters such as K (for bevels), E (serrations), P (chr ome overlay), MC (moly-disulfide)

- oil control rings employ a wiping edge design and tension control to create contact pressure between ring and cylinder to allow lubrication while minimizing oil usage

- 303-DCX is a double-edge ring with drain slots that make it a good wiper for most applications

- 319-SIX is a confor mable ring combined with a seal joint. This will help contr ol oil and minimize passage of gas by the ring

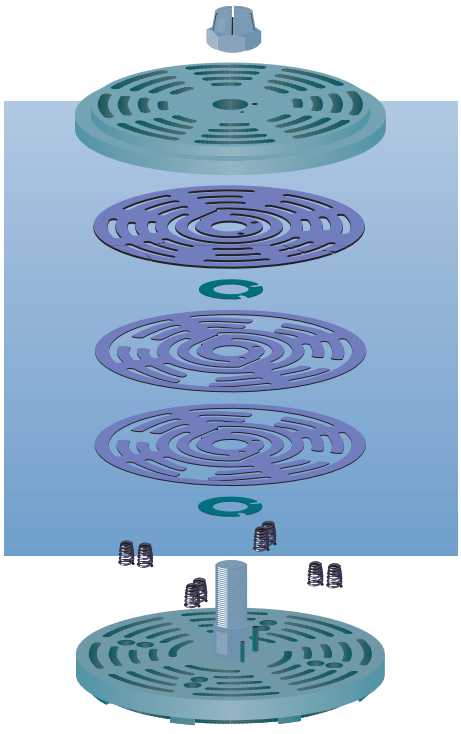


Notes

COMPRESSION
TECHNOLOGY
GROUP

Service Guide

SERVICE GUIDE FOR MAINTENANCE OF HOERBIGER VALVES



HOERBIGER

General

SERVICE GUIDE FOR MAINTENANCE OF HOERBIGER-VALVES

Modern compressors equipped with HOERBIGER-Valves require a minimum of maintenance. The performance and the reliability of such compressors depend, however, to a large degree on the care applied to these few maintenance operations.

AT WHAT INTERVALS HAS MAINTENANCE OF VALVES TO BE CARRIED OUT?

We cannot give any general guide lines as valve life is influenced by many parameters. Maintenance frequency will depend for example on the type of compressor (e.g. Process machine or garage compressor), whether the compressor is running on continuous duty or intermittent duty, on the compressor speed and pressures, the compression ratio, also the type of gas (corrosive or non-corrosive gas, clean gas with or without carry-over of foreign material, moisture content). The compressor manufacturer will have established guide lines both for the running in period and subsequent operation, which will have to be followed. Experience proves that after the initial running - in period the maintenance intervals can be extended considerably.

THEY COVER THE FOLLOWING PROCEDURES

1 Remove valve from compressor

2 Dismantle the valve

3 Clean all parts

4 Check the condition of all components
especially for wear, damage to the seat face, the plates, and for setting of the springs.

5 Repair or replace worn parts
Repair all parts which can be remachined without impairing the strength. Replace all parts which are worn or show any cracks.

6 Reassemble the valve
following the instructions on our drawing or assembly sheet.

RECOMMENDATIONS AND WARNINGS

1 Recommendations and warnings are to be followed according to the compressor manufacturer.

In case our recommendations and warnings deviate from those of the compressor manufacturer, the ones of the compressor manufacturer take precedence.

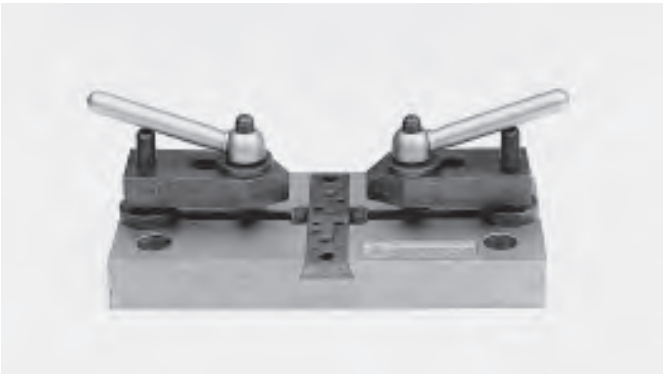
ASSEMBLY DEVICE

The HOERBIGER Assembly Device allows the valve to be held correctly without danger of damage. Adjustable location pins secure the valve against rotation. These pins locate in the slots of the seat or guard respectively without causing damage. The best way to tighten the nut is with a torque wrench. HOERBIGER Assembly Devices can be used for all valve types. The standard clamps will hold heights "H" (fig. 12) up to 78 mm. The base plate can be screwed on to any work bench or held in a suitable holding device.

3 sizes are available:

Size	max. O. D. of valve mm	L mm	B mm
1	20-100	260	120
2	20-250	420	200
3	20-430	590	350

fig. 1



1 Remove valve from compressor

2 Before valves are removed from the compressor, all pressure has to be released from the cylinders and piping. If combustible or poisonous gases are present, cylinder and piping have to be vented. Take necessary measures to prevent start up of the compressor. If the compressor valve is stuck in the cylinder, try to use valve puller device. If valve is to be jarred free by striking, use a wood block or soft metal bar to avoid damage. Never use a steel hammer to strike the valve directly.

2 Dismantle the valve

After sufficient cleaning of the center bolt and loosening of the locking device of the unit (either by removing of the cotter pin in case of a castle nut, or by pressing down the ends of the locking washer, if equipped with same), the valve should be held by means of a simple holding device shown in fig. 3 and 4. The holding pins keep the valve from rotating. It is better to use our Standard Assembly fixture shown in fig. 1 and 2 where the valve parts are clamped down effectively.



fig. 2



fig. 3



fig. 4

3 In order to prevent the locating pins in the valve from shearing off, it is advisable to hold the suction seat and delivery guard respectively, while loosening or tightening the nut especially in the case of valves with open guard (fig. 5).



fig. 5

4 How it should not be done!

Never should a valve be directly tightened in a vice, neither as shown in fig. 6 on the shoulder, nor as shown in fig. 7. Do not hammer on the wrench when loosening or tightening the nut (fig. 8 and 9).

fig. 6



fig. 7



fig. 8



fig. 9



3 Clean all parts

with a cleansing fluid using a soft brush, taking particular care to free the ports of the seat and the guard from all foreign matter to ensure full seat area in operation. Never use wire brushes or tools with sharp edges to clean the seats and plates.

5 All precautionary measures stipulated by the Occupational Safety and Health Act of 1970 (OSHA) or local safety instructions must be adhered to when handling solvents.

Caution: all excess solvent solutions used in the cleaning of compressor valves and/or pockets should be removed prior to start-up since their presence may cause an explosion hazard.

4 Check the condition of all components

6 Use only genuine HOERBIGER replacement parts.

5 Repair or replace worn parts

Valve plates
When a valve plate, or damper plate shows signs of wear, it is imperative to replace these parts, even if no breakage has occurred.

7 Valve plates and rings when worn should be replaced, not reground or inverted.

8 When a spring in a valve shows signs of deterioration, not only that particular spring but all springs must be replaced in this valve. In the case of conical springs care should be taken that they are inserted into the spring well with the large diameter resting at the bottom of the spring well (fig. 10).

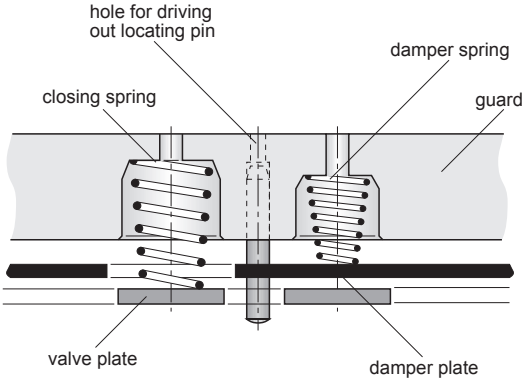
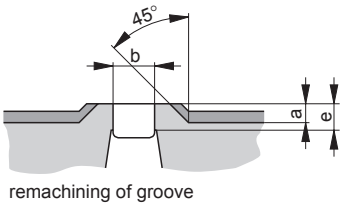


fig. 10

Seats
For highest efficiency of the valve it is important that the seat face is flat and free of any traces of wear, thus preventing valve leakage. If any damage of the seat face appears, it is necessary to remachine and lap the seating areas. Locating pins, if fitted, have to be removed first of all. Generally remachining is done by concentric grinding and lapping. If the seat face shows only slight defects, lapping alone may prove satisfactory. Also remachining on a center lathe with very low feed may be considered, particular attention being paid to the seat face being machined. Burrs are best removed with emery paper (fig. 11.1 and 11.2)

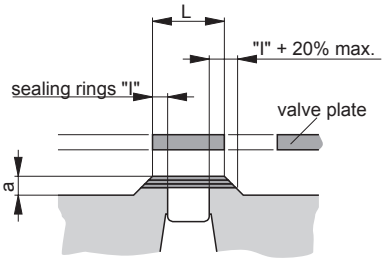
9 When a valve seat surface is remachined, new valve plates or rings must be used to assure proper seal.



remachining of groove

fig. 11.1

How often may a valve seat be remachined?
Under no circumstances must the bottom of the turned slots be machined to increase the depth, as this would impair the strength of the seat. The following may serve as a rough guide for remachining of seats. The material thickness „e“ (fig. 11.1) under the seating ledge should not be reduced to less than 60% of the slot width „b“ an



remachining of seat-face

fig. 11.2

exeption to the above are the steel seats of valve Types 52 R and 42 R, for which dimension „e“ should be limited to 1.2 mm minimum. Every grinding or lapping of the seat face increases the width of the ring surface marked „l“ in fig. 11.2. In order to keep the dimension constant the grooves have to be remachined. The maximum increase on width which can be tolerated is 20%.

10 Do not remachine valve seats below the specified minimum dimension, otherwise there is danger of breakage.

11 Remachining has to be extended over the entire seat-face, including the center where lift washers or guide rings are located, in order to avoid any change of the valve lift.

Center bolts are secured into seats (or guards) with a dowel pin (Version A) or a bolt lock using a small ball (Version B). To remove the centre bolt, drill out the (soft) dowel pin or ball and unscrew the bolt. Upon re-assembly drill a new hole in the thread area of the

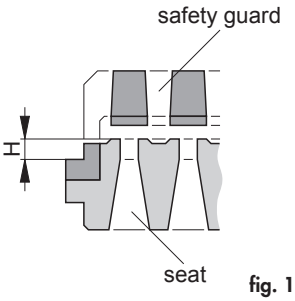


fig. 12

bolt and the seat or guard, respectively, and insert a new pin or ball to secure the bolt from coming loose.

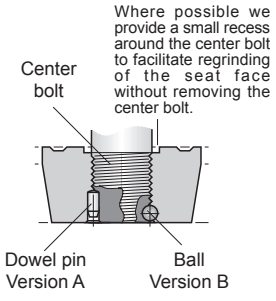


fig. 13

The dowel pin or ball, after it is inserted, has to be peened (slightly hammered in) to prevent it from falling out (fig. 13).

If so-called safety guards (Standard design fig.16) are centered on the seat, care must be taken to maintain dimension „H“ (fig. 16). This means any centering step on the seat, must be remachined to the same extent as the seat face.

After remachining of the seat the locating pins have to be refitted (fig. 15).

12 If the valve plate and guide plate are riveted together, the groove in the valve seat under the rivets has to be remachined after every grinding to prevent the rivet heads from hitting the seat. Remachine until the rivet has ample clearance (fig. 14).

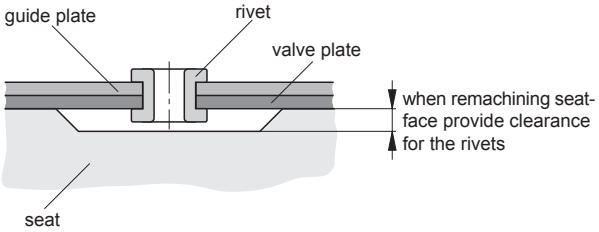


fig. 14

Locating Pins

Locating pins, which have been removed from the seat before the remachining, have to be refitted, taking care that the free length is the same as before (fig. 15). If necessary, the pin holes have to be drilled deeper in order to ensure that the maximum free length is not exceeded. If the pin in the seat or the hole is damaged redrill the locating pin holes displaced by 180°.

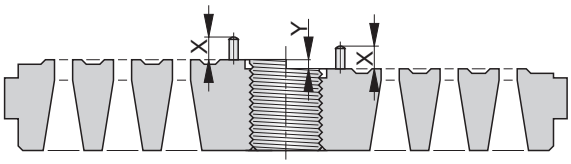


fig. 15
X... free length before and after remachining
Y... height reduction by remachining

The diameter of the new hole has to provide a press fit (dia. of drill. 0.1 mm less than dia. of locating pin). Make sure that the locating pins are at right angles to the seat face. When re-assembling the valve align the seat with the guard. In this position the nut can be tightened. Never tighten the nut without positioning the seat and guard properly. Any damage of the locating pins can impair the proper functioning of the valve.

Certain valves have no hole in their seat to accept the free end of the locating pin. Such valves are provided with marking holes on the periphery of seat and guard or visually by aligning the webs of the seat and guard, which must be lined up before the valve nut is tightened down (see fig. 16).

Valves using spirol pins instead of solid dowel pins must never have through holes in the seats to accommodate the pin. Drilling a through hole would result in leakage through the valve seat.

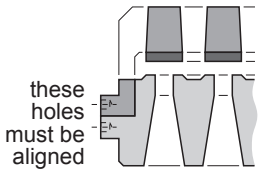


fig. 16

6 Reassemble the valve

Take special care in assembling the valve and follow procedures shown on our drawings. We are glad to give any further advice should problems arise. If valves are equipped with lock washers or locking plates, they have to be replaced after every dismantling. For more convenient assembly of the valve it is a good practice to grease the spring pockets, in order to hold the springs in place. This does not apply for valves of oxygen compressors. You will do a better job if you use a torque wrench for tightening the selflocking nut. (Follow the torque table given in this leaflet). When tightening the nut hold the suction seat, or the discharge guard, especially in case of valves with open guards (fig. 5) both parts should not move relative to each other. This could damage the locating pins in the valve and result in valve failure. Certain valves are provided with marking holes on the periphery of seat and guard which must be lined up before the valve nut is tightened down (fig. 16).

13 Never use oil or grease for valves used on oxygen-compressors!

14 Tightening torque of center bolt nut has to be maintained as specified. Bolt and nut threads must be clean, free of burrs and well lubricated. CAUTION: With Oxygen Compressors. Valves have to be completely free of oil and grease. Inspect valve again before installation. Failure to do so many result in an EXPLOSION! Never use self locking nuts on austenitic stainless steel material.

The torques listed in the table are for greased nuts and bolts. The data is only valid with a Genuine Centre Bolt. Self locking nuts should always be lubricated before tightening.

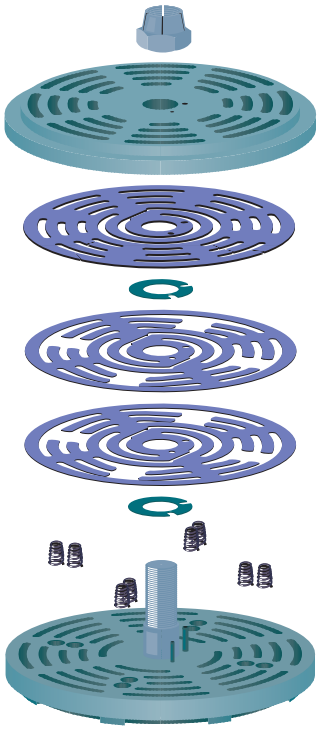


fig. 17

15 If suction valves are equipped with unloaders, the clearance between the valve plate and unloader finger as well as the clearance between unloader and actuator push rod has to be checked.

16 Valve plates have to be checked for free movement.

17 Before assembling the valve into the cylinder also clean the valve pocket and the cages.

18 When re-installing valves, do not interchange suction and discharge valves - DANGER OF EXPLOSION!

19 Do not install discharge valves upside down - DANGER OF EXPLOSION!

20 Valves must always be placed in the cylinder with the center bolt and nut AWAY from the cylinder bore.

fig. 18



21 Set screws or cover stud nuts holding the valve in place have to be tightened to the specified torque values, otherwise there is danger of valve seat breakage.

22 After all of the valves are installed, bar over the compressor at least one complete revolution to be certain there is no interference with moving parts.

Table of torque.
(valid for castle nuts, slotted nuts and self locking nuts).

PRACTICAL LEAKAGE TESTING OF COMPRESSOR VALVES

Compressor valves should be flowefficient and durable in service. Leakage is one criteria that impacts on both of the above. Excessive leakage causes back-flow of gas when the valve is closed, raises the temperature of the gas and reduces efficiency. Elevated temperatures also adversely affect valve life.

For this reason, HOERBIGER`s quality assurance program dictates that all valves are subjected to a leakage test. This policy covers newly made valves in our production plants and repaired valves in all our service centers. Different geometry valves and sealing elements made from steel or non-metallic material all undergo such rigorous testing.

Test methods may vary but preference is given to those procedures that simulate the conditions as they exist in a cylinder.

VALVE TESTING METHODS

There are 3 customary leakage test procedures, and HOERBIGER recommends 2 of the testing methods.

Flow Meter Testing

The leakage is determined by subjecting the closed valve to a "set" air pressure of e.g. 5 bar (70 PSI) and measuring the leakage through the valve by means of a flow meter (fig. 19).
Since small contaminants at times can be caught between the valve plate and seat lands,

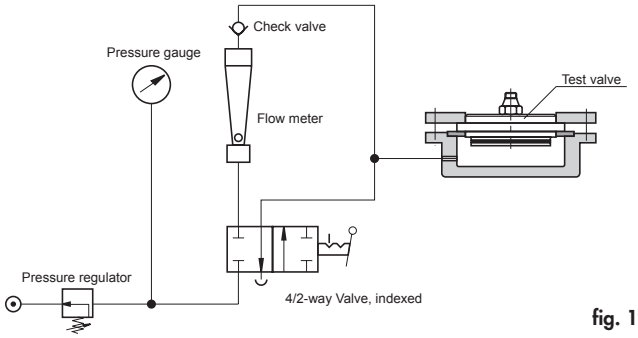


fig. 19

it is common practice to "tap" the valve plate in several areas repeatedly. This will briefly lift the plate off the seat lands and the escaping air will blow out any small particles that might be trapped between the sealing surfaces and cause excessive leakage.
This should be done with an appropriate tool (flat or soft-tipped) so no damage is done to the valve plate or sealing element. Particular care is called for when non-metallic plates are used so no damage is done to these components.

Measuring Pressure Drop

In this test method, leakage is measured in pressure drop over time, using a fixed volume "V" (air supply is shut off) and measuring the time it takes for the pressure to drop from p1 to p2 (fig. 20).

The time for the pressure drop to occur and parameter for acceptable leakage are dependent on the valve size, volume of the vessel and the selected pressures of p1 and p2.

The prior "tapping" of the valve to blow out any impurities should be standard practice in this test procedure as well.

Liquid Testing

Test procedures as discussed under 2.1 and 2.2 are compatible and represent conditions as they prevail in the compressor cylinder. The sealing element is "pressure loaded" much like it is in its operating environment when installed in a cylinder (the suction valve is kept closed by the cylinder pressure while the discharge valve is under the influence of the line pressure).

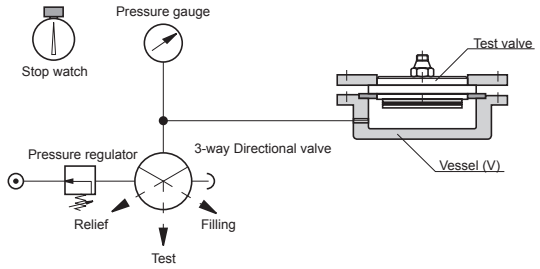


fig. 20

Thread size	Carbon Steel Min. tensile strength 800 N/mm²			
METRIC mm	Martensitic Stainless Steel*)(En56) Min. tensile strength 750 N/mm²		Austenitic Stainless**) (En 58) Min. tensile strength 550 N/mm²	
	Torque in Nm		Torque in Nm	
	Minimal	Maximal	Minimal	Maximal
4	1,2	1,5	1,0	1,2
5	2,4	2,9	1,8	1,2
6	4,1	5,0	3,2	3,8
8	10,0	12,0	7,5	9,0
10	20,0	24,5	15,5	18,5
12	36,0	44,0	28,0	33,0
14	57,0	69,0	43,0	52,0
16	90,0	110,0	70,0	85,0
20	178,0	215,0	135,0	160,0
22	245,0	295,0	185,0	220,0
24	305,0	370,0	230,0	280,0
27	330,0	400,0	330,0	400,0
30	450,0	540,0	450,0	540,0

*) Martensitic stainless steel (magnetic) is used with slightly corrosive gases
**) Austenitic stainless steel (non magnetic) is used with highly corrosive gases

Frequently, field people do not have access to leakage testers and resort to a simple "liquid testing" of the valve.

Filling the seat ports of a valve with a fluid and observing the leakage rate of the fluid through the valve is a common practice. Kerosene, Varsol and other light viscosity fluids (even water) are employed in such crude leakage tests.

Although the procedure is widely used, it is not without controversy as to the viability of its results. Contrary to the previously described methods of air pressure testing, the liquid test does not simulate conditions as found in the cylinder. The fluid pre-loads the sealing element towards its opening lift, and test results can be distorted, especially if valves use non-metallic sealing elements and if the pre-load of the springs used in the valve is very light.

Certain valves, due to thier design, cannot be tested at all with the fluid method, and others will create the appearance of "leakers" when their sealing characteristic under air pressure is perfectly acceptable. This test method, therefore, is controversial and should be avoided whenever possible. The cleaning process described in air testing cannot be applied in liquid tests, and any impurities in the sealing area will show as excessive leakage.

Frequently, such liquid tests lead to unnecessary labor and repair of the valve which would possibly be termed fine under air tests.

It is recognized that proper testing of valves with air pressure is not always possible, but it remains the superior prodedure and should be adopted wherever possible.





Our experts are available at any time - worldwide

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Practical Leakage Testing of Compressor Valves

HOERBIGER®

1. Introduction

Compressor valves should be flow-efficient and durable in service. Leakage is one criteria that impacts on both of the above. Excessive leakage causes back-flow of gas when the valve is closed, raises the temperature of the gas and reduces efficiency. Elevated temperatures also adversely affect valve life.

For this reason, HOERBIGER's quality assurance program dictates that all valves are subjected to a suitable leakage test. This policy covers newly made valves in our production plants and repaired valves in all our service centers. Different geometry valves and sealing elements made from steel or non-metallic material all undergo such rigorous testing.

Test methods may vary but preference is given to those procedures that simulate the conditions as they exist in a cylinder.

2. Valve Testing Methods

There are 3 customary leakage test procedures, and HOERBIGER recommends 2 of the testing methods.

2.1 Flow Meter Testing

The leakage is determined by subjecting the closed valve to a "set" air pressure of e.g. 5 bar (70 PSI) and measuring the leakage through the valve by means of a flow meter (fig. 1).
Since small contaminants at times can be caught between the valve plate and seat lands, it is common practice to "tap" the valve plate in several areas repeatedly. This will briefly lift the plate off the seat lands and the escaping air will blow out any small particles that might be trapped between the sealing surfaces and cause excessive leakage.
This should be done with an appropriate tool (flat or soft-tipped) so no damage is done to the valve plate or sealing element. Particular care is called for when non-metallic plates are used so no damage is done to these components.

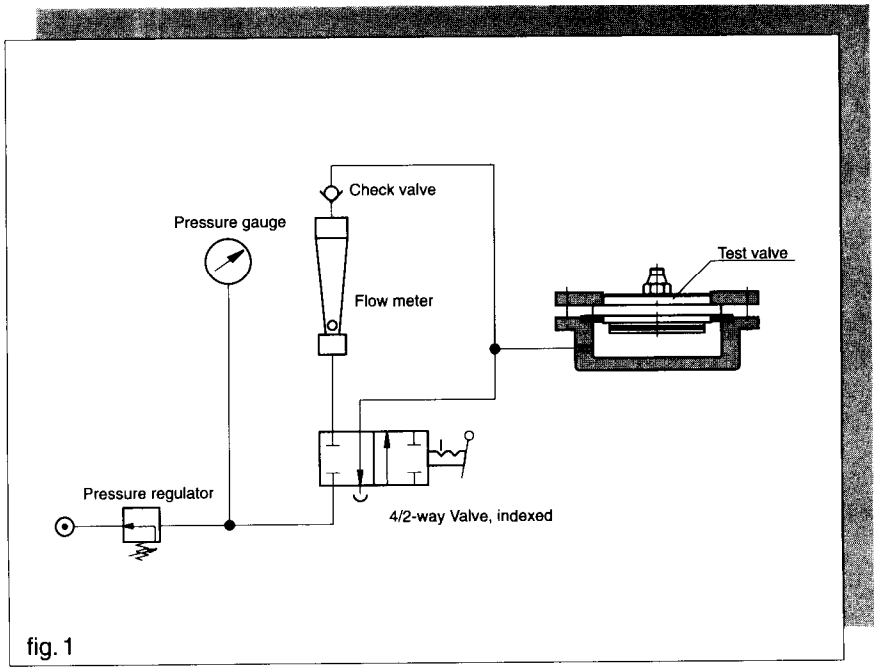


fig. 1

HOERBIGER CORPORATION OF AMERICA, INC.
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2.2 Measuring Pressure Drop

In this test method, leakage is measured in pressure drop over time, using a fixed volume "V" (air supply is shut off) and measuring the time it takes for the pressure to drop from p1 to p2 (fig. 2).

The time for the pressure drop to occur and parameter for acceptable leakage are dependent on the valve size, volume of the vessel and the selected pressures of p1 and p2.

The prior "tapping" of the valve to blow out any impurities should be standard practice in this test procedure as well.

2.3 Liquid Testing

Test procedures as discussed under 2.1 and 2.2 are compatible and represent conditions as they prevail in the compressor cylinder. The sealing element is "pressure loaded" much like it is in its operating environment when installed in a cylinder (the suction valve is kept closed by the cylinder pressure while the discharge valve is under the influence of the line pressure).

Frequently, field people do not have access to leakage testers and resort to a simple "liquid testing" of the valve.

Filling the seat ports of a valve with a fluid and observing the leakage rate of the fluid through the valve is a common practice. Kerosene, Varsol and other light viscosity fluids (even water) are employed in such crude leakage tests.
Although the procedure is widely used, it is not without controversy as to the viability of its results. Contrary to the previously described methods of air pressure testing, the liquid test does not simulate conditions as found in the cylinder. The fluid pre-loads the sealing element towards its opening lift, and test results can be distorted, especially if valves use non-metallic sealing elements and if the pre-load of the springs used in the valve is very light.

Certain valves, due to their design, cannot be tested at all with the fluid method, and others will create the appearance of "leakers" when their sealing characteristic under air pressure is perfectly acceptable.
This test method, therefore, is controversial and should be avoided whenever possible. The cleaning process described in air testing cannot be applied in liquid tests, and any impurities in the sealing area will show as excessive leakage.

Frequently, such liquid tests lead to unnecessary labor and repair of the valve which would possibly be termed fine under air tests.

It is recognized that proper testing of valves with air pressure is not always possible, but it remains the superior prodedure and should be adopted wherever possible.

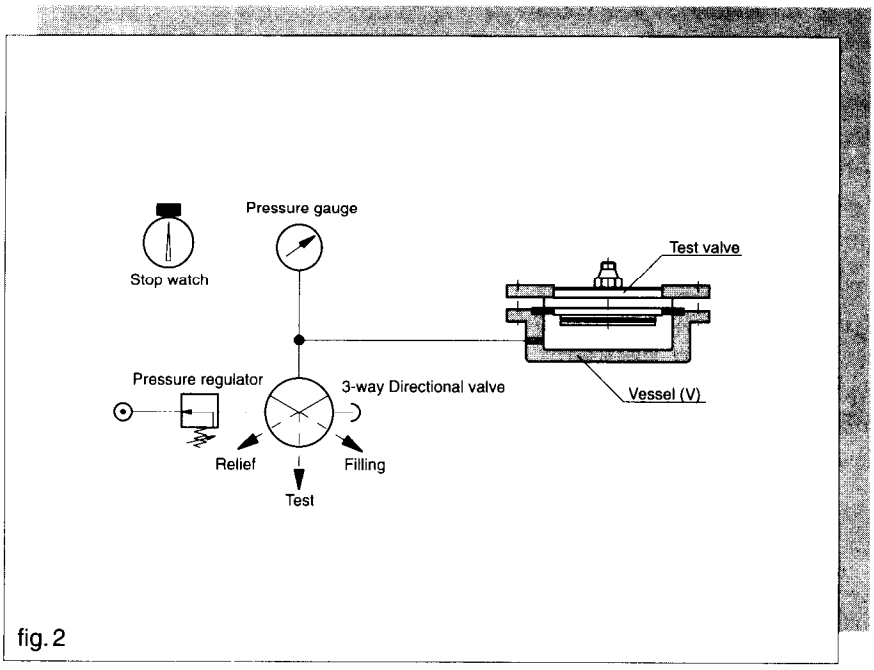


fig. 2

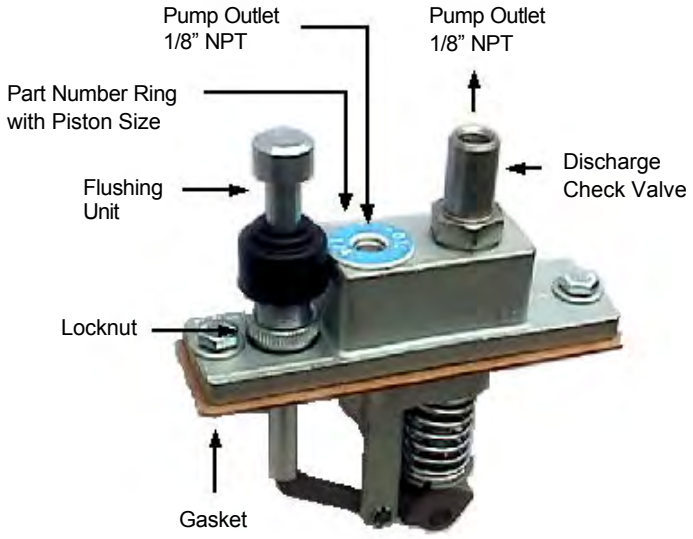
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204 Pennsylvania Ave.
Oakmont, PA 15139
Phone: 412-828-2420

Operating Instructions for Premier Pressurized Suction Pump – Force Feed Lubrication

Pressurized Suction Pumps

- Install Pump In Lubricator Reservoir
- Fill pump inlet with oil and prime by manually pumping Flushing Unit until air free oil is observed at pump outlet.

Note: It may be necessary to install manual hand priming gun in inlet to expel air from pump.

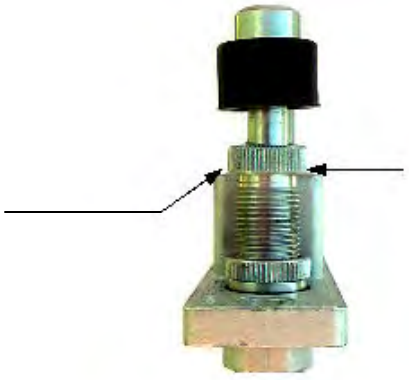


Features

- One Piece Steel Pump Body
- Modular Cast Iron Cylinder Assembly
- Hardened Steel Roller Rocker Arm
- Weatherproof Construction
- Suitable for use with Petroleum and Synthetic Lubricants

Flow Rate Adjustment

- Check OEM Data for correct Lube Rate.
- Loosen Locknut on Flushing Unit.
- Turn Flushing Unit counter clockwise to increase flow
- Turn Flushing Unit clockwise to decrease flow
- Tighten Locknut when desired flow is achieved.



End View of Pump

Ariel Part Number	Piston Size – Diameter		Maximum Displacement per Stroke @ 7/16 Inch (11.112 mm) Stroke		Maximum Working Pressure		Oil Viscosity SUS (cSt = mm^2/s)
	Inches	(mm)	Cubic Inches	(cm^2)	PSI	(bar)	
A-9476	3/16	(4.762)	0.012	(0.197)	7,500	(517)	Maximum: 8,000 SUS Minimum: 90 SUS (Maximum: 1760 cSt) (Minimum: 17.8 cSt)
A-9477	1/4	(6.350)	0.021	(0.344)	8,000	(551)	
A-9478	3/8	(9.525)	0.048	(0.787)	4,000	(275)	

INSTALLATION AND SERVICE INSTRUCTIONS

FOR SERIES LA – LE PUMPS

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- Selection ..... Page 1
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- Inspection ..... Page 3
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- Model 2LE ..... Page 10

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INSTALLATION AND SERVICE INSTRUCTIONS

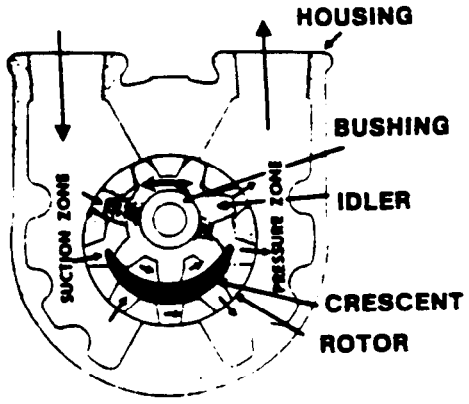
FOR SERIES LA – LE PUMPS

GENERAL DESCRIPTION

The Tuthill Series LA-LE is a compact highly efficient, positive displacement, rotary internal gear type pump with mechanical seal. Built in five sizes, it provides capacities from 20 to 360 gallons per hour and pressures up to 500 psi and is available with 2-bolt flange in the LA Series and 3-bolt flange in the LE Series. Optional mounting feet are available. It is multi-directional in rotation and designed for direct drive at standard motor speeds, with modifications available for indirect drive.

PUMPING PRINCIPLE

These pumps employ the Tuthill internal gear principle which is based upon the use of a rotor, idler gear and a crescent-shaped partition that is cast integrally with the cover. (See accompanying figure.) Thus, only two moving parts comprise this efficient pumping element. Power is applied to the rotor and transmitted to the idler gear with which it meshes. The space between the outside diameter of the idler and the inside diameter of the rotor is sealed by the crescent. When the pump is started, there is an increase in volume as the teeth come out of mesh. This creates a partial vacuum, drawing the liquid into the pump through the suction port. The liquid fills the spaces between the teeth of the idler and rotor and is carried past the crescent partition to the pressure side of the pump. When the teeth mesh on the pressure side, the liquid is forced from the spaces and out through the discharge port.



COUNTERCLOCKWISE ROTATION

SEAL

The seal is a device to prevent leakage between the stationary pump body and rotating drive shaft. A rotating lapped surface is attached to the shaft by an elastomer bellows. This rotating face is spring loaded to rub against a stationary lapped surface in the housing plug bushing. The clearance between these two surfaces is so minute that resistance to flow is great enough that fluid will not leak out and air will not be drawn in.

SELECTION

The Series LA and LE pumps are designed for working pressures up to 500 psi and are required to develop 25" mercury vacuum at 0 psi on factory test. While these pumps will develop as high as 27" of vacuum, it is sound engineering to avoid extreme vacuum whenever possible. Select pipe size to reduce line friction loss to a minimum. On transfer service, place pump as close to supply tank as conditions will permit, and eliminate the use of foot valves or check valves in the suction line whenever possible. The LA and LE pumps are self priming and particularly suited to handle liquids of 35 SSU to 1000 SSU viscosity. Higher viscosities can be handled at reduced speeds. It is important that the piping used in connecting the pump be clean and free of chips or scales.

Consult us in selecting the proper pump and size of motor, giving us all the following information:

1. Capacity required
2. Maximum and minimum liquid temperature when entering the pump.
3. The viscosity at the minimum temperature.
4. Total length of suction pipe and discharge pipe, including pipe sizes.
5. Suction lift and height to which the pump must force the liquid.

Direct motor drive through a flexible coupling is the most satisfactory method.

NOTE: **LA and LE pumps can be driven in either direction of rotation.** The seal chamber communicates with the neutral zone and therefore the seal is subjected to one-half of the discharge pressure.

Viewing the pump from the shaft end, the inlet port is on the right-hand side for clockwise rotation, on the left-hand side for counter-clockwise rotation.

Pumps with built-in relief valves are uni-directional. Therefore, rotation, clockwise or counter-clockwise, facing the shaft end, must be specified.

1. All pump and motor units are properly aligned at the factory. However, misalignment may occur due to abuse or conditions beyond our control.
2. Pipe strains often force the pump and motor shafts out of alignment. See that all piping leading to the pump is properly supported by wall brackets. Do not expect the pump to act as a pipe support.
3. Provide for proper expansion of pipes when handling hot liquid.
4. Series L pumps are not designed to take end thrust toward the cover. Provide sufficient clearance, 1/16" to 1/8" between coupling halves with shafts in closest operating position, to allow for end wear in the driving shaft.
5. Never align the pump and motor supplied with pin type coupling without first removing the pins.
6. Never depend upon sight or feel for freeness in aligning a pump.

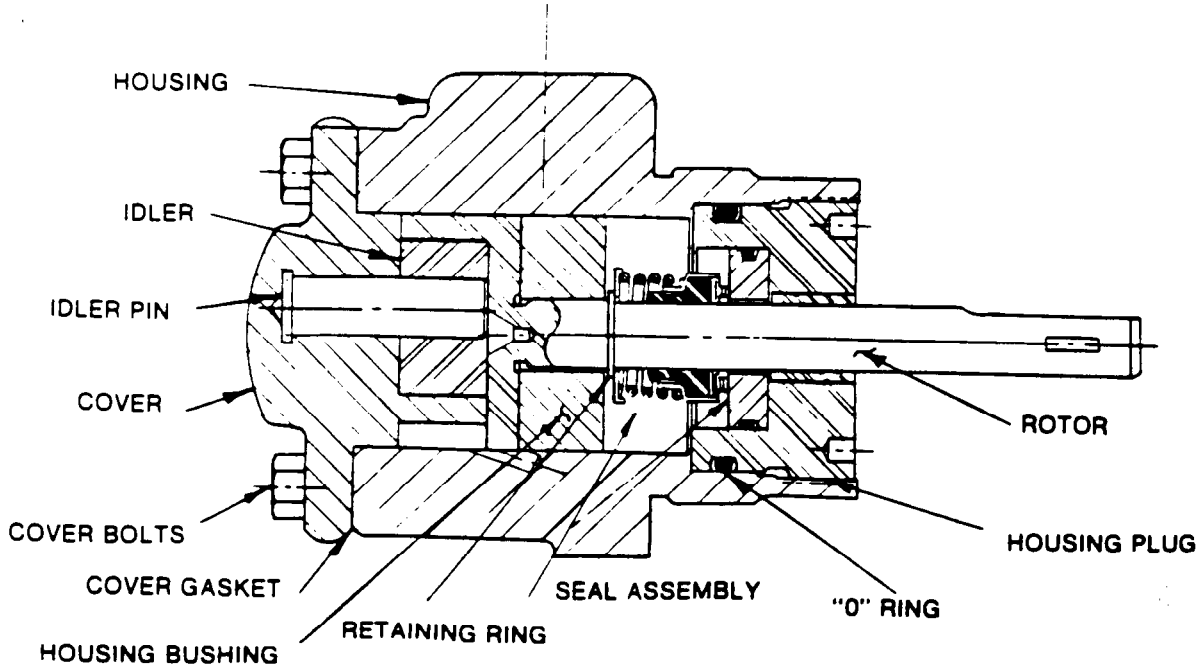
LA and LE pumps should be filled with oil at installation and should never be allowed to run dry.

STRAINER PROTECTION

Strainers are used to remove contaminating particles from the hydraulic system and every Tuthill pump should be protected from these particles by a strainer in the suction line.

1. Strainer size and mesh of screen is determined by rate of flow and viscosity of fluid. Consult strainer manufacturer for recommendations.
2. Never use a strainer with a built-in automatic by-pass on the suction line set to open under 30" Hg. vacuum.
3. Install strainer according to arrows or flow designation.
4. Have strainer accessible for servicing.
5. Use a duplex type where shutdown during service is not permitted.
6. Provide a vacuum gage in the suction line for determining when the strainer requires cleaning.
7. Make certain strainer baskets are properly reinforced so as not to collapse under 30" Hg. vacuum.

Series LA-LE pumps should always be installed with both ports pointing upward to insure proper priming. If it becomes necessary to install the pump with the ports pointed to the side, then the top port should be the suction port. When the pump is installed above the supply tank, an inverted "U" bend should be incorporated in the suction line close to the pump to trap liquid in the pump for priming.



DISASSEMBLY OF SEAL

The seal assembly of the LA and LE pump may be changed without dis-assembly of the rest of the pump.

1. Place the pump in vise, shaft facing up, so that one jaw grips across the two ports. Do not tighten excessively as pump housing may be distorted.
2. Inspect shaft at keyway, flat or drive tang. Any burrs will interfere with removal of housing plug bearing assembly.
3. Remove housing plug with face type spanner wrench (available from Tuthill as part No. OL506).
4. Remove the seal from shaft. The rubber boot will be bonded to the shaft, so it is necessary to push down on the seal to break this bond. Grasp the metal outer shell with any suitable device and pull the seal assembly upwards. The spring and washer should also be removed.
5. The 30LA through 1LA and 30LE through 1LE pump assemblies have a snap ring on the shaft to back up the seal assembly. Do not remove this snap ring unless you are completely disassembling the pump. The 2LA and 2LE pumps do not have a snap ring. A step on the shaft is used as the seal back up.
6. Remove stationary seal face from housing plug by pressing out from opposite side.
7. If damaged, remove the O-ring from O.D. of housing plug.

DISASSEMBLY OF PUMP

Seal assembly must be removed before disassembly of pump. Also remove snap ring on shaft on 30LA through 1LA and 30LE through 1LE.

Mark cover and body of the pump for proper reassembly. Remove cap screws, cover, idler and rotor from housing.

INSPECTION

Check pump housing, rotor, idler gear, idler pin and crescent for wear, chipped or broken teeth.

Housing bore and rotor O.D. may be checked for wear by positioning rotor in the housing and check for clearance in the bearing. The shaft must turn freely without any detectable side play. Any side play will require replacement of the housing, rotor or both. If both housing and rotor require replacing, it is economically advisable to replace the pump.

ASSEMBLY OF PUMP

The following must be carefully followed when pump is reassembled:

1. Clean all parts thoroughly using great care to eliminate all dirt.
2. Install rotor in pump body.
3. Apply gasket to cover. Use new gasket if old one is damaged.
4. Place idler gear on pin in cover assembly.
5. Place cover assembly with gear on pump. (Align matching marks for proper location.)
6. Install cover cap screws. Pull down gradually and alternate from a screw on one side to one on the opposite side.
7. Install snap ring on shaft.

PUMP PERFORMANCE TEST

PUMP SIZE	SPEED (RPM)	PRESSURE(PSI)	CAPACITY (GPM)
30L	1750	100	.30
00L	1750	100	.75
0L	1750	100	1.50
1L	1750	100	2.70
2L	1750	100	5.70

Performance data based on pumping a liquid of 200 SSU viscosity.

ASSEMBLY OF SEAL

1. Clean all parts thoroughly using great care to eliminate all dirt.
2. Oil shaft with suitable lubricating oil.
3. Oil inside of new rotary seal assembly.

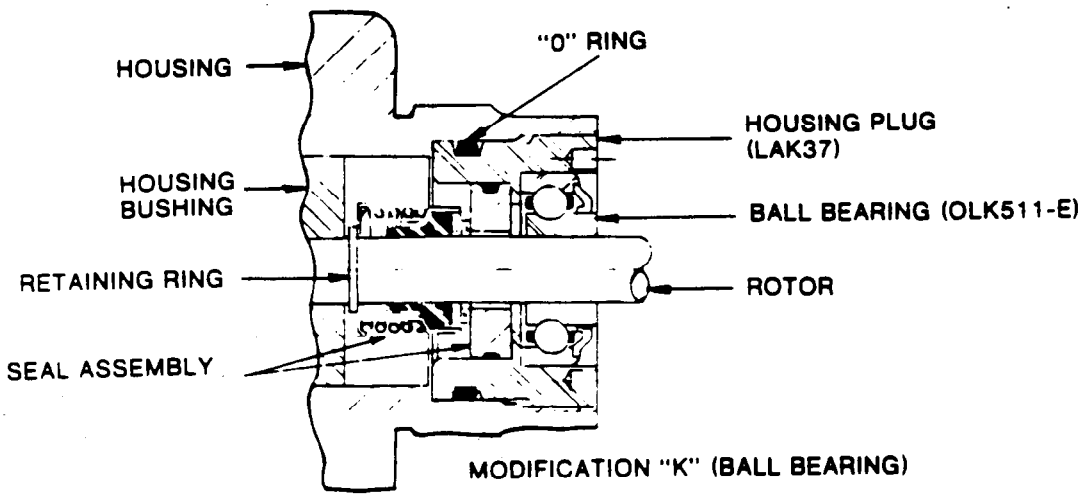
For standard full length shafts with flat and/or keyway:

a. Place rotary seal assembly on pump shaft.
b. Push seal down with your fingers to a position approximately half way down shaft.

For Mod. "A" tang shafts:

a. Use plastic seal assembly tapered sleeve.
(Available from Tuthill as part No. 1LPF531-7010.)
b. Oil seal assembly sleeve.
c. Place rotary seal assembly on sleeve. Tapered end of sleeve fits into spring end of assembly.
d. Place slotted end of sleeve on bench. Press down on carbon face of seal with your fingers and slide seal about mid-point on sleeve.
e. Place slotted end of tool over tang on pump shaft. Line up outside diameters of sleeve and shaft by eye.
f. Push seal down with your fingers so that it passes from the assembly sleeve to a position half way down the shaft.

4. Press stationary face into housing plug. Lapped surface must be up. Protect this lapped surface by covering it with a piece of paper when pressing down on face. Use your fingers for this operation.
5. Place new O-ring on O.D. of housing plug, if required, and lubricate with oil.
6. Lubricate carbon face liberally with lube oil.
7. Reassemble housing plug into position over the pump shaft. Do not nick seal face by hitting pump shaft. Tighten the housing plug with spanner wrench (OL506). Rotating seal will automatically be positioned by this operation.
8. If pump is equipped with ball bearing ("K" Model only), press bearing on to shaft. Press on bearing inner race with suitable sleeve. Do not hammer into position or press on bearing outer race.
9. Check pump for free rotation by turning shaft with suitable wrench. There will be a definite resistance to turning because of the seal load. The pump must turn freely without binding.



MODIFICATION "K" (BALL BEARING)

TROUBLE-SHOOTING HINTS

WHAT TO LOOK FOR WHEN

NO OIL IS DELIVERED.

a. Suction lift too high for vapor pressures of liquid pumped. While Tuthill pumps will develop as high as 27 inches of vacuum, it is good engineering practice to reduce the vacuum to a minimum.
b. Bad leaks in suction line or port passages can be detected by submerging pressure line from discharge side of pump into a pail of oil, where the air will be seen in the form of bubbles.
c. Pump shaft not rotating.
Coupling defective - tongue and groove or gear not engaged.

CAPACITY IS TOO LOW.

a. Suction lift too high.
b. Air leaks in suction line.
c. Suction line too small.
   Can be detected by installing a vacuum gage directly at the pump suction. The maximum vacuum at the pump suction should never exceed 15 inches of mercury. It is necessary to keep below 15 inches, not because of the inability of the pump to handle a higher vacuum, but primarily because of the vaporization that is liable to take place at a higher vacuum. Vaporization caused by higher vacuums will generally result in capacity drop-off.
d. Pump speed too slow.
e. Strainer too small or obstructed.
f. Suction pipe or port not immersed in the liquid deep enough.
g. Piping improperly installed, permitting air pocket to form in pump.
h. Increased clearances or wear in the pump will sometimes cause the pump to deliver an insufficient supply of liquid.

PUMP WORKS SPASMODICALLY.

a. Leaky suction lines.
b. Suction lift too high.
c. Air or vapor in liquid.
d. Coupling slipping on pump shaft.

PUMP WASTES POWER.

a. Pressures too high.
b. Liquid more viscous than desired.
c. Suction or discharge lines obstructed.
d. Mechanical defects.
   End thrust on pump shaft. (Tuthill pumps are not designed to take end thrust toward the pump cover and extreme care must be taken to prevent thrust in this direction.)
   Driving shaft and pump shaft misaligned.
   The pump may be binding due to insufficient end clearance.
   Pump shaft bent.
   Misalignment within pump due to strains built up by bad piping or installation of pump into equipment.

PUMP IS NOISY.

a. Machine or part of it is acting as a sounding board.
b. Misalignment or bad design of coupling.
c. Coupling set up too close to pump.
d. Vibration of pump.
   Bent Shaft
   Worn pump.
   Inferior workmanship.
e. Air leaks into suction side of pump.
f. Suction lift so high that vapor forms within liquid.

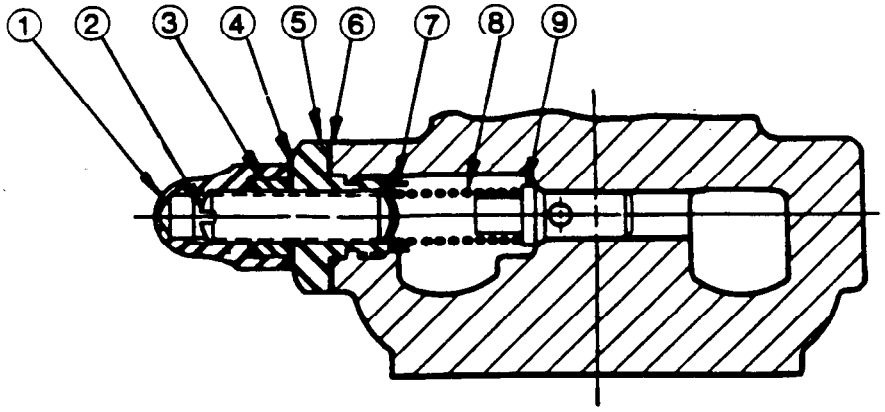
PUMP LEAKS.

a. Cover bolts need tightening, or cover gasket is defective.
b. See seal under service instructions.

HANDLE WITH CARE.

If it becomes necessary to remove pump from your equipment to return to the manufacturer, plugs should be inserted in the ports to prevent foreign material from getting into the moving parts. Tuthill pumps are precision-built and should be given every reasonable care.

TYPICAL RELIEF VALVE ASSEMBLY
MODEL "LEV"

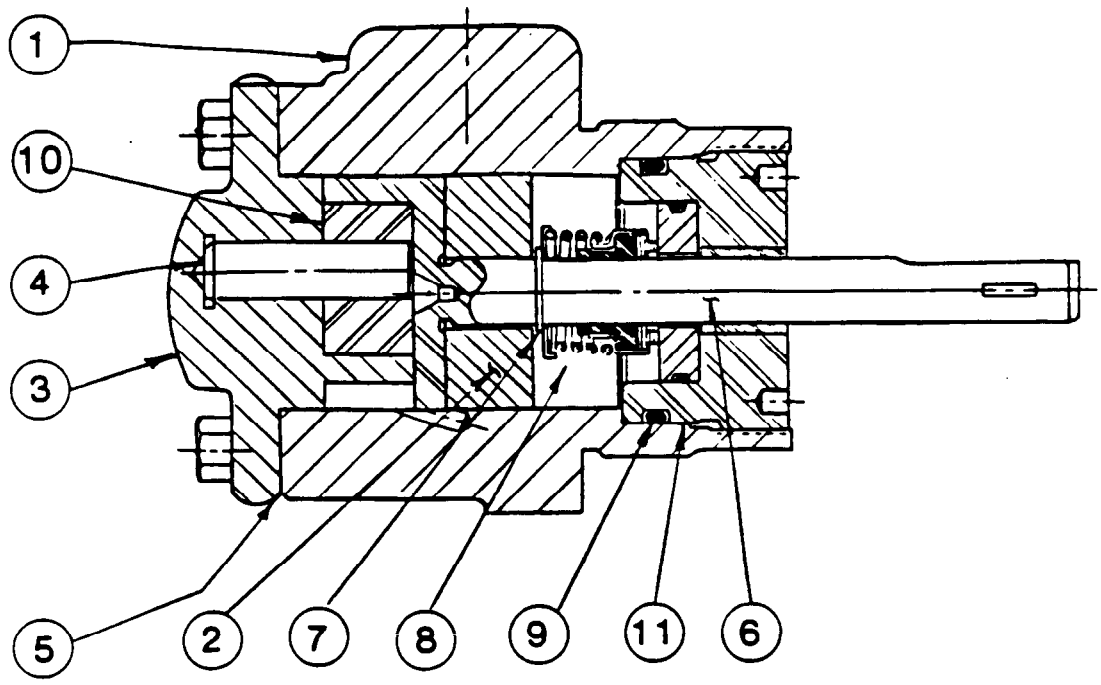


REPLACEMENT PARTS LIST FOR LEV VALVE ASSEMBLY

ITEM NUMBER	PART NUMBER	PART DESCRIPTION
1	30LE56	Valve Cap Cover
2	P103-11	5/16-18 NC2 X 1-3/8" Long Set Screw
3	30LE528	Nut
4	30LE64-A	Valve Cap Cover Gasket
5	OLWV56	Valve Cap
6	30F64 X 201	Valve Cap Gasket
7	30EN92	Spring Retainer
8	• •	Spring (See Chart Below)
9	OLV58 X 201	Plunger

• • Relief Valve Springs
Standard Relief Valve setting is 55 psi unless otherwise requested.

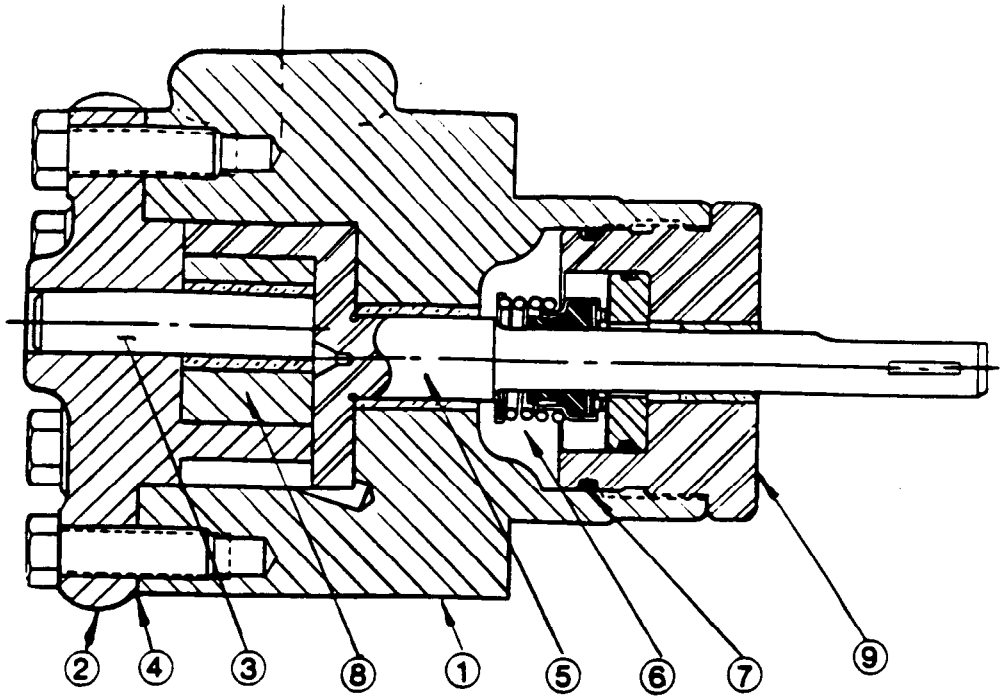
PUMP SIZE	30F80-X min-max	OC62 X201 min-max	OC62 X299 min-max	OLWV63 min-max	OLWVH63 min-max	OLPV63 min-max	OLV63X min-max	OLVH63 X478 min-max
30	15-30	30-35	35-55	55-120	60-170	200-375	376-600	600-850
00	---	25-35	35-55	55-120	60-170	200-375	376-600	600-850
0	---	25-35	35-55	55-120	60-170	200-375	376-600	600-850
1	---	25-35	35-55	55-120	60-170	200-375	376-600	600-850
2	---	---	35-55	55-120	60-170	200-375	376-600	600-850



SERIES LA PUMP PARTS LIST

ITEM NO.	PART DESCRIPTION ALL MODELS	SIZE 30 PART NO.	SIZE 00 PART NO.	SIZE 0 PART NO.	SIZE 1 PART NO.
1	Housing	30LA20	0LA20	0LA20	1LA20
2	Housing Bushing	30LA71	1LA71	1LA71	1LA71
	Cover Assembly	30L6	00L6	0L6	1L6
3	Cover	30L35	00L35	0L35	1L35
4	Idler Pin	30L31	1M31	1M31	1L31
5	Cover Gasket	30B34	0B34	0B34	0B34
6	Rotor	30LA24	00LA24	0LA24	1LA24
7	Retaining Ring	P206-34	P206-34	P206-34	P206-34
8	Seal Assy (Buna N)	1LA9	1LA9	1LA9	1LA9
9	O-Ring (Buna N)	P701-34-37	P701-34-37	P701-34-37	P701-34-37
	MODEL LA				
10	Idler Gear	30L32	00B32-1	0B32-1	1L32-1
11	Housing Plug Assy	30LA11	1LA11	1LA11	1LA11
	MODEL LAH				
10	Idler Gear	30L32	00B32	0B32	1L32
11	Housing Plug Assy	30LA11	1LA11	1LA11	1LA11
	MODEL LAK				
10	Idler Gear	30L32	00B32-1	0B32-1	1L32-1
11	Housing Plug	30LAK37	1LAK37	1LAK37	1LAK37
	*Ball Bearing	0LK511-E	0LK511-E	0LK511-E	0LK511-E
	MODEL LAT				
10	Idler Gear	30L32	00B32	0B32	1L32
11	Housing Plug	30LAK37	1LAK37	1LAK37	1LAK37
	*Ball Bearing	0LK511-E	0LK511-E	0LK511-E	0LK511-E

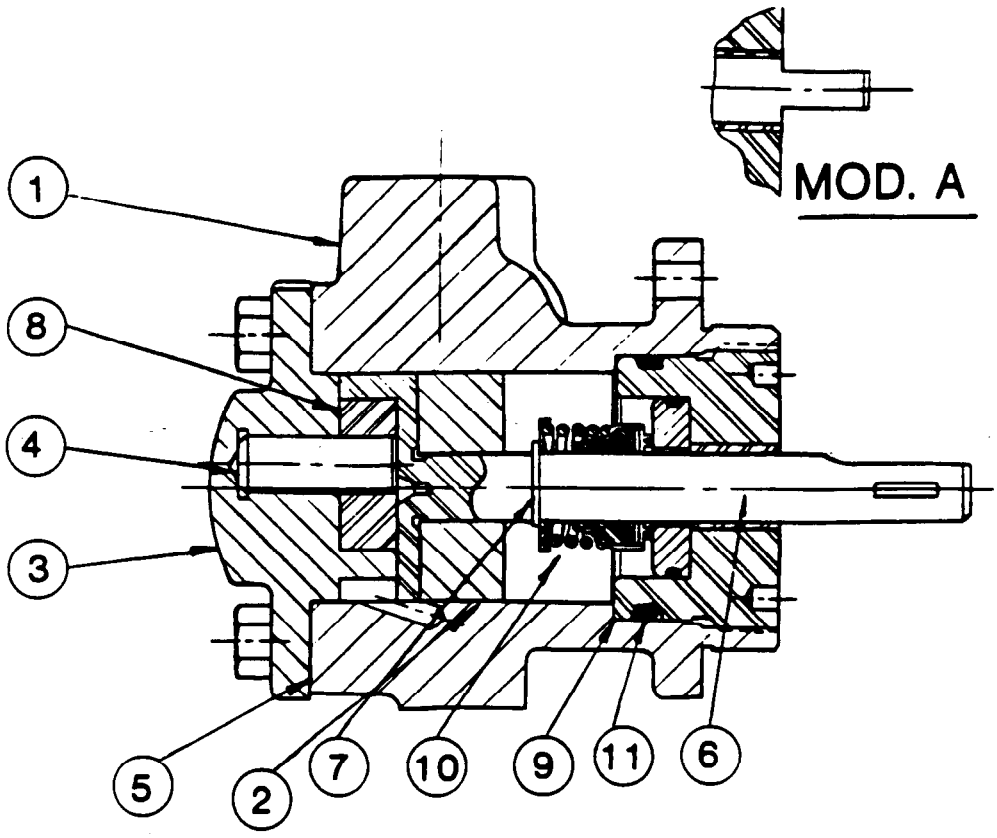
*See "K" seal construction on page 4.



SERIES 2LA PUMP PARTS LIST

ITEM NO.	PART DESCRIPTION ALL MODELS	SIZE 2 PART NO.
1	Housing Assembly	2LA2
	Cover Assembly	2L6
2	Cover	2L35
3	Idler Pin	2L31
4	Cover Gasket	2RFD34
5	Rotor	2LA24
6	Seal Assy (Buna N)	1LA9
7	O-Ring (Buna N)	P701-34-37
	MODEL LA	
8	Idler Gear	2L32-1
9	Housing Plug Assy	2LA11
	MODEL LAH	
8	Idler Gear	2L5
9	Housing Plug Assy	2LA11
	MODEL LAK	
8	Idler Gear	2L32-1
9	Housing Plug	2LAK37
	*Ball Bearing	0LK511-E
	MODEL LAT	
8	Idler Gear	2L5
9	Housing Plug	2LAK37
	*Ball Bearing	0LK511-E

*See "K" seal construction on page 4.



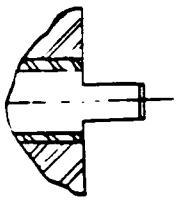
SERIES LE-LEV PUMP PARTS LIST

ITEM NO.	PART DESCRIPTION	SIZE 30 PART NO.	SIZE 00 PART NO.	SIZE 0 PART NO.	SIZE 1 PART NO.
1	Housing (LE)	30LE20	0LE20	0LE20	1LE20
2	Housing Bushing	30LA71	1LA71	1LA71	1LA71
1	Housing (LEV)*	30LEV20	0LEV20	0LEV20	1LEV20
2	Housing Bushing	30LA71	1LA71	1LA71	1LA71
	Cover Assembly	30L6	00L6	0L6	1L6
3	Cover	30L35	00L35	0L35	1L35
4	Idler Pin	30L31	1M31	1M31	1L31
5	Cover Gasket	30B34	0B34	0B34	0B34
6	Rotor**	30LE24	00LE24	0LE24	1LE24
7	Retaining Ring	P206-34	P206-34	P206-34	P206-34
8	Idler Gear (Standard Pump)	30L32	00B32-1	0B32-1	1L32-1
8	Idler Gear (Mod. "H" Pump)	30L32	00B32	0B32	1L32
9	Housing Plug Assembly	1LA11	1LA11	1LA11	1LA11
10	Seal Assy (Buna N)	1LA9	1LA9	1LA9	1LA9
11	O-Ring (Buna N)	P701-34-37	P701-34-37	P701-34-37	P701-34-37
10	Seal Assy (Viton)	1LA9-7	1LA9-7	1LA9-7	1LA9-7
11	O-Ring (Viton)	P701-34-77	P701-34-77	P701-34-77	P701-34-77

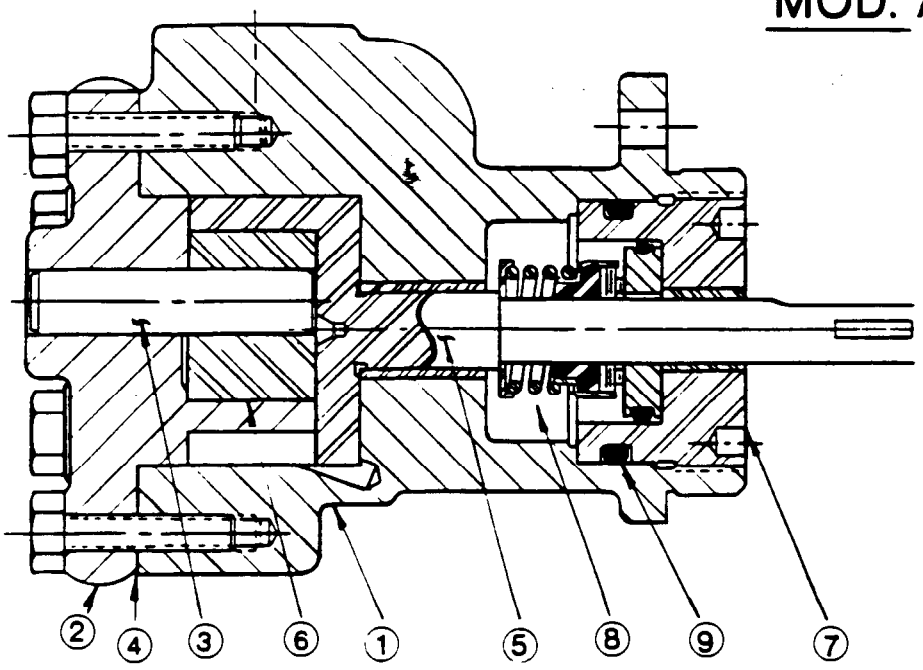
*Specify pump rotation

**Specify if standard or Modification "A" shaft end

See page 6 for relief valve parts identification



MOD. A



SERIES 2LE-2LEV PUMP PARTS LIST

ITEM NO.	PART DESCRIPTION	SIZE 2 PART NO.
1	Housing Assembly (LE)	2LE2
1	Housing Assembly (LEV)*	2LEV2
	Cover Assembly	2L6
2	Cover	2L35
3	Idler Pin	2L31
4	Cover Gasket	2RFD34
5	Rotor**	2LE24
6	Idler Gear (Standard Pump)	2L32-1
-6	Idler Gear (Mod. "H" Pump)	2L5
7	Housing Plug Assembly	1LA11
8	Seal Assembly (Std., Buna N)	1LA9
8	Seal Assembly (Viton)	1LA9-7
9	O-Ring (Standard, Buna N)	P701-34-37
9	O-Ring (Viton)	P701-34-77

*Specify pump rotation

**Specify if standard or Modification "A" shaft end

See page 6 for relief valve parts identification

TESTING DIVIDER ASSEMBLIES - IT IS NO BIG DEAL!

For any assembly to do its job, we must rely on the hydraulic integrity of each piston. If a piston fit gets sloppy, part of the designed displacement may leak past the piston and the required volume will not be delivered where it is needed. The only way to verify all the piston fits is through a simple pressure test. Using a test pump and 10 wt oil, each outlet of the divider must be plugged and pressure tested.

Here is the simple procedure:

1 - Remove all tubing connections from the assembly. You may want to remove the assembly to a clean work area with a drip pan.

2 - Hook up a test pump (hand, air or electric with 5000 PSI gauge) to the divider inlet. Operate the pump to verify oil discharge at all outlets.

3 - Using a tube cap or pipe plug, close one outlet. Be sure the plug does not leak!

4 - Operate the test pump up to 3000 PSI and stop pumping. The divider should not “bypass” for at least 60 seconds. A Bypass is indicated by the pressure gauge dropping rapidly along with visible discharge from all open outlets or a bleed-down of more than 500 PSI over 60 seconds.

5 - All active outlets must be tested as above to complete the assembly.

6 - During the testing of each outlet, look for external leakage (bad O-rings) and verify that indicators pop at the rated pressure.

WHAT IF I FIND A BAD DIVIDER IN THE ABOVE TEST?

If one piston has gone bad, the others will not be far behind. **Save yourself a lot of time and effort - replace all the sections in the divider with new.** Some folks like to keep a spare batch of sections for each active divider assembly in operation. They can then replace the sections in the active divider, and test the others at their leisure.

HOW DO I SPECIFY NEW SB DIVIDERS?

Call us with the old divider specs - we’ll tell you what you need. We can replace the whole assembly complete with discharge checks, indicators and fittings. Top or bottom inlets are available, as are Parker or Swagelok fittings in Carbon or Stainless Steel. In some cases where Primary and Secondary Dividers are in use, the entire system can be greatly simplified with fewer dividers. Although some re-tubing may be required, operation and maintenance in the future will be much simpler. Ask us to make a recommendation.

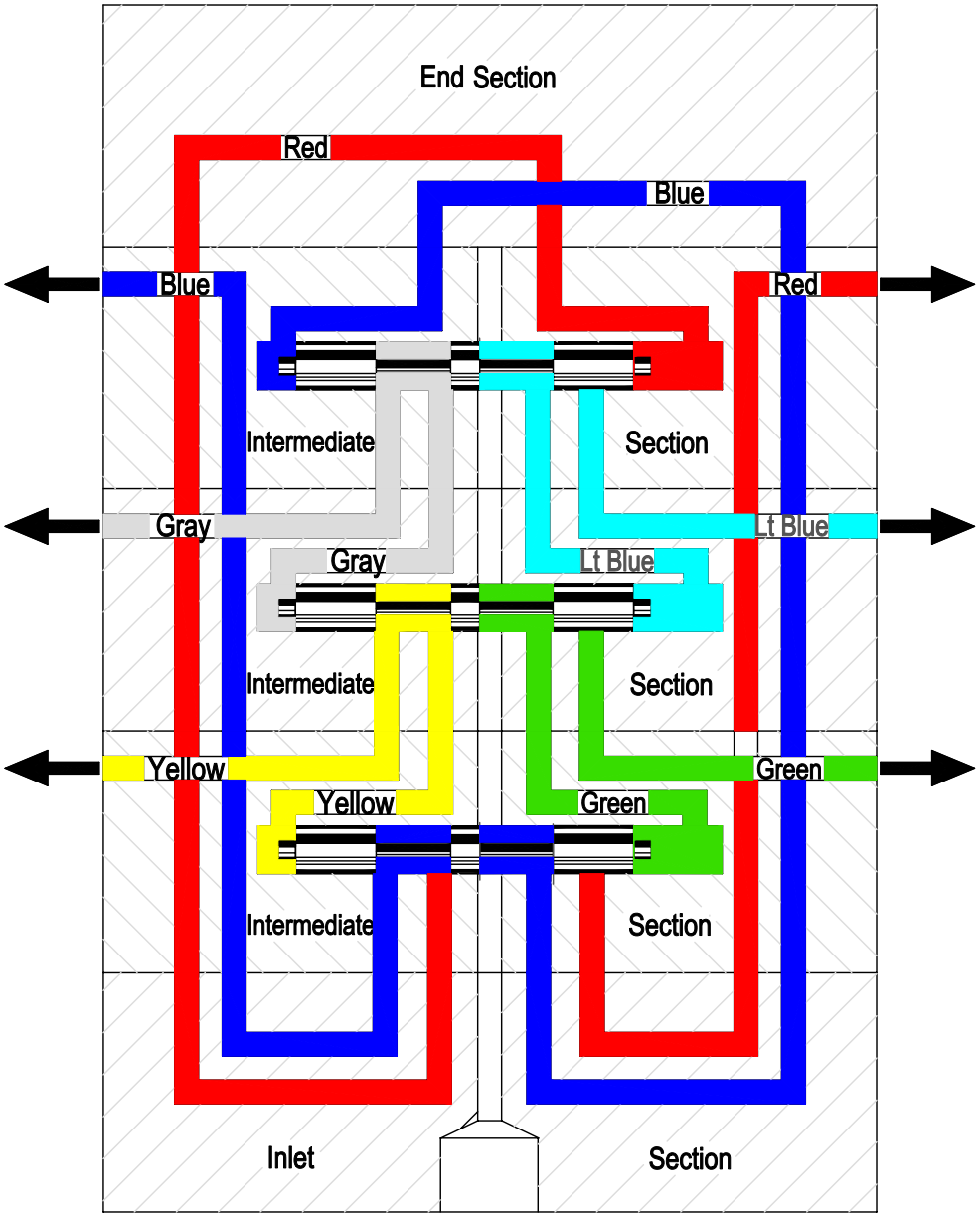
SB Series Divider Assembly
Operation and Testing Guide



SB Series divider assemblies are used in lubrication systems to deliver and monitor precise volumes of oil to lube points on engines, compressors and other critical equipment.

Bulletin SBD-2003

Sloan Brothers Company
204 Pennsylvania Avenue
P.O. Box 378
Oakmont, PA 15139
Toll Free: 1-800-722-0250
Fax: 412-828-2424
Visit us online at: SBCO.COM



Why DO we Test Divider Assemblies?

Each divider assembly is designed to deliver specific proportions of oil to various lubrication points. Its various piston sizes and internal porting are specific to the application, and every divider assembly may be different in design. The numbers and letters on the face of each individual divider section denote that sections displacement per cycle and internal porting arrangement.

It is imperative that when an assembly or individual component is replaced, or if any individual section in an assembly is replaced, it has the EXACT same number and letter designation on every section, and that every outlet in the baseplate below are in exactly the same location as the original. If different number designations are used, or if singled or crossported sections are used in place of twins, the assembly may not cycle, or it may deliver improper proportions.

Yearly pressure testing of dividers is highly recomended. This ensures the continued accuracy of oil delivery. Should piston wear go undetected, the divider block may fail to deliver oil to one or more points. This risks damage to the compressor or machine being lubricated.

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Divider Assembly Components

① SB Divider Sections

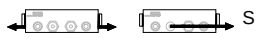
SB-6T	Divider Section 6T
SB-6S	Divider Section 6S
SB-9T	Divider Section 9T
SB-9S	Divider Section 9S
SB-12T	Divider Section 12T
SB-12S	Divider Section 12S
SB-18T	Divider Section 18T
SB-18S	Divider Section 18S
SB-24T	Divider Section 24T
SB-24S	Divider Section 24S
SB-30T	Divider Section 30T
SB-30S	Divider Section 30S

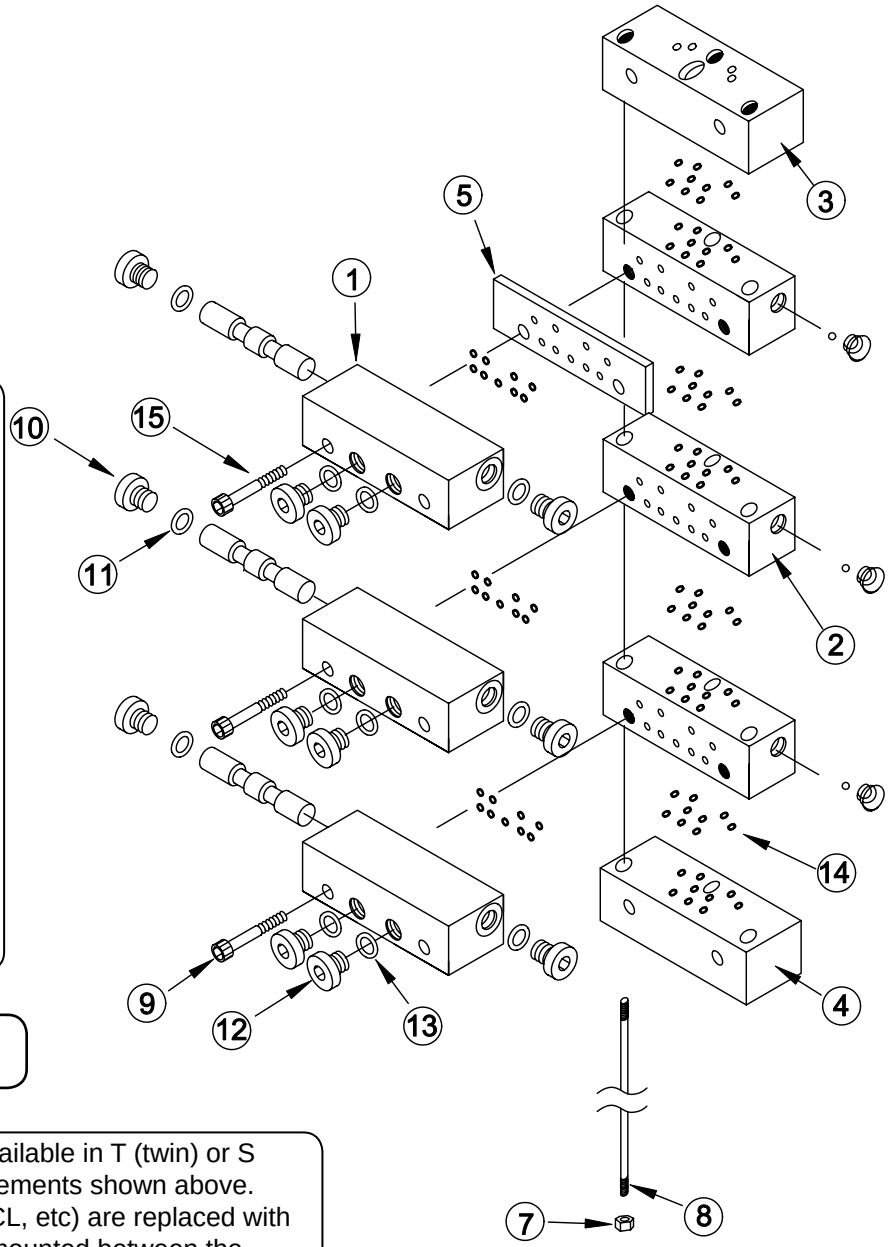
WHAT DO THE NUMBERS ON THE BLOCKS MEAN?

The numbers represent the cubic inch displacement of 1 outlet, in thousandths. There are two outlets per section. The letter or last digit corresponds to the internal porting arrangement. Each piston discharge can be internally valved to combine with its opposite end (singled).

Section Number		Displ/cycle each side
061	6T	.006 cu.in.
091	9T	.009 cu.in.
121	12T	.012 cu.in.
181	18T	.018 cu.in.
241	24T	.024 cu.in.
301	30T	.030 cu.in.

Porting Reference





Divider Block Parts Breakdown

2	Intermediate Base Plate	SB-BP
3	Top End Section w/ vent	SB-ST
4	Bottom Inlet Section	SB-SBD
5	Crossport Plate - Right	SB-CPR
	Crossport Plate - Left	SB-CPL
	Crossport Plate - Both	SB-CPB
7	Tie Rod Nut Only	SB-N
8	Tie Rod - 3 Section	SB-T3
	Tie Rod - 4 Section	SB-T4
	Tie Rod - 5 Section	SB-5T
	Tie Rod - 6 Section	SB-6T
	Tie Rod - 7 Section	SB-7T
	Tie Rod - 8 Section	SB-8T
9	Plunger Section Screw (2/ Sect)	SB-BB
10	Side Section Plug	SB-SSP
11	Side Section Plug O-ring	SB-SSP-OR
12	Front Section Plug	SB-FSP
13	Front Section Plug O-ring	SB-FSP-OR
14	Intermediate O-ring (Viton)	SB-I-OR
15	Cross Port Section Screw	SB-BBCP

Lincoln Bolt Centers Available

SB-LT	Lincoln Top Section
SB-LB	Lincoln Bottom Section

Reset Fault Indicators

500# Reset Indicator	(blue)	SBI-500
1000# Reset Indicator	(yellow)	SBI-1000
1500# Reset Indicator	(red)	SBI-1500
2000# Reset Indicator	(orange)	SBI-2000
2500# Reset Indicator	(purple)	SBI-2500
3000# Reset Indicator	(brown)	SBI-3000
3500# Reset Indicator	(grey/black)	SBI-3500

Other replacement parts

Proximity Switch	SB-PRX, SB-PS
Cycle Indicator	SB-CI
Outlet check valve	SB-OCV
Divider Test Stand	SB-TEST-STAND

(See next page)

NOTE: New SB Divider Sections are available in T (twin) or S (singled) sections only, in piston displacements shown above. Crossported sections (6SCR, 066, 12TCL, etc) are replaced with T or S sections and a crossporting bar mounted between the Divider section and the baseplate beneath it.
Thus a 9SCL section (singled & crossed left) is replaced by a 9S section p/n SB-9S, and a crossport left p/n SB-CPL.

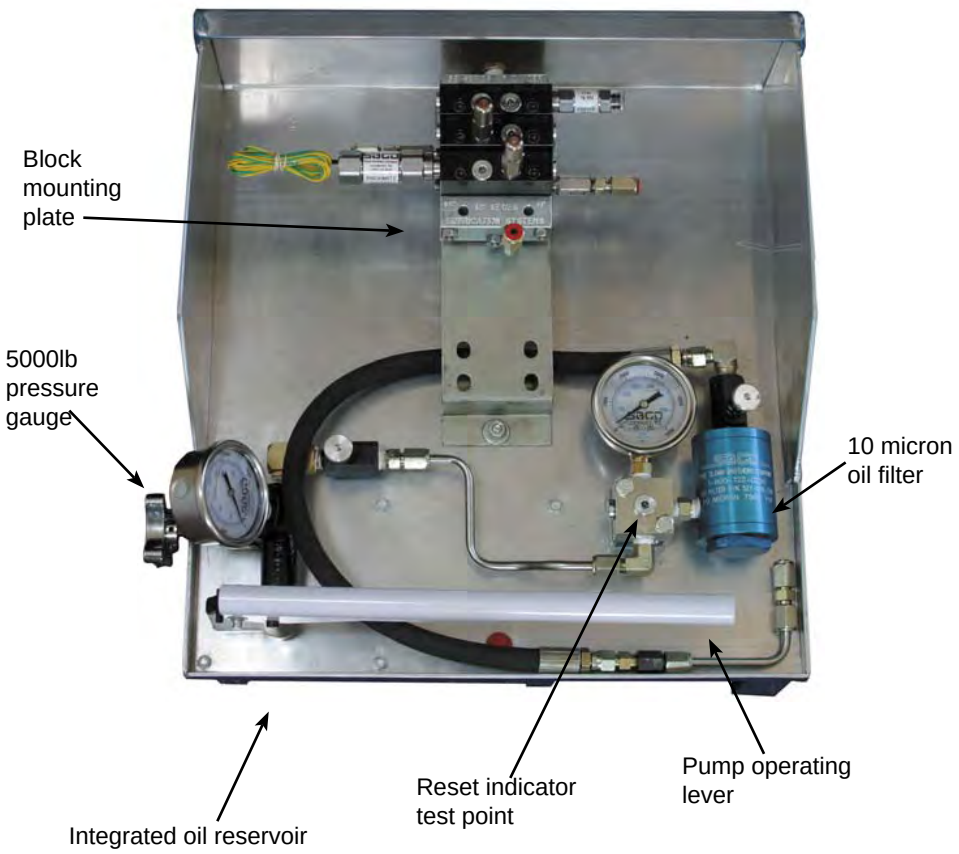
Call Us!!
We build it - any way you want it.

SBCO
1-800-722-0250 SBCO.COM Fax: 412-828-2424

SB Divider Block Testing Stand

Our portable test stand is now available for field or shop testing of our SB block assemblies. This compact unit includes a quick-mount plate for the block, an integrated oil reservoir, hand pump, oil filter, and 5000 psi pressure gauge.

An optional resettable indicator tester (left hand gauge below) can be used to test individual pressure indicators.



HOW DO THESE THINGS WORK, ANYWAY?

The inlet from the pump may be at the top or bottom of the divider and the inlet passage is ported to the center of each piston. Note the “lands” or reduced diameter portions in each piston. The operating principle is based on the fact that at any time, only one land is in the proper position to flow oil to move the piston below. All others are at one end or the other of their travel and cannot be moved. When the pump flow moves that piston to its opposite end, its displacement is made down one line, and its land moves to the opposite position, valving oil to move the next piston below into position and so on. At the bottom of the assembly, reversing passages start the piston movements down the other side. One cycle is completed when all pistons move over and back one time. The total oil displaced is the total of all the piston displacements. Each oil line must receive its oil to permit the piston to move and set up the flow to the next line. If one line is plugged up, the divider assembly will stop on that piston and the divider will not cycle.

HOW DO WE MONITOR THE OIL DELIVERY?

Since each piston must move over and back, we need to watch only one piston to “see” a complete cycle. This is done with a magnetic “Proximity Switch”. Each divider cycle is converted to one switch impulse which is monitored with the Wizard Monitor. Remember that the total divider displacement is fixed - it is the total of all the piston displacements. If you pump more oil to it, the divider cycles faster - less oil and it slows down. The rate at which the divider cycles (seconds per cycle) determines how much oil is actually being delivered. For example, a divider block of .036 cu.in. cycling once every 15 seconds is delivering 7.2 Pints per 24 Hours. The Wizard Monitor is field-programmed with the “displacement per cycle” and a “lube failure alarm limit”. The Wizard uses the cycle time of the proximity switch to display the actual “Pints/24 Hours” being delivered. It also compares that current delivery to the lube failure limit, and maintains fault relay contacts open or closed accordingly.

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FRAME



Ariel Compressor Balancing Record

Order #: 78310 (AP030916)

Balance By: **BRIAR BLECHINGER** Completed: 10/28/2016 Frame: **JGQ/2** Frame S/N: **F53162**

Rated RPM: **1800**

Stroke, in: **3.00**

Parts Group	Throw #1		Throw #2									
	3.625SG-CE		**5.500P-CE**									
	CE SN: **C189419**		CE SN: **C189423**									
	1.750SG-FS-HE		**10.750P-HE**									
	HE SN: **C189410**		HE SN: **C189414**									
	P/N	LB	P/N	LB								
Connecting Rod with Bushing, bolts and bearing shells	AD-1043	14.78	AD-1043	14.24								
Piston(s) with rings, rod, collar & nut or stub shaft	C-3591	18.62	C-6000	38.48								
			C-5974 C-6001									
Crosshead with bushings	D-0061	19.20	D-3284	7.94								
Crosshead nut with setscrews	A-0377	8.72	B-0015	0.66								
Total Recip Weight Max: 103.20	61.32		61.32									
Imbalance Max: 1.00	0.00											

Ariel Lubrication Sheet

Order #: 78310 (AP030916)

Frame: JGQ/2 **Stroke, in:** 3.00 **Rod Dia, in:** 1.125 **Frame S/N:** F53162
Gas Stream: Pipeline Quality Natural Gas Including CNG (Dry)
Configured: JZOLMAN - 08/10/2016

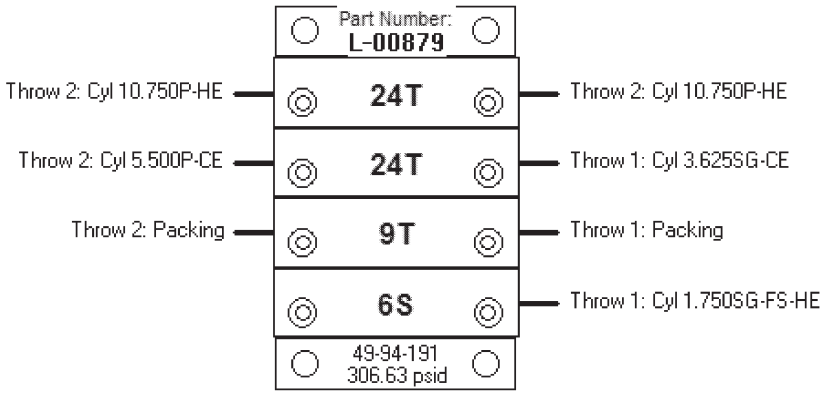
Throw	Cylinder Model	MAWP psig	Service	Stage #	Suct Press psia	Disch Press psia	Serial No.
1	3.625SG-CE	2550.0	Service 1	3	335.96	1187.74	C189419
	1.750SG-FS-HE	6100.0	Service 1	4	1174.93	4559.47	C189410
2	5.500P-CE	525.0	Service 1	2	116.64	343.24	C189423
	10.750P-HE	225.0	Service 1	1	29.33	119.74	C189414

Applied Speed, RPM	**1775**
Cycle Time at Applied Speed, sec	**44.6** (see chart, lower right)
Break-In Cycle Time, sec	**23.3** (For period of 200 hours)
Recommended lubricant (synthetic) for application and pressures	Synthetic PAG (ISO 150)

Automatic Relief Valve	**G-23734**	5000.00 psig cracking press (Gray Spring and Indicator Pin)
Lubricator Pump Diameter	**3/16"**	(0.1875 in)
Qty of Pumps feeding this block	**1**	
Recommended base feed rate	**0.30**	Pints/day/in of bore diameter

High mawp requires thick walled tubing on this pump system per ER-96.0.5

Throw 1, 2
(Configuration Locked)



Lube Point Description	Base Rate Multiplier	Recommended Pints/day	Delivered Pints/day	Del/ Rec
Throw 2: Cylinder 10.750P-HE	1.00	1.59	1.61	101%
Throw 2: Cylinder 10.750P-HE	1.00	1.59	1.61	101%
Throw 2: Cylinder 5.500P-CE	1.00	1.63	1.61	99%
Throw 1: Cylinder 3.625SG-CE	1.00	1.07	1.61	150%
Throw 2: Packing	1.00	0.67	0.60	91%
Throw 1: Packing	1.00	0.67	0.60	91%
Throw 1: Cylinder 1.750SG-FS-HE	1.50	0.78	0.80	104%

RPM	Cycle Time, sec Normal	Cycle Time, sec Break-In	Pints/day Normal	Pints/day Break-In
1800	44.0	23.0	8.6	16.4
1775	**44.6**	**23.3**	**8.5**	**16.2**
1700	46.6	24.4	8.1	15.5
1600	49.5	25.9	7.6	14.6
1500	52.8	27.6	7.2	13.7
1400	56.6	29.6	6.7	12.8
1300	60.9	31.8	6.2	11.8
1200	66.0	34.5	5.7	10.9
1100	72.0	37.6	5.3	10.0
1000	79.2	41.4	4.8	9.1
900	88.0	46.0	4.3	8.2

****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 of the Ariel Packager Standards for more information.

Special Oil Recommendation

Frame: F53162 **Model: JGQ/2**

This notice is to alert the customer that this unit has a special oil recommendation that may require that the force feed lubricator, which supplies lubricating oil to the compressor cylinders and piston rod packings, have an independent oil supply.

This oil recommendation is based on the gas composition and operating conditions provided. Please refer to the ARIEL CORPORATION Lubrication Sheet(s) for the details of the above frame including the correct cylinder bore sizes and throw positions.

Avoid mixing oil types that are not compatible with each other. Contact the oil manufacturer regarding the compatibility of their product with other fluids. A system flush may be required when changing to a different fluid.

The following information should be reviewed regarding Independent Oil Supply in Section 6 Lubrication of the Reciprocating Packager's Standards within Ariel's Application Manual.

Paragraphs:
Independent Oil Supply
Cylinder Lubrication
Lubricator Cycle Time
Warranty

Contact Ariel

Contact	Telephone	FAX	E-Mail
Ariel Response Center	888-397-7766	740-397-1060	arc@arielcorp.com
Spare Parts	(toll free USA-Canada) or	740-393-5054	spareparts@arielcorp.com
Order Entry	740-397-3602 (International)	740-397-6450	----
Ariel World Headquarters	740-397-0311	740-397-3856	info@arielcorp.com
Technical Field Service			fieldservice@arielcorp.com

Report Option	Serial Number	Material Number	Quantity	Rec Spares	Item Desc.	Sales Item
CONSUMABLE	C189410	1-3/4SG FS HE	1	A-0013	O-RING,VT, 3.520 O.D. X .210	300
CONSUMABLE		1-3/4SG FS HE	1	A-1367	LOCKNUT, DRAKE 3/8-24	300
CONSUMABLE		1-3/4SG FS HE	1	A-1812	O-RING,VT, 3.887 O.D. X .139	300
CONSUMABLE		1-3/4SG FS HE	1	A-18496	CHK VLV,DBL BALL,SS,1/4TX1/8P	300
CONSUMABLE		1-3/4SG FS HE	2	A-23478	STL GASKET, 2.438 X 2.000 X 60	300
CONSUMABLE		1-3/4SG FS HE	1	A-4876	UPPER PART CONC VLV	300
CONSUMABLE		1-3/4SG FS HE	1	A-4877-A	LOWER PART ASSY,CONCENTRIC VLV	300
CONSUMABLE	C189410	1-3/4SG FS HE	1	KB-1788-E	KIT,VLV CONC,078/035	300
CONSUMABLE	C189414	10-3/4P HE	1	A-0469	O-RING,VT,13.395 O.D. X .210	400
CONSUMABLE		10-3/4P HE	1	A-0653	O-RING,VT,12.395 O.D. X .210	400
CONSUMABLE		10-3/4P HE	1	A-10434	O-RING,VT, 6.512 O.D. X .139	400
CONSUMABLE		10-3/4P HE	1	A-1462	LOCKNUT, DRAKE,3/4-16	400
CONSUMABLE		10-3/4P HE	1	A-15072	O-RING,VT,11.895 O.D. X .210	400
CONSUMABLE		10-3/4P HE	2	A-17457	PISTON RING, 10-3/4P-HE	400
CONSUMABLE		10-3/4P HE	1	A-17910	GUIDE RING,147CT/256CFS.441THK	400
CONSUMABLE		10-3/4P HE	2	A-18496	CHK VLV,DBL BALL,SS,1/4TX1/8P	400
CONSUMABLE		10-3/4P HE	1	A-22008-A	UPPER PART ASSY,CONCENTRIC VLV	400
CONSUMABLE		10-3/4P HE	1	A-22009-A	LOWER PART ASSY,CONCENTRIC VLV	400
CONSUMABLE		10-3/4P HE	1	A-2858	WAFER PLATE.147CHT	400
CONSUMABLE	C189414	10-3/4P HE	1	KB-7242-GG	KIT,CONC VLV,147CT/256CFS	400
CONSUMABLE	C189419	3-5/8SG CE	2	A-0027	O-RING,VT, 2.520 O.D. X .210	200
CONSUMABLE		3-5/8SG CE	1	A-10355	GUIDE RING,52RX,.260 THK	200
CONSUMABLE		3-5/8SG CE	4	A-11796	RIDER RING, 3-5/8SG,SJ	200
CONSUMABLE		3-5/8SG CE	1	A-12099	GUIDE RING,52RX,.299 THK	200
CONSUMABLE		3-5/8SG CE	1	A-12180-A	DIS VLV SEAT ASSY, 52RX THK	200
CONSUMABLE		3-5/8SG CE	1	A-12991	SUC VLV SEAT, 52RX	200
CONSUMABLE		3-5/8SG CE	2	A-1366	LOCKNUT, DRAKE,5/16-24	200
CONSUMABLE		3-5/8SG CE	1	A-13933	STL GASKET, 4.000 X 3.813 X 60	200
CONSUMABLE		3-5/8SG CE	1	A-18496	CHK VLV,DBL BALL,SS,1/4TX1/8P	200
CONSUMABLE		3-5/8SG CE	4	A-19366	PISTON RING, 1-3/4SG,PK	200
CONSUMABLE		3-5/8SG CE	1	A-5962	WEAR BAND,1-3/4JG:SG:RJ:R .875	200
CONSUMABLE		3-5/8SG CE	2	A-7038	PISTON RING, 1-3/4JG:SG,PK,SJ	200
CONSUMABLE		3-5/8SG CE	1	B-2648-K	RBLD KIT,PIST ROD PKG,1.125	200
CONSUMABLE		3-5/8SG CE	1	KB-3712-ZN	KIT,VLV, 52RX ,PK	200
CONSUMABLE	C189419	3-5/8SG CE	1	KB-4087-AA	KIT,VLV, 52RX ,MTX	200
CONSUMABLE	C189423	5-1/2P CE	3	A-0237	PISTON RING, 5-1/2R:M:P:H:RJ	500
CONSUMABLE		5-1/2P CE	2	A-1367	LOCKNUT, DRAKE 3/8-24	500
CONSUMABLE		5-1/2P CE	1	A-15636-A	DIS VLV SEAT ASSY, 79CRE	500
CONSUMABLE		5-1/2P CE	1	A-15639	SUC VLV SEAT, 79CRE	500
CONSUMABLE		5-1/2P CE	2	A-1735	GUIDE RING,70RX,.205 THK	500
CONSUMABLE		5-1/2P CE	1	A-17591	STL GASKET, 5.813 X 5.625 X 60	500
CONSUMABLE		5-1/2P CE	1	A-18496	CHK VLV,DBL BALL,SS,1/4TX1/8P	500
CONSUMABLE		5-1/2P CE	1	B-2650-K	RBLD KIT,PIST ROD PKG,1.125	500
CONSUMABLE		5-1/2P CE	1	KB-5091-CC	KIT,VLV, 79CRE,MTX	500
CONSUMABLE	C189423	5-1/2P CE	1	KB-5092-ZM	KIT,VLV, 79CRE,PK	500
CONSUMABLE	F53162	JGQ/2 CLASS	2	A-0661	LO FILTER ELEMENT,SPIN-ON	100
CONSUMABLE		JGQ/2 CLASS	2	A-18496	CHK VLV,DBL BALL,SS,1/4TX1/8P	100
CONSUMABLE		JGQ/2 CLASS	1	A-18525-A	FF LUBR PUMP 3/16 ARIEL,REPL	100
CONSUMABLE		JGQ/2 CLASS	2	A-21614	O-RING,NBR, 8.395 O.D. X .210	100
CONSUMABLE		JGQ/2 CLASS	1	A-21616	O-RING,NBR,18.375 O.D. X .210	100
CONSUMABLE	F53162	JGQ/2 CLASS	1	A-2348	GSKT,ARL SNGL LUB BOX CVR,1/32	100
INSURANCE	C189410	1-3/4SG FS HE	1	A-0013	O-RING,VT, 3.520 O.D. X .210	300
INSURANCE		1-3/4SG FS HE	1	A-1812	O-RING,VT, 3.887 O.D. X .139	300
INSURANCE		1-3/4SG FS HE	2	A-23478	STL GASKET, 2.438 X 2.000 X 60	300
INSURANCE	C189410	1-3/4SG FS HE	1	B-1788-E	CONC VLV,078/035 1-3/4,1-5/8	300
INSURANCE	C189414	10-3/4P HE	1	A-0469	O-RING,VT,13.395 O.D. X .210	400
INSURANCE		10-3/4P HE	1	A-0653	O-RING,VT,12.395 O.D. X .210	400
INSURANCE		10-3/4P HE	1	A-10434	O-RING,VT, 6.512 O.D. X .139	400
INSURANCE		10-3/4P HE	1	A-15072	O-RING,VT,11.895 O.D. X .210	400
INSURANCE		10-3/4P HE	1	B-0019	PISTON NUT, 2-1/4"THRU 8"JG:MP	400
INSURANCE	C189414	10-3/4P HE	1	B-7242-GG	CONC VLV,147CT/256CFS	400
INSURANCE	C189419	3-5/8SG CE	4	A-0027	O-RING,VT, 2.520 O.D. X .210	200
INSURANCE		3-5/8SG CE	1	A-0065	GSKT,RND,12 X 1/64	200
INSURANCE		3-5/8SG CE	2	A-13192	STL GASKET, 2.250X 2.438X 60	200
INSURANCE		3-5/8SG CE	1	A-9870	O-RING,VT, 2.254 O.D. X .070	200
INSURANCE		3-5/8SG CE	1	B-3712-ZN	DIS VLV, 52RX ,PK	200
INSURANCE		3-5/8SG CE	1	B-4087-AA	SUC VLV, 52RX ,MTX	200
INSURANCE	C189419	3-5/8SG CE	1	C-3591	PIST/ROD, 3.625 X 1.750SA	200
INSURANCE	C189423	5-1/2P CE	2	A-0026	O-RING,VT, 3.895 O.D. X .210	500

INSURANCE		5-1/2P CE	1	A-0057	PISTON COLLAR, 2-1/2=8JG:MP	500
INSURANCE		5-1/2P CE	1	A-0065	GSKT,RND,12 X 1/64	500
INSURANCE		5-1/2P CE	2	A-15600	STL GASKET, 3.575 X 3.406 X 30	500
INSURANCE		5-1/2P CE	1	A-3511	O-RING,VT,10.395 O.D. X .210	500
INSURANCE		5-1/2P CE	1	B-5091-CC	SUC VLV, 79CRE,MTX	500
INSURANCE		5-1/2P CE	1	B-5092-ZM	DIS VLV, 79CRE,PK	500
INSURANCE	C189423	5-1/2P CE	1	C-6001	P ROD, 3.00STK/23.689LG	500
INSURANCE	F53162	JGQ/2 CLASS	1	A-0059	12 PT,3/8 -24 X 5,SPCL	100
INSURANCE		JGQ/2 CLASS	1	A-0060	CROSSHEAD PIN,JG:A:M:P:I:S	100
INSURANCE		JGQ/2 CLASS	1	A-0068	GSKT,RND,5-1/4X1/32	100
INSURANCE		JGQ/2 CLASS	1	A-0073	GSKT,NST,1/32,M:P:I:JG/2,TUT	100
INSURANCE		JGQ/2 CLASS	1	A-0077	SIGHT GLASS,1" NPT	100
INSURANCE		JGQ/2 CLASS	1	A-0194	GSKT,RND,OIL SEAL,1/32	100
INSURANCE		JGQ/2 CLASS	1	A-0203	CHAIN,35-1 X 94	100
INSURANCE		JGQ/2 CLASS	1	A-0245	DUST SEAL,TFE,JG:A:M:P:N:Q	100
INSURANCE		JGQ/2 CLASS	1	A-17258-A	GAUGE,7500PSI,REPL,BACK MOUNT	100
INSURANCE		JGQ/2 CLASS	1	A-18255	FF.WHTLK PROX SWITCH,TRBN-SB	100
INSURANCE		JGQ/2 CLASS	1	A-18450-A	GAUGE,100PSI,REPL,BOTTOM MOUNT	100
INSURANCE		JGQ/2 CLASS	1	A-18525-A	FF LUBR PUMP 3/16 ARIEL,REPL	100
INSURANCE		JGQ/2 CLASS	1	A-18592	FF LUB PUMP GSKT,1/16, ARIEL	100
INSURANCE		JGQ/2 CLASS	1	A-18682	FF.CYCLE IND,ARIEL,TBN	100
INSURANCE		JGQ/2 CLASS	2	A-21614	O-RING,NBR, 8.395 O.D. X .210	100
INSURANCE		JGQ/2 CLASS	1	A-21616	O-RING,NBR,18.375 O.D. X .210	100
INSURANCE		JGQ/2 CLASS	1	A-2348	GSKT,ARL SNGL LUB BOX CVR,1/32	100
INSURANCE		JGQ/2 CLASS	1	A-3763	CHK VLV,1/8MX1/8F,SS,PPT/14PSI	100
INSURANCE		JGQ/2 CLASS	1	A-5641	SIGHT GLASS,3/4" NPT	100
INSURANCE		JGQ/2 CLASS	1	A-9649	O-RING,VT, FPE	100
INSURANCE		JGQ/2 CLASS	1	A-9724	ELEMENT,THERM.VLV,3/4",170,FPE	100
INSURANCE		JGQ/2 CLASS	1	A-9725	LIP SEAL,TEFLON,3/4"VALVE, FPE	100
INSURANCE		JGQ/2 CLASS	6	B-0002	BUSHING,BZ,XHD,JG:N:A:Q	100
INSURANCE		JGQ/2 CLASS	2	B-0003	BUSHING,BZ,ROD,JG:A:M:P:S:I	100
INSURANCE		JGQ/2 CLASS	4	B-0023	SLEEVE BRG,H/S,ROD,JG:M:P:S	100
INSURANCE		JGQ/2 CLASS	3	B-0024	SLEEVE BRG,H/S,MAIN,JG:M:P	100
INSURANCE		JGQ/2 CLASS	1	B-0025	SLEEVE BRG,H/S,THRUST,JG:M:P:S	100
INSURANCE		JGQ/2 CLASS	1	B-7849	BEARING PUSHER,JGM:P:N:Q:A:R:J	100
INSURANCE		JGQ/2 CLASS	2	FN0461EA	SELF-LOCK NUT,ESNA,3/8-24	100
INSURANCE		JGQ/2 CLASS	1	FP0500EE	DOWEL PIN,3/16 X 3/4 +.0002	100
INSURANCE		JGQ/2 CLASS	3	FP0500FE	DOWEL PIN, 1/4 X 3/4 +.0002	100
INSURANCE		JGQ/2 CLASS	1	FW0500GA	FLAT WASHER, 1/2 SAE	100
INSURANCE	F53162	JGQ/2 CLASS	1	L-00879	24T-24T-9T-6S	100
STARTUP	C189410	1-3/4SG FS HE	1	A-0013	O-RING,VT, 3.520 O.D. X .210	300
STARTUP		1-3/4SG FS HE	1	A-1812	O-RING,VT, 3.887 O.D. X .139	300
STARTUP		1-3/4SG FS HE	1	A-23478	STL GASKET, 2.438 X 2.000 X 60	300
STARTUP	C189410	1-3/4SG FS HE	1	B-1788-E	CONC VLV,078/035 1-3/4,1-5/8	300
STARTUP	C189414	10-3/4P HE	1	A-0469	O-RING,VT,13.395 O.D. X .210	400
STARTUP		10-3/4P HE	1	A-0653	O-RING,VT,12.395 O.D. X .210	400
STARTUP		10-3/4P HE	1	A-10434	O-RING,VT, 6.512 O.D. X .139	400
STARTUP		10-3/4P HE	1	A-15072	O-RING,VT,11.895 O.D. X .210	400
STARTUP	C189414	10-3/4P HE	1	B-7242-GG	CONC VLV,147CT/256CFS	400
STARTUP	C189419	3-5/8SG CE	1	A-0027	O-RING,VT, 2.520 O.D. X .210	200
STARTUP		3-5/8SG CE	1	A-13192	STL GASKET, 2.250X 2.438X 60	200
STARTUP		3-5/8SG CE	1	A-13933	STL GASKET, 4.000 X 3.813 X 60	200
STARTUP		3-5/8SG CE	1	A-9870	O-RING,VT, 2.254 O.D. X .070	200
STARTUP		3-5/8SG CE	1	B-3712-ZN	DIS VLV, 52RX ,PK	200
STARTUP	C189419	3-5/8SG CE	1	B-4087-AA	SUC VLV, 52RX ,MTX	200
STARTUP	C189423	5-1/2P CE	1	A-0026	O-RING,VT, 3.895 O.D. X .210	500
STARTUP		5-1/2P CE	1	A-15600	STL GASKET, 3.575 X 3.406 X 30	500
STARTUP		5-1/2P CE	1	A-17591	STL GASKET, 5.813 X 5.625 X 60	500
STARTUP		5-1/2P CE	1	B-5091-CC	SUC VLV, 79CRE,MTX	500
STARTUP	C189423	5-1/2P CE	1	B-5092-ZM	DIS VLV, 79CRE,PK	500
STARTUP	F53162	JGQ/2 CLASS	1	A-0661	LO FILTER ELEMENT,SPIN-ON	100
STARTUP		JGQ/2 CLASS	1	A-21614	O-RING,NBR, 8.395 O.D. X .210	100
STARTUP	F53162	JGQ/2 CLASS	1	A-21616	O-RING,NBR,18.375 O.D. X .210	100

10/15/2016

ARIEL CORPORATION

SALES ORDER COVER SHEET

Serial # : F53162

Part # : JGQ/2 CLASS **Description :** JGQ/2 FRAME CLASS

Part Number	QTY	Description	Drawing No.
G-23759	1	FRAME ASSEMBLY, JGM:N:P:Q/2	A-21630
G-5690	1	CRANKSHAFT ASSEMBLY, 3" STROKE, JGQ/2	A-6501
G-1662	2	CONNECTING ROD ASSEMBLY, FS, UNF THREADS, JG:A:N:Q	A-3985
G-0154	2	CROSSHEAD ASSEMBLY, JG:A:N:Q:325JGS	A-6873
G-3220	1	1"SIGHT GLASS, JG:A/2:4:6, M:P:N:Q/1:2, R:W:J/2, ACF	N.A.
G-19674	1	LUBE OIL PUMP ASSEMBLY, JGM:P:N:Q/2	A-18552
FF LUBRICATOR	1	FORCE FEED LUBRICATOR	A-22082
G-5095	1	DIST.BLK.MTG.SPACER,M:N:P:Q	N.A.
G-23734	1	AUTOMATIC RELIEF VALVE ASSEMBLY, 5000 PSI	A-21769
G-1080	2	FF TUB.TANDEM,JG:A:M:P EA CYL	N.A.
G-1079	1	FF TUBING,JG:A:M:P/2 D.A.CYLS	N.A.
G-2935	1	FORCE FEED TUBING, BOTTOM LUBE, JG:A:M:P:N:Q:R:W:J:H:E:K:T, EACH CYLINDER, STD	N.A.
G-9055	1	FORCE FEED TUBING, M=R2, W/CYL>3600	N.A.
G-0176	1	CHAIN ASSEMBLY, STANDARD OR REVERSE ROTATION, JGM:P:N:Q	A-7765
G-23760	1	TOP COVER ASSEMBLY, JGM:P:N:Q/2, STANDARD AND REVERSE ROTATION, WITH O-RING SEAL	A-21631
G-19557	1	FORCE FEED GAUGE ASSEMBLY, 7500 PSI, GAUGE BRACKET, 3/8 TUBE, M:N:P:Q	A-18429
G-19340	1	FORCE FEED PROXIMITY SWITCH, CYCLE INDICATOR, WHITLOCK, TRABON-SB	A-18396
G-24771	1	THERMOSTATIC VALVE, 3/4", MTD, JGM:P:N:Q/2	A-23020
G-16340	1	TOOL KIT ASSY, JG:A:M:N:P:Q:I:S	N.A.
B-0015	1	CROSSHEAD NUT, .7#, HEX, JG:A:M:P	NA
D-0061	1	CROSSHEAD, MED, DI, 19.2#, JG:A:M:P:N:Q	NA
D-3284	1	CROSSHEAD, XLGT, DI, 8.0#, JG:A:M:P:N:Q	NA
L-00879	1	24T-24T-9T-6S	N.A.

NOTES:

1. LOOSEN AND TIGHTEN ALL FASTENERS PER RECOMMENDED PROCEDURES AND TORQUE VALUES IN MANUAL.

2. THIS SURFACE IS TO BE LIGHTLY COATED WITH CORTEC VPCI 369 CORROSION INHIBITOR OR MARINE GRADE GREASE BEFORE INSTALLING COVERS.

3. OIL FACES OF STAT-O-SEALS BEFORE INSTALLING TO PREVENT ABRASION.

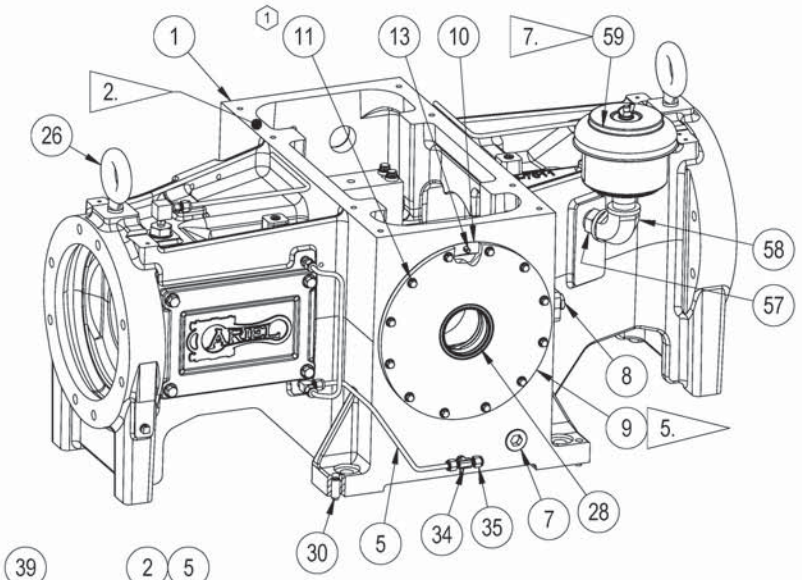
4. OIL O-RING BEFORE INSTALLING.

5. CLEARANCE BETWEEN CRANK AND END COVER TO BE CHECKED BY USING .008" FEELER GAUGE ALL AROUND.

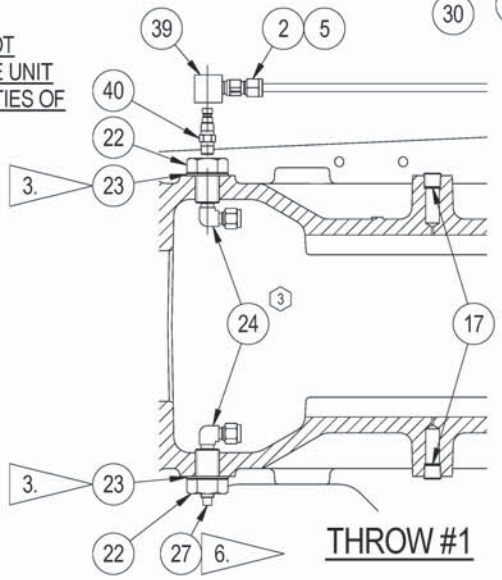
6. REMOVE SHIPPING PLUG AND TUBE TO A SAFE ATMOSPHERE OR DRAIN AS APPROPRIATE.

7. INSTALL BREATHER (ITEM #59) PRIOR TO TEST. AFTER TESTING, REPLACE WITH ITEMS #15 & #60 FOR SHIPPING.

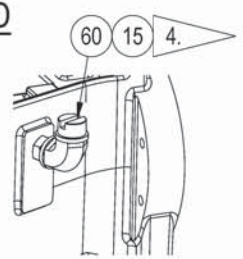
8. THIS FRAME ASSEMBLY IS FOR ILLUSTRATION PURPOSES ONLY AND MAY NOT NECESSARILY REPRESENT THE EXACT CONFIGURATION PERTAINING TO THE UNIT ORDERED. REFER TO ACCOMPANYING PARTS LIST FOR ITEMS (AND QUANTITIES OF EACH) REQUIRED FOR THIS PARTICULAR ASSEMBLY.



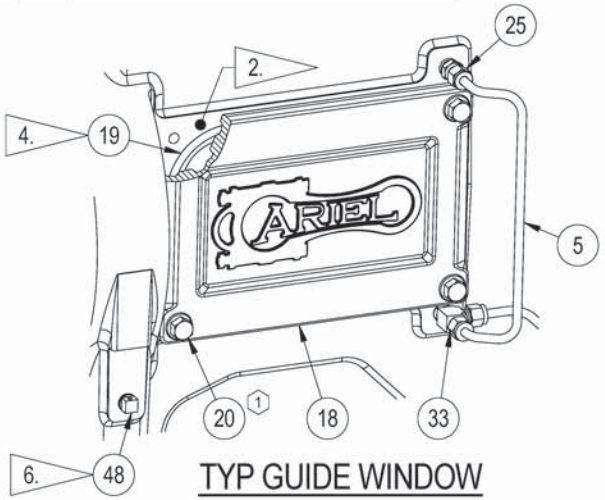
DRIVE END



THROW #1



AS SHIPPED



TYP GUIDE WINDOW

VER	DESCRIPTION	INIT/DATE
3	SHEET #1: @B3: ROTATED (ITEM #24) 90°. SHEET #2: @B2 : ROTATED (ITEM #24) 90°.	JJP 06/01/2016

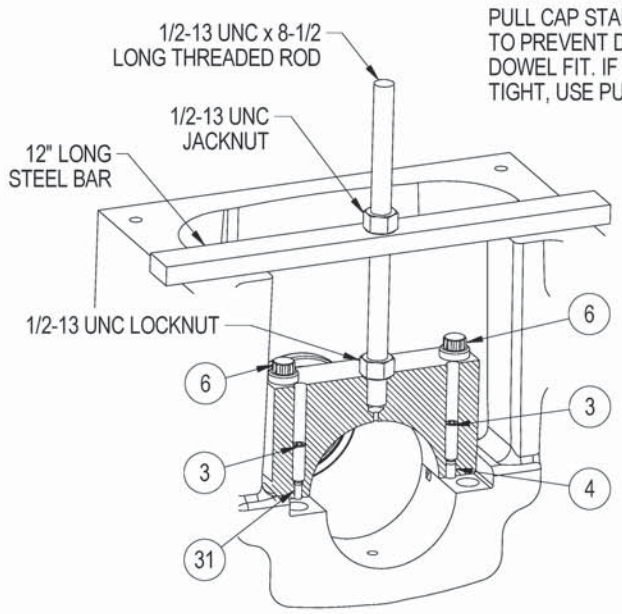
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VER	ECN
3	201600406
2	20455
1	19620
0	18982

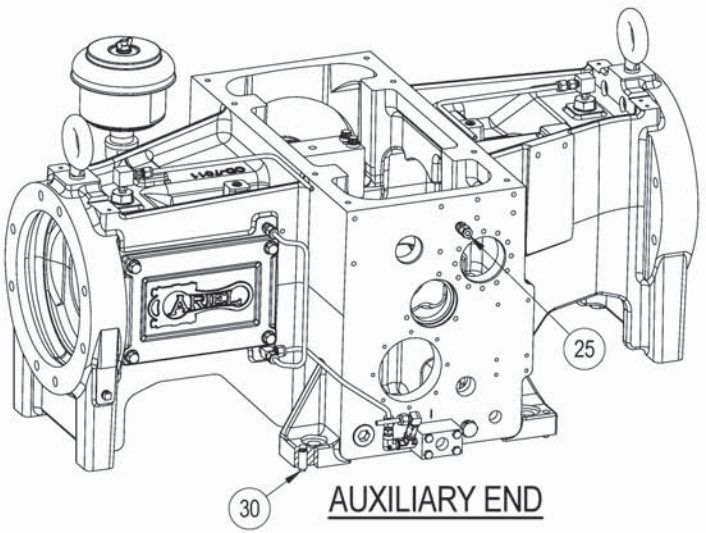
ARIEL CORPORATION
35 BLACKJACK ROAD
MOUNT VERNON, OHIO 43050

DRAWN:	CHECKED:	SCALE:	ASSEMBLY DWG. NO.
TDM 4/11/14	CPM 4/22/14	NONE	A-21630

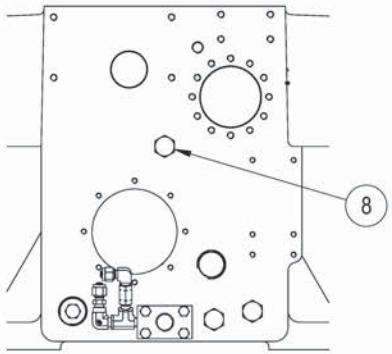
SHT 1 OF 2



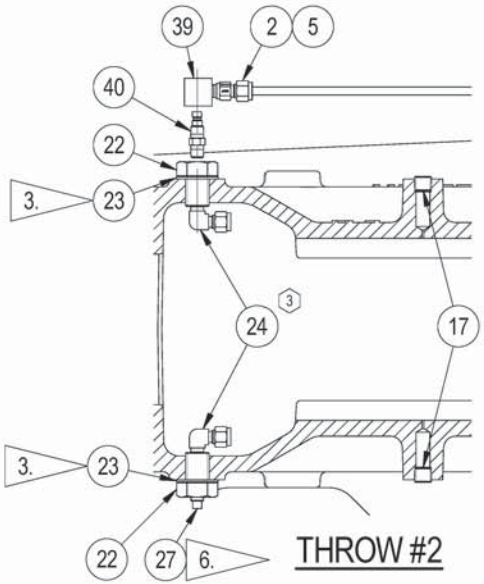
PULL CAP STAIGHT UP TO PREVENT DAMAGE OF DOWEL FIT. IF CAP IS TIGHT, USE PULLER.



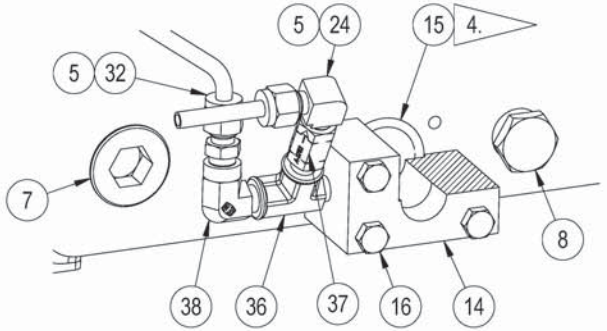
AUXILIARY END



② AUXILIARY END
(ON STANDARD FRAMES PLUG WITH ITEM #8)



THROW #2



3	SHEET #1: @B3: ROTATED (ITEM #24) 90°. SHEET #2: @B2 : ROTATED (ITEM #24) 90°.
VER	DESCRIPTION

JJP 06/01/2016
INIT/DATE

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VER	ECN
3	201600406
2	20455
1	19620
0	18982

ARIEL CORPORATION
35 BLACKJACK ROAD
MOUNT VERNON, OHIO 43050

DRAWN: TDM 4/11/14
CHECKED: CPM 4/22/14
SCALE: NONE
ASSEMBLY DWG. NO. A-21630
SHT 2 OF 2

10/15/2016

ARIEL CORPORATION

PARTS LIST

Part No. G-23759

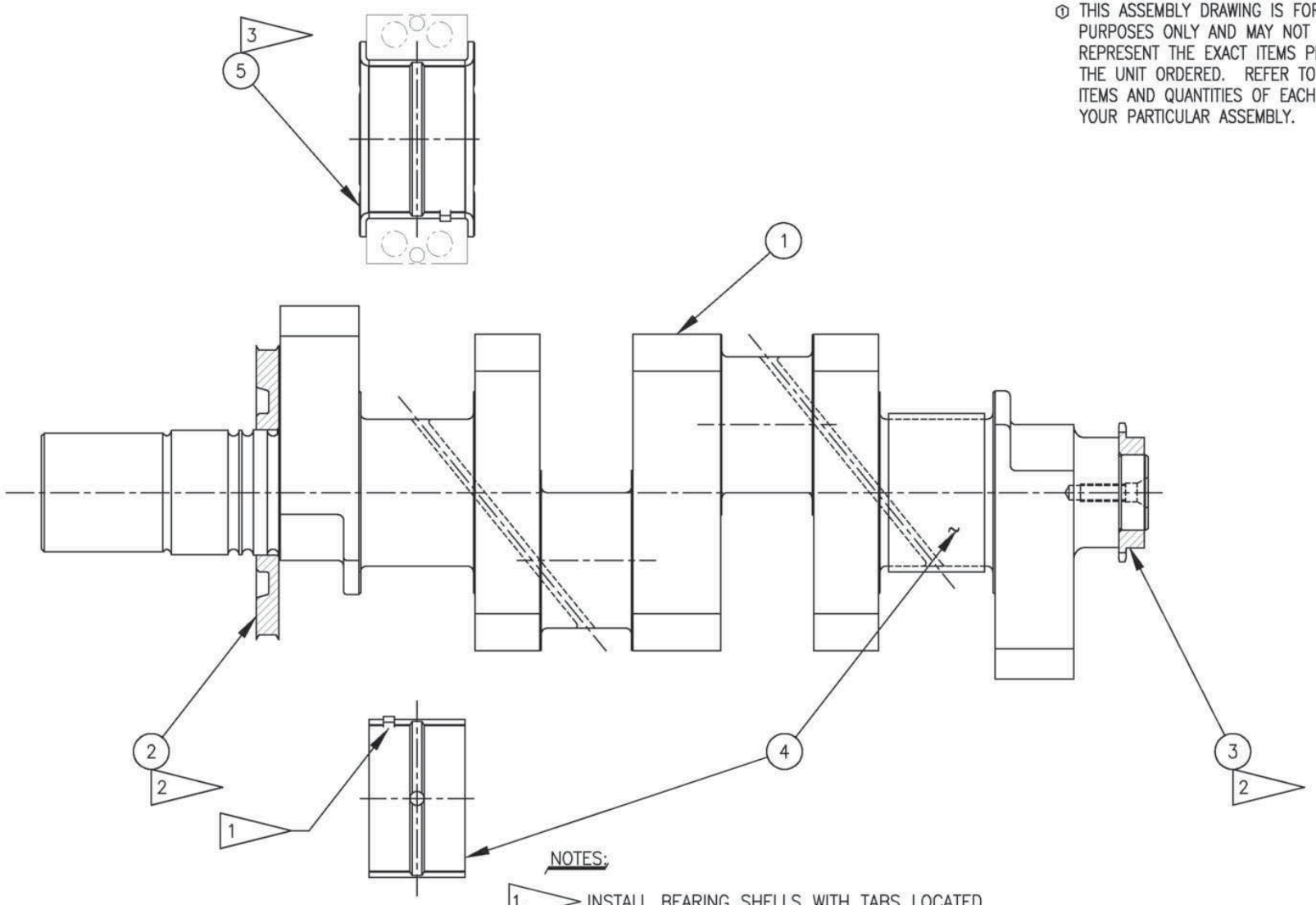
FRAME ASSEMBLY, JGM:N:P:Q/2 **Ref Drawing.** A-21630

ITEM	PART NUMBER	QTY	UOM	DESCRIPTION
001	D-7012	1		FRAME, JGM:P:N:Q/2
002	A-18496	2		CHECK VALVE, DOUBLE BALL, 1/4 TUBE X 1/8 NPT, SS
003	FS0400DG	0		SET SCREW, CUP POINT, 5/16-18 X 1"
004	FP0500FE	0		DOWEL PIN, 1/4 OD X 3/4 LONG, +.0002
005	PT0200CB	153	IN	TUBING, SS, 1/4 OD X .035 WALL
006	FC0120GT	8		12-POINT CAPSCREW, 1/2-13 X 4-1/2, G8
007	PP0850KB	2		PIPE PLUG, HEX SOCKET, 1" NPTF, STL
008	PP0810GB	3		PIPE PLUG, HEX HEAD, 1/2 NPT, STL
009	C-0080	1		SHAFT SEAL HOUSING,JGM:P:N:Q
010	A-0194	1		FIBER GASKET, 10.625 OD X 09.265 ID X .031, OIL SEAL, JGM:P:N:Q
011	FC0176AD	12		FLANGED HEX HEAD CAP SCREW, 1/4-20 X 3/4, G5
013	FP0505FF	1		ROLL PIN, 1/4 OD X 7/8 LONG
014	A-0147	1		END PLATE, OIL GALLERY, JG:A/2:4
015	A-0009	2		O-RING, VT, 1.387 OD X .139, 75/85 DUROMETER
016	FC0102CK	4		HEX HEAD CAPSCREW, 1/4-20 X 2, G5
017	PP0850CB	4		PIPE PLUG, HEX SOCKET, 1/4 NPTF, STL
018	B-7014	2		COVER, GUIDE, JGM:P:N:Q/2 WITH O-RING GROOVE
019	A-21614	2		O-RING,NBR, 8.395 OD X .210, 70 DUROMETER
020	FC0176CI	8		FLANGED HEX HEAD CAP SCREW, 3/8-16 X 1-1/4, G5
022	A-23795	4		LUBE FITTING, 3/4-10 X .930
023	FW0550IA	4		STAT-O-SEAL, 3/4 DIA., NITRILE
024	A-0815	5		MALE ELBOW, STL, 1/4 TUBE X 1/8 NPT
025	A-0827	3		MALE CONNECTOR, STL, 1/4 TUBE X 1/4 NPT
026	A-3881	2		EYEBOLT, 7/8-9 UNC
027	A-15842	2		PIPE PLUG, SQUARE HEAD, 1/8 NPT, STL, DRILLED
028	A-0245	1		DUST SEAL, TFE, JG:A:M:P:N:Q
030	FS0401GH	4		SET SCREW, HALF DOG POINT, 1/2-13 X 1-1/4
031	FP0500EE	0		DOWEL PIN, 3/16 OD X 3/4 LONG, +.0002

ITEM	PART NUMBER	QTY	UOM	DESCRIPTION
032	A-0830	1		MALE CONNECTOR, STL, 1/4 TUBE X 1/8 NPT
033	A-0856	2		MALE RUN TEE, STL, 1/4 TUBE X 1/4 NPT
034	A-0808	1		MALE BRANCH TEE, STL, 1/4 TUBE X 1/4 NPT
035	A-0918	1		PLUG, TUBE FITTING, STL, 1/4 TUBE
036	A-15556	1		STREET TEE, 1/8 NPT, STL
037	A-3763	1		CHECK VALVE, 1/8 NPT X 1/8 NPT, POPPET, SS, 14 PSI
038	A-0804	1		STREET ELBOW, 90°, 1/8 NPT, STL
039	A-17774	2		OIL TRAP, BODY, SS, 1/8 NPT
040	A-17775	2		OIL TRAP, STEM, SS, 1/8 NPT
048	A-12569	2		PIPE PLUG, SQUARE HEAD, 1/4 NPT, STL, DRILLED
057	A-0832	1		HEX PIPE NIPPLE, 1" NPT (MALE), STL
058	A-21615	1		FEMALE ELBOW, 90°, 1" NPT, STEEL
059	B-6521	1		BREATHER, 1" NPT, FRAME
060	A-7655	1		PIPE PLUG, SLOTTED HEAD, 1" NPT, PLASTIC

*** ALWAYS PROVIDE SERIAL NUMBER WHEN ORDERING SPARE PARTS. ***
WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT DOES NOT REPRESENT THE QUANTITY REQUIRED.

① 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.



NOTES:

1. INSTALL BEARING SHELLS WITH TABS LOCATED IN NOTCHES IN CAPS AND CRANKCASE.
2. HEAT TO 400° F TO SHRINK ON.
3. INSTALL IN CAP

REV	DESCRIPTION	INIT/DATE
1	ADDED NOTE "THIS ASSEMBLY DRAWING IS FOR ILLUSTRATION PURPOSES ONLY..." ©C4.	NEE 01/14/2003

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REV	ECN
1	11125
0	6441

ARIEL CORPORATION
35 BLACKJACK ROAD
MOUNT VERNON, OHIO 43050

DRAWN: JJZ 9/10/96
CHECKED:
APPROVED:
SCALE: NONE
ASSEMBLY DWG. NO. A-6501

10/15/2016

ARIEL CORPORATION

PARTS LIST

Part No. G-5690

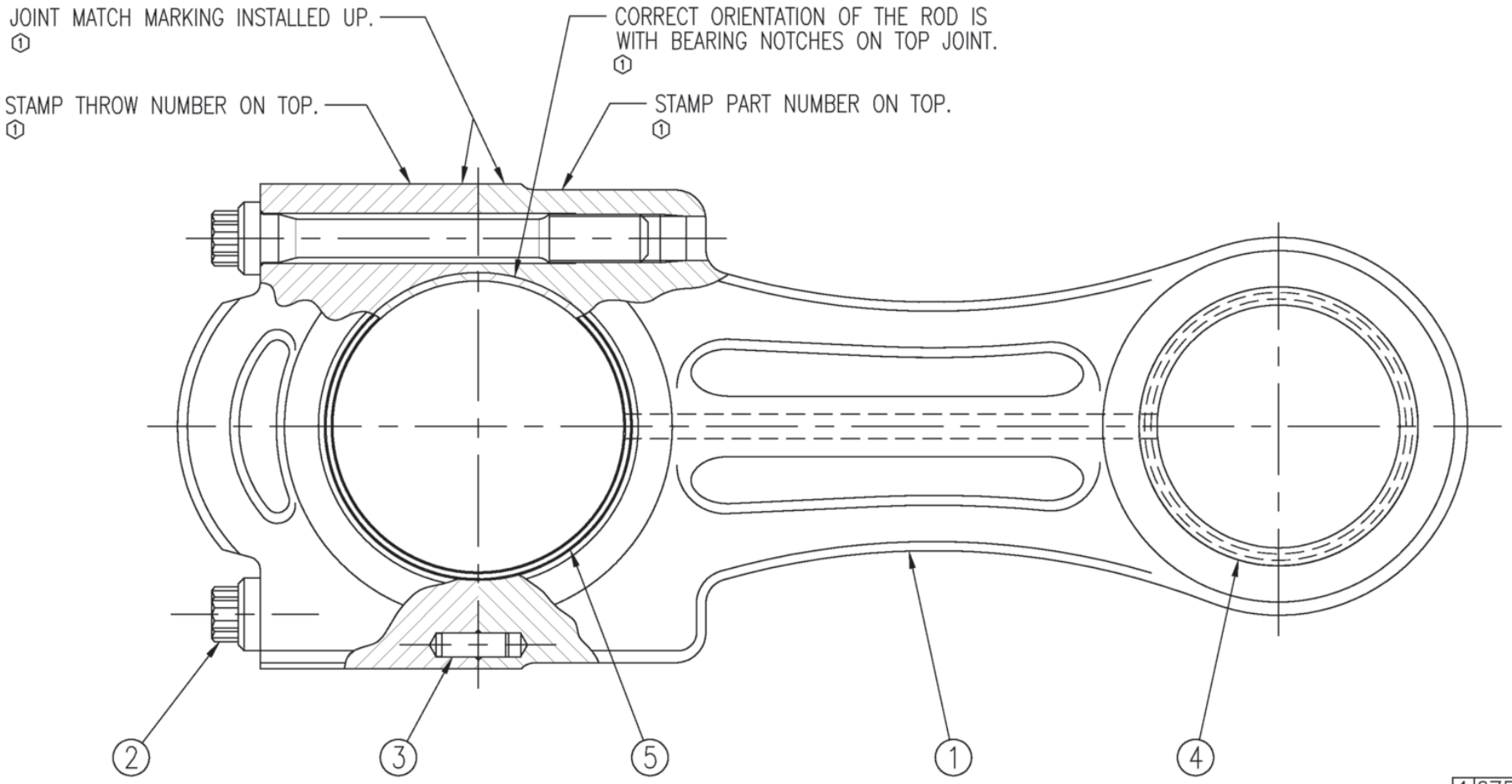
CRANKSHAFT ASSEMBLY, 3" STROKE, JGQ/2 **Ref Drawing.** A-6501

ITEM	PART NUMBER	QTY	UOM	DESCRIPTION
001	AD-1972	1		CRANKSHAFT ASSEMBLY, FS, NO KEYWAY, JGA:Q:P/2
002	B-0004	0		OIL SLINGER,JG:A:M:P:Q:N
003	A-0003	0		SPROCKET, 35-1 X 24T
004	B-0024	3		SLEEVE BEARING, HALF SHELL, MAIN, JG:M:P
005	B-0025	1		SLEEVE BEARING, HALF SHELL, THRUST, JG:A:M:P:N:Q:S
099	AD-1972-C	0		CRANKSHAFT ASSEMBLY WITH CRATE, JGA:Q:P/2

*** ALWAYS PROVIDE SERIAL NUMBER WHEN ORDERING SPARE PARTS. ***
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.



REV	DESCRIPTION
1	ADDED NOTES: "JOINT MATCH MARKING INSTALLED UP", "STAMP THROW NUMBER ON TOP", "STAMP PART NUMBER ON TOP", AND "CORRECT ORIENTATION OF THE ROD IS WITH BEARING NOTCHES ON TOP JOINT".

1	6756
0	4734

ARIEL CORPORATION
35 BLACKJACK ROAD
MOUNT VERNON, OHIO 43050

ASSEMBLY DWG. No. A-3985

10/15/2016

ARIEL CORPORATION

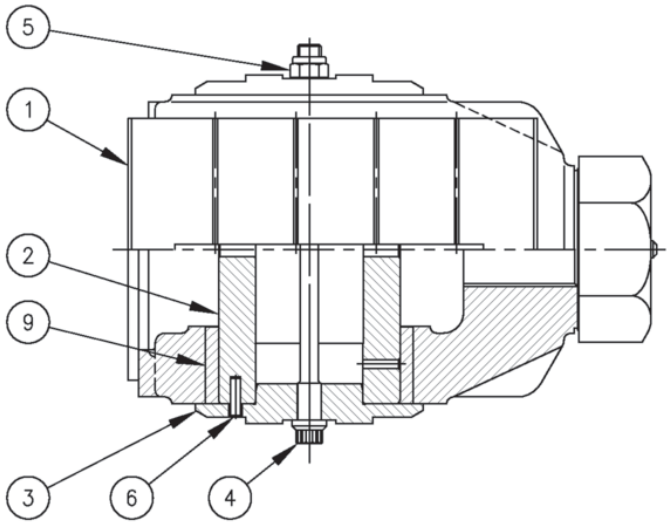
PARTS LIST

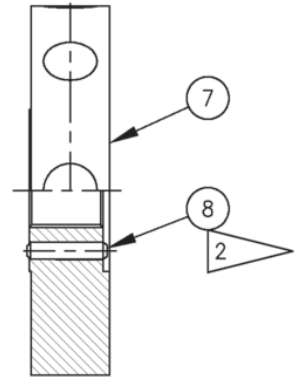
Part No. G-1662

CONNECTING ROD ASSEMBLY, FS, UNF THREADS, JG:A:N:Q **Ref Drawing.** A-3985

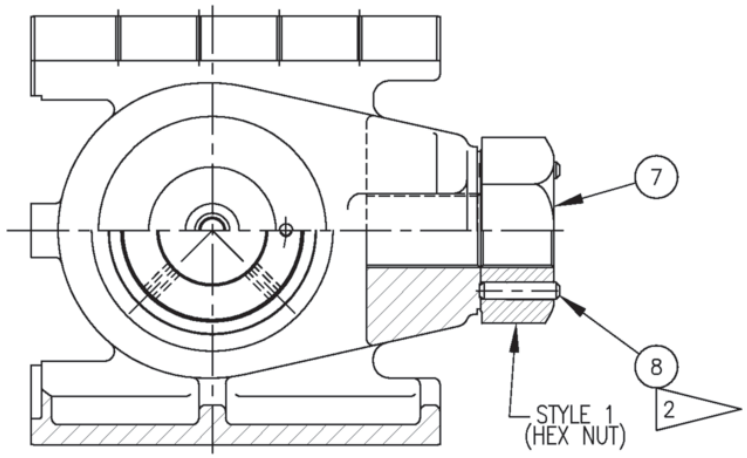
ITEM	PART NUMBER	QTY	UOM	DESCRIPTION
001	AD-1043	1		CONNECTING ROD ASSEMBLY, FS, UNF, JG:A:N:Q:325JGS
002	A-2120	0		12-POINT CAPSCREW, 1/2-20 X 4, G8
003	FP0500FE	0		DOWEL PIN, 1/4 OD X 3/4 LONG, +.0002
004	B-0003	0		BUSHING, CONNECTING ROD, BZ, JG:A:M:P:S:I
005	B-0023	2		SLEEVE BEARING, HALF SHELL, CONNECTING ROD, JG:A:M:P:N:Q:I:S

*** ALWAYS PROVIDE SERIAL NUMBER WHEN ORDERING SPARE PARTS. ***
WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT DOES NOT REPRESENT THE QUANTITY REQUIRED.

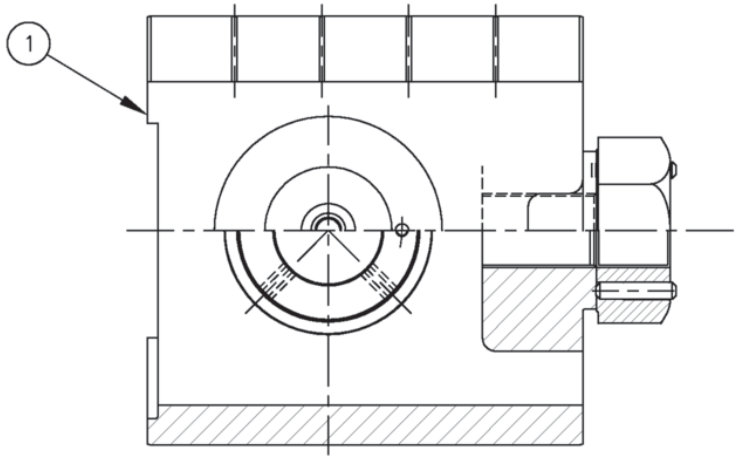




STYLE 2
(ROUND NUT)



STYLE 1 CROSSHEAD



STYLE 2 CROSSHEAD

NOTES:

1. LOOSEN OR TIGHTEN ALL FASTENERS PER RECOMMENDED PROCEDURES AND TORQUE VALUES IN MANUAL.

① 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.

① 3. THIS CROSSHEAD 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.

REV	DESCRIPTION	INIT/DATE
①	UPDATED TO CURRENT STANDARDS. (A-1) UPDATED NOTE #2 TO CURRENT STANDARD ITEM ROTATION. (A-2) ADDED NOTE #3. UPDATED ITEMS TO CURRENT STANDARD ITEM ROTATION.	DPD 10/10/07

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REV	ECN
1	14647
0	6859

ARIEL CORPORATION
35 BLACKJACK ROAD
MOUNT VERNON, OHIO 43050

DRAWN:	APPROVED:	ASSEMBLY DWG. NO.
DJB 4/18/97		A-6873
CHECKED:	SCALE: NONE	

10/15/2016

ARIEL CORPORATION

PARTS LIST

Part No. G-0154

CROSSHEAD ASSEMBLY, JG:A:N:Q:325JGS **Ref Drawing.** A-6873

ITEM	PART NUMBER	QTY	UOM	DESCRIPTION
001	CROSSHEAD	0		FOR PART NO. SEE COVER SHEET
001	D-0060	0		CROSSHEAD, LGT, DI, 11.5#, JG:A:M:P:N:Q
001	D-0061	0		CROSSHEAD, MED, DI, 19.2#, JG:A:M:P:N:Q
001	D-0089	0		CROSSHEAD, HVY, BZ, 24.2#, JG:A:M:P:N:Q
001	D-3284	0		CROSSHEAD, XLGT, DI, 8.0#, JG:A:M:P:N:Q
001	D-7610	0		CROSSHEAD, HVY, BZ, 28.7#, JG:A:M:P:N:Q
002	A-0060	1		CROSSHEAD PIN, JG:A:M:P:I:S
003	A-0061	2		END PLATE, CROSSHEAD PIN, JG:A:M:P:N:Q
004	A-0059	1		12-POINT CAPSCREW, 3/8-24 X 5, SPECIAL
005	FN0461EA	1		SELF-LOCK NUT, ESNA, 3/8-24
006	FP0505CE	2		ROLL PIN, 1/8 OD X 3/4 LONG
007	A-0051	0		CROSSHEAD NUT, 2.7#, ROUND, JG:A:M:P
007	A-0052	0		CROSSHEAD NUT, 4.7#, ROUND, JG:A:M:P
007	A-0053	0		CROSSHEAD NUT, 6.7#, ROUND, JG:A:M:P
007	A-0377	0		CROSSHEAD NUT, 8.7#, ROUND, JG:A:M:P
007	A-3886	0		CROSSHEAD NUT, 10.0#, ROUND, JG:A:M:P
007	B-0015	0		CROSSHEAD NUT, .7#, HEX, JG:A:M:P
007	CROSSHEAD NUT	0		FOR PART NO. SEE COVER SHEET
008	FS0455CG	0		SET SCREW, CUP POINT, NYLON PATCH, 1/4-28 X 1"
009	B-0002	0		BUSHING, CROSSHEAD, BZ, JG:A:N:Q

*** ALWAYS PROVIDE SERIAL NUMBER WHEN ORDERING SPARE PARTS. ***
WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT DOES NOT REPRESENT THE QUANTITY REQUIRED.

10/15/2016

ARIEL CORPORATION

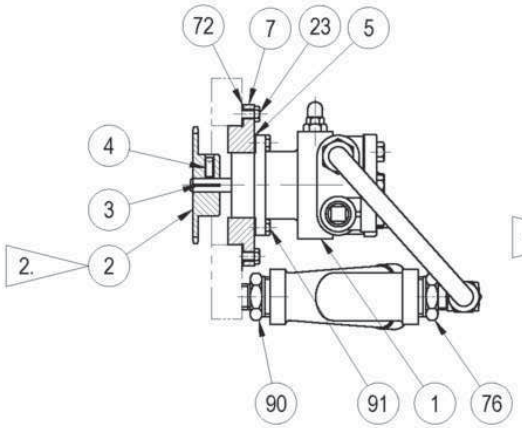
PARTS LIST

Part No. G-3220
Ref Drawing. N.A.

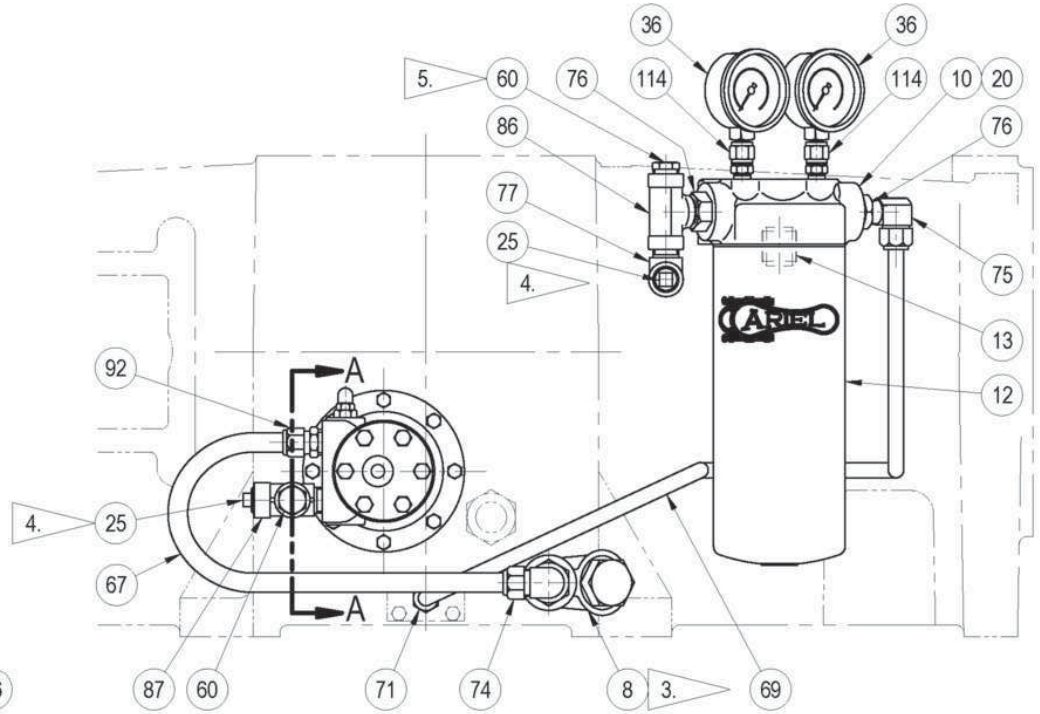
1"SIGHT GLASS, JG:A/2:4:6, M:P:N:Q/1:2, R:W:J/2, ACF

ITEM	PART NUMBER	QTY	UOM	DESCRIPTION
001	A-0077	1		SIGHT GLASS, 1" NPT

*** ALWAYS PROVIDE SERIAL NUMBER WHEN ORDERING SPARE PARTS. ***
WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT DOES NOT REPRESENT THE QUANTITY REQUIRED.



VIEW A-A



NOTES:

1.- LOOSEN OR TIGHTEN ALL FASTENERS PER RECOMMENDED PROCEDURES AND TORQUE VALUES IN MANUAL.

2. ALIGN PUMP SPROCKET WITH CRANK SPROCKET AND TIGHTEN SET SCREWS.

3. REMOVE AND INSPECT SCREEN WHEN CHANGING OIL. (CLEAN IN SUITABLE SOLVENT).

4. CUSTOMER CONNECTION PLUGGED FOR SHIPMENT.

5. OPTIONAL CUSTOMER CONNECTION FOR LUBE OIL TEMPERATURE GAUGE.

REV	DESCRIPTION	INIT/DATE

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REV	ECN	REV	ECN
		0	17756

ARIEL CORPORATION
35 BLACKJACK ROAD
MOUNT VERNON, OHIO 43050

DRAWN: CPM 09/26/11
CHECKED: DLI 10/19/11
SCALE: NONE
ASSEMBLY DWG. NO. A-18552
SHT 1 OF 1

10/15/2016

ARIEL CORPORATION

PARTS LIST

Part No. G-19674

LUBE OIL PUMP ASSEMBLY, JGM:P:N:Q/2 **Ref Drawing.** A-18552

ITEM	PART NUMBER	QTY	UOM	DESCRIPTION
001	C-0084	1		LUBE OIL PUMP, THL, M:P:N:Q:I, JG:A/2
002	A-0002	1		SPROCKET, 35-1 X 30T
003	FK0360AA	1		WOODRUFF KEY, #204, 1/2 OD X 1/16 WIDE
004	FS0455CE	1		SET SCREW, CUP POINT, NYLON PATCH, 1/4-28 X 3/4
005	A-0073	1		FIBER GASKET, .031, TUTHILL OIL PUMP
007	B-0029	1		ADAPTER, LUBE OIL PUMP, TUTHILL, JG:A/2
008	A-8247	1		LUBE OIL STRAINER, 3/4 NPT
010	C-0394	1		LUBE OIL FILTER HEAD, SINGLE L/R
012	A-0661	1		SPIN-ON FILTER, LUBE OIL
013	A-0660	0		STUD, LUBE OIL SPIN-ON FILTER
020	FC0102EG	2		HEX HEAD CAPSCREW, 3/8-16 X 1", G5
023	FC0102CF	8		HEX HEAD CAPSCREW, 1/4-20 X 7/8, G5
025	A-15683	2		PIPE PLUG, SQUARE HEAD, 1/2 NPT, STL, DRILLED
036	A-18450	2		PRESSURE GAUGE, 100 PSI, BOTTOM MOUNT, 3/8 TUBE
060	PP0810GB	2		PIPE PLUG, HEX HEAD, 1/2 NPT, STL
067	PT0200GC	24	IN	TUBING, SS, 5/8 OD X .049 WALL
069	PT0200FB	54	IN	TUBING, SS, 1/2 OD X .035 WALL
071	A-0857	1		MALE CONNECTOR, STL, 1/2 TUBE X 1/2 NPT
072	A-0068	1		FIBER GASKET, 05.250 OD X 03.875 ID X .031, LUBE OIL PUMP MOUNTING, JG/2:M:P
074	A-0860	1		MALE ELBOW, STL, 5/8 TUBE X 1/2 NPT
075	A-0901	1		MALE ELBOW, STL, 1/2 TUBE X 1/2 NPT
076	A-0844	3		HEX REDUCING BUSHING, 3/4 NPT (MALE) X 1/2 NPT (FEMALE), STL
077	A-0843	1		STREET ELBOW, 90°, 1/2 NPT, STL
086	A-0864	1		MALE BRANCH TEE, 1/2 NPT, STL
087	A-15558	1		STREET TEE, 1/2 NPT, STL
090	A-0828	1		HEX REDUCING NIPPLE, 3/4 NPT (MALE) X 1/2 NPT (MALE), STL
091	FC0125CE	3		12-POINT CAPSCREW, 1/4-28 X 3/4, G8
092	A-0859	1		MALE CONNECTOR, STL, 5/8 TUBE X 1/2 NPT
099	A-18450-A	0		PRESSURE GAUGE, 100 PSI, REPLACEMENT SET, BOTTOM MOUNT, 3/8 TUBE
114	A-0934	2		MALE CONNECTOR, STL, 3/8 TUBE X 1/4 NPT

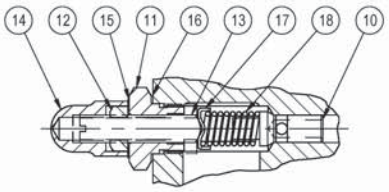
*** ALWAYS PROVIDE SERIAL NUMBER WHEN ORDERING SPARE PARTS. ***

ARIEL PART No.	ROTATION	MODEL No.	GPR
C-0084	STANDARD	2 LEVK-CC-7429	.00346
C-0866	REVERSE	2 LEVK-CC-7429	

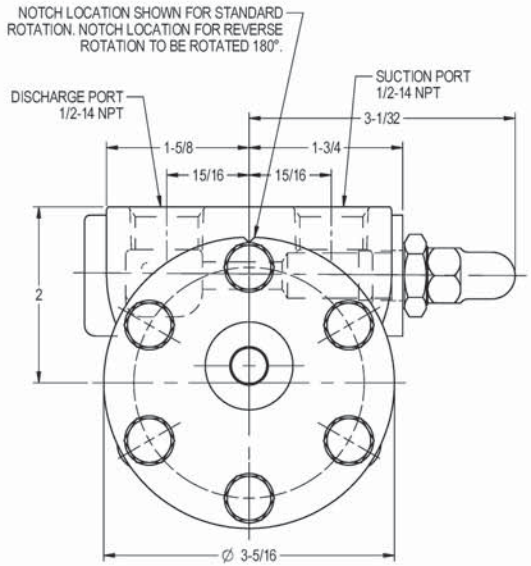
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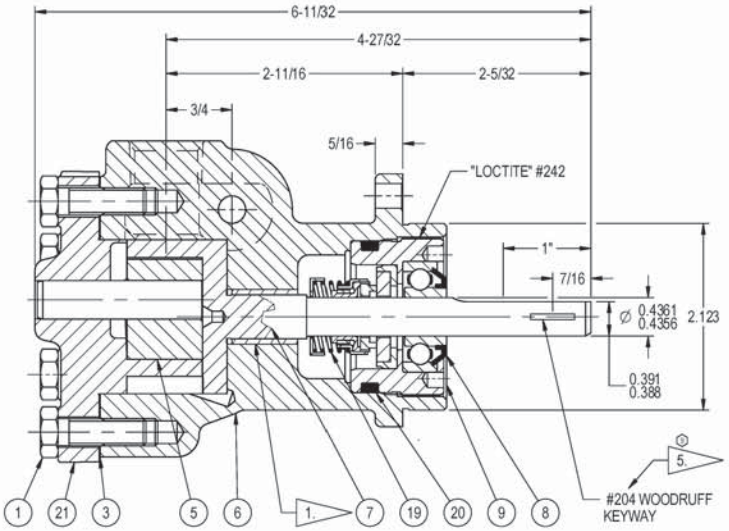
1. BUSHING IS NOT FIELD REPLACEABLE.
2. C-0866 IS MADE FROM C-0084 BY ROTATING COVER, ITEM #21 180° SO THAT THE NOTCH ON THE O.D. OF THE COVER IS "DOWN", OPPOSITE THE SUCTION AND DISCHARGE PORTS. FOR STANDARD ROTATION, SHAFT ROTATION TO BE COUNTER-CLOCKWISE (LEFT HAND SUCTION). FOR REVERSE ROTATION, SHAFT ROTATION TO BE CLOCKWISE (LEFT HAND SUCTION) WITH END PLATE ROTATED 180°. TORQUE THE 6 COVER PLATE BOLTS TO 12 LB-FT. THE SUCTION AND DISCHARGE PORTS REMAIN THE SAME AS C-0084.
3. RELIEF VALVE SPRING SETTING: 55-60 PSIG.
4. GALLON PER REVOLUTION (GPR) IS THEORETICAL DISPLACEMENT. FOR DESIGN PURPOSES, REFER TO ER-116.X PERFORMANCE CURVES.
5. IN ACCORDANCE WITH ANSI B17.2-1967 (R2013) OR MOST CURRENT PUBLISHED BY ASME.

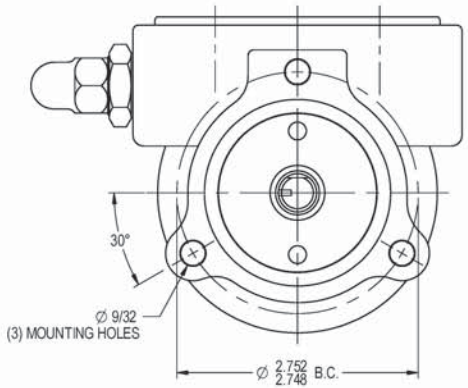
ITEM No.	ARIEL P/N	QTY	DESCRIPTION
1	FC0102DG	6	5/16-18 UNC x 1" HEX HEAD CAP SCREW
3	A-5003	1	GASKET (.013)
5	A-5005	1	IDLER
6	A-5006	-	HOUSING ASSEMBLY
7	A-5007	1	ROTOR
8	A-5008	1	BALL BEARING
9	A-5009	1	HOUSING PLUG ASSEMBLY
10	A-5010	1	PLUNGER
11	A-5011	1	VALVE CAP
12	A-5012	1	HEX NUT
13	A-5013	1	5/16-18 UNC x 1-3/8 SET SCREW
14	A-5014	1	VALVE CAP COVER
15	A-5015	1	VALVE CAP COVER GASKET
16	A-5016	1	VALVE CAP GASKET
17	A-21078	1	SPRING RETAINER
18	A-5018	1	VALVE SPRING (55-120 PSI)
	A-4926	1	VALVE SPRING (35-55 PSI) (OPTIONAL)
	A-4927	1	VALVE SPRING (121-169 PSI) (OPTIONAL)
19	A-16195	1	SEAL ASSY, MECHANICAL
20	A-16196	1	O-RING-VITON
21	A-16454	1	COVER W/IDLER PIN



SECTION A-A
RELIEF VALVE DETAIL







REV	DESCRIPTION	INITIATE
13	REVISION TO THE ER TO IDENTIFY RE NEWEST VERSION OF THE PRINT.	DWF 09/16/15
12	(D-3) REVISED NOTE #4. GALLONS PER REVOLUTION (GPR) IS THEORETICAL DISPLACEMENT FOR DESIGN PURPOSES. REFER TO ER-116.X PERFORMANCE CURVES. WAS GALLONS PER REVOLUTION (GPR) IS THEORETICAL DISPLACEMENT FOR DESIGN PURPOSES. REFER TO MANUFACTURERS PERFORMANCE CHARTS. (D-2) REMOVED PUMP CAPACITY COLUMN.	JGF 11/29/14

VER	ECN	VER	ECN	VER	ECN
		11	19870	5	11922
		10	19322	4	12304
		9	19531	3	12132
		8	16707	2	11247
13	201500027	7	16162	1	4306
12	19538	6	15818	0	72

THIRD ANGLE PROJECTION

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DIMENSIONS ARE IN INCHES UNLESS OTHERWISE SPECIFIED.
— DO NOT SCALE DRAWING —

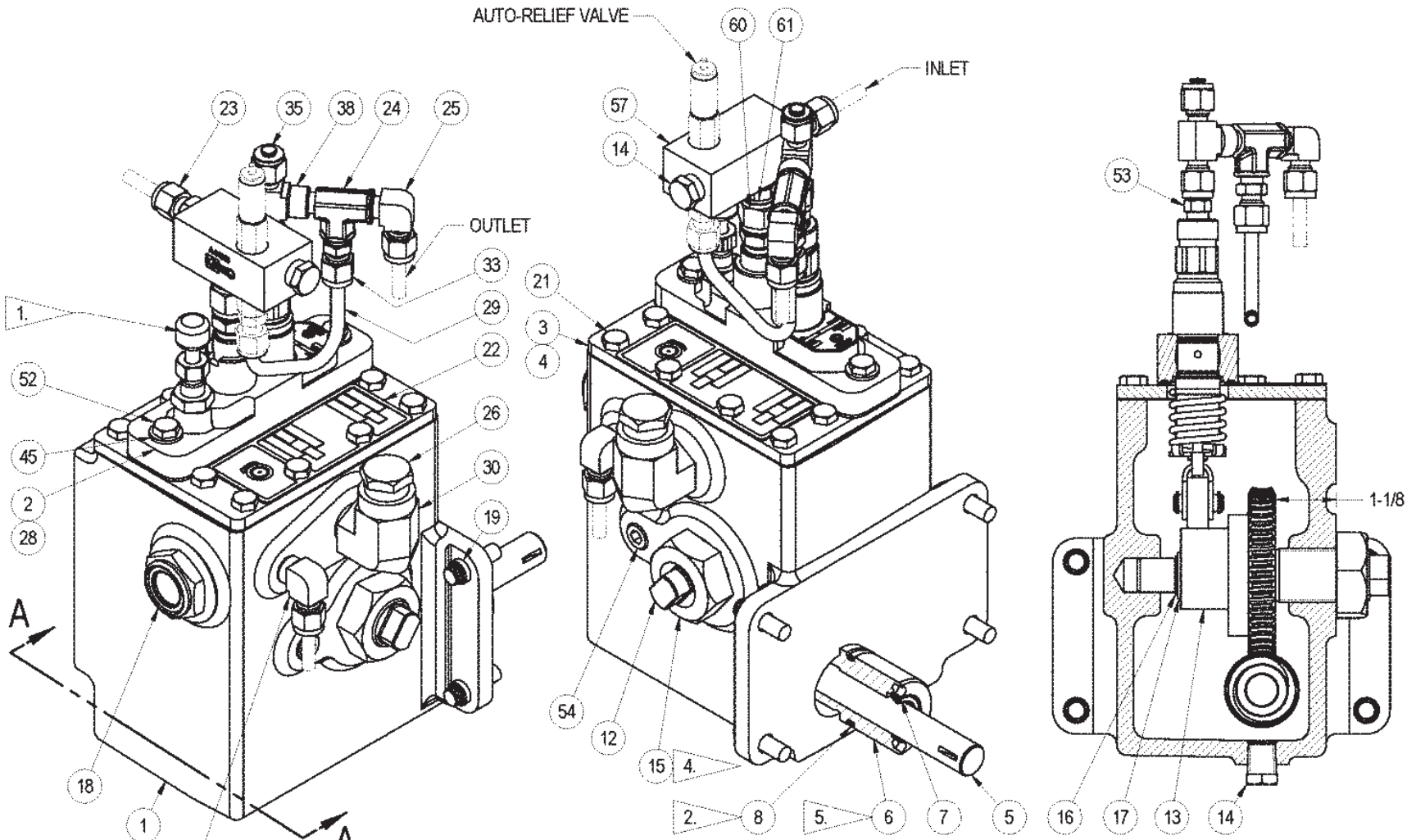
ARIEL CORPORATION
35 BLACKJACK ROAD
MOUNT VERNON, OHIO 43050

TITLE: LUBE OIL PUMP, TUTHILL, JGA/2 JGM:P:N:Q

DRAWN	JEC 05/4/76
CHECKED	JPB 07/14/76
MATERIAL	PROCURED
SCALE	NONE
R.S. No.	
PART No.	SEE TABLE ABOVE
DWG No.	C-0084

SHT 1 OF 1

WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT DOES NOT REPRESENT THE QUANTITY REQUIRED.



REV	DESCRIPTION	INIT/DATE

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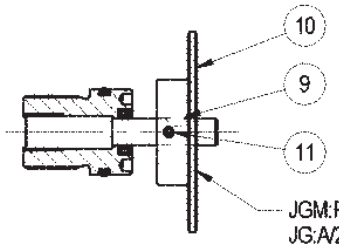
REV	ECN	REV	ECN
		0	19343

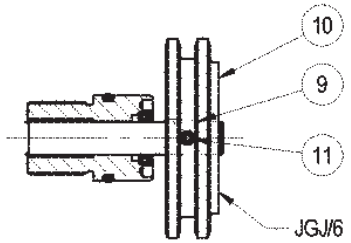
ARIEL CORPORATION
35 BLACKJACK ROAD
MOUNT VERNON, OHIO 43050

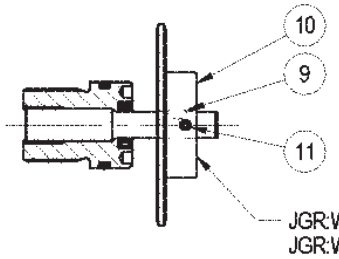
DRAWN	CWH 07/31/14	ASSEMBLY DWG NO	A-22082
CHECKED	CPM 08/06/14	SCALE NONE	SHT 1 OF 2

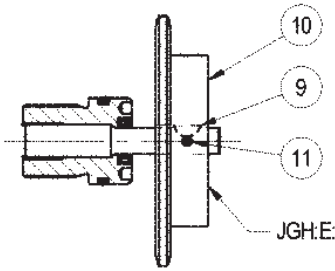
NOTES:

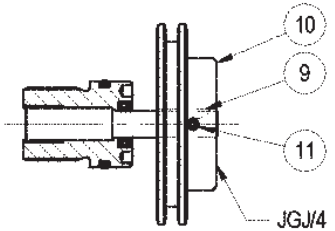
1. SCREW ADJUSTMENT KNOB IN TO REDUCE FEED, SCREW ADJUSTMENT KNOB OUT TO INCREASE FEED.
2. OIL O-RING BEFORE INSTALLING.
3. SEE CYLINDER LUBRICATION SHEET FOR CORRECT PUMP SETTING. (DISTRIBUTION BLOCK CYCLE INDICATOR TIMING).
4. TORQUE TO 75 FT-LBS.
5. TORQUE TO 70 FT-LBS.
6. LOOSEN OR TIGHTEN ALL FASTENERS PER RECOMMENDED PROCEDURES AND TORQUE VALUES IN MANUAL.
7. THIS ASSEMBLY IS FOR ILLUSTRATION PURPOSES ONLY AND MAY NOT NECESSARILY REPRESENT THE EXACT CONFIGURATION PERTAINING TO THE UNIT ORDERED. REFER TO ACCOMPANYING PART LIST FOR ITEMS (AND QUANTITIES OF EACH) REQUIRED FOR THIS PARTICULAR ASSEMBLY.

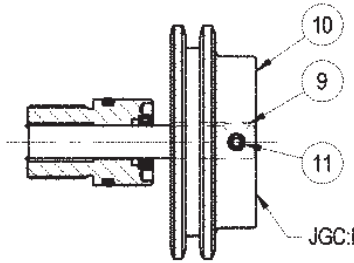












REV	DESCRIPTION	INIT/DATE

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REV	ECN	REV	ECN
		0	19343

ARIEL CORPORATION
35 BLACKJACK ROAD
MOUNT VERNON, OHIO 43050

DRAWN: CWH 07/31/14
CHECKED: CPM 08/06/14
SCALE: NONE
ASSEMBLY DWG NO: A-22082
SHT 2 OF 2

10/15/2016

ARIEL CORPORATION

PARTS LIST

Part No. FF LUBRICATOR

FORCE FEED LUBRICATOR

Ref Drawing. A-22082

G SHEETS USED: G-19868,G-23593

ITEM	PART NUMBER	QTY	UOM	DESCRIPTION
001	D-6137	1		FORCE FEED LUBRICATOR, LEFT HAND THREADS, (1) PUMP TANK ASSEMBLY, 1/2 INCH SHAFT
002	A-18525	1		FORCE FEED LUBRICATOR PUMP, 3/16, ARIEL
003	A-2346	0		TOP COVER, SINGLE FORCE FEED LUBRICATOR BOX
004	A-2348	0		GASKET, TOP COVER, ARL SINGLE FORCE FEED LUBRICATOR BOX, 1/32 THICK
005	A-2360	0		WORM SHAFT, FORCE FEED LUBRICATOR, 1/2 OD, JGM:N:P:Q, JG:A/2:4, JGA/6, JGR:W/2:4, JGJ/2:4, JGH:E:K:T/2:4
006	A-5638	0		BEARING HOUSING, FORCE FEED LUBRICATOR, LEFT HAND THREADS
007	A-3911	0		SHAFT OIL SEAL, 1/2 SHAFT
008	A-0030	0		O-RING, VT, 1.637 OD X .139, 75/85 DUROMETER
009	FK0360AA	1		WOODRUFF KEY, #204, 1/2 OD X 1/16 WIDE
010	A-0072	1		SPROCKET, 35-1 X 30T, FORCE FEED LUBRICATOR, JG:A/2:4, JGM:P:N:Q:I
011	FS0455CE	1		SET SCREW, CUP POINT, NYLON PATCH, 1/4-28 X 3/4
012	A-2352	0		ADJUSTER SHAFT, SINGLE LUBE BOX
013	B-1176	0		CAM/WORM GEAR, (1) PUMP FORCE FEED LUBRICATOR
014	PP0810CB	2		PIPE PLUG, HEX HEAD, 1/4 NPT, STL
015	FN0457KA	0		HEX JAM NUT, 1-14, STL
016	A-2359	0		SNAP RING,STL,RADIAL ASSYO.625
017	A-2358	0		FLAT WASHER,SUPPORT,5/8,HARD
018	A-5641	0		SIGHT GLASS, 3/4 NPT
019	FC0120DF	4		12-POINT CAPSCREW, 5/16-18 X 7/8, G8
021	FC0102CE	0		HEX HEAD CAPSCREW, 1/4-20 X 3/4, G5
022	A-16622	1		DATA PLATE, 1 & 2 PUMP FORCE FEED LUBRICATOR
023	A-0827	1		MALE CONNECTOR, STL, 1/4 TUBE X 1/4 NPT
024	A-15556	1		STREET TEE, 1/8 NPT, STL
025	A-0815	1		MALE ELBOW, STL, 1/4 TUBE X 1/8 NPT

G SHEETS USED: G-19868,G-23593

ITEM	PART NUMBER	QTY	UOM	DESCRIPTION
026	PP0810GB	1		PIPE PLUG, HEX HEAD, 1/2 NPT, STL
027	A-0800	1		MALE ELBOW, STL, 1/4 TUBE X 1/4 NPT
028	A-18592	0		GASKET, FORCE FEED LUBRICATOR PUMP, 1/16 THICK, ARIEL PUMP
029	PT0200CB	25	IN	TUBING, SS, 1/4 OD X .035 WALL
030	A-0843	1		STREET ELBOW, 90°, 1/2 NPT, STL
033	A-0830	1		MALE CONNECTOR, STL, 1/4 TUBE X 1/8 NPT
035	A-0918	1		PLUG, TUBE FITTING, STL, 1/4 TUBE
038	A-8824	1		FEMALE BRANCH TEE, STL, 1/4 TUBE X 1/8 NPT
045	FW0500CA	0		WASHER, 1/4 ID, SAE
052	FC0102CH	0		HEX HEAD CAPSCREW, 1/4-20 X 1-1/4, G5
053	A-8828	1		MALE ADAPTER, STL, 1/4 TUBE X 1/8 NPT
054	PP0850CB	1		PIPE PLUG, HEX SOCKET, 1/4 NPTF, STL
057	A-21236	1		MANIFOLD, (1) PUMP, AUTO RELIEF VALVE
060	A-0934	1		MALE CONNECTOR, STL, 3/8 TUBE X 1/4 NPT
061	PS0012BE	1		MALE ADAPTER, STL, 3/8 TUBE X 1/4 NPT
099	A-18525-A	0		FORCE FEED LUBRICATOR PUMP, REPLACEMENT SET, 3/16, ARIEL

*** ALWAYS PROVIDE SERIAL NUMBER WHEN ORDERING SPARE PARTS. ***
WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT DOES NOT REPRESENT THE QUANTITY REQUIRED.

10/15/2016

ARIEL CORPORATION

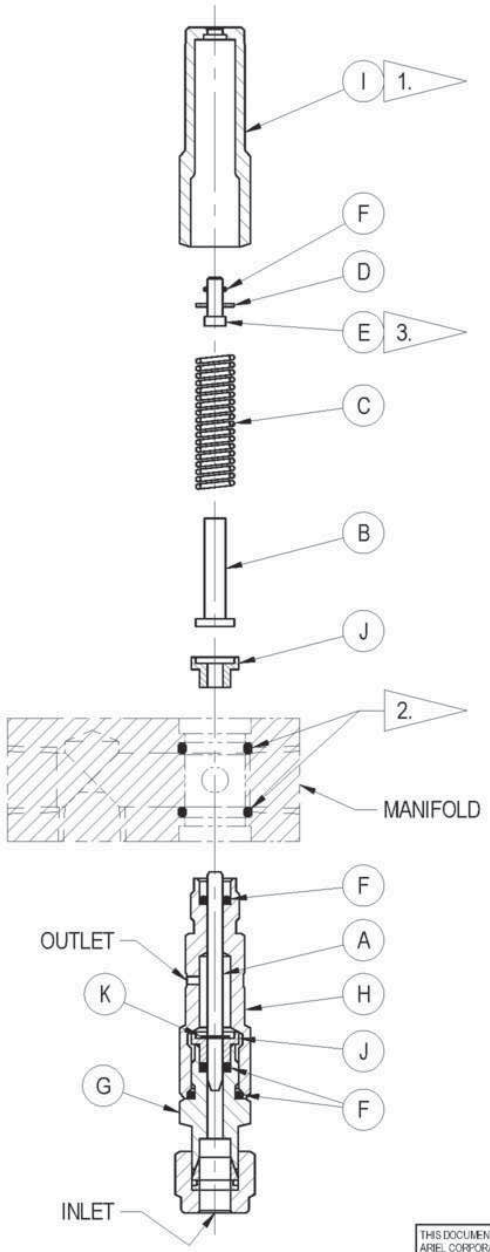
PARTS LIST

Part No. G-5095

DIST.BLK.MTG.SPACER,M:N:P:Q **Ref Drawing.** N.A.

ITEM	PART NUMBER	QTY	UOM	DESCRIPTION
001	A-5617	2		DISTRIBUTION BLOCK SPACER, TBN
002	FC0102CL	4		HEX HEAD CAPSCREW, 1/4-20 X 2-1/4, G5

*** ALWAYS PROVIDE SERIAL NUMBER WHEN ORDERING SPARE PARTS. ***
WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT DOES NOT REPRESENT THE QUANTITY REQUIRED.



PART NUMBER	CRACKING PRESSURE (PSI)	SPRING/ PIN COLOR
A-21239	3000 PSI	GREEN
A-21240	5000 PSI	GRAY

ITEM	DESCRIPTION
A	PRESSURE PIN
B	SPRING PISTON
C	SPRING
D	WASHER
E	INDICATOR PIN
F	O-RING
G	ADAPTER
H	INTERMEDIATE BARREL
I	SPRING BARREL
J	O-RING RETAINER
K	E-CLIP

NOTES:

1. TORQUE TO 75 IN-LBS FOR INSTALLATION. AUTO RELIEF VALVE CAN SWIVEL IN MANIFOLD ONCE TORQUED.

2. OIL O-RINGS BEFORE INSTALLING.

3. ALLOW INDICATOR PIN TO PROTRUDE FROM SPRING BARREL DURING ASSEMBLY. ONCE THE BARREL IS TIGHTENED, DEPRESS INDICATOR PIN SO IT IS FLUSH WITH THE END OF THE SPRING BARREL.

4. ENSURE THE SPRING AND INDICATOR PIN COLOR MATCH AND CRACKING PRESSURE INDICATED ON BARREL AGREES WITH COLOR CODE:
   GREEN = 3000 PSI
   GRAY = 5000 PSI

5. SPRING MUST BE COMPRESSED SLIGHTLY WHILE THREADING SPRING BARREL ONTO INTERMEDIATE BARREL. SPRING FORCE WILL BE PRESENT ON SPRING BARREL DURING DISASSEMBLY.

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REV	ECN	REV	ECN
		0	19343

ARIEL CORPORATION
35 BLACKJACK ROAD
MOUNT VERNON, OHIO 43050

DRAWN: JJP 05/02/14
CHECKED: CPM 05/07/14
SCALE: NONE
ASSEMBLY DWG. NO. A-21769
SHT 1 OF 1

10/15/2016

ARIEL CORPORATION

PARTS LIST

Part No. G-23734

AUTOMATIC RELIEF VALVE ASSEMBLY, 5000 PSI **Ref Drawing.** A-21769

ITEM	PART NUMBER	QTY	UOM	DESCRIPTION
001	A-21240	1		AUTO RELIEF VALVE, 5000 PSI

*** ALWAYS PROVIDE SERIAL NUMBER WHEN ORDERING SPARE PARTS. ***
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10/15/2016

ARIEL CORPORATION

PARTS LIST

Part No. G-1080

FF TUB.TANDEM,JG:A:M:P EA CYL **Ref Drawing.** N.A.

ITEM	PART NUMBER	QTY	UOM	DESCRIPTION
001	PT0200CB	100	IN	TUBING, SS, 1/4 OD X .035 WALL
002	A-0886	1		BULKHEAD UNION, STL, 1/4 TUBE
003	A-0401	1		BRACKET, BULKHEAD UNION
004	FC0102CC	1		HEX HEAD CAPSCREW, 1/4-20 X 1/2, G5

*** ALWAYS PROVIDE SERIAL NUMBER WHEN ORDERING SPARE PARTS. ***
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10/15/2016

ARIEL CORPORATION

PARTS LIST

Part No. G-1079

FF TUBING,JG:A:M:P/2 D.A.CYLS **Ref Drawing.** N.A.

ITEM	PART NUMBER	QTY	UOM	DESCRIPTION
001	PT0200CB	250	IN	TUBING, SS, 1/4 OD X .035 WALL
002	A-0886	2		BULKHEAD UNION, STL, 1/4 TUBE
003	A-0401	2		BRACKET, BULKHEAD UNION
004	FC0102CC	2		HEX HEAD CAPSCREW, 1/4-20 X 1/2, G5

*** ALWAYS PROVIDE SERIAL NUMBER WHEN ORDERING SPARE PARTS. ***
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10/15/2016

ARIEL CORPORATION

PARTS LIST

Part No. G-2935
Ref Drawing. N.A.

FORCE FEED TUBING, BOTTOM LUBE,
JG:A:M:P:N:Q:R:W:J:H:E:K:T, EACH CYLINDER, STD

ITEM	PART NUMBER	QTY	UOM	DESCRIPTION
001	PT0200CB	90	IN	TUBING, SS, 1/4 OD X .035 WALL
002	A-0886	1		BULKHEAD UNION, STL, 1/4 TUBE
003	A-0401	1		BRACKET, BULKHEAD UNION
004	FC0102CC	1		HEX HEAD CAPSCREW, 1/4-20 X 1/2, G5
005	A-0831	1		TUBING CLAMP, 1/4 TUBE
006	A-21900	1		BUTTON HEAD SEMS SCREW, WITH INTERNAL TOOTH LOCK WASHER, 10-24 X 1/2, G2

*** ALWAYS PROVIDE SERIAL NUMBER WHEN ORDERING SPARE PARTS. ***
WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT DOES NOT REPRESENT THE QUANTITY REQUIRED.

10/15/2016

ARIEL CORPORATION

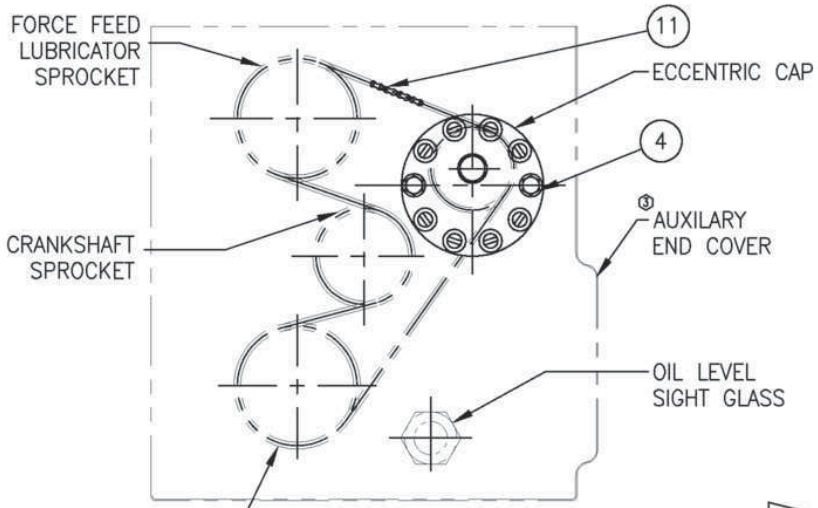
PARTS LIST

Part No. G-9055

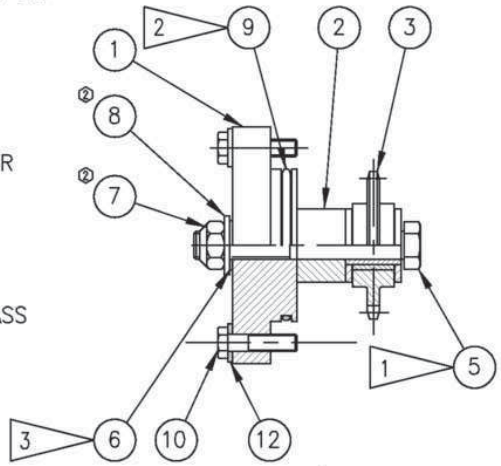
FORCE FEED TUBING, M=R2, W/CYL>3600 **Ref Drawing.** N.A.

ITEM	PART NUMBER	QTY	UOM	DESCRIPTION
001	PT0201CD	255	IN	TUBING, 316 SS, 1/4 OD X .065 WALL

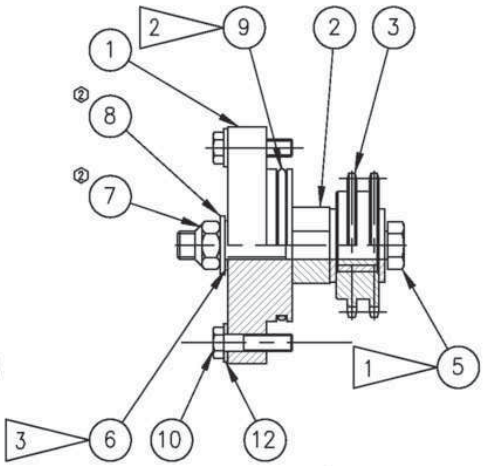
*** ALWAYS PROVIDE SERIAL NUMBER WHEN ORDERING SPARE PARTS. ***
WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT DOES NOT REPRESENT THE QUANTITY REQUIRED.



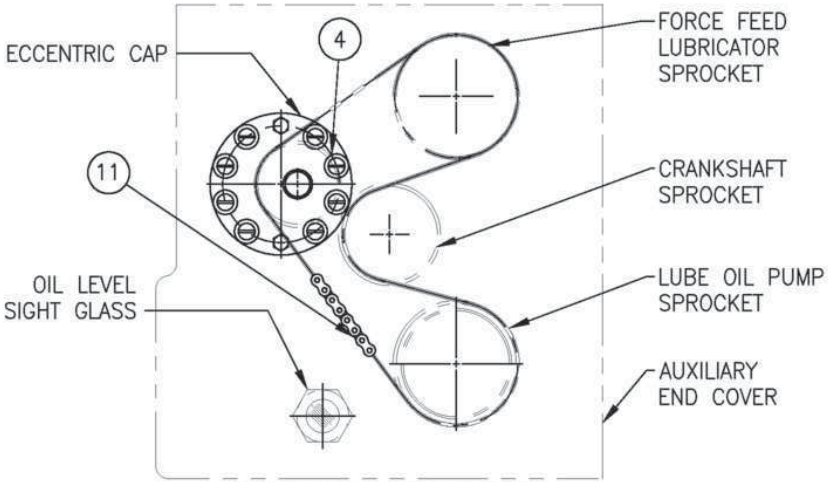
STANDARD ROTATION



③ JG:A/2:4
③ JGM:P:N:Q



③ JGA/6



REVERSE ROTATION

NOTES:

② 1 USE NEW CAPSCREW AND NUT (ITEM#5&7) WHEN REPLACING IDLER SPROCKET (ITEM#3).

2 OIL O-RING (ITEM#9) BEFORE INSTALLING.

3 OIL FACES BEFORE INSTALLING TO PREVENT ABRASION OF STATO-SEAL (ITEM #6).

④③ 4. FOR CHAIN TIGHTENING REFER TO ER-74.

5. LOOSEN OR TIGHTEN ALL FASTENERS PER RECOMMENDED PROCEDURES AND TORQUE VALUES IN MANUAL.

REV	DESCRIPTION	INIT/DATE
4	④B3 NOTE #4, REVISED CHAIN TIGHTENING NOTE.	RWR 8/26/04
3	③ "C2" CORRECTED SPELLING OF AUXILARY. NOTE #4 (2) CAP SCREWS WAS (4), (8) PLUGS WAS (16). ③ "C4" ADDED JGA/6 VIEW. ③"B3" ADDED TITLE JG:A/2: & JGM:P:N:Q. ③"B4" ADDED TITLE JGA/6.	JLS 01/17/01

REV	ECN
4	11872
3	8412
2	8434
1	8281
0	7220

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ARIEL CORPORATION
35 BLACKJACK ROAD
MOUNT VERNON, OHIO 43050

DRAWN: MLA 6/25/98
APPROVED:
CHECKED:
SCALE: NONE
ASSEMBLY DWG. NO. A-7765

10/15/2016

ARIEL CORPORATION

PARTS LIST

Part No. G-0176
Ref Drawing. A-7765

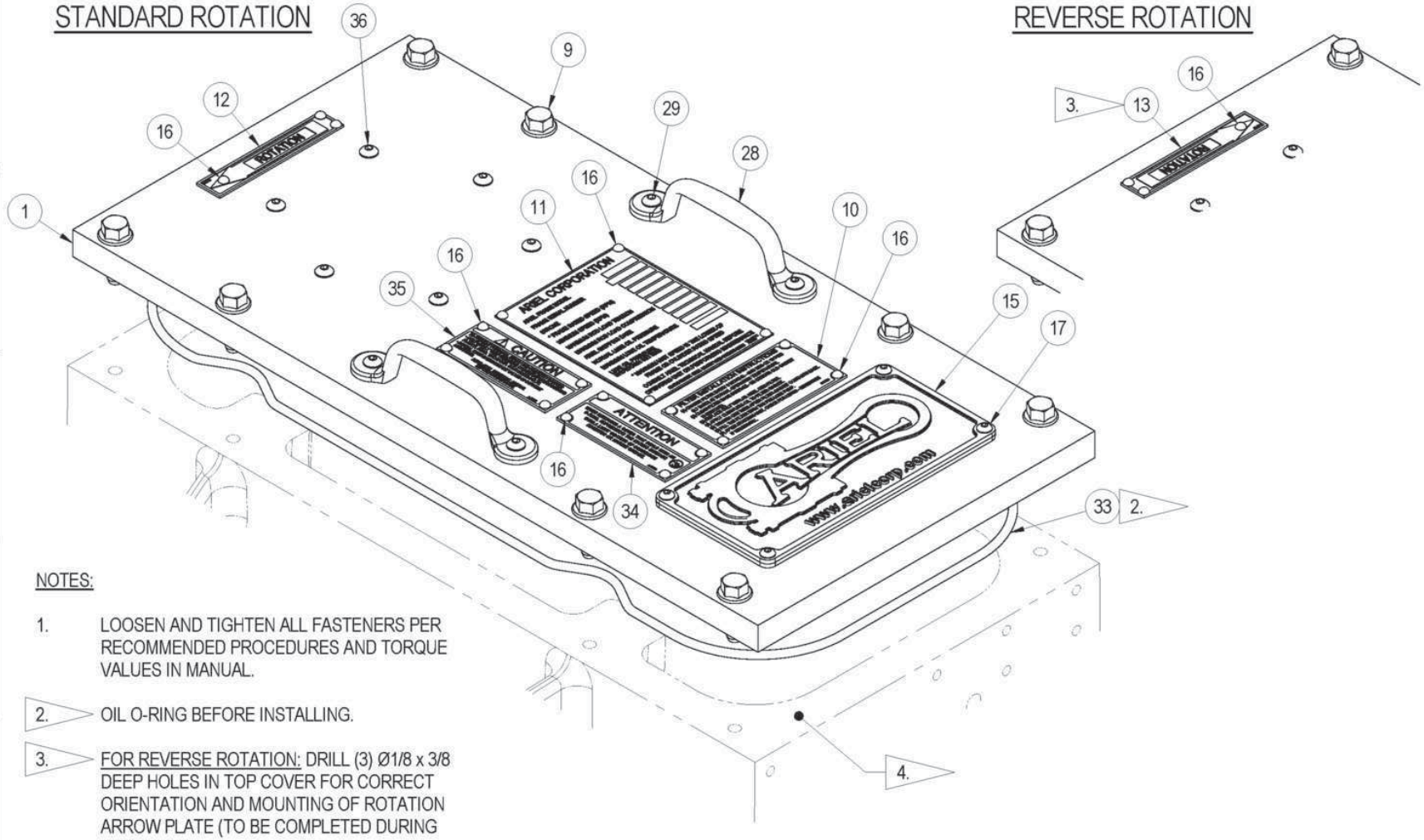
CHAIN ASSEMBLY, STANDARD OR REVERSE ROTATION,
JGM:P:N:Q

ITEM	PART NUMBER	QTY	UOM	DESCRIPTION
001	B-0030	1		ECCENTRIC VERNIER CAP
002	A-0071	1		IDLER SPACER, JG:A/2:4 AND JGI
003	A-0085	1		SPROCKET, 35-1 X 20T
004	A-0109	8		MACHINE SCREW PLUG, PLASTIC, 7/16-14
005	FC0107GS	1		HEX HEAD CAPSCREW, 1/2-20 X 4, G5
006	FW0550GA	1		STAT-O-SEAL, 1/2 DIA., BLACK
007	FN0468GA	1		HEX NUT, STOVER TYPE C, 1/2-20
008	FW0500GA	1		FLAT WASHER, 1/2 SAE
009	A-0010	1		O-RING,VT, 2.637 O.D. X .139
010	FC0120DH	2		12-POINT CAPSCREW, 5/16-18 X 1-1/4, G8
011	A-0203	1		CHAIN, 35-1 X 94
012	FW0501CA	2		WASHER, 5/16 ID, PLAIN

*** ALWAYS PROVIDE SERIAL NUMBER WHEN ORDERING SPARE PARTS. ***
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STANDARD ROTATION

REVERSE ROTATION



NOTES:

1. LOOSEN AND TIGHTEN ALL FASTENERS PER RECOMMENDED PROCEDURES AND TORQUE VALUES IN MANUAL.

2. OIL O-RING BEFORE INSTALLING.

3. FOR REVERSE ROTATION: DRILL (3) Ø1/8 x 3/8 DEEP HOLES IN TOP COVER FOR CORRECT ORIENTATION AND MOUNTING OF ROTATION ARROW PLATE (TO BE COMPLETED DURING ASSEMBLY).

4. THE FRAME TOP RAIL IS TO BE LIGHTLY COATED WITH CORTEC VPCI 369 CORROSION INHIBITOR OR MARINE GRADE GREASE BEFORE INSTALLING TOP COVER.

REV	DESCRIPTION	INIT/DATE
1	RELOCATED DATA TAGS.	JJP 02/06/15

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REV	ECN	REV	ECN
		1	20067
		0	19176

ARIEL CORPORATION
35 BLACKJACK ROAD
MOUNT VERNON, OHIO 43050

DRAWN: TDM 4/07/14
CHECKED: CPM 4/21/14
SCALE: NONE
ASSEMBLY DWG NO: A-21631
SHT 1 OF 1

10/15/2016

ARIEL CORPORATION

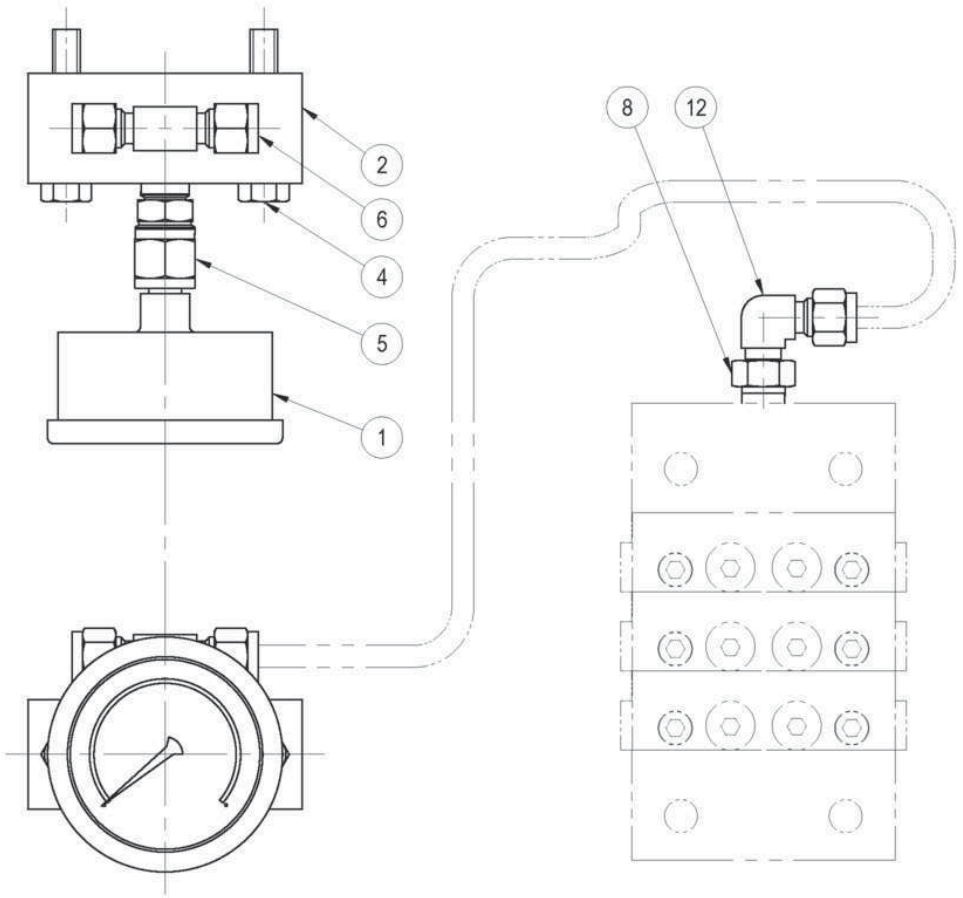
PARTS LIST

Part No. G-23760
Ref Drawing. A-21631

TOP COVER ASSEMBLY, JGM:P:N:Q/2, STANDARD AND REVERSE ROTATION, WITH O-RING SEAL

ITEM	PART NUMBER	QTY	UOM	DESCRIPTION
001	C-6912	1		TOP COVER, JGM:P:N:Q/2, WITH O-RING GROOVE.
009	FC0176CI	8		FLANGED HEX HEAD CAP SCREW, 3/8-16 X 1-1/4, G5
010	A-21586	1		INFORMATION PLATE, LUBE OIL FILTER, SPIN-ON, SMALL
011	A-14766	1		DATA PLATE, FRAME SPECIFICATION
012	A-0719	1		INFORMATION PLATE, ROTATION ARROW
015	A-23168	1		NAME PLATE, ARIEL LOGO, 50TH ANNIVERSARY, ALUMINUM
016	FR0571CC	19		DRIVE SCREW, TYPE U, SS, #6 X 1/4
017	A-22996	4		BUTTON HEAD CAPSCREW, #10-24 X 1/2, 316SS, TAMPER-RESISTANT
028	A-2958	2		TOP / SIDE COVER HANDLE, AL, 2 HOLE
029	FC0134CD	4		BUTTON HEAD CAPSCREW, 1/4-20 X 5/8, 316SS
033	A-21616	1		O-RING,NBR, 18.375 OD X .210, 70 DUROMETER
034	A-17380	1		INFORMATION PLATE, TOP COVER REPRESERVATION
035	A-21585	1		CAUTION PLATE, COMPRESSOR VENTING AND VALVES
036	FC0134CB	6		BUTTON HEAD CAPSCREW, 1/4-20 X 3/8, 316SS

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NOTES:

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REV	DESCRIPTION	INIT/DATE

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REV	ECN	REV	ECN
		0	17756

ARIEL CORPORATION
35 BLACKJACK ROAD
MOUNT VERNON, OHIO 43050

DRAWN: CPM 08/29/11
CHECKED: DLI 09/01/11
SCALE: NONE
ASSEMBLY DWG. NO. A-18429
SHT 1 OF 1

10/15/2016

ARIEL CORPORATION

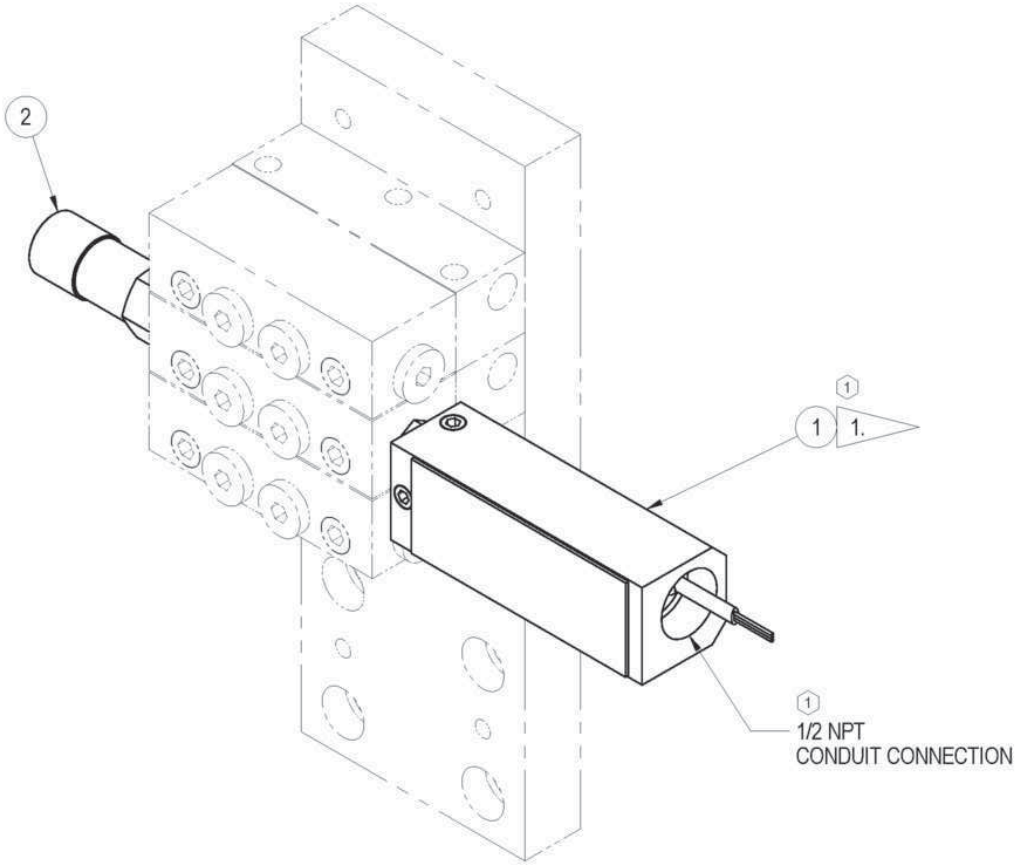
PARTS LIST

Part No. G-19557
Ref Drawing. A-18429

FORCE FEED GAUGE ASSEMBLY, 7500 PSI, GAUGE BRACKET, 3/8 TUBE, M:N:P:Q

ITEM	PART NUMBER	QTY	UOM	DESCRIPTION
001	A-17258	1		PRESSURE GAUGE, 7500 PSI, BACK MOUNT, 3/8 TUBE, SS
002	A-9019	1		BRACKET, FORCE FEED GAUGE MOUNTING
004	FC0102DJ	2		HEX HEAD CAPSCREW, 5/16-18 X 1-3/4, G5
005	A-0934	1		MALE CONNECTOR, STL, 3/8 TUBE X 1/4 NPT
006	A-2288	1		MALE BRANCH TEE, STL, 1/4 TUBE X 1/8 NPT
008	A-0811	1		HEX REDUCING BUSHING, 1/4 NPT (MALE) X 1/8 NPT (FEMALE), STL
012	A-0815	1		MALE ELBOW, STL, 1/4 TUBE X 1/8 NPT
099	A-17258-A	0		PRESSURE GAUGE, 7500 PSI, REPLACEMENT SET, BACK MOUNT, 3/8 TUBE

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WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT DOES NOT REPRESENT THE QUANTITY REQUIRED.



(1) NOTES:

1. REFER TO CUSTOMER BOOK OR www.arielcorp.com FOR INSTALLATION AND OPERATION.

REV	DESCRIPTION	INIT/DATE
1	@A1: ADDED NOTE. @B3: ADDED FLAG #1. @B4: ADDED "CONDUIT CONNECTION" TO CALLOUT.	JJP 09/13/13

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REV	ECN
1	18758
0	17535

ARIEL CORPORATION
35 BLACKJACK ROAD
MOUNT VERNON, OHIO 43050

DRAWN: CPM 08/03/11
CHECKED: KRN 08/04/11
SCALE: NONE
ASSEMBLY DWG. NO. A-18396
SHT 1 OF 1

10/15/2016

ARIEL CORPORATION

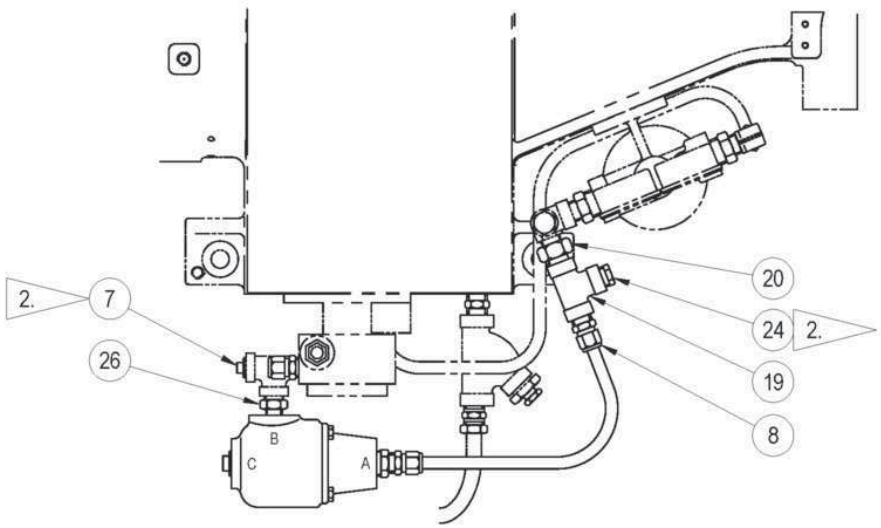
PARTS LIST

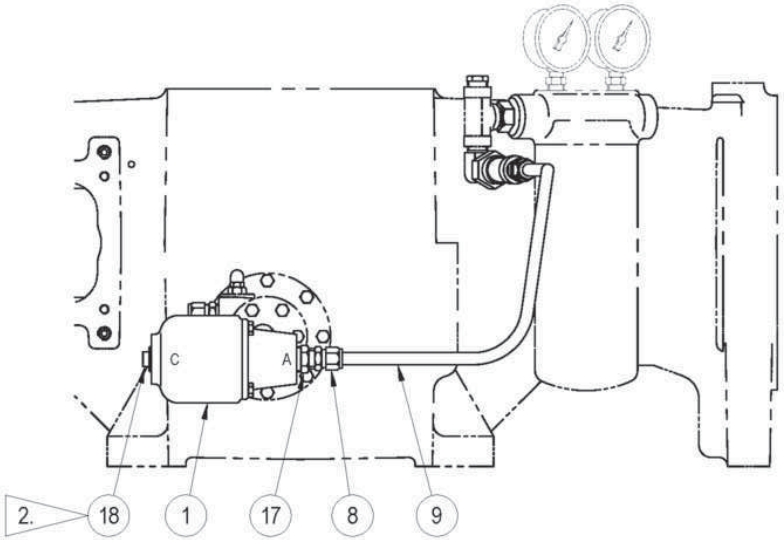
Part No. G-19340
Ref Drawing. A-18396

FORCE FEED PROXIMITY SWITCH, CYCLE INDICATOR, WHITLOCK, TRABON-SB

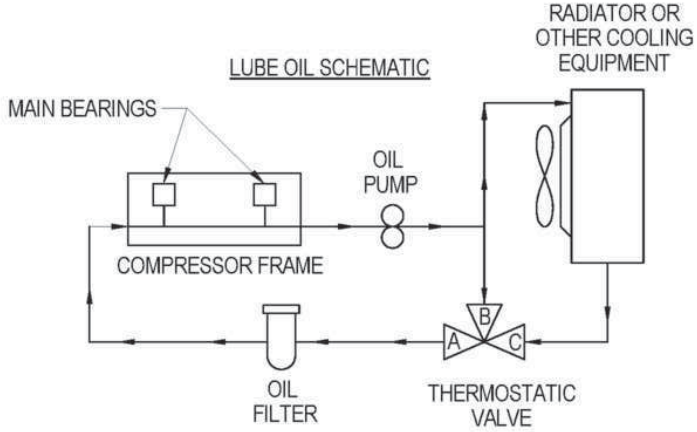
ITEM	PART NUMBER	QTY	UOM	DESCRIPTION
001	A-18255	1		FORCE FEED SHUTDOWN, WHITLOCK PROXIMITY SWITCH, TRABON-SB
002	A-18682	1		FORCE FEED CYCLE INDICATOR, ARIEL, TBN

*** ALWAYS PROVIDE SERIAL NUMBER WHEN ORDERING SPARE PARTS. ***
WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT DOES NOT REPRESENT THE QUANTITY REQUIRED.





LUBE OIL SCHEMATIC



NOTES:

1. LOOSEN OR TIGHTEN ALL FASTENERS PER RECOMMENDED PROCEDURES AND TORQUE VALUES IN MANUAL.

2. CUSTOMER CONNECTION, PLUGGED FOR SHIPMENT.

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REV	ECN	REV	ECN
		0	13638

ARIEL CORPORATION
35 BLACKJACK ROAD
MOUNT VERNON, OHIO 43050

DRAWN: JJP 04/20/15
CHECKED: CPM 04/21/15
SCALE: NONE
ASSEMBLY DWG. NO. A-23020
SHT 1 OF 1

10/15/2016

ARIEL CORPORATION

PARTS LIST

Part No. G-24771

THERMOSTATIC VALVE, 3/4", MTD, JGM:P:N:Q/2 **Ref Drawing.** A-23020

ITEM	PART NUMBER	QTY	UOM	DESCRIPTION
001	B-2745	1		THERMOSTATIC VALVE, 3/4" NPT, 170°F, FPE
007	A-15683	1		PIPE PLUG, SQUARE HEAD, 1/2 NPT, STL, DRILLED
008	A-0857	2		MALE CONNECTOR, STL, 1/2 TUBE X 1/2 NPT
009	PT0200FB	36	IN	TUBING, SS, 1/2 OD X .035 WALL
017	A-0844	1		HEX REDUCING BUSHING, 3/4 NPT (MALE) X 1/2 NPT (FEMALE), STL
018	A-15844	1		PIPE PLUG, SQUARE HEAD, 3/4 NPT, STL, DRILLED
019	A-0848	1		PIPE TEE, 1/2 NPT (FEMALE), STL
020	A-0849	1		HEX PIPE NIPPLE, 1/2 NPT (MALE), STL
024	PP0810GB	1		PIPE PLUG, HEX HEAD, 1/2 NPT, STL
026	A-0828	1		HEX REDUCING NIPPLE, 3/4 NPT (MALE) X 1/2 NPT (MALE), STL
099	A-9649	0		O-RING, VT, FPE, THERMOSTATIC VALVE
099	A-9724	0		ELEMENT, THERMOSTATIC VALVE, 3/4" FLANGE, 170°F, FPE
099	A-9725	0		LIP SEAL, TEFLON, 3/4" VALVE, FPE

*** ALWAYS PROVIDE SERIAL NUMBER WHEN ORDERING SPARE PARTS. ***

WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT DOES NOT REPRESENT THE QUANTITY REQUIRED.

10/15/2016

ARIEL CORPORATION

PARTS LIST

Part No. G-16340

TOOL KIT ASSY, JG:A:M:N:P:Q:I:S **Ref Drawing.** N.A.

ITEM	PART NUMBER	QTY	UOM	DESCRIPTION
001	A-0076	1		PEG WRENCH, 3/4
002	A-0135	1		VALVE PULLER, 5/16 X 1/2 UNF
003	A-0279	1		PISTON NUT SPANNER, JG:M:P
004	A-0409	1		VALVE PULLER, 1/4-28 X 3/8-24
005	A-0798	1		TOOL BOX
006	B-0016	1		CROSSHEAD NUT WRENCH, 2 INCH
007	TA0100CA	10		ALLEN WRENCH, 3/32 SHORT ARM
008	TA0100EA	10		ALLEN WRENCH, 1/8 SHORT ARM
009	TA0100FA	1		ALLEN WRENCH, 9/64 SHORT ARM
010	TA0100GA	5		ALLEN WRENCH, 5/32 SHORT ARM
011	TA0100HA	5		ALLEN WRENCH, 3/16 SHORT ARM
012	TA0100JA	3		ALLEN WRENCH, 1/4 SHORT ARM
013	TA0100KA	3		ALLEN WRENCH, 5/16 SHORT ARM
014	TA0100LB	2		ALLEN WRENCH, 3/8 LONG ARM
015	ER-63	1		TORQUE CHART, ALL UNITS
017	A-14781	1		PISTON ROD ENTERING SLEEVE, 2PC, JG:A:M:P:N:Q
018	A-15236	1		THREAD GAUGE
019	B-7849	1		BEARING PUSHER, JGM:P:N:Q:A:R:J

*** ALWAYS PROVIDE SERIAL NUMBER WHEN ORDERING SPARE PARTS. ***
WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT DOES NOT REPRESENT THE QUANTITY REQUIRED.

10/15/2016

ARIEL CORPORATION

PARTS LIST

Part No. B-0015

CROSSHEAD NUT, .7#, HEX, JG:A:M:P **Ref Drawing.** NA

ITEM	PART NUMBER	QTY	UOM	DESCRIPTION

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10/15/2016

ARIEL CORPORATION

PARTS LIST

Part No. D-0061

CROSSHEAD, MED, DI, 19.2#, JG:A:M:P:N:Q **Ref Drawing.** NA

ITEM	PART NUMBER	QTY	UOM	DESCRIPTION

*** ALWAYS PROVIDE SERIAL NUMBER WHEN ORDERING SPARE PARTS. ***
WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT DOES NOT REPRESENT THE QUANTITY REQUIRED.

10/15/2016

ARIEL CORPORATION

PARTS LIST

Part No. D-3284

CROSSHEAD, XLGT, DI, 8.0#, JG:A:M:P:N:Q **Ref Drawing.** NA

ITEM	PART NUMBER	QTY	UOM	DESCRIPTION

*** ALWAYS PROVIDE SERIAL NUMBER WHEN ORDERING SPARE PARTS. ***
WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT DOES NOT REPRESENT THE QUANTITY REQUIRED.

10/15/2016

ARIEL CORPORATION

PARTS LIST

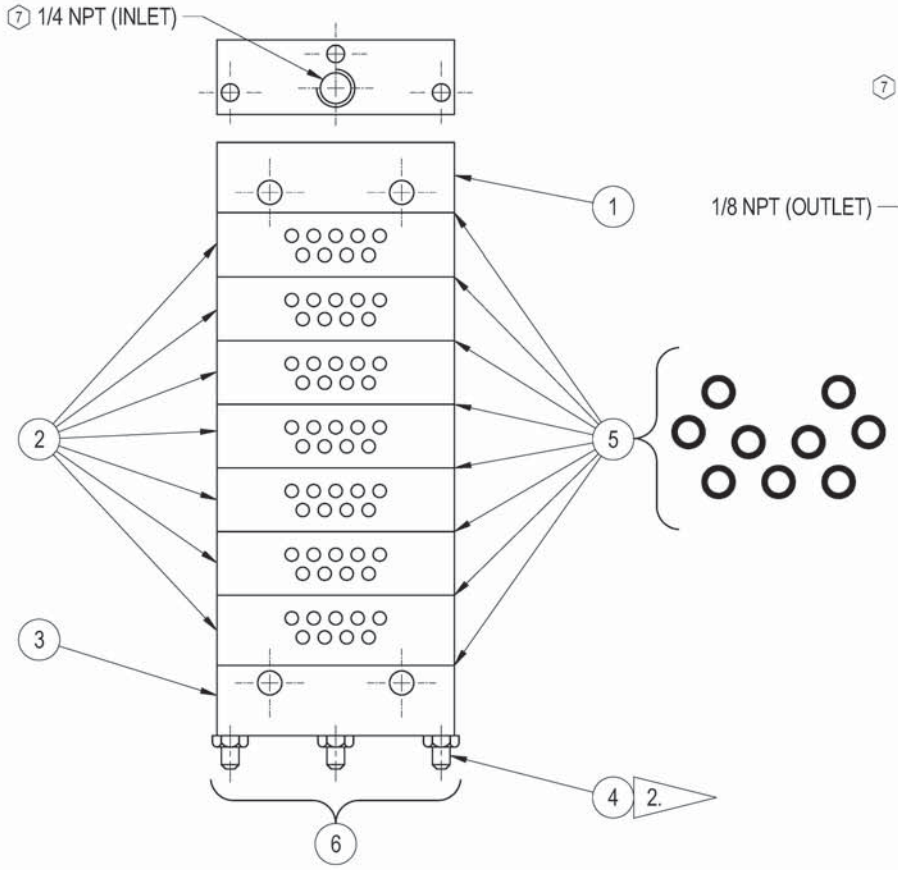
Part No. L-00879

24T-24T-9T-6S **Ref Drawing.** N.A.

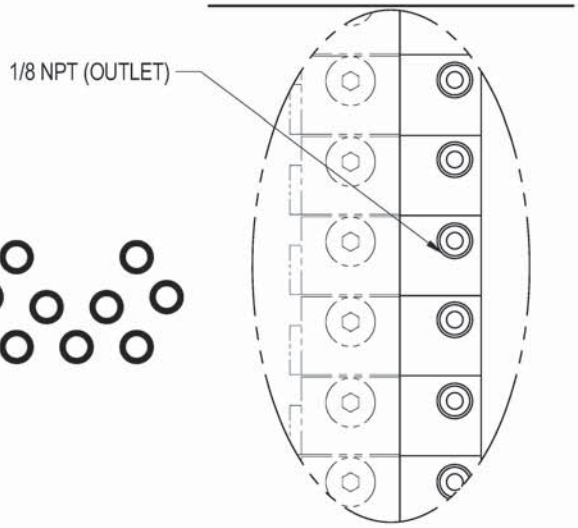
ITEM	PART NUMBER	QTY	UOM	DESCRIPTION

*** ALWAYS PROVIDE SERIAL NUMBER WHEN ORDERING SPARE PARTS. ***
WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT DOES NOT REPRESENT THE QUANTITY REQUIRED.

DISTRIBUTION BLOCK BASE PLATE ASSEMBLY							
NUMBER OF BASE PLATE SECTIONS						ARIEL P/N	ITEM #
3	4	5	6	⑦ 7			
1	1	1	1	⑦ 1	INLET SECTION	A-5537	1
3	4	5	6	⑦ 7	INTERMEDIATE SECTION	A-5531	2
1	1	1	1	⑦ 1	END SECTION	A-5538	3
3					TIE STUD W/ NUT, 3 SECTION 1/4-28 ⑦	A-5539	4
	3				TIE STUD W/ NUT, 4 SECTION 1/4-28 ⑦	A-5540	
		3			TIE STUD W/ NUT, 5 SECTION 1/4-28 ⑦	A-5541	
			3		TIE STUD W/ NUT, 6 SECTION 1/4-28 ⑦	A-5542	
				⑦ 3	TIE STUD W/ NUT, 7 SECTION 1/4-28 ⑦	⑦ A-5854	
36	45	54	63	⑦ 72	O-RING, VITON	A-5703	5
A-5533	A-5534	A-5535	A-5536	⑦ A-11157	COMPLETE BASE PLATE ASSEMBLY	-	6



⑦ RIGHT SIDE VIEW ITEM #2



		5	14799
		4	12506
9	19263	3	10737
8	18914	2	8200
7	17609	1	8175
6	17759	0	5695
REV	ECN	REV	ECN

REV	DESCRIPTION	INIT/DATE
9	SHEET #1 & 3: NO REVISION. SHEET #2: ITEM #3 CONFIGURATIONS: A-5568 WAS A-5567 AND A-5567 WAS A-5568.	CRN 10/28/13

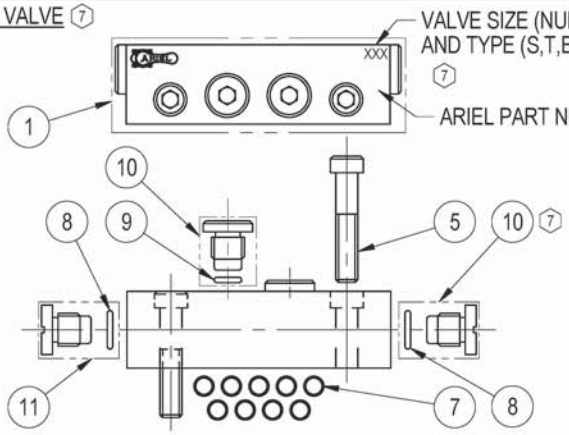
ARIEL CORPORATION
35 BLACKJACK ROAD
MOUNT VERNON, OHIO 43050

TITLE: DISTRIBUTION BLOCK ⑦ COMPONENTS

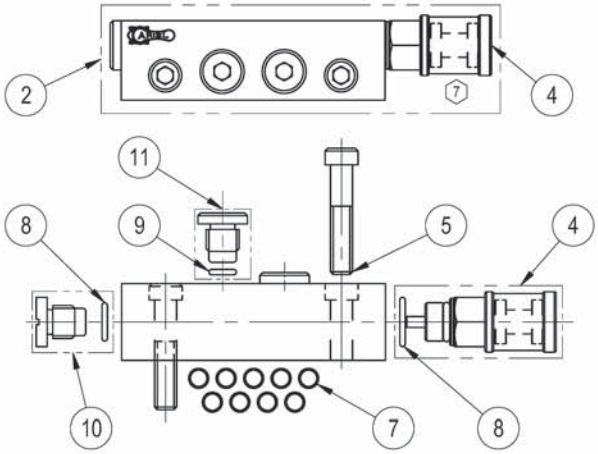
DWG. No. A-5340

SHT 1 OF 3

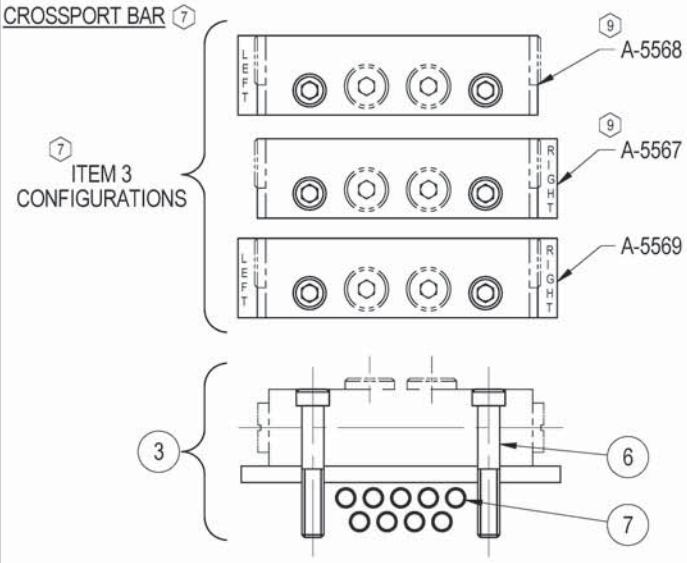
DIVIDER VALVE (7)



DIVIDER VALVE WITH CYCLE INDICATOR PIN (7)



CROSSPORT BAR (7)



ITEM	ARIEL P/N	QTY	DESCRIPTION	
1	A-5543	1	DIVIDER VALVE, 6T	
	A-5545	1	DIVIDER VALVE, 6S	
	A-5547	1	DIVIDER VALVE, 9T	
	A-5549	1	DIVIDER VALVE, 9S	
	A-5551	1	DIVIDER VALVE, 12T	
	A-5553	1	DIVIDER VALVE, 12S	
	A-5555	1	DIVIDER VALVE, 18T	
	A-5557	1	DIVIDER VALVE, 18S	
	A-5559	1	DIVIDER VALVE, 24T	
	A-5561	1	DIVIDER VALVE, 24S	
	A-5563	1	DIVIDER VALVE, 30T	
	A-5565	1	DIVIDER VALVE, 30S	
	A-7807	1	BYPASS SECTION (NOT SHOWN)	(7)
2	A-5544	1	DIVIDER VALVE, 6T W/ CIP	
	A-5546	1	DIVIDER VALVE, 6S W/ CIP	
	A-5548	1	DIVIDER VALVE, 9T W/ CIP	
	A-5550	1	DIVIDER VALVE, 9S W/ CIP	
	A-5552	1	DIVIDER VALVE, 12T W/ CIP	
	A-5554	1	DIVIDER VALVE, 12S W/ CIP	
	A-5556	1	DIVIDER VALVE, 18T W/ CIP	
	A-5558	1	DIVIDER VALVE, 18S W/ CIP	
	A-5560	1	DIVIDER VALVE, 24T W/ CIP	
	A-5562	1	DIVIDER VALVE, 24S W/ CIP	
	A-5564	1	DIVIDER VALVE, 30T W/ CIP	
	A-5566	1	DIVIDER VALVE, 30S W/ CIP	
3	A-5567	1	CROSSPORT BAR, RIGHT	
	A-5568	1	CROSSPORT BAR, LEFT	
	A-5569	1	CROSSPORT BAR, BOTH	
4	A-18682	1	CYCLE INDICATOR (W/ O-RING)	(7)
5	FC0115CH	2	SOC. CAP. 1/4-28 X 1-1/4	
6	FC0115CI	2	SOC. CAP. 1/4-28 X 1-1/2	

A-5706-K O-RING KIT CONTENTS (ITEM 7, 8, & 9)				(7)
7	A-5703	20	O-RING, INTERFACE, VITON	
8	A-5704	4	O-RING, ENCLOSURE, VITON	
9	A-19823	4	O-RING, OUTLET, VITON	(7)
10	A-14300	1	PLUG, SAE, SERIES A W/ O-RING	
	A-16800	1	PLUG, SAE, SERIES B W/ O-RING	
11	A-18405	1	PLUG, NPS, INDICATOR PORT W/ O-RING	

REV	DESCRIPTION	INIT/DATE
9	SHEET #1 & 3: NO REVISION. SHEET #2: ITEM #3 CONFIGURATIONS: A-5568 WAS A-5567 AND A-5567 WAS A-5568.	CRN 10/28/13

REV	ECN	REV	ECN
		5	14799
		4	12506
9	19263	3	10737
8	18914	2	8200
7	17609	1	8175
6	17759	0	5695

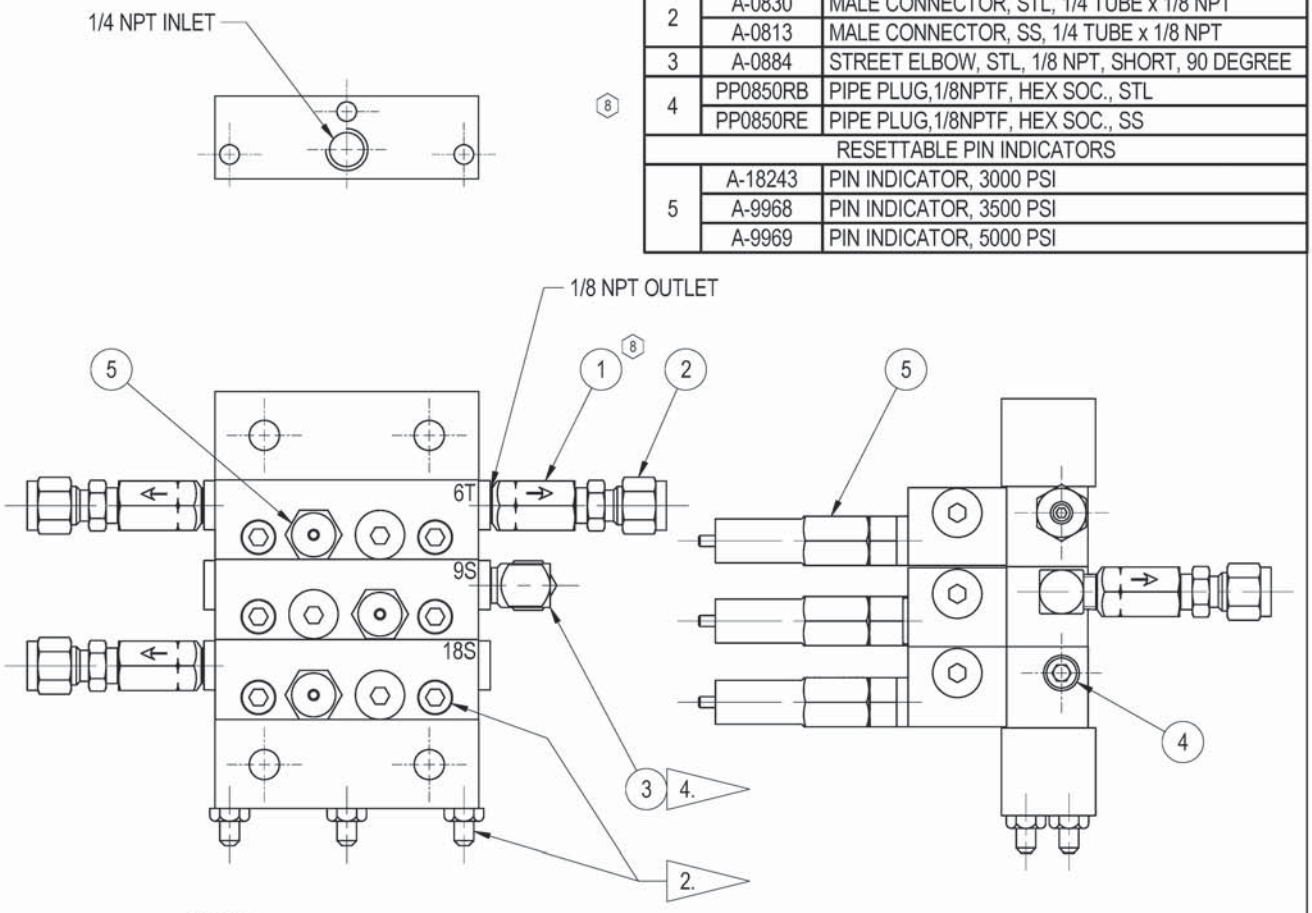
ARIEL CORPORATION
35 BLACKJACK ROAD
MOUNT VERNON, OHIO 43050

TITLE: DISTRIBUTION BLOCK (7) COMPONENTS

DWG. No. A-5340

SHT 2 OF 3

BAESPLATE FITTINGS		
ITEM	ARIEL P/N	DESCRIPTION
1	A-3689	CHECK VALVE 1/8 NPT, SS
2	A-0830	MALE CONNECTOR, STL, 1/4 TUBE x 1/8 NPT
	A-0813	MALE CONNECTOR, SS, 1/4 TUBE x 1/8 NPT
3	A-0884	STREET ELBOW, STL, 1/8 NPT, SHORT, 90 DEGREE
4	PP0850RB	PIPE PLUG,1/8NPTF, HEX SOC., STL
	PP0850RE	PIPE PLUG,1/8NPTF, HEX SOC., SS
RESETTABLE PIN INDICATORS		
5	A-18243	PIN INDICATOR, 3000 PSI
	A-9968	PIN INDICATOR, 3500 PSI
	A-9969	PIN INDICATOR, 5000 PSI



NOTES:

1. ITEM #5 O-RINGS SHOULD BE PURCHASED IN A KIT (A-5706-K) VITON. KIT CONTENTS APPEARS ON SHEET #2, (ITEM 7, 8, & 9).

2. FOR FASTENER TORQUE VALUES REFERENCE ER-63.

3.- ACTUAL DISTRIBUTION BLOCK ASSEMBLY MAY BE DIFFERENT FROM WHAT IS DISPLAYED. REFER TO THE ARIEL LUBE SHEETS FOUND IN CUSTOMER BOOK.

4. EACH BASEPLATE OUTLET FEEDING A LUBE LINE REQUIRES INSTALLING ITEM 1 IN THE 1/8 NPT OUTLET PORT. ITEM 3 MAY BE USED WITH ITEM 1 FOR LIMITED CLEARANCE APPLICATIONS.

5.- RESETTABLE PIN INDICATORS ARE AN OPTIONAL TROUBLESHOOTING TOOL FOR LOCATING LUBE LINE BLOCKAGES THAT CAUSE RUPTURE DISCS TO BURST. THE INDICATOR SIZE AND INSTALLATION LOCATION WILL APPEAR ON THE ARIEL LUBE SHEETS FOR UNITS ORDERED WITH THIS OPTION. REFER TO ER-105.13 FOR OPERATING INSTRUCTIONS AND SIZING INFORMATION.

		5	14799
		4	12506
9	19263	3	10737
8	18914	2	8200
7	17609	1	8175
6	17759	0	5695
REV	ECN	REV	ECN

REV	DESCRIPTION	INIT/DATE
9	SHEET #1 & 3: NO REVISION. SHEET #2: ITEM #3 CONFIGURATIONS: A-5568 WAS A-5567 AND A-5567 WAS A-5568.	CRN 10/28/13

ARIEL CORPORATION
35 BLACKJACK ROAD
MOUNT VERNON, OHIO 43050

TITLE: DISTRIBUTION BLOCK
7 COMPONENTS

DWG. No. A-5340

SHT 3 OF 3

1 ST STAGE CYLINDER



10/15/2016

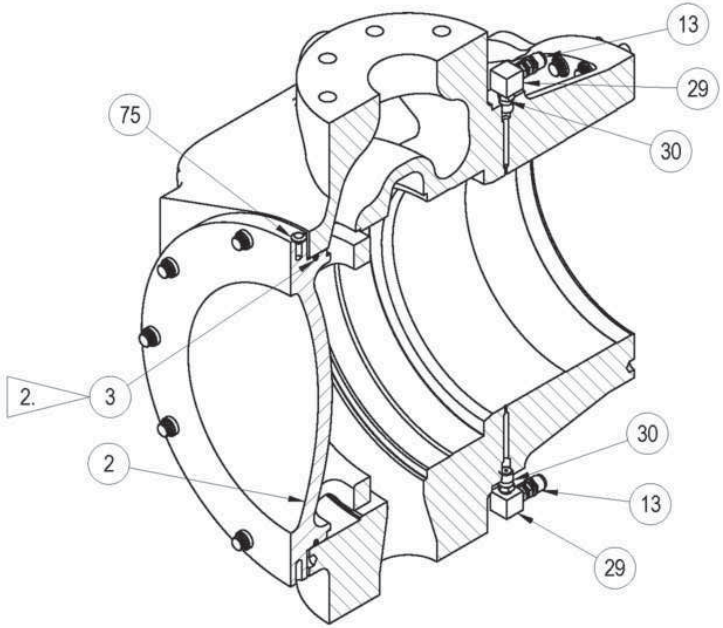
ARIEL CORPORATION

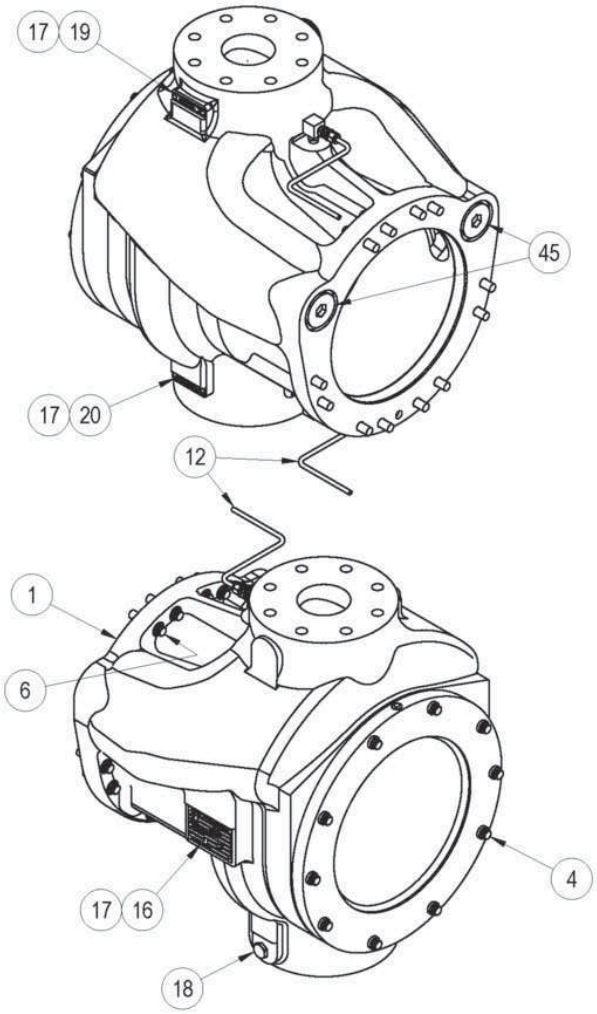
SALES ORDER COVER SHEET

Serial # : C189414

Part # : 10-3/4P HE **Description :** 10-3/4" JGP HE CYLINDER CLASS

Part Number	QTY	Description	Drawing No.
G-20734	1	CYLINDER ASSEMBLY, 10-3/4JGP-HE0, STD, 225 MAWP	A-17826
G-24731	1	CONCENTRIC VALVE ASSEMBLY, 10-3/4P-HE, STANDARD CLEARANCE POSITION	A-22617
G-18526	1	PISTON ASSEMBLY, 10-3/4P-HE0, STD	A-17849
B-7242-GG	1	CONCENTRIC VALVE, 147CT/256CFS	A-17491
G-18897	1	VALVE PULLER, 10-3/4P-HE	A-17801





NOTES:

1.- LOOSEN OR TIGHTEN ALL FASTENERS PER RECOMMENDED PROCEDURES AND TORQUE VALUES IN MANUAL.

2. OIL O-RINGS BEFORE INSTALLING.

3. THIS CYLINDER ASSEMBLY 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.

REV	DESCRIPTION	INIT/DATE

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REV	ECN	REV	ECN
		0	17066

ARIEL CORPORATION
35 BLACKJACK ROAD
MOUNT VERNON, OHIO 43050

DRAWN: CPM 01/21/11
CHECKED: DLI 01/31/11
SCALE: NONE
ASSEMBLY DWG. NO. A-17826
SHT 1 OF 1

10/15/2016

ARIEL CORPORATION

PARTS LIST

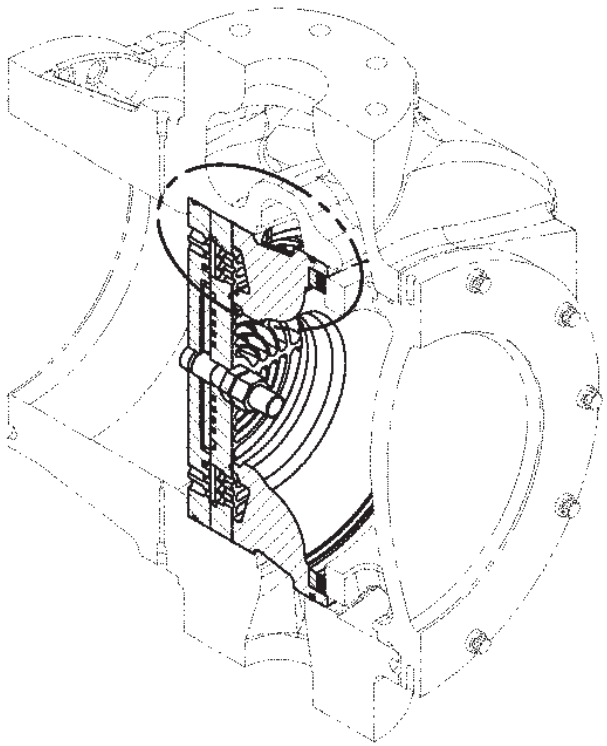
Part No. G-20734

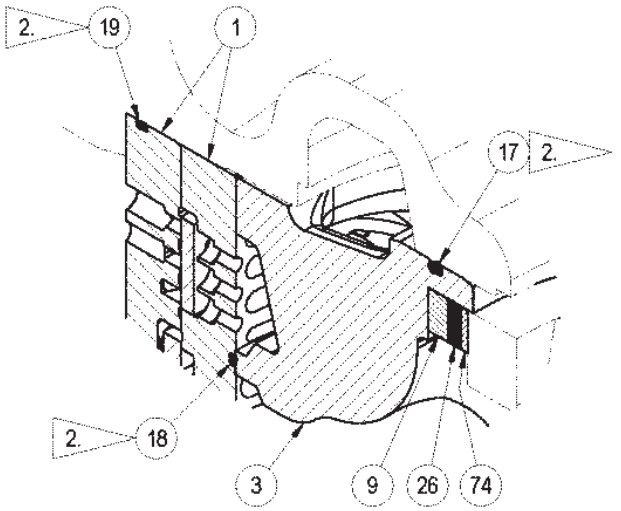
CYLINDER ASSEMBLY, 10-3/4JGP-HE0, STD, 225 MAWP **Ref Drawing.** A-17826

ITEM	PART NUMBER	QTY	UOM	DESCRIPTION
001	D-5893	1		CYLINDER, 10-3/4P-HE0, 225 MAWP
002	C-5970	0		HEAD END HEAD, 10-3/4P-HE, 225 MAWP CYLINDER
003	A-0469	1		O-RING, VT, 13.395 OD X .210, 75/85 DUROMETER
004	FC0120GM	10		12-POINT CAPSCREW, 1/2-13 X 2-1/2, G8
006	FC0120GK	12		12-POINT CAPSCREW, 1/2-13 X 2, G8
012	PT0200CB	36	IN	TUBING, SS, 1/4 OD X .035 WALL
013	A-18496	2		CHECK VALVE, DOUBLE BALL, 1/4 TUBE X 1/8 NPT, SS
016	A-0465	1		DATA PLATE, CYLINDER SPECIFICATION, 3-1/2 X 2-1/4
017	FR0571CC	8		DRIVE SCREW, TYPE U, SS, #6 X 1/4
018	PP0810GB	1		PIPE PLUG, HEX HEAD, 1/2 NPT, STL
019	A-0640-A	1		INFORMATION PLATE, SUCTION
020	A-0640-B	1		INFORMATION PLATE, DISCHARGE
029	A-17774	2		OIL TRAP, BODY, SS, 1/8 NPT
030	A-17776	2		OIL TRAP, STEM, SS, 1/4 NPT
045	PP0861LB	2		SAE PLUG, SOCKET HEAD, #24, 1-7/8-12
075	A-0467	2		PUSH-IN PLUG, PLASTIC, 3/8 THREAD, YELLOW
900	A-15763	2		COVER, SHIPPING FLANGE, 3.00" - 300#, SM
900	A-15795	2		LATHE CUT SEAL,3-1/2 ID X .234, 70 DUROMETER, NITRILE
900	FC0102IG	16		HEX HEAD CAPSCREW, 3/4-10 X 1", G5

*** ALWAYS PROVIDE SERIAL NUMBER WHEN ORDERING SPARE PARTS. ***

WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT DOES NOT REPRESENT THE QUANTITY REQUIRED.





0.0 IN³
ADDED FIXED CLEARANCE

NOTES:

1. SEE SHEET #2 FOR ALL ALTERNATE FIXED VOLUME CLEARANCE CONFIGURATIONS.

2. OIL O-RING BEFORE INSTALLING.

3. DETAIL VIEWS SHOW EACH ALTERNATE CONFIGURATION FOR HIGH CLEARANCE VALVE SPACER LOCATIONS (ITEMS #9, #26 & #74).

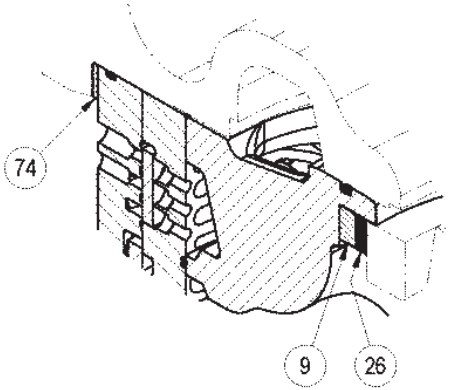
4. THIS VALVE ASSEMBLY IS FOR ILLUSTRATION PURPOSES ONLY AND MAY NOT NECESSARILY REPRESENT THE EXACT CONFIGURATION PERTAINING TO THE UNIT ORDERED. REFER TO ACCOMPANYING PARTS LIST FOR ITEMS (AND QUANTITIES OF EACH) REQUIRED FOR THIS PARTICULAR ASSEMBLY.

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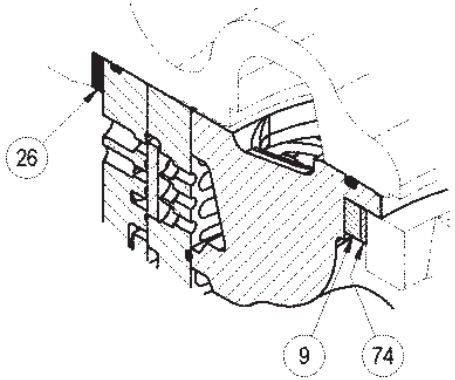
REV	ECN	REV	ECN
		0	19783

ARIEL CORPORATION
35 BLACKJACK ROAD
MOUNT VERNON, OHIO 43050

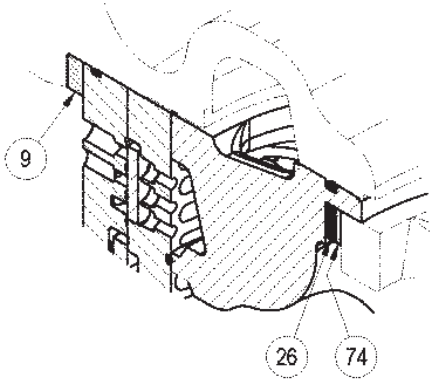
DRAWN JJP 12/18/14
CHECKED CPM 12/23/14
SCALE NONE
ASSEMBLY DWG NO A-22617
SHT 1 OF 2



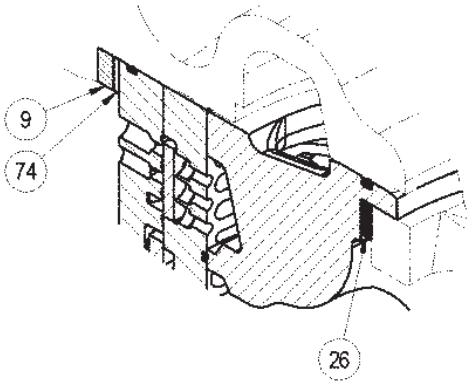
11.3 IN³
ADDED FIXED CLEARANCE



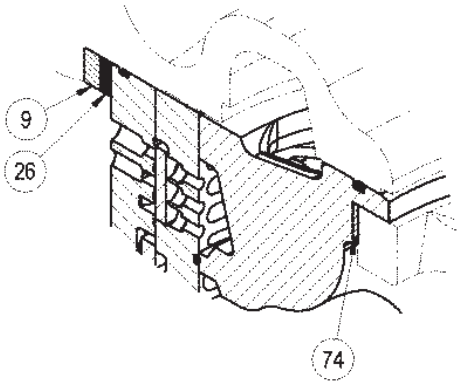
22.7 IN³
ADDED FIXED CLEARANCE



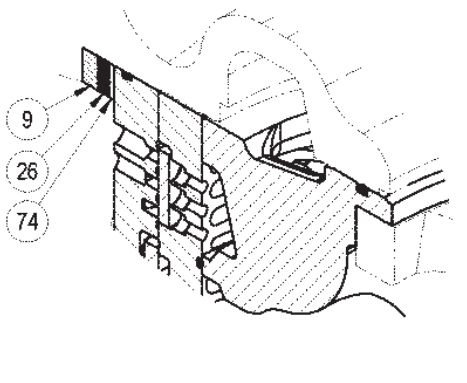
34.0 IN³
ADDED FIXED CLEARANCE



45.3 IN³
ADDED FIXED CLEARANCE



56.7 IN³
ADDED FIXED CLEARANCE



68.0 IN³
ADDED FIXED CLEARANCE

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REV	ECN	REV	ECN
		0	19783

ARIEL CORPORATION
35 BLACKJACK ROAD
MOUNT VERNON, OHIO 43050

DRAWN JJP 12/18/14
CHECKED CPM 12/23/14
SCALE NONE
ASSEMBLY DWG NO A-22617
SHT 2 OF 2

10/15/2016

ARIEL CORPORATION

PARTS LIST

Part No. G-24731

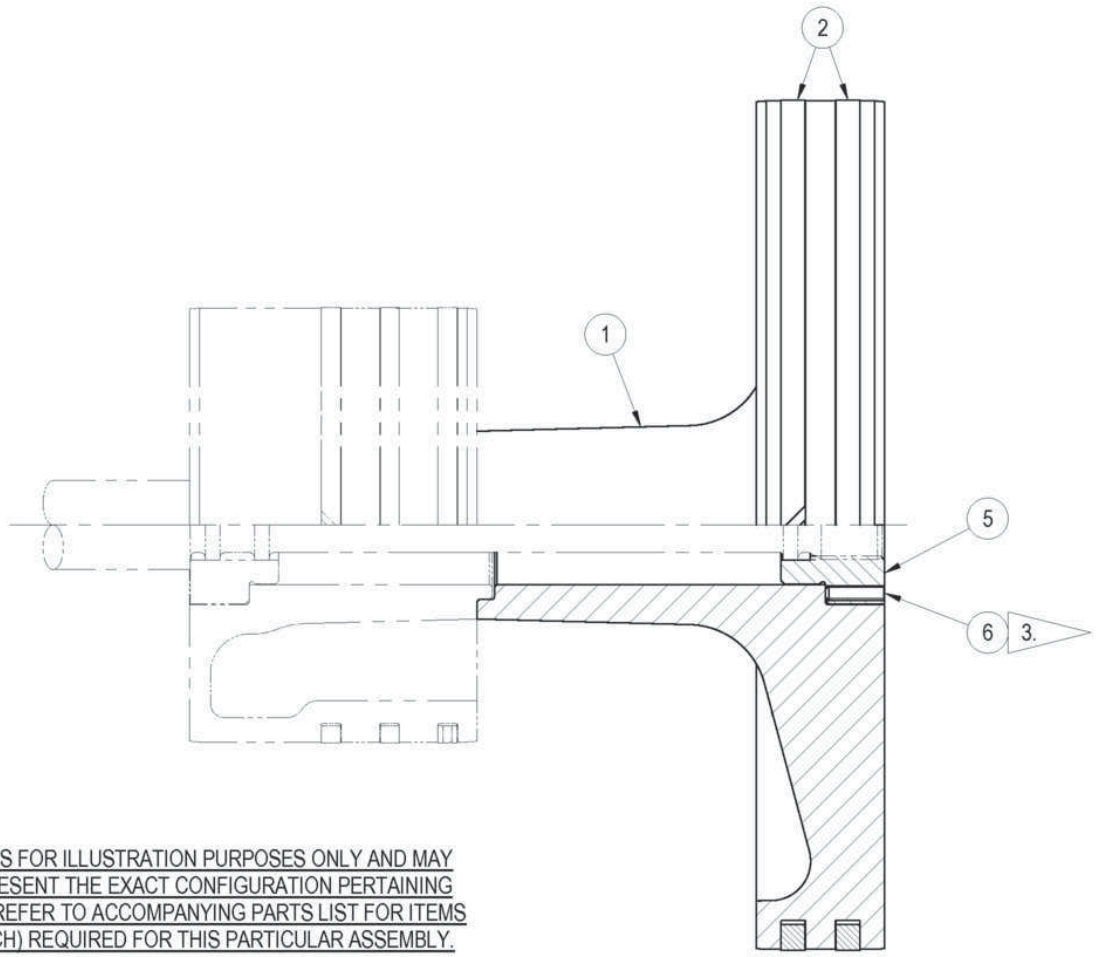
CONCENTRIC VALVE ASSEMBLY, 10-3/4P-HE, STANDARD CLEARANCE POSITION

Ref Drawing. A-22617

ITEM	PART NUMBER	QTY	UOM	DESCRIPTION
001	CONCENTRIC VLV.	0		FOR PART NO. SEE COVER SHEET
003	B-5717	1		VALVE RETAINER, 10-3/4P-HE
009	A-17455	1		HIGH CLEARANCE VALVE SPACER, 10-3/4P-HE, 34.0 CUBIC INCH
017	A-0653	1		O-RING, VT, 12.395 OD X .210, 75/85 DUROMETER
018	A-10434	1		O-RING, VT, 6.512 OD X .139, 75/85 DUROMETER
019	A-15072	1		O-RING, VT, 11.895 OD X .210, 75/85 DUROMETER
026	A-22545	1		HIGH CLEARANCE VALVE SPACER, 10-3/4P-HE, 22.7 CUBIC INCHES
074	A-22546	1		HIGH CLEARANCE VALVE SPACER, 10-3/4P-HE, 11.3 CUBIC INCHES

*** ALWAYS PROVIDE SERIAL NUMBER WHEN ORDERING SPARE PARTS. ***

WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT DOES NOT REPRESENT THE QUANTITY REQUIRED.



NOTES:

1.- THIS PISTON ASSEMBLY 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 MANUAL FOR RECOMMENDED PROCEDURES AND TORQUE VALUES FOR ASSEMBLY OR REASSEMBLY OF THIS UNIT.

3. PRICK PUNCH TO RETAIN SET SCREWS (ITEM #6).

REV	DESCRIPTION	INIT/DATE

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REV	ECN	REV	ECN
		0	17066

ARIEL CORPORATION
35 BLACKJACK ROAD
MOUNT VERNON, OHIO 43050

DRAWN: CPM 01/26/11
CHECKED: KRN 01/28/11
SCALE: NONE
ASSEMBLY DWG. NO. A-17849
SHT 1 OF 1

10/15/2016

ARIEL CORPORATION

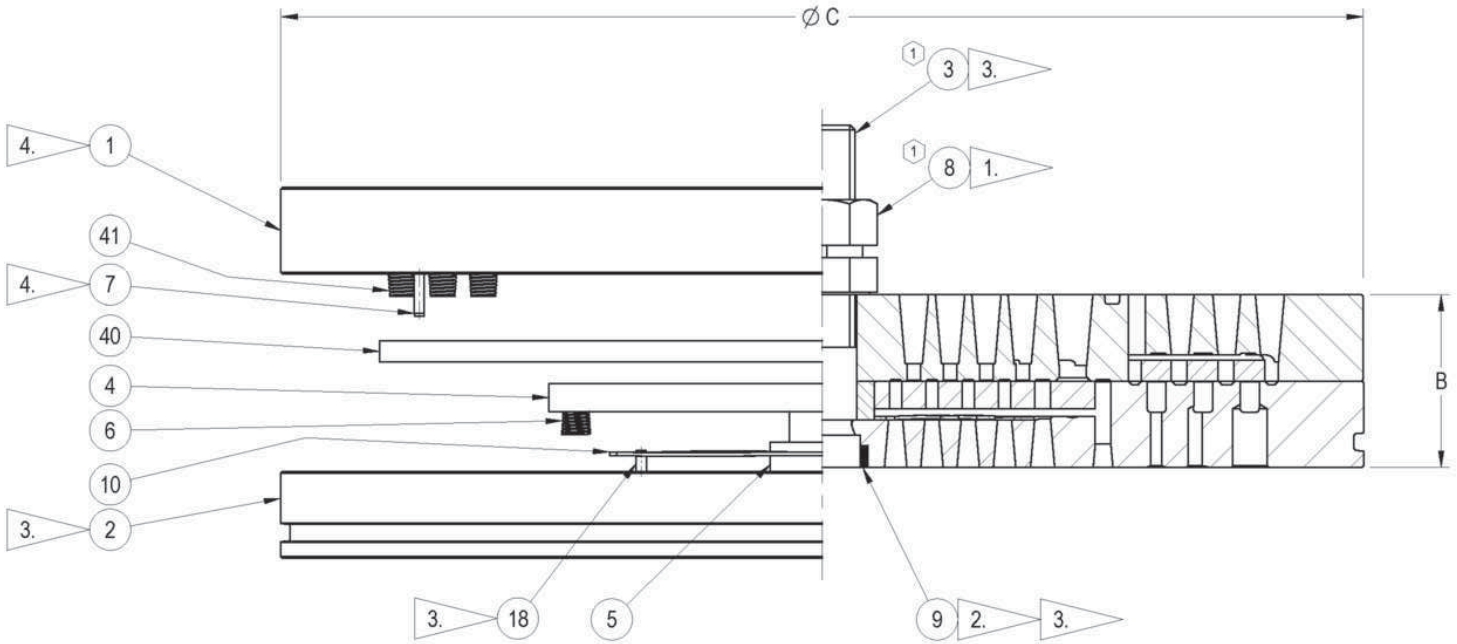
PARTS LIST

Part No. G-18526

PISTON ASSEMBLY, 10-3/4P-HE0, STD **Ref Drawing.** A-17849

ITEM	PART NUMBER	QTY	UOM	DESCRIPTION
001	C-5974	1		PISTON, 10-3/4P-HE, 3.000 & 3.500 STROKE
002	A-17457	2		PISTON RING, 10-3/4P-HE
005	B-0019	1		PISTON NUT, 2-1/4" THROUGH 8" PISTONS, JG:A:M:P
006	FS0405BE	2		SET SCREW, CUP POINT, #10-32 X 3/4

*** ALWAYS PROVIDE SERIAL NUMBER WHEN ORDERING SPARE PARTS. ***
WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT DOES NOT REPRESENT THE QUANTITY REQUIRED.



NOTES:

1. SEE MANUAL FOR TORQUING VALUES (ITEM #8).
2. INSTALL PER ER-52.
3. LOWER PART ASSEMBLY (ITEM #2) CONSISTS OF LOWER PART, CENTER STUD (ITEM #3), DOWEL PIN (ITEM #9) AND SPIROL PIN (ITEM #18).
4. UPPER PART ASSEMBLY (ITEM #1) CONSISTS OF UPPER PART AND SPIROL PIN (ITEM #7).

REV	DESCRIPTION	INIT/DATE
1	AT C3 REVISED VIEW OF LOCKNUT (ITEM 8) AND CENTER STUD (ITEM 3) TO SHOW DRAKE LOCKNUT WAS A GREER LOCKNUT AND LONGER CENTER STUD.	MLB 01/10/2011

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DIMENSIONS ARE IN INCHES UNLESS OTHERWISE SPECIFIED.
--- DO NOT SCALE DRAWING ---

REV	ECN
1	17265
0	17066

ARIEL CORPORATION
35 BLACKJACK ROAD
MOUNT VERNON, OHIO 43050

TITLE: CONCENTRIC VALVE

MATERIAL: PROCURED

DRAWN: KSL 11/05/10 — R.S. No.

CHECKED: DLI 12/17/10 — PART NO.

SCALE: NONE — DWG. No: A-17491

SHT 1 OF 1

10/15/2016

ARIEL CORPORATION

PARTS LIST

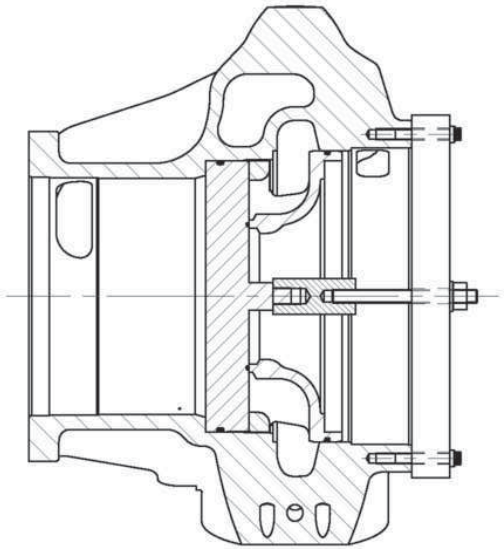
Part No. B-7242-GG

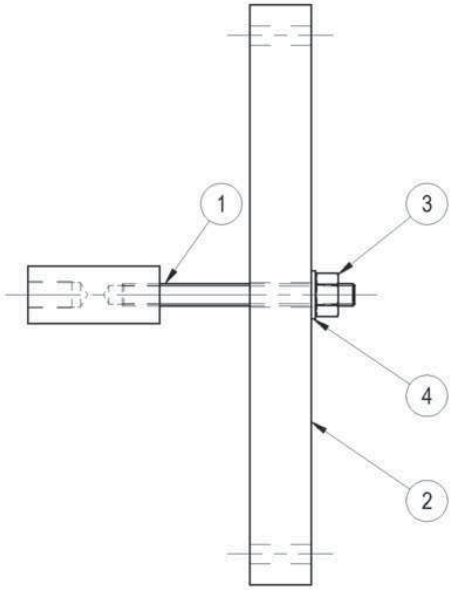
CONCENTRIC VALVE, 147CT/256CFS **Ref Drawing.** A-17491

0.0000=A
1.9690=B
12.323=C
0.0870=LFT

ITEM	PART NUMBER	QTY	UOM	DESCRIPTION
001	A-22008-A	1		UPPER PART ASSEMBLY, CONCENTRIC VALVE
002	A-22009-A	1		LOWER PART ASSEMBLY, CONCENTRIC VALVE
003	A-17800	1		CENTER STUD, 3/4-16 X 3.898 LONG
004	A-15670	1		VALVE PLATE, 147CT, .315 THICK, PC
005	A-17910	1		GUIDE RING, 147CT/256CFS, .441 THICK
006	A-1344	32		SPRING (.354/.276 OD X .630 FREE LENGTH) GREEN, .026 WIRE DIAMETER
007	A-2039	2		SPIROL PIN, .118 OD X .591 LONG
008	A-1462	1		LOCKNUT, DRAKE, 3/4-16
009	A-1481	1		DOWEL PIN, .150 OD X .323 LONG
010	A-2858	1		WAFER PLATE, 147CHT
018	A-2941	2		SPIROL PIN, .118 OD X .787 LONG
040	A-17487	1		VALVE PLATE, 256CFS, .315 THICK, PC
041	A-12064	16		SPRING (.354 OD X .669 FREE LENGTH) GREEN, .041 WIRE DIAMETER
099	KB-7242-GG	0		KIT, CONCENTRIC VALVE, 147CT/256CFS

*** ALWAYS PROVIDE SERIAL NUMBER WHEN ORDERING SPARE PARTS. ***
WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT DOES NOT REPRESENT THE QUANTITY REQUIRED.





AS SHIPPED

NOTES:

1.- DEPRESSURIZE THE CYLINDER AND REMOVE VALVE CAP, (REFER TO TECHNICAL MANUAL FOR FURTHER INSTRUCTIONS).

2.- LOOSEN THE PULLER NUT (ITEM #3) UNTIL THERE IS ENOUGH LENGTH TO INSERT THE VALVE PULLER ASSEMBLY (ITEM #1) INTO THE VALVE POCKET. ATTACH PULLER BAR (ITEM #2) TO CLYINDER USING TWO VALVE CAP BOLTS. THREAD THE VALVE PULLER ASSEMBLY ONTO THE THREADED STUD ON THE VALVE.

3.- TIGHTEN THE NUT (ITEM #3) ON THE VALVE PULLER ASSEMBLY UNTIL THE RETAINER AND VALVE O-RINGS HAVE CLEARED THEIR BORES.

4.- CAREFULLY REMOVE VALVE ASSEMBLY FROM CYLINDER.
CAUTION: ASSEMBLY WILL BE VERY HEAVY.

REV	DESCRIPTION	INIT/DATE

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REV	ECN	REV	ECN
		0	17066

ARIEL CORPORATION
35 BLACKJACK ROAD
MOUNT VERNON, OHIO 43050

DRAWN: CPM 01/09/11
CHECKED: DLI 01/12/11
SCALE: NONE
ASSEMBLY DWG. NO. A-17801
SHT 1 OF 1

10/15/2016

ARIEL CORPORATION

PARTS LIST

Part No. G-18897

VALVE PULLER, 10-3/4P-HE

Ref Drawing. A-17801

ITEM	PART NUMBER	QTY	UOM	DESCRIPTION
001	A-17749	0		VALVE PULLER ASSEMBLY, 5/8-11
002	B-5807	0		VALVE PULLER BAR, 10-3/4P-HE
003	FN0451HD	0		HEX NUT, HEAVY WEIGHT, 2H, 5/8-11
004	FW0502IA	0		WASHER,5/8 STEEL
005	AB-5806	1		VALVE PULLER, 10-3/4P-HE

*** ALWAYS PROVIDE SERIAL NUMBER WHEN ORDERING SPARE PARTS. ***

WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT DOES NOT REPRESENT THE QUANTITY REQUIRED.

2ND STAGE CYLINDER



10/15/2016

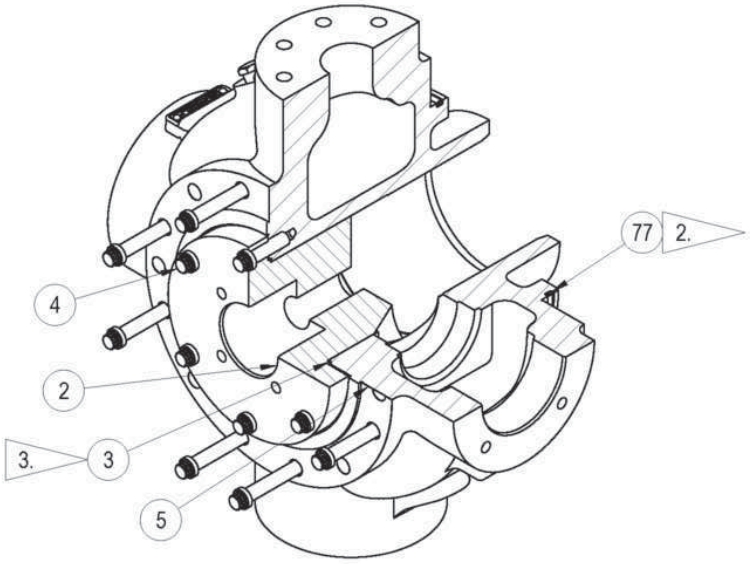
ARIEL CORPORATION

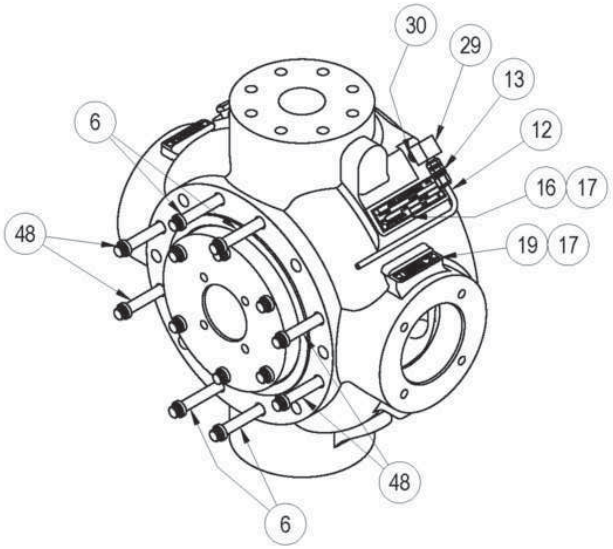
SALES ORDER COVER SHEET

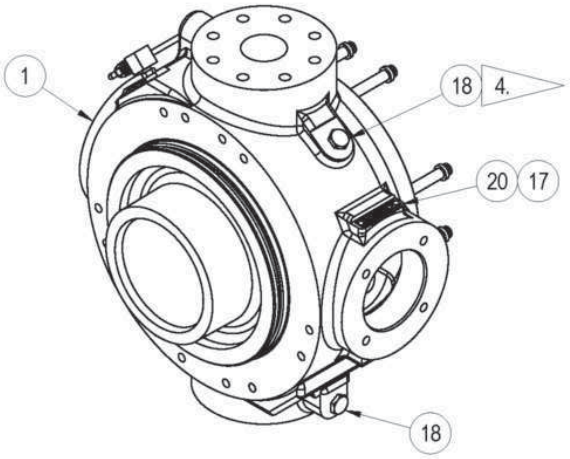
Serial # : C189423

Part # : 5-1/2P CE **Description :** 5-1/2" JGP CE CYLINDER CLASS

Part Number	QTY	Description	Drawing No.
G-20733	1	CYLINDER ASSEMBLY, 5-1/2JGP-CE, STD, 525 MAWP	A-17825
G-18742	1	SUC VLV ASSY, 5-1/2P-CE	B-0144
G-18741	1	DIS VLV ASSY, 5-1/2P-CE	B-0145
G-25695	1	PISTON ASSEMBLY, 5-1/2P-CE0, STD	A-23813
B-5091-CC	1	SUCTION VALVE, 79CRE, MTX	A-9277
B-5092-ZM	1	DISCHARGE VALVE, 79CRE, PK	A-9255







NOTES:

1.- LOOSEN OR TIGHTEN ALL FASTENERS PER RECOMMENDED PROCEDURES AND TORQUE VALUES IN MANUAL.

2. OIL O-RINGS BEFORE INSTALLING.

3. APPLY AN ANTI-SEIZE LUBRICANT TO BOTH SIDES OF GASKET SURFACES.

4. USED TO PLUG INDICATOR PASSAGES WHERE APPLICABLE.

5. THIS CYLINDER ASSEMBLY 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.

REV	DESCRIPTION	INIT/DATE

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REV	ECN	REV	ECN
		0	17066

ARIEL CORPORATION
35 BLACKJACK ROAD
MOUNT VERNON, OHIO 43050

DRAWN: CPM 01/19/11
CHECKED: DLI 01/21/11
SCALE: NONE
ASSEMBLY DWG. NO. A-17825
SHT 1 OF 1

10/15/2016

ARIEL CORPORATION

PARTS LIST

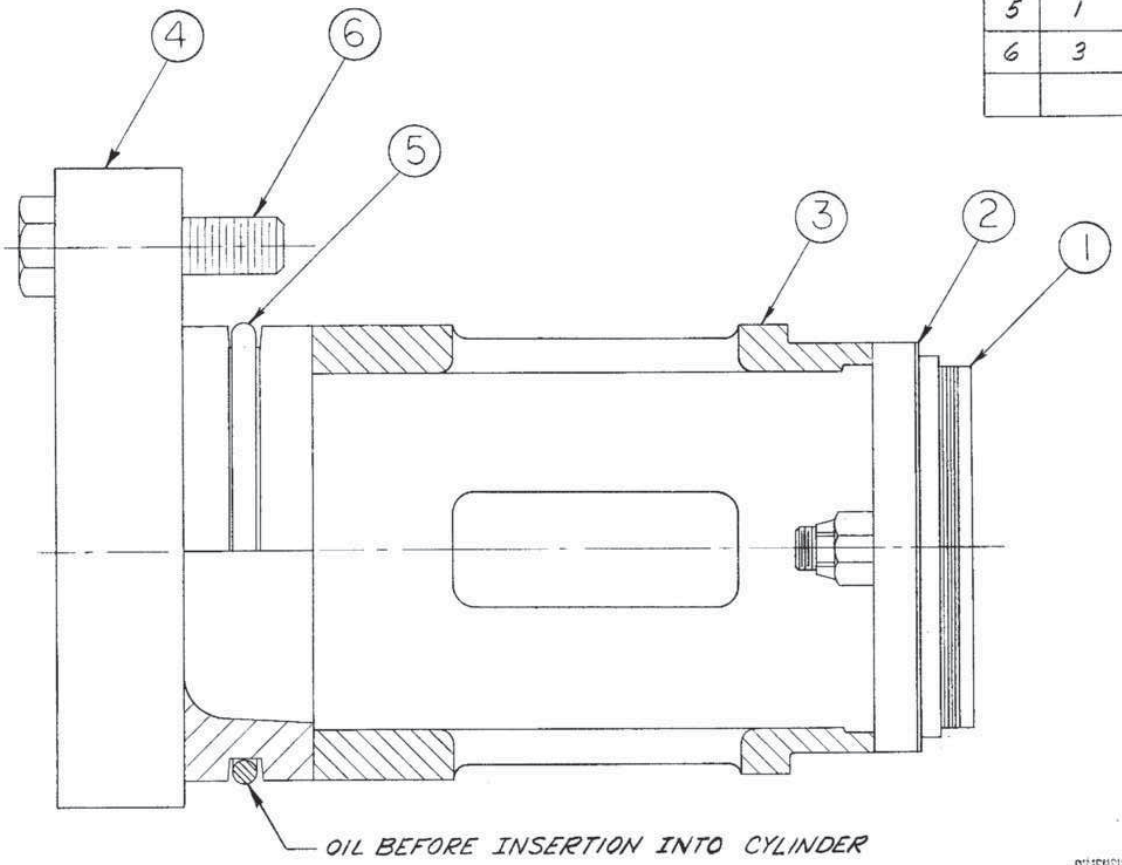
Part No. G-20733

CYLINDER ASSEMBLY, 5-1/2JGP-CE, STD, 525 MAWP **Ref Drawing.** A-17825

ITEM	PART NUMBER	QTY	UOM	DESCRIPTION
001	D-5915	1		CYLINDER, 5-1/2P-CE, 525 MAWP
002	C-5999	0		CRANK END HEAD, 5-1/2P-CE
003	A-17591	1		STEEL GASKET, 05.813 OD X 05.625 ID X .060, HEAD
004	FC0120GJ	6		12-POINT CAPSCREW, 1/2-13 X 1-3/4, G8
005	A-0065	1		FIBER GASKET, 12.000 OD X 09.015 ID X .015, CYLINDER TO DISTANCE PIECE, JG:M:P
006	FC0120GP	4		12-POINT CAPSCREW, 1/2-13 X 3-1/4, G8
012	PT0200CB	18	IN	TUBING, SS, 1/4 OD X .035 WALL
013	A-18496	1		CHECK VALVE, DOUBLE BALL, 1/4 TUBE X 1/8 NPT, SS
016	A-0576	1		DATA PLATE, CYLINDER SPECIFICATION, 4 X 1-1/8
017	FR0571CC	8		DRIVE SCREW, TYPE U, SS, #6 X 1/4
018	PP0810GB	2		PIPE PLUG, HEX HEAD, 1/2 NPT, STL
019	A-0640-A	1		INFORMATION PLATE, SUCTION
020	A-0640-B	1		INFORMATION PLATE, DISCHARGE
029	A-17774	1		OIL TRAP, BODY, SS, 1/8 NPT
030	A-17776	1		OIL TRAP, STEM, SS, 1/4 NPT
048	FC0120GO	4		12-POINT CAPSCREW, 1/2-13 X 3, G8
077	A-3511	1		O-RING, VT, 10.395 OD X .210, 75/85 DUROMETER
900	A-15750	2		COVER, SHIPPING FLANGE, 2.00" - 300#:600# ANSI
900	A-15795	2		LATHE CUT SEAL,3-1/2 ID X .234, 70 DUROMETER, NITRILE
900	FC0102HG	16		HEX HEAD CAPSCREW, 5/8-11 X 1", G5

*** ALWAYS PROVIDE SERIAL NUMBER WHEN ORDERING SPARE PARTS. ***
WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT DOES NOT REPRESENT THE QUANTITY REQUIRED.

NO.	QUAN REQD.	DESCRIPTION	G-187-2
1	1	SUCTION VALVE	
2	1	GASKET, STEEL	
3	1	VALVE RETAINER, SUCTION	
4	1	VALVE CAP	
5	1	O-RING	
6	3	CAPSCREW	



DIMENSIONING AND TOLERANCING PER ARIEL SPECIFICATION ER-17.0.01
UNLESS OTHERWISE SPECIFIED PER ECN #6203

ARIEL CORPORATION
MT. VERNON, OHIO

SUCT. VALVE, RETAINER, CAP ASSY.
5 1/8" M CLASS

MATERIAL	
DRAWN JEC 6-23-75	PART NO. B-144
CHECKED JFG 7-15-75	
SCALE —	

10/15/2016

ARIEL CORPORATION

PARTS LIST

Part No. G-18742

SUC VLV ASSY, 5-1/2P-CE

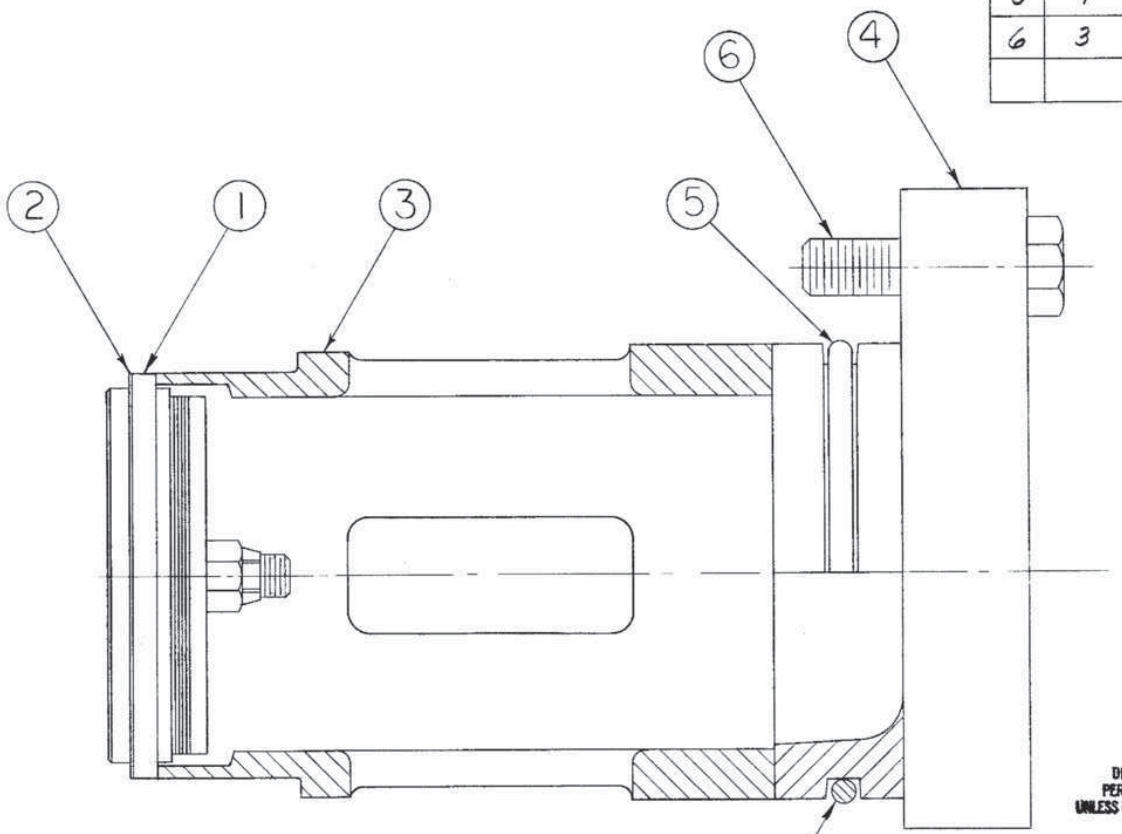
Ref Drawing. B-0144

ITEM	PART NUMBER	QTY	UOM	DESCRIPTION
001	SUCTION VALVE	0		FOR VALVE PART NUMBER, SEE COVER SHEET
002	A-15600	1		STEEL GASKET, 03.575 OD X 03.406 ID X .030, VALVE
003	B-5746	1		VLV RET,SUC, 5-1/2P-CE
004	B-5757	1		VALVE CAP, 5-1/2P-CE
005	A-0026	1		O-RING, VT, 3.895 OD X .210, 75/85 DUROMETER
006	FC0171CED	4		12-POINT CAPSCREW, 1/2-13 X 2 X 9/16, G8

*** ALWAYS PROVIDE SERIAL NUMBER WHEN ORDERING SPARE PARTS. ***

WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT DOES NOT REPRESENT THE QUANTITY REQUIRED.

NO.	QUAN. REQD.	DESCRIPTION	G-188-2
1	1	DISCHARGE VALVE	
2	1	GASKET, STEEL	
3	1	VALVE RETAINER, DISCHARGE	
4	1	VALVE CAP	
5	1	O-RING	
6	3	CAPSCREW	



DIMENSIONING AND TOLERANCING PER ARIEL SPECIFICATION ER-17.0.01 UNLESS OTHERWISE SPECIFIED PER ECN #6203

ARIEL CORPORATION
MT. VERNON, OHIO

DISCH. VALVE, RETAINER, CAP ASSY. 5 1/8" M CLASS

MATERIAL

DRAWN JEC 6-23-75

CHECKED JPB 7-15-75

SCALE 1

PART NO. B-145

10/15/2016

ARIEL CORPORATION

PARTS LIST

Part No. G-18741

DIS VLV ASSY, 5-1/2P-CE

Ref Drawing. B-0145

ITEM	PART NUMBER	QTY	UOM	DESCRIPTION
001	DISCHARGE VALVE	0		FOR VALVE PART NUMBER, SEE COVER SHEET
002	A-15600	1		STEEL GASKET, 03.575 OD X 03.406 ID X .030, VALVE
003	B-5745	1		VLV RET,DIS, 5-1/2P-CE
004	B-5757	1		VALVE CAP, 5-1/2P-CE
005	A-0026	1		O-RING, VT, 3.895 OD X .210, 75/85 DUROMETER
006	FC0171CED	4		12-POINT CAPSCREW, 1/2-13 X 2 X 9/16, G8

*** ALWAYS PROVIDE SERIAL NUMBER WHEN ORDERING SPARE PARTS. ***
WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT DOES NOT REPRESENT THE QUANTITY REQUIRED.

NOTES:

1. 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.

2. REFER TO MANUALS FOR RECOMMENDED PROCEDURES AND TORQUE VALUES FOR ASSEMBLY OR REASSEMBLE.

3. OIL O-RING BEFORE INSTALLING.

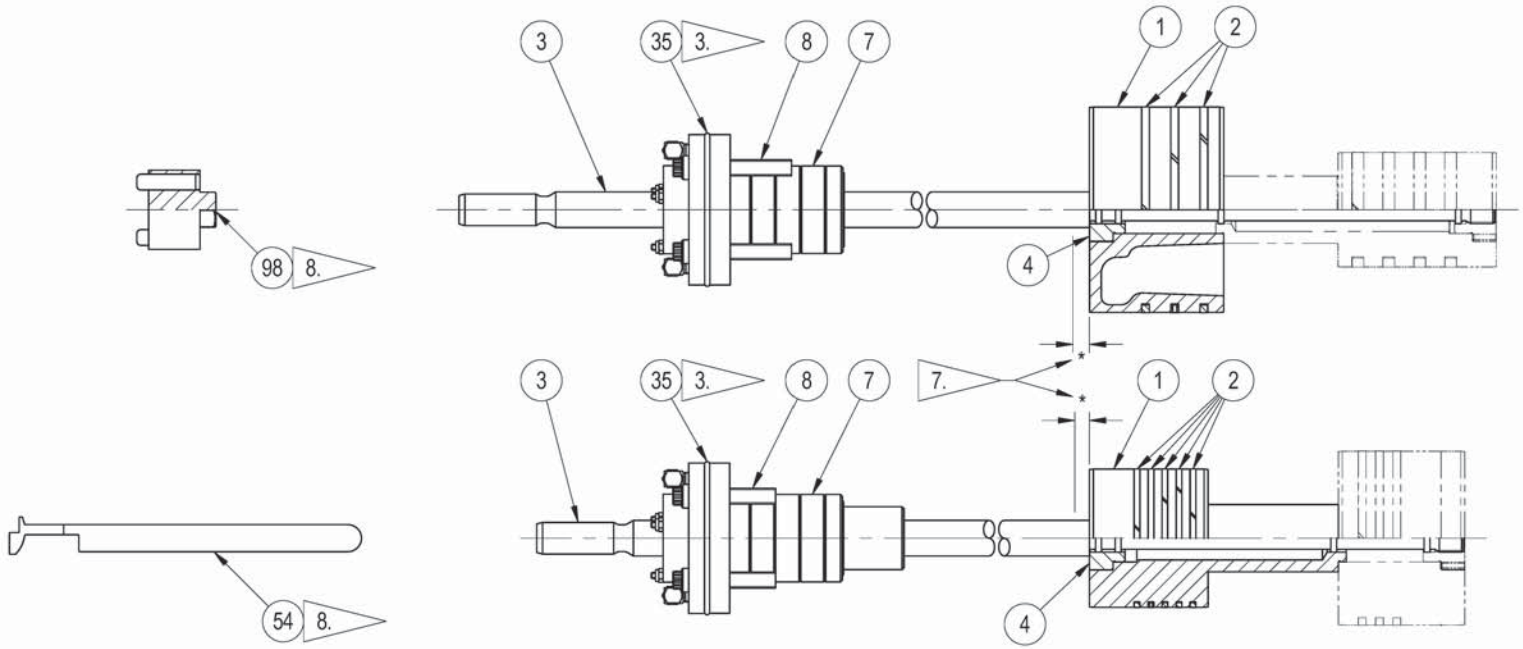
4. REFER TO SHEET #2 AND #3 FOR PACKING TUBE LINE CONFIGURATION.

5. ASSEMBLE FITTINGS BEFORE INSTALLING PACKING.

6. RETIGHTEN TIE STUD NUTS AFTER PACKING CASE (ITEM #7) IS BOLTED TO CYLINDER.

7. REMOVE C.E. SUCTION VALVE TO ADJUST C.E. PISTON CLEARANCE. (SEE CYLINDER SPECIFICATION DATA PLATE OR MANUAL). **DO NOT USE STRAP WRENCH ON PISTON ROD -** USE TURNING TOOL WHICH FITS TURNING HOLES IN PISTON ROD.

8. PISTON NUT SPANNER (ITEM #98) & CRANK END CLEARANCE TOOL (ITEM # 54) ARE SHIPPED IN TOOL BOX, WHEN REQUIRED.



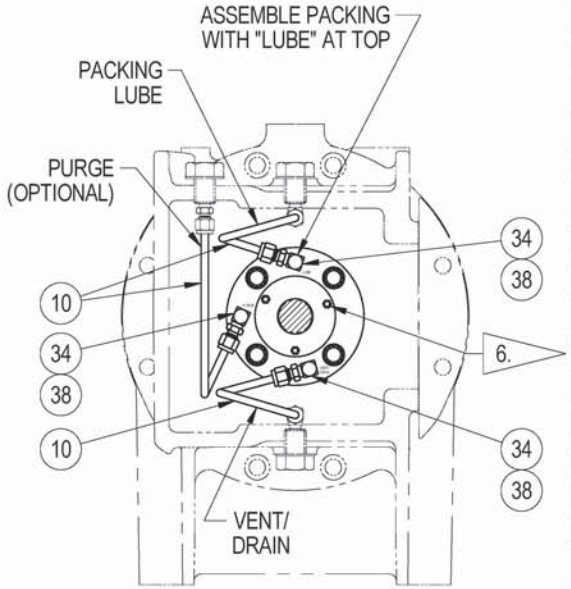
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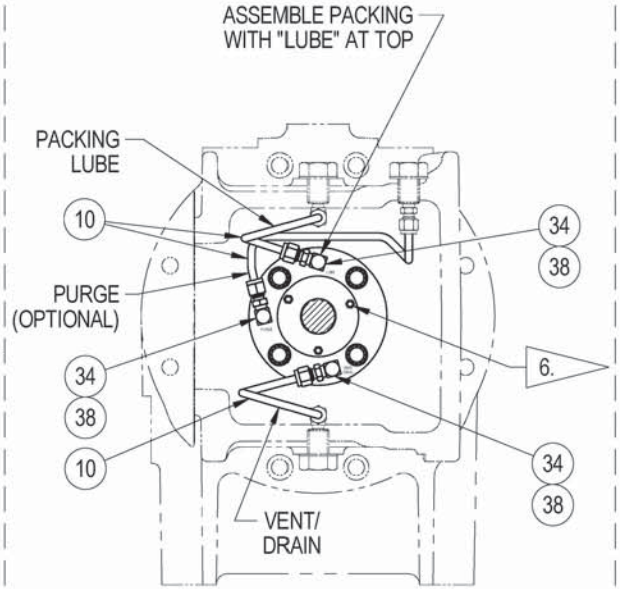
VER	ECN
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0	201600406

ARIEL CORPORATION
35 BLACKJACK ROAD
MOUNT VERNON, OHIO 43050

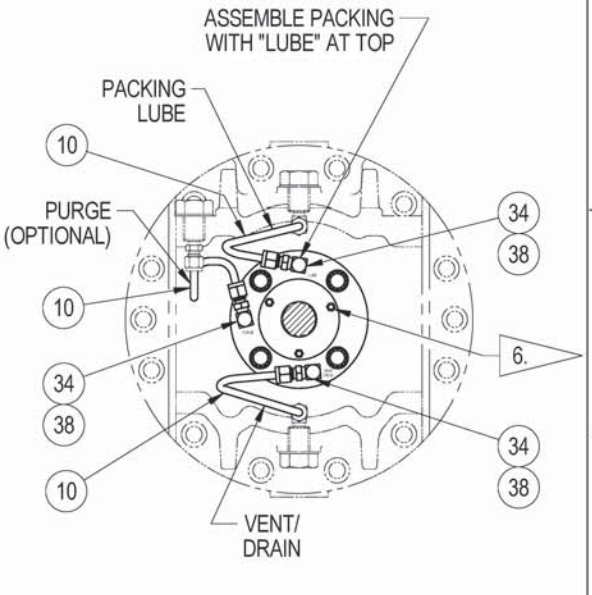
DRAWN: JJP 05/03/16
CHECKED: CPM 05/03/16
SCALE: NONE
ASSEMBLY DWG. NO. A-23813
SHT 1 OF 3



① JGM:P:N:Q/1



① JGM:P:N:Q/2



① JG:A
(STD GUIDE)

FOUR BOLT PACKING NON-COOLED CASES

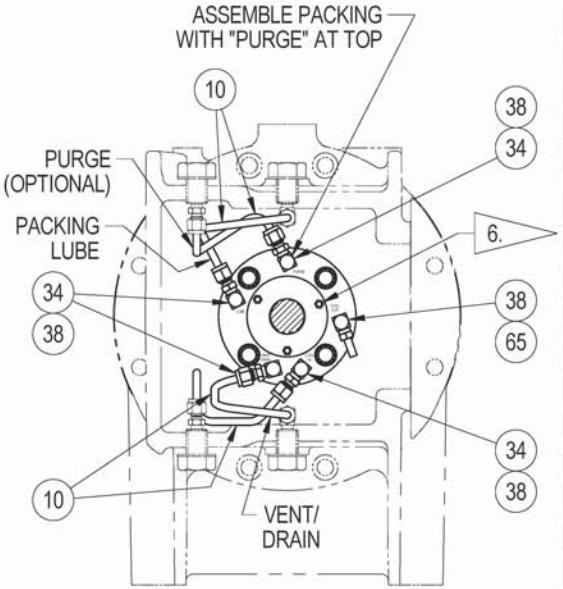
VER	DESCRIPTION	INIT/DATE
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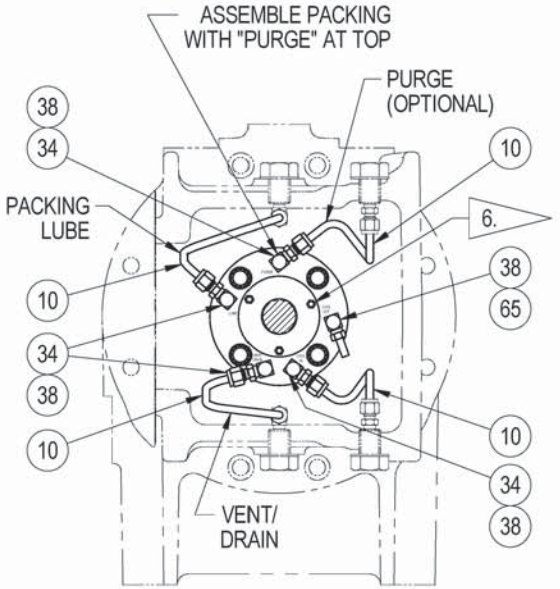
VER	ECN
1	201600583
0	201600406

ARIEL CORPORATION
35 BLACKJACK ROAD
MOUNT VERNON, OHIO 43050

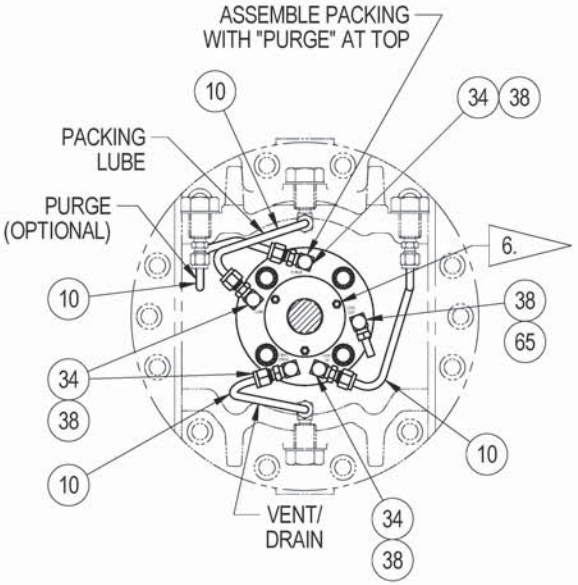
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CHECKED: CPM 05/03/16
SCALE: NONE
ASSEMBLY DWG. NO. A-23813
SHT 2 OF 3



① JGM:P:N:Q/1



① JGM:P:N:Q/2



① JG:A
(STD GUIDE)

FOUR BOLT PACKING COOLED CASES

VER	DESCRIPTION	INIT/DATE
1	SHEET #1: NO REVISIONS. SHEET #2 & #3: @A1: ADDED "JGM:P:N:Q/1" TO VIEW. @A2: ADDED "JGM:P:N:Q/2" TO VIEW. @A4: ADDED "JG:A (STD GUIDE)" TO VIEW.	JJP 07/20/2016

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VER	ECN
1	201600583
0	201600406

ARIEL CORPORATION
35 BLACKJACK ROAD
MOUNT VERNON, OHIO 43050

DRAWN: JJP 05/03/16
CHECKED: CPM 05/03/16
SCALE: NONE
ASSEMBLY DWG. NO. A-23813
SHT 3 OF 3

10/15/2016

ARIEL CORPORATION

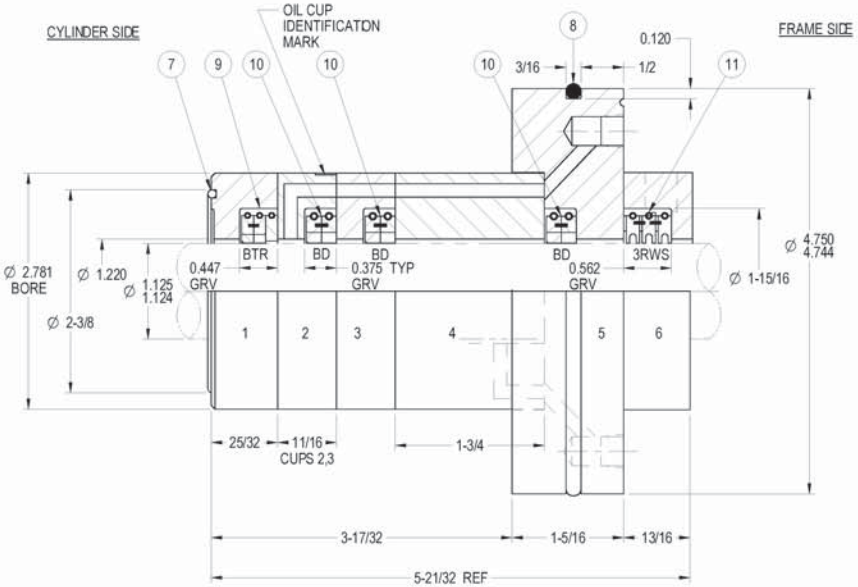
PARTS LIST

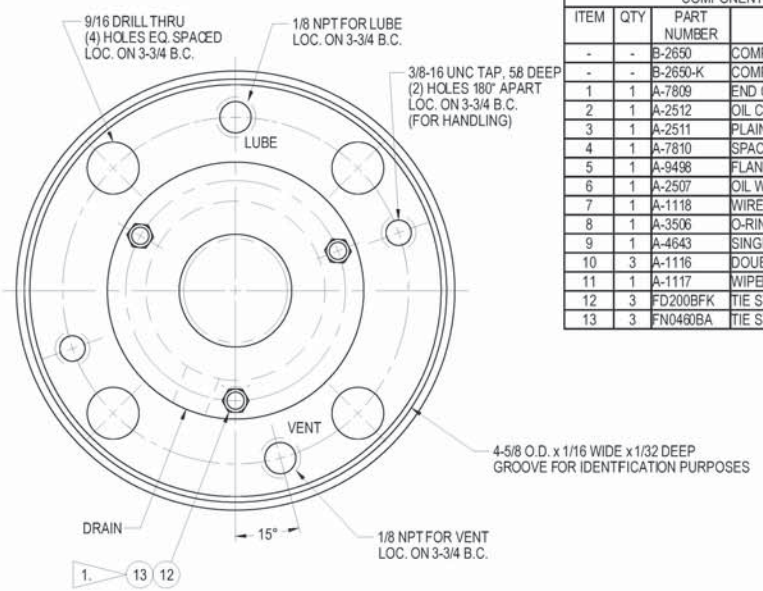
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PISTON ASSEMBLY, 5-1/2P-CE0, STD **Ref Drawing.** A-23813

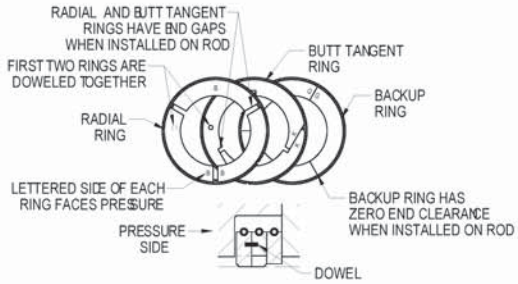
ITEM	PART NUMBER	QTY	UOM	DESCRIPTION
001	C-6000	1		PISTON, 5-1/2P-CE, 3.000 STROKE
002	A-0237	3		PISTON RING, 5-1/2R:M:P:H:RJ
003	C-6001	1		PISTON ROD, 3.000 STROKE / 23.689 LONG
004	A-0057	1		PISTON COLLAR, 2-1/2" THROUGH 8" PISTONS, JG:M:P
007	B-2650	1		PKG,1.125, 600
008	FC0120GP	4		12-POINT CAPSCREW, 1/2-13 X 3-1/4, G8
010	PT0200CB	18	IN	TUBING, SS, 1/4 OD X .035 WALL
034	A-0830	2		MALE CONNECTOR, STL, 1/4 TUBE X 1/8 NPT
038	A-0884	2		STREET ELBOW, 90°, 1/8 NPT, SHORT, STL
099	B-2650-K	0		REBUILD KIT, 1.125 PISTON ROD PACKING

*** ALWAYS PROVIDE SERIAL NUMBER WHEN ORDERING SPARE PARTS. ***
WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT DOES NOT REPRESENT THE QUANTITY REQUIRED.

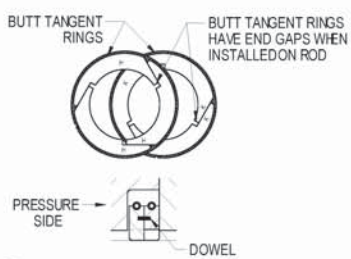




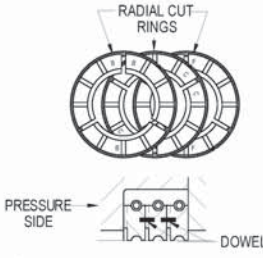
COMPONENT PART LIST				
ITEM	QTY	PART NUMBER	DESCRIPTION	MATL
-	-	B-2650	COMPLETE PACKING	
-	-	B-2650-K	COMPLETE REBUILD KIT	
1	1	A-7809	END CUP	C.I.
2	1	A-2512	OIL CUP	C.I.
3	1	A-2511	PLAIN CUP	C.I.
4	1	A-7810	SPACER	C.I.
5	1	A-9498	FLANGE	C.I.
6	1	A-2507	OIL WIPER CUP	C.I.
7	1	A-1118	WIRE GASKET	ALUM.
8	1	A-3506	O-RING, 4.762 O.D. x .139	VITON
9	1	A-4643	SINGLE SEAL RING "BTR"	TFE/C.I.
10	3	A-1116	DOUBLE SEAL RING "BD"	TFE
11	1	A-1117	WIPER RING "3RWS"	C.I.
12	3	FD200BFK	TIE STUD #10-24 x 5-5/8	STL.
13	3	FN0460BA	TIE STUD NUT, #10-24	STL.



CORRECT ORIENTATION OF "BTR" RING



④ CORRECT ORIENTATION OF "BD" RING



④ CORRECT ORIENTATION OF "3RWS" RING

NOTES:

1. TIE STUD NUTS (ITEM #13) MUST BE LOCKNUTS. RETIGHTEN AFTER CASE IS BOLTED INTO STUFFING BOX.

2.- MATCHMARK LETTERS ON RINGS TO FACE COMPRESSOR PISTON.

REV	DESCRIPTION	INIT/DATE
④	REDRAWN TO SOLID EDGE. UPDATED ITEM ROTATION & ORIENTATION TO MATCH CURRENT VENDOR DRAWING. ADDED CORRECT ORIENTATION OF "BD" RING AND "3RW'S RING VIEWS. IN TITLE BLOCK. 600PSI WAS 500 PSI	DPD 01/21/11

REV	ECN
4	17138
3	14040
2	14000
1	10088
0	7984

THIRD ANGLE PROJECTION

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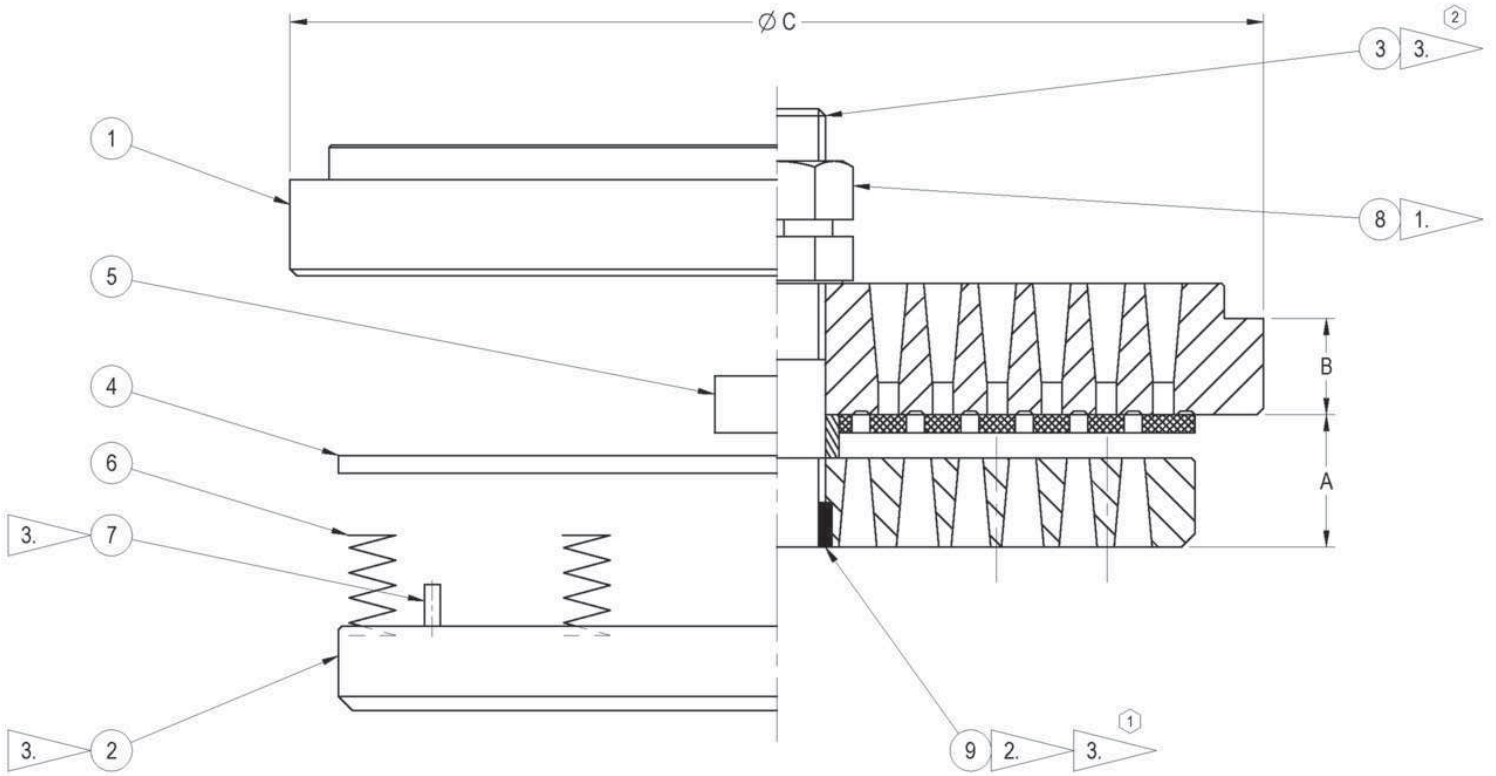
DIMENSIONS ARE IN INCHES UNLESS OTHERWISE SPECIFIED — DO NOT SCALE DRAWING —

ARIEL CORPORATION
35 BLACKJACK ROAD
MOUNT VERNON, OHIO 43050

DRAWN:	IG 11/11/99
CHECKED:	CAH 11/16/99
MATERIAL:	SEE TABULATION
SCALE:	NONE

TITLE: ROD PACKING, 1.125 VAC - 600 PSI ④

R.S. No: CB-2650
PART No: B-2650
DWG. No: B-2650
SHT 1 OF 1



NOTES:

1. SEE MANUAL FOR TORQUE VALUES (ITEM 8).
2. INSTALL PER ER-52.
3. VALVE GUARD ASSEMBLY (ITEM 2) CONSISTS OF VALVE GUARD, CENTER STUD (ITEM 3), SPIROL PIN (ITEM 7) AND DOWL PIN (ITEM 9).

REV	DESCRIPTION	INIT/DATE
2	AT C4 FLAG 3 WAS FLAG 2.	MLB 02/28/11
1	UPDATED TO SOLID EDGE, AT B3 ADDED FLAG 3. IN TITLE BLOCK CRE WAS CRO.	MLB 02/07/11

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DIMENSIONS ARE IN INCHES UNLESS OTHERWISE SPECIFIED.
--- DO NOT SCALE DRAWING ---

REV	ECN
2	17410
1	17350
0	7796

ARIEL CORPORATION
35 BLACKJACK ROAD
MOUNT VERNON, OHIO 43050

TITLE: SUCTION VALVE, CRE (1)

MATERIAL: PROCURED

DRAWN: IG 04/30/99

CHECKED: ED 10/14/99

SCALE: NONE

R.S. No.

PART NO.

DWG. No: A-9277

SHT 1 OF 1

10/15/2016

ARIEL CORPORATION

PARTS LIST

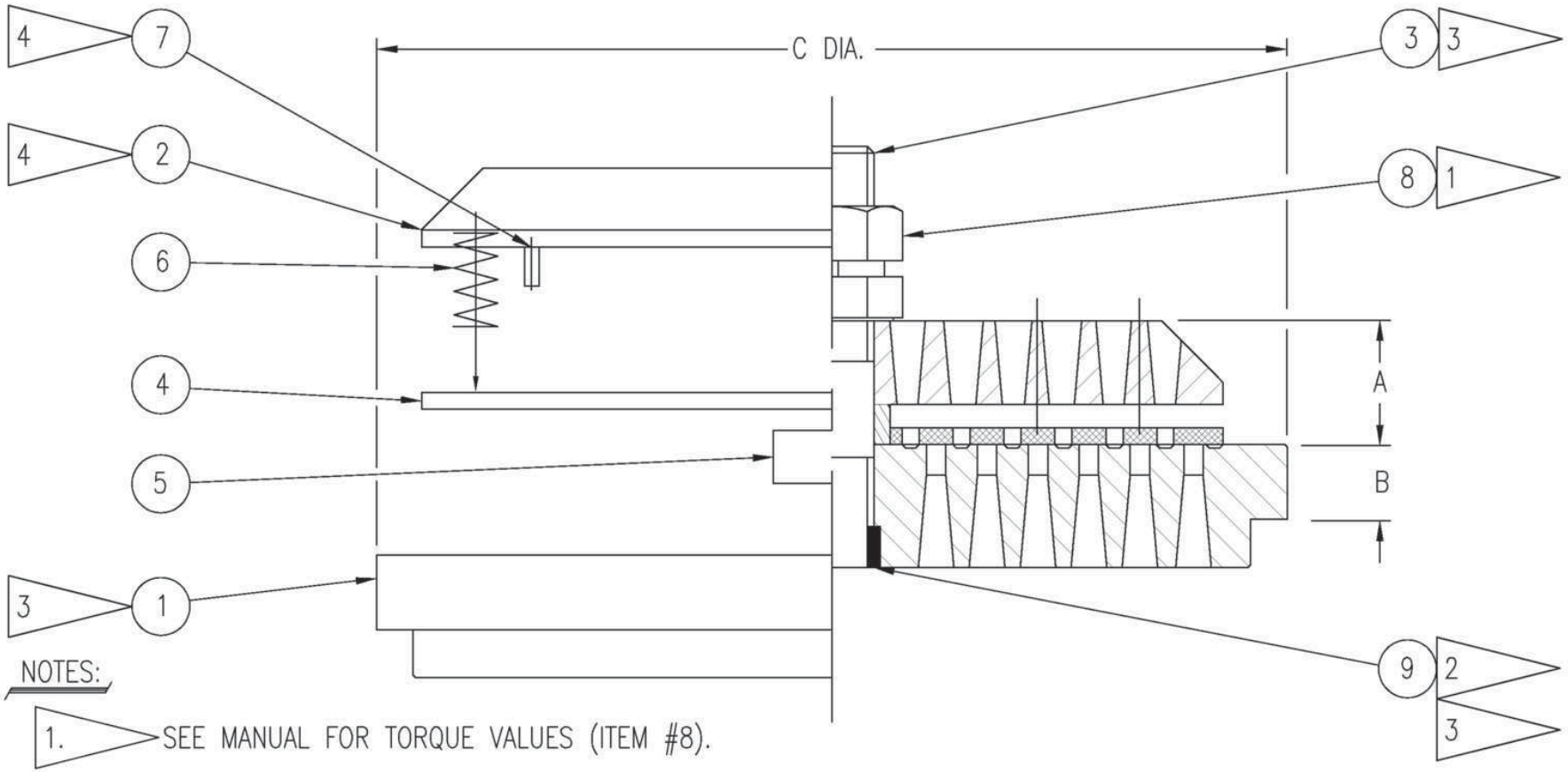
Part No. B-5091-CC

SUCTION VALVE, 79CRE, MTX **Ref Drawing.** A-9277

0.5980=A
0.6610=B
3.5800=C
0.0470=LFT

ITEM	PART NUMBER	QTY	UOM	DESCRIPTION
001	A-15639	1		SUCTION VALVE SEAT, 79CRE
002	A-19954-A	1		SUCTION VALVE GUARD ASSEMBLY, 79CRE
003	A-2669	1		CENTER STUD, 3/8-24 X 2.56 LONG
004	A-15637	1		VALVE PLATE, 79CRE, .157 THICK, MTX
005	A-1735	1		GUIDE RING, 70RX, .205 THICK
006	A-8898	9		SPRING (.197 OD X .413 FREE LENGTH) BLUE, .024 WIRE DIAMETER
007	A-1023	2		SPIROL PIN, .091 OD X .433 LONG
008	A-1367	1		LOCKNUT, DRAKE, 3/8-24
009	A-16466	1		LOCK, STUD, .098 OD
099	KB-5091-CC	0		KIT, VALVE, 79CRE, MTX

*** ALWAYS PROVIDE SERIAL NUMBER WHEN ORDERING SPARE PARTS. ***
WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT DOES NOT REPRESENT THE QUANTITY REQUIRED.



NOTES:

1. SEE MANUAL FOR TORQUE VALUES (ITEM #8).
2. INSTALL PER ER-52.
3. VALVE SEAT ASSEMBLY (ITEM #1) CONSISTS OF VALVE SEAT, CENTER STUD (ITEM #3), AND DOWEL PIN (ITEM #9).
4. VALVE GUARD ASSEMBLY (ITEM #2) CONSISTS OF VALVE GUARD, AND SPIROL PINS (ITEM #7).

REV	DESCRIPTION

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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
0	7799

ARIEL CORPORATION
35 BLACKJACK ROAD
MOUNT VERNON, OHIO 43050

TITLE: DISCHARGE VALVE, CRO

MATERIAL: PROCURED	
DRAWN: IG 9/24/99	R.S. No.
CHECKED: ED 10/4/99	PART NO.
SCALE: NONE	DWG. No: A-9255

10/15/2016

ARIEL CORPORATION

PARTS LIST

Part No. B-5092-ZM

DISCHARGE VALVE, 79CRE, PK **Ref Drawing.** A-9255

0.7950=A
0.3740=B
3.5800=C
0.0470=LFT

ITEM	PART NUMBER	QTY	UOM	DESCRIPTION
001	A-15636-A	1		DISCHARGE VALVE SEAT ASSEMBLY, 79CRE
002	A-15638-A	1		DISCHARGE VALVE GUARD ASSEMBLY, 79CRE
003	A-2676	1		CENTER STUD, 3/8-24 X 2.32 LONG
004	A-20740	1		VALVE PLATE, 79CRE, .157 THICK, PK
005	A-1735	1		GUIDE RING, 70RX, .205 THICK
006	A-8908	9		SPRING (.197 OD X .413 FREE LENGTH) RED, .022 WIRE DIAMETER
007	A-1023	2		SPIROL PIN, .091 OD X .433 LONG
008	A-1367	1		LOCKNUT, DRAKE, 3/8-24
009	A-16466	1		LOCK, STUD, .098 OD
099	KB-5092-ZM	0		KIT, VALVE, 79CRE, PK

*** ALWAYS PROVIDE SERIAL NUMBER WHEN ORDERING SPARE PARTS. ***
WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT DOES NOT REPRESENT THE QUANTITY REQUIRED.

3 RD STAGE CYLINDE R



10/15/2016

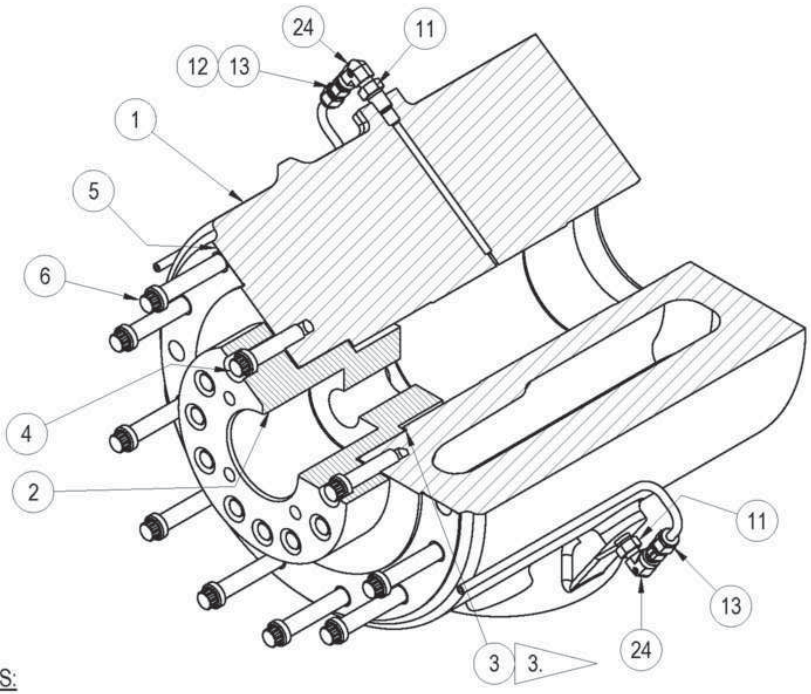
ARIEL CORPORATION

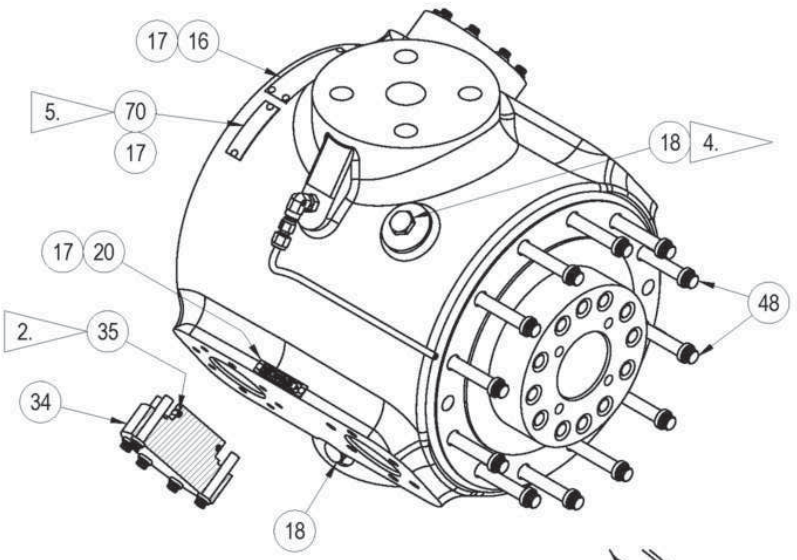
SALES ORDER COVER SHEET

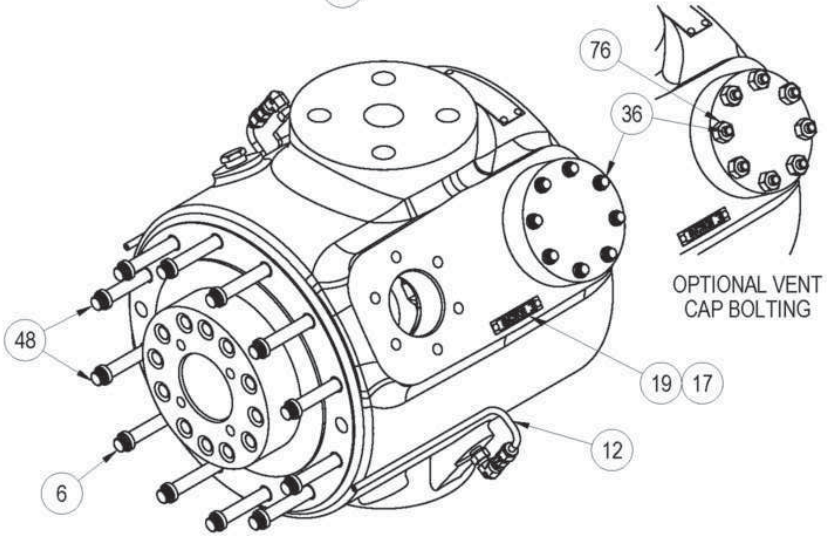
Serial # : C189419

Part # : 3-5/8SG CE **Description :** 3-5/8SG-CE CYLINDER CLASS

Part Number	QTY	Description	Drawing No.
G-20423	1	CYLINDER ASSEMBLY, 3-5/8SG-CE, 2550 MAWP	A-18942
G-11159	1	SUC VLV ASSY, 3-5/8SG-CE	A-6267
G-22033	1	DISCHARGE VALVE ASSEMBLY, 3-5/8SG-CE	A-20145
G-25690	1	PISTON ASSEMBLY, 3.625 X 1.750SA, 3" STROKE	A-23800
B-4087-AA	1	SUCTION VALVE, 52RX, MTX	A-9251
B-3712-ZN	1	DISCHARGE VALVE, 52RX, PK	A-9208







OPTIONAL VENT CAP BOLTING

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 BOTH SIDES OF GASKET SURFACES.

4. USED TO PLUG INDICATOR PASSAGES WHERE APPLICABLE.

5. LOCATION FOR FIXED VOLUME CLEARANCE TAG (ITEM #70) WHEN APPLICABLE.

6. THIS CYLINDER ASSEMBLY 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.

REV	DESCRIPTION	INIT/DATE

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REV	ECN	REV	ECN
		0	17233

ARIEL CORPORATION
35 BLACKJACK ROAD
MOUNT VERNON, OHIO 43050

DRAWN: CPM 01/25/12
CHECKED: DLI 01/28/12
SCALE: NONE
ASSEMBLY DWG. NO. A-18942
SHT 1 OF 1

10/15/2016

ARIEL CORPORATION

PARTS LIST

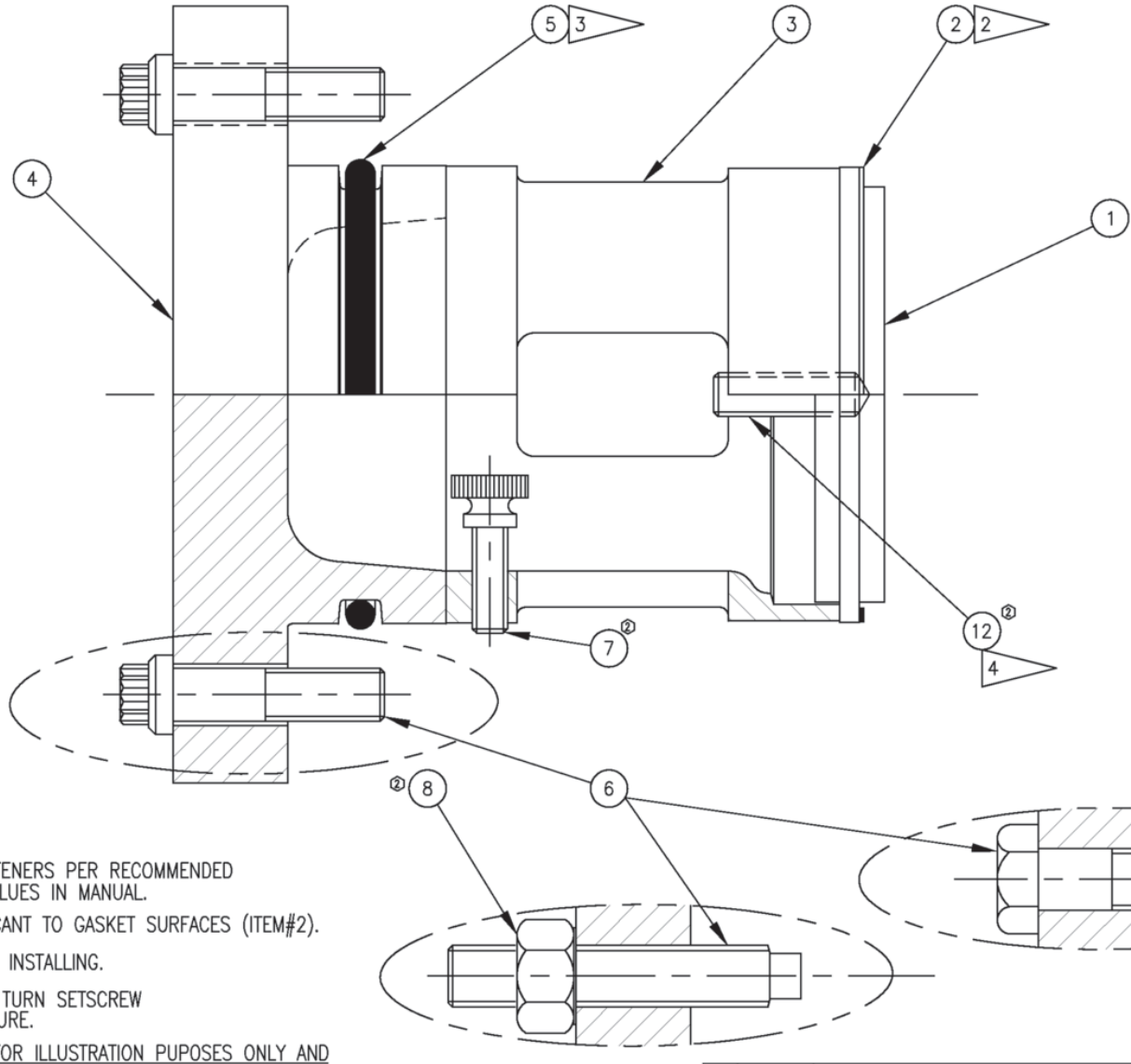
Part No. G-20423

CYLINDER ASSEMBLY, 3-5/8SG-CE, 2550 MAWP **Ref Drawing.** A-18942

ITEM	PART NUMBER	QTY	UOM	DESCRIPTION
001	D-4526	1		CYLINDER, 3-5/8SG-CE:SA-CE, 2550 MAWP
002	C-4597	0		CRANK END HEAD, 3-5/8SG-CE:SA-CE, REV
003	A-13933	1		STEEL GASKET, 04.000 OD X 03.813 ID X .060, HEAD
004	FC0120GK	12		12-POINT CAPSCREW, 1/2-13 X 2, G8
005	A-0065	1		FIBER GASKET, 12.000 OD X 09.015 ID X .015, CYLINDER TO DISTANCE PIECE, JG:M:P
006	FC0120GP	8		12-POINT CAPSCREW, 1/2-13 X 3-1/4, G8
011	A-0811	1		HEX REDUCING BUSHING, 1/4 NPT (MALE) X 1/8 NPT (FEMALE), STL
012	PT0201CD	27	IN	TUBING, 316 SS, 1/4 OD X .065 WALL
013	A-18496	1		CHECK VALVE, DOUBLE BALL, 1/4 TUBE X 1/8 NPT, SS
016	A-0576	1		DATA PLATE, CYLINDER SPECIFICATION, 4 X 1-1/8
017	FR0571CC	8		DRIVE SCREW, TYPE U, SS, #6 X 1/4
018	PP0810GB	2		PIPE PLUG, HEX HEAD, 1/2 NPT, STL
019	A-0640-A	1		INFORMATION PLATE, SUCTION
020	A-0640-B	1		INFORMATION PLATE, DISCHARGE
024	A-0804	1		STREET ELBOW, 90°, 1/8 NPT, STL
034	B-4305	0		VENT CAP, 3SG-CE & 3-5/8SG-CE
035	A-0027	2		O-RING, VT, 2.520 OD X .210, 75/85 DUROMETER
036	FC0120EK	16		12-POINT CAPSCREW, 3/8-16 X 2, G8
048	FC0120GO	4		12-POINT CAPSCREW, 1/2-13 X 3, G8
900	A-15748	2		COVER, SHIPPING FLANGE, 1.50" - 1500# ANSI
900	A-15794	2		LATHE CUT SEAL,2-1/4 ID X .234, 70 DUROMETER, NITRILE
900	FC0102KI	8		HEX HEAD CAPSCREW, 1-8 X 1-1/2, G5

*** ALWAYS PROVIDE SERIAL NUMBER WHEN ORDERING SPARE PARTS. ***

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.

②①5. THIS ASSEMBLY DRAWING IS FOR ILLUSTRATION PUPOSES 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. WAS "MAY NOT APPLY TO ALL ASSSEMBLIES." ADDED ITEM #8 (NUT)	JCS 9/30/02

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REV	ECN
2	10873
1	10217
0	6157

ARIEL

ARIEL CORPORATION
35 BLACKJACK ROAD
MOUNT VERNON, OHIO 43050

DRAWN:	APPROVED:	ASSEMBLY DWG. NO.
CAH 3/28/96		A-6267
CHECKED: 4/11/96	SCALE: NONE	

10/15/2016

ARIEL CORPORATION

PARTS LIST

Part No. G-11159

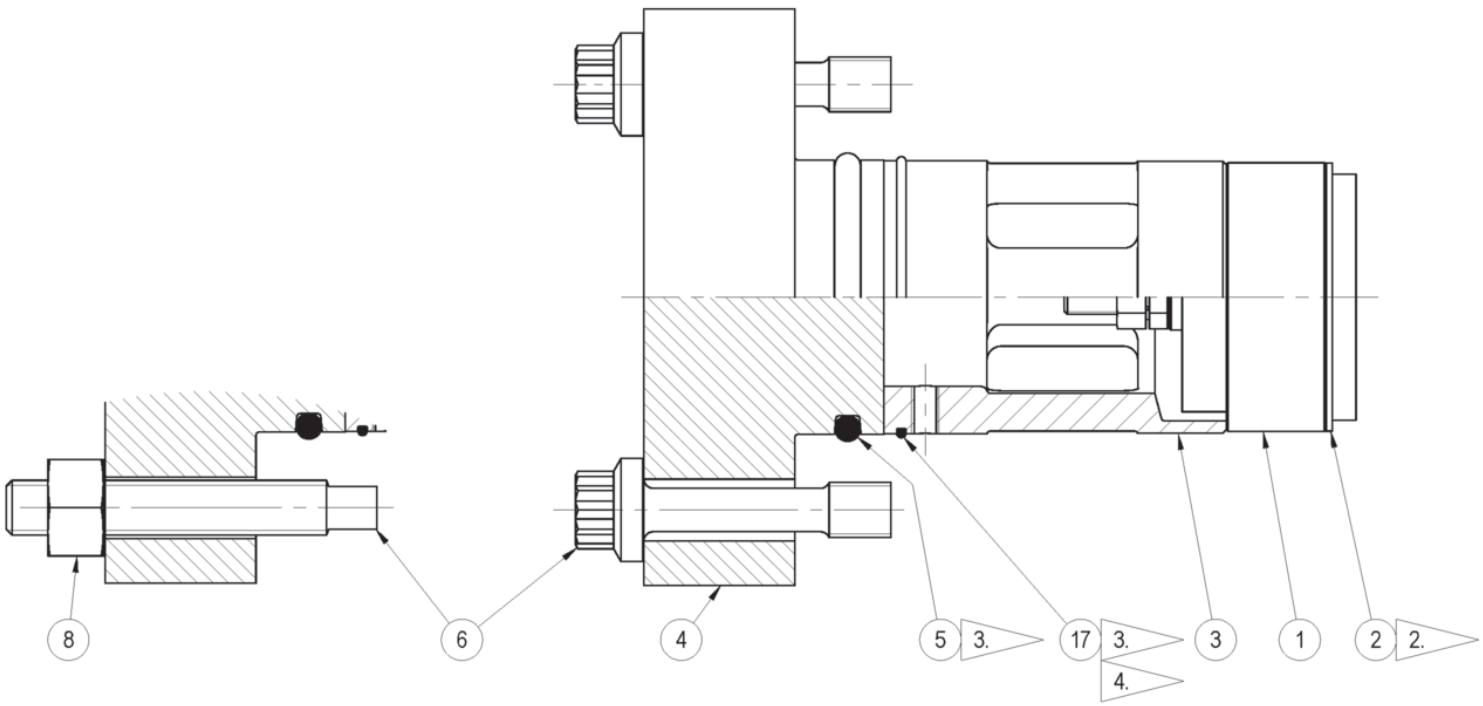
SUC VLV ASSY, 3-5/8SG-CE

Ref Drawing. A-6267

ITEM	PART NUMBER	QTY	UOM	DESCRIPTION
001	SUCTION VALVE	0		FOR VALVE PART NUMBER, SEE COVER SHEET
002	A-13192	1		STEEL GASKET, 02.438 OD X 02.250 ID X .060, VALVE
003	B-3410	1		VLV RET,SUC, 3-5/8SG-CE CL
004	B-3411	1		VALVE CAP, 3SG-CE:SG-CE HP:SG-CE HP PRC, 3-5/8SG-CE:SG-CE HP & 3-3/4SG CE
005	A-0027	1		O-RING, VT, 2.520 OD X .210, 75/85 DUROMETER
006	FC0171CFD	6		12-POINT CAPSCREW, 1/2-13 X 2-1/4 X 9/16, G8

*** ALWAYS PROVIDE SERIAL NUMBER WHEN ORDERING SPARE PARTS. ***

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 BOTH SIDES OF GASKET SURFACES.

3. OIL O-RING BEFORE INSTALLING.

4. USED IN DISCHARGE ASSEMBLY ONLY.

5.- THIS VALVE ASSEMBLY 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 YOUR PARTICULAR ASSEMBLY.

REV	DESCRIPTION	INIT/DATE

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REV	ECN	REV	ECN
		0	18399

ARIEL CORPORATION
35 BLACKJACK ROAD
MOUNT VERNON, OHIO 43050

DRAWN: CWH 01/29/13
CHECKED: CPM 01/30/13
SCALE: NONE
ASSEMBLY DWG. NO. A-20145
SHT 1 OF 1

10/15/2016

ARIEL CORPORATION

PARTS LIST

Part No. G-22033

DISCHARGE VALVE ASSEMBLY, 3-5/8SG-CE **Ref Drawing.** A-20145

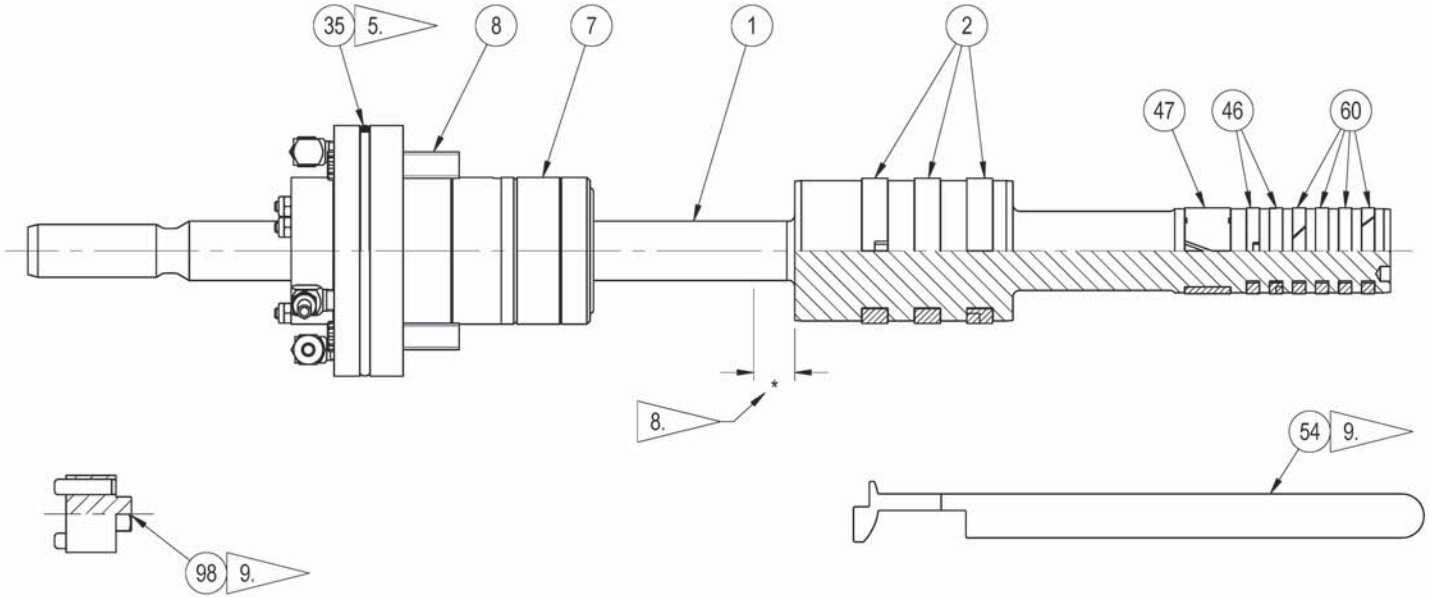
ITEM	PART NUMBER	QTY	UOM	DESCRIPTION
001	DISCHARGE VALVE	0		FOR VALVE PART NUMBER, SEE COVER SHEET
002	A-13192	1		STEEL GASKET, 02.438 OD X 02.250 ID X .060, VALVE
003	B-6604	1		VALVE RETAINER, DISCHARGE, 3-5/8SG-CE, WITH O-RING GROOVE
004	B-3411	1		VALVE CAP, 3SG-CE:SG-CE HP:SG-CE HP PRC, 3-5/8SG-CE:SG-CE HP & 3-3/4SG CE
005	A-0027	1		O-RING, VT, 2.520 OD X .210, 75/85 DUROMETER
006	FC0171CFD	6		12-POINT CAPSCREW, 1/2-13 X 2-1/4 X 9/16, G8
017	A-9870	1		O-RING, VT, 2.254 OD X .070, 75/85 DUROMETER
099	B-6599	0		VALVE RETAINER, DISCHARGE, 3-5/8SG-CE, WITH O-RING

*** ALWAYS PROVIDE SERIAL NUMBER WHEN ORDERING SPARE PARTS. ***

WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT DOES NOT REPRESENT THE QUANTITY REQUIRED.

NOTES:

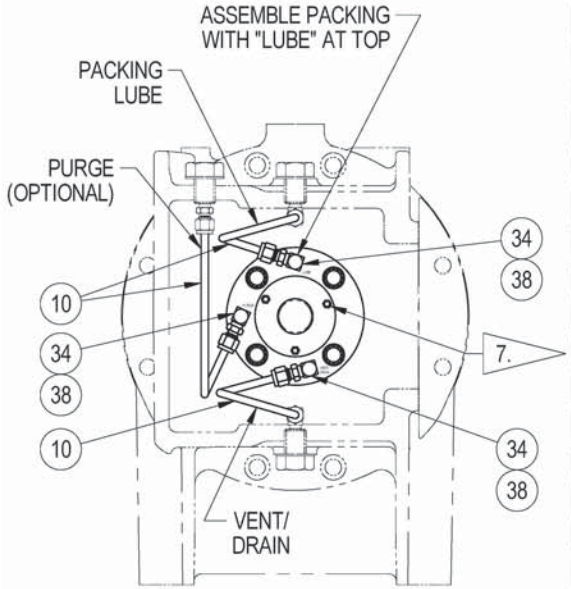
1. THIS ASSEMBLY IS FOR ILLUSTRATION PURPOSES ONLY AND MAY NOT NECESSARILY REPRESENT THE EXACT CONFIGURATION PERTAINING TO THE UNIT ORDERED. REFER TO ACCOMPANYING PARTS LIST FOR ITEMS (AND QUANTITIES OF EACH) REQUIRED FOR THIS PARTICULAR ASSEMBLY.
2. REFER TO MANUAL FOR RECOMMENDED PROCEDURES AND TORQUE VALUES FOR ASSEMBLY OR REASSEMBLY OF THIS UNIT.
3. REFER TO SHEET #2 AND SHEET #3 FOR PACKING TUBE LINE CONFIGURATIONS.
4. SEE ER-59 FOR RING ORIENTATION.
5. LIGHTLY OIL O-RING BEFORE INSTALLING.
6. ASSEMBLE FITTINGS BEFORE INSTALLING.
7. RETIGHTEN TIE STUD NUTS AFTER PACKING CASE (ITEM #7) IS BOLTED TO CYLINDER.
8. REMOVE C.E. SUCTION VALVE TO ADJUST C.E. PISTON CLEARANCE. (SEE CYLINDER SPECIFICATIONS DATA PLATE OR THE MANUAL). **DO NOT USE STRAP WRENCH ON PISTON ROD** - USE TURNING TOOL WHICH FITS TURNING HOLES IN PISTON ROD.
9. PISTON NUT SPANNER (ITEM #98) & CRANK END CLEARANCE TOOL (ITEM #54) ARE SHIPPED IN TOOL BOX, WHEN REQUIRED.



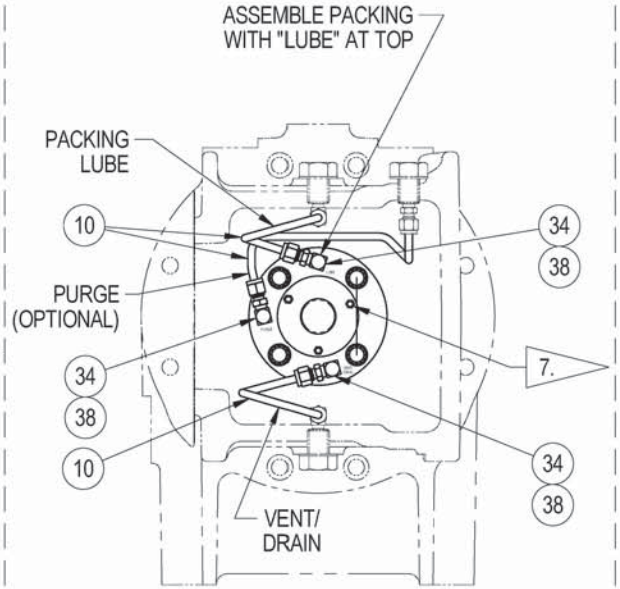
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VER	ECN	DRAWN		ASSEMBLY DWG. NO.
0	201600406	JJP 04/20/16		A-23800
		CHECKED: CPM 04/20/16	SCALE: NONE	SHT 1 OF 3

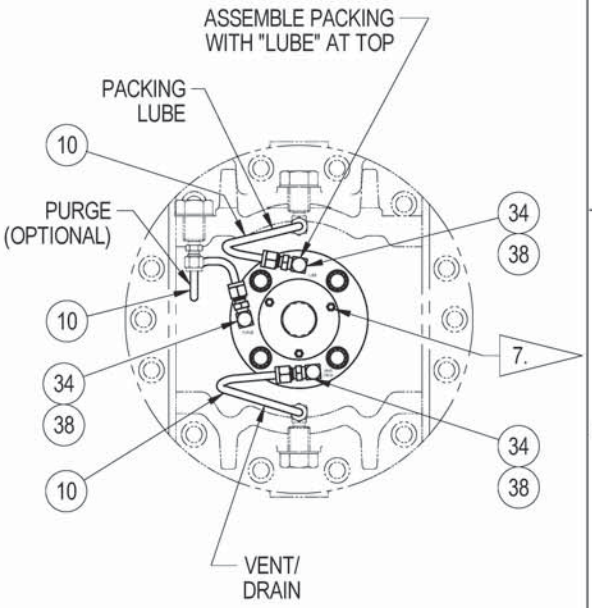
ARIEL CORPORATION
35 BLACKJACK ROAD
MOUNT VERNON, OHIO 43050



JGM:P:N:Q/1



JGM:P:N:Q/2



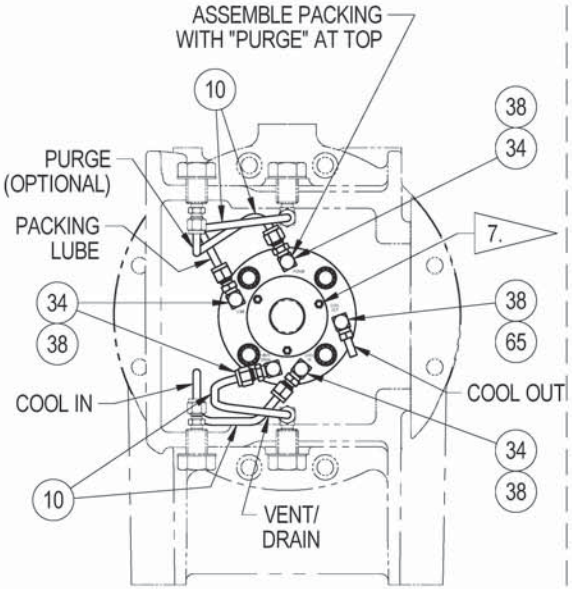
JG:A
(STD GUIDE)

FOUR BOLT PACKING NON-COOLED CASES

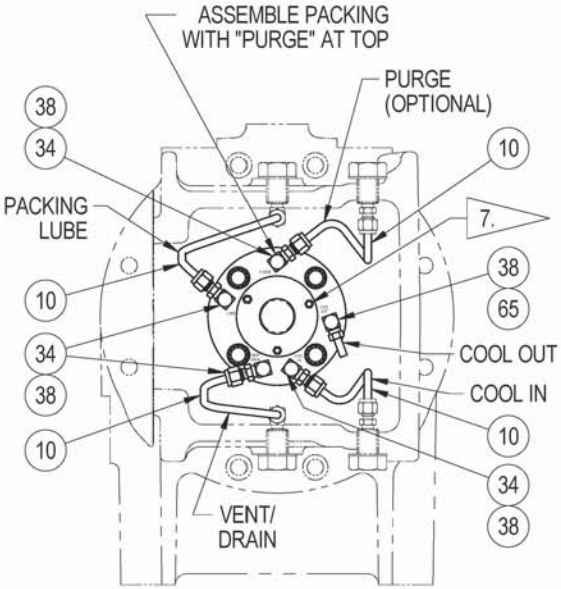
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VER	ECN	DRAWN		ASSEMBLY DWG. NO.
0	201600406	JJP 04/20/16		A-23800
		CHECKED: CPM 04/20/16	SCALE: NONE	SHT 2 OF 3

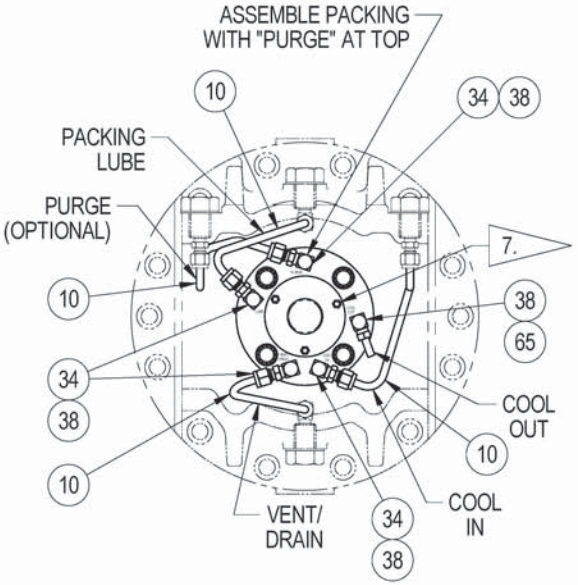
ARIEL CORPORATION
35 BLACKJACK ROAD
MOUNT VERNON, OHIO 43050



JGM:P:N:Q/1



JGM:P:N:Q/2



JG:A
(STD GUIDE)

FOUR BOLT PACKING COOLED CASES

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VER	ECN	DRAWN	SCALE	ASSEMBLY DWG. NO.
0	201600406	JJP 04/20/16	NONE	A-23800
		CHECKED: CPM 04/20/16		SHT 3 OF 3

ARIEL CORPORATION
35 BLACKJACK ROAD
MOUNT VERNON, OHIO 43050

10/15/2016

ARIEL CORPORATION

PARTS LIST

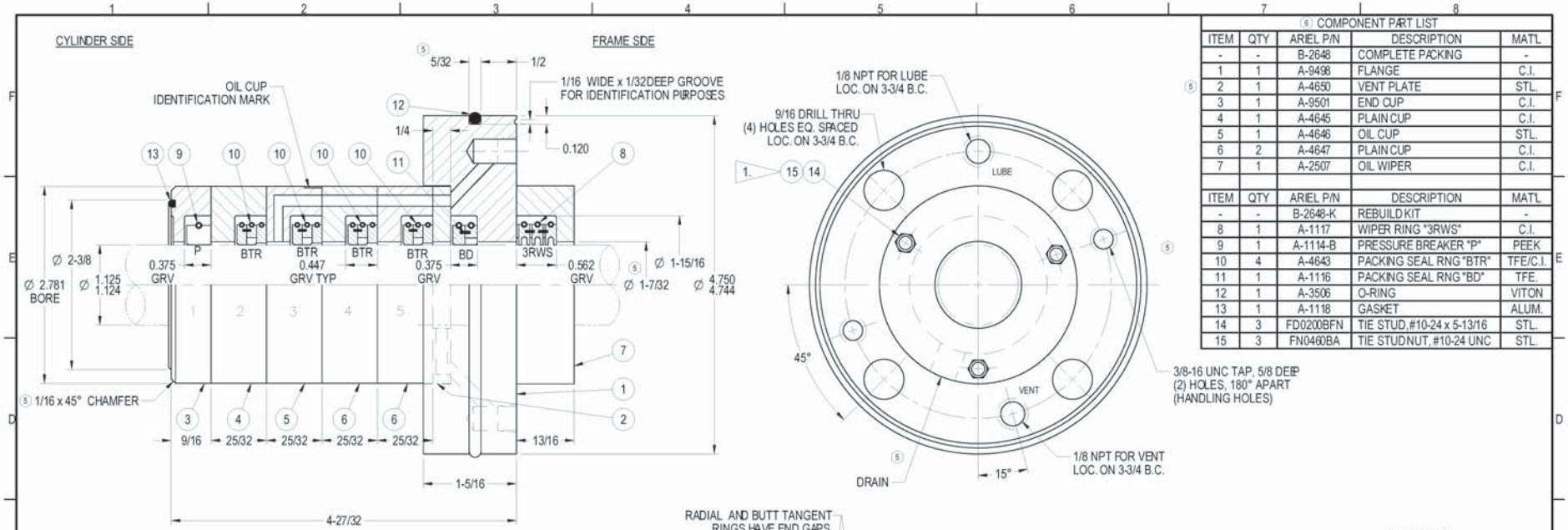
Part No. G-25690

PISTON ASSEMBLY, 3.625 X 1.750SA, 3" STROKE **Ref Drawing.** A-23800

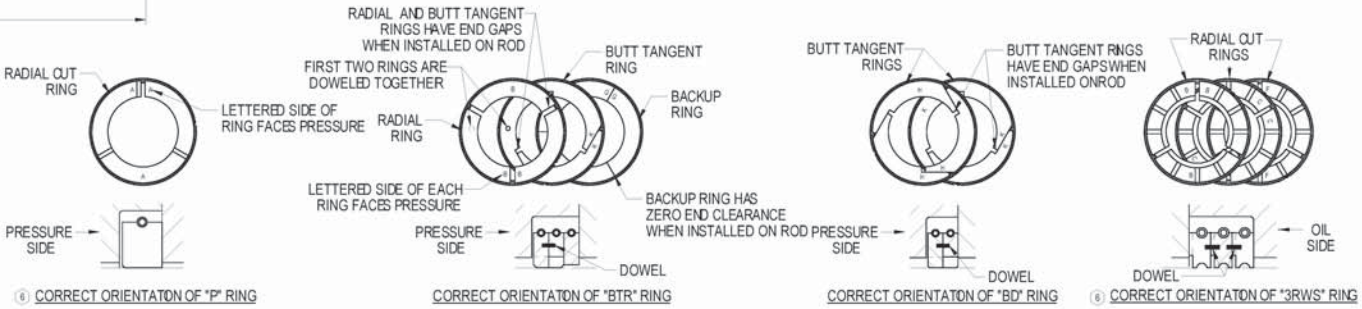
ITEM	PART NUMBER	QTY	UOM	DESCRIPTION
001	C-3591	1		PISTON/PISTON ROD, 3-5/8 X 1-3/4SA:SA-HP
002	A-11796	4		RIDER RING, 3-5/8SG-CE:SA-CE:SG-CE-HP:SA-CE-HP, SJ
007	B-2648	1		PKG,1.125,2550,STD
008	FC0120GL	4		12-POINT CAPSCREW, 1/2-13 X 2-1/4, G8
010	PT0201CD	12	IN	TUBING, 316 SS, 1/4 OD X .065 WALL
034	A-0830	2		MALE CONNECTOR, STL, 1/4 TUBE X 1/8 NPT
038	A-0884	2		STREET ELBOW, 90°, 1/8 NPT, SHORT, STL
046	A-7038	2		PISTON RING, 1-3/4JG:SG,PK,SJ
047	A-5962	1		WEAR BAND, 1-3/4JG:SG:RJ:R, .875 GROOVE WIDTH
060	A-19366	4		PISTON RING, 1-3/4SG, PK
098	A-1678	1		PISTON NUT SPANNER,SPECIAL
099	B-2648-K	0		REBUILD KIT, 1.125 PISTON ROD PACKING

*** ALWAYS PROVIDE SERIAL NUMBER WHEN ORDERING SPARE PARTS. ***

WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT DOES NOT REPRESENT THE QUANTITY REQUIRED.



COMPONENT PART LIST				
ITEM	QTY	ARIEL P/N	DESCRIPTION	MATL
-	-	B-2648	COMPLETE PACKING	-
1	1	A-9498	FLANGE	C.I.
2	1	A-4650	VENT PLATE	STL.
3	1	A-9501	END CUP	C.I.
4	1	A-4645	PLAIN CUP	C.I.
5	1	A-4646	OIL CUP	STL.
6	2	A-4647	PLAIN CUP	C.I.
7	1	A-2507	OIL WIPER	C.I.
ITEM	QTY	ARIEL P/N	DESCRIPTION	MATL
-	-	B-2648-K	REBUILD KIT	-
8	1	A-1117	WIPER RING "3RWS"	C.I.
9	1	A-1114-B	PRESSURE BREAKER "P"	PEEK
10	4	A-4643	PACKING SEAL RNG "BTR"	TFE/C.I.
11	1	A-1116	PACKING SEAL RNG "BD"	TFE.
12	1	A-3506	O-RING	VITON
13	1	A-1118	GASKET	ALUM.
14	3	FD0200BFN	TIE STUD, #10-24 x 5-13/16	STL.
15	3	FN0460BA	TIE STUD NUT, #10-24 UNC	STL.



6 CORRECT ORIENTATON OF "P" RING

CORRECT ORIENTATON OF "BTR" RING

CORRECT ORIENTATON OF "BD" RING

6 CORRECT ORIENTATON OF "3RWS" RING

NOTES:

5 1. TIE STUDNUTS (ITEM#15) MUST BE LOCKNUTS. RE-TIGHTENNUTS AFTER CASE IS INSTALLED.

5 2. NUMBERS STAMPED ON CUPS ARE FOR ASSEMBLYPURPOSES ONLY AND WILL BE LOCATED ON TOP OF PACKING WHEN INSTALLED. REPLACEMENT CUPS WILL NOTBE STAMPED. REFER TO ITEM NUMBERS AND TABLE FOR CORRECT PART NUMBERS.

REV	DESCRIPTION	INIT/DATE
6	REPLACED "3RWS" RING BLOCK WITH CORRECT ORIENTATION. REPLACED "P" RING BLOCK. REVISED TABLE TO SPLIT THE COMPLETE PACKING PARTS FROM THE REBUILD KIT PARTS.	CRS 07/14/16

VER	ECN	VER	ECN
		5	19663
		4	16134
		3	14716
		2	13508
		1	8001
6	201600674	0	7984

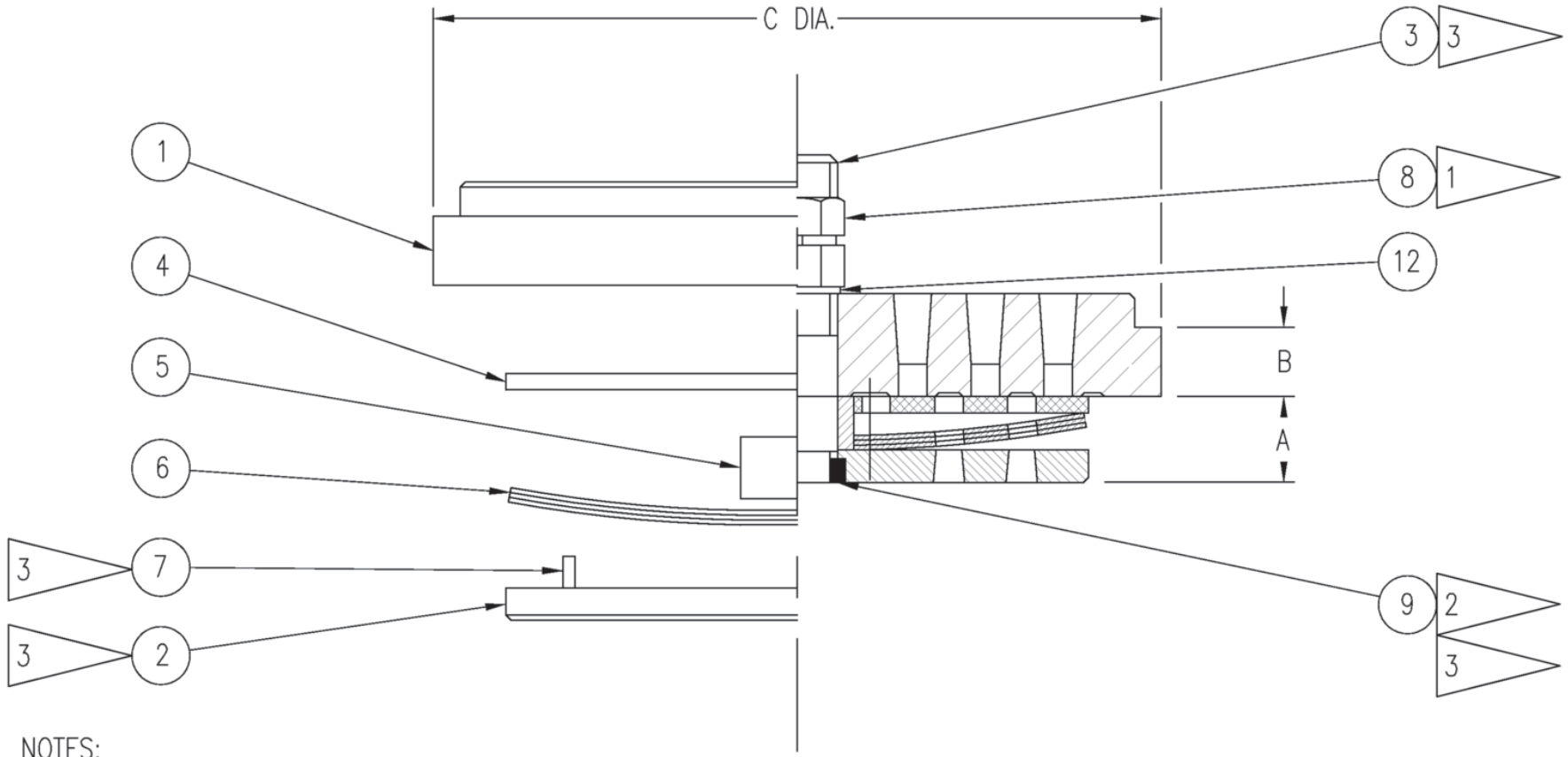
THIRD ANGLE PROJECTION

ARIEL CORPORATION
35 BLACKJACK ROAD
MOUNT VERNON, OHIO 43050

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DIMENSIONS ARE IN INCHES UNLESS OTHERWISE SPECIFIED — DO NOT SCALE DRAWING —

TITLE:	PISTON ROD PACKING, 1.125 ROD, BTR, 2550 PSIG
DRAWN:	IG 11/11/99
CHECKED:	CAH 11/16/99
MATERIAL:	SEE PARTS LIST
SCALE:	NONE
R.S. No:	CB-2648
PART No:	B-2648
DWG. No:	B-2648
	SHT 1 OF 1



NOTES:

1. SEE MANUAL FOR TORQUE VALUES (ITEM #8).
2. INSTALL PER ER-52.
3. VALVE GUARD ASSEMBLY (ITEM #2) CONSISTS OF VALVE GUARD, CENTER STUD (ITEM #3), SPIROL PIN (ITEM #7) AND DOWEL PIN (ITEM #9).

REV	DESCRIPTION
?	XXXX

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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
0	7799

ARIEL CORPORATION
35 BLACKJACK ROAD
MOUNT VERNON, OHIO 43050

TITLE: SUCTION VALVE, RX

MATERIAL: PROCURED	
DRAWN: IG 9/24/99	R.S. No.
CHECKED: ED 10/1/99	PART NO.
SCALE: NONE	DWG. No: A-9251

10/15/2016

ARIEL CORPORATION

PARTS LIST

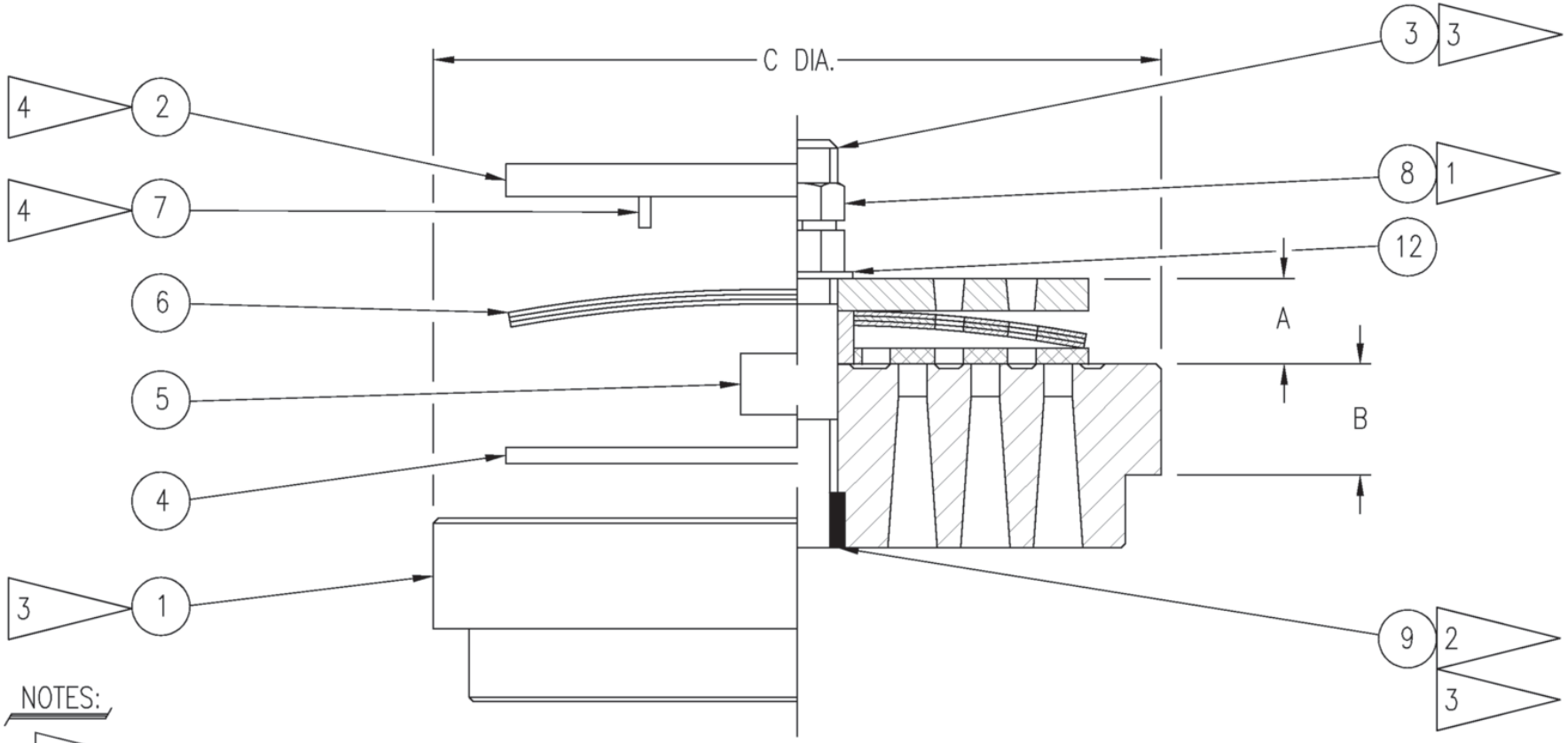
Part No. B-4087-AA

SUCTION VALVE, 52RX, MTX **Ref Drawing.** A-9251

0.3780=A
0.6930=B
2.4720=C
0.0550=LFT

ITEM	PART NUMBER	QTY	UOM	DESCRIPTION
001	A-12991	1		SUCTION VALVE SEAT, 52RX
002	A-12992-A	1		SUCTION VALVE GUARD ASSEMBLY, 52RX
003	A-12990	1		CENTER STUD, 5/16-24, 2.36 LONG, THICK
004	A-11606	1		VALVE PLATE, 52RX, .157 THICK, MTX
005	A-10355	1		GUIDE RING, 52RX, .260 THICK
006	A-1002	2		SPRING PLATE, 52RX, .020 THICK
007	A-1314	1		SPIROL PIN, .078 OD X .563 LONG
008	A-1366	1		LOCKNUT, DRAKE, 5/16-24
009	A-16466	1		LOCK, STUD, .098 OD
012	A-11437	1		VALVE WASHER, 5/16, .118 THICK
099	KB-4087-AA	0		KIT, VALVE, 52RX, MTX

*** ALWAYS PROVIDE SERIAL NUMBER WHEN ORDERING SPARE PARTS. ***
WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT DOES NOT REPRESENT THE QUANTITY REQUIRED.



NOTES:

1. SEE MANUAL FOR TORQUE VALUES (ITEM #8).
2. INSTALL PER ER-52.
3. VALVE SEAT ASSEMBLY (ITEM #1) CONSISTS OF VALVE SEAT, CENTER STUD (ITEM #3) AND DOWEL PIN (ITEM #9).
4. VALVE GUARD ASSEMBLY (ITEM #2) CONSISTS OF VALVE GUARD AND SPIROL PIN (ITEM #7).

REV	DESCRIPTION

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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
0	7799

ARIEL CORPORATION
35 BLACKJACK ROAD
MOUNT VERNON, OHIO 43050

TITLE: DISCHARGE VALVE, RX

MATERIAL: PROCURED

DRAWN: IG 9/21/99

CHECKED: ED 10/1/99

SCALE: NONE

R.S. No.

PART NO.

DWG. No: A-9208

10/15/2016

ARIEL CORPORATION

PARTS LIST

Part No. B-3712-ZN

DISCHARGE VALVE, 52RX, PK **Ref Drawing.** A-9208

0.5350=A
0.9090=B
2.4490=C
0.0550=LFT

ITEM	PART NUMBER	QTY	UOM	DESCRIPTION
001	A-12180-A	1		DISCHARGE VALVE SEAT ASSEMBLY, 52RX, THICK
002	A-1177-C	1		DISCHARGE VALVE GUARD ASSEMBLY, 52RX
003	A-14577	1		CENTER STUD, 5/16-24 X 2.62 LONG
004	A-20762	1		VALVE PLATE, 52RX, .157 THICK, PK
005	A-12099	1		GUIDE RING, 52RX, .299 THICK
006	A-1002	4		SPRING PLATE, 52RX, .020 THICK
007	A-2042	1		SPIROL PIN, .078 OD X .625 LONG
008	A-1366	1		LOCKNUT, DRAKE, 5/16-24
009	A-16466	1		LOCK, STUD, .098 OD
012	A-11437	1		VALVE WASHER, 5/16, .118 THICK
099	KB-3712-ZN	0		KIT, VALVE, 52RX, PK

*** ALWAYS PROVIDE SERIAL NUMBER WHEN ORDERING SPARE PARTS. ***
WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT DOES NOT REPRESENT THE QUANTITY REQUIRED.

4TH STAGE CYLINDER



10/15/2016

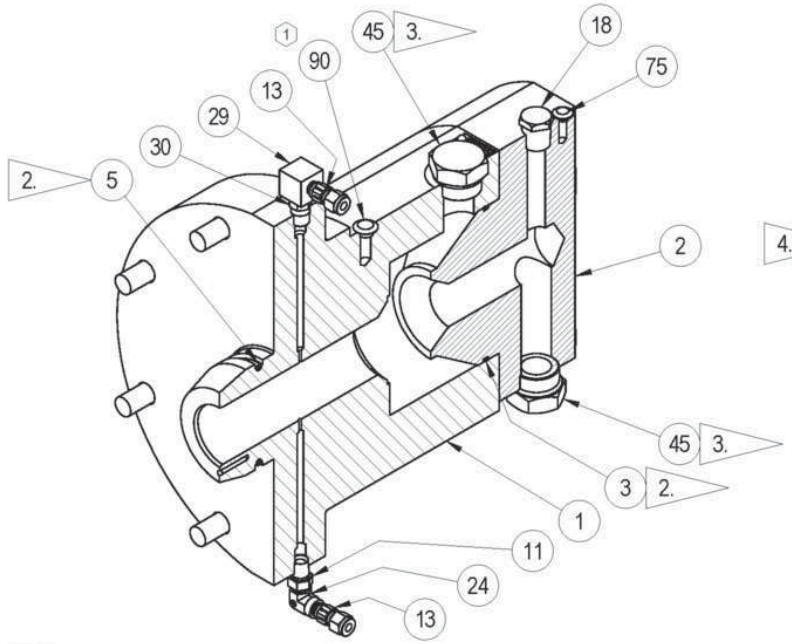
ARIEL CORPORATION

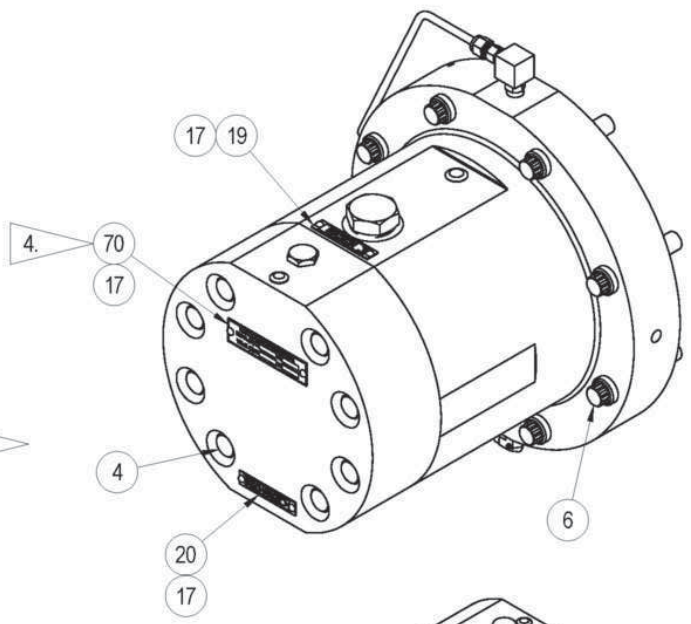
SALES ORDER COVER SHEET

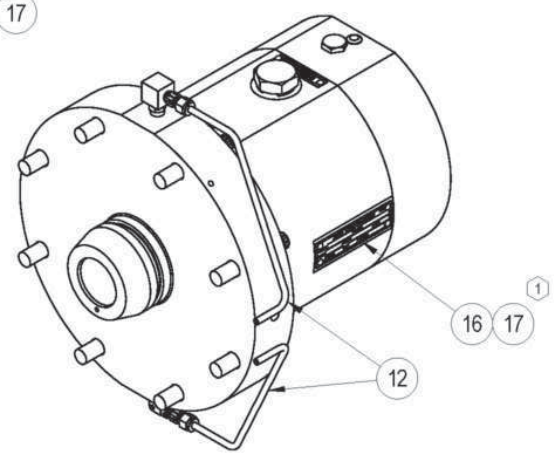
Serial # : C189410

Part # : 1-3/4SG FS HE **Description :** 1-3/4SG-FS-HE CYLINDER CLASS

Part Number	QTY	Description	Drawing No.
G-25391	1	CYLINDER ASSEMBLY, 1-3/4SG-HE, STD, 6100 MAWP	A-18941
G-25401	1	CONC VLV.ASSY(1.75JG:2R:RJ)-HE	A-6094
B-1788-E	1	CONCENTRIC VALVE, 078/035, 1-3/4, 1-5/8	A-9236
G-1446	1	VALVE TOOL, 1.625/1.75M:JG 2RJ-HE:SG-HE, 1-1/2SG12-FS-HE	B-0992







NOTES:

1. LOOSEN AND TIGHTEN ALL FASTENERS PER RECOMMENDED PROCEDURES AND TORQUE VALUES IN MANUAL.

2. OIL O-RING BEFORE INSTALLING.

3. (ITEM #45) 1" SAE PLUG FOR SHIPPING ONLY.

4. LOCATION FOR ADDED FIXED CLEARANCE DATA TAG (ITEM #70).

5. THIS CYLINDER ASSEMBLY 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 ORDER.

REV	DESCRIPTION	INIT/DATE
1	@A4: RELOCATED ITEMS #16 & #17 FROM C4 (TOP) TO A4 (SIDE). @C1: ADDED ITEM #90.	CWH 01/31/14

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REV	ECN
1	18998
0	17233

ARIEL CORPORATION
35 BLACKJACK ROAD
MOUNT VERNON, OHIO 43050

DRAWN: CPM 01/25/12
CHECKED: DLI 01/30/12
SCALE: NONE
ASSEMBLY DWG NO: A-18941
SHT 1 OF 1

10/15/2016

ARIEL CORPORATION

PARTS LIST

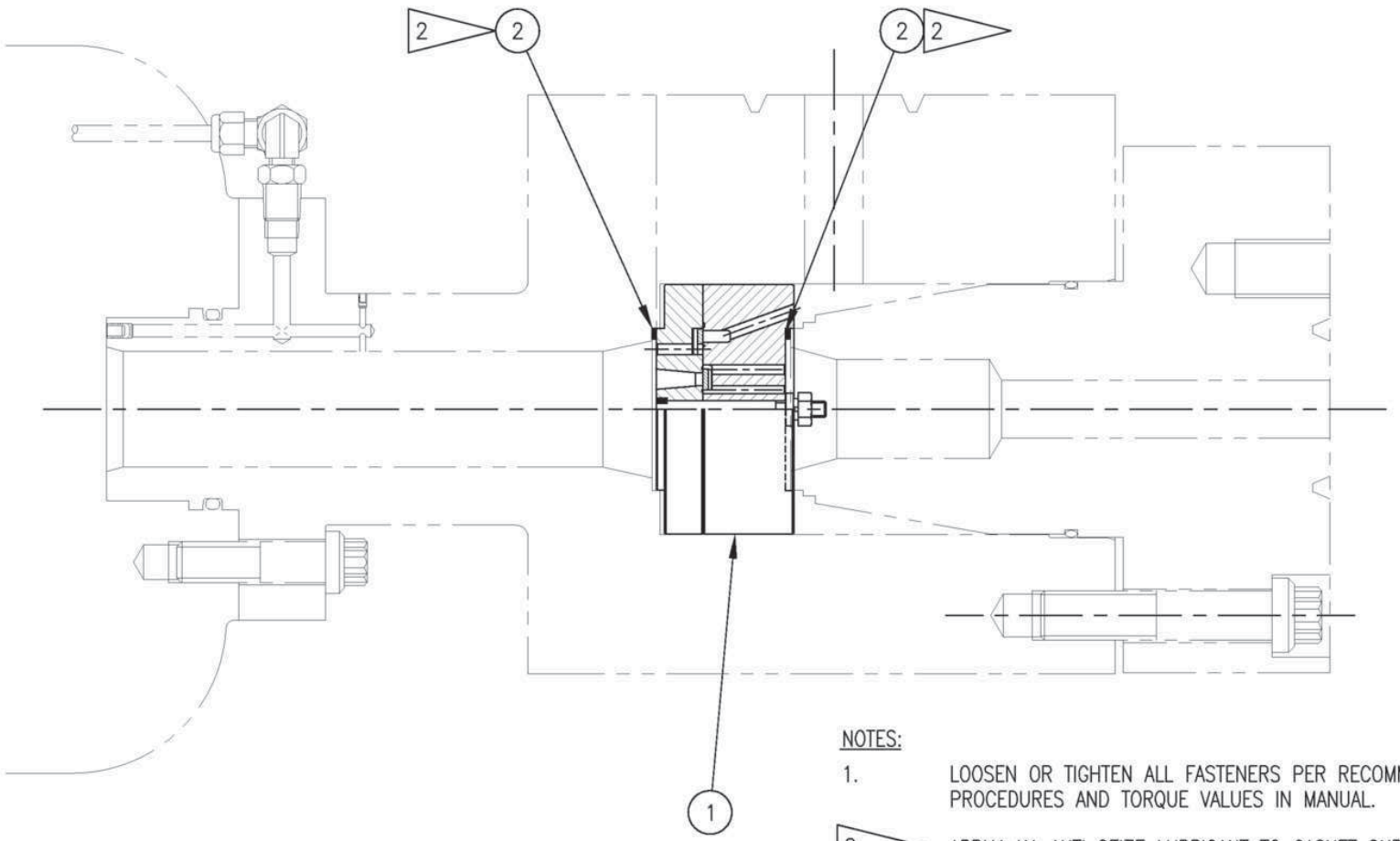
Part No. G-25391

CYLINDER ASSEMBLY, 1-3/4SG-HE, STD, 6100 MAWP **Ref Drawing.** A-18941

ITEM	PART NUMBER	QTY	UOM	DESCRIPTION
001	D-3687	1		CYLINDER, 1-3/4SG-HE:SA-HE, 16N, 6100 MAWP
002	C-7888	0		HEAD END HEAD, 1-3/4SG-HE CLASS
003	A-1812	1		O-RING, VT, 3.887 OD X .139, 95 DUROMETER
004	FC0120IO	8		12-POINT CAPSCREW, 3/4-10 X 3, G8
005	A-0013	1		O-RING, VT, 3.520 OD X .210, 75/85 DUROMETER
006	FC0120HO	8		12-POINT CAPSCREW, 5/8-11 X 3, G8
012	PT0201CD	83	IN	TUBING, 316 SS, 1/4 OD X .065 WALL
013	A-18496	1		CHECK VALVE, DOUBLE BALL, 1/4 TUBE X 1/8 NPT, SS
016	A-0576	1		DATA PLATE, CYLINDER SPECIFICATION, 4 X 1-1/8
017	FR0571CC	8		DRIVE SCREW, TYPE U, SS, #6 X 1/4
018	PP0810GB	1		PIPE PLUG, HEX HEAD, 1/2 NPT, STL
019	A-0640-A	1		INFORMATION PLATE, SUCTION
020	A-0640-B	1		INFORMATION PLATE, DISCHARGE
029	A-17774	1		OIL TRAP, BODY, SS, 1/8 NPT
030	A-17776	1		OIL TRAP, STEM, SS, 1/4 NPT
045	PP0860JB	2		PLUG, HEX HEAD, SAE-16, STL
090	A-14131	1		PUSH-IN PLUG, PLASTIC, 1/2 THREAD, BLACK

*** ALWAYS PROVIDE SERIAL NUMBER WHEN ORDERING SPARE PARTS. ***

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). PROCEDURES AND TORQUE VALUES IN MANUAL.

① 3. 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 CYLINDER ORDERED.

REV	DESCRIPTION	INIT/DATE
①	● A3: ADDED NOTE #3. UPDATED TO CURRENT STANDARDS.	ARW 08/07/2003

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REV	ECN
1	11493
0	6000

ARIEL CORPORATION
35 BLACKJACK ROAD
MOUNT VERNON, OHIO 43050

DRAWN:	APPROVED:	ASSEMBLY DWG. NO.
CAH 12/26/95		A-6094
CHECKED:	SCALE: NONE	

10/15/2016

ARIEL CORPORATION

PARTS LIST

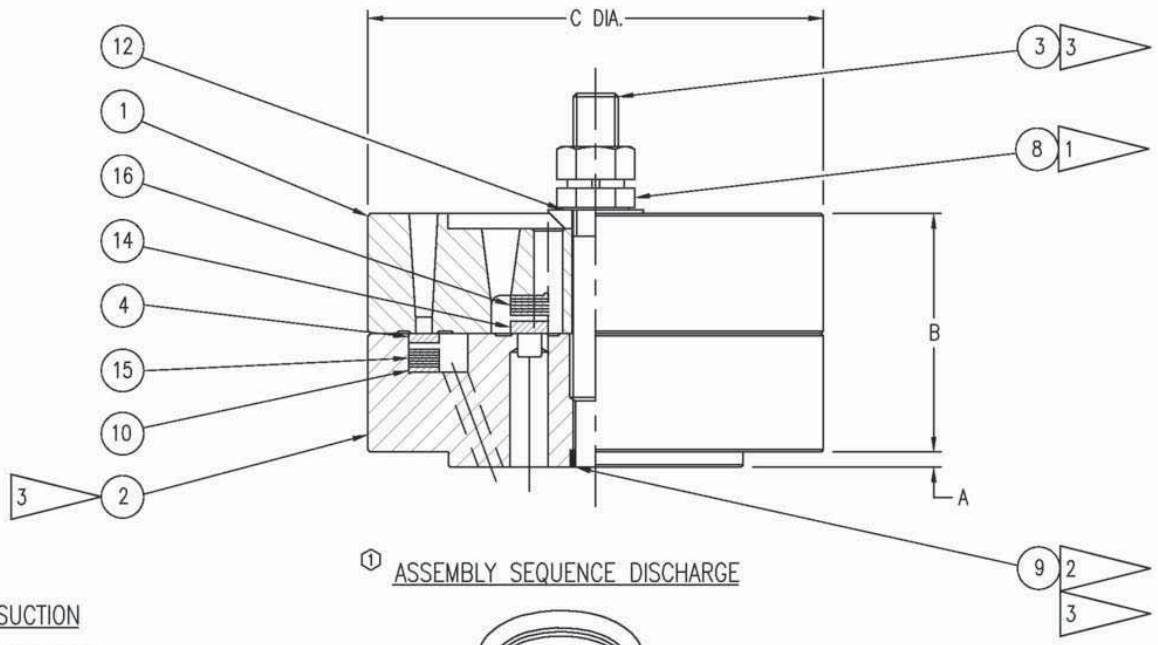
Part No. G-25401

CONC VLV.ASSY(1.75JG:2R:RJ)-HE **Ref Drawing.** A-6094

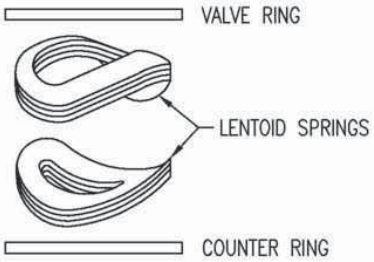
ITEM	PART NUMBER	QTY	UOM	DESCRIPTION
001	CONCENTRIC VLV.	0		FOR PART NO. SEE COVER SHEET
002	A-23478	2		STEEL GASKET, 02.438 OD X 02.000 ID X .060, VALVE

*** ALWAYS PROVIDE SERIAL NUMBER WHEN ORDERING SPARE PARTS. ***

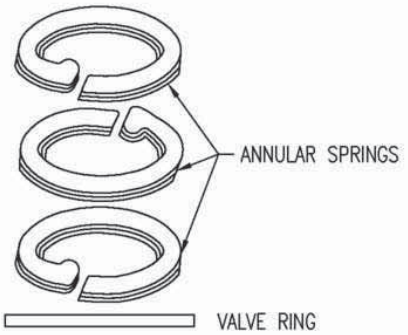
WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT DOES NOT REPRESENT THE QUANTITY REQUIRED.



① ASSEMBLY SEQUENCE SUCTION



① ASSEMBLY SEQUENCE DISCHARGE



NOTES:

1. SEE MANUAL FOR TORQUE VALUES (ITEM #8).
2. INSTALL PER ER-52.
3. LOWER PART ASSEMBLY (ITEM #2) CONSISTS OF LOWER PART, CENTER STUD (ITEM #3) AND SPIROL PIN (ITEM #7).

REV	DESCRIPTION	INIT/DATE
1	UPDATED DRAWING TO CURRENT STANDARDS. ADDED VIEWS SHOWING ASSEMBLY SEQUENCE FOR BOTH SUCTION/DISCHARGE SHOWING ORIENTATION OF LENTOID AND ANNULAR SPRINGS	MLB 09/29/06

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DIMENSIONS ARE IN INCHES UNLESS OTHERWISE SPECIFIED.
---- DO NOT SCALE DRAWING ----

REV	ECN
1	13965
0	7799

ARIEL CORPORATION
35 BLACKJACK ROAD
MOUNT VERNON, OHIO 43050

TITLE: CONCENTRIC VALVE

MATERIAL: PROCURED

DRAWN: IG 09/23/99

CHECKED: ED 10/04/99

SCALE: NONE

R.S. No.

PART NO.

DWG. No: A-9236

10/15/2016

ARIEL CORPORATION

PARTS LIST

Part No. B-1788-E

CONCENTRIC VALVE, 078/035, 1-3/4, 1-5/8 **Ref Drawing.** A-9236

0.1260=A
1.9770=B
3.7760=C
0.0470=LFT

ITEM	PART NUMBER	QTY	UOM	DESCRIPTION
001	A-4876	1		UPPER PART, CONCENTRIC VALVE
002	A-4877-A	1		LOWER PART ASSEMBLY, CONCENTRIC VALVE
003	A-1842	1		CENTER STUD, 3/8-24 X 3.15 LONG
004	A-1844	1		VALVE RING, 78CD, .079 THICK
008	A-1367	1		LOCKNUT, DRAKE, 3/8-24
009	A-16466	1		LOCK, STUD, .098 OD
010	A-1848	1		COUNTER RING, 78C1, .047 THICK, CONCENTRIC VALVE
012	A-1847	1		VALVE WASHER, 3/8
014	A-1843	1		VALVE RING, 35CD10, .098 THICK
015	A-1845	6		LENTOID SPRING, .024 THICK, CONCENTRIC VALVE
016	A-1846	6		ANNULAR SPRING, 35CD1, CONCENTRIC VALVE
099	KB-1788-E	0		KIT, CONCENTRIC VALVE, 078/035

*** ALWAYS PROVIDE SERIAL NUMBER WHEN ORDERING SPARE PARTS. ***
WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT DOES NOT REPRESENT THE QUANTITY REQUIRED.

G-1446
G-1809

TO REMOVE A COMPRESSOR VALVE :

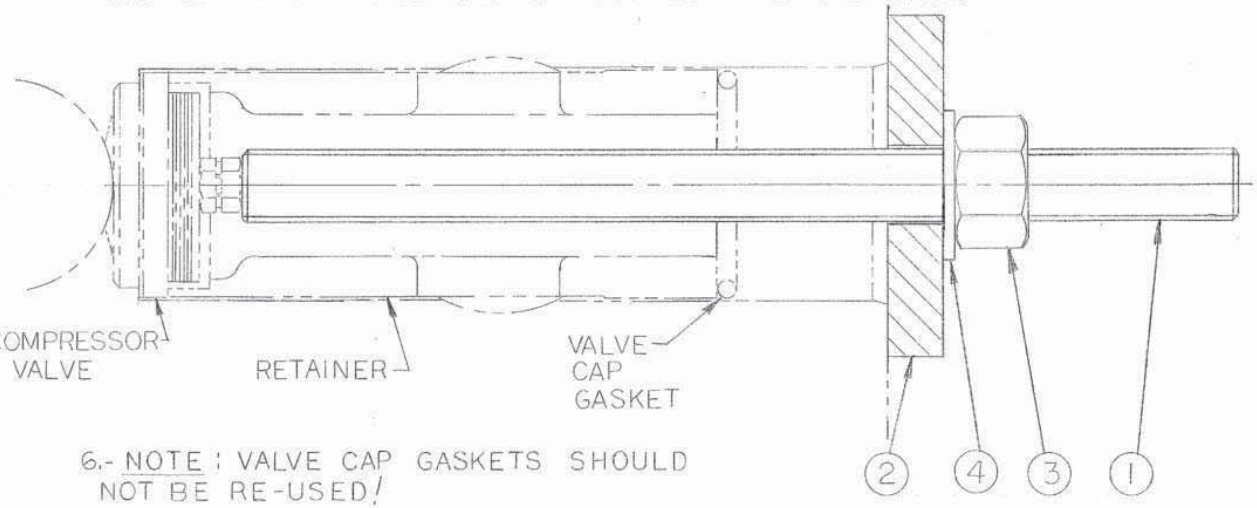
1.- AFTER DEPRESSURIZING THE CYLINDER AND REMOVING THE VALVE CAP; ATTACH THE VALVE PULLER STUD, ITEM #1 TO THE VALVE STUD.

2.- SLIDE THE VALVE PULLER PLATE, ITEM #2 OVER THE END OF THE PULLER STUD SO THAT IT RESTS ON THE CYLINDER BODY.

3.- SLIDE THE WASHER, ITEM #4 OVER THE STUD AND THREAD THE NUT, ITEM #3 ONTO THE STUD.

4.- TIGHTEN THE NUT, THIS WILL PULL THE VALVE, RETAINER AND VALVE CAP GASKET OUT OF THE POCKET.

5.- THE ASSEMBLY ONLY NEEDS TO BE PULLED FAR ENOUGH OUT OF THE POCKET SO THERE IS ROOM BETWEEN THE TOP OF THE RETAINER AND THE VALVE CAP GASKET TO PRY THE GASKET OUT OF THE CYLINDER.



6.- NOTE : VALVE CAP GASKETS SHOULD NOT BE RE-USED!

13768
03379

ARIEL CORPORATION
MT. VERNON, OHIO
ASSY. DRWG. NO.: B-992

10/15/2016

ARIEL CORPORATION

PARTS LIST

Part No. G-1446
Ref Drawing. B-0992

VALVE TOOL, 1.625/1.75M:JG 2RJ-HE:SG-HE,
1-1/2SG12-FS-HE

ITEM	PART NUMBER	QTY	UOM	DESCRIPTION
001	A-1759	1		ALL THREAD STUD, VALVE PULLER, 1-3/4M
002	A-1760	1		PLT,VLV PULLER,1-3/4M
003	FN0451HD	1		HEX NUT, HEAVY WEIGHT, 2H, 5/8-11
004	FW0500HA	1		WASHER, 5/8 SAE

*** ALWAYS PROVIDE SERIAL NUMBER WHEN ORDERING SPARE PARTS. ***
WHEN A ZERO APPEARS IN THE QUANTITY COLUMN IT DOES NOT REPRESENT THE QUANTITY REQUIRED.

COOLER



Installation, Operation & Maintenance Manual

SRC B83-11083

J-W Power Company 329-01115 / 335-22834

Air Cooler:	61.5x661I48H
Gas Cooler Coil:	12x66-4R-58/120
Gas Cooler Coil:	16.5x66-3R-58/120
Gas Cooler Coil:	15x66-4R-58/120
Gas Cooler Coil:	18x66-4R-58/120

GENERAL OPERATION INSTRUCTIONS of SRC AIR COOLER

All possible care has been taken to be certain that the mechanical equipment installed on your SRC Air Cooler is correct and carefully inspected. Periodic inspection and regular servicing is our best protection against depreciation or mechanical failure. Your experience in operating similar equipment in your plant should be the best guide to servicing your SRC Air Cooler. Do not overlook any established service procedure.

Before Starting Aircoil Unit

1) Check the oil level in gears (if furnished).
2) Check the lubrication of the motors of other driving units.
3) If unit is installed with tripod support for gear and fan, check the lubrication thrust bearings.
4) Be certain that there is clearance between the tips of the fan blades and the fan rings.
5) Turn each fan through several revolutions by hand to be sure it turns freely. If any binding or grinding noise is noticeable, do not operate the unit until the cause has been eliminated.
6) Clear the area adjacent to the fans of all debris or loose lumber which might be picked up by air flowing into the fan.

Mounting Bearings

(If Required)

1) Be sure shaft is clean and free of any abrasive substance.
2) A small amount of clean lubricant should coat the bore of the bearing.
3) Back-out setscrews in both collars far enough to clean bearing bore.
4) Make certain that both collars are fully engaged with the inner face.
5) Start entire unit squarely on shaft and slide along shaft to proper position. Apply pressure through collar. Do not use a heavy hammer.
6) Bolt the unit to supports. Check shaft for freedom of rotation.
7) Tighten the setscrews in both collars securely to the shaft.
8) Check the shaft for freedom of rotation.

Fan Belt Driving Unit Assembly Procedure

(If Required)

1) Install motor to motor hanger and install on motor support.
2) Assemble sheave onto motor shaft.
3) Place belts on sheaves and correctly align sheaves. Tighten bushings to securely hold in place.

4) Tighten belts to proper tension using adjustment and lock in place.
5) Turn fan by hand for proper assembly and to see if proper clearance between fan blades and barrel is held.
6) Drive assembly is now ready for electrical hook up and test run.

After Operation has Started

The following service points are recommended to be included in your service routine.
1) Check motor and bearing temperatures once a day.
2) After the first five (5) days of operation of the Airfin unit, the oil originally placed in c the gears(if furnished) should be drained and replaced with new oil.

Belt Drive Maintenance

Belt tension is adjusted by slightly loosening bolts which hold motor hanger to tripod and sliding motor along slotted holes in motor support base by means of adjusting screws. For proper adjustment, run driver at full speed and adjust take-up until only slight bow appears in slack side of belts. Tighten motor bolts. After a few days operation, take-up should be re-adjusted to insure proper bolt tension. Keep sheaves free from oil or grease.

Operation and Lubrication Instructions

Important

Bearing must be lubricated before operation. Bearings should be lubricated at regular intervals. Periodic inspection during first year of operation will dictate the allowable intervals between lubrication.

Re-Greasing

When re-greasing, the following steps should be followed:
1) Clean the exterior of the grease zerk.
2) Re-grease bearing with low pressure grease gun.
3) Fill until new grease is purged at the bearing seal.

NOTE: If the bearings are rough, the unit should be disassembled and the bearings replaced.

Periodic Inspection

1) Once each week, check the oil in the gears (if furnished) to determine that no water or foreign material has entered the oil. If oil appears frothy or emulsified, stop motor, drain oil immediately, and replace with proper grade of new oil; and investigate cause.

2) Once each month the pitch angle setting of the fan blades should be carefully checked.
3) Once every sixty (60) days the motor bearings should be checked and lubricated, if necessary. The manufacturer's lubrication specifications should be carefully followed using only high-grade recommended lubricants.
4) Lubricating oil for gears should be selected from standard brands, in accordance with manufacturer's recommendations.

Recommended Re-Greasing Unit Time

The maximum time recommended before re-greasing is approximately 4,000 to 6,000 operating hours.

NOTE: For unusually severe operating conditions, such as corrosive atmospheres of chemical fumes, acids, alkalies, extremely high humidity, or high shock loads, more frequent re-greasing may be required or special greases will be recommended. Consult a lubrication specialist.

Recommended Greases

It is recommended the greases shown in the Manufacturer's Installation, Operation and Maintenance Instructions or an equivalent be used for re-lubing the equipment requiring this maintenance.

Plug Insertion and Recommended Torque Values

Install new gaskets on plugs any time a plug is removed and re-installed into the header. The plug threads should be carefully inspected after removal. If damaged threads are evident, the plug should be replaced. Apply an "anti-seize" lubricant to the plug threads prior to inserting into the header. Carbon steel (C.S.) and plated plugs may be inserted mechanically. Stainless Steel (S.S) or High Alloy (H.A.) plugs must be inserted by hand only, due to the galling characteristics of these materials. The following are recommended torque ranges for various plug types. Ranges are recommended, but not restricted to the values shown below. Plug torque should begin at the low range and be increased in increments of 25 ft. lbs until seal is obtained.

¾" C.S. 175-225 ft-lbs.
¾" S.S. or H.A. 175-250 ft-lbs.

1-1/8" C.S. 225-300 ft-lbs.
1-1/8" S.S. or H.A. 250-350 ft-lbs.

1-1/4" C.S. 275-375 ft-lbs.
1-1/4" S.S. or H.A. 300-450 ft-lbs.

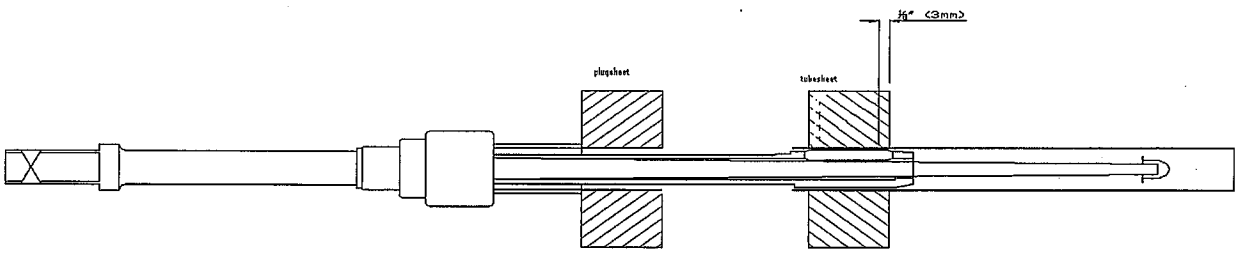
1-3/8" C.S. 325-425 ft-lbs.
1-3/8" S.S. or H.A. 350-475 ft-lbs.

Maintenance of Mechanical Equipment

For specific recommendation on mechanical equipment such as gears, electric motors, turbines, etc., refer to manufacturer's instructions.

Instructions for Tube Expanding by Hand

1. Remove access plug for tube that is leaking.
2. Set the expander for the proper location in the tube sheet. The end of the rolls should be set flush with the tube side of the tube sheet. The adjustment can be made by holding the tube expander on top of the header, parallel to the tube, with the bearing collar against the plug sheet. See view below. Care needs to be taken if rolls protrude through the tube sheet, the expander will tend to cut the tube inside and at the edge of tube sheet.
   If the rolls do not protrude in the tube sheet deep enough, there may be inadequate surface bond.
   To set roll depth: loosen Allen screw in the thrust collar, then screw collar in or out to position the rolls.
3. If the cooler is used for oil, the corresponding plug on opposite head must be removed so the oil turbulator can be pulled out of the way of the expander.
4. After inserting the tube expander into the tube, push lightly and turn the mandrel clockwise. This rotation progresses the mandrel forward.
   Since the mandrel is tapered, this forward progression forces the rolls against the tube wall.
   To determine the proper amount of expansion:
   - After a few rotations of the mandrel, the rolls make contact with the tube and the mandrel gets harder to turn. <u>From this point of contact, expanding is in progress</u>.
   - Continue turning the mandrel in a clockwise direction as many turns as needed to progress the mandrel a full ¼" beyond the point of the initial contact.
   - If installing a new tube that has not been previously expanded, progress the mandrel 3/8" beyond the point of the initial contact.



TAG	DESCRIPTION	QTY
A	COIL ASSEMBLY: (STAGE 1) 12 X 66 (4R) .625/120 COMP. GAS	1
B	COIL ASSEMBLY: (STAGE 2) 16.5 X 66 (3R) .625/120 COMP. GAS	1
C	COIL ASSEMBLY: (STAGE 3) 15 X 66 (4R) .625/120 COMP. GAS	1
D	COIL ASSEMBLY: (STAGE 4) 18 X 66 (4R) .625/120 COMP. GAS	1
E	MOTOR: WEG/TECO, 10 HP, 900 RPM, 3PH, 60HZ, 230/460V, TEFC, 284T	1
F	PROP: MOORE, CLASS 10000 SCVT, SERIES 18, 48" DIA, 4 BLADE, 20° PITCH, 1.875"Ø	1
G	ELECTRICAL BOX, NEMA 3R, W/ TERMINAL STRIP	1

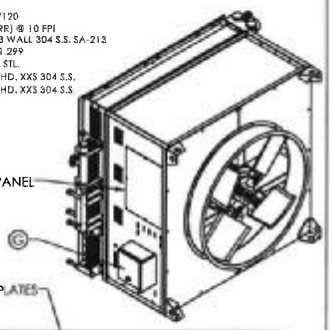
STAGE 1
COIL TEST PRESSURE: 826 PSIG HYDROSTATIC
M.A.W.P.: 635 PSIG @ 400°F
DIE# 1C
COIL: 12 X 66 (4R) .625/120
FINS: .0095 ALUM. (CORR) @ 10 FPI
TUBING: 5/8" OD, X .049 WALL C.S. SA-214
TUBE CENTERS: 1.500 X 1.299
CASING: 12 GA. GALV. STL.
HEADER: 3" NOM. SCHD. 40 C.S.
HEADER: 3" NOM. SCHD. 40 C.S.
DISTRIBUTOR: N/A
ROWS DEEP: 4
TUBES HIGH: 8
CIRCUITS: 8

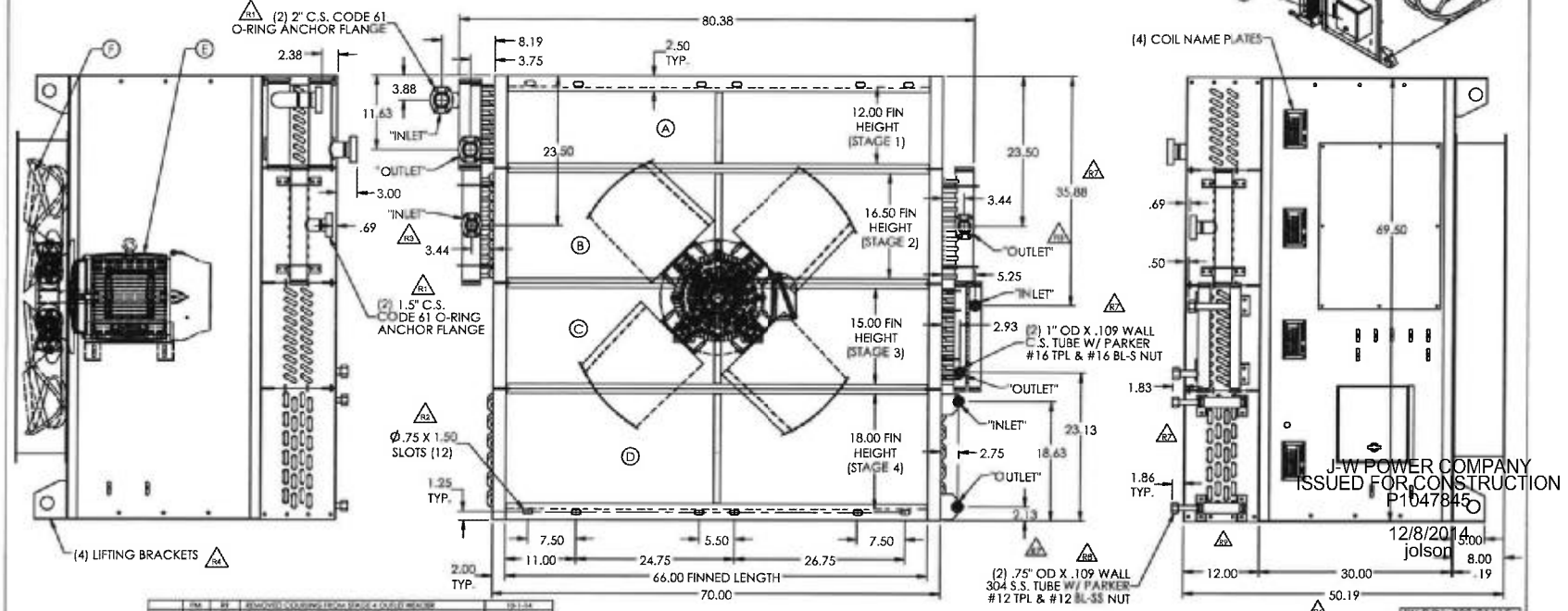
STAGE 2
COIL TEST PRESSURE: 1170 PSIG HYDROSTATIC
M.A.W.P.: 900 PSIG @ 400°F
DIE# 1S
COIL: 16.5 X 66 (3R) .625/120
FINS: .0095 ALUM. (SINE) @ 10 FPI
TUBING: 5/8" OD, X .049 WALL C.S. SA-214
TUBE CENTERS: 1.500 X 1.299
CASING: 12 GA. GALV. STL.
HEADER: 2.5" NOM. SCHD. 40 C.S.
HEADER: 2.5" NOM. SCHD. 40 C.S.
DISTRIBUTOR: N/A
ROWS DEEP: 3
TUBES HIGH: 11
CIRCUITS: 11

STAGE 3
COIL TEST PRESSURE: 3120 PSIG HYDROSTATIC
M.A.W.P.: 2400 PSIG @ 400°F
DIE# 1C
COIL: 15 X 66 (4R) .625/120
FINS: .0095 ALUM. (CORR) @ 10 FPI
TUBING: 5/8" OD, X .083 WALL C.S. SA-179
TUBE CENTERS: 1.500 X 1.299
CASING: 12 GA. GALV. STL.
HEADER: 1.5" NOM. SCHD. 160 C.S.
HEADER: 1.5" NOM. SCHD. 160 C.S.
DISTRIBUTOR: N/A
ROWS DEEP: 4
TUBES HIGH: 10
CIRCUITS: 10

STAGE 4
COIL TEST PRESSURE: 6930 PSIG HYDROSTATIC
M.A.W.P.: 5000 PSIG @ 350°F
DIE# 1C
COIL: 18 X 66 (4R) .625/120
FINS: .0095 ALUM. (CORR) @ 10 FPI
TUBING: 5/8" OD, X .083 WALL 304 S.S. SA-213
TUBE CENTERS: 1.500 X 1.299
CASING: 12 GA. GALV. STL.
HEADER: 1.25" NOM. SCHD. XXS 304 S.S.
HEADER: 1.25" NOM. SCHD. XXS 304 S.S.
DISTRIBUTOR: N/A
ROWS DEEP: 4
TUBES HIGH: 12
CIRCUITS: 4

NOTE:
TWO COAT PAINT SYSTEM ON C.S. MAT'L





REV	BY	REVISION	DATE
	PM	REMOVED LOCKWIRE FROM STAGE 4 COILED HEADER	10-1-14
	PM	CHANGED STAGE 4 CONNECTIONS TO .109 WALL	8-18-14
	PM	CHANGED STAGE 3 & 4 CONN. DESIGN, UPDATED MATERIAL	1-28-14
	TC	LABELED ACC. PANEL, ADDED ELECT. BOX, REMOVED FAN GUARD	10-8-13
	PM	CHANGED FAN PITCH	7-26-13
	PM	ADDED GRIND BRACKET	4-11-13
	PM	CHANGED STAGE 3 VALVE OUTLET SIDE, FAN GUARD	10-22-12
	PM	CUSTOMER REQUESTED CHANGES	8-13-12
	PM	CHANGE TO ASME TO CODE 61	1-26-12

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TOLERANCES:
X.XX +/- 0.13
X.XXX +/- 0.06
[ ] = +/- .005 NON-CUMULATIVE
UNLESS OTHERWISE STATED

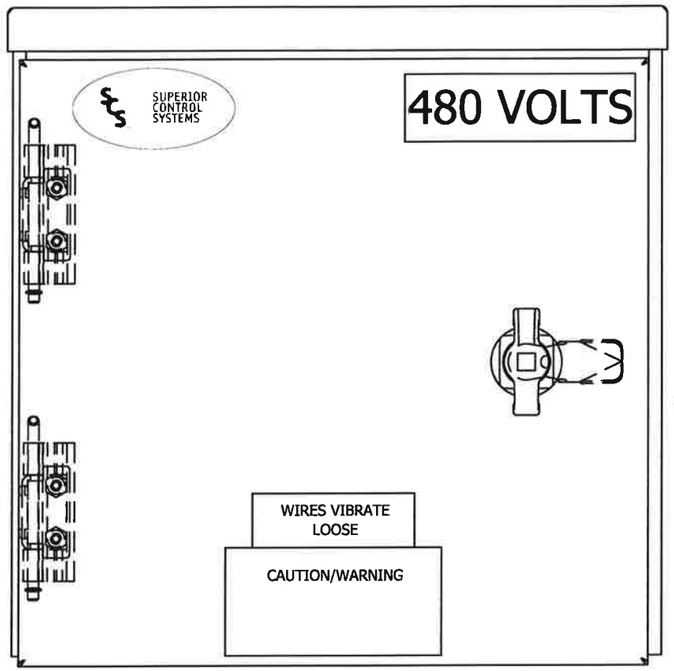
ENGINEERED AIR-COOLED HEAT EXCHANGERS
A Division Of Super Radiator Coils
customaircoolers.com
2622 S. 21ST STREET
PHOENIX, ARIZONA 85034
CUSTOM AIR COOLERS

DATE: 11-4-11	COIL DESCRIPTION: AIR COOLER UNIT ASSEMBLY
DESIGNED BY: PM	
APPROVED BY:	CUSTOMER: JW POWER COMPANY
	DWG NO. B83-11083 REV.9

J-W P/N 329-01115
J-W Dwg. No. 335-22834 Rev.09
Sheet 2 of 2 01Dec14

THIS DRAWING MUST BE FIELD VERIFIED BEFORE USE
DRAWING NOT TO SCALE UNLESS SCALE BAR IS PRESENT

AS BUILT



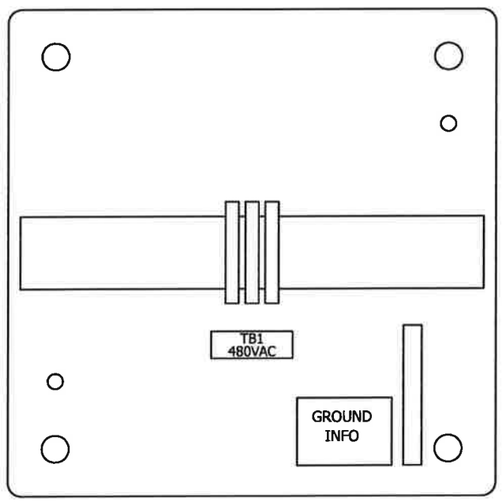
STICK TO INSIDE SIDE WALL OF ENCLOSURE

COPPER ONLY
RATED @ 60 DEGREES

TORQUE CHART

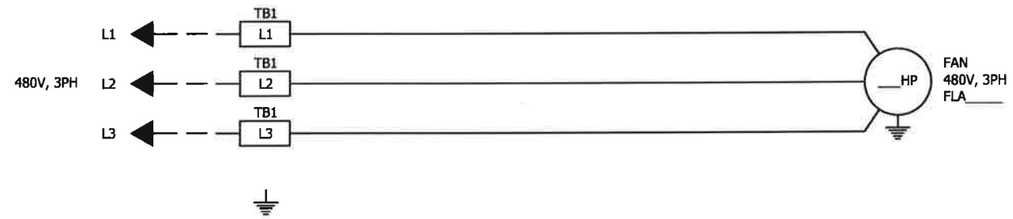
1/2" KNOCKOUT IN BOTTOM CENTER OF BOX FOR CONDUIT ENTRY

GROUND STRAP FROM SIDE ENCLOSURE TO DOOR



INSTALL AN END CLAMP AND BARRIER IN BETWEEN EACH TERMINAL

SHORT CIRCUIT PROTECTION DISCONNECT AND OVERLOAD PROTECTION PROVIDED BY OTHERS



Drawing Approved

7/8/15

USER: TroyWin7 FILE: C: \Users \TroyWin7 Dropbox \SUPERIOR \Engineering \CUSTOMER DRAWINGS & PLC PROGRAMS \SUPER RADIATOR COILS \SRC-JWE-480-3RJB-1.dwg DATE: 7/07/15 TIME: 02:00pm

SUPERIOR CONTROL SYSTEMS

SUPERIOR CONTROL SYSTEMS INC
939 S 48TH STREET SUITE 216
TEMPE, AZ 85281
O: 480-966-1400
F: 480-966-1422
WWW.SUPERIORCONTROL.COM

REVISIONS

NO.	BY	DATE	CKD	REMARKS
0	TH	09/27/2013	TH	FOR REVIEW
1	MV	10/17/2013	TH	FOR CONSTRUCTION
2	MC	12/11/2013	TH	AS BUILT
3	ML	07/07/2015	TH	AS BUILT – ADDED GROUNDING STRAP

SUPER RADIATOR COILS

MAX VOLTS: 480VAC
PHASE: 3
TOTAL FLA:
LARGEST FLA:
ENCL TYPE: 3R
SCCR KA RMS: 10KA
UL: 508A

JW POWER COMPANY
FAN JUNCTION BOX

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All ideas are classified confidential and cannot be revealed to anyone without permission of Superior Control Systems Inc.
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PROJECT# N/A

DATE: 09/27/2013

1 SHEET OF 1

DRAWING# SRC-JWE-480-3RJB-1

CUSTOM AIR COOLERS

	Date: 9/26/2014			Rev.: 8			By: WC								
	SRC Drawing #: B83-11083														
	Customer: J-W Power Company (Part #: 329-01115 / Drawing #: 335-22834)														
	Address:														
1	THERMAL PERFORMANCE														
2	Model Number			61.5x66											
3	Job Item			Stage 1			Stage 2			Stage 3			Stage 4		
4	Dimensions			W	L	H	W	L	H	W	L	H	W	L	H
5	Fin Side														
6	Gas Type			Air			Air			Air			Air		
7	Gas Flow	ACFM		5000			5250			6225			7500		
8	Face Velocity	ft/min		800			610.9			796.8			800		
9	Altitude	ft/psig		2000			2000			2000			2000		
10	Static Press Drop	inH2O		0.9			0.9			0.9			0.9		
11	Temperature In	°F		100.0			100.0			100.0			100.0		
12	Temperature Out	°F		134.0			129.8			140.0			132.1		
13	Tube Side														
14	Fluid Type			Natural Gas (SG=0.65)			Natural Gas (SG=0.65)			Natural Gas (SG=0.65)			Natural Gas (SG=0.65)		
15	Flow Rate	Lb/Hr		2200 (737 SCFM)			2200 (737 SCFM)			2200 (737 SCFM)			2200 (737 SCFM)		
16	Tube Velocity	ft/sec		52.2			19.9			10			9.9		
17	Circuits			8 (4 Pass)			11 (3 Pass)			10 (4 Pass)			4 (12 Pass)		
18	Pressure Drop	psig		6.4			2.8			6.7			16.7		
19	Avg Specific Heat	Btu/lb·°F		0.5784			0.5851			0.6115			0.7608		
20	Avg Thermal Cond	Btu/hr·ft·°F		0.0239			0.0242			0.0299			0.0441		
21	Avg Viscosity	cP		0.0141			0.0146			0.0171			0.021		
22	Specific Gravity			0.0137			0.0261			0.0724			0.1834		
23	Temperature In	°F		257.0			245.0			306.0			258.0		
24	Temperature Out	°F		128.5			128.4			127.9			119.8		
25	Total Heat Exchanged	Btu/hr		163222			149882			239128			230932		
26	Fouling Factor	hr·ft²·°F/Btu		0.001			0.001			0.001			0.001		
27	Bare Tube Surface	ft²		28.80			29.70			36.00			43.20		
28	Extended Surface	ft²		476.01			490.89			595.01			714.02		
29	CONSTRUCTION														
30	Coil Type			12x66-4R-58/120			16.5x66-3R-58/120			15x66-4R-58/120			18x66-4R-58/120		
31	Tube OD	in		5/8			5/8			5/8			5/8		
32	Tube Wall	in		0.049			0.049			0.083			0.083		
33	Tube Material			Carbon Steel SA-214			Carbon Steel SA-214			Carbon Steel SA-179			304 Stainless SA-213		
34	Fins			0.0095 Aluminum			0.0095 Aluminum			0.0095 Aluminum			0.0095 Aluminum		
35	Coil Frame			Galvanized			Galvanized			Galvanized			Galvanized		
36	Headers			Carbon Steel Pipe			Carbon Steel Pipe			Carbon Steel Pipe			304 SS Pipe		
37	Connections			2.0" Flange			1.5" Flange			1.0" Seal Lok			0.75" Seal Lok		
38	Turbulators			None			None			None			None		
39	ASME Stamp			None			None			None			None		
40	Operating Pressure	psig		305			589			1740.7			4242.14		
41	Design Pressure	psig		635			900			2400			5000		
42	Design Temperature	°F		400 / -20			400 / -20			400 / -20			350 / -20		
43	Mechanical Equipment														
44				FAN			DRIVE			MISCELLANEOUS					
45				Manufact.	Moore		Manufact.	WEG/TECO		- Horizontal coils/vertical induced draft air flow.					
46				Quantity	1		Horsepower	10		- Support & plenum galvanized.					
47				Diameter (in)	48		RPM	900		- Motor wired to a terminal strip in a NEMA 3R box					
48				RPM	870		Voltage	230-460		mounted to the plenum.					
49				Blades	4		Phase	3							
50				Pitch	20°		Frequency	60							
51				Drive Type	Direct		Enclosure	TEFC							
52				Material	Al		Type	Electric							
53	Comments:														
54															

2622 South 21st St. Phoenix, AZ 85034 Phone: (800) 899-2645 Fax: (602) 253-0334

J-W P/N 329-01115
J-W Dwg. No. 335-22834 Rev.09
Sheet 1 of 2 01Dec14

J-W POWER COMPANY
ISSUED FOR CONSTRUCTION
P1047845

12/8/2014
jolson

Moore Fans LLC Rating

Phone: (660) 376-3575 http://www.moorefans.com **Fax:(660) 376-2909**

Version 2.16

2/6/2014 9:16

JW Power Company		Ref No.:	**329-01115**	Item No:	**B83-11083**
Class:	**10000**	Hub Type:	**HD**	Blade Type:	**SC**
Blade Tip:	**VT**	Adjustment:	**MAN**	Rotation:	**RH**
Series:	**18**	Diameter:	**4** feet	Blades:	**4**
Temperature:	**134** Deg. F	Elevation:	**2000** feet	Density Ratio:	**0.829**
Volume:	**25430** ACFM	Air Vel.:	**2202.57** fpm	Speed:	**870** RPM
Static Pressure:	**0.95** in H2O	Pv:	**0.250** in H2O	Pt:	**1.275** in H2O
Power Reqd.:	**7.19** bhp	Motor:	**10** bhp	Total Eff:	**71.1%**
		Bld Natural Freq.:	**33.5** Hz	Static Eff:	**53.0%**
Blades Required:	**2.83**	API Blades Req.:	**4**	Blade Load:	**0.708**
Tip Speed:	**10932.8** fpm	Deflection Angle:	**50.3** deg.	Pitch Number:	**1.69**
Entry Correction:	**1.3**	Tip Clearance:	**0.5** inches	Design Angle:	**13.2** deg
Exit Correction:	**1.00**	Draft:	**Induced**	Orientation:	**Horizontal**
Torque Factor:	**2**	Motor Torque:	**121** ft. lbs	Torq/Bld:	**30** ft. lbs
Appr fan weight:	**66** lbs	**30** kg		Bore Size:	inches
WR2	**54** lb-ft2	**2.3** kg m2		Bushing Type:	**U**
Thrust Load:	**83** lbs	**38** kg		Qty required:	**1**

Noise Levels Per Fan (Induced Draft) (Horizontal Orientation)

Sound Power Level

dBA	HZ	63	125	250	500	1000	2000	4000	8000
92.7		**98.7**	**97.7**	**94.7**	**89.7**	**87.7**	**81.7**	**75.7**	**69.7**

Sound Pressure Level 1 meter below bundle

81.4	**87.4**	**86.4**	**83.4**	**78.4**	**76.4**	**70.4**	**64.4**	**58.4**

Sound Pressure Level 1 meter radially from blade tip

78.6	**84.6**	**83.6**	**80.6**	**75.6**	**73.6**	**67.6**	**61.6**	**55.6**

Class 10000, Series 18, 4 feet Diameter, 4 Blades

Manual Adjustment, Heavy Duty, Standard Chord, Right Hand Rotation

With VT Blade Tips,

Fan Model No. 1018/073-U0-A/18R-VT-3-4.00-4

Fan Drawing: http://www.moorefans.com/pdfs/TMC_813_A.pdf

Note: Maximum blade angle to prevent fan stall is 21.4 degrees.

Available motor power may limit maximum angle to a lower value.

LONG TERM STORAGE PROCEDURE

1) DRIVE BELTS
   a) Remove drive belts and store inside. Coat sheaves with rust preventative. NOTE: Rust preventative must be removed from sheaves prior to re-installation of belts.
2) FAN SHAFT AND BEARINGS
   a) Check fan shaft and other machined surface approximately every 90 days and coat with rust preventative as required.
   b) Rotate fan shaft by hand every three months to prevent the bearings from "brinelling" into the races.
   c) The fan should be tied so it cannot rotate.
3) ELECTRIC MOTORS
   a) See manufacturers' suggested procedure.
4) VIBRATION SWITCHES, LOUVER ACTUATORS, INSTRUMENTATION AND INSTRUMENT PANELS, AND ALL OTHER PARTS BOXED AND SHIPPED SEPARATELY
   a) Store inside in a dry, well ventilated area. The instrumentation, vibration switches, louver actuators and instrument panels are not to be installed until ready for commissioning. Check every 30 days.
5) FINNED TUBE BUNDLES
   a) If finned tube bundles have been charged with nitrogen and sealed and the nitrogen charge falls below 5 psi, add nitrogen to bring the pressure to 10 psi. Check every 30 days.
   b) If a constant leak is apparent, apply a water/soap solution to each connection where a leak can occur. (i.e. rooted joints on flanges). The presence of bubbles shows a leak.

		No.:
		Date: 11-APR-2014

DATA SHEET
Three-phase induction motor - Squirrel cage rotor

Customer	:	
Product line	:	W22 NEMA Premium - Ball Bearings

Frame	:	284T
Output	:	10 HP
Frequency	:	60 Hz
Poles	:	8
Full load speed	:	880
Slip	:	2.22 %
Voltage	:	208-230/460 V
Rated current	:	29.6-26.8/13.4 A
Locked rotor current	:	150/75.0 A
Locked rotor current (Il/In)	:	5.6
No-load current	:	13.0/6.50 A
Full load torque	:	58.9 lb.ft
Locked rotor torque	:	200 %
Breakdown torque	:	240 %
Design	:	B
Insulation class	:	F
Temperature rise	:	80 K
Locked rotor time	:	32 s (hot)
Service factor	:	1.25
Duty cycle	:	S1
Ambient temperature	:	-20°C - +40°C
Altitude	:	1000
Degree of Protection	:	IP55
Approximate weight	:	373 lb
Moment of inertia	:	7.1992 sq.ft.lb
Noise level	:	54 dB(A)

	D.E.	N.D.E.
Bearings	6311 C3	6211 C3
Regreasing interval	20000 h	20000 h
Grease amount	18 g	11 g

Load	Power factor	Efficiency (%)
100%	0.78	90.2
75%	0.72	90.2
50%	0.61	89.5

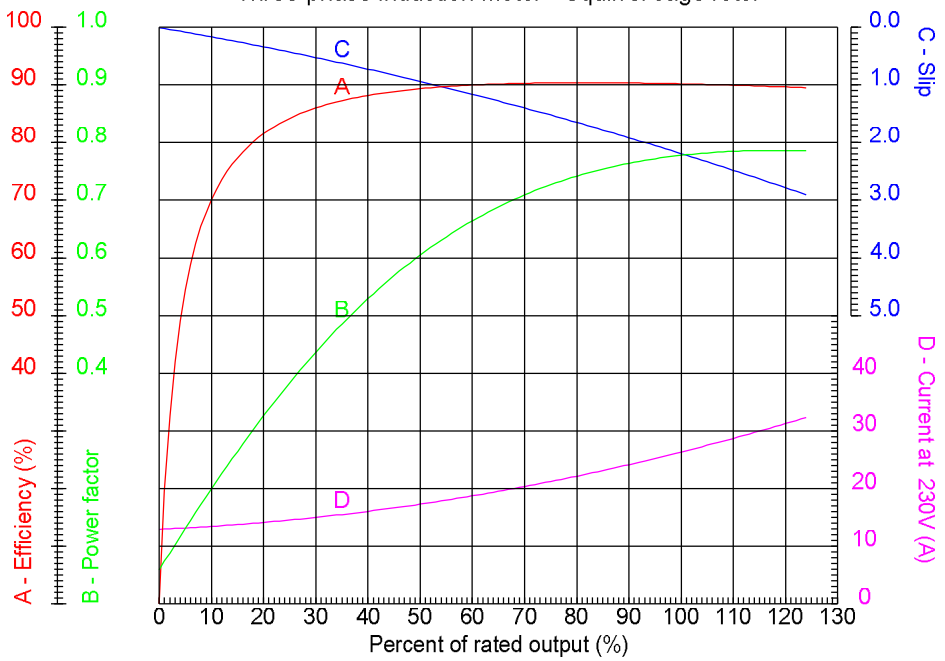
Notes:

Performed by	Checked

		No.:
		Date: 11-APR-2014

PERFORMANCE CURVES RELATED TO RATED OUTPUT

Three-phase induction motor - Squirrel cage rotor



Customer	:
Product line	: W22 NEMA Premium - Ball Bearings

Frame	: 284T	Locked rotor current (Il/In)	: 5.6
Output	: 10 HP	Duty cycle	: S1
Frequency	: 60 Hz	Service factor	: 1.25
Full load speed	: 880	Design	: B
Voltage	: 208-230/460 V	Locked rotor torque	: 200 %
Rated current	: 29.6-26.8/13.4 A	Breakdown torque	: 240 %
Insulation class	: F		

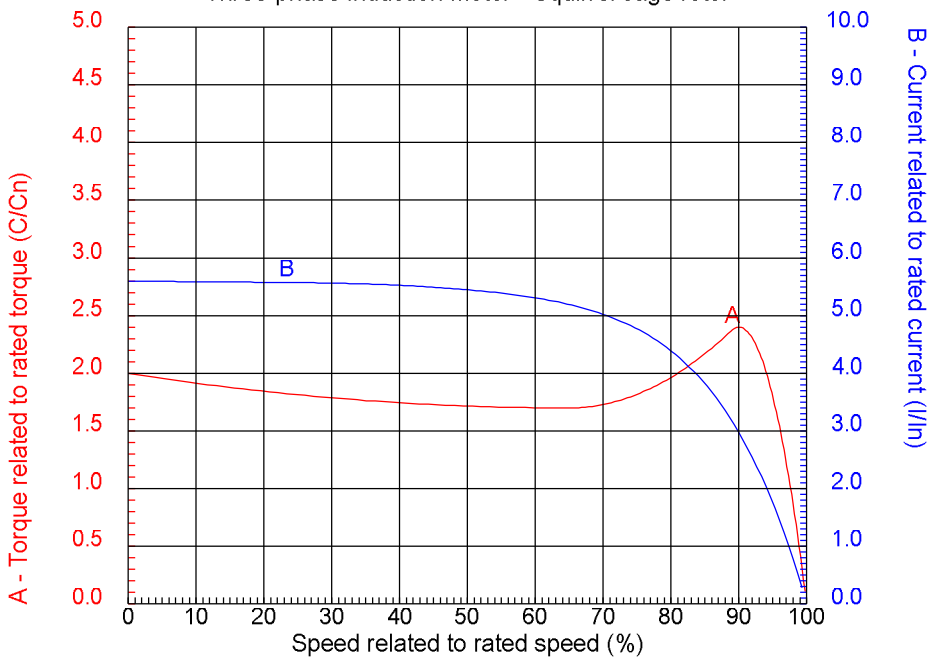
Notes:

Performed by	Checked

		No.:
		Date: 11-APR-2014

CHARACTERISTIC CURVES RELATED TO SPEED

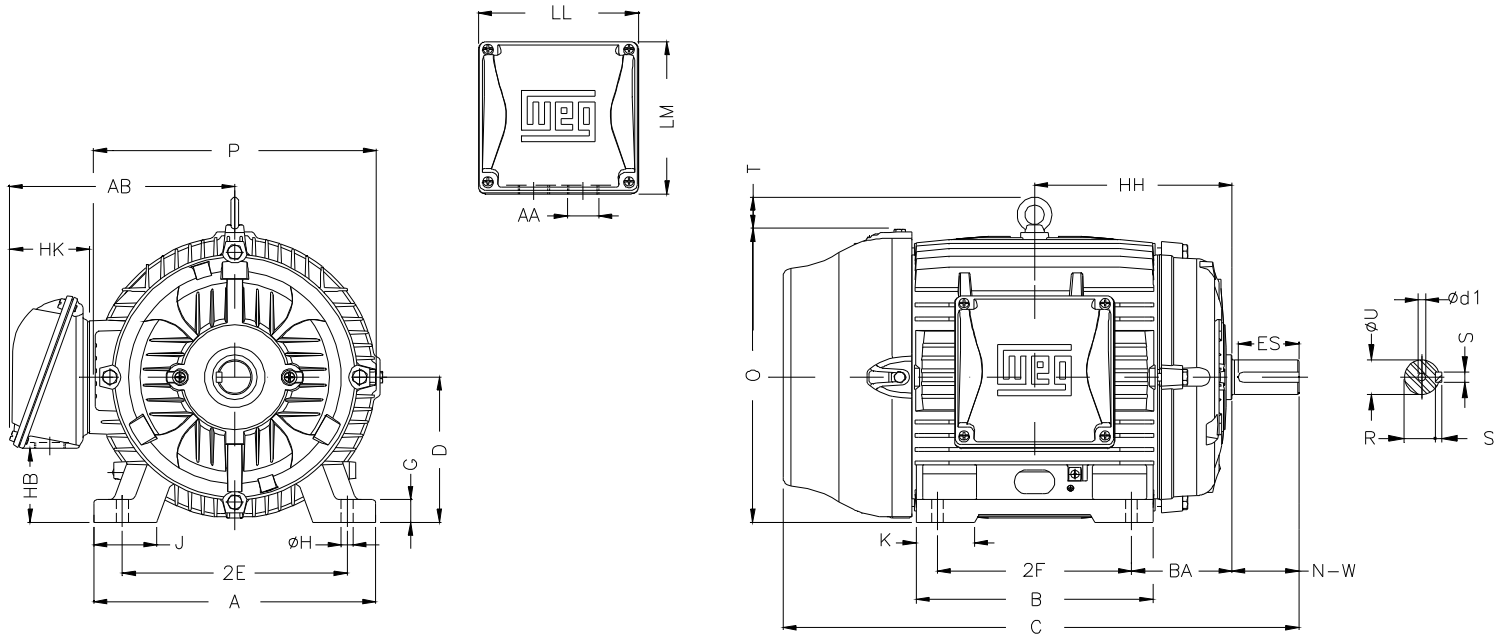
Three-phase induction motor - Squirrel cage rotor



Customer	:		
Product line	:	W22 NEMA Premium - Ball Bearings	
Frame	: 284T	Locked rotor current (Il/In)	: 5.6
Output	: 10 HP	Duty cycle	: S1
Frequency	: 60 Hz	Service factor	: 1.25
Full load speed	: 880	Design	: B
Voltage	: 208-230/460 V	Locked rotor torque	: 200 %
Rated current	: 29.6-26.8/13.4 A	Breakdown torque	: 240 %
Insulation class	: F		

Notes:

Performed by	Checked



Notes:

Performed by:

Checked:

Customer:

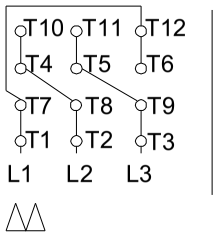
W22 NEMA Premium - Ball Bearings

2E 11.000	J 3.110	A 13.780	P 14.173	AB 11.073
2F 9.500	K 2.874	B 11.575	BA 4.750	U 1.875
N-W 4.622	ES 3.149	S 0.500	R 1.594	depth 0.500
D 7.000	G 1.023	HB 3.535	O 14.067	T 2.087
HF 7.000	HH 9.500	HK 3.976	H 0.531	C 26.433
LL 7.815	LM 7.480	AA NPT 1 1/2"	d1 A 4	

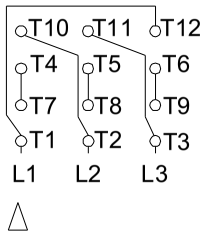
Three-phase induction motor
Frame 284T - IP55

11-APR-2014

LOW VOLTAGE

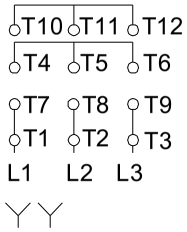


HIGH VOLTAGE

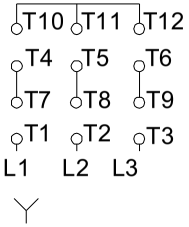


CONNECTIONS FOR STARTING ONLY:

LOW VOLTAGE



HIGH VOLTAGE



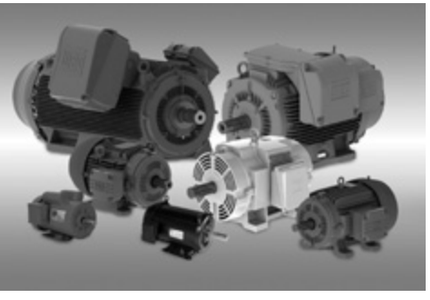
Notes:	
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Customer:	
W22 NEMA Premium - Ball Bearings	
Three-phase induction motor Frame 284T - IP55	11-APR-2014

Low and high voltage electric motors

Instructions manual for installation, operation and maintenance of electric motors

Motores Eléctricos de baja y alta tensión

Manual de instalación, operación y mantenimiento de motores eléctricos



Cod: 50031071 | Rev.05 | Date (m/y): 03/2015
The values shown are subject to change without prior notice.

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info-mx@weg.net
www.weg.net/mx

ENGLISH

1. Foreword

The installation, operation and maintenance of the motor must be always performed by qualified personnel using proper tools and methods and following the instructions contained in the documents supplied with the motor.

The instructions presented in this document are valid for WEG motors with the following characteristics:

- Three-phase and single-phase induction motors (squirrel cage rotor);
- Three-phase permanent magnet motors;
- Three-phase hybrid motors (squirrel cage rotor + permanent magnets);

The objective of this manual is to provide important information, which must be considered during the shipment, storage, installation, operation and maintenance of WEG motors. Therefore, we advise to make a careful and detailed study of the instructions contained herein before performing any procedures on the motor. The noncompliance with the instructions informed in this manual and others mentioned on the website www.weg.net voids the product warranty and may cause serious personal injuries and material damages.

Electric motors have energized circuits and exposed rotating parts which may cause injuries to people.

2. Shipment, storage and handling

Check the conditions of the motor immediately upon receipt. Where any damage is noticed, this must be reported in writing to the transportation company, and immediately communicated to the insurance company and to WEG. In this case, no installation job can be started before the detected problem has been solved.

Check if the nameplate data matches the invoice data and the environmental conditions in which the motor will be installed. If the motor is not immediately installed, it must be stored in a clean and dry room protected against dust, vibrations, gases and corrosive agents, and with relative humidity not exceeding 60%.

In order to prevent water condensation within the motor during the storage period, it is recommended to keep the space heater ON (where provided). In order to prevent oxidation of the bearings and ensure an even distribution of the lubricant, rotate the motor shaft at least once a month (at least five turns), always leaving it in a different position. For bearings with oil mist lubrication systems, the motor must be stored horizontally, independently from the mounting configuration, with ISO VG 68 oil in the bearing, (the amount is indicated in the motor manual available on the website www.weg.net) and the shaft must be turned weekly. If the motors are stored for more than two years, it is recommended to change the bearings, or to remove, wash, inspect and relubricate them before the motor is started. After this storage period, it is also recommended to change the start capacitors of single-phase motors since they loss their operating characteristics.

Always handle the motor carefully in order to prevent impacts and damages to the bearings and always install the shaft transportation/locking device (if supplied) when transporting the motor.

Use only the eyebolts to lift the motor. However these eyebolts are designed for the motor weight only. Thus never use these eyebolts to lift the motor with additional loads coupled to it. The lifting eyebolts of the terminal box, fan cover, etc., are intended to handle only these parts when disassembled from the motor. Additional information regarding the maximum allowable angle-of-inclination is indicated in the general manual available on the website www.weg.net.

Periodically and mainly before the initial star-up, measure the insulation resistance of the motor winding. Check the recommended values and the measuring procedures on the website www.weg.net.

3. Installation

During the installation, the motors must be protected against accidental energization.
Check the motor direction of rotation, turning it without load before it is coupled to the load.

Remove the transportation devices and shaft locking device (if supplied) before starting the motor installation.
Motors must be only installed in places compatible with their mounting features and in applications and environments for which they are intended.

Those motors with feet must be installed on bases duly planned in order to prevent vibrations and assure perfect alignment. The motor shaft must be properly aligned with the shaft of the driven machine. Incorrect alignment, as well as improper belt tension, will certainly damage the bearings, resulting in excessive vibrations and even causing the shaft to rupture. The admissible shaft radial and axial loads indicated in the general manual of the website must be respected. Use flexible coupling whenever possible. When motors are fitted with oil lubricated bearings or oil mist lubrication systems, connect the cooling and lubrication tubes (where provided).
For oil lubricated bearings, the oil level must be in the center of the sight glass.
Only remove the corrosion protection grease from the shaft end and flange immediately before the motor installation.
Unless specified otherwise in the purchase order, WEG motors are dynamically balanced with "half key" and without load (uncoupled).
The driving elements, such as pulleys, couplings, etc., must be balanced with "half key" before they are mounted on the shaft of the motors.

The motor must always be positioned so the drain hole is at the lowest position.
Motors supplied with rubber drain plugs leave the factory in the closed position and must be opened periodically to allow the exit of condensed water. For environments with high water condensation levels and motor with degree of protection IP55, the drain plugs can be mounted in open position .

For motors with degree of protection IP56, IP65 or IP66, the drain plugs must remain at closed position, being opened only during the motor maintenance procedures.
The drain system of motors with Oil Mist lubrication system must be connected to a specific collection system.

Do not cover and block the motor ventilation openings. Ensure a minimum clearance of ¼ (25%)of the diameter of the air intake of the fan cover from the walls. The air used for cooling the motor must be at ambient temperature, limited to the temperature indicated on the motor nameplate.

Motors installed outdoors or in the vertical position require the use of additional shelter to protect them from water; for instance, use of a drip cover.

To prevent accidents, ensure that the grounding connection has been performed according to the applicable standards and that the shaft key has been securely fastened before the motor is started.

Connect the motor properly to the power supply by means of safe and permanent contacts, always considering the data informed on the nameplate, such as rated voltage, wiring diagram, etc.

For power cables, switching and protection devices dimensioning, consider the rated motor current, the service factor, and the cable length, among others. For motors without terminal block, insulate the motor terminal cables by using insulating materials that are compatible with the insulation class informed on the nameplate. The minimum insulation distance between the non-insulated live parts themselves and between live parts and the grounding must be: 5.5 mm for rated voltage up to 690 V; 8 mm for voltages up to 1.1 kV; 45 mm for voltages up to 6.9 kV; 70 mm for voltages up to 11 kV and 105 mm for voltages up to 16.5 kV.

In order to assure the degree of protection, unused cable inlet holes in the terminal box must be properly closed with blanking plugs having and equal or higher degree of protection to that indicated on the motor nameplate.

The motor must be installed with overload protection devices. For three-phase motors, it is recommended to install a phase failure protection device. When motor is fitted with temperature-monitoring devices in the stator windings and/or bearings, they must be connected during the operation and even during tests.

For flying leads motors, do not push the overlength of leads into the motor in order to prevent that they touch the rotor.

Ensure the correct operation of the accessories (brake, encoder, thermal protection, forced ventilation, etc.) installed on the motor before it is started.

Motors fitted with Automatic Thermal Protectors will reset automatically as soon as the motor cools down. Thus, do not use motors with Automatic Thermal Protection in applications where the auto-reseting of this device may cause injuries to people or damage to equipment. Motors fitted with Manual Thermal Protectors require manual reset after they trip. If the Automatic Thermal Protector or the Manual Thermal Protector trip, disconnect the motor from the power supply and investigate the cause of the thermal protector triping.

Wmagnet motors must be driven by WEG variable frequency drives only.

For more information about the use of variable frequency drives, follow the instructions in the motor manual on the website www.weg.net and in the manual of the variable frequency drive.

4. Operation

During operation, do not touch the non-insulated energized parts and never touch or stay too close to rotating parts.

Ensure that the space heater is always OFF during the motor operation.

The rated performance values and the operating conditions are specified on the motor nameplate. The voltage and frequency variations of the power supply should never exceed the limits established in the applicable standards.
Occasional different behavior during the normal operation (actuation of thermal protections, noise level, vibration level, temperature and current

increase) must always be assessed by qualified personnel. In case of doubt, turn off the motor immediately and contact the nearest WEG service center.

Do not use roller bearings for direct coupling. Motors fitted with roller bearings require radial load to ensure their proper operation.

For motors fitted with oil lubrication or oil mist systems, the cooling system must be ON even after the machine is OFF and until the machine is at complete standstill.
After complete standstill, the cooling and lubrication systems (if any exist) must be switched OFF and the space heaters must be switched ON.

5. Maintenance

Before any service is performed, ensure that motor is it at standstill, disconnected from the power supply and protected against accidental energization. Even when the motor is stopped, dangerous voltages may be present in space heater terminals.

If motors are fitted with capacitors, discharge them before any handling or service is performed.

Motor disassembly during the warranty period must be performed by a WEG authorized service center only.

For motors with permanent magnet rotor (lines WQuattro and Wmagnet), the motor assembly and disassembly require the use of proper devices due to the attracting or repelling forces that occur between metallic parts. This work must only be performed by a WEG Authorized service center specifically trained for such an operation. People with pacemakers cannot handle these motors. The permanent magnets can also cause disturbances or damages to other electric equipment and components during maintenance.

Regularly inspect the operation of the motor, according to its application, and ensure a free air flow. Inspect the seals, the fastening bolts, the bearings, the vibration and noise levels, the drain operation, etc. The lubrication interval is specified on the motor nameplate.

6. Additional information

For further information about shipment, storage, handling, installation, operation and maintenance of electric motors, access the website www.weg.net.

For special applications and operating conditions (for example, smoke extraction motors, totally enclosed air over (TEAO), motors for high thrust applications, motors with brake) refer to applicable manual on the website or contact WEG.
When contacting WEG, please, have the full description of the motor at hand, as well as the serial number and manufacturing date, indicated on the motor nameplate.

Warranty Term

WEG Equipamentos Elétricos S/A, Motors Unit ("WEG"), offers warranty against defects in workmanship and materials for its products for a period of 18 months from the invoice date issued by the factory or distributor/dealer, limited to 24 months from the date of manufacture.
Motors of the HGF Line are covered for a period of 12 months from the invoice date issued by the factory or distributor / dealer, limited to 18 months from the date of manufacture.
The paragraphs above contain the legal warranty periods.
If a warranty period is defined in a different way in the commercial/technical proposal of a particular sale, that will supersede the time limits set out above.
The warranty periods above are independent of the product installation date and the startup.
If any defect or abnormal occurrence is detected during machine operation, the customer must immediately notify WEG in writing about the occurred defect, and make the product available for WEG or its Authorized Service Center for the period required to identify the cause of the defect, check the warranty coverage, and perform the proper repairs.

In order for the warranty to be valid, the customer must be sure to follow the requirements of WEG's technical documents, especially those set out in the product Installation, Operation and Maintenance Manual, as well as the applicable standards and regulations in force in each country.
Defects arising from the inappropriate or negligent use, operation, and/or installation of the equipment, non-execution of regular preventive maintenance, as well as defects resulting from external factors or equipment and components not supplied by WEG, will not be covered by the warranty.
The warranty will not apply if the customer at its own discretion makes repairs and/or modifications to the equipment without prior written consent from WEG.
The warranty will not cover equipment, components, parts and materials whose lifetime is usually shorter than the warranty period. It will not cover defects and/or problems resulting from force majeure or other causes not imputable to WEG, such as, but not limited to: incorrect or incomplete specifications or data supplied by the customer; transportation, storage, handling, installation, operation and maintenance not complying with the provided instructions; accidents; defects in the construction works; use in applications and/or environments for which the machine was not designed; equipment and/or components not included in the scope of WEG supply. The warranty does not include disassembly services at the buyer's premises, product transportation costs and travel, lodging and meal expenses for the technical staff of the Service Centers, when requested by the customer.
The services under warranty will be provided exclusively at WEG authorized Service Centers or at one of its manufacturing plants. Under no circumstances will the warranty services extend the equipment warranty period.
WEG's Civil Liability is limited to the supplied product; WEG will not be liable for indirect or consequential damages, such as losses of profit and revenue losses and alike which may arise from the contract signed between the parties.

ESPAÑOL

1. Introducción

La instalación, operación y mantenimiento del motor debe llevarse siempre a cabo por personal cualificado, utilizando herramientas y métodos adecuados, y siguiendo los procedimientos indicados en los documentos suministrados con el motor.

Las instrucciones suministradas en este documento son válidas para motores WEG con las siguientes características:

- Motores de inducción trifásicos y monofásicos (con rotor de jaula)
- Motores trifásicos de imanes permanentes
- Motores trifásicos híbridos (con rotor de jaula + imanes permanentes)

El objetivo de este manual es aportar informaciones importantes que deben ser seguidas durante el transporte, almacenamiento, instalación, funcionamiento y mantenimiento de los motores WEG. Por ese motivo, recomendamos leer atentamente las instrucciones antes de realizar cualquier intervención en el motor.
El incumplimiento de las instrucciones reflejadas en este manual, y demás instrucciones a las que se hace referencia en el sitio www.weg.net, ocasionará la anulación de la garantía del producto, y puede ocasionar serios daños personales y materiales.

Los motores eléctricos tienen circuitos bajo tensión, y componentes giratorios que pueden causar daños a las personas.

2. Transporte, almacenamiento y manipulación

Verifique la situación del motor al recibirlo. De encontrarse daños, estos deben ser informados por escrito a la agencia de transporte, y comunicarlos inmediatamente tanto a la empresa aseguradora como a WEG. En ese caso, no se debe iniciar ningún trabajo de instalación hasta que se haya solucionado el problema encontrado.

Los datos que aparecen en la placa de características, deben corresponder con los del pedido del producto y las condiciones ambientales de trabajo en el lugar donde el motor será instalado. En caso de que el motor no fuera instalado inmediatamente, se recomienda almacenarlo en lugar limpio y seco, libre de polvo, vibraciones, gases y agentes corrosivos, y con una humedad relativa del aire no superior al 60%.
Para evitar la condensación de agua en el interior del motor durante el período de almacenamiento, se recomienda mantener la resistencia de caldeo encendida (de estar incluida).
Para evitar la oxidación de los rodamientos y asegurar una distribución uniforme del lubricante, gire el eje del motor por lo menos una vez por mes (dando, como mínimo, 5 vueltas) y dejándolo siempre en una posición diferente. Para rodamientos con sistema de lubricación tipo “oil mist”, el motor debe estar ubicado en posición horizontal, independientemente de su forma constructiva, con aceite ISO VG 68 en el rodamiento, con la cantidad indicada en el manual disponible en la página web, y el eje debe girarse semanalmente. En caso de que los motores queden almacenados por un periodo superior a 2 años, se recomienda cambiar los rodamientos, o como alternativa, desmontarlos, lavarlos, revisarlos y lubricarlos nuevamente antes de hacer trabajar el motor.

Tras este período de almacenamiento también se recomienda que los condensadores de arranque de motores monofásicos sean cambiados debido a posibles pérdidas de sus características de trabajo.

Toda manipulación del motor debe ser realizada con cuidado para evitar impactos y daños a los cojinetes, y con el dispositivo de transporte/bloqueo del eje (de ser suministrado) siempre instalado. Levante el motor siempre por los elementos de elevación, los cuales han sido diseñados para el peso del motor, y nunca deben utilizarse para levantar cargas adicionales acopladas. Los elementos de elevación de los componentes, como la caja de bornes, la tapa deflectora, etc., deben utilizarse solo para manipular estas piezas cuando estén desmontadas. En el manual general disponible en la página web, se podrá encontrar información adicional sobre los ángulos máximos de elevación.

Mida periódicamente la resistencia de aislamiento del motor y sobre todo, antes de la primera puesta en marcha. Verifique los valores recomendados y los procedimientos de medición en la página web.

3. Instalación

Durante la instalación, los motores deben estar protegidos contra puestas en marcha accidentales.

Verifique el sentido de rotación del motor, haciéndolo funcionar en vacío antes de acoplarlo a la carga.

Elimine los dispositivos de transporte y de bloqueo del eje (en caso que existan) antes de iniciar la instalación del motor.
Los motores solo deben estar instalados en lugares compatibles con sus características constructivas y en las aplicaciones y ambientes para los cuales fueron proyectados.
Los motores con patas deben estar ubicados sobre bases debidamente proyectadas para evitar vibraciones y asegurar un perfecto alineamiento. El eje del motor debe estar adecuadamente alineado con el eje de la máquina accionada. Un alineamiento incorrecto, así como una tensión inadecuada de las correas de accionamiento, seguramente dañarán los rodamientos, resultando en excesivas vibraciones e incluso causar la ruptura del eje.

Se deben respetar las cargas radiales y axiales admisibles en el eje, las cuales se indican en el manual general disponible en la página web. Se recomienda el uso de acoplamientos flexibles.
En los motores con rodamientos cuya lubricación sea a base de aceite o un sistema de lubricación tipo “oil mist”, conecte los tubos de refrigeración y lubricación (caso de estar disponibles).
Para cojinetes con lubricación a aceite, el nivel de aceite debe permanecer en la mitad del visor de nivel.
Elimine la grasa de protección contra corrosión de la punta del eje y de la brida únicamente justo antes de la instalación del motor.
A no ser que se especifique lo contrario en el pedido de compra, los motores WEG se equilibran dinámicamente con “media chaveta” y en vacío (desacoplados). Los elementos de transmisión, como poleas, acoplamientos, etc., deben equilibrarse antes de ser instalados en el eje del motor.

Los motores siempre deben estar posicionados de forma que el drenaje sea facilitado (en el punto mas bajo del motor). Motores con drenaje de goma salen de la fabrica en la posicion cerrado y deben ser abiertos periodicamente para permitir la salida del agua condensado. Para ambientes con elevada condensacion del agua y motores con grado de proteccion IP55, los drenajes pueden ser armados el la posicion abierto. Para motores con grado de proteccion IP56, IP65 o IP66, los drenajes deben permanecer en la posicion cerrado, siendo abiertos solamente durante el mantenimiento del motor. Los motores con lubricacion de tipo Oil Mist deben tener sus drenajes conectados a un sistema de recoleccion especifico.

No cubra u obstruya la ventilación del motor. Mantenga una distancia libre mínimo de ¼ (25%) del diámetro de la entrada de aire de la deflectora en relación a la distancia de las paredes. El aire utilizado para la refrigeración del motor debe estar a temperatura ambiente, limitada a la temperatura indicada en la placa de características del motor.

Para motores instalados a la intemperie o montados en la posición vertical, se necesitará utilizar una protección adicional contra la entrada de líquidos y/o partículas sólidas, por ejemplo, el uso de un sombrerete.

Para evitar accidentes, con anterioridad al arranque del motor, se ha de asegurar que la puesta a tierra fue realizada conforme a las normas vigentes y que la conexión esté bien apretada.
Conecte el motor correctamente a la red eléctrica a través de contactos seguros y permanentes, siguiendo siempre los datos mostrados en la placa de características, como la tensión nominal, el esquema de conexionado, etc.

Para el dimensionamiento de los cables de alimentación y de los dispositivos de maniobra y protección se debe considerar la corriente nominal del motor, el factor de servicio, la longitud de los cables, entre otros.
Para motores sin placa de bornes, aísle los terminales del motor, utilizando materiales aislantes compatibles con la clase de aislamiento informada en la placa de características.
La distancia mínima de aislamiento entre partes vivas no aisladas entre sí y entre partes vivas y la tierra debe ser: 5.5 mm para tensiones nominales hasta 690 V; 8 mm para tensiones hasta 1.1 kV; 45 mm para tensiones hasta 6.9 kV; 70 mm para tensiones hasta 11 kV y 105 mm hasta 16.5 kV.

Las entradas de cables no utilizadas en la caja de conexiones deben estar debidamente tapadas con sistemas de cierre para garantizar el grado de protección indicado en la placa de características.

El motor debe ser protegido con dispositivos de protección contra sobrecarga. Para motores trifasicos se recomienda tambien la instalacion de sistemas de proteccion contra fallo de fase.
En caso de que el motor posea dispositivos para control de temperatura en el devanado y/o cojinetes, los mismos deben estar conectados durante el funcionamiento, e inclusive, durante las pruebas.

Para motores sin placa de bornes, no forzar los cables de alimentación para el interior para evitar contacto con el rotor.

Verifique el correcto funcionamiento de los accesorios (freno, encoder, protección térmica, ventilación forzada, etc.) instalados en el motor antes del arranque.

Los motores equipados con protectores térmicos del tipo Automático se reconectarán automáticamente cuando se alcance la temperatura adecuada para el motor. No utilizar motores con protección térmica del tipo automática en aplicaciones en donde el re-arranque automático pueda ser peligroso para personas o para el equipamiento.

Los motores equipados con protectores térmicos del tipo *Manual,* tienen que ser reconectados después del disparo.
En caso de que se active la protección térmica del tipo Automático o *Manual*, desconecte el motor de la red eléctrica y verifique la causa que provocó la actuación del protector térmico.

Los motores de la línea Wmagnet deben ser accionados solamente por convertidores de frecuencia WEG.

Para más información sobre el uso del inversor de frecuencia es obligatorio seguir las instrucciones del manual del motor en www.weg.net y del manual del convertidor de frecuencia.

4. Funcionamiento

Durante el funcionamiento, no toque las zonas con riesgo de contacto eléctrico, y nunca toque o permanezca muy cerca de partes giratorias.
Asegúrese de que la resistencia de caldeo esté desconectada durante el funcionamiento del motor.

Los valores nominales de trabajo y las condiciones de funcionamiento están especificados en la placa de características del motor. Las variaciones de la tensión y la frecuencia de alimentación nunca deben exceder los límites establecidos en las normas vigentes.

Posibles desvíos en relación al normal funcionamiento (actuación de las protecciones térmicas, aumento de los niveles de ruido y vibración, temperatura y corriente) deben ser evaluados por personal cualificado.
En caso de dudas, desconecte el motor inmediatamente, y entre en contacto con el servicio técnico autorizado WEG más próximo.

No se recomienda la utilización de rodamiento de cilindros para acoplamiento directo. Los motores equipados con estos rodamientos necesitan una carga radial mínima para garantizar su correcto funcionamiento.

Los sistemas de lubricación de los cojinetes de aceite u “*oil mist*” y de refrigeración tienen que permanecer conectados incluso tras el corte de alimentación, y hasta la parada total de la máquina.

Tras la parada del motor, los sistemas de refrigeración y de lubricación (de existir) deben desconectarse y se deben conectar las resistencias de caldeo.

5. Mantenimiento

Antes de iniciar cualquier tipo de servicio en el motor, éste debe estar completamente parado, desconectado de la red de alimentación y protegido contra una posible reconexión. Aunque el motor estuviese parado, puede haber tensión en los terminales de las resistencias de caldeo.

En motores equipados con condensadores, descárguelos antes de manipularlos o realizar algún servicio.

El desmontaje del motor durante el período de garantía solamente debe ser realizado por un servicio técnico autorizado WEG.

En el caso de motores con rotor de imanes permanentes (lineas WQuattro y Wmagnet), el montaje y desmontaje del motor requiere de la utilización de dispositivos adecuados debido a las fuerzas de atracción o de repulsión entre piezas metálicas. Este servicio solamente debe llevarse a cabo por un Servicio Técnico Autorizado WEG con formación específica para dicha operación.

Las personas que utilicen marcapasos no pueden maniñpular estos motores. Los imanes permanentes también pueden causar perturbaciones o daños en otros equipamientos eléctricos y componentes durante la mantenimiento.

Inspeccione periódicamente el funcionamiento del motor según su aplicación, asegurándose de que el aire fluya libremente.
Inspeccione los sellos, los tornillos de fijación, los cojinetes, los niveles de vibración y ruido, los drenajes, etc. El intervalo de lubricación está especificado en la placa de identificación del motor.

6. Instrucciones adicionales

Para informaciones adicionales sobre transporte, almacenaje, manipulación, instalación, funcionamiento y mantenimiento de motores eléctricos, entre en www.weg.net.

Para aplicaciones y condiciones especiales de trabajo (ejemplo: motores de extracción de humos, *totally enclosed air over* (TEAO), motores para altas cargas radiales y axiales, motores con freno) se debe consultar el manual o entrar en contacto con WEG.

Al entrar en contacto con WEG, tenga a mano la denominación completa del motor, así como también su número de serie y fecha de fabricación indicados en la placa de características del mismo.

Término de garantía

WEG Equipamentos Elétricos S/A, Unidad Motores (“WEG”), ofrece garantía contra defectos de fabricación o de materiales para sus productos por un período de 18 meses, contados a partir de la fecha de emisión de la factura de fábrica, o del distribuidor/revendedor, limitado a 24 meses de la fecha de fabricación.
Para motores de la línea HGF, la garantía ofrecida es de 12 meses, contados a partir de la fecha de emisión de la factura de fábrica, o del distribuidor/revendedor, limitado a 18 meses a partir de la fecha de fabricación.
El párrafo anterior cuenta con los plazos de garantía legal, no siendo acumulativos entre sí.
En caso de que un plazo de garantía diferenciado esté definido en la propuesta técnica comercial para un determinado suministro, éste prevalecerá por sobre los plazos definidos anteriormente.
Los plazos establecidos anteriormente no dependen de la fecha de instalación del producto ni de su puesta en operación.
Ante un desvío en relación a la operación normal del producto, el cliente debe comunicar inmediatamente por escrito a WEG sobre los defectos ocurridos, y poner a disposición el producto para WEG o su Asistente Técnico Autorizado por el plazo necesario para la identificación de la causa del desvío, verificación de la cobertura de garantía, y para su debida reparación.
Para tener derecho a la garantía, el cliente debe cumplir las especificaciones de los documentos técnicos de WEG, especialmente aquellas previstas en el Manual de Instalación, Operación y Mantenimiento de los productos, y las normas y regulaciones vigentes en cada país.
No poseen cobertura de garantía los defectos derivados de utilización, operación y/o instalación inadecuadas o inapropiadas de los equipos, su falta de mantenimiento preventivo, así como defectos derivados de factores externos

o equipos y componentes no suministrados por WEG.
La garantía no se aplica si el cliente, por iniciativa propia, efectúa reparaciones y/o modificaciones en el equipo sin previo consentimiento por escrito de WEG.
La garantía no cubre equipos, partes y/o componentes, cuya vida útil sea inferior al período de garantía. No cubre, igualmente, defectos y/o problemas derivados de fuerza mayor u otras causas que no puedan ser atribuidas a WEG, como por ejemplo, pero no limitado a: especificaciones o datos incorrectos o incompletos por parte del cliente, transporte, almacenado, manipulación, instalación, operación y mantenimiento en desacuerdo con las instrucciones suministradas, accidentes, deficiencias de obras civiles, utilización en aplicaciones y/o ambientes para los cuales el producto no fue proyectado, equipos y/o componentes no incluidos en el alcance de suministro de WEG. La garantía no incluye los servicios de desmantelamiento en las instalaciones del cliente, los costos de transporte del producto, los costos de locomoción, hospedaje y alimentación del personal de Asistencia Técnica, cuando sean solicitados por el cliente.
Los servicios en garantía serán prestados exclusivamente en talleres de Asistencia Técnica autorizadas por WEG o en su propia fábrica. Bajo ninguna hipótesis, estos servicios en garantía prorrogarán los plazos de garantía del equipo.
La responsabilidad civil de WEG está limitada al producto suministrado, no responsabilizándose por daños indirectos o emergentes, tales como lucros cesantes, pérdidas de ingresos y similares que deriven del contrato firmado entre las partes.


Instruction Manual:
Prolonged Motor Storage

1. General:

Developing technology requires the increasing use of electric motors. Due to its wide range of applications, the electric motor can be used in almost every sector of modern industry.

Provided that the application, service performance, and maintenance requirements, are taken into account when selecting an electric motor, it will provide many years of trouble-free operation.

Construction and production of the WEG motors are based on the latest technological advances.

The WEG quality assurance system integrated to meet maximum requirements ensures that systematic fault prevention is carried out during all phases of product manufacture.

This leads to high reliability and long service life of the motor.

The existing trends, especially in plant construction, to store the motors several years prior to commissioning or install it to some units already, result in the fact that the motors are exposed to influences, which cannot be assessed in advance for this period of time.

The stress (atmospheric, chemical, thermal, and mechanical) exerted on the motor, which may occur during transportation storage, mounting, trial operations and standstill until commissioning in various and superimposed ways, is difficult to assess.

Another essential factor is transportation, which is outside our sphere of influence. For example, transportation of the motor or constructional unit with motor can be performed as combined shipping to site by the general contractor.

The hollow spaces of the motor (interior motor space, rolling-contact bearing and terminal box space) are exposed to atmospheric air and temperature fluctuations. Due to the air humidity, formation of condensation is possible, and, depending on type and degree of air contamination, aggressive substances may penetrate into the hollow spaces.

This may have as a consequence that after prolonged periods of time internal components, such as the rolling contact bearing, have rust deposits; the insulation resistance of the winding decreases to an inadmissibly low value, the lubricity of the grease for rolling-contact bearings is adversely affected.

The described influence increases the damage risk prior to commissioning of the plant.

In order to be able to maintain the manufacturer's guarantee, it must be ensured that the preventive measures described in these instructions, such as

- constructional design
- conservation, packing, storage and
- inspection

are taken.

For performance of the preventive measures it is recommendable to get into contact with us.

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Jaraguá do Sul – Santa Catarina – Brasil
Home-page: Http://www.weg.com.br

2. Scope of validity:

These instructions are valid for motors with prolonged storage and / or standstill periods prior to commissioning.
In addition to these instructions, the operating instructions supplied with the motor must be adhered to.

3. Measures for prevention and elimination of adverse effects:

3.1 Protection on motor:

3.1.1 Protection of bare surfaces:

All bare surfaces (e.g. shaft extension) have been coated in the factory with a temporary protective agent. Removed and / or damaged protective coats must be reapplied or touched up at once.

3.2 Protection to be provided for storage in unpacked condition:

If the motors are stored in unpacked condition, the ambient conditions must be as follows:

- Closed storage room with roof
- Ventilation system with filter
- Constant temperature (temperature limits $\geq$ 5° C, $\leq$ 60 °C)
- No sudden temperature fluctuations
- Relative air humidity $\leq$ 50 %
- Prevention of dirt and dust deposits
- No aggressive fumes
- No vibrations, since otherwise there is a risk of chatter marks formation (brinelling) on the contact surfaces of the rolling-contact bearing.

It is recommendable to regularly check the climatic conditions and the condition of the motors at specific intervals

The temporary protective coat applied to bar surfaces (especially fitting surfaces) must be checked at regular intervals and, if required, touched up (see paragraph 3.1.1).

If most of the above mentioned conditions are not given, a protective packing in accordance with paragraph 3.3 is required.

3.3 Protection by packing:

3.3.1 Type of packing:

The packing described in this case has proven well and can be recommended.
It consists of the following:

Wooden box or similar container, insulating-coating foil, quantity of desiccant, moisture indicator and foil welding.

If there is a risk of infestation and formation of mould fungus, the packing must be protected at the storage location by spraying or painting it with appropriate chemical agents.

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Preparation of packing must be done with greatest care by an experienced person. Packing must therefore be performed by a packing company which takes over liability.

3.3.1.3 Moisture indicator (not supplied by WEG):

The moisture indicator must permit reading of the relative air humidity of 30 %, 40 % and 50 %.

Limit value:
The relative air humidity inside the packing must not exceed **50 %** until the motor is unpacked.

3.4 Inspection during storage:

Inspections should be performed at regular intervals, in order to ensure that quality of the packing and the motor is maintained. Any detected deficiencies must be eliminated at once.

During inspection the following characteristics must be especially checked:

- Identification, storage period
- Condition of packing
- Protective coat and protective agents
- Desiccant by checking the moisture indicator
- Mechanical damage
- Cleanness

If the limit value of the relative air humidity (see paragraph 3.3.1.3) is exceeded, the desiccant must be replaced and the enclosing foil must be welded again.

3.5 Checking of winding:

Measure the insulation resistance before operating the motor and/or when there is any sign of humidity in the winding.

The resistance measured at 25°C must be equal or higher than 100MΩ:
(Measured with 500 V DC Megger)

Warning:

If the insulation resistance is less than 100MΩ , the winding must be dried according to the following:

- Warm it up inside an oven at a minimum temperature of 80°C increasing 5°C every hour until 105°C, remaining under this temperature for at least one hour.
- Check if the stator insulation resistance remains constant within the accepted values. If not, stator must be re-impregnated.

3.6 Anti-friction bearing:

In case the motors are stored for more than two years, the bearings must be replaced or the lubrication grease must be totally removed after cleaning.

We recommend turning the shaft (by hand) at least once a month.

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3.6.1 Lubrication:

Machines without Grease Nipples
Motors up to frame 320 are normally fitted without grease nipples. In these cases the regreasing shall be done at the preventive maintenance job observing the following aspects:
- disassemble carefully the motors
- take all the grease out
- wash the bearing with kerosene or diesel
- regrease the bearing immediately

Machine fitted with Grease Nipples
It is strongly recommended to grease the machine while running. This allows the grease renewal in the bearing housing. When this is not possible due to turning parts by the grease device (pulleys, bushing, etc) that offer some risk to the physical integrity of the operator, proceed as follows:
- clean the area near the grease nipple
- put approximately half of the total grease and run the motor for 1 minute at full speed. Then turn off the motor and insert the rest of the grease
- the injection of all the grease with the motor in standstill can make the grease penetrate into the motor, through the inner seal of the bearing housing.

Warning

For lubrication interval indicated at the nameplate of the motor is specifically intended for relubrication with POLYREX EM grease and bearing absolute operating temperature of :
- 70°C (158°F) for 250 to 320 frame motors
- 85°C (185°F) for 360 to 580 frame motors

For every 15°C (59°F) above these limits, relubrication interval must be reduced by half. Shielded bearing (ZZ) are lubricated for bearings life as long are they operate under conditions and temperature of 70°C (158°F).

3.7 Terminal box:

Upon delivery of the motors, the terminal box corresponds at least with degree of protection IP 55 (protection against harmful dust deposits and protection against water jets). Improper transportation or storage may lead to a decrease in this degree of protection.
When “checking the winding” as described in paragraph 3.6, the terminal box must be especially checked for the following quality characteristics:

- The interior must be dry, clean and free from any dust deposits.
- No corrosion on the connecting and mounting elements.
- Sealing of the joints must be in proper condition.
- Rubber seals must not be rigid, brittle or cracked (Except for EX(d) motors)
- Metal sealing surfaces must be bare and greased. (Except for EX(d) motors)
- Inlet openings must be tightly sealed.

If these requirements are not fulfilled, cleaning or replacement must be performed.

WEG INDÚSTRIAS S.A. - MOTORES
Av. Prefeito Waldemar Grubba, 3000 – Fone (47) 372-4000 – Fax (47) 372-4180 – Cx. P. 420 – CEP 89256-900
Jaraguá do Sul – Santa Catarina – Brasil
Home-page: Http://www.weg.com.br



SUPER RADIATOR COILS

SHOP RUN IN TEST REPORT

Purchase Order # P1140489 **Customer** JW POWER

Customer Item # 329-01115 **SRC Job/Serial #** 967211

This is to certify that the run in test for this unit was completed in full compliance with Super Radiator Coils Shop Run in Test Procedure #SRC-PQ-0030 and applicable customer specifications.

The above referenced Exchanger was run tested for 1/2 **hour(s).**

Amperes: **Motor A** (1) MAX 13.4
T1 13.0 Amps
T2 13.2 Amps
T3 12.9 Amps

Motor B (4) MAX 13.4
T1 13.5 Amps
T2 13.1 Amps
T3 13.4 Amps

Motor A Serial # 01009ET3E284T **Motor B Serial #** 01009ET3E284T

Average Fan R.P.M. **Fan A:** 870 **R.P.M.** **Fan B:** 870 **R.P.M.**

Vibration Data: Readings are peak to peak taken at primary structural components.

Columns: — **Mils** VELOCITY (IN/SEC) 0.13 / 0.25 **Motor Mounts** 1.8 / 2.2 **Mils**

Columns: — **Mils** **Drive Quad** _____ **Mils**

FAN BLADE TIP CLEARANCES TO FAN RING

Fan 1 **Minimum** _____ **Maximum** _____

Fan 2 **Minimum** _____ **Maximum** _____

Fan Blade Pitch Angle **(if required)**

Fan 1 20°

Fan 2 20°

Date: _____ **Signature:** _____

Date: 11.7.16 **Engineer:** Mark Fettt

2610 S. 21st. Street, Phoenix, AZ. 85034 Ph. 602-257-9708 Fax 602-253-0334

SUPER RADIATOR COILS

SHOP RUN IN TEST REPORT

Purchase Order # P1140489 **Customer** JW Power

Customer Item # 329-01115 **SRC Job/Serial #** 907211

This is to certify that the run in test for this unit was completed in full compliance with Super Radiator Coils Shop Run in Test Procedure #SRC-PQ-0030 and applicable customer specifications.

The above referenced Exchanger was run tested for 1/2 **hour(s).**

Amperes: **Motor A** (2) **T1** 13.4 **Amps** **T2** 13.2 **Amps** **T3** 13.3 **Amps**

Motor B (3) **T1** 13.2 **Amps** **T2** 13.0 **Amps** **T3** 12.9 **Amps**

Motor A Serial # 0100 9ET3E284T **Motor B Serial #** 0100 9ET3E284T

Average Fan R.P.M. **Fan A:** 870 **R.P.M.** **Fan B:** 870 **R.P.M.**

Vibration Data: Readings are peak to peak taken at primary structural components.

Columns:	—	**Mils**	VELOCITY (IN/SEC) 0.13 / 0.12	**Motor Mounts**	1.8 / 1.9 **Mils**
Columns:	—	**Mils**		**Drive Quad**	**Mils**

FAN BLADE TIP CLEARANCES TO FAN RING

Fan 1 **Minimum** _____ **Maximum** _____

Fan 2 **Minimum** _____ **Maximum** _____

Fan Blade Pitch Angle (if required)

Fan 1 20°

Fan 2 20°

Date: _____ **Signature:** _____

Date: 11.7.16 **Engineer:** [signature]

2610 S. 21st. Street, Phoenix, AZ. 85034 Ph. 602-257-9708 Fax 602-253-0334

SUPER RADIATOR COILS

SHOP RUN IN TEST REPORT

Purchase Order # P1140489 **Customer** JW POWER

Customer Item # 329-01115 **SRC Job/Serial #** 907211

This is to certify that the run in test for this unit was completed in full compliance with Super Radiator Coils Shop Run in Test Procedure #SRC-PQ-0030 and applicable customer specifications.

The above referenced Exchanger was run tested for 1/2 **hour(s).**

Amperes:	**Motor A** (5)	**T1** 13.3 **Amps** (MAX 13.4)		**Motor B** (6)	**T1** 13.3 **Amps** (MAX 13.4)	
		T2 13.1 **Amps**			**T2** 12.9 **Amps**	
		T3 13.2 **Amps**			**T3** 13.0 **Amps**	

Motor A Serial # 01009E3TE284T **Motor B Serial #** 01009E3TE284T

Average Fan R.P.M. **Fan A:** 870 **R.P.M.** **Fan B:** 870 **R.P.M.**

Vibration Data: Readings are peak to peak taken at primary structural components.

Columns: — **Mils** (VELOCITY (IN/SEC)) 0.11 / 0.11 **Motor Mounts** 1.8 / 1.8 **Mils**

Columns: — **Mils** **Drive Quad** _____ **Mils**

FAN BLADE TIP CLEARANCES TO FAN RING

Fan 1 **Minimum** _____ **Maximum** _____

Fan 2 **Minimum** _____ **Maximum** _____

Fan Blade Pitch Angle **(if required)**

Fan 1 20°

Fan 2 20°

Date: _____ **Signature:** _____

Date: 11.7.16 **Engineer:** Mark Smith

2610 S. 21st. Street, Phoenix, AZ. 85034 Ph. 602-257-9708 Fax 602-253-0334

SUPER RADIATOR COILS

SHOP RUN IN TEST REPORT

Purchase Order # P1140489 **Customer** JW Power

Customer Item # 329-0115 **SRC Job/Serial #** 90727

This is to certify that the run in test for this unit was completed in full compliance with Super Radiator Coils Shop Run in Test Procedure #SRC-PQ-0030 and applicable customer specifications.

The above referenced Exchanger was run tested for 1/2 **hour(s).**

max 13.4 max 13.4

Amperes: **Motor A** (1) T1 11.3 Amps 13.3 T2 11.2 Amps 13.5 T3 11.3 Amps 13.6

Motor B (2) T1 13.2 Amps 13.4 T2 ~~13.3~~ Amps 13.3 T3 ~~13.2~~ Amps 13.4

Motor A Serial # 10332911897 **Motor B Serial #** 10332911893

max 900 max 900

Average Fan R.P.M. **Fan A:** 870 **R.P.M.** **Fan B:** 870 **R.P.M.**

Vibration Data: Readings are peak to peak taken at primary structural components.

Columns:	— Mils	Velocity (in/sec) 0.15 / 0.15	**Motor Mounts**	1.7 / 2.5	Mils
Columns:	— Mils		**Drive Quad**	—	Mils

FAN BLADE TIP CLEARANCES TO FAN RING

Fan 1 **Minimum** 1/4 **Maximum** 1/2

Fan 2 **Minimum** 1/4 **Maximum** 1/2

Fan Blade Pitch Angle (if required)

Fan 1 20°

Fan 2 20°

Date: _____ **Signature:** _____

Date: 11/21/16 **Engineer:** _____

2610 S. 21st. Street, Phoenix, AZ. 85034 Ph. 602-257-9708 Fax 602-253-0334

SUPER RADIATOR COILS

SHOP RUN IN TEST REPORT

Purchase Order # P1140489 **Customer** JW Power

Customer Item # 329-01115 **SRC Job/Serial #** 80722

This is to certify that the run in test for this unit was completed in full compliance with Super Radiator Coils Shop Run in Test Procedure #SRC-PQ-0030 and applicable customer specifications.

The above referenced Exchanger was run tested for 1/2 **hour(s).**

max 13.4

Amperes: Motor A T1 13.3 Amps 13.5
T2 13.1 Amps 13.3
T3 13.2 Amps 13.4

(3)

max 13.4

Motor B T1 11.3 Amps 13.4
T2 11.4 Amps 13.2
T3 11.5 Amps 13.5

(4)

Motor A Serial # ~~[illegible]~~ 103329 1890

Motor B Serial # 103329 ~~1899~~ 1894

max 900

max 900

Average Fan R.P.M. **Fan A:** 870 **R.P.M.** **Fan B:** 870 **R.P.M.**

Vibration Data: Readings are peak to peak taken at primary structural components.

Columns:	— **Mils**	Velocity (in/sec)	**Motor Mounts**	1.5 / 1.0	**Mils**
Columns:	— **Mils**	0.17 / 0.14	**Drive Quad**	—	**Mils**

FAN BLADE TIP CLEARANCES TO FAN RING

Fan 1 **Minimum** 1/4 **Maximum** 1/2

Fan 2 **Minimum** 1/4 **Maximum** 1/2

Fan Blade Pitch Angle (if required)

Fan 1 20°

Fan 2 20°

Date: _____ **Signature:** _____

Date: 11/21/16 **Engineer:** _____

2610 S. 21st. Street, Phoenix, AZ. 85034 Ph. 602-257-9708 Fax 602-253-0334

SUPER RADIATOR COILS

SHOP RUN IN TEST REPORT

Purchase Order # P1140489 **Customer** JW Power

Customer Item # 329-0115 **SRC Job/Serial #** 901221

This is to certify that the run in test for this unit was completed in full compliance with Super Radiator Coils Shop Run in Test Procedure #SRC-PQ-0030 and applicable customer specifications.

The above referenced Exchanger was run tested for 1/2 **hour(s).**

max 13.4

Amperes: Motor A (5)
T1 ~~13.0~~ 13.0 Amps
T2 ~~13.1~~ 13.4 Amps
T3 ~~13.2~~ 13.5 Amps

max 13.4

Motor B (10)
T1 ~~13.2~~ 13.5 Amps
T2 ~~13.0~~ 13.2 Amps
T3 ~~13.2~~ 13.6 Amps

Motor A Serial # 10332918911 **Motor B Serial #** 10332918911

max 900

Average Fan R.P.M. Fan A: 870 **R.P.M.** max 900 **Fan B:** 870 **R.P.M.**

Vibration Data: Readings are peak to peak taken at primary structural components.

Columns: — **Mils** Velocity (in/sec) **Motor Mounts** 2.0 / 1.2 **Mils**

Columns: — **Mils** 0.20 / 0.10 **Drive Quad** — **Mils**

FAN BLADE TIP CLEARANCES TO FAN RING

Fan 1 Minimum 1/4 **Maximum** 1/2

Fan 2 Minimum 1/4 **Maximum** 1/2

Fan Blade Pitch Angle (if required)

Fan 1 20°

Fan 2 20°

Date: _____ **Signature:** _____

Date: 11/21/16 **Engineer:** _____

2610 S. 21st. Street, Phoenix, AZ. 85034 Ph. 602-257-9708 Fax 602-253-0334

BILL OF LADING NUMBER: 000021547 CARRIER NAME: ~~SEE RUBY~~ DATE: ~~10/31/2016~~ 11/01/16

WAYBILL SEQ: 0000

SHIP FROM

SUPER RADIATOR COILS
2610 SOUTH 21ST STREET
PHOENIX, AZ 85034

Ph: (602) 257-9708 Fax: (602) 257-0472

SHIP TO

J-W POWER COMPANY-LONGVIEW
2315 HWY 322
LONGVIEW, TX 75603
US

Ph: (800) 436-7800 [redacted]

SPECIAL INSTRUCTIONS

DO NOT STACK - USE DECKING TABLE ONLY

FREIGHT TERMS

FOB OUR DOCK - PREPAID & ADD

BILL FREIGHT TO

SUPER RADIATOR COILS
2610 SOUTH 21ST STREET
PHOENIX, AZ 85034

Ph: (602) 257-9708 Fax: (602) 257-0472

Sales Order	Line	Customer PO #	Part Number		Coil Qty	Ship Units	Weight (Lbs)
8009072	001	P1140489	B83-11083	R9	6	6	27,000

COMMODITY DESCRIPTION	TOTAL PCS	GROSS WGT (LBS)
RADIATORS, AIR HEATING or COOLING, IRON or STEEL combined with other Metals, Item 26800, Sub 2, Class 85	6	27,000

Shipment Number(s): 8009072 - 0000

CARRIER: SEE RUBY

Carrier acknowledges receipt of packages and required placaards. Carrier certifies emergency response information was made available and/or carrier has the U.S. DOT emergency response guidebook or equivalent documentation in the vehicle.

PER _____ DATE

Property described above is received in good order, except as noted.

Shipper: SUPER RADIATOR COILS

Per: _____

Pro#

The property described above, in apparent good order, except as noted (contents and condition of contents of packages unknown), marked, consigned, and destined as indicated above, which said carrier (the word carrier being understood throughout this contract as meaning any person or corporation in possession of the property under the contract) agrees to carry to its usual place of delivery at said destination, if on its route, otherwise to deliver to another carrier on the route to said destination. It is mutually agreed as to each carrier of all or any of said property over all or any portion of said route to destination, and as to each party at any time interested in all or any of said property, that every service to be performed hereunder shall be subject to all the terms and conditions of the Uniform Domestic Straight Bill of Lading set forth (1) in Uniform Freight Classifications in effect on the date hereof, if this a rail or a rail-water shipment, or (2) in the applicable motor carrier classification or tariff if this is a motor carrier shipment. Shipper hereby certifies that he is familiar with all the terms and conditions of the said bill of lading, including those on the back thereof, set forth in the classification or tariff which governs the transportation of this shipment, and the said terms and conditions are hereby agreed to by the shipper and accepted for himself and his assigns.

BILL OF LADING NUMBER: 000021651 **CARRIER NAME: SEE RUBY** **DATE:11/28/2016**

WAYBILL SEQ: 0001

SHIP FROM	SHIP TO
SUPER RADIATOR COILS 2610 SOUTH 21ST STREET PHOENIX, AZ 85034 Ph: (602) 257-9708 Fax: (602) 257-0472	J-W POWER COMPANY-LONGVIEW 2315 HWY 322 LONGVIEW, TX 75603 US Ph: (800) 436-7800

SPECIAL INSTRUCTIONS

DO NOT STACK - USE DECKING TABLE ONLY

FREIGHT TERMS

FOB OUR DOCK - PREPAID & ADD

BILL FREIGHT TO

SUPER RADIATOR COILS
2610 SOUTH 21ST STREET
PHOENIX, AZ 85034

Ph: (602) 257-9708 Fax: (602) 257-0472

Sales Order	Line	Customer PO #	Part Number		Coil Qty	Ship Units	Weight (Lbs)
8009072	002	P1140489	B83-11083	R9	6	6	39,000 ~~6,500~~

COMMODITY DESCRIPTION	TOTAL PCS	GROSS WGT (LBS)
RADIATORS, AIR HEATING or COOLING, IRON or STEEL combined with other Metals, Item 26800, Sub 2, Class 85	6	~~6,500~~ 39,000

Shipment Number(s) : 8009072 - 0001

CARRIER: SEE RUBY

Carrier acknowledges receipt of packages and required placaards. Carrier certifies emergency response information was made available and/or carrier has the U.S. DOT emergency response guidebook or equivalent documentation in the vehicle.

PER Raul Echeverria DATE 11-28-16

Property described above is received in good order, except as noted.

Shipper: SUPER RADIATOR COILS

Per:

Pro# Cricket Transp.

The property described above, in apparent good order, except as noted (contents and condition of contents of packages unknown), marked, consigned, and destined as indicated above, which said carrier (the word carrier being understood throughout this contract as meaning any person or corporation in possession of the property under the contract) agrees to carry to its usual place of delivery at said destination, if on its route, otherwise to deliver to another carrier on the route to said destination. It is mutually agreed as to each carrier of all or any of said property over all or any portion of said route to destination, and as to each party at any time interested in all or any of said property, that every service to be performed hereunder shall be subject to all the terms and conditions of the Uniform Domestic Straight Bill of Lading set forth (1) in Uniform Freight Classifications in effect on the date hereof, if this a rail or a rail-water shipment, or (2) in the applicable motor carrier classification or tariff if this is a motor carrier shipment. Shipper hereby certifies that he is familiar with all the terms and conditions of the said bill of lading, including those on the back thereof, set forth in the classification or tariff which governs the transportation of this shipment, and the said terms and conditions are hereby agreed to by the shipper and accepted for himself and his assigns.

SUPER RADIATOR COILS™
2610 South 21st Street, Phoenix, AZ 85034
Ph: 602-257-9708 Fx: 602-257-0472

PACKING LIST

SOLD TO:
J-W POWER COMPANY-LONGVIEW
PO BOX 803527
APPROVER CODE PY004
DALLAS TX 75380
US

SHIP TO:
J-W POWER COMPANY-LONGVIEW
2315 HWY 322
LONGVIEW TX 75603
US

Sales Order	Cust No	Customer P.O.	Tax	Mark Shipment
8009072	400289	P1140489	E	

Ship Date	Shipped Via	Freight Terms	Cartons	Weight	Waybill Number	Ins	Ship#
11/28/16	~~SEE RUBY~~ C.K/SINI TRANSPORT	Prepaid & Add	6.00	6,500.00	000021651	N	0001

Item	Quantity Order	Quantity B/O	Quantity Ship	Unit	Part Number/Revision	WO #	Description
002	6		6	EA	B83-11083 R9	√ 907221-000	THANK YOU FOR YOUR BUSINESS - WES CRYTZER 061.500X066.000-01-I-048.000-H UNIT - HORIZONTAL Cust Part 329-01115

Ravi Echeverria 11-28-16

PRESSURE VESSELS







aerospace
climate control
electromechanical
filtration
fluid & gas handling
hydraulics
pneumatics
process control
sealing & shielding





Compressed Air & Gas Filters

High Efficiency Coalescing Filters



Parker

ENGINEERING YOUR SUCCESS.

Why Filter Compressed Air?

Product rejects and increased maintenance expenses can occur due to poor air quality

Submicronic contaminants in compressed air systems plug orifices of sensitive pneumatic instrumentation, wear out seals, erode system components, reduce the absorptive capacity of desiccant air/gas dehydrators, foul heat transfer surfaces, reduce air tool efficiency, and damage finished products. The results include product rejects, lost production time and increased maintenance expense. For example, trace amounts of submicronic oil can cause serious fish eye blemishing in automotive finishing operations. Water left in air lines can freeze during exposure to cold temperatures, blocking flow or rupturing pipes. Compressor lubricant not captured in a coalescing filter will eventually collect in pneumatic components, causing premature component repair or replacement. Environmental concerns will be raised if oily, compressed air is continually discharged into the atmosphere through a pneumatic muffler.



Finite filters are used everyday in food grade applications.

Finite's H-Series Offers...

- **Coalescing, particulate and adsorption filter elements**
- **Optional indicators, gauges and drains**
- **Temperatures to 450° F (232° C)**
- **Pressures to 500 PSIG (34 bar)**
- **Connection sizes from 1/4" to 3" NPT, BSPP & BSPT**
- **Flows from 10 to 1660 SCFM (17-2822 m^3/hr)**





Manufacturing plants use compressed air in a variety of automated processes.

Why Use Finite Filters?

Element formation
Our special UNI-CAST formed elements provide lower pressure drop and less frequent changeouts, saving you time and money.

We meet your needs
Finite offers a variety of filter elements to meet your application requirements.

Technical support
We are committed to providing unmatched technical support to all of our customers.

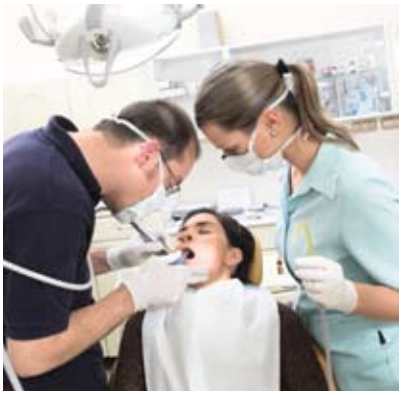
Short lead times
Our LEAN manufacturing capability assures that you will have the right filter product at the right time. Popular products are shipped in three days.

Typical Applications

(See Pages 4-5 for application and air cleanliness schematics)

Coalescing (Oil Removal)
Air dryer prefilter
Paint spray booths
Breathing air
Tool protection
Air valve protection
Air cylinder protection
Natural gas filtration
Technical gas filtration
Interceptor (Particulate Removal)
Desiccant dryer afterfilter
Prefilter for coalescer
Systems with high concentrations of solid contaminant
Particulate protection for non-lubricated systems
Adsorber (Vapor Removal)
Odor removal
Breathing air
Food packaging equipment
High purity laboratory gases
Hydrocarbon vapor removal





Four steps to clean, dry compressed air and gas.

Step 1.

Determine your application, media grade, media type and end seal material.
Pages 4-7

Step 2.

Choose your housing and replacement elements.
Pages 8-9

Step 3.

Choose your accessories. Find out what's standard or choose what's best for your application.
Page 9

Step 4.

How to Order. Build your own part number here!
Page 10

Sources of Contamination

Compressed air and gas lines typically contain water, oil and particulate contamination

The contaminants of greatest concern in precision compressed air systems are water, oil and solids.

Water vapor is present in all compressed air and it becomes greatly concentrated by the compression process. While air dryer systems can be used effectively to remove water from compressed air, they will not remove the second major liquid contaminant – oil.

Most oil comes from compressor lubrication carry-over, but even the air produced by oil-free compressors has hydrocarbon contamination brought into the system through the intake.

The third contaminant is solid matter including dirt, rust and scale. Solid particulates, combined with aerosols of water and oil, can clog and shorten the life of air system components and can foul processes.

Compressed Air Standards and Applications

From aeration in pharmaceutical and chemical processes to pneumatic power systems, the possibilities for applications are endless. Finite has some suggested air cleanliness standards that may fit your needs.

International Standard ISO8573-1 has become the industry standard method for specifying compressed air cleanliness. The following diagrams describe various systems in terms of their corresponding ISO classification.

International ISO Standards

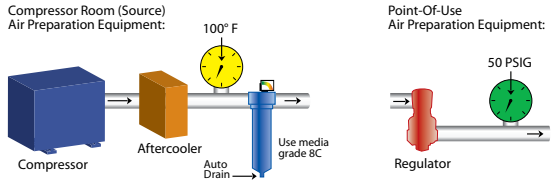
Notification as specified in ISO8573 - 1 (1991)

Class	Maximum Particle Size	Solid		Water		Oil	
		Maximum Concentration*		Maximum Pressure Dewpoint		Maximum Concentration*	
	(µm)	ppm	mg/m³	°F	°C	ppm	mg/m³
1	0.1	0.08	(0.1)	-94	(-70)	0.008	(0.01)
2	1	0.8	(1)	-40	(-40)	0.08	(0.1)
3	5	4.2	(5)	-4	(-20)	0.83	(1)
4	15	6.7	(8)	37	(+3)	4.2	(5)
5	40	8.3	(10)	45	(+7)	21	(25)
6	-	-	-	50	(+10)	-	-

*At 14.7 psi (1 bar) absolute pressure, +70ºF (+20ºC) and a relative humidity of 60%.
It should be noted that at pressures above atmospheric, the contaminant concentration is higher.

Notes:
1. The quality of the air delivered by non-lubricated compressors is influenced by the quality of the intake air and the compressor design.

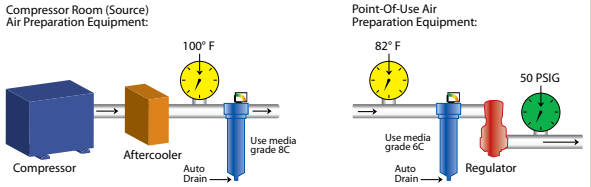
ISO Class 2 ☐ 3



Any compressor with aftercooler. Air intended for use with lubricated air tools, air motors, cylinders, shot blasting, non-frictional valves.

OTHER SPECS MET: Compressed Air & Gas Institute: CGA – G7.1 (Grades A & Ba1)

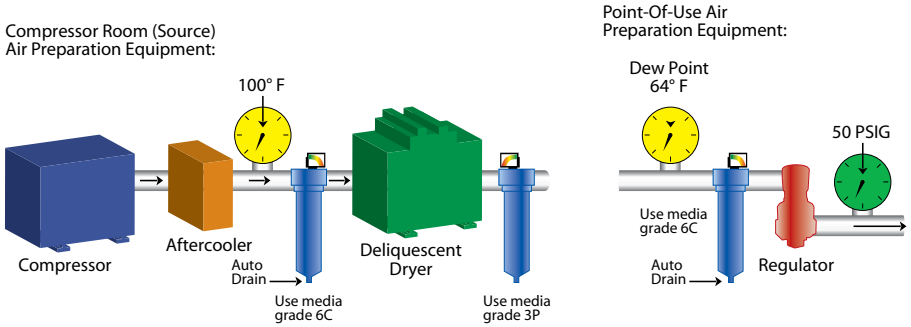
ISO Class 1 ☐ 1



Any compressor with aftercooler and 2-stage coalescing. Air intended for use with lubricated control valves, cylinders, parts blow-down, etc.

OTHER SPECS MET: Mil. Std. 282 H.E.P.A., U.S.P.H.S. 3A Accepted particles for milk

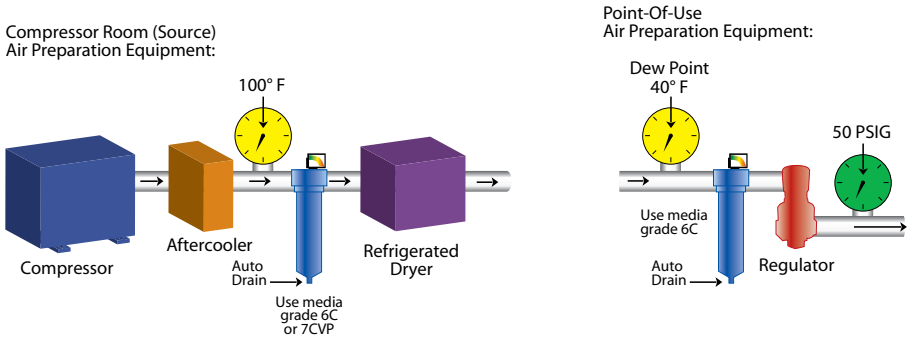
ISO Class 1 ☐ 1



Any compressor with aftercooler, 2-stage coalescing and deliquescent dryer. Air intended for use with general pneumatic systems, body shop spray painting and components sensitive to high moisture content.

OTHER SPECS MET: Compressed Air & Gas Institute: CGA – G7.1 (Grade C)

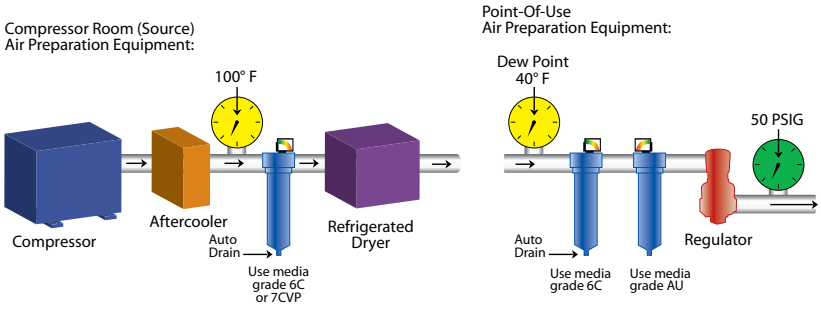
ISO Class 1 4 1



Any compressor with aftercooler, 2-stage coalescing and refrigerated dryer. Air intended for use with air-gauging, air conveyors, spray-painting, food processing, instrumentation, blow molding, cosmetics, film processing, bottling, pharmaceuticals, dairy, breweries, medical, robotics and close tolerance valves.

SPECS MET: CGA – G7.1 (Grades D & E), ISAS7.3 Fed. Std. 209 (Class 100)

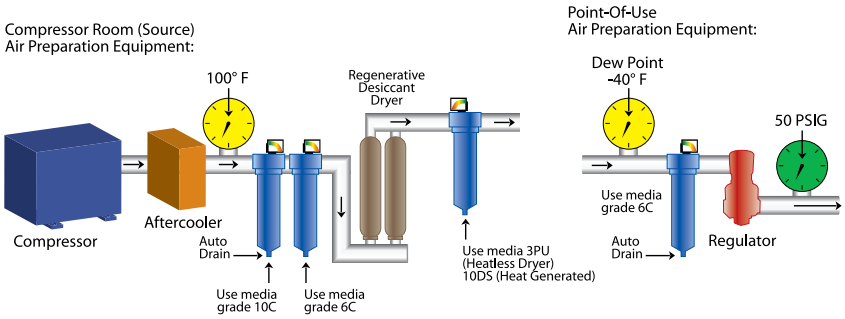
ISO Class 1 4 1



Any compressor with aftercooler, 2-stage coalescing, refrigerated dryer and carbon absorber. Air intended for use as industrial breathing air and decompression chambers. CAUTION: Always use high temperature synthetic lubricants and monitor (alarm for carbon monoxide concentrations). This system will not eliminate toxic gases!

OTHER SPECS MET: O.S.H.A. 29CFR 1910.134

ISO Class 1 2 1



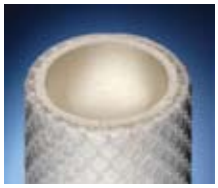
Any compressor with aftercooler, two-stage and double coalescing and a regenerative-type desiccant dryer. Air intended for use in applications involving rapid expansion of compressed air, critical instrumentation, high purity gases, computer chip drying, etc. CAUTION: This air is too dry for respiratory use.

SPECS MET: CGA – G7.1 (Grade F)

Step 1. Determine your application, media grade, media type and end seals.

Find your (or similar) application from the descriptions below, from the basic application circuits on the previous page, or consult a Finite application engineer. Determine media grade, media type and end seal required. If your application requires a coalescing element, use the information listed below. For other media types, please see the following page.

Coalescing Elements (removal of liquids and particulate)



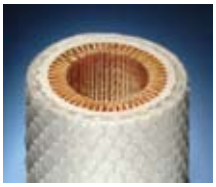
Media type C

Available in grades 4,6,8 or 10

Air Flow: Inside to Outside

This coalescing element is made with our special UNI-CAST construction. Composed of an epoxy saturated, borosilicate glass micro-fiber media, this media is used in applications requiring the removal of liquid and particulate contamination. The outer synthetic fabric layer allows swift removal of coalesced liquids.

Media type I is constructed similarly to the C media but also includes an inner retainer intended for additional strength where reverse flow is likely.

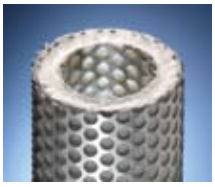


Media type Q

Available in grades 4,6,8 or 10

Air Flow: Inside to Outside

This coalescing element is composed of an epoxy saturated, borosilicate glass micro-fiber media, and is also made with our special UNI-CAST construction. This media type has a built-in pleated cellulose prefilter as the inner layer. As with the C and I media types, the outer synthetic fabric layer aids in the swift and efficient removal of coalesced liquids.

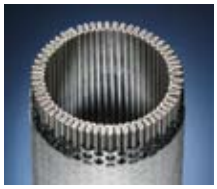


Media type D

Available in grades 4,6,8 or 10

Air Flow: Inside to Outside

Media type D elements are composed of a micro-glass coalescer, utilize a special high temperature UNI-CAST formulation, but are surrounded by inner and outer diameter metal retainers. These metal retainers, coupled with a glass drain layer, make this an extremely robust element designed to remove both solid and liquid contaminants at elevated temperatures.



Media type 7CVP or ME

Only available in 1¼" NPT port size housings and larger

Air Flow: Inside to Outside

Finite's 7CVP media type consists of two filter layers between metal retainers. The outer layer removes aerosols while the inner layer traps solid particles, protecting and extending the life of the outer layer. 7CVP elements are used in bulk liquid coalescing applications or when relatively high efficiency and low pressure drop are required. A special 7DVP media is constructed the same way, however it allows for higher temperature applications.

Finite's ME media type are mist eliminator elements that are constructed similarly to the 7CVP, but offer even higher filtration efficiency for more critical compressed air quality demands.

For types C, D, I and Q... Choose your grade...

Grade 4

Finite's media grade 4 is typically chosen when an extremely high coalescing efficiency is required. Its 99.995% rating is the best available and is ideal for use as a final filter in applications with elevated operating pressures (up to 500 PSIG), or when removing liquid contaminants from gases lighter than compressed air.

Grade 6 (Standard)

Grade 6 filters are used when "total removal of liquid aerosols and suspended fines" is required. Because of its overall performance characteristics, this grade is most often recommended in a variety of industrial applications. Grade 6 is an excellent choice as a prefilter for regenerative desiccant air dryers, as it prevents oil or varnish from coating the desiccant.

Grade 8

Grade 8 filters combine high efficiency (98.5%) with high flow rate and long element life. A separate prefilter is not required for "normal to light" particulate loading. A grade 8 element is often chosen as protection for refrigerated air dryers. This element allows the dryer to maintain efficiency by preventing the coating of copper coils with the build-up of oil or varnish.

Grade 10

Grade 10 filters are used as prefilters for grades 6 or 8 to remove gross amounts of liquid aerosols or tenacious aerosols. Grade 10 is often referred to as a coarse coalescer, or precoalescer. A grade 10 in a media type D filter element is recommended as an afterfilter for heat regenerated desiccant type air dryers as its one micron rating is ideal for collecting air dryer desiccant fines before they pass downstream.

Water Separator Element
(removal of bulk liquids)



Media type 100WS

Air Flow: Inside to Outside

This rolled stainless steel mesh element has ID and OD metal retainers with rolled stainless steel mesh in between. It is an extremely robust design. With a nominal rating of 100 micron, this media is used for the reduction and elimination of excess liquids in gas streams. It also would be a good choice as a prefilter for coalescing grades 6 and 10 when extreme volumes of liquid contaminants are present.

Interceptor Element
(removal of solids)



Media type 3P

Air Flow: Outside to Inside

Finite's 3P pleated cellulose element removes solid contaminants, with a 3 micron absolute rating. Because this element is designed to flow from its outside to the inside, it has a strong inner retainer that gives this element added strength. 3P particulate "Interceptor" elements are used where very high dirt loading is expected but a relatively fine pore structure is required. It is also used as a prefilter to a coalescing filter in systems where a lot of solid contamination exists.

Adsorption Element
(removal of odor)



Media type A

Air Flow: Outside to Inside

This hydrocarbon vapor removal element consists of an ultra-fine grained, highly concentrated, activated carbon sheet media. Because these elements are designed to flow from the outside to their inside, they have a strong inner retainer giving this element added strength. This media type is used to remove hydrocarbon vapor and is often used to remove the smell or taste of compressor lube oil from breathing air.

Finite Media Specifications

Grade Designation	Coalescing Efficiency 0.3 to 0.6 Micron Particles	Maximum Oil Carryover[1] PPM w/w	Micron Rating	Pressure Drop (PSID) @ Rated Flow[2]	
				Media Dry	Media Wet With 10-20 wt. oil
4	99.995%	0.003	0.01	1.25	3-4
6	99.97%	0.008	0.01	1.0	2-3
ME	99.95%	0.02	0.3	0.5	1.0
7	99.5%	0.09	0.5	0.25	0.5-0.7
8	98.5%	0.2	0.5	0.5	1-1.5
10	95%	0.85	1.0	0.5	0.5
100WS	99+%[3]	N/A	100	<0.25	<0.25
3P	N/A	N/A	3.0	0.25	N/A
A	99+%[4]	N/A	3.0	1.0	N/A

[1]Tested per ISO 12500-1 at 40 ppm inlet.
[2]Add dry + wet for total pressure drop.
[3]Bulk liquid removal efficiency.
[4]Oil vapor removal efficiency is given for A media.

End Seals available:

End Seals	Available on Media type:	Max temp of element with end seal
No end seals. Element are self sealing.	C	175°F (79°C)
U: Molded Urethane (standard)	C	175°F (79°C)
	I	
	Q	
	3P	
	100WS	
	A	
S: Molded Silicone Rubber	C	175°F (79°C)
	Q	175°F (79°C)
	D	450°F (232°C)
	3P	350°F (177°C)
V: Fluorocarbon gaskets on metal end caps Note: V option is only available on 1¼" NPT and larger. Standard on all 7CVP, 7DVP, ME and 100WS media.	C	350°F (177°C)
	Q	350°F (177°C)
	D	450°F (232°C)
	ME	175°F (79°C)
	7CVP	175°F (79°C)
	7DVP	400°F (204°C)
	100WS	450°F (232°C)
	3P	350°F (177°C)
	A	175°F (79°C)

Step 2. Determine your housing

Find your desired flow rate under the appropriate media grade column. For pressures other than 100 PSIG or temperatures other than 70°F, please see Alternate Housing Selection Chart, Step 2a, on following page.

Note: The housing assembly part numbers below have a NPT connection. For BSPP, insert F in place of N. For BSPT, insert T in place of N.

Housing Selection Chart

Rated Flows: SCFM @ 100 PSIG (m^3/hr @ 7 bar)
For other pressures, please see Step 2a on following page.

Housing Assembly	Port Size	Grade 4 Coalescer	Grade 6 Coalescer (Standard)	Grade 7CVP Coalescer (or ME Media)	Grade 8 Coalescer	Grade 10 Coalescer	Grade 3PU Interceptor	Grade 100WS Water Separator	Grade A Adsorber
HN1S	1/4"	11 (19)	15 (26)	N/A	20 (34)	25 (43)	25 (43)	50 (85)	15 (26)
HN15S	3/8"	15 (26)	20 (34)	N/A	27 (46)	33 (56)	33 (56)	66 (112)	20 (34)
HN2S	1/2"	19 (32)	25 (43)	N/A	34 (58)	42 (71)	42 (71)	83 (141)	25 (43)
HN1L	1/4"	23 (39)	30 (51)	N/A	41 (68)	50 (85)	50 (85)	50 (85)	30 (51)
HN15L	3/8"	30 (51)	40 (68)	N/A	55 (94)	66 (112)	66 (112)	66 (112)	40 (68)
HN2L	1/2"	38 (65)	50 (85)	N/A	68 (116)	83 (141)	83 (141)	83 (141)	50 (85)
HN3S	3/4"	61 (104)	80 (136)	N/A	109 (185)	133 (226)	133 (226)	133 (226)	80 (136)
HN4S	1"	76 (129)	100 (170)	N/A	136 (231)	166 (282)	166 (282)	232 (394)	100 (170)
HN4L	1"	106 (180)	140 (238)	N/A	191 (325)	232 (394)	232 (394)	232 (394)	140 (238)
HN5S	1¼"	190 (323)	250 (425)	415 (706)	330 (461)	415 (706)	415 (706)	415 (706)	250 (425)
HN6S	1½"	260 (442)	350 (595)	600 (1020)	465 (791)	600 (1020)	600 (1020)	600 (1020)	350 (595)
HN8E	2"	260 (442)	350 (595)	600 (1020)	465 (791)	600 (1020)	600 (1020)	600 (1020)	350 (595)
HN8S	2"	340 (578)	450 (765)	750 (1275)	600 (1020)	750 (1275)	750 (1275)	750 (1275)	450 (765)
HN8L	2"	470 (799)	625 (1063)	1035 (1760)	830 (1411)	1035 (1760)	1035 (1760)	1035 (1760)	625 (1063)
HN0L	2½"	600 (1020)	800 (1360)	1330 (2261)	1060 (1802)	1330 (2261)	1330 (2261)	1330 (2261)	800 (1360)
HN12L	3"	750 (1275)	1000 (1700)	1660 (2822)	1330 (2261)	1660 (2822)	1660 (2822)	1660 (2822)	1000 (1700)

Replacement Element Part Numbers

*Insert selected media grade 4, 6, 8, 10.

Housing Assembly	Coalescer	Coalescer w/inner retainer	High Temperature	Coalescer w/ built-in prefilter	ME Mist Eliminator	7CVP Pleated Coalescer	3PU Interceptor	100WS Water Separator	AU Adsorber
HN1S	*C10-025	*IU10-025	*DS10-025	*QU10-025	N/A	N/A	3PU10-025	100WSU10-025	AU10-025
HN15S	*C10-025	*IU10-025	*DS10-025	*QU10-025	N/A	N/A	3PU10-025	100WSU10-025	AU10-025
HN2S	*C10-025	*IU10-025	*DS10-025	*QU10-025	N/A	N/A	3PU10-025	100WSU10-025	AU10-025
HN1L	*C10-050	*IU10-050	*DS10-050	*QU10-050	N/A	N/A	3PU10-050	100WSU10-025	AU10-050
HN15L	*C10-050	*IU10-050	*DS10-050	*QU10-050	N/A	N/A	3PU10-050	100WSU10-025	AU10-050
HN2L	*C10-050	*IU10-050	*DS10-050	*QU10-050	N/A	N/A	3PU10-050	100WSU10-025	AU10-050
HN3S	*C15-060	*IU15-060	*DS15-060	*QU15-060	N/A	N/A	3PU15-060	100WSU15-060	AU15-060
HN4S	*C15-060	*IU15-060	*DS15-060	*QU15-060	N/A	N/A	3PU15-060	100WSU15-060	AU15-060
HN4L	*C15-095	*IU15-095	*DS15-095	*QU15-095	N/A	N/A	3PU15-095	100WSU15-060	AU15-095
HN5S	*CU25-130	*CU25-130	*DS25-130	*QU25-130	ME25-130	7CVP25-130	3PU25-130	100WS25-130	AU25-130
HN6S	*CU25-130	*CU25-130	*DS25-130	*QU25-130	ME25-130	7CVP25-130	3PU25-130	100WS25-130	AU25-130
HN8E	*CU25-130	*CU25-130	*DS25-130	*QU25-130	ME25-130	7CVP25-130	3PU25-130	100WS25-130	AU25-130
HN8S	*CU25-187	*CU25-187	*DS25-187	*QU25-187	ME25-187	7CVP25-187	3PU25-187	100WS25-187	AU25-187
HN8L	*CU25-235	*CU25-235	*DS25-235	*QU25-235	ME25-235	7CVP25-235	3PU25-235	100WS25-235	AU25-235
HN0L	*CU35-280	*CU35-280	*DS35-280	*QU35-280	ME35-280	7CVP35-280	3PU35-280	100WS35-280	AU35-280
HN12L	*CU35-280	*CU35-280	*DS35-280	*QU35-280	ME35-280	7CVP35-280	3PU35-280	100WS35-280	AU35-280

Step 2a. Alternate Housing Selection Chart

Use this step for applications with technical gases or for applications that do not have standard conditions (100 PSIG and 70°F).

Because the required size of a filter is affected not only by flow, but also by operating pressure and operating temperature, it is necessary to convert those actual conditions to standardized conditions (100 PSIG and 70°F). The calculated adjusted flow rate can then be used to choose the appropriate filter in the chart on the previous page. When using the chart, choose the closest flow rate from the appropriate media grade column.

Note: Take the square root of your specific gravity. If this is for a compressed air application, skip this step because the specific gravity of air equals one. Please see chart to the right for specific gravities.

Gas	Specific Gravity
Air	1
Ammonia	0.58
Argon	1.37
Carbon Dioxide	1.52
Carbon Monoxide	0.96
Chlorine	2.48
Ethane	1.04
Ethylene	0.97
Helium	0.13
Hexane	2.73
Hydrogen	0.06
Methane	0.55
Natural Gas	0.66
Neon	0.69
Nitrogen	0.96
Oxygen	1.18
Pentane	2.47
Propane	1.56

Refer to this chart if you do not know the specific gravity of the gas you are filtering.

Equation

Flow Rate:		Pressure:		Temperature:		Specific Gravity: (See chart above)		Adjusted Flow Rate:
Actual System Flow Rate (SCFM)	X	$\frac{(100\ \text{PSIG} + 14.7\ \text{PSIG})}{(\text{System Pressure (PSIG)} + 14.7\ \text{PSIG})}$	X	$\frac{(\text{System Temp. °F} + 460°\text{F})}{70°\text{F} + 460°\text{F}}$	X	$\sqrt{\ }$	=	____SCFM @ 100 PSIG, 70°F

Information Given:
Flow Rate = 136 SCFM
Pressure = 150 PSIG
Actual Temperature = 100°F

Example:

$$136\ \text{SCFM} \times \frac{(100\ \text{PSIG} + 14.7\ \text{PSIG})}{(150\ \text{PSIG} + 14.7\ \text{PSIG})} \times \frac{(100°\text{F} + 460°\text{F})}{70°\text{F} + 460°\text{F}} \times \sqrt{1} = 100\ \text{SCFM}$$

Now go to the chart on page 8, look down the media grade 6 column for a flow of 100 SCFM, you will see the correct housing is the HN4S.

Step 3. Accessories

Consult Finite when choosing pre-installed accessories for gases other than air.

Pre-installed Accessories

Accessory Designator	Installed with...	Maximum Pressure	Maximum Temperature
A	Auto Drain	250 PSIG (17 bar)	175°F (79°C)
D	DPI Indicator	250 PSIG (17 bar)	175°F (79°C)
G	DPG Gauge	500 PSIG (34 bar)	175°F (79°C)
J	High Temp	250 PSIG (17 bar)	450°F (232°C)
N	No Accessories	500 PSIG (34 bar)	175°F (79°C)
P	DP Ports (1/8" NPT gauge ports)	500 PSIG (34 bar)	175°F (79°C)
V	Fluorocarbon O-rings	500 PSIG (34 bar)	175°F (79°C)
W	Auto Drain and DPI Indicator	250 PSIG (17 bar)	175°F (79°C)
X	Auto Drain and DP Ports	250 PSIG (17 bar)	175°F (79°C)
Y	Auto Drain and DGP Gauge	250 PSIG (17 bar)	175°F (79°C)


DPG Gauge


DPI Indicator


Auto Drain (AD-12)

[1]Note: Auto drains require a minimum operating pressure of 10 PSIG to seal.

Mounting brackets available: BK-M (1/4" - 1/2" connections); BK-3 (3/4" - 1" connections).

Other Compatible Accessories


TV-50 Timed Drain Valve


ZLD-013 Zero Loss Drain


VS-50 Visual Sump Drain (not shown: standard bowl guard)


MS-50 Metal Sump Drain (External)

210° F (99° C)	140° F (60° C)	125° F (52° C)	175° F (79° C)
300 PSIG (20 Bar)	232 PSIG (16 Bar)	150 PSIG (10 Bar)	250 PSIG (17 Bar)
1/2" NPT	1/2" NPT	1/2" NPT	1/2" NPT

Note: The accessories above are compatible with this product line, however, they are sold separately. Other timed drain valves can be found in Finite's Catalog 1300-300-06/USA.

Step 4. How to Order

Use the steps below to build your own part number.
For any permutation not mentioned below, please consult factory at 1-800-521-4357.

Step 2 or 2a

H — Series Name

N — Port Type

N - NPT
F - BSPP
S - SAE*
T - BSPT

*SAE-32 2" connection only

12 — Port (Connection) Size

1 - 1/4"
15 - 3/8"
2 - 1/2"
3 - 3/4"
4 - 1"
5 - 1¼"
6 - 1½"
8 - 2"
0 - 2½"
12 - 3"

L - — Bowl

S - Standard
L - Long
E - Economy (short bowl)*

*Economy bowl is only available on 2" connection size.

Note: Bowl length is determined by the flow rate required. See page 8, Housing Selection Chart, for flow rates.

Step 1

6 — Element Grade

4
6
8
10

Note: Grades are available on element type C, Q, D and I. For 7CVP, 7DVP, ME, 3P, 100WS and A, leave this blank.

C — Element Type / End Seal

Element Type	End Seal		
C	Blank	=	No end seal, Standard on 1/4" to 1" connection sizes
	U	=	Urethane, Standard on 1¼" to 3" connection sizes
	S	=	Molded Silicone Rubber
	V	=	Fluorocarbon, Available 1¼" to 3" connections only
Q	U	=	Urethane, Standard all connection sizes
	S	=	Molded Silicone Rubber
	V	=	Fluorocarbon, Available 1¼" to 3" connections only
D	S	=	Molded Silicone Rubber, Standard on all conn. sizes
	V	=	Fluorocarbon, Available 1¼" to 3" conn. sizes only
7CVP 7DVP ME	Blank	=	Fluorocarbon, Standard on all 7CVP, 7DVP, and ME elements; elements available 1¼" to 3" connections only
I	U	=	Urethane, Standard on 1/4" to 1" connection sizes
3P	U	=	Urethane, Standard on all connection sizes
	S	=	Molded Silicone Rubber
	V	=	Fluorocarbon, Available 1¼" to 3" connections only
100WS	U	=	Urethane, Standard on 1/4" to 1" connection sizes
	Blank	=	Fluorocarbon, Standard on 100WS elements 1¼" to 3" connections only
A	U	=	Urethane, Standard on all connection sizes
	S	=	Molded Silicone Rubber

Step 3

G — Accessory Designator

for preinstalled accessories

A - Auto Drain
D - DPI Indicator
G - DPG Gauge (Standard on 3/4" & up)
J - High Temperature (450°F)
N - No Accessories
P - 1/8" Differential (3/4" & up) Sensing Ports
V - Fluorocarbon O-rings
W - A + D
X - A + P
Y - A + G

Note: For max. pressures and temperatures related to Accessories, please see chart on previous page.

Examples on How to Order

Example 1:

HN12L-6CUY

What am I ordering?
An H-Series, with a 3" NPT connection, long bowl, standard grade 6 coalescing element with urethane end seals, an auto drain and a standard DPG gauge.

Example 2:

HN15L-8CA

What am I ordering?
An H-Series, with a 3/8" NPT connection, long bowl, grade 8 coalescing element without end seals and an auto drain.

Example 3:

HN8S-7CVPG

What am I ordering?
An H-Series, with a 2" NPT connection, standard bowl, a 7CVP coalescing element, with the standard fluoro-carbon end seals and standard DPG gauge.

Example 4:

HN8E-10DVJ

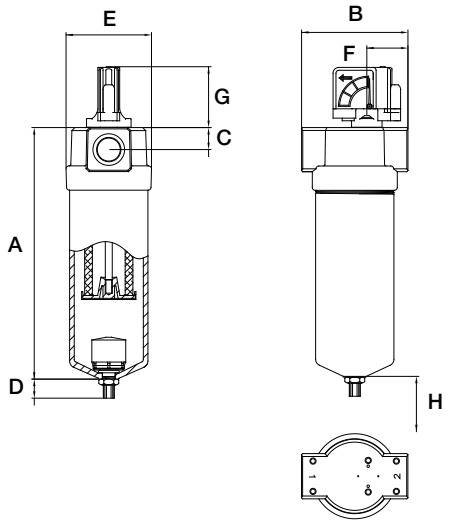
What am I ordering?
An H-Series, with a 2" NPT connection, economy short bowl, grade 10 high-temp coalescing element, with the standard fluorocarbon end seals and "J" as an accessory. This high temperature option converts all materials to be capable of handling temperatures of 450°F.

Example 5:

HN2S-AUN

What am I ordering?
An H-Series, with a 1/2" NPT connection, short bowl, adsorber element, with the standard urethane end seals and no accessories.

Drawings, Dimensions & Specifications



¼" to 1" Port Size Housings

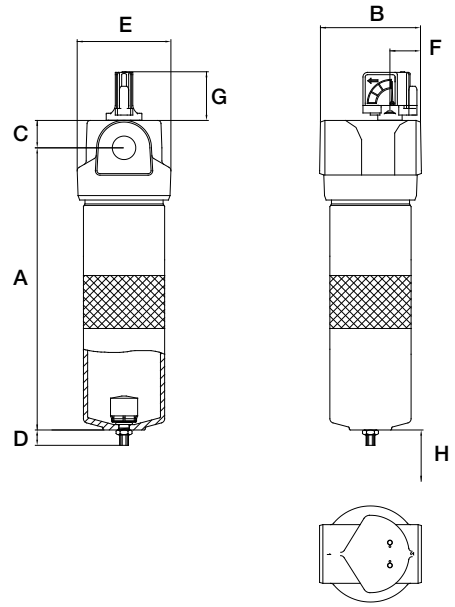
Specifications

Max. Pressure: 500 PSIG (34 bar)
Safety Factor: Max. operating to burst 4:1
Max. Temp.: 175°F (79°C) with option to 450°F (232°C)
Seals: Nitrile Std./Fluorocarbon optional
Materials: Aluminum - 380 Die cast heads;
6061 Drawn bowls
Coatings: Chromated heads and bowls;
Powder painted exterior
Design: In-line threaded bowl to head

Note: Manual Drain Port is 1/8" FNPT when tee valve is removed from drain bushing.

Model	A	B	C	D	E	F	G	H*	Sump (ml)	Weight
H_1S	6.80 (172)	3.12 (79)	.63 (16)	.79 (20)	2.98 (76)	1.56 (39.5)	2.6 (66)	2.99 (76)	150	1.49 (.68)
H_15S	6.80 (172)	3.12 (79)	.63 (16)	.79 (20)	2.98 (76)	1.56 (39.5)	2.6 (66)	2.99 (76)	150	1.47 (.66)
H_2S	6.80 (172)	3.12 (79)	.63 (16)	.79 (20)	2.98 (76)	1.56 (39.5)	2.6 (66)	2.99 (76)	150	1.44 (.65)
H_1L	9.19 (233)	3.12 (79)	.63 (16)	.79 (20)	2.98 (76)	1.56 (39.5)	2.6 (66)	5.51 (140)	140	1.89 (.86)
H_15L	9.19 (233)	3.12 (79)	.63 (16)	.79 (20)	2.98 (76)	1.56 (39.5)	2.6 (66)	5.51 (140)	140	1.87 (.85)
H_2L	9.19 (233)	3.12 (79)	.63 (16)	.79 (20)	2.98 (76)	1.56 (39.5)	2.6 (66)	5.51 (140)	140	1.85 (.84)
H_3S	10.86 (276)	4.65 (118)	.96 (24)	.79 (20)	3.68 (93.5)	1.73 (44)	2.6 (66)	6.5 (165)	270	3.56 (1.61)
H_4S	10.86 (276)	4.65 (118)	.96 (24)	.79 (20)	3.68 (93.5)	1.73 (44)	2.6 (66)	6.5 (165)	270	3.29 (1.49)
H_4L	14.36 (365)	4.65 (118)	.96 (24)	.79 (20)	3.68 (93.5)	1.73 (44)	2.6 (66)	10.00 (254)	270	4.11 (1.86)

Special Note: Dimensions are in inches (millimeters); weight is in pounds (kilograms).
* Clearance required to remove bowl.



1¼" to 3" Port Size Housings

Specifications

Max. Pressure: 500 PSIG (34 bar)
Safety Factor: Max. operating to burst 4:1
Max. Temp.: 175°F (79°C) with option to 450°F (232°C)
Seals: Nitrile Std./Fluorocarbon optional
Materials: Aluminum - 356 Sand cast heads;
6061 Drawn bowls
Coatings: Chromated heads and bowls;
Powder painted exterior
Design: In-line threaded bowl to head

Note: Manual Drain Port is 1/8" FNPT when tee valve is removed from drain bushing.

Model	A	B	C	D	E	F	G	H*	Sump (ml)	Weight
H_5S	18.23 (463)	6.0 (152)	1.65 (42)	.83 (21)	5.67 (144)	1.85 (47)	2.6 (66)	13.50 (343)	440	12.11 (5.49)
H_6S	18.23 (463)	6.0 (152)	1.65 (42)	.83 (21)	5.67 (144)	1.85 (47)	2.6 (66)	13.50 (343)	440	11.97 (5.43)
H_8E	18.23 (463)	6.0 (152)	1.65 (42)	.83 (21)	5.67 (144)	1.85 (47)	2.6 (66)	13.50 (343)	440	11.97 (5.43)
H_8S	24.23 (617)	6.0 (152)	1.65 (42)	.83 (21)	5.67 (144)	1.85 (47)	2.6 (66)	19.25 (489)	530	14.00 (6.35)
H_8L	29.23 (742)	6.0 (152)	1.65 (42)	.83 (21)	5.67 (144)	1.85 (47)	2.6 (66)	24.02 (610)	620	15.99 (7.25)
H_0L	35.70 (907)	8.0 (203)	2.4 (61)	.83 (21)	7.24 (184)	2.36 (60)	2.6 (66)	28.50 (724)	880	35.00 (15.87)
H_12L	35.70 (907)	8.0 (203)	2.4 (61)	.83 (21)	7.24 (184)	2.36 (60)	2.6 (66)	28.50 (724)	880	34.14 (15.48)

Special Note: Dimensions are in inches (millimeters); weight is in pounds (kilograms).
* Clearance required to remove bowl.

Worldwide Manufacturing Locations

North America

Engine Filtration

Parker Hannifin Corporation
Racor Division
3400 Finch Road
P.O. Box 3208
Modesto, CA 95354
phone 209 521 7860
fax 209 529 3278
www.parker.com/racor

Parker Hannifin Corporation
Racor Division
P.O. Box 6030
Holly Springs, MS 38635
phone 662 252 2656
fax 662 274 2118
www.parker.com/racor

Parker Hannifin Corporation
Racor Division
302 Parker Drive
Beaufort, SC 29906
phone 843 846 3200
fax 843 846 3230
www.parker.com/racor

Compressed Air Treatment

Parker Hannifin Corporation
Filtration and Separation
Balston Operation
242 Neck Road
Haverhill, MA 01835-0723
phone 978 858 0505
fax 978 858 0625
www.parker.com/baltson

Parker Hannifin Corporation
Filtration and Separation
Finite Filter Operation
500 Glaspie Street
P.O. Box 599
Oxford, MI 48371-5132
phone 248 628 6400
fax 248 628 1850
www.parker.com/finitefilter

Parker Hannifin Corporation
Airtek Division
4087 Walden Avenue
Lancaster, NY 14086
phone 716 685 4040
fax 716 685 1010
www.airtek.com

Hydraulic Filtration

Parker Hannifin Corporation
Hydraulic Filter Division
16810 Fulton County Road #2
Metamora, OH 43540-9714
phone 419 644 4311
fax 419 644 6205
www.parker.com/hydraulicfilter

Process Filtration

Parker Hannifin Corporation
Process Advanced Filtration
2340 Eastman Avenue
Oxnard, CA 93030
phone 805 604 3400
fax 805 604 3401
www.parker.com/processfiltration

Europe

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Parker Hannifin Corporation
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Parker Hannifin Corporation
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www.zander.de

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Process Filtration

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March 2008 / Bulletin 1300-993C/USA

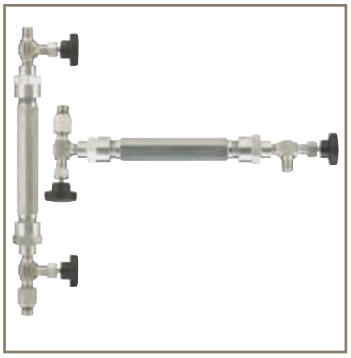
Parker Hannifin Corporation
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fax 248 628-1850
www.parker.com/finitefilter

Parker





aerospace
climate control
electromechanical
filtration
fluid & gas handling
hydraulics
pneumatics
process control
sealing & shielding





High Pressure Compressed Air and Gas Filters

J-Series High Efficiency Filters / CNG and Alternative Fuel Filters



Bulletin 1300-220/USA Rev A

Parker

ENGINEERING YOUR SUCCESS.

Finite J-Series High Pressure Filters

Why do high pressure systems need filtration?

High pressure compressors are used in a variety of applications. Many owners, operators and designers of high pressure compressed air or gas systems rely on Parker's Finite Filter Operation for high efficiency filters. End users of high pressure compressed air, such as scuba divers and fire rescue workers, depend on high quality breathable air.



Throughout the stages of compression many contaminants can enter into the system. Excessive amounts of liquid aerosols, primarily lube oil carryover and solid particulate contamination are common in high pressure systems. In addition, higher temperature levels are possible and may cause liquid oils to varnish. This contamination can lead to poor component performance and wear that may lead to unscheduled maintenance. Even submicronic contaminants in compressed air or gas systems can foul multistage compressors, increasing maintenance costs and impacting product quality.

Parker's Finite Filter Operation offers a variety of high pressure compressed air and gas filters. With our wide range of elements, we have a solution for every stage of compression, as well as at the point of use. Whether you are storing high pressure air or gas or using a continuous flow, count on Parker to protect your equipment from contamination. Parker Finite is the solution to ending high pressure contamination fouling.

Parker's Finite Filter Operation's J-Series Filters are designed to filter contaminants such as rust, pipe scale, compressor lube oil, and water from compressed gases. These filters are often used in high pressure compressed natural gas (CNG) systems, not only as inter-stage filters in the multi-stage compression of the gas, but also in the storage and delivery of the gas for CNG powered vehicles.



Parker's varied media choices remove up to 99.995% of both solid and liquid aerosols, and contaminants as small as 0.01 microns in size. An activated carbon media is also available which removes oil vapor. This stage of filtration is often used as the final filter before the storage of high pressure breathing air used by scuba divers, firefighters, and others who utilize portable breathing devices.

The filter housings and the replaceable elements used in this product line have an extremely robust construction, specially designed for use in system pressures up to 5,000 psig. Five housing sizes and two thread styles (NPT or SAE) are available with connections ranging from 1/4" to 2"; temperatures up to 350°F, and flows up to 26,000 SCFM at 5,000 PSIG.

J-Series High Pressure Filters

- CNG, alternative fuel and breathing air filters
- Pressures to 5000 PSIG
- Spheroidal Graphite Cast Iron
- Coalescing, particulate and adsorption filter elements available

Filter Element Features

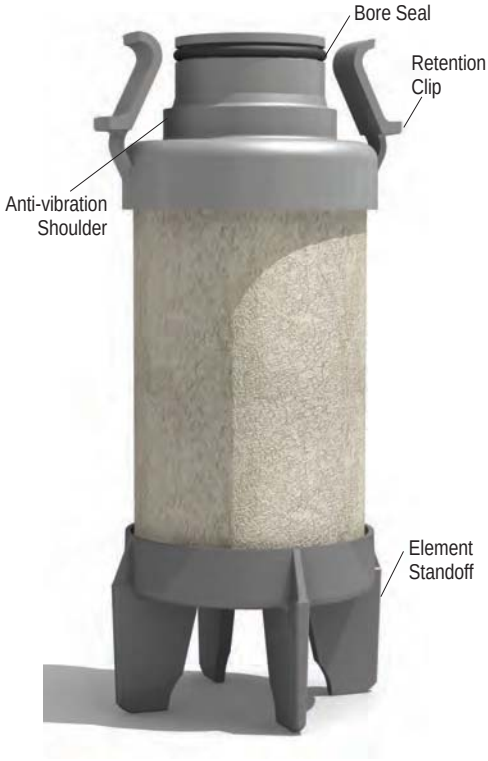
Parker Finite offers six filter media grades ensuring that we have the correct media choice for nearly any application requirement.

Available are coalescing grades with 95% to 99.995% efficiency and pleated or UNI-CAST coalescing media designs. Additionally, a bulk liquid separator, a particulate removal and oil vapor removal choices are standard offerings.

Each element uses a retention clip design that ensures the element is seated and sealed properly. This built-in, fail-safe feature will virtually eliminate any possibility of contaminant by-pass and is unique amongst high pressure filters.

Each element is composed of internal and external plated carbon steel retainers which provide the element with a 75+ PSID burst rating. Each element also features a bore seal interface with the housing, an anti-vibration shoulder, and an integrated standoff which minimizes the likelihood of any movement of the element, even during severe system pulsations.

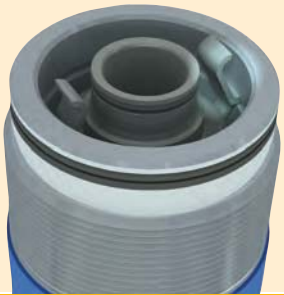
Element standoff lengths were designed for each housing size to allow an optimal volume of liquid contaminant to be collected in the filter's quiet zone, further minimizing any chance of contaminant carryover.



Filter Housing Features

- Robust, spheroidal graphite-cast iron offers higher mechanical strength, improved ductility, and increased shock resistance, assuring the user that this filter is built for the task at hand.
- Head to bowl bore seal ensures greater seal integrity.
- Threaded mounting holes on top of filter head allow each size to be easily panel mounted when line mounting is not an option.
- Engraved flow direction arrow in filter's head notifies the user of proper flow direction. One direction flow for all media choices reduces the possibility of a housing being installed improperly.
- The spheroidal graphite cast iron head and steel bowl are nickel plated for corrosion resistance. The completed assembly is finished with a UV stable epoxy powder paint that will allow the filter to stand-up to harsh outdoor conditions.
- An imprinted aluminum part number tag ensures that each unit's identifying information will be visible in the years ahead.
- SAE-6 steel drain plug with positive o-ring seal installed. This port also allows the easy installation of Finite's JDK5000H or JDK5000V high pressure drain kits which allow the safe removal of liquid contamination at system pressures.
- Bowls are designed to be easily tightened or loosened with a standard socket wrench.
- Bowls feature a slotted positional locator which enables the element to be positively retained, therefore having a low bowl removal clearance.



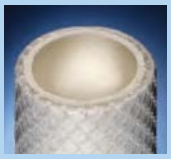


Element Types and Media Grade Options

Coalescers:

Removes: Oil, water, liquids

Coalescing elements are specially designed for the removal of liquid contaminants from gaseous flows. These media types flow from the inside of the element to the outside. Coalesced liquid collects in the bowl where it is drained, while clean air or gas exits the housing through the outlet port. Particulate contaminants are captured and held in the media.



Type C

The Finite UNI-CAST coalescing elements are made of epoxy saturated borosilicate glass microber and includes a polyester drain layer. (1)(2)



Type 7CP

This pleated coalescer is made of uor ocarbon saturated borosilicate glass microber and includes a polyester drain layer. (1)(2)

Water Separator:

Removes: Bulk liquids

In this element, the gas or liquid flows from the inside of the element to the outside



Type WS

The Finite water separator element is composed of wrapped stainless steel mesh. (1)(2)

Adsorber:

Removes: Oil vapor (odor)

Adsorption elements are used to remove vapors (hydrocarbon) that are not removed by the coalescing filter. Hydrocarbon vapors collect in the element, while clean air exits the housing through the outlet port. In this element, the air or gas flows from the inside of the element to the outside



Type A

Our Type A media is wrapped activated carbon. This element has a galvanized carbon steel inner retainer and a stainless steel perforated metal outer retaining layer. (2)

* Consult factory for other media types.

Particulate:

Removes: Solid contaminants

Particulate filters in the J-Series flow from the inside of the element to the outside. Particles collect in the element, while the clean air exits through the outlet port.



Type 3P

This 3 micron absolute rated pleated element is made of cellulose. (1)(2)

Notes:
1 Each element is retained internally and externally with galvanized carbon steel perforated metal. Not shown in some photos above.
2 Top and bottom end caps are made of glass filled nylon to ensure durability.

Media Grades and Specifications:

Finite media grades determine the filtration efficiency. Capture efficiencies are available up to 99.995%. Micron ratings range from 0.01 to 3 micron. The columns on the right note both the wet and dry pressure drops.

Grade Designation	Media Type	Removes...	Coalescing Efficiency	Max Oil Carryover ppm[1]	Micron Rating (um)	Pressure Drop Media Dry (PSID)	Additional Pressure Drop Media Wet[2] (PSID)
4C	Coalescing	Liquid from Gas	99.995%	0.003	0.01	1.25	3-4
7CP	Coalescing	Liquid from Gas	99.5%	0.09	0.5	0.25	0.5-0.7
10C	Coalescing	Liquid from Gas	95%	0.85	1.0	0.5	0.5
WS	Bulk Separator	Bulk Liquid from Gas	99+%[3]	N.A.	100	<0.25	<0.25
3P	Particulate	Solids from Gas	N.A.	N.A.	3.0	0.25	N.A.
A	Adsorber	Vapor from Gas	99+%[4]	N.A.	3.0	1.0	N.A.

[1]Tested per ISO 12500-1 at 40 ppm inlet.
[2]Add dry + wet columns for total pressure drop.
[3]Bulk liquid removal efficiency..
[4]Oil vapor removal efficiency is given for A media.

Applications:

High Pressure (HP) Filter Applications

Test Air for HP Hydraulics	10C / 7CP						
Inter-stage HP Compressor	WS / 10C						
CNG Compressor Outlet	10C	→	4C				
CNG Storage Cascades	10C	→	4C				
CNG Dispensers	10C	→	4C				
Breathing Air / SCUBA	10C	→	4C	→	A		
High Pressure “Ultra Pure Air”	10C	→	4C	→	4C	→	A
Bulk Liquid contamination	WS	→	7CP	→	4C		
Bulk solid Contamination	3P	→	7CP	→	4C		
HP Air / Gas Dryer Protection	10C / 7CP	→	4C	→	Dryer	→	7CP / 3P
Food Applications / Odor Removal	10C / 7CP	→	4C	→	A		



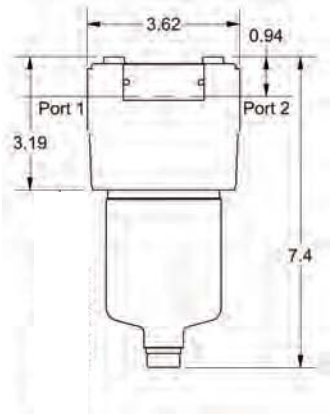
Flow Rates:

Choose Filter Size to find the corresponding flow rates

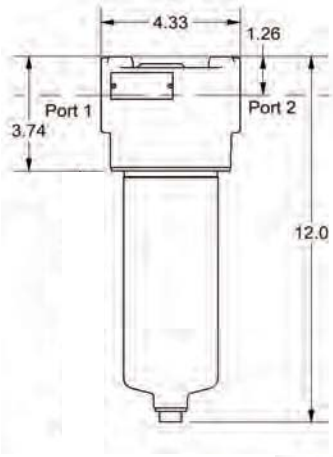
J-Series Flow Rates (SCFM)

Model	Port	Filter Type	100 PSIG	1000 PSIG	1500 PSIG	2000 PSIG	2500 PSIG	3000 PSIG	3500 PSIG	4000 PSIG	4500 PSIG	5000 PSIG
J_1A	**1/4”**	4C, A	15	135	200	265	330	395	460	525	590	655
		7CP, 10C, 3P, WS	30	265	395	525	660	790	920	1050	1180	1310
J_2A	**1/2”**	4C, A	25	220	330	440	550	655	765	875	985	1095
		7CP, 10C, 3P, WS	50	440	660	880	1095	1315	1530	1750	1970	2185
J_2B	**1/2”**	4C, A	35	310	460	615	765	920	1070	1225	1380	1530
		7CP, 10C, 3P, WS	80	710	1055	1405	1755	2105	2450	2800	3150	3500
J_3B	**3/4”**	4C, A	60	530	790	1055	1315	1575	1840	2100	2360	2525
		7CP, 10C, 3P, WS	130	1150	1715	2285	2850	3415	3985	4550	5115	5685
J_4C	**1”**	4C, A	90	795	1190	1580	1975	2365	2760	3150	3540	3935
		7CP, 10C, 3P, WS	200	1770	2640	3515	4385	5255	6130	7000	7870	8745
J_6D	**1-1/2”**	4C, A	180	1590	2375	3160	3945	4730	5515	6300	7085	7870
		7CP, 10C, 3P, WS	400	3540	5280	7025	8770	10515	12255	14000	15745	17490
J_8E	**2”**	4C, A	275	2435	3630	4830	6030	7230	8425	9625	10825	12025
		7CP, 10C, 3P, WS	600	5310	7925	10540	13155	15770	18385	21000	23615	26230

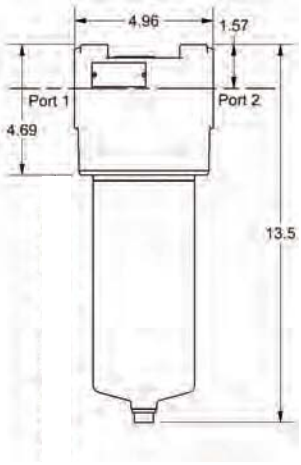
Note: These rates are based on compressed air flow. For CNG, these flows can be multiplied by a factor of 1.2.



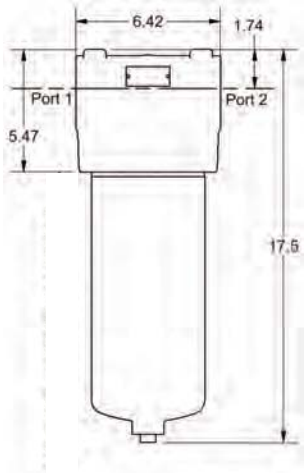
J_A Series



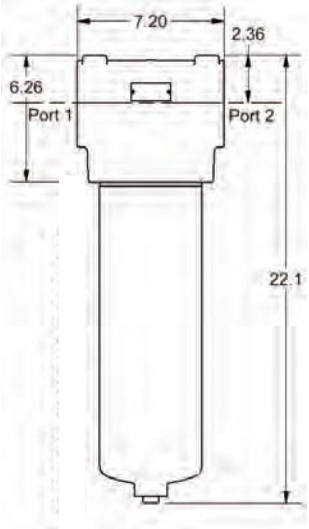
J_B Series



J_C Series



J_D Series



J_E Series

Specifications:

Model	J_1A	J_2A	J_2B	J_3B	J_4C	J_6D	J_8E
Port Size (N=NPT)	1/4" NPT	1/2"NPT	1/2"NPT	3/4" NPT	1"NPT	1-1/2"NPT	2" NPT
Port Size (S=SAE)	SAE-4	SAE-8	SAE-8	SAE-12	SAE-16	SAE-24	SAE-32
Max. Pressure	5000 PSIG	5000 PSIG	5000 PSIG	5000 PSIG	5000 PSIG	5000 PSIG	5000 PSIG
Max. Temperature[1]	350°F	350°F	350°F	350°F	350°F	350°F	350°F
Head	SG Iron*	SG Iron*	SG Iron*	SG Iron*	SG Iron*	SG Iron*	SG Iron*
Bowl	Steel	Steel	Steel	Steel	Steel	Steel	Steel
Seals:	Fluorocarbon	Fluorocarbon	Fluorocarbon	Fluorocarbon	Fluorocarbon	Fluorocarbon	Fluorocarbon
Backing Ring	Nitrile	Nitrile	Nitrile	Nitrile	Nitrile	Nitrile	Nitrile
Sump Volume	50 mL	50 mL	180 mL	180 mL	230 mL	500 mL	500 mL
Weight	9.0 lbs.	9.0 lbs.	13.0 lbs.	13.0 lbs.	21.0 lbs.	45.0 lbs.	67.0 lbs.
Port to Port	3.62"	3.62"	4.33"	4.33"	4.96"	6.42"	7.2"
Height	7.4"	7.4"	12.0"	12.0"	13.5"	17.5"	22.1"
Clearance	2.0"	2.0"	2.25"	2.25"	2.25"	3.0"	3.0"
Drain Port	SAE-6	SAE-6	SAE-6	SAE-6	SAE-6	SAE-6	SAE-6
Socket / Bowl Removal	1-1/16" HEX	1-1/16" HEX	1-1/16" HEX	1-1/16" HEX	1-1/16" HEX	1-1/2 HEX	1-1/2 HEX
Head / Bowl Torque	15-20 ft-lbs.	15-20 ft-lbs.	25-30 ft-lbs.	25-30 ft-lbs.	25-30 ft-lbs.	60-70 ft-lbs.	60-70 ft-lbs.

*Note: SG Iron is an abbreviation for Spheroidal Graphite Cast Iron

High Pressure Drains and Gauge:

JDK5000H	Horizontal Drain Kit 5000 psig
JDK5000V	Vertical Drain Kit 5000 psig
BDPI-25	Differential Pressure Gauge and Bracket

Note: Replacement Element supplied with o-ring and lube tube.

How To Order
Part Numbers for Complete Assemblies:

Use the steps below to build your own part number.
For any permutation not mentioned below, please consult factory at 1-800-521-4357.

Series Name	Thread	Port Size	=	Housing Size	-	Media Grade	Accessories
J	N - NPT	1 (1/4")	=	A		4C	N = None
	S - SAE	2 (1/2")	=	A		10C	Available
		2 (1/2")	=	B		7CP	
		3 (3/4")	=	B		WS	
		4 (1")	=	C		3P	
		6 (1-1/2")	=	D		A	
		8 (2")	=	E			

Examples:

JN2A-4CN, JS6D-WSN, JN3B-3PN

Replacement Element Part Numbers:

Note: Replacement element supplied with replacement head/bowl seals and tube of lubricant.

Media Grade/Type	Series Name	Housing Size	Kit
4C	J	A	K
10C		B	
7CP		C	
WS		D	
3P		E	
A			

Examples:

4CJAK, WSJDK, 3PJBK



J-Series filters are used in a number of applications, ranging from breathing air for scuba divers, to high-pressure hydraulic circuit testing, to a variety of uses in the alternative fuel industry.









Worldwide Filtration Manufacturing Locations

North America

Compressed Air Treatment

Filtration & Separation/Balston
Haverhill, MA
978 858 0505
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Finite Airtek Filtration
Airtek/domnick hunter/Zander
Lancaster, NY
716 686 6400
www.parker.com/faf

Finite Airtek Filtration/Finite
Oxford, MI
248 628 6400
www.parker.com/ nite lter

Engine Filtration & Water Purification

Racor
Modesto, CA
209 521 7860
www.parker.com/racor

Holly Springs, MS
662 252 2656
www.parker.com/racor

Beaufort, SC
843 846 3200
www.parker.com/racor

Racor – Village Marine Tec.
Gardena, CA
310 516 9911
desalination.parker.com

Parker Sea Recovery
Carson, CA
310 637 3400
www.searecovery.com

Hydraulic Filtration

Hydraulic Filter
Metamora, OH
419 644 4311
www.parker.com/hydraulic lter

Laval, QC Canada
450 629 9594
www.parkerfarr.com

Process Filtration

domnick hunter Process Filtration
Oxnard, CA
805 604 3400
www.parker.com/process ltration

Madison, WI
608 824 0500
www.scilog.com

Phoenixville, PA
610 933 1600
www.parker.com/process ltration

Aerospace Filtration

Velcon Filtration
Colorado Springs, CO
719 531 5855
www.velcon.com

Europe

Compressed Air Treatment

domnick hunter Filtration & Separation
Gateshead, England
+44 (0) 191 402 9000
www.parker.com/dhfns

Parker Gas Separations
Etten-Leur, Netherlands
+31 76 508 5300
www.parker.com/dhfns

Hiross Zander
Padova Business Unit
Padova, Italy
+39 049 9712 111
www.parker.com/hzd

Hiross Zander
Essen Business Unit
Essen, Germany
+49 2054 9340
www.parker.com/hzd

Engine Filtration & Water Purification

Racor
Dewsbury, England
+44 (0) 1924 487 000
www.parker.com/rfde

Racor Research & Development
Stuttgart, Germany
+49 (0)711 7071 290-10
www.parker.com/rfde

Hydraulic Filtration

Hydraulic Filter
Arnhem, Holland
+31 26 3760376
www.parker.com/hfde

Urjala Operation
Urjala, Finland
+358 20 753 2500
www.parker.com/hfde

Condition Monitoring Centre
Norfolk, England
+44 (0) 1842 763 299
www.parker.com/hfde

Parker Kittiwake
West Sussex, England
+44 (0) 1903 731 470
www.kittiwake.com

Parker Procal
Peterborough, England
+44 (0) 1733 232 495
www.kittiwake.com

Process Filtration

domnick hunter Process Filtration
Birtley, England
+44 (0) 191 410 5121
www.parker.com/process ltration

Parker Twin Filter BV
Zaandam, Netherlands
+31(0)75 655 50 00
www.twin lter.com

Asia Pacific

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Castle Hill, Australia
+61 2 9634 7777
www.parker.com/australia

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www.parker.com/china

India
Navi Mumbai, India
+91 22 651 370 8185
www.parker.com/india

Parker Fowler
Bangalore, India
+91 80 2783 6794
www.johnfowlerindia.com

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Tokyo, Japan
+81 45 870 1522
www.parker.com/japan

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Osaka, Japan
+81 66 340 1600
www.techno.taiyo-ltd.co.jp

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+65 6887 6300
www.parker.com/singapore

Thailand
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+66 2186 7000
www.parker.com/thailand

Latin America

Parker Comercio Ltda.
Filtration Division
Sao Paulo, Brazil
+55 12 4009 3500
www.parker.com/br

Pan American Division
Miami, FL
305 470 8800
www.parker.com/panam

Africa

Aeroport Kempton Park, South Africa
+27 11 9610700
www.parker.com/africa

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Parker Hannin Corporation
Finite Airtek Filtration Division
500 S. Glaspie Street
Oxford, MI 48371
phone 248 628 6400
fax 248 628 1850
www.parker.com/nitelter

133580
W/O#
P1120251-042
P.O. Number

FORM U-1A MANUFACTURER'S DATA REPORT FOR PRESSURE VESSELS

(Alternative Form for Single Chamber, Completely Shop or Field Fabricated Vessels Only)
As Required by the Provisions of the ASME Boiler and Pressure Vessel Code Rules, Section VIII, Division 1

Corrected Copy

1. Manufactured and certified by J-W Power Company, 1008 Cox Drive, Kilgore, Texas, 75662
(Name and address of Manufacturer)

2. Manufactured for J-W Power Company, Hwy 322 South at FM 2204, Longview, Texas, 75603
(Name and address of Purchaser)

3. Location of Installation Not Known
(Name and address)

4. Type Vertical Blwdn Tank (Horizontal or vertical, tank) | **C9105** (Manufacturer's serial number) | N/A (CRN) | 335-26823-0 (Drawing number) | **8095** (National Board number) | 2016 (Year built)

5. ASME Code, Section VIII, Division 1 | 2015/ N/A [Edition and Addenda, if applicable (date)] | 2732-1 (Code Case numbers) | N/A (Special service per UG-120(d))

6. Shell: SA-516-70 (Material spec. number, grade) | 0.375" (Nominal thickness) | 0.00" (Corr. allow.) | 2' 4.0" (OD) (Inner diameter) | 6' 0.0" [Length (overall)]

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

7. Seams: Welded (1), Butt [Long. (welded, dbl., sngl., lap, butt)] | Full [R.T.(spot or full)] | 100% (Eff.,%) | N/A (H.T. temp) | N/A (Time, hr) | Welded (1), Butt [Girth. (welded, dbl., sngl., lap, butt)] | None [R.T. (spot or full)] | 70% (Eff., %) | 1 (No. of courses)

8. Heads: (a) Material SA-516-70 (Spec. no., grade) (b) Material SA-516-70 (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	0.340"	0.00"	N/A	N/A	2:1	N/A	N/A	N/A	Concave
(b)	BOTTOM	0.340"	0.00"	N/A	N/A	2:1	N/A	N/A	N/A	Concave

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

9. MAWP 300 psi (Internal) | 15 psi (External) at max. temp. 350 °F (Internal) | 350 °F (External)

Min. design metal temp. -20 °F at 300 psi . Hydro, pneu., or comb. test pressure HYDRO. at 390 psi .

Proof test N/A .

10. Nozzles, inspection and safety valve openings:

Purpose (Inlet, Outlet, Drain, etc.)	No.	Diameter or Size	Type	Material		Nozzle Thickness		Reinforcement Material	Attachment Details		Location (Insp. Open.)
				Nozzle	Flange	Nom.	Corr.		Nozzle	Flange	
Gas Inlet	**1**	**1"**	**CPLT**	**SA-105**		**3000#**		**Integral**	**UW-16.1(bb)**		
Gas Outlet	**1**	**2"**	**CPLT**	**SA-105**		**3000#**		**Integral**	**UW-16.1(bb)**		**Shell**
Drain	**1**	**1"**	**CPLT**	**SA-105**		**3000#**		**Integral**	**UW-16.1(bb)**		
Vent	**1**	**1"**	**CPLT**	**SA-105**		**3000#**		**Integral**	**UW-16.1(bb)**		
High Level Switch	**1**	**2"**	**CPLT**	**SA-105**		**3000#**		**Integral**	**UW-16.1(bb)**		**Shell**
Vent	**1**	**1/2"**	**CPLT**	**SA-105**		**3000#**		**Integral**	**UW-16.1(bb)**		
Relief Valve	**1**	**1"**	**CPLT**	**SA-105**		**3000#**		**Integral**	**UW-16.1(bb)**		

11. Supports: Skirt **Yes** (Yes or no) Lugs 2 (Number) Legs N/A (Number) Other **N/A** (Describe) Attached **Skirt-hd (b), Lugs-hd (a), wld** (Where and how)

12. Remarks: Manufacturer's Partial Data Reports properly identified and signed by Commissioned Inspectors, have been furnished for the following items of the report:

Shell, S/N 312220-1-2 ,Port City Metal Services Inc, ASME Clover stamp, U
(Name of part, item number, Manufacturer's name and identifying stamp)

Part Number: 330-02029
Impact Testing: Not Required Per UG-20(f).Overpressure device not required per UG-125.
Eff. & RT: Per UW-11(a)(5)(b) & UW-12(d)

FORM U-1A (Back)

NB Number 8095

CERTIFICATE OF SHOP/FIELD COMPLIANCE

We certify that the statements made in this report are correct and that all details of design, material, construction, and workmanship of this vessel conform to the ASME BOILER AND PRESSURE VESSEL CODE, Section VIII, Division 1. "U" Certificate of Authorization Number 30396 expires June 14, 2019.

Date 11/03/2016 Co. name **J-W Power Company** (Manufacturer) Signed (Representative)

CERTIFICATE OF SHOP/FIELD INSPECTION

Vessel constructed by **J-W Power Company** at **1008 Cox Drive, Kilgore, Texas, 75662**

I, the undersigned, holding a valid commission issued by The National Board of Boiler and Pressure Vessel Inspectors and employed by OneCIS Insurance Company, of Lynn, MA

have inspected the component described in this Manufacturer's Data Report on March 2, 2017, and state that, to the best of my knowledge and belief, the Manufacturer has constructed this pressure vessel in accordance with ASME BOILER AND PRESSURE VESSEL CODE, Section VIII, Division 1. By signing this certificate neither the Inspector nor his/her employer makes any warranty, expressed or implied, concerning the pressure vessel described in this Manufacturer's Data Report. Furthermore, neither the Inspector nor his/her employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.

Date 03/02/2017 Signed (Authorized Inspector) Commissions 8934 [National Board (incl. endorsements)]

CONTROL PANEL



J-W POWER COMPANY

J-W PART NO. 328-00820

J-W POWER COMPANY
FOR REFERENCE ONLY
UNIT 7351 CLEAN ENERGY

8/24/2017 bfontenot

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NO.	REVISION	BY	CK'D	APP'D	DATE
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0	ISSUE FOR CONSTRUCTION	DM	KD	BWF	6/21/17

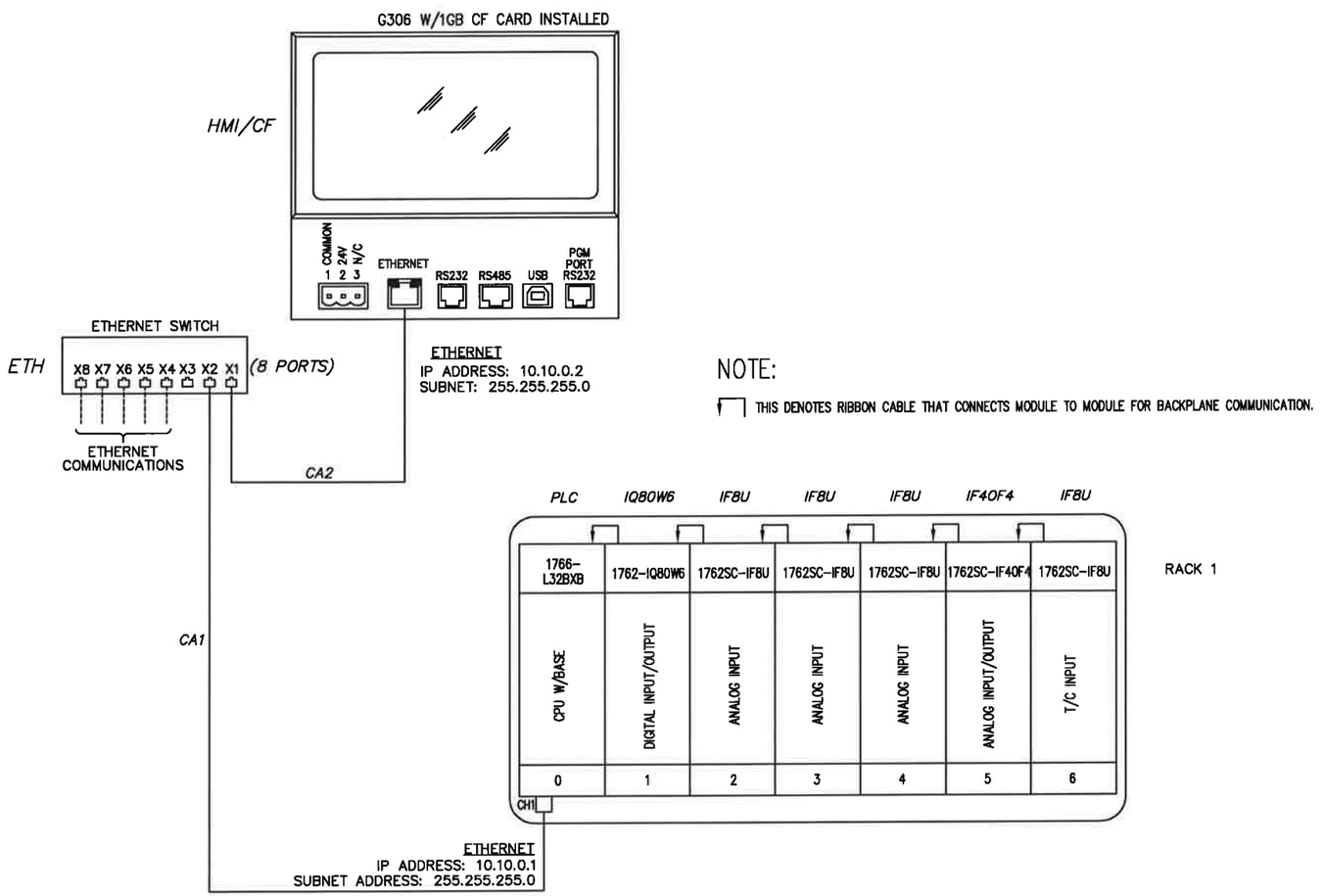
DRWN	CK'D	APP'D	DATE	SCALE
JO	KD	BWF	6/15/17	NONE

J-W POWER COMPANY
LONGVIEW, TEXAS, USA

PANEL PLC UNIT CNG
UL NNNY F/120VSOL P-PNL

SHEET 1 OF 17

P/N 328-00820 | DWG. 335-29548 | REV. 1



NOTE:

THIS DENOTES RIBBON CABLE THAT CONNECTS MODULE TO MODULE FOR BACKPLANE COMMUNICATION.

NOTES:

1. FACTORY WIRING: ————————
   CUSTOMER WIRING: — — — — —
   END USER WIRING: —— · — · ——
   PNEUMATIC: —|—|—|—|—
2. ROUTE SENSOR LEADS SEPARATE FROM ALL OTHER WIRING.
3. "18-BL-25" REPRESENTS "AWG-WIRE COLOR-WIRE NUMBER".
4. **CAUTION**: DISCONNECT ALL SENSOR LEADS & REMOVE MODULES FROM RACK BEFORE WELDING.
5. THIS PANEL IS DESIGNED FOR USE IN CLASS 1, DIV. 2, GROUP D HAZARDOUS LOCATIONS.
6. GROUND SYMBOLS WILL BE SHOWN PER THE FOLLOWING:
   EARTH / NON-INCENDIVE ⏚ CHASSIS / NON-INCENDIVE ⏚ DC COM / CLOSE LOOP ▽
   INSTRUMENT ELECTRONIC GROUND (IEG)
7. UNLESS OTHERWISE NOTED ALL DEVICES ARE SHOWN IN THE SHELF POSITION.
8. ALL UNASSIGNED SPARE TERMINALS SHALL BE PLACED ON SEPARATE "SPARE TB".
9. SEE PI&D DRAWINGS FOR DEVICE TAGS.
10. **WARNING**: ALL WIRING SHALL BE INSTALLED AS PERMITTED BY THE NEC FOR CLASS 1, DIV. 2 HAZARDOUS LOCATIONS. ALL COMPONENTS SHALL BE CSA, FM OR UL APPROVED FOR CLASS 1, DIV. 2 SUBSTITUTIONS OF COMPONENTS MAY IMPAIR SUITABILITY FOR CLASS 1, DIV. 2 HAZARDOUS LOCATIONS.

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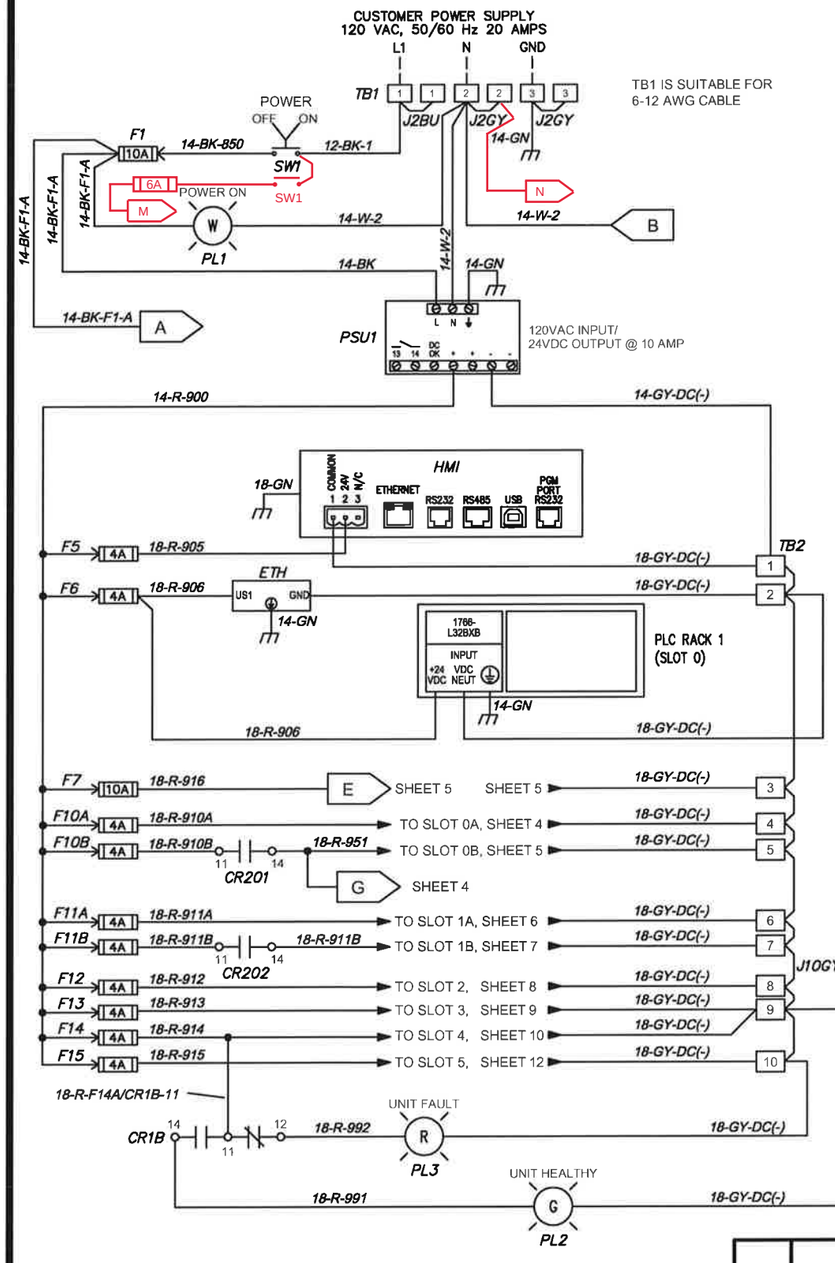
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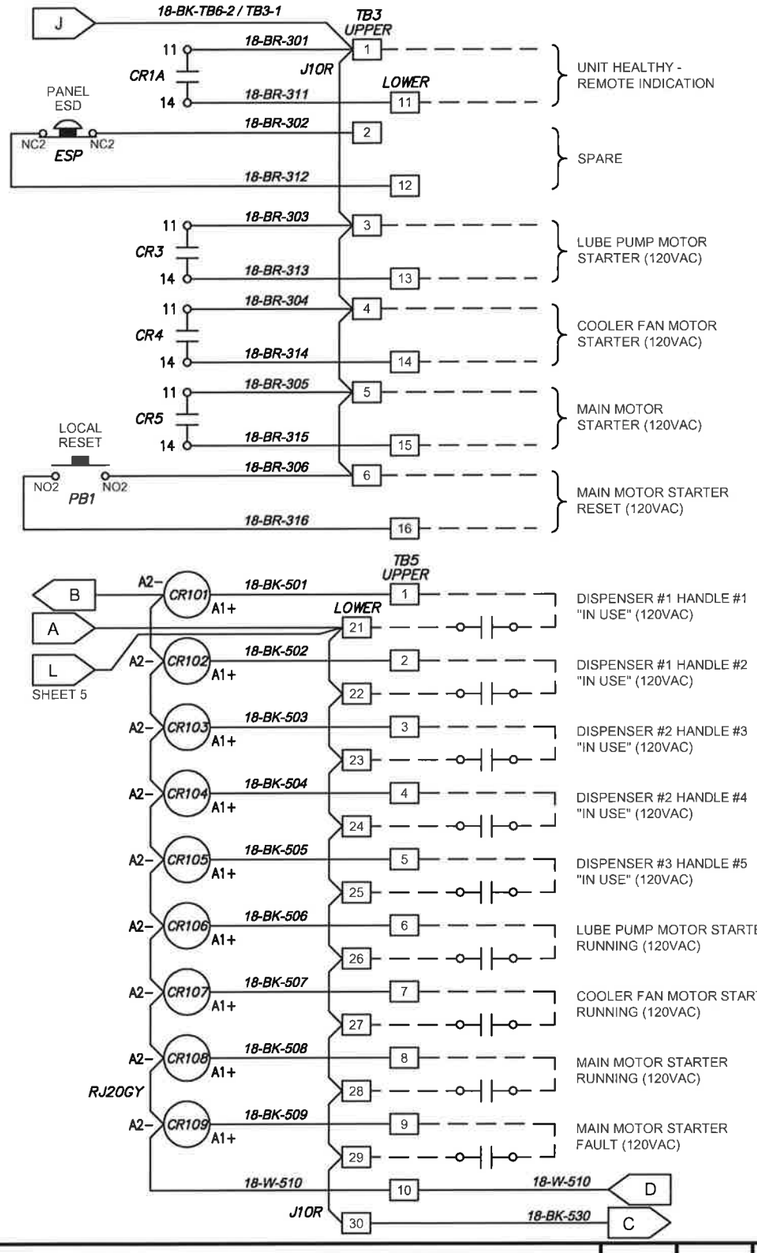
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LONGVIEW, TEXAS, USA

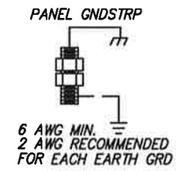
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UL NNNY F/120VSOL P-PNL

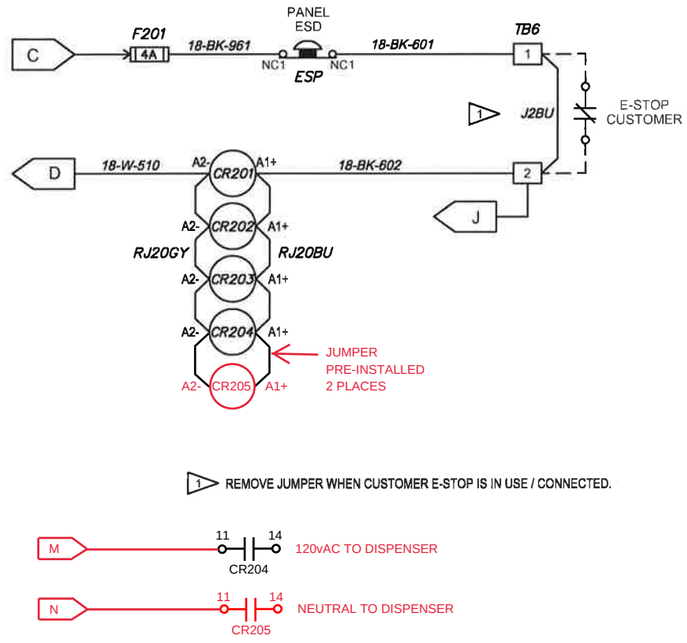
SHEET 2 OF 17

P/N 328-00820 | DWG. 335-29548 | REV. 1









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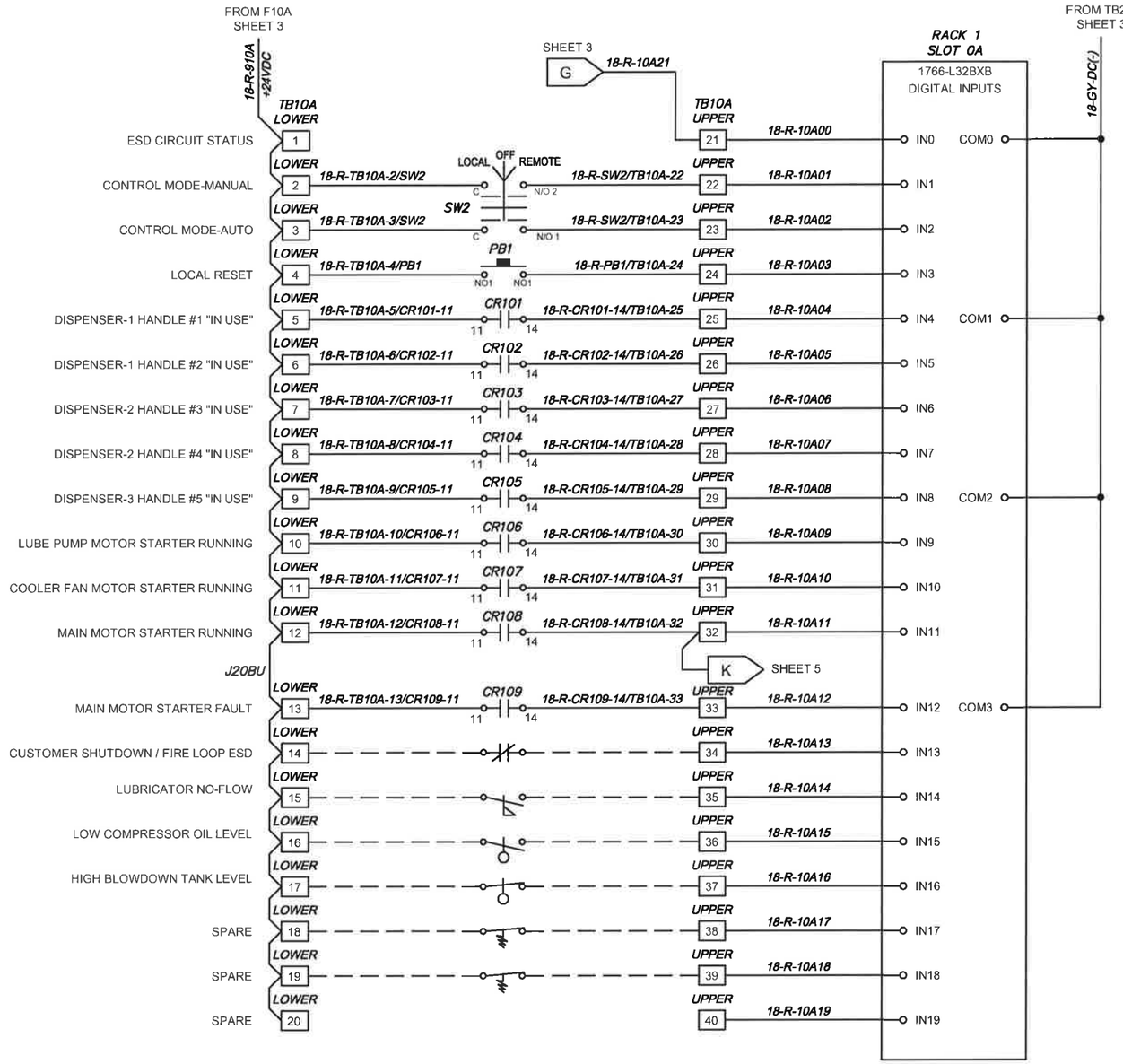
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0	ISSUE FOR CONSTRUCTION	DM	KD	BWF	6/21/17

DRWN	CK'D	APP'D	DATE	SCALE	P/N	DWG.	REV.
JO	KD	BWF	6/15/17	NONE	328-00820	335-29548	1

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LONGVIEW, TEXAS, USA

PANEL PLC UNIT CNG
UL NNNY F/120VSOL P-PNL

SHEET 3 OF 17



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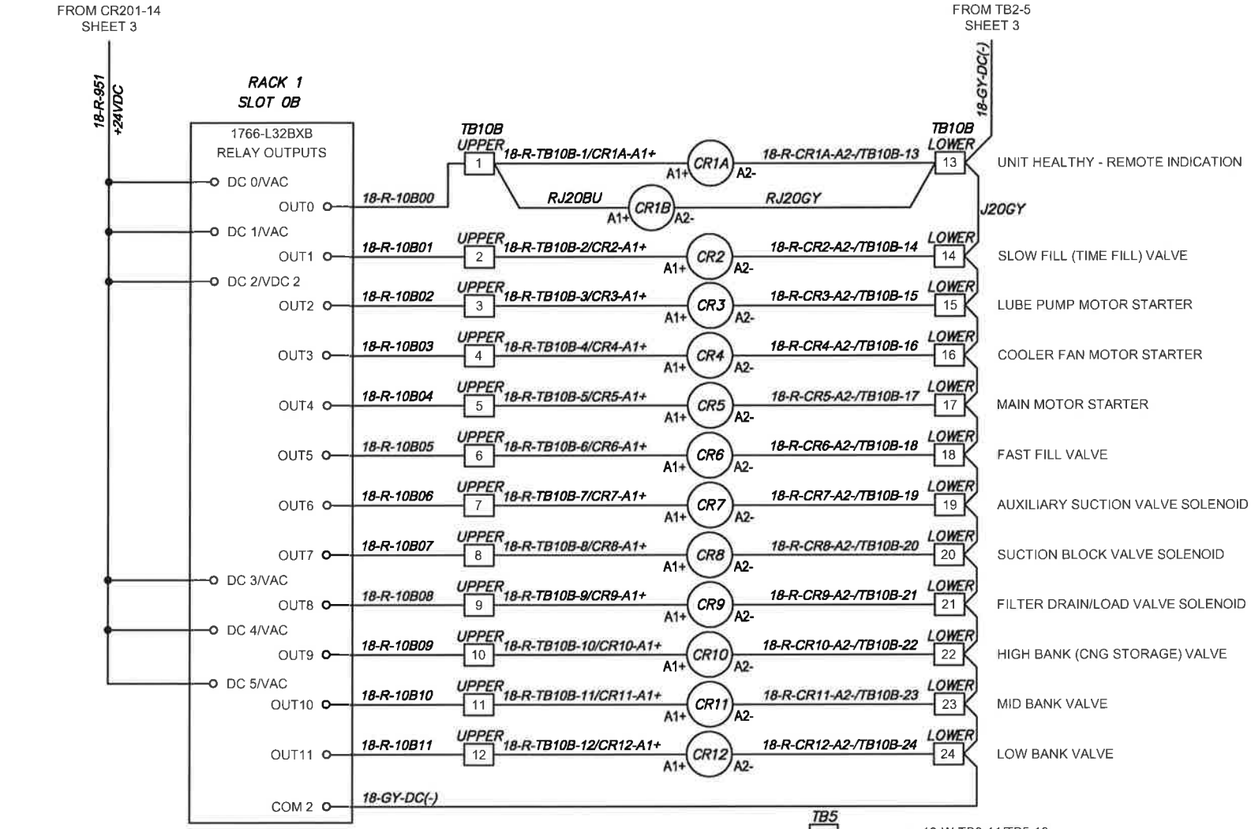
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DRWN	CK'D	APP'D	DATE	SCALE	P/N	DWG.	REV.
JO	KD	BWF	6/15/17	NONE	328-00820	335-29548	1



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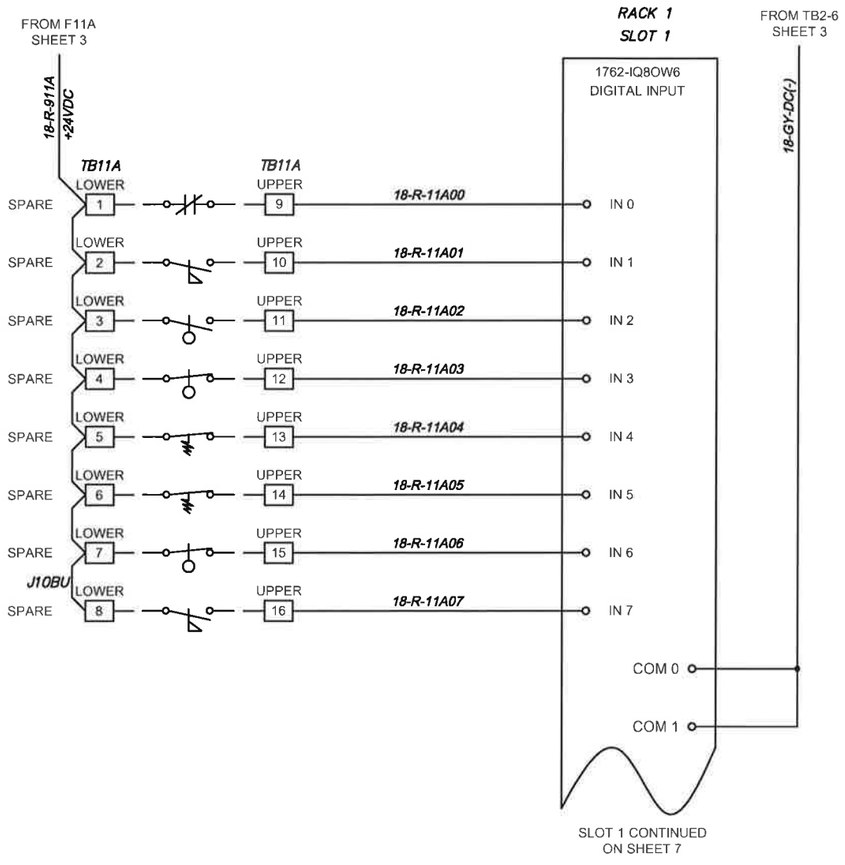
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JO	KD	BWF	6/15/17	NONE

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SHEET 5 OF 17

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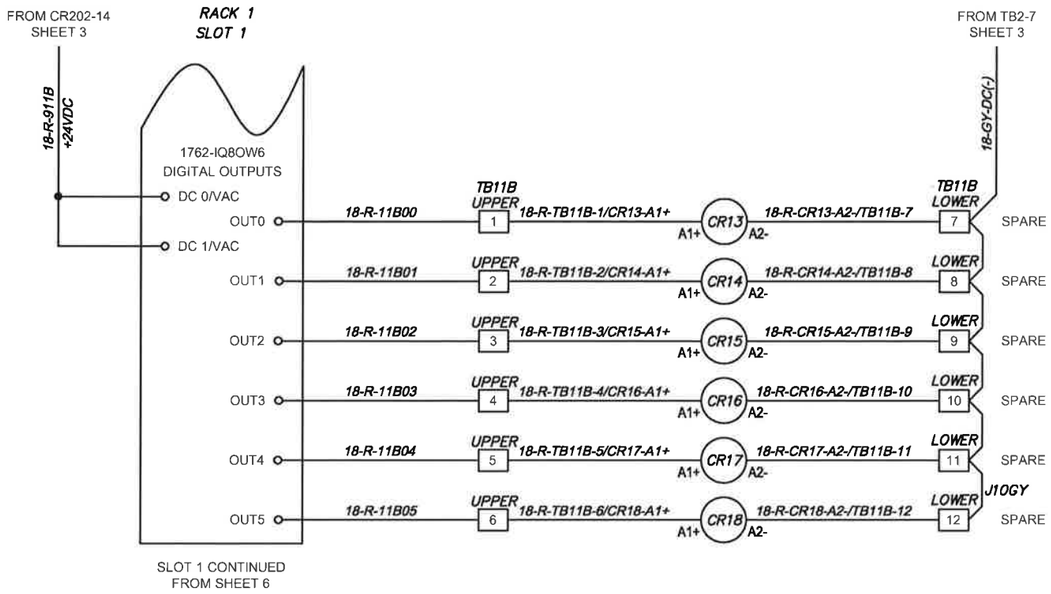
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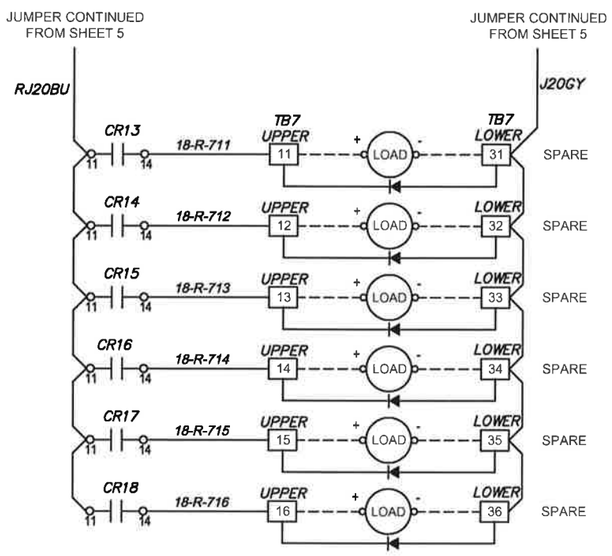
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SHEET 6 OF 17

P/N 328-00820 | DWG. 335-29548 | REV. 1





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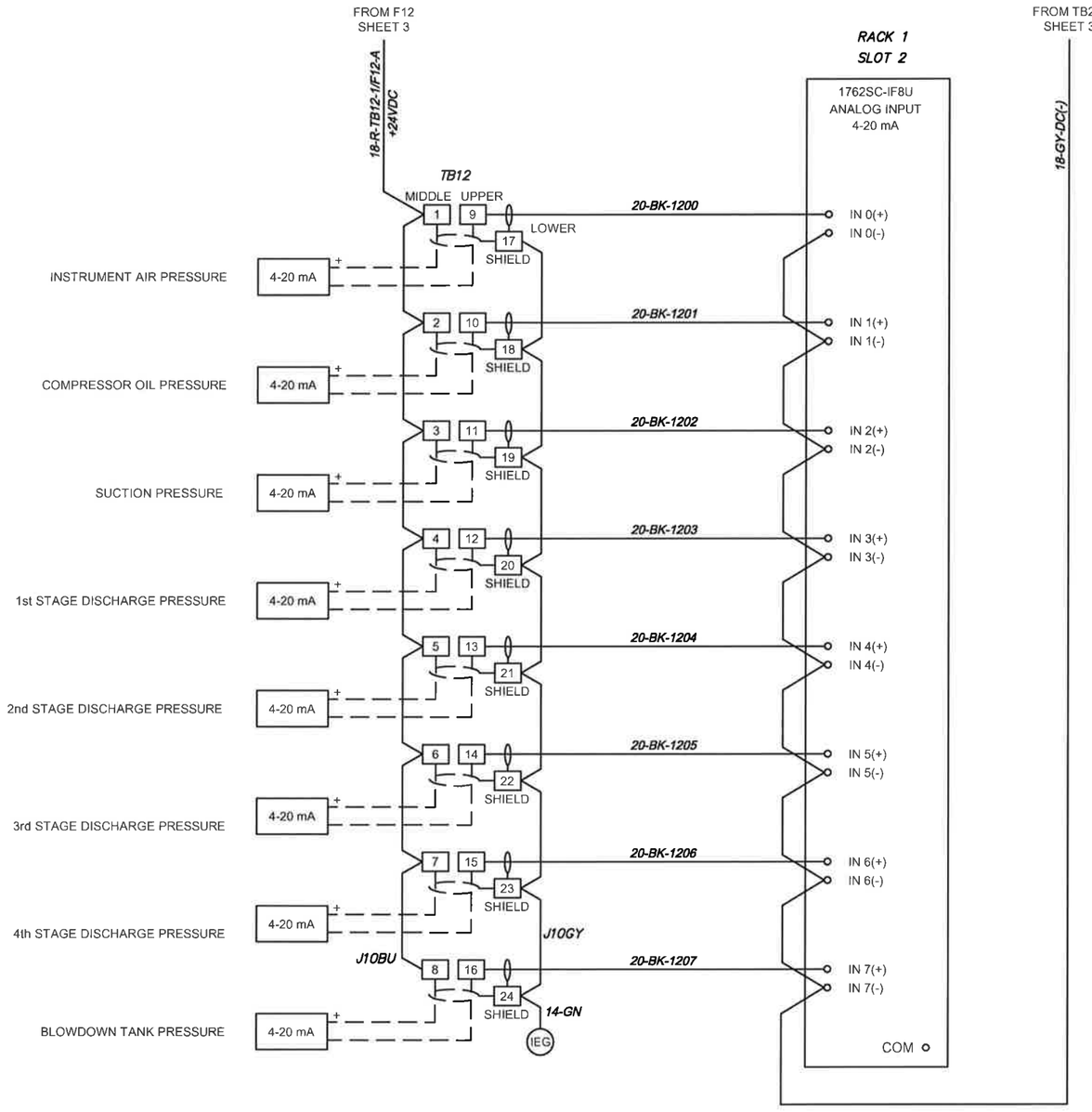
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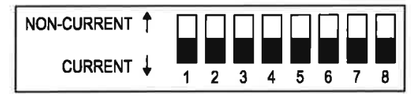
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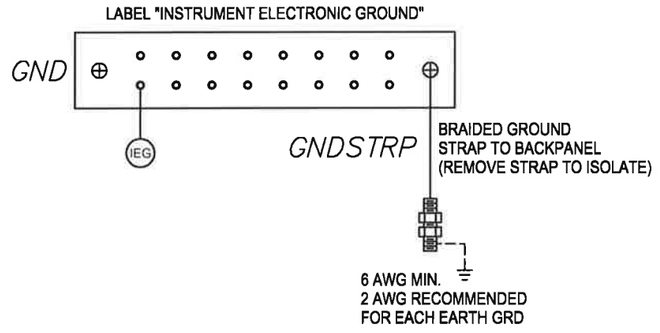
SHEET 7 OF 17

P/N 328-00820 | DWG. 335-29548 | REV. 1



DIP SWITCH SETTINGS





NOTE:
1. ALL SHIELDS TERMINATED SHOULD BE TIED TO GROUND BUS BAR PROVIDED.

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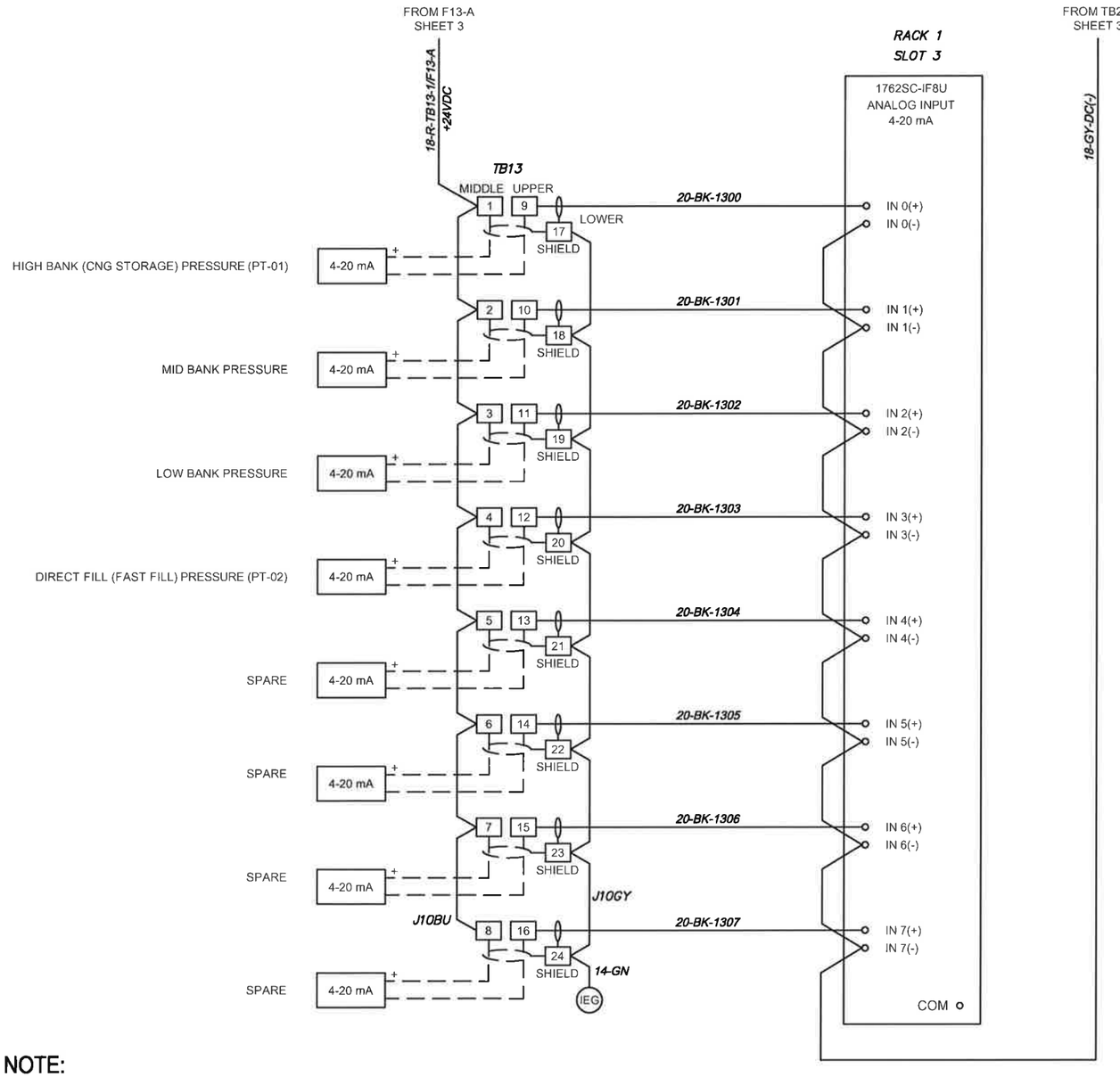
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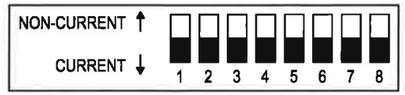
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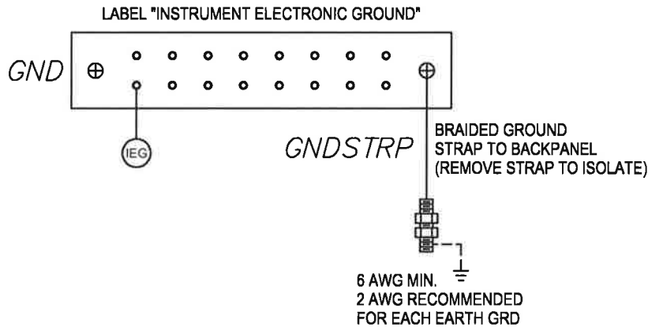
SHEET 8 OF 17

DRWN	CK'D	APP'D	DATE	SCALE	P/N	DWG.	REV.
JO	KD	BWF	6/15/17	NONE	328-00820	335-29548	1



DIP SWITCH SETTINGS





NOTE:
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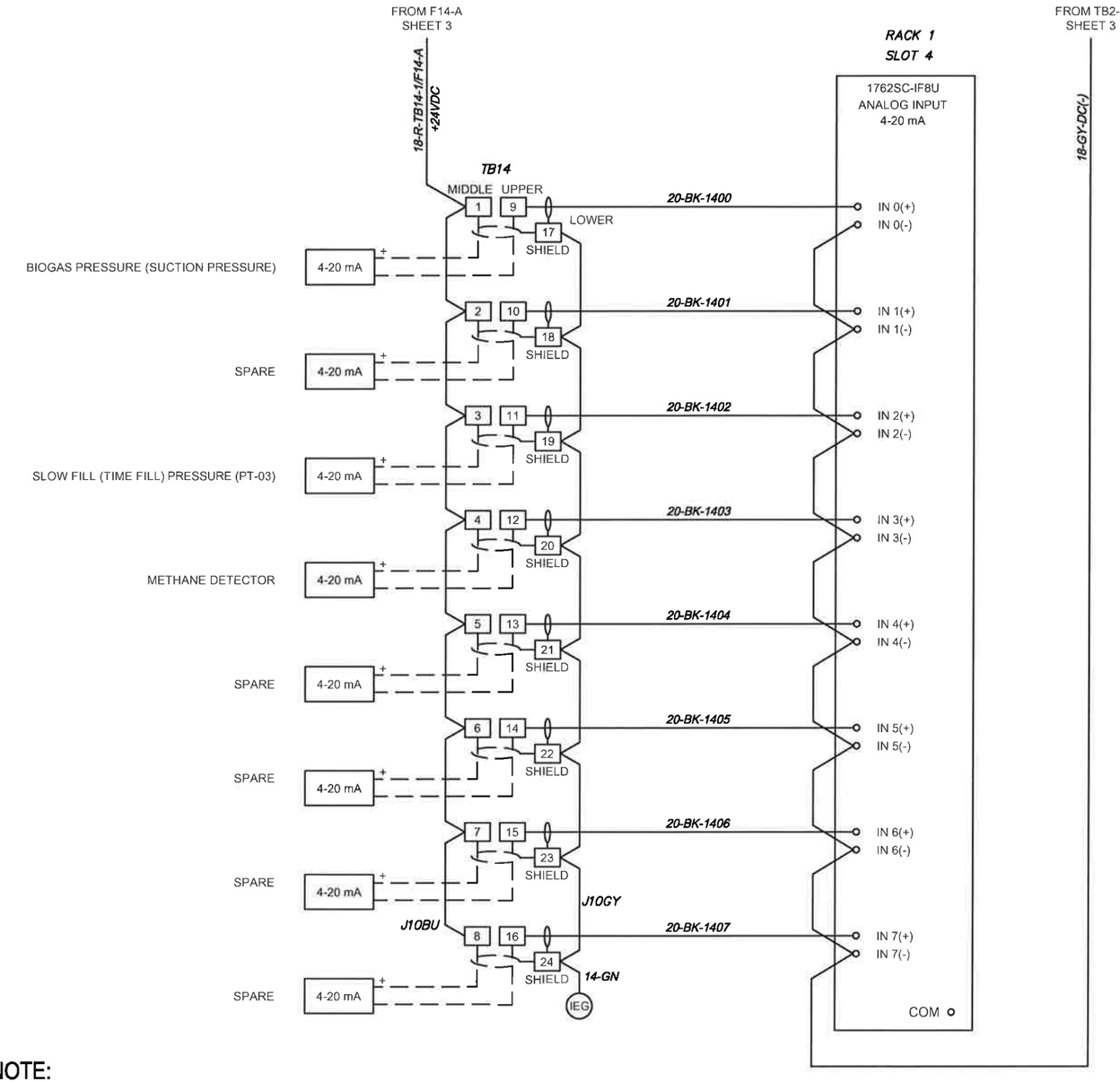
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1	UPDATE PER AS BUILT	WGJ	BWF	RAP	7/28/17
0	ISSUE FOR CONSTRUCTION	DM	KD	BWF	6/21/17

DRWN	CK'D	APP'D	DATE	SCALE	P/N	DWG.	REV.
JO	KD	BWF	6/15/17	NONE	328-00820	335-29548	1

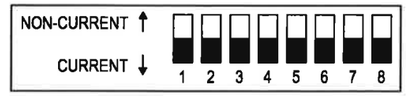
J-W POWER COMPANY
LONGVIEW, TEXAS, USA

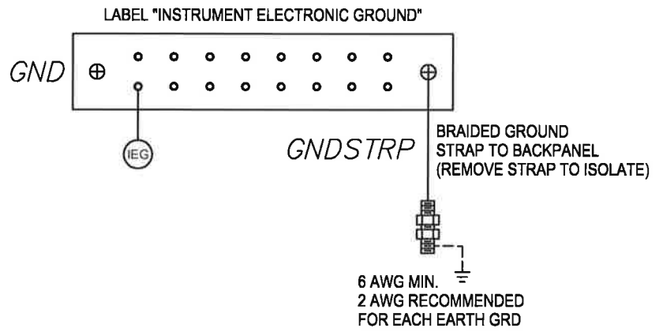
PANEL PLC UNIT CNG
UL NNNY F/120VSOL P-PNL

SHEET 9 OF 17



DIP SWITCH SETTINGS





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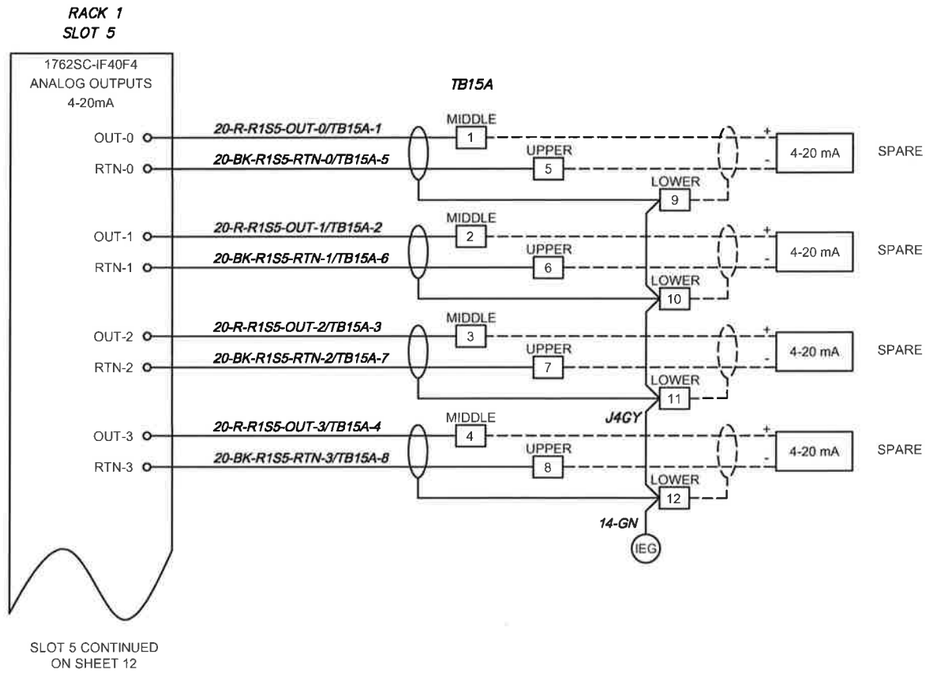
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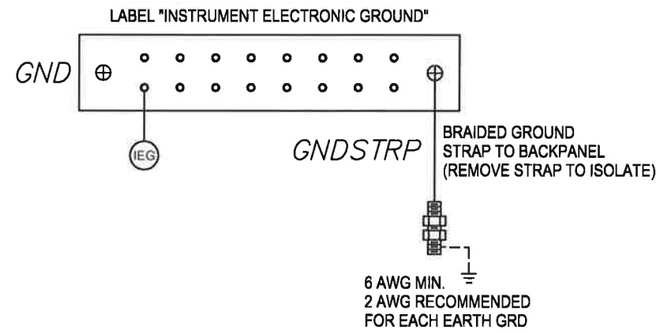
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1	UPDATE PER AS BUILT	WGJ	BWF	RAP	7/28/17
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LONGVIEW, TEXAS, USA

PANEL PLC UNIT CNG
UL NNNY F/120VSOL P-PNL

DRWN	CK'D	APP'D	DATE	SCALE	SHEET	P/N	DWG.	REV.
JO	KD	BWF	6/15/17	NONE	10 OF 17	328-00820	335-29548	1





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DRWN	CK'D	APP'D	DATE	SCALE
JO	KD	BWF	6/15/17	NONE

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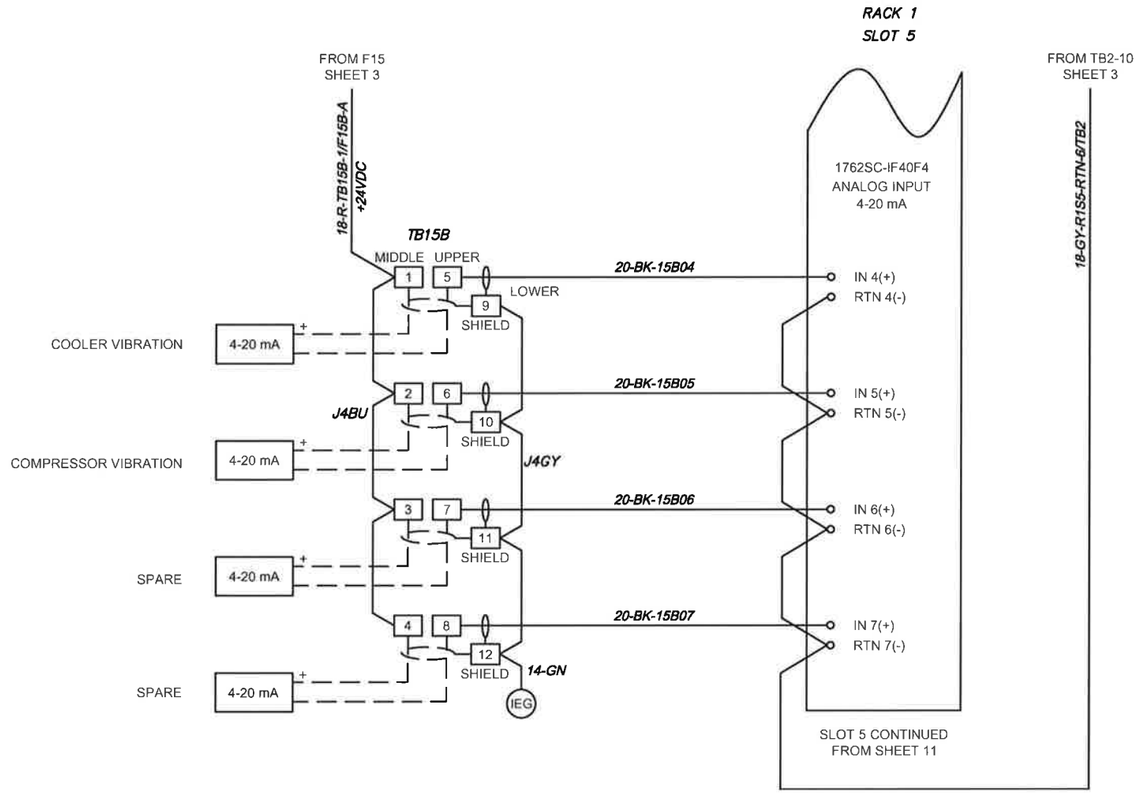
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LONGVIEW, TEXAS, USA

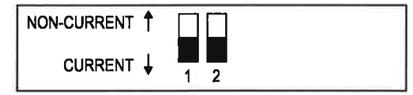
PANEL PLC UNIT CNG
UL NNNY F/120VSOL P-PNL

SHEET 11 OF 17

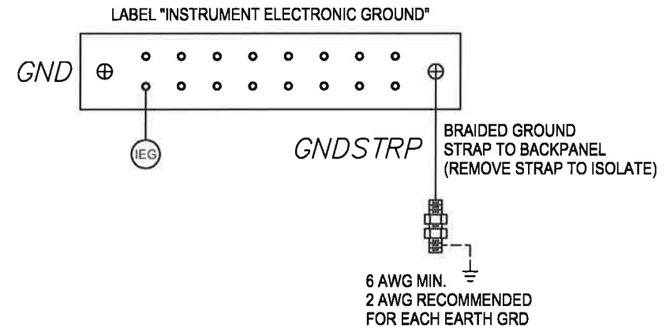
P/N 328-00820 | DWG. 335-29548 | REV. 1



DIP SWITCH SETTINGS



CHANNEL # 6 & 7



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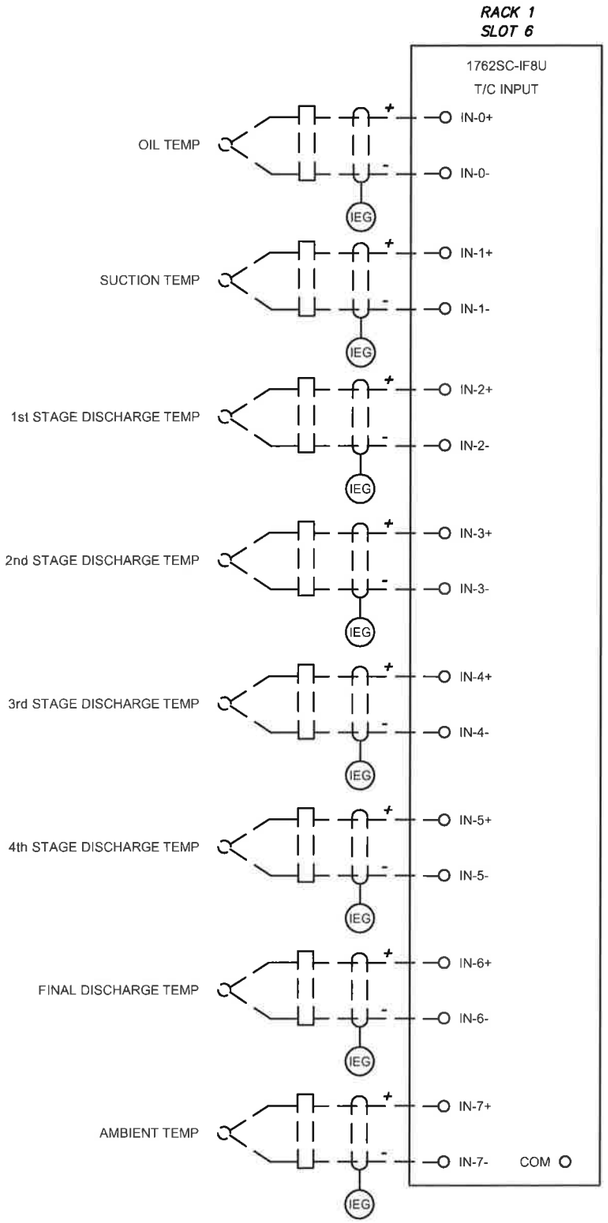
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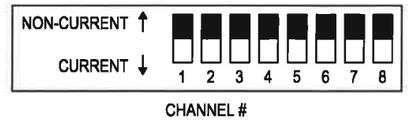
PANEL PLC UNIT CNG
UL NNNY F/120VSOL P-PNL

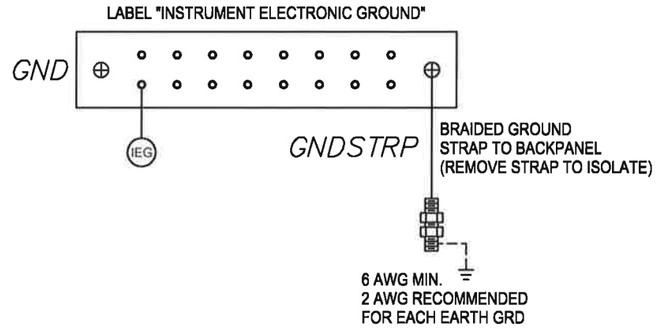
SHEET 12 OF 17

DRWN	CK'D	APP'D	DATE	SCALE	P/N	DWG.	REV.
JO	KD	BWF	6/15/17	NONE	328-00820	335-29548	1



DIP SWITCH SETTINGS





INSTALLATION NOTE:

ONLY TWISTED SHIELDED, EXTENSION GRADE THERMOCOUPLE WIRE SHOULD BE USED. THE SHIELD GROUND (DRAIN WIRE) SHOULD BE GROUNDED AT THE T/C SHIELD GROUND. NO DISSIMILAR METALS SHOULD BE USED TO MAKE SPLICES IN THIS WIRE. FOR TYPE J AND K THERMOCOUPLES (-) IS COLOR CODED RED. TYPE J (+) IS WHITE, AND TYPE K (+) IS YELLOW. FOR OTHER TYPES, CONSULT A REFERENCE BOOK. THERMOCOUPLE WIRE SHALL BE RUN IN A SEPARATE CONDUIT FROM ANY POWER WIRES.

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DRWN	JO	CK'D	KD	APP'D	BWF	DATE	6/15/17	SCALE	NONE

J-W POWER COMPANY
LONGVIEW, TEXAS, USA

PANEL PLC UNIT CNG
UL NNNY F/120VSOL P-PNL

SHEET 13 OF 17

P/N 328-00820 | DWG. 335-29548 | REV. 1

PANEL LEGEND

ITEM	SEQ. #	J-W PART #	QTY	MANUFACTURER	MFR. PART NO.	DESCRIPTION
ENCL	1	700-02287	1	RITTAL	WM363612NC	ENCLOSURE, 36 X 36 X 12 W/SUBPANEL
TAB	2	700-02288	1	RITTAL	SZ8018.791-WMSMB6	LIFT TAB
GND	3	700-02388	1	J-W	--	GROUND BAR, ISOLATED, 12-POSITION, #8-32
PLC	4	593-00482	1	ALLEN-BRADLEY	1766-L32BXB	CHASSIS ML1400 20 / 12 DC POWER
IQ8OW6	5	593-00625	1	ALLEN-BRADLEY	1762-IQ8OW6	MODULE DIGITAL INPUT/OUTPUT 8IN/6OUT
IF4OF4	6	593-00626	1	SPECTRUM CONTROLS	1762SC-IF4OF4	MODULE ANALOG INPUT/OUTPUT 4IN/4OUT
IF8U	7	593-00627	4	SPECTRUM CONTROLS	1762SC-IF8U	MODULE ANALOG INPUT 8PT UNIVERSALmA/mV/V/TC
ETH	8	700-02299	1	PHOENIX	2832771	ETHERNET SWITCH (8 PORT)
CA1	9	700-16062	1	A-TEL	AT1507EVBU	7 FT. ETHERNET PATCH CABLE, RJ45, CAT 5e
CA2	10	700-02291	1	A-TEL	AT1503EVBU	3 FT. ETHERNET PATCH CABLE, RJ45, CAT 5e
HMI	11	593-00485	1	RED LION	G306 A000	HMI / MMI INTERFACE W/ETHERNET COMMUNICATIONS
CF	12	712-00983	1	SANDISK	585-1234-ND	1GB CF FLASHCARD (INSTALL ON HMI)
PSU1	13	700-01584	1	PHOENIX	2938604	POWER SUPPLY, 85-264 VAC IN / 24 VDC, 10 AMP OUT
F1	14	700-02293	1	PHOENIX	3048386	FUSE HOLDER, 10.3-HESI
	15	700-02294	1	BUSSMAN	KTK-R-10	10 AMP FUSE (CLASS CC)
F7	68	700-00631	1	MERSEN	GAB-10	10 AMP FUSE (CERAMIC, SAND FILLED)
	17	700-00908	1	PHOENIX	3005507	FUSE HOLDER, UK10-DREHSI
F5-6,10A,10B, F11-15,101,201	16	700-13509	11	MERSEN	GAB-4	4 AMP FUSE (CERAMIC, SAND FILLED)
	17	700-00908	12	PHOENIX	3005507	FUSE HOLDER, UK10-DREHSI
	69	700-02764	1	MERSEN	GAB-6	6 AMP FUSE (CERAMIC, SAND FILLED)
CR1A,B,2-18	18	700-02215	19	IDEC	RV8H-L-D24-C1D2	SPDT RELAY, 24 VDC, 6 AMP
	63	700-02372	1.6	IDEC	SV9Z-PW10	RELAY MARKER, CUSTOM
CR101-109,201-204	19	700-02286	13	IDEC	RV8HL-AD110-C1D2	SPDT RELAY, 120 VAC, 6 AMP
	63	700-02372	1.6	IDEC	SV9Z-PW10	RELAY MARKER, CUSTOM
SW1	20	700-01916	1	C3CONTROLS	HSS02-SHWE-CBFSR	2 POSITION SWITCH W / 10 AMP CONTACTS
SW2	21	700-02295	1	C3CONTROLS	HSS03-SHWE-CBFSR/CBFSR	3 POSITION SWITCH W / 10 AMP CONTACTS
	64	700-01456	1	C3CONTROLS	SHWE	OPERATION HANDLE, 3 POSITION, WHITE
	65	700-02300	1	C3CONTROLS	CBFSR	1 N.O., 1 N.C. CONTACT BLOCK
ESP	22	700-01775	1	C3CONTROLS	HPTR-TMCRD-CBFS	EMERGENCY STOP PUSHBUTTON, TWIST MUSHROOM HD
	23	700-02200	1	C3CONTROLS	CBFS	1 N.O., 1 N.C. CONTACT BLOCK
PL1	24	700-01938	1	C3CONTROLS	PLLWE	WHITE LENS
			1	C3CONTROLS	HFVLU120	LAMP BASE W / 120 VAC BULB
PL2	25	700-01914	1	C3CONTROLS	PLLGN	GREEN LENS
			1	C3CONTROLS	HFVLU24	LAMP BASE W / 24 VDC BULB
PL3	26	700-01913	1	C3CONTROLS	PLLRD	RED LENS
			1	C3CONTROLS	HFVLU24	LAMP BASE W / 24 VDC BULB
PB1	27	700-00846	1	C3CONTROLS	HPBO/CBFS	PUSHBUTTON W/10 AMP CONTACTS
	23	700-02200	1	C3CONTROLS	CBFS	1 N.O., 1 N.C. CONTACT BLOCK
TB1,2,6	28	700-02205	18	PHOENIX	UT 4	SINGLE TERMINAL BLOCK
	29	700-02206	3	PHOENIX	D-UT 2,5/10	SINGLE TERMINAL BLOCK END PLATE
TB3,5,10A, 10B,11A,11B,TB8	30	700-02289	72	PHOENIX	UTTB 2,5	DOUBLE TERMINAL BLOCK
	31	700-02290	7	PHOENIX	D-UTTB 2,5/4	DOUBLE TERMINAL BLOCK END PLATE
TB7	32	700-02312	17	PHOENIX	UTTB 2,5-DIO/U-O	DOUBLE TERMINAL BLOCK **WITH INTERNAL DIODE**
	31	700-02290	1	PHOENIX	D-UTTB 2,5/4	DOUBLE TERMINAL BLOCK END PLATE
TB12,13,14, 15A,15B	33	700-02207	32	PHOENIX	UT 2,5-3L	TRIPLE TERMINAL BLOCK
	34	700-02208	5	PHOENIX	D-UT 2,5-3L	TRIPLE TERMINAL BLOCK END PLATE
N101-N115	35	700-01291	16	PHOENIX	KLM-A - 1004348	TERMINAL BLOCK GROUP MARKER HOLDER
	36	700-02237	16	PHOENIX	UCT--TM5-0828734	TERMINAL BLOCK GROUP MARKER
TBENDCLP	37	700-01246	34	PHOENIX	E/NS 35 N - 0800886	TERMINAL BLOCK END CLAMP
J2BU	38	700-02351	2	PHOENIX	FBS 2-6 BU 3036932	PLUG IN BRIDGE (2) BLUE
J2GY	39	700-02316	2	PHOENIX	FBS 2-6 GY 3032237	PLUG IN BRIDGE (2) GREY
J10GY	40	700-02224	1	PHOENIX	FBS 10-6 GY 3032253	PLUG IN BRIDGE (10) GREY
J4BU	41	700-02352	1	PHOENIX	FBS 4-5 BU 3036893	PLUG IN BRIDGE (4) BLUE
J4GY	42	700-02353	2	PHOENIX	FBS 4-5 GY 3038985	PLUG IN BRIDGE (4) GREY
J10R	43	700-02209	2	PHOENIX	FBS 10-5 3030213	PLUG IN BRIDGE (10) RED
J10BU	44	700-02354	4	PHOENIX	FBS 10-5 BU 3036916	PLUG IN BRIDGE (10) BLUE
J10GY	45	700-02225	5	PHOENIX	FBS 10-5 GY 3039007	PLUG IN BRIDGE (10) GREY
J20BU	46	700-02355	1	PHOENIX	FBS 20-5 BU 3036929	PLUG IN BRIDGE (20) BLUE
J20GY	47	700-02356	2	PHOENIX	FBS 20-5 GY 3038671	PLUG IN BRIDGE (20) GREY

PANEL LEGEND

ITEM	SEQ. #	J-W PART #	QTY	MANUFACTURER	MFR. PART NO.	DESCRIPTION
RJ20GY	48	700-02217	2	IDEC	SV9Z-J20 W	RELAY JUMPER 20PT GREY
RJ20BU	49	700-02218	2	IDEC	SV9Z-J20 S	RELAY JUMPER 20PT BLUE
CD25X40	50	700-02357	2	PHOENIX	CD 25x40 3240188	CABLE DUCT GREY 25W40H
CD25X60	51	700-02358	2	PHOENIX	CD 25x60 3240191	CABLE DUCT GREY 25W60H
CD25X80	52	700-02359	2	PHOENIX	CD 25x80 3240197	CABLE DUCT GREY 25W80H
CD40X80	53	700-02360	2	PHOENIX	CD 40x80 3240198	CABLE DUCT GREY 40W80H
LBLC1D2	54	727-00420	1	J-W		LABEL C1D2 UL LISTED ENCLOSED INDUSTRIAL CTRL PANEL
LBLPD	55	727-00421	7	J-W		LABEL PANEL DOOR UL PL/PB/SW/ESP
LBLEXP	56	727-00422	1	J-W		LABEL PANEL UL "DANGER: EXPLOSION HAZARD"
LBLFUSE	57	727-00426	1	J-W		LABEL PANEL FUSE REPLACEMENT 4"
COND1	58	700-00007	1	PANDUIT	CTL25F-C20	WIRE LOOM, .250 ID ELECTRICAL WIRE PROTECTOR, 120VAC
COND2	59	700-00268	1	PANDUIT	CLT75F-C20	WIRE LOOM, .750 ID ELECTRICAL WIRE PROTECTOR, 24VDC
WIRE HOLDER	60	700-11680	6	ELLIOTT	TC344A	TYRAP HOLDER, 3/4"
	61	700-11682	6	ELLIOTT	TC342A	TYRAP HOLDER, 1"
DINRAIL	62	700-01258	2	PHOENIX	1201730	DINRAIL MOUNTING 35mm X 6.5'
GNDSTRP	66	700-02408	1	ERICO	BJ6-150S	GROUND STRAP, .26" HOLES, 5.91" C-C
STANDOFF	67	736-01735	1	ELLIOTT	BSB25	DINRAIL MOUNTING BRACKET

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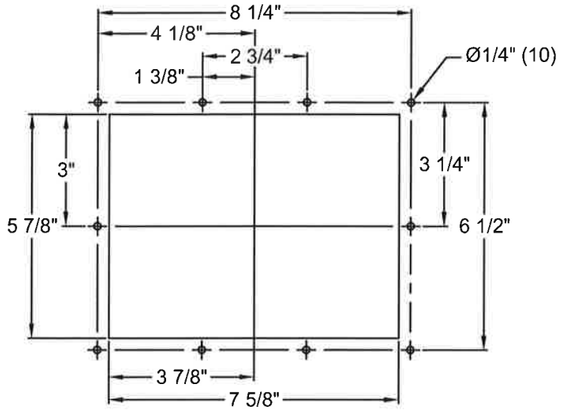
PANEL PLC UNIT CNG
UL NNNY F/120VSOL P-PNL

SHEET 14 OF 17

DRWN	CK'D	APP'D	DATE	SCALE	P/N	DWG.	REV.
JO	KD	BWF	6/15/17	NONE	328-00820	335-29548	1

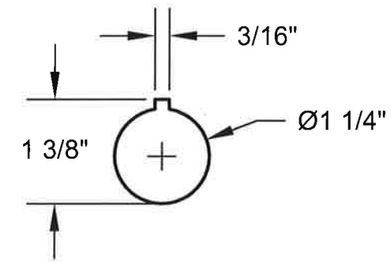


TOP VIEW



HMI CUTOUT DETAIL

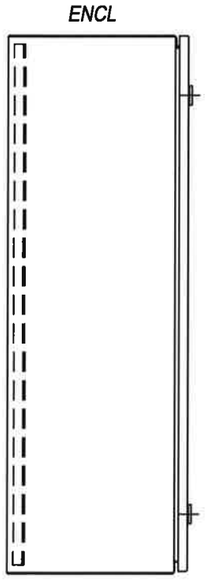
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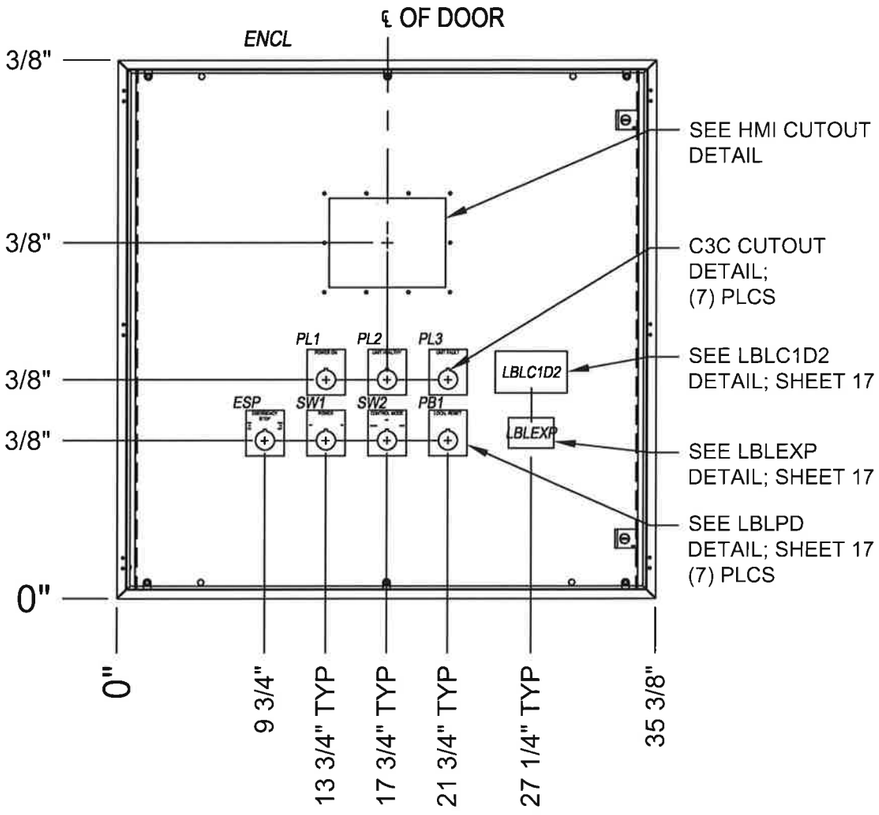
C3C CUTOUT DETAIL

SCALE: 1:2

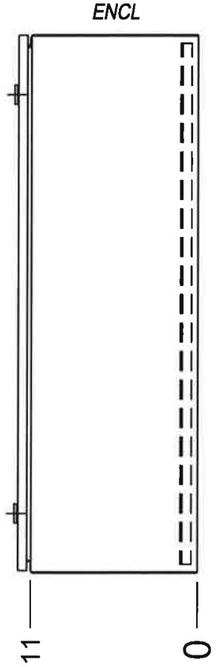
TYP (7) PLCS



LEFT VIEW



FRONT VIEW



RIGHT VIEW

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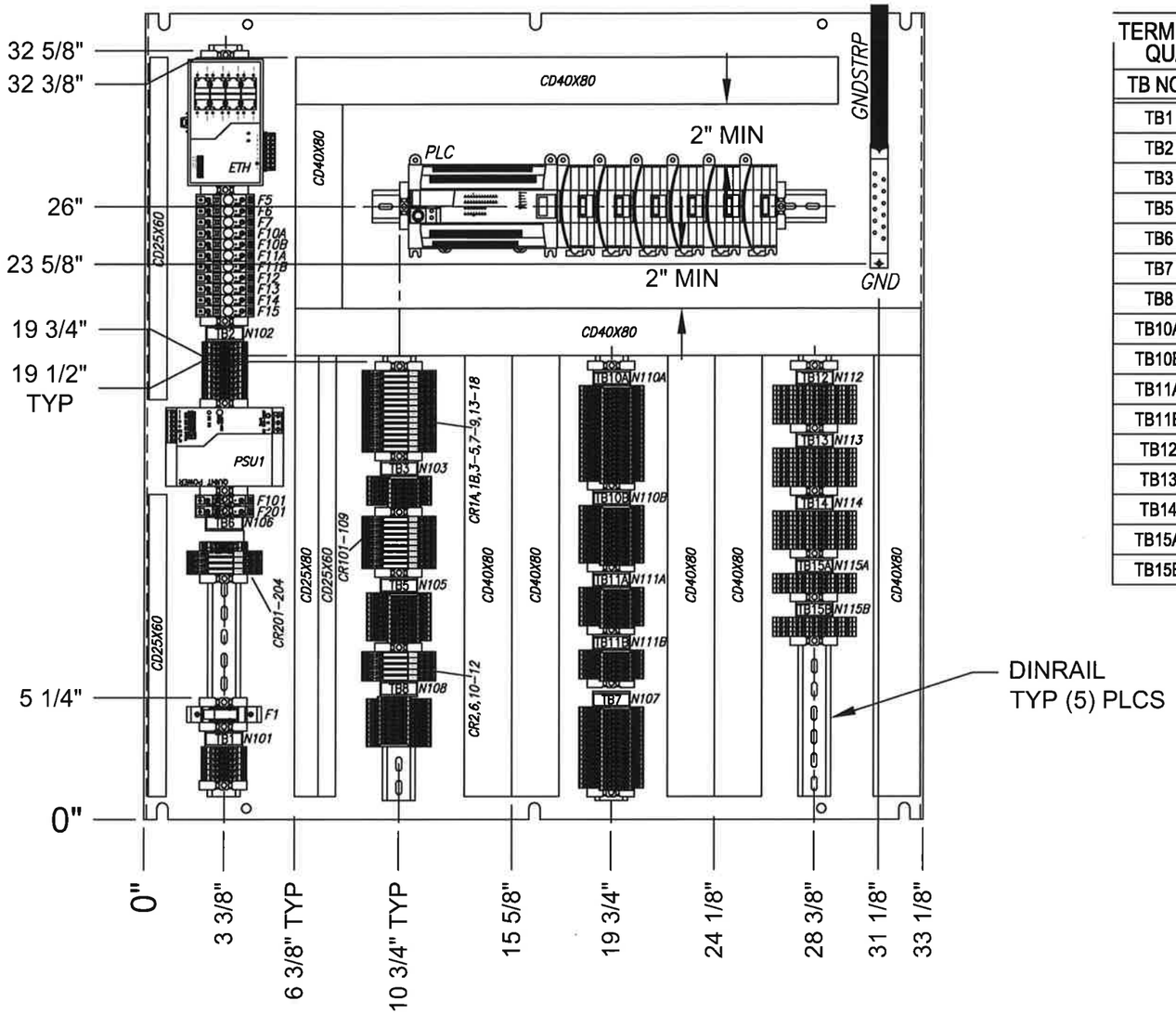
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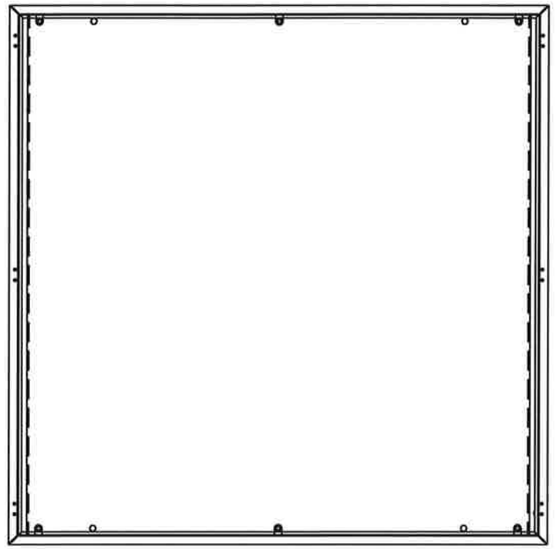
SHEET 15 OF 17

DRWN	CK'D	APP'D	DATE	SCALE	P/N	DWG.	REV.
JO	KD	BWF	6/15/17	NONE	328-00820	335-29548	1



BACKPLATE LAYOUT DETAIL

TERMINAL BLOCK QUANTITIES	
TB NO.	QTY
TB1	6
TB2	10
TB3	6
TB5	10
TB6	2
TB7	17
TB8	10
TB10A	20
TB10B	12
TB11A	8
TB11B	6
TB12	8
TB13	8
TB14	8
TB15A	4
TB15B	4



BACK VIEW



BOTTOM VIEW

SCALE: 1:10

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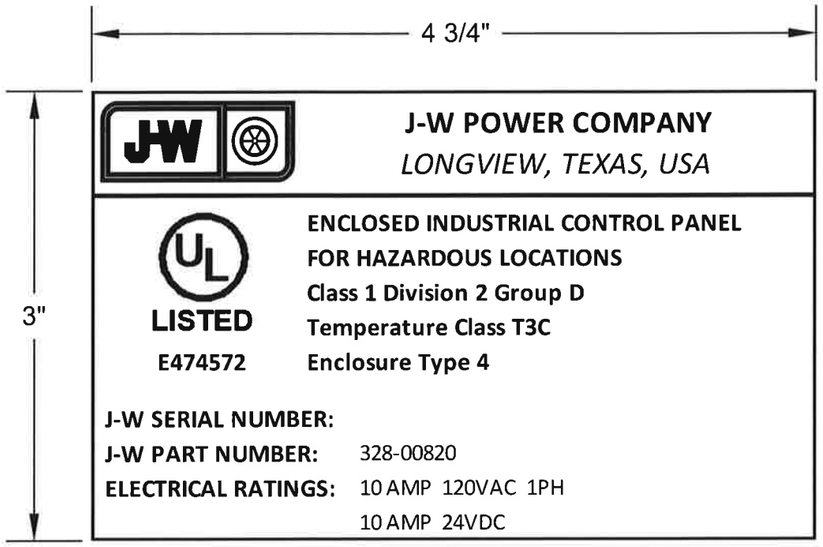
NO.	REVISION	BY	CK'D	APP'D	DATE
1	UPDATE PER AS BUILT	WGJ	BWF	RAP	7/28/17
0	ISSUE FOR CONSTRUCTION	DM	KD	BWF	6/21/17

J-W POWER COMPANY
LONGVIEW, TEXAS, USA

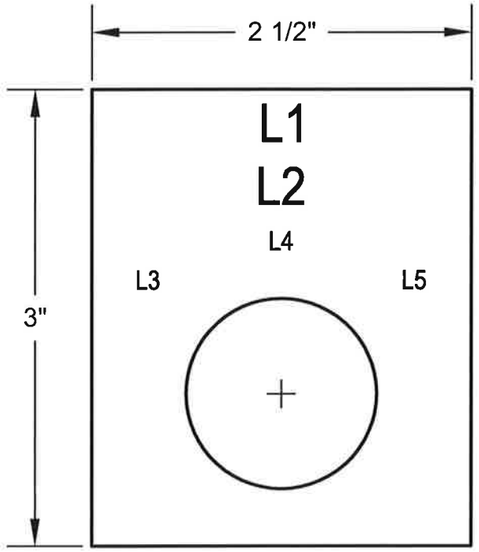
PANEL PLC UNIT CNG
UL NNNY F/120VSOL P-PNL

SHEET 16 OF 17

DRWN	CK'D	APP'D	DATE	SCALE	P/N	DWG.	REV.
JO	KD	BWF	6/15/17	NONE	328-00820	335-29548	1



"LBLC1D2" DETAIL

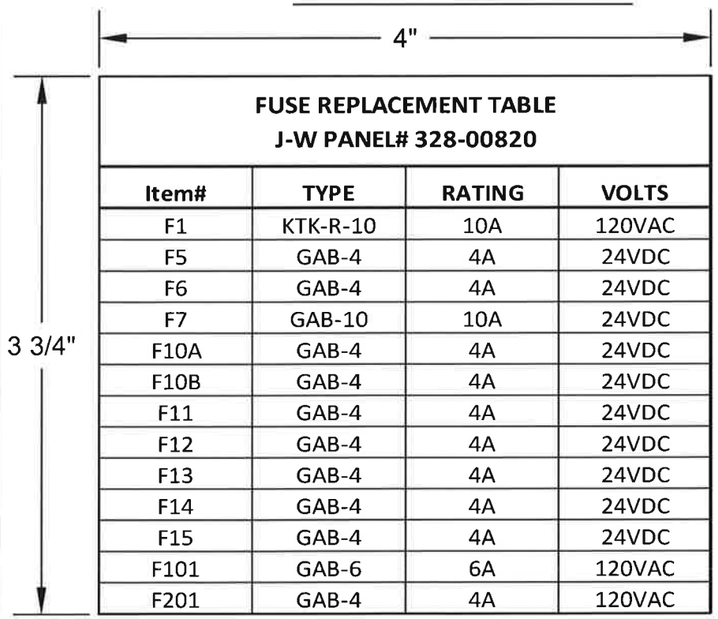


"LBLPD" DETAIL

REPLACE "L1-L5" TEXT WITH
TEXT FROM PANEL LABEL TABLE
TYP (7) PLCS

PANEL LABEL TABLE

TAG	TAG/LTRS	L1	L2	L3	L4	L5
PL1	WHITE/BLACK	POWER ON				
PL2	WHITE/BLACK	UNIT HEALTHY				
PL3	WHITE/BLACK	UNIT FAULT				
SW1	WHITE/BLACK	POWER		OFF		ON
SW2	WHITE/BLACK	CONTROL MODE		MANUAL	OFF	AUTO
PB1	WHITE/BLACK	LOCAL RESET				
ESP	RED/WHITE	EMERGENCY	STOP	PULL TO RUN		PUSH TO STOP
N101	WHITE/BLACK	TB1				
N102	WHITE/BLACK	TB2				
N103	WHITE/BLACK	TB3				
N105	WHITE/BLACK	TB5				
N106	WHITE/BLACK	TB6				
N107	WHITE/BLACK	TB7				
N108	WHITE/BLACK	TB8				
N110A	WHITE/BLACK	TB10A				
N110B	WHITE/BLACK	TB10B				
N111A	WHITE/BLACK	TB11A				
N111B	WHITE/BLACK	TB11B				
N112	WHITE/BLACK	TB12				
N113	WHITE/BLACK	TB13				
N114	WHITE/BLACK	TB14				
N115A	WHITE/BLACK	TB15A				
N115B	WHITE/BLACK	TB15B				



FUSE REPLACEMENT TABLE
J-W PANEL# 328-00820

Item#	TYPE	RATING	VOLTS
F1	KTK-R-10	10A	120VAC
F5	GAB-4	4A	24VDC
F6	GAB-4	4A	24VDC
F7	GAB-10	10A	24VDC
F10A	GAB-4	4A	24VDC
F10B	GAB-4	4A	24VDC
F11	GAB-4	4A	24VDC
F12	GAB-4	4A	24VDC
F13	GAB-4	4A	24VDC
F14	GAB-4	4A	24VDC
F15	GAB-4	4A	24VDC
F101	GAB-6	6A	120VAC
F201	GAB-4	4A	120VAC

"LBLFUSE" DETAIL

TOLERANCE NOTE

UNLESS OTHERWISE NOTED:

1) FRACTIONS	± 1/8"
2) ANGLES	± 1/2°
3) .X	± .1"
4) .XX	± .03"

J-W POWER COMPANY
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UNIT 7351 CLEAN ENERGY

8/24/2017 bfontenot

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DRWN	CK'D	APP'D	DATE	SCALE	P/N	DWG.	REV.
JO	KD	BWF	6/15/17	NONE	328-00820	335-29548	1

J-W POWER COMPANY
LONGVIEW, TEXAS, USA

PANEL PLC UNIT CNG
UL NNNY F/120VSOL P-PNL

SHEET 17 OF 17

328-00820 -- PANEL PLC UNIT CNGUL NNNY F/120VSOL P-PNL*

Seq Nbr	Component	Description			Qty Per	UM
0	328-00753	PANEL PLC UNIT CNG		UL NNNY	0.00	EA
0	335-29548	PANEL PLC UNIT CNG			1.00	B
0	700-01246	TERM END BRKT E/NS 35 N		PHOENIX #0800886	4.00	EA
0	700-02020	SNUBBER RC SURGE	UL	SUPPRES REDLION SNUB0000	6.00	EA
17	700-00908	HOLDER FUSE UK10-DREHSI		PHOENIX 3005507	1.00	EA
30	700-02289	TERM BLOCK 20A	UL	26-12AWG UTTB2 5-3044636	10.00	EA
31	700-02290	TERM BLOCK END PLATE	UL	PHX D-UTTB 2 5/4-3047293	1.00	EA
35	700-01291	STRIP TERM MARKER	UL	PHOENIX KLM-A #1004348	1.00	EA
36	700-02237	MARKERS TB # STRIP	UL	PHOENIX UCT-TM5-0828734	1.00	EA
45	700-02225	BRDG TERMINAL 10 POS		PHNX FBS10-5 GY 3039007	1.00	EA
69	700-02764	FUSE 6 AMP MERSEN		GAB-6	1.00	EA

J-W Power Company
A Subsidiary of J-W Energy Company
P.O. Box 12340, Longview, TX 75607
(903)-643-3413

CNG UNIT/PRIORITY PANEL CONTROLLER

J-W POWER COMPANY

Operation Sequence
REV. A

PANEL: #328-00820
DRAWING: #335-29548

UNIT 7351

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1 TYPE OF SYSTEM

The control system is comprised of an Allen-Bradley MicroLogix 1400 controller communicating via Ethernet with a locally mounted Red Lion 5.7" color touchscreen. Throughout this sequence, the controller is referred to as **PLC** and the touchscreen referred to as **HMI/MMI**. The panel is powered by customer supplied 120VAC 50/60Hz 20A Single Phase. An AC to DC power supply will provide the 24VDC needed to power the PLC and HMI/MMI. All user configurable setpoints are password protected and can be entered into the PLC via the local HMI/MMI. The PLC will perform the following functions: **1**) system configuration including transmitter ranges, lube pump logic, UCP/SCP designation, etc. **2**) monitoring all process variables including level, vibration, pressure and temperature, etc. and **3**) the reporting and logging of all alarms and shutdowns associated with the user configured trip setpoints.

2 GENERAL MOTOR CONTROLS

The Lube Pump, Cooler Fan and Main Motors have running feedback inputs (AUX contacts on the respective motor controller). If a motor is commanded to run, the respective motor run fail timer will be started. If the respective motor running input is not closed before the timer expires, the unit will be shutdown on the respective motor run failure.

3 SITE / UNIT CONTROLLER CONFIGURATION

3.1 The control system has the capability to be assigned and wired on site as either a site controller or unit controller, hereafter referred to as SCP for site controller and UCP for unit controller. The assignment of SCP or UCP is configurable via the HMI/MMI.

3.2 When the control system is assigned as an SCP, the PLC will perform both the function of a site controller (controlling the priority valves, and all UCP's) and a unit controller (controlling the compressor package).

3.3 When the control system is assigned as a UCP, the PLC will perform the function of a unit controller only (controlling the compressor package).

3.4 Regardless of site configuration, when the site ESD loop is faulted, all compressor packages will immediately experience an ESD type shutdown, all digital relay outputs will be **De-Energized** and electrically isolated from the 24VDC power supply, and the dispensers will be electrically isolated from the 120VAC power supply.

4 SITE CONTROLLER DETECTION

4.1 When the control system is assigned as an SCP via the HMI/MMI, upon power up and the PLC achieving a **'RUN'** state, the PLC will poll the Ethernet network for presence of additional compressor packages at the following IP addresses.

- Unit #1 ..... IP Address: 10.10.0.1 ..... Subnet Mask: 255.255.255.0
- Unit #2 ..... IP Address: 10.10.0.3 ..... Subnet Mask: 255.255.255.0
- Unit #3 ..... IP Address: 10.10.0.5 ..... Subnet Mask: 255.255.255.0
- Unit #4 ..... IP Address: 10.10.0.7 ..... Subnet Mask: 255.255.255.0

4.2 When additional compressor package PLCs are found at the IP Addresses listed above, the control system will determine which if any of the compressor packages are assigned as an SCP or UCP.

4.3 If no additional compressor package is detected as being assigned SCP status, the control system will assume the role of **'PRIMARY SCP'** (site controller).

4.4 If an additional compressor package is detected as already having achieved **'PRIMARY SCP'** status, the control system will automatically assume the role of redundant **'SECONDARY SCP'**. Redundancy is assumed only upon the detection of another control package already achieving **'PRIMARY SCP'** status.

4.5 When redundancy is detected, the current operating status of the **PRIMARY SCP** will be continuously written to the **SECONDARY SCP**, to allow the **SECONDARY SCP** to assume the role of site controller upon the loss of the **PRIMARY SCP**.

5 UNIT CONTROL MODE (COMRESSOR PACKAGE)

5.1 The compressor package control mode is selected via the local **CONTROL MODE** selector switch. The selector switch has 3 positions: 1) **MANUAL**, 2) **OFF** and 3) **AUTO**.

5.2 **Manual Mode** – The compressor is started manually via the **'START'** HMI/MMI touchbutton.

5.3 **Off Mode** – The compressor start is locked out. Additionally, if the selector switch is placed in **'OFF'** position while the unit is running, a '**Unit Normal Stop**' is initiated. Once the '**Unit Normal Stop**' is complete, the compressor start is locked out.

5.4 **Auto Mode** – The compressor is started automatically via the SCP logic.

6 POWER ON

When the Power ON/OFF switch is turned to the **'ON'** position, the PLC and HMI/MI will power up. Once the PLC achieves the **'RUN'** state, a fixed 10 second PLC Power On Delay timer will begin counting down. This timer prohibits the logic solving of all alarms and shutdowns until the HMI/MMI has fully started and the control system configuration has been determined as explained in Section 4.0 and 5.0. The outputs will remain at their system default values as specified below:

- Unit Healthy - Remote Indication ..... **De-Energized**
- Lube Pump Motor Starter..... **De-Energized**
- Cooler Fan Motor Starter ..... **De-Energized**
- Main Motor Starter ..... **De-Energized**
- Suction Block Valve ..... **De-Energized (Closed)**
- Auxiliary Suction Valve ..... **De-Energized (Closed)**
- Filter Drain/Load Valve ..... **De-Energized (Open)**
- Slow Fill (**Time Fill**) Valve..... **De-Energized (Closed)**
- **Fast Fill Valve** ..... **De-Energized (Closed)**
- High Bank (**CNG Storage**) Valve..... **De-Energized (Closed)**
- Mid Bank Valve ..... **De-Energized (Closed)**
- Low Bank Valve ..... **De-Energized (Closed)**

7 UNIT READY TO START

When the fixed 10 second PLC Power On Delay timer expires, the PLC will scan all inputs and the HMI/MMI will display any alarms or shutdowns that may exist. After the operator has corrected all shutdown conditions and pressed the **"LOCAL RESET"** pushbutton, the PLC will initiate the current control mode of operation. If the compressor package is not commanded to run, the HMI/MMI will display **"UNIT READY TO START"** and the outputs will be driven to the following states:

- Unit Healthy - Remote Indication ..... **Energized**
- Lube Pump Motor Starter..... **De-Energized**
- Cooler Fan Motor Starter ..... **De-Energized**
- Main Motor Starter ..... **De-Energized**
- Suction Block Valve ..... **De-Energized (Closed)**
- Auxiliary Suction Valve ..... **De-Energized (Closed)**
- Filter Drain/Load Valve ..... **De-Energized (Open)**
- Slow Fill (**Time Fill**) Valve..... **Based on SCP Status**
- **Fast Fill Valve** ..... **De-Energized (Closed)**
- High Bank (**CNG Storage**) Valve..... **Based on SCP Status**
- Mid Bank Valve ..... **Based on SCP Status**
- Low Bank Valve ..... **Based on SCP Status**

8 PLC I/O FORCING

8.1 When the PLC auto sequence is in either the **'Unit Ready to Start'** or **'Unit Shutdown'** states, the operator has the ability to manually force on or off all digital outputs.

8.2 When the **'MANUAL OVERRIDE'** HMI/MMI touchbutton is selected via the UNIT PROCESS MENU screen, the operator will be prompted to either continue to the MANUAL OVERRIDE #1 screen or

close and return to the previous screen. Once the operator has pressed the **'CONTINUE'** HMI/MMI touchbutton, if I/O forcing is allowed, the operator will then be required to press the **'PRESS AND HOLD TO ACTIVATE PLC IO FORCING'** HMI/MMI touchbutton to activate PLC I/O forcing.

8.3 While I/O Forcing is activated, the operator can manually pre-select the desired force state of the digital outputs on (green) or off (red) via an individual Manual Override HMI/MMI touchbutton for each channel of the digital output card. The touchbuttons are always reset to the default OFF state when I/O Forcing is not activated (i.e. the panel is powered on, or the unit has been started).

8.4 While I/O Forcing has been activated but not yet enabled, the PLC auto sequence controls the state of the digital outputs. Once I/O Forcing has been enabled, the current state of each individual Manual Override HMI/MMI touchbutton will control its respective digital output.

8.5 To enable I/O Forcing, the operator must press the **'ENABLE ALL IO FORCES'** HMI/MMI touchbutton. Once I/O Forcing is enabled, the operator has 5 minutes (300 seconds), to manually force the digital outputs before I/O Forcing is automatically disabled. If more time is required, pressing the **'RESET FORCE TIMER'** HMI/MMI touchbutton will reset this timer.

8.6 While I/O Forcing is enabled, the HMI/MMI will display **"PLC I/O FORCING ENABLED"**.

8.7 PLC I/O Forcing may be disabled at any time when the **DISABLE I/O FORCING** HMI/MMI touchbutton is pressed. Once PLC I/O Forcing is disabled, all digital outputs will be controlled via the PLC auto sequence.

9 LEAD / LAG ASSIGNMENT

9.1 It is assumed no more than 4 compressor packages will comprise a CNG system. It is further assumed no more than 3 compressor packages will run loaded at the same time. When more than one compressor package is detected, the site controller will assign a LEAD / LAG designation to all compressor packages based on their current UNIT RUN HOURS and availability at that moment in time as specified in the table below.

# Compressor Packages Detected	1	2	3	4
Lowest UNIT RUN HOURS	LEAD UNIT	LEAD UNIT	LEAD UNIT	LEAD UNIT
2nd Lowest UNIT RUN HOURS		LAG UNIT #1	LAG UNIT #1	LAG UNIT #1
3rd Lowest UNIT RUN HOURS			LAG UNIT #2	LAG UNIT #2
Highest UNIT RUN HOURS				UNASSIGNED

9.2 The Lead UCP will Start when one of the following conditions are met:

- Slow Fill (Time Fill) Enable ..... **Enabled**
- Site Controller Standard Mode..... **Enabled**

9.3 The Lag #1 UCP Delay Timer will begin timing once the following conditions are met:

- Site Controller Standard Mode..... **Enabled**
- Start Lead UCP ..... **Enabled**
- High Bank Pressure < High Bank Start Pressure minus Lag #1 Deadband Start setpoint **OR** Number of Dispensers in Use $\geq$ Number of Dispensers Start Lag #1 setpoint.

9.4 Once the Start Lag #1 Delay Timer has expired, Lag #1 UCP will Start.

9.5 The Lag #2 UCP Delay Timer will begin timing once the following conditions are met:

- Site Controller Standard Mode..... **Enabled**
- Start Lead UCP ..... **Enabled**
- Start Lag #1 UCP ..... **Enabled**
- High Bank Pressure < High Bank Start Pressure minus Lag #2 Deadband Start setpoint **OR** Number of Dispensers in Use $\geq$ Number of Dispensers Start Lag #2 setpoint.

9.6 Once the Start Lag #2 Delay Timer has expired, Lag #2 UCP will Start.

9.7 Once started, the Lead, Lag #1 and Lag #2 UCPs will remain Enabled until all banks have reached the Temperature Compensated Fill Set Pressure.

10 START SEQUENCE

10.1 When the compressor is in **Auto Mode** and in the **'Unit Ready to Start'** state, a unit start will be initiated once the site controller issues a run command.

10.2 When the compressor is in **Manual Mode** and in the **'Unit Ready to Start'** state, a unit start will be initiated once the HMI/MMI **'START"** touchbutton is pressed.

11 COMPRESSOR PRELUBE

11.1 Once a unit start has been initiated, the Lube Pump Motor Starter output will be **Energized** to start the Lube Pump Motor.

11.2 The Suction Valve Actuator output will be **Energized** to open the valve.

11.3 The Compressor Oil Pressure, Compressor Oil Temperature, and Instrument Air Pressure will be monitored and compared to their respective start permissive setpoints.

11.4 While the start permissives are not met, the Compressor Prelube Permissive Fail Timer will begin counting down, and the HMI/MMI will display **"COMP OIL PRESS/TEMP/INSTR AIR PRESS < PERMISSIVES "**.

11.5 If the Compressor Oil Pressure, Compressor Oil Temperature, and Instrument Air Pressure remain less than their respective start permissive setpoints and the Prelube Fail Timer expires, the unit will shut down on **"COMP PRELUBE OR START PERMISSIVES FAILURE"**.

11.6 Once the Compressor Oil Pressure, Compressor Oil Temperature, & Instrument Air Pressure exceed their respective start permissive setpoints, the Compressor Prelube Duration timer will begin counting down, and the HMI/MMI will display **"COMPRESSOR PRELUBE DURATION TIMING"**.

11.7 While the Compressor Prelube Duration Timing state has been achieved, the Compressor Oil Pressure, Compressor Oil Temperature, and Instrument Air Pressure must remain above their respective start permissive setpoints or the unit will shut down on **"COMP PRELUBE OR START PERMISSIVES FAILURE"**.

11.8 Once the Compressor Prelube Duration Timer has expired, the Main Motor Starter output will be **Energized** to start the Main Motor.

11.9 Once the Compressor Prelube Duration Timer has expired, the Cooler Fan output will be **Energized** to start the Cooler Fan under the following conditions:

- The Ambient Temperature exceeds 90°F.
- Any of the 1st thru 4th Stage Discharge Temperatures exceeds 200°F.
- The Final Discharge Temperature exceeds the **Aftercooler Dis Temp** setpoint.

11.10 Once the Main Motor is confirmed running via the Main Motor Running digital input, the Class B1 and B2 Shutdown Delay, and Lube Pump Off Delay timers will begin counting down. Once the Lube Pump Off Delay timer expires, the Lube Pump Motor Starter output will be **De-Energized** to stop the pump.

11.11 When the Class B1 and B2 Shutdown Delay timers expire, all Class B1 and B2 Alarm and Shutdown Faults will become **Enabled.**

11.12 The Lubricator No-Flow pulse (discrete Input) will be monitored and the 3 Lube Pulse Fail Timer will begin counting down. The HMI/MMI will display **"UNIT RUNNING – LUBE PULSE PERMISSIVE TIMING"**. When 3 pulses are achieved the permissive will be met. If the permissive has not been met before the permissive timer has expired, then the unit will shutdown on **"LUBE PULSE FAILURE"**.

11.13 Once the lube pulse permissive has been met, the Warmup Duration timer will begin counting down and the HMI/MMI will display **"UNIT RUNNING – WARMUP DURATION"**.

11.14 Once Warmup timer has expired the following Loading Logic will be enabled.

12 UNIT RUNNING – UNLOADED

12.1 If the unit is in Manual control mode, the Load Permissive Fail Timer will begin counting down and the HMI/MMI will display **"UNIT RUNNING UNLOADED - MANUAL CONTROL MODE"**.

12.2 While in the 'Unit Running Unloaded - Manual Control Mode' state, if the site controller has determined Manual Mode Capacity exists, the **'ENABLE UNIT LOADING'** HMI/MMI touchbutton will be available on the Process Overview Screen #1. If Manual Mode Capacity does not exist, the **'ENABLE UNIT LOADING'** HMI/MMI touchbutton will be replaced with 'STORAGE BANKS @ CAPACITY'.

12.3 If the Load Permissive Fail Timer expires before the **'ENABLE UNIT LOADING'** HMI/MMI touchbutton is pressed, the unit will shutdown on **"UNLOAD FAIL STOP"**.

12.4 If the **'ENABLE UNIT LOADING'** HMI/MMI touchbutton is pressed before the Load Permissive Fail Timer expires, the touchbutton will be replaced with the **'DISABLE UNIT LOADING'** HMI/MMI touchbutton. The Filter Load/Drain Valve Actuator output will be **Energized** to close the valve and the HMI/MMI will display **"UNIT RUNNING – LOADED"**.

12.5 The operator may choose to manually Load and Unload the compressor as necessary while the Manual Mode Capacity exists. Once site controller determines capacity no longer exists, the touchbuttons will be replaced with 'STORAGE BANKS @ CAPACITY' and the Load Permissive Fail Timer will begin counting down.

12.6 If the unit is in Auto control mode, the Filter Load/Drain Valve Actuator output will be **Energized** to close the valve and the HMI/MMI will display **"UNIT RUNNING – LOADED"**.

13 UNIT RUNNING – LOADED

13.1 While in the 'Unit Running **–** Loaded' state, the Class P Alarm and Shutdown Faults will become **Enabled** and the Drain Interval Timer will begin counting down.

13.2 When the Drain Interval timer expires, the Filter Drain/Load Valve output will be **De-Energized** to open the valve **(Unload Machine)**, the Drain Duration and Drain Debounce Shutdown Enable timers will begin counting down, and all process low pressure alarm and shutdown faults will be **Disabled**.

13.3 When the Drain Duration Timer has expired, the Filter Drain/Load Valve output will be **Energized** to close the valve **(Load Machine)**, and the Drain Interval timer will reset.

13.4 When the Drain Debounce Shutdown Enable timer expires, all process low pressure alarm and shutdown faults will be **Enabled**. This process will continue repeating while the unit remains in the 'Unit Running **–** Loaded' state.

14 TEST MODE

14.1 During **RUNNING** modes, the unit can be put in test mode by depressing the Start Test Mode touch button on the HMI/MMI interface. Once in test mode, the Test Timer will be started and all shutdowns identified as Class A, B, or C will be able to be tested without shutting down the unit (unless otherwise specified). Some functions may be designated as Class ESD which will **not** be locked out in the test mode. Pressures & temperatures are not included in test mode, a drop in oil pressure below the Low Shutdown set point will stop the compressor.

14.2 The test mode will be ended if the test timer is expired (reaches zero) or the Stop Test Mode touch button is depressed. If more time is needed for test, the test timer can be reset by depressing the Start Test Mode touch button again on the HMI/MMI interface.

Note: When system is in TEST mode, typically only ESD class shutdowns will cause an actual Shutdown. All shutdowns of other classes will only be displayed but will not cause an actual system shutdown.

15 STOP SEQUENCE

15.1 While in the Manual control mode, a Unit Normal Stop may be initiated via the **'LOCAL STOP'** HMI/MMI touchbutton.

15.2 While in the Auto control mode, a Unit Normal Stop will be initiated when the Unit Run Command is **De-Energized** via the site controller.

15.3 While in either Manual or Auto control mode, switching to Off control mode for 5 seconds will initiate a Unit Normal Stop.

15.4 The HMI/MMI interface display **"UNIT NORMAL STOP INITIATED / COOLDOWN TIMING"**.

15.5 Once the Cooldown timer expires the following conditions will be provided:

- Unit Healthy - Remote Indication ..... **Energized (De-Energized on ESD activation)**
- Lube Pump Motor Starter..... **De-Energized**
- Cooler Fan Motor Starter ..... **De-Energized**
- Main Motor Starter ..... **De-Energized**
- Suction Block Valve ..... **De-Energized (Closed)**
- Auxiliary Suction Valve ..... **De-Energized (Closed)**
- Filter Drain/Load Valve ..... **De-Energized (Open)**
- Slow Fill (**Time Fill**) Valve ..... **Based on SCP Status**
- **Fast Fill Valve** ..... **De-Energized (Closed)**
- High Bank (**CNG Storage**) Valve..... **Based on SCP Status**
- Mid Bank Valve ..... **Based on SCP Status**
- Low Bank Valve ..... **Based on SCP Status**

15.6 The PLC will advance to the **"UNIT READY TO START"** state and await a new start sequence.

16 FAULT SHUTDOWN SEQUENCE

16.1 While in either Manual or Auto control mode, when a shutdown condition occurs the following conditions will be provided:

- Unit Healthy - Remote Indication ..... **De-Energized**
- Lube Pump Motor Starter..... **De-Energized**
- Cooler Fan Motor Starter ..... **De-Energized**
- Main Motor Starter ..... **De-Energized**
- Suction Block Valve ..... **De-Energized (Closed)**
- Auxiliary Suction Valve ..... **De-Energized (Closed)**
- Filter Drain/Load Valve ..... **De-Energized (Open)**
- Slow Fill (**Time Fill**) Valve ..... **Based on SCP Status**
- **Fast Fill Valve** ..... **De-Energized (Closed)**
- High Bank (**CNG Storage**) Valve..... **Based on SCP Status**
- Mid Bank Valve ..... **Based on SCP Status**
- Low Bank Valve ..... **Based on SCP Status**

16.2 The HMI/MMI will display **“UNIT SHUTDOWN”**.

16.3 Once the fault shutdown condition has been corrected and the operator has pressed the **"RESET"** pushbutton, the PLC will advance to the **"UNIT READY TO START"** state and await a new start sequence.

17 ESD SHUTDOWN SEQUENCE

17.1 If an ESD condition occurs, the following conditions will be provided:

- Unit Healthy - Remote Indication ..... **De-Energized**
- Lube Pump Motor Starter..... **De-Energized**
- Cooler Fan Motor Starter ..... **De-Energized**
- Main Motor Starter ..... **De-Energized**
- Suction Block Valve ..... **De-Energized (Closed)**
- Auxiliary Suction Valve ..... **De-Energized (Closed)**
- Filter Drain/Load Valve ..... **De-Energized (Open)**
- Slow Fill (**Time Fill**) Valve..... **Based on SCP Status**
- **Fast Fill Valve** ..... **De-Energized (Closed)**
- High Bank (**CNG Storage**) Valve..... **Based on SCP Status**
- Mid Bank Valve ..... **Based on SCP Status**
- Low Bank Valve ..... **Based on SCP Status**

17.2 The HMI/MMI will display “UNIT ESD CONDITION EXISTS”.

17.3 Once the ESD condition has been corrected and the operator has pressed the "LOCAL RESET" pushbutton, the PLC will advance to the “UNIT READY TO START” state and await a new start sequence.

18 FILL MODE SELECTION

18.1 The start sequence **Fill Mode** shall be determined by the operator and can be 1 of 3 modes selectable via the HMI/MMI. Should power be lost to the site controller (PRIMARY SCP), the redundant SECONDARY SCP (if available) will assume the role of site controller. Otherwise, the selected mode will be resumed on power up of the PRIMARY SCP.

- **Standard Mode**
- **First System Fill Mode**
- **Back Pressure Set Mode**

18.2 **Standard Mode** is the mode used for filling the storage tanks using the method described in section 19.0. The SCP will be in this mode for the majority of operation, as the other modes are for first time setup/startup.

18.3 **First System Fill Mode** is used to bring all storage tanks up to the same pressure simultaneously. This is done by **Energizing** all storage bank valves (High, Mid, & Low), and **Energizing** the Unit Run Command to one compressor package.

18.4 **Back Pressure Set Mode** is used to set the back pressure regulator (**PR-01**) for the direct filling of the CNG Storage. The SCP will allow one compressor package to run in Auto control mode providing gas to the priority panel so that the back pressure regulators can be adjusted/set. All storage bank valves remain closed during this Mode. Once compressor is loaded, discharge pressure should quickly rise to the setting of the backpressure regulator.

19 STANDARD MODE FILL SEQUENCE

19.1 Once the site controller has issued a run command to the lead compressor , the site controller will **Energize** the corresponding Solenoid Valve output to the bank whose pressure is below its start permissive pressure setpoint to begin filling that storage bank.

19.2 The **Start Permissive Pressure** setpoints for the High, Mid, and Low Storage Banks should be of value ranging from highest to lowest because filling is always done from the **High** bank first, then the **Mid** bank, and lastly the **Low** bank. This will allow the user to better utilize the storage capacity of each bank.

19.3 Once the High bank is filled, the **High Bank Solenoid** valve will remain **Energized** & the **Mid Bank Solenoid** valve will be **Energized** to fill the Mid bank. Once the Mid bank is filled, the **Mid Bank Solenoid** Valve will also remain **Energized** & the **Low Bank Solenoid** valve will be **Energized** to fill the Low bank.

19.4 Check valves are installed downstream of the solenoid valves to prevent the banks from equalizing during the fill process. However, the storage banks will equalize pressures once the low bank is near the Temperature Compensated Fill Set Pressure. This will ensure a more complete top-off of all storage banks.

19.5 When the Mid storage bank is being filled, if the high storage bank pressure drops below the **Bank Fill Set Temperature Compensated Pressure** setpoint minus the **Bank Fill Set Deadband Pressure** setpoint, then the **Mid Bank Solenoid** valve will be **De-Energized** to allow the compressor(s) to fill the High storage bank. The same applies when the Low storage bank is being filled, if the High or Mid storage bank pressure drops below the **Bank Fill Set Temperature Compensated Pressure** setpoint minus the **Bank Fill Set Deadband Pressure** setpoint, then the **Low Bank Solenoid** valve will be **De-Energized** to allow the compressor(s) to fill the High or Mid storage banks as necessary.

19.6 While dispensing gas (a handle in use signal is received), if the **Direct Fill Pressure** drops below the **Direct Fill Set Pressure** setpoint while the compressor is running loaded, then the site controller will **De-Energize** the **High, Mid,** and **Low Bank Solenoid** valves to direct fill the vehicle at the dispenser. Once the dispenser handle in use is removed or if the **Direct Fill Pressure** rises 200 PSI above the **Direct Fill Set Pressure** setpoint, then the site controller will resume filling the storage banks. The direct fill pressure falling below the **Direct Fill Set Pressure** set point will not start the compressor.

20 SLOW FILL (TIME FILL) MODE SEQUENCE

20.1 The Slow Fill (Time Fill) Mode provides the ability to fill a transient large capacity slow fill header to a temperature compensated pressure during a predetermined window of time.

20.2 Slow Fill Mode is **Enabled,** when the Slow Fill Pressure is less than the **Slow Fill Set Pressure** minus the **Slow Fill Start Span** and the current PLC hour is within the Slow Fill Enable and Disable Time set points.

20.3 Once Slow Fill Mode has been **Enabled,** the **Slow Fill Leak Test Delay Timer** will begin counting down. The Slow Fill Valve Actuator will be **Energized** to open the valve.

20.4 Once the **Slow Fill Leak Test Delay Timer** expires the Slow Fill Valve Actuator will be **De-Energized** to close the valve and the current **Slow Fill Pressure** will be copied into the Leak Test Peak Pressure. Loading of the compressor is inhibited at this time.

20.5 Once the Slow Fill Valve has closed, the **Slow Fill Leak Test Hold Timer** will begin counting down. When the timer has expired, if the Slow Fill Pressure remains greater than the Leak Test Peak Pressure minus the **Slow Fill Leak Test Hold Pressure Deadband** setpoint, the Lead UCP loading will be resumed and the Slow Fill will continue to be filled until the **Slow Fill Set Pressure** has been reached.

20.6 If the **Slow Fill Leak Test Hold Timer** has expired, and the **Slow Fill Pressure** is less than the Leak Test Peak Pressure minus the **Slow Fill Leak Test Hold Pressure Deadband** setpoint, Slow Fill Mode will be disabled and the HMI Active Alarm screen will display **'**AL: SLOW FILL LEAK TEST FAIL - SF DISABLED'. The Slow Fill Logic will remain disabled until the condition is addressed and the SCP is reset.

21 SPECIAL CONSIDERATIONS FOR BIOGAS OPERATION

21.1 A Secondary Suction Pressure Transducer installed upstream of the compressor package will monitor Biogas pressure. The operator will input two values, a **Biogas Low Pressure Stop Setpoint**, and a **Biogas Span** value.

CAUTION: The **Biogas Low Pressure Stop Setpoint** may need to be set to a value higher than actual suction pressure provided by the non-Biogas sales line, otherwise the compressor may not go into the Biogas Delay mode.

21.2 From these two values the PLC will provide the operator with the Biogas restart Pressure value (read only). Based on these settings the compressor will operate in this delayed mode while filling Slow Fill (Time Fill) from Saturday night until Sunday night.

21.3 The PLC will be tasked with determining whether to continue running the unit without biogas to satisfy slow fill (Time Fill) based on the requirement of ensuring the vehicles are ready for deployment.

21.4 The operator will have the ability to control when the biogas delay mode turns on and off.

22 DISPENSER VALVE (ESD VALVE) ACTUATION

22.1 The Dispenser Valve or ESD Valve solenoid actuation is controlled by the status of the ESD Circuit. When No ESD condition exists the Dispenser Valves or ESD Valves will remain open.

WARNING: Upon restoration of the ESD circuit the ESD valves will open without physical reset to the PLC.

23 TEMPERATURE COMPENSATION

23.1 The **Bank Fill Set Pressure @ 70°F** setpoint is used to derive the **Temperature Compensated Fill Set Pressure** using the following Calculation $P_1 = [(P_2 + P_{atm})*(T_1 + T_{conv}) / T_2] - P_{atm}$ where:

- P_1 = is the **Temperature Compensated Fill Set Pressure** used for the filling process.
- P_2 = **Bank Fill Set Pressure @ 70°F** setpoint entered via the local HMI/MMI.
- P_{atm} = **Atmospheric Pressure** setpoint entered via the local HMI/MMI.
- T_1 = is the **Ambient Air Temperature**.
- T_{conv} = is the value of 460 to convert °F to Rankine)
- T_2 = is the value of 530 (70°F converted to Rankine)

23.2 Temperature Compensation is clipped above 70°F meaning that even at 100°F ambient temperature the PLC will only use the actual value entered in **Bank Fill Set Pressure @ 70°F**.

24 METHANE DETECTION

24.1 If the methane level rises to greater than or equal to the high alarm setpoint, the HMI will indicate that an alarm condition exists and the Cooler Fan Motor output will be **Energized** if not already energized via normal operation. The Cooler Fan Motor will remain running until the methane level drops to 5% less than the high alarm setpoint. This functionality can be enabled/disabled via the local HMI interface however, it is required when the compressor is in an enclosure.

25 ROD LOAD CALCULATIONS

25.1 Using the Ariel Calculation Method, rod load will be calculated using the following pre-determined configuration data and appropriate formulas:

Double Acting Cylinders

$$RL_c = (A_{he} \times p_{di}) - (A_{ce} \times p_{si}) - (A_{rod} \times p_{atm})$$
$$RL_t = (A_{ce} \times p_{di}) - (A_{he} \times p_{si}) + (A_{rod} \times p_{atm})$$

Single Acting Crank-End Cylinders

$$RL_c = (A_{he} \times p_{di,he}) - (A_{ce} \times p_{si}) - (A_{rod} \times p_{atm})$$
$$RL_t = (A_{ce} \times p_{di,he}) - (A_{he} \times p_{si,he}) + (A_{rod} \times p_{atm})$$

Tandem Cylinders - (High Pressure Cylinder Outboard)

$$RL_c = (A_{he,HP} \times p_{di,HP}) - [(A_{he,LP} - A_{he,HP})] \times p_{sflg,LP} - (A_{ce,LP} \times p_{si,LP}) - (A_{rod} \times p_{atm})$$
$$RL_t = (A_{ce,LP} \times p_{di,LP}) - [(A_{he,LP} - A_{he,HP})] \times p_{sflg,LP} - (A_{ce,HP} \times p_{si,HP}) - (A_{rod} \times p_{atm})$$

Tandem Cylinders - (High Pressure Cylinder Inboard)

$$RL_c = (A_{he,LP} \times p_{di,LP}) - [(A_{he,LP} - A_{he,HP})] \times p_{sflg,LP} - (A_{ce,HP} \times p_{si,HP}) - (A_{rod} \times p_{atm})$$
$$RL_t = (A_{ce,HP} \times p_{di,HP}) - [(A_{he,LP} - A_{he,HP})] \times p_{sflg,LP} - (A_{ce,LP} \times p_{si,LP}) - (A_{rod} \times p_{atm})$$

where:

RL_c = internal compression gas rod load, lbf
RL_t = internal tension gas rod load, lbf
A_{he} = head end area, $\left(\frac{\pi \times D_{cyl}^2}{4}\right)$, in in^2, where D_{cyl} is the cylinder diameter, in inches
A_{ce} = crank end area, $(A_{he} - A_{rod})$, in in^2.
A_{rod} = rod area, $\left(\frac{\pi \times D_{rod}^2}{4}\right)$, in in^2, where D_{rod} is the rod diameter, in inches
LP = designation for low pressure cylinder or stage
HP = designation for high pressure cylinder or stage
PL_s = suction pressure loss, in %
PL_d = discharge pressure loss, in %
p_{sflg} = flange suction pressure, in psia
p_{dflg} = flange discharge pressure, in psia
p_{si} = internal suction pressure, $p_{sflg} \times \left(\frac{100 - PL_s}{100}\right)$, in psia
p_{di} = internal discharge pressure, $p_{dflg} \times \left(\frac{100 - PL_d}{100}\right)$, in psia
p_{atm} = atmospheric pressure, in psi

25.2 The following pressure drops are recommended for a) intake scrubber, piping and bottles, b) Interstage piping, cooling section, scrubber and bottles, and c) bottles, piping, discharge cooling and scrubber.

Flange Pressure	Pressure Loss	Not to Exceed
35 psia and below	5%	1 psi
36 psia to 250 psia	3%	5 psi
251 psia to 1000 psia	2%	10 psi
1001 psia and above	1%	N/A

25.3 High alarm and shutdown functions are provided for rod load in compression, tension, and total which is compression and tension combined. See Section 20.0 for more details.

26 LUBRICATOR TOTALIZE AND LOSS OF FLOW PULSE (NO-FLOW)

26.1 The Lubricator flow rate is calculated by using the Lubricator No-Flow pulsed input**.** The **Zone #1 Sum of Lube Block Face Values** setpoint is used to convert the pulse received from the no-flow device to pints. This value can be determined by adding up the number stamped on each lubricator block without regard to any letters found on the blocks.

26.2 The pulsed input will be monitored and the total pints per day will be calculated.

26.3 The average time of the last 5 pulses is displayed. Once the Class B1 Timer has expired, if there are no pulses from the Lubricator input and the Lubricator Flow Fail timer expires, the unit will Shutdown on Recip Comp Lubricator No-Flow.

27 STANDBY LUBE PUMP HEATING LOGIC

27.1 If the lube pump logic is enabled, the prelube pump motor will **Energize** if the ambient temperature falls below the **"OIL TEMP ENABLE SETPONT"** & will **De-Energize** if the temperature rises above the **"OIL TEMP DISABLE SETPONT"**. The Low Oil Pressure and the Low Oil Level shutdowns are enabled during lube pump operation even when the main motor is not energized.

28 COOLER FAN LOGIC

28.1 The Cooler Fan logic described below will be examined only after a start has been initiated while in either Auto or Manual control modes.

28.2 The Cooler Fan Motor Starter output will be **Energized** when <u>any</u> of the following conditions are met:

- The Ambient Temperature rises above the **Ambient Temp Enable** setpoint.
- Any of the 1st thru 4th Stage Discharge Temperatures rise above 225°F.
- The Final Discharge Temperature rises above the **Aftercooler Enable Temp** setpoint.

28.3 Once **Energized (**Running), the Cooler Fan Motor Starter output will be **De-Energized** when <u>all</u> of the following conditions are met:

- The Ambient Temperature drops below the **Ambient Temp Disable** setpoint.
- All of the 1st thru 4th Stage Discharge Temperatures drops below 175°F.
- The Final Discharge Temperature drops below the **Aftercooler Enable Temp** setpoint minus 40°.
- An ESD type shutdown occurs

29 UNIT STAGE SELECTION

29.1 The number of stage setting is used to match the number of compression stages unit on the unit that the control panel is operating. This setting is used to disable the process pressures and temperatures shutdowns for the stages in not in use.

30 STATION DISPENSER SELECTION

30.1 The number of dispensers present within the station which needs to match the number of actual dispensers. Enter the number of CNG handles (or hoses) being utilized by the system. This setting is used with the SCP logic for this display of active handles as well as the logic for starting the Lead, Lag #1, or Lag #2 units based on a number of active handles.

31 ALARM AND SHUTDOWN FUNCTIONS (adjustable via the HMI/MMI interface)

AL: Alarm

SD: Shutdown

IND: Indication (value display only)

CTL: Control

N/A: Not Applicable

Shutdown/Alarm Class descriptions:

Class "ESD" - Active at all times. **(Not Affected By Test Mode)**

Class "A" - Active at all times.

Class ”A/S” – Active at all times once a certain process condition is met.

Class ”B1” - Disabled during startup and enabled after Class B1 timer expires. Class B1 timer starts timing when unit is running.

Class "C" - Active when a certain process shutdown condition has been cleared for at least 2 seconds.

Class "S" – Active when a certain process condition is met.

Class "P" - Enabled once the unit is Unit Running - Load Control Enabled.

↑ - Signifies Rising or Increasing.

↓ - Signifies Falling or Decreasing.

NOTE: J-W Power Company is not responsible for the accuracy or completeness of these setpoints.

32 CONFIGURABLE PROCESS VARIABLES (adjustable via the HMI/MMI interface)

NOTE: J-W Power Company is not responsible for the accuracy or completeness of these setpoints.

Item #	Setpoint	Description	Setpoint Range	Factory Setting
1	Compressor Oil Temperature Permissive Setpoint. (Hard Coded at 40°F)	The required minimum Compressor Lube Oil temperature for satisfying permissive to start the compressor.	N/A	40°F
2	Aftercooler Dis Temp	This setting is used to start the cooler fan being compared to final discharge temperature.	0-130	120°F
3	Aftercooler Dis Temp (Calculated)	This calculated value is used to stop the cooler fan when compared to final discharge temperature. (Aftercooler Dis Temp – 40°F = Stop temperature setpoint)	NA	80°F
4	Test Timer	Time allowed conducting testing on alarms and shutdowns. Timer starts timing upon test mode starts. Test mode will be ended when this timer expires.	0-1200	600 sec
71	Lube Pump Enable Setpoint	Temperature at which the lube pump motor will energize to heat and circulate oil. Requires enabling the **Standby Lube Pump Heater Logic.**	40-80	65°F
72	Lube Pump Disable Setpoint	Temperature at which the lube pump motor will be de-energized. Requires enabling the **Standby Lube Pump Heater Logic.**	80-120	90°F
73	Class B3 Shutdown Delay	After energizing the lube pump motor, delay this amount of time before enable class B3 shutdowns. Used only for Standby Lube Pump Logic.	0-30	30 sec
74	Standby Low Oil Press SD Setpoint	Setpoint for Low Oil Pressure Shutdown while in standby and Standby Lube Pump Heater Logic is enabled.	10-200	15 psig
101	Number of Compression Stages	This setting is used to match the skid the panel is controlling. This setting will be used to disable process pressures and shutdowns alarms/shutdowns of stages not present, and will determined what is displayed on the local HMI interface.	1-4	4
102	Warm up Timer	This is the amount of time the unit runs during startup prior to loading.	1-15	3 sec
103	Cooldown Timer	This is the amount of time the unit runs unloaded after the run command is removed.	0-600	0 sec
104	Unload Fail Timer	Timer for the maximum amount of time that the compressor can run unloaded before shutting down on **RECIP COMP UNLOAD FAIL STOP**	0-1800	300 sec
201	Prelube Permissive Setpoint	The required minimum Compressor Lube Oil pressure for satisfying prelube permissive.	0-60	17 psig
202	Prelube Failure Timer	Time allowed getting the prelube permissive before shutdown the unit on Prelube Permissive Failure.	0-300	30 sec
203	Prelube Duration Timer	When prelube permissive is met, delay this amount of time before proceed to “Prelube Satisfied” state.	1-300	30 sec
204	Prelube Off Delay Timer	Duration for which the prelube pump motor will continue to run after receiving the run feedback from the main motor starter.	0-60	5 sec
301	Lube Pump Run Fail Timer	Time allowed for motor running (AUX) contact to close once the motor output is energized before the motor run failure is set.	0-120	5 sec
302	Cooler Fan Run Fail Timer	Time allowed for motor running (AUX) contact to close once the motor output is energized before the motor run failure is set.	0-120	5 sec

Item #	Setpoint	Description	Setpoint Range	Factory Setting
303	Main Motor Run Fail Timer	Time allowed for motor running (AUX) contact to close once the motor output is energized before the motor run failure is set.	0-120	20 sec
304	Atmospheric Pressure	Estimated atmospheric pressure for current elevation, used in calculation of Temperature Compensated Bank Fill Set Pressure.	14.0-15.0	14.5 psia
401	Drain Duration	Time allowed to drain coalescing filters.	1-10	4 sec
402	Drain Interval	Time allowed to run loaded before draining the coalescing filters.	0-3600	600 sec
403	Class B1 Shutdown Delay	After the motor running, delay this amount of time before enable class B1 shutdowns and alarms.	0-300	25 sec
404	Class B2 Shutdown Delay	After the motor running, delay this amount of time before enable class B2 shutdowns and alarms.	0-300	30 sec
501	Methane Detector logic Enable/Disable	This setting is used to determine if the cooler fan will operate on a high gas level detection.	Enable / Disable	Enable
502	Screw Compressor Logic Enable/Disable	Enable / Disable toggle for screw compressor logic	Enable / Disable	Disable
503	Standby Lube Pump Heater Logic Enable/Disable	Enable / Disable toggle for logic related to keep the oil above a minimum temperature setting while the compressor is in standby.	Enable / Disable	Enable
504	Instrument Air Pressure logic Enable/Disable	This setting is used to determine instrument air pressure logic will be present.	Enable / Disable	Enable
505	Instrument Air Pressure Perm Setpoint	Instrument Air pressure must be above this setpoint for the compressor to start.	0-200	80 psig
601	Recip Lube No-Flow Pulse Fail Timer	This is the maximum time allowed between lubricator proximity switch pulses.	0-600	120 sec
602	Zone #1 Sum of Lube Block Face Values	Sum of the numbers stamped on each lube block. This number is critical to the accuracy of pints displayed on the HMI/MMI.	0-999	48
603	# Lube Pulses During Startup Permissive	This setting will delay the loading of the compressor until the No-Flow has counted this number of pulses.	0-3	0
701	Panel Type	UCP (Unit Control Panel only, serves as a slave to SCP/UCP), SCP/UCP (Site & Unit Control Panel), DSC (Designated Site Control Panel, Site Functionality only, no UCP functionality)	UCP SCP/UCP DSC	SCP/UCP
702	PLC IP Address 10.10.0:	Select the 4th Octet for the PLC. This number will almost always be 1, 3, 5, or 7, depending on how many units are on site. It is critical that this number is correct for the compressors to operate and communicate correctly. Use only odd numbers between 1-7 to represent units 1-4.	0-255	1
703	Number of Packages	Select the number of CNG compressor packages on the network. It is critical that this number is correct for the compressors to operate and communicate correctly.	1-4	1
801	Number of Storage Tanks in CNG System	This value is the number of banks in the system, in terms of a cascade system, ex: High, Mid, and Low would be a 3-bank system. A buffer system would be a 1-bank system. This number does not represent the number of tubes or spheres on site. If two or more tube or spheres are manifolded together then they would count as 1 bank.	1-3	3
802	Number of Dispensers in CNG system	Number of Dispenser Handles that comprise the CNG system onsite.	1-5	2
803	Number of Dispensers Start Lead UCP	Number of Dispensers needed to trigger the Lead unit to start.	0-5	0

Item #	Setpoint	Description	Setpoint Range	Factory Setting
804	Direct Fill Logic Enable/Disable	Enable / Disable toggle for direct fill functionality.	Enable / Disable	Enable
805	Direct Fill Set Pressure	The Minimum Direct Fill Pressure allowed before De-Energizing the High, Mid, and Low Bank Solenoid valves while a Dispenser Handle call is active and any compressor is running.	0-5000	3800 psig
901	Bank Fill Set Deadband Pressure	When the storage bank being filled exceeds the Temperature Compensated Bank Fill Set Pressure the next bank may begin filling as long as the previous bank's pressure does not drop below the Temperature Compensated Bank Fill Set Pressure minus this value.	0-5000	200 psig
902	High Bank Lead UCP Start Span	This setpoint will be subtracted from the Temperature Compensated Bank Fill Set Pressure (Calculated) to determine the starting setpoint for the High Bank Storage before starting a fill cycle for the High Bank.	0-6000	400 psig
903	Mid Bank Lead UCP Start Span	This setpoint will be subtracted from the Temperature Compensated Bank Fill Set Pressure (Calculated) to determine the starting setpoint for the Mid Bank Storage before starting a fill cycle for the Mid Bank.	0-6000	2000 psig
904	Low Bank Lead UCP Start Span	This setpoint will be subtracted from the Temperature Compensated Bank Fill Set Pressure (Calculated) to determine the starting setpoint for the Low Bank Storage before starting a fill cycle for the Low Bank.	0-6000	2500 psig
1,001	High / Mid / Low Bank Fill Set Pressure @ 70°F	Desired High, Mid and Low Storage Bank filled pressure @ 70°F.	0-5000	4050 psig
1,002	Temperature Compensated Bank Fill Set Pressure	Calculated Value using the setpoint above to determine when the High, Mid and Low Storage Banks are filled. This valve is dependent upon temperature.	N/A	Calculated
1,003	Not To Exceed Pressure Setpoint	This value will clip the calculated value above to prevent overfilling of storage as well as prevent the possibility of shutting down the compressor on a high interstage or discharge pressure.	0-5000	4450 psig
1,004	Fill Setpoint Method: Single / Multiple	Single / Multiple Toggle button used in conjunction will filling storage banks to different pressures. This can be used on sites that have spheres or tubes with different MAWP's.	Single / Multiple	Single
1,101	High Bank Lag #1 UCP Start Deadband	The pressure to be subtracted from the High Bank Start Pressure setpoint before starting the UCP assigned Lag #1.	0-10000	200 psig
1,102	High Bank Lag #2 UCP Start Deadband	The pressure to be subtracted from the High Bank Lag #2 UPC Start deadband before starting the UCP assigned Lag #2.	0-10000	300 psig
1,103	Number of Dispensers Start Lag #1 UCP	Number of Dispensers needed to trigger the Lag #1 Delay Timer. The Lag #1 Timer will help to distribute inrush current if both the Lead and Lag #1 compressors are needed.	1-5	3
1,104	Number of Dispensers Start Lag #2 UCP	Number of Dispensers needed to trigger the Lag #1 Delay Timer. The Lag #1 Timer will help to distribute inrush current if the Lead, Lag #1, and Lag #2 compressors are needed.	1-5	5
1,201	Slow Fill Logic: Enable/Disable	Enable / Disable toggle for Slow Fill functionality.	Enable / Disable	Enable
1,202	Slow Fill Enable Time	Hour of Day in military time format when the Slow Fill Mode will be Enabled.	0-24	0 hours
1,203	Slow Fill Disable Time	Hour of Day in military time format when the Slow Fill Mode will be Disabled.	0-24	24 housr
1,301	Slow Fill Set Pressure at 70°F	Desired Pressure @ 70°F for filling the Slow Fill Storage Bank. This value may need to be higher depending on the pressure drop in the slow fill line to ensure optimal filling of the Slow Fill System.	0-5000	3600 psig

Item #	Setpoint	Description	Setpoint Range	Factory Setting
1,302	Slow Fill Start Span	This setpoint will be subtracted from the Temperature Compensated Slow Fill Set Pressure (Calculated) to determine the starting setpoint for the Slow Fill System before starting a fill cycle for the Slow Fill.	0-5000	1000 psig
1,303	Slow Fill Leak Test Logic: Enable/Disable	Enable / Disable toggle for Slow Fill leak test functionality. Enabling this feature will allow the SCP to test the slow fill line for excessive pressure drop (in the event of a leak or hose rupture on the slow fill manifold). If the Slow Fill Leak Test fails then the Slow Fill logic will not be functional until issue is addressed and the SCP is reset.	Enable / Disable	Enable
1,304	Slow Fill Leak Test Hold Pressure Deadband	Maximum pressure drop allowed once the Slow Fill Actuator Valve is closed during a Leak Test in Slow Fill Mode.	0-200	500 psig
1,305	Slow Fill Leak Test Delay Timer	Once the SCP is filling slow fill, delay this amount of time prior to performing the Slow Fill Leak Test. This time can be increased to ensure that the Blowdown Tank pressure is pulled down to suction pressure prior to conducting the Leak Test.	0-600	180 sec
1,306	Slow Fill Leak Test HOLD Time	This is the time for the duration of the leak test. Pressure drop will be calculated upon expiration of this timer to determine if excessive pressure drop exists within the Slow Fill System.	1-60	2 sec
10,001	Throw #1 Configuration	Select Blank, Single Acting, Double Acting, Tandem (HP) Outboard, or Tandem (HP) Inboard	N/A	Tandem (HP) Inboard
10,002	Throw #1 Assignment Stage (HP Stage when configured for Tandem)	Select the correct stage assigned for Throw #1. When a Tandem configuration is selected, the text will change to Throw #1 Assignment HP Stage and be used to select the correct stage assignment for the Tandem High Pressure Cylinder.	1-4	2
10,003	Throw #1 Assignment LP Stage	When a Tandem Configuration is selected, the Throw #1 Assignment LP Stage selection will become available and used to select the correct stage assignment for the Tandem Low Pressure Cylinder.	1-4	1
10,004	Throw #1 Rod Diameter	Rod Diameter for Throw #1.	0.000-999.999	1.125 inch
10,005	Throw #1 Cylinder Head End Diameter (HP Cylinder when configured for Tandem)	Throw #1 Cylinder Head End Diameter used for Area Calculation when Single or Double Acting configuration is selected. When a Tandem configuration is selected, the text will change to Throw #1 HP Cylinder Head End Diameter and the Throw #1 LP Cylinder Head End Diameter will become available and used for the Head End Area Calculation of the Tandem High Pressure Cylinder.	0.000-999.999	4.125 inch
10,006	Throw #1 LP Cylinder Head End Diameter	When a Tandem configuration is selected, the Throw #1 LP Cylinder Head End Diameter will become available and used for Head End Area Calculation of the Tandem Low Pressure Cylinder.	0.000-999.999	8.000 inch
20,001	Throw #2 Configuration	Select Blank, Single Acting, Double Acting, Tandem (HP) Outboard, or Tandem (HP) Inboard	N/A	Tandem (HP) Outboard
20,002	Throw #2 Assignment Stage (HP Stage when configured for Tandem)	Select the correct stage assigned for Throw #2. When a Tandem configuration is selected, the text will change to Throw #2 Assignment HP Stage and be used to select the correct stage assignment for the Tandem High Pressure Cylinder.	1-4	4
20,003	Throw #2 Assignment LP Stage	When a Tandem Configuration is selected, the Throw #2 Assignment LP Stage selection will become available and used to select the correct stage assignment for the Tandem Low Pressure Cylinder.	1-4	3
20,004	Throw #2 Rod Diameter	Rod Diameter for Throw #2.	0.000-999.999	1.125 inch
20,005	Throw #2 Cylinder Head End Diameter (HP Cylinder when configured for Tandem)	Throw #2 Cylinder Head End Diameter used for Area Calculation when Single or Double Acting configuration is selected. When a Tandem configuration is selected, the text will change to Throw #2 HP Cylinder Head End Diameter and the Throw #2 LP Cylinder Head End Diameter will become available and used for the Head End Area Calculation of the Tandem High Pressure Cylinder.	0.000-999.999	1.250 inch
20,006	Throw #2 LP Cylinder Head End Diameter	When a Tandem configuration is selected, the Throw #2 LP Cylinder Head End Diameter will become available and used for Head End Area Calculation of the Tandem Low Pressure Cylinder.	0.000-999.999	3.000 inch
30,001	Throw #3 Configuration	Select Blank, Single Acting, Double Acting, Tandem (HP) Outboard, or Tandem (HP) Inboard	N/A	Blank

Item #	Setpoint	Description	Setpoint Range	Factory Setting
30,002	Throw #3 Assignment Stage (HP Stage when configured for Tandem)	Select the correct stage assigned for Throw #3. When a Tandem configuration is selected, the text will change to Throw #3 Assignment HP Stage and be used to select the correct stage assignment for the Tandem High Pressure Cylinder.	1-4	____
30,003	Throw #3 Assignment LP Stage	When a Tandem Configuration is selected, the Throw #3 Assignment LP Stage selection will become available and used to select the correct stage assignment for the Tandem Low Pressure Cylinder.	1-4	____
30,004	Throw #3 Rod Diameter	Rod Diameter for Throw #3.	0.000-999.999	____ inch
30,005	Throw #3 Cylinder Head End Diameter (HP Cylinder when configured for Tandem)	Throw #3 Cylinder Head End Diameter used for Area Calculation when Single or Double Acting configuration is selected. When a Tandem configuration is selected, the text will change to Throw #3 HP Cylinder Head End Diameter and the Throw #3 LP Cylinder Head End Diameter will become available and used for the Head End Area Calculation of the Tandem High Pressure Cylinder.	0.000-999.999	____ inch
30,006	Throw #3 LP Cylinder Head End Diameter	When a Tandem configuration is selected, the Throw #3 LP Cylinder Head End Diameter will become available and used for Head End Area Calculation of the Tandem Low Pressure Cylinder.	0.000-999.999	____ inch
40,001	Throw #4 Configuration	Select Blank, Single Acting, Double Acting, Tandem (HP) Outboard, or Tandem (HP) Inboard	N/A	Blank
40,002	Throw #4 Assignment Stage (HP Stage when configured for Tandem)	Select the correct stage assigned for Throw #4. When a Tandem configuration is selected, the text will change to Throw #4 Assignment HP Stage and be used to select the correct stage assignment for the Tandem High Pressure Cylinder.	1-4	____
40,003	Throw #4 Assignment LP Stage	When a Tandem Configuration is selected, the Throw #4 Assignment LP Stage selection will become available and used to select the correct stage assignment for the Tandem Low Pressure Cylinder.	1-4	____
40,004	Throw #4 Rod Diameter	Rod Diameter for Throw #4.	0.000-999.999	____ inch
40,005	Throw #4 Cylinder Head End Diameter (HP Cylinder when configured for Tandem)	Throw #4 Cylinder Head End Diameter used for Area Calculation when Single or Double Acting configuration is selected. When a Tandem configuration is selected, the text will change to Throw #4 HP Cylinder Head End Diameter and the Throw #4 LP Cylinder Head End Diameter will become available and used for the Head End Area Calculation of the Tandem High Pressure Cylinder.	0.000-999.999	____ inch
40,006	Throw #4 LP Cylinder Head End Diameter	When a Tandem configuration is selected, the Throw #4 LP Cylinder Head End Diameter will become available and used for Head End Area Calculation of the Tandem Low Pressure Cylinder.	0.000-999.999	____ inch

NOTE: J-W Power Company is not responsible for the accuracy or completeness of these setpoints.

33 PASS CODE ACCESS

33.1 The setpoint adjustments that are available on the HMI/MMI interface are access protected with a username and password. If the user attempts to make setpoint changes a logon popup will be initiated. The user must logon before setpoints can be implemented.

33.2 The Default login(s) (Registered Users) for this control panel is as follows:

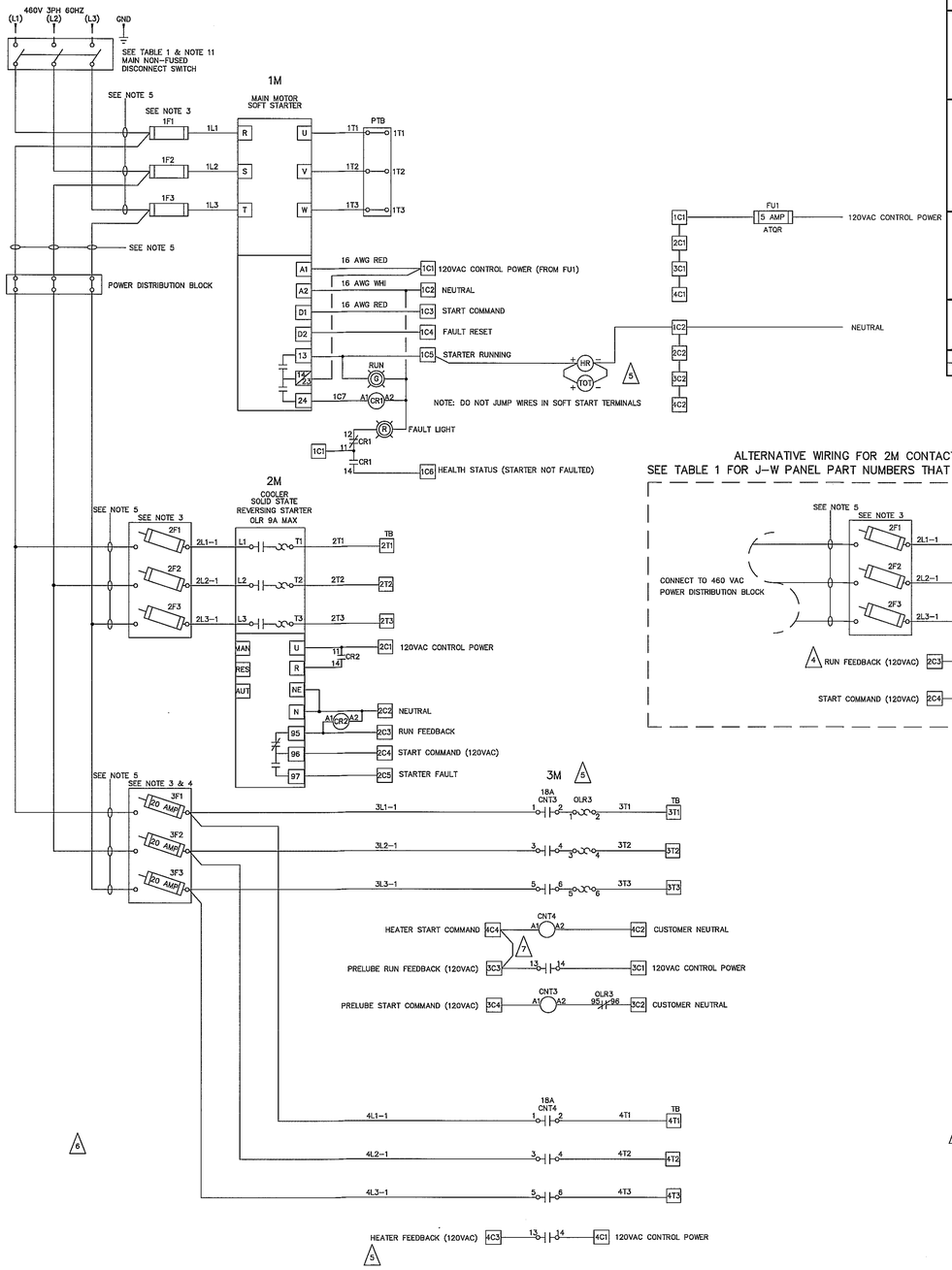
Username: **op** (Limited Access to view and change)
Password: **7351**
Username: **jw** (Full Access to view and change)
Password: **4500**

34 WEB VIEWER ACCESS

34.1 The HMI/MMI interface may be accessed for view only access by entering the desired IP address (shipped as 10.10.0.11, or 10.10.0.13, 10.10.0.15, 10.10.0.17 when multiple units comprise one CNG system) and entering the Web User username and password. A logon popup will appear if the user attempts to make setpoint changes. The user must logon as a registered user in order to change any type of setpoint.

34.2 The Web Viewer login provides View ONLY Access to the panel, however the user is permitted to navigate through most of the screens with this access level. The Web Viewer login for this control panel is as follows:

Username: **web_user (View ONLY Access)**
Password: **7351**



ALTERNATIVE WIRING FOR 2M CONTACTOR WITH OVERLOAD RELAY
SEE TABLE 1 FOR J-W PANEL PART NUMBERS THAT INCLUDE CONTACTOR W/OVERLOAD RELAY

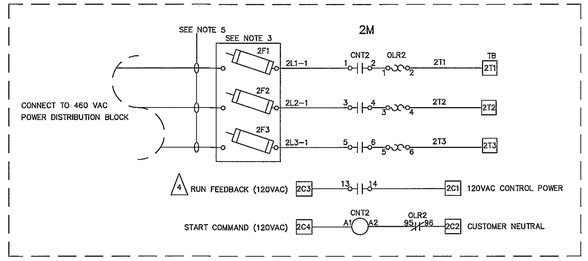


TABLE 1

	J-W Panel Part Number	328-00631	328-00703	328-00632	328-00705	328-00664	328-00707	328-00633	328-00634
	Enclosure Size	36x30x12	36x30x12	36x30x12	36x30x12	36x30x12	36x30x12	48x36x16	48x36x16
	Recommended Main Breaker Size	175A | 200A	175A | 200A	250A	250A	300A	300A	350A	400A
	Recommended Incoming Power Conduit Size	2"	2"	2"	2"	2-1/2"	2-1/2"	3"	3"
	Main Power Disconnect	No | No	No | No	No	No	No	No	Yes	Yes
	Max. Incoming Cable size	2/0	2/0	3/0	3/0	4/0	4/0	350 MCM	500 MCM
	Control Power	120V 1PHASE 60Hz	120V 1PHASE 60Hz	120V 1PHASE 60Hz	120V 1PHASE 60Hz	120V 1PHASE 60Hz	120V 1PHASE 60Hz	120V 1PHASE 60Hz	120V 1PHASE 60Hz
1M	Main Motor Soft Start	Motor HP: 75 | 100	75 | 100	125	125	150	150	200	250
		Motor FLA: 96 | 124	96 | 124	139	139	175	175	230	277
		SoftStart Setting DWG#	335-25189	335-25189	335-25137	335-25137	335-25190	335-25190	335-25245	335-25148
		Approved Manufacturer/Model	WEG / SSW070130TSSZ	WEG / SSW070130TSSZ	WEG / SSW070171TSSZ	WEG / SSW070171TSSZ	WEG / SSW070200TSSZ	WEG / SSW070200TSSZ	WEG / SSW070255TSSZ	WEG / SSW070312TSSZ
		Fuses	MERSEN A6T300 OR EQUAL	MERSEN A6T300 OR EQUAL	MERSEN A6T450 OR EQUAL	MERSEN A6T450 OR EQUAL	MERSEN A6T500 OR EQUAL	MERSEN A6T500 OR EQUAL	MERSEN A6T400 OR EQUAL	MERSEN A6T500 OR EQUAL
		Ground Wiring	#1 AWG GREEN	#1 AWG GREEN	#1 AWG GREEN	#1 AWG GREEN	#1 AWG GREEN	#1 AWG GREEN	#1/0 AWG GREEN	#1/0 AWG GREEN
		Max. Motor Cable Connection Size	2/0	2/0	3/0	3/0	4/0	4/0	350 MCM	500 MCM
2M	Cooler Motor Starter	Motor HP	5	10	5	10	5	10	10	
		Motor FLA	6.24 A	14.2 A	6.24A	14.2A	6.24A	14.2A	14.2 A	
		Max. Overload Trip Setting	Do not exceed 1.4 x FLA per NEC 2014 430.32(C)	Do not exceed 1.4 x FLA per NEC 2014 430.32(C)	Do not exceed 1.4 x FLA per NEC 2014 430.32(C)	Do not exceed 1.4 x FLA per NEC 2014 430.32(C)	Do not exceed 1.4 x FLA per NEC 2014 430.32(C)	Do not exceed 1.4 x FLA per NEC 2014 430.32(C)	Do not exceed 1.4 x FLA per NEC 2014 430.32(C)	
		Starter Setting DWG#	335-26559	335-26560	335-26559	335-26560	335-26559	335-26560	335-26560	
		Approved Manufacturer/Model	Phoenix / 2900422	WEG / CWM18-10-30V18 with RW27-1D3-U023	Phoenix / 2900422	WEG / CWM18-10-30V18 with RW27-1D3-U023	Phoenix / 2900422	WEG / CWM18-10-30V18 with RW27-1D3-U023	WEG / CWM18-10-30V18 with RW27-1D3-U023	
		Fuses	(3) 30A CC	(3) 30A CC	(3) 30A CC	(3) 30A CC	(3) 30A CC	(3) 30A CC	(3) 30A CC	
		Max. Motor Wire Connection Size	10AWG	10AWG	10AWG	10 AWG	10AWG	10 AWG	10AWG	
3M	Prelube Motor Starter	Motor HP	1							
		Motor FLA	1.8 A							
		Max. Overload Trip Setting	2.52A (Do not exceed 1.4 x FLA per NEC 2014 430.32(C))							
		Starter Setting DWG#	335-26664							
		Approved Manufacturer/Model	WEG / CWM18-10-30V18 with RW27-1D3-D028							
		Fuses	(3) 20A CC							
		Max. Motor Wire Connection Size	10AWG							
CNT4	Oil Heater	Voltage	460V 3Phase 60Hz	460V 3Phase 60Hz	460V 3Phase 60Hz	460V 3Phase 60Hz	460V 3Phase 60Hz	460V 3Phase 60Hz	460V 3Phase 60Hz	460V 3Phase 60Hz
		Watts	2000W	2000W	2000W	2000W	2000W	2000W	2000W	2000W
		Approved Manufacturer/Model	WEG / CWM18-10-30V18							
		Max. Heater Wire Connection Size	10AWG							
HR	Hour Meter	Redington Model 711-0113 or equal (must be Non-reset)								
TOT	Number of Main Motor Starts Totalizer	Redington Model P2-4816 or equal (must be Non-reset)								

MOTOR CONTROL PANEL DESIGN & BUILD REQUIREMENTS

1. PANEL MUST BE UL508 CERTIFIED
2. MUST BE IN A NEMA 4 OR 3R ENCLOSURE
3. FUSES IN MOTOR POWER CIRCUITS TO BE SIZED AS RECOMMENDED BY THE SOFT START MANUFACTURER OR CONTACTOR MANUFACTURER (SEE TABLE 1, CONTACT J-W ENGINEERING IF FUSE SELECTION DOES NOT MATCH FUSES SPECIFIED IN TABLE 1).
4. HEATER FUSES TO BE RATED FOR 20A
5. WIRE AND CABLE INSIDE THE PANEL TO BE SIZED & SELECTED PER THE LATEST REVISION OF NEC & UL 508 EXCEPTION FOR 2M AND 3M CABLES NEED TO BE SIZED FOR 1.4 x FLA OF MOTORS.
6. TERMINAL BLOCKS MUST BE LABELED AS SHOWN
7. SPARE SET OF THE COOLER, PRELUBE AND HEATER FUSES TO BE INCLUDED WITH THE PANEL
8. 2 SPARE 120V RELAYS AND 1 SPARE 24VDC RELAY TO BE INCLUDED IN PANEL
9. VENDOR DRAWING MUST BE APPROVED BY J-W POWER COMPANY ENGINEERING PRIOR TO ASSEMBLY.
10. AFTER VENDOR FUNCTION TEST IS COMPLETE ALL STARTERS SETTINGS ARE TO BE SET PER J-W DRAWING "SOFT START SETTINGS DWG" OR "STARTER SETTINGS DWG". SEE TABLE 1 FOR J-W DRAWING NUMBER.
11. ALL TERMINALS, POWER DISTRIBUTION BLOCK AND MAIN DISCONNECTS ARE TO BE SIZED TO ACCEPT THE MAX CABLE OR WIRE SIZE LISTED IN TABLE 1 FOR THE CORRESPONDING COMPONENT.
12. IF A MAIN NON-FUSED DISCONNECT IS NOT REQUIRE FOR A PANEL IN TABLE 1, THEN IT IS TO BE REPLACED BY A POWER DISTRIBUTION BLOCK (PDB).
13. SEND ELECTRONIC COPIES OF LITERATURE AND AS BUILT DRAWINGS TO d11media@jwenergy.com
14. ALL WEG SOFT STARTS IN TABLE 1 TO INCLUDE A LOCAL KEY PAD
15. ALL TERMINATIONS AND CONNECTIONS TO BE FINGER SAFE

J-W POWER COMPANY
FOR REFERENCE ONLY
Issued for Units 7351
Rev from PIC Sheet
8/31/2017 rmaldonado

WARNING:
THE INTENT OF THIS DRAWING IS TO PROVIDE INSTRUCTIONS FOR THE ASSEMBLY OF THE EQUIPMENT DEPICTED BY THIS DRAWING. BEFORE ATTEMPTING TO INSTALL OR OPERATE THE EQUIPMENT DESCRIBED HEREIN, PLEASE READ THE CORRESPONDING J-W POWER UNIT MANUAL AND ANY OTHER EQUIPMENT MANUALS AND SPECIFICATIONS. FOLLOW SAFE WORK PRACTICES; OBEY ALL LOCAL, STATE AND FEDERAL AND PROVINCIAL LAWS, RULES AND REGULATIONS WITH RESPECT TO SAFE USE OF THIS EQUIPMENT. **DO NOT MODIFY SYSTEM, EQUIPMENT WITHOUT PRIOR WRITTEN CONSENT BY J-W POWER COMPANY PACKAGE ENGINEERING OR TECHNICAL SERVICES DEPARTMENTS. DEVIATING FROM THE DESIGN DEPICTED ON THE UNIT SPECIFIC DRAWINGS MAY RESULT IN POOR PERFORMANCE, EQUIPMENT DAMAGE, PROPERTY DAMAGE, HUMAN INJURY OR DEATH.**

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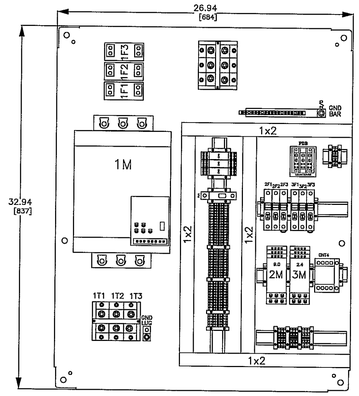
J-W POWER COMPANY
LONGVIEW, TEXAS, USA

NO.	REVISION	BY	CK'D	APP'D	DATE
7	ADDED JUMPER FROM 3C3 TO 4C4	CAM	CAM	CAM	01/03/17
6	REMOVED HTR FUSED DISCONNECT	CAM	CAM	CAM	09/17/14
5	ADDED 3M CNTR, HOUR METER & COUNTER	CAM	CAM	CAM	08/18/14
4	UPDATE PRLB STR TO 9A & ADDED MCPs	JC	KN	CAM	08/04/14

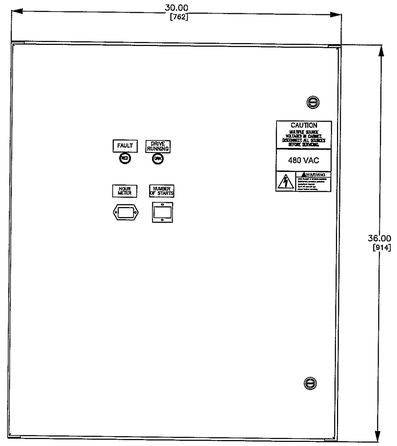
MOTOR CONTROL SS PANELS 75HP THRU 250HP

DRWN	CK'D	APP'D	DATE	SCALE	P/N	DWG.	REV.
MT	MH	CAM	08/27/13	NONE	SEE CHART	335-25174	7

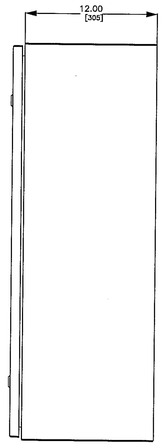
PANEL LAYOUT FOR 75HP THRU 150HP SS MCP
328-00631, 632, 664, 703, 705 & 707



PANEL LAYOUT

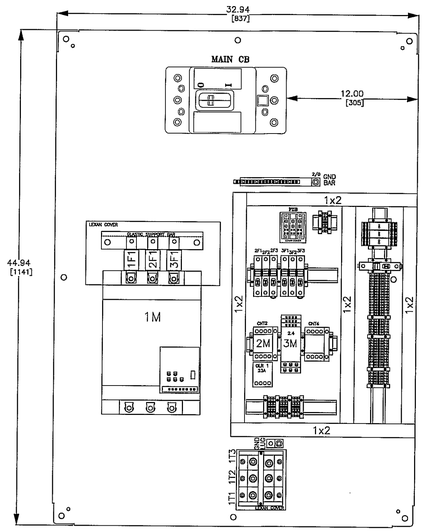


FRONT VIEW

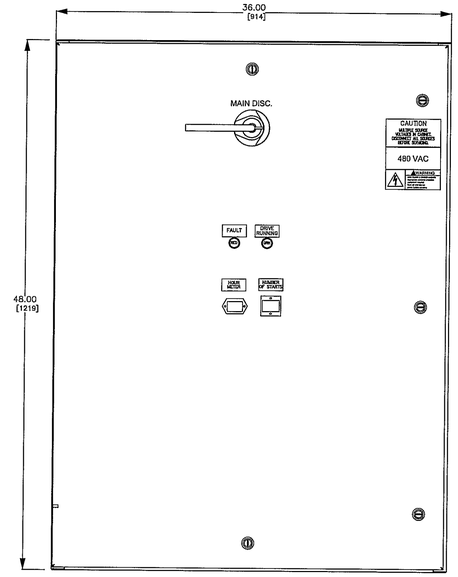


SIDE VIEW

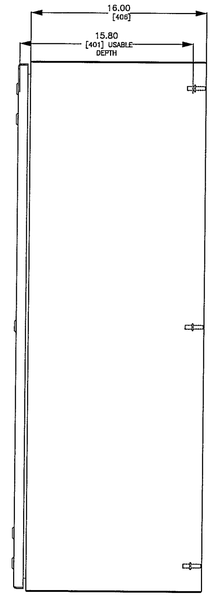
PANEL LAYOUT FOR 200HP THRU 250HP SS MCP
328-00633 & 634



PANEL LAYOUT



FRONT VIEW



SIDE VIEW

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NO.	REVISION	BY	CK'D	APP'D	DATE
7	ADDED JUMPER FROM 3C3 TO 4C4	CAM	CAM	CAM	01/03/17
6	REMOVED HTR FUSED DISCONNECT	CAM	CAM	CAM	09/17/14
5	ADDED 3M CNTR, HOUR METER & COUNTER	CAM	CAM	CAM	08/18/14
4	UPDATE PRLB STR TO 9A & ADDED MCPs	JC	KN	CAM	08/04/14

DRWN	CK'D	APP'D	DATE	SCALE	P/N	DWG.	REV.
MT		CAM	06/06/12	NONE	SEE CHART	335-25174	7

J-W POWER COMPANY
LONGVIEW, TEXAS, USA

MOTOR CONTROL SS PANELS 75HP THRU 250HP

J-W Recommended
Soft Start Settings



Main Motor Soft Start

JW Part #: 700-01871

Manufacturer/Model: WEG / SSW070255T5SZ (255 A)

Main Motor: 200HP / 460V / FLA = 230A

Parameter	Description	Setting	Method of Modification
000	Access to Parameters	5	Software[1] /Keypad
102	Acceleration Ramp Time	20s	Trimpot
104	Deceleration Ramp Time	0 = Inactive	Trimpot
110	Current Limitation	300%	Trimpot
Note: Parameter 110 x SSW Rated Current (Parameter 295) = Starting Current Limit			
202	Type of Control	1 = Current Limit	Dip Switch #1
207	Auto-Reset	0 = Inactive (OFF)	Dip Switch #8
220	Local/Remote	1 = Always Remote	Software[1]
277	RL1 Relay Function	2 = Full Voltage	Software[1]
278	RL2 Relay Function	6 = No Fault	Software[1]
295	SSW Rated Current	11 = 255 A	Software[1]
400	Motor Nominal Voltage	460 V	Software[1]
401	Motor Current Setting	90%	Trimpot
Note: Parameter 401 = Motor FLA ÷ SSW Rated Current (Parameter 295)			
406	Service Factor	1.15	Software[1]
520	Kick Start	0 = Inactive (OFF)	Dip Switch #2
521	Kick Start Pulse Time	0.2 sec	Trimpot
611	Phase Loss/Imm. Undercurrent	1 sec, (ON)	Dip Switch #4
613	Immediate Overcurrent	1 sec, (ON)	Dip Switch #3
617	Blocked Rotor / Stall	1 = Active (ON)	Dip Switch #6
620	Phase Sequence	0 = Inactive (OFF)	Dip Switch #5
640	Motor Protection Thermal Class	(ON) 6: Class 30 (OFF) (OFF)	Dip Switch #7 Therm.Class DIP#1 Therm.Class DIP#2

Note: All other parameter settings are WEG Factory Default Settings

(1): WEG SuperDrive G2 Software

J-W Drawing # 335-25245-03

J-W
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Parameter Settings

Project Name: 7351
Parameters Content File: C:\WEG\SuperDrive G2 11.3.0\Projects\7351\7351.par

Drive Type: SSW-07 V1.45 255A

Parameter	User Setting	Parameter	User Setting
P0000 Parameter Access	0	P0205 LED Default	1
P0001 SSW Current	0 %	P0206 Auto-Reset Time	0 s (Changed)
P0002 Motor Current (%)	0 %	P0215 Copy Function	0: Inactive
P0003 Motor Current (A)	0 A	P0219 Programming Mode	0: Trimpots and dip
P0005 Line Frequency	0 Hz	P0220 LOC/REM Selector	1: Always REM (Changed)
P0006 SSW Status	0: Ready	P0229 LOC Com. Selec.	0: HMI Key
P0007 Output Voltage	0 %	P0230 REM Com. Selec.	1: Dix
P0011 Reactive Power	0 kVA	P0263 DI1 Function	1: Start/Stop
P0012 DI1...DI3 Status	00000000b	P0264 DI2 Function	6: Reset
P0013 RL1...RL2 Status	01000000b	P0265 DI3 Function	6: Reset
P0014 Last Fault	70	P0277 RL1 Function	2: Full Volt. (Changed)
P0015 Second Fault	70	P0278 RL2 Function	6: No Fault (Changed)
P0016 Third Fault	70	P0295 SSW RatedCurrent	10: 255A
P0017 Fourth Fault	3	P0308 SSW Address	1
P0020 Present Fault	0	P0312 Serial Protocol	1: MB 9600 N
P0023 Software Version	1.45	P0313 Comm.ErrorAction	1: Turn Off
P0030 Current Phase R	0 A	P0314 Serial Timeout	0 s
P0031 Current Phase S	0 A	P0331 CAN Address	63
P0032 Current Phase T	0 A	P0332 CAN Baud Rate	3: Autobaud
P0050 Thermal State	0 %	P0333 Bus Off Error Reset	0: Manual
P0081 Heat sink temperature	33.6 °C	P0335 I/O Assembly Inst.	0: ODVA
P0090 CAN Controller Status	0: Disabled	P0336 DNet Read Word #2	0
P0091 DNet Network Status	0: Offline	P0337 DNet Read Word #3	0
P0092 DNet Master Status	0: Run	P0338 DNet Read Word #4	0
P0093 RX CAN Telegrams	0	P0339 DNet Read Word #5	0
P0094 TX CAN Telegrams	0	P0340 DNet Read Word #6	0
P0095 Bus Off Counter	0	P0341 DNet Read Word #7	0
P0096 CAN Lost Messages	0	P0342 DNet Write Word #2	0
P0101 Init. Volt Start	60 % (Changed)	P0343 DNet Write Word #3	0
P0102 Start Time Ramp	20 s	P0344 DNet Write Word #4	0
P0103 Step Down Stop	100 %	P0345 DNet Write Word #5	0
P0104 Stop Time	0 s	P0346 DNet Write Word #6	0
P0105 End Voltage Stop	30 %	P0347 DNet Write Word #7	0
P0110 Current Limit	298 % (Changed)	P0348 Fieldbus Error Action	1: Turn Off
P0111 Initial Current Ramp	150 %	P0400 Motor Rated Volt	460 V (Changed)
P0112 Time Current Ramp	20 %	P0401 Motor Rated Cur.	90.5 % (Changed)
P0200 Password	1: Active	P0406 Sevice Factor	1.15 (Changed)
P0202 Type of Control	1: Curr.Lim. (Changed)	P0501 Braking Time	0 s
P0203 Fan Control Config.	2: SW Controlled	P0502 Braking Voltage Level	30 %
P0204 Load/Save Param.	0: Not Used	P0510 Jog	0: Inactive

Project Name: 7351
Parameters Content File: C:\WEG\SuperDrive G2 11.3.0\Projects\7351\7351.par

Drive Type: SSW-07 V1.45 255A

Parameter	User Setting	Parameter	User Setting
P0511 Jog Level	30 %		
P0520 Kickstart	0: Inactive		
P0521 Kickstart Time	0.2 s		
P0522 Kickst. Voltage	80 %		
P0610 Under Current	80 %		
P0611 Delay Under Curr	1 s		
P0612 Over Current	100 %		
P0613 Delay Over Curr.	1 s		
P0614 Unbalance Curr.	15 %		
P0615 Delay Unbal.Curr	0 s		
P0616 Bypass Under Cur	0: Inactive		
P0617 Blocked Rotor	1: Active		
P0620 Phase Sequence	0: Inactive (Changed)		
P0621 E77 Enable	1: Active		
P0630 Restart Delay	2 s		
P0640 Ther.Prot.Class	6: Class 30		
P0641 Reset Ther.Prot.	0 s		

INSTRUMENTS



MERCER VALVE CO., INC.

AUTO SEAT TECHNOLOGY ®

9100 SERIES
Threaded



THINK...MERCER FIRST™

MERCER VALVE

9100 Series Threaded Product Overview

The Mercer Valve 9100 Series Pressure Relief Valve is "State of the Art" in soft seat, high flow rate, pressure relieving devices. The 9100 Series is a continuation of the 8100 Series, incorporating our patented **Auto Seat Technology®** into its design. Mercer Valve's **Auto Seat Technology®** has made the 9100 Series an industry leader with its reliable, repeatable set pressures. The patented soft seat design and fully guided disk allow the valve to continually outlast the competition. The soft seat 9100 Series has a field-proven lip seal design, which allows for a tighter seal up to set pressure. This tight seal reduces leaks and limits product loss.



The 9100 Series is manufactured in accordance with the requirements of ASME Boiler and Pressure Vessel Code, Section VIII, Division 1 for Air/Gas and Liquid service. The 9100 Series is well suited for specialty gases, compressors, separators, transmission, gathering lines and other production processes.

9100 Series Threaded Features

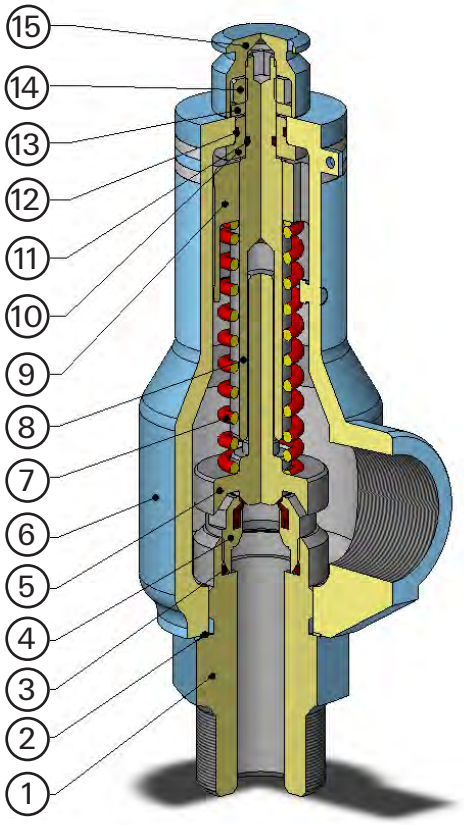
- **Designed with Auto Seat Technology®.**
- **Consistent Set Pressures allowing repeatable uses without repair or resetting.**
- **Open, Close, Seat and Seal.**
- **Fully guided disk keeps the disk properly alligned, opening and closing, helping to reseat the valve.**
- **Mechanical Stop prevents wear on parts and controls valve lift.**
- **Low rated and fully guided spring allows for more consistent set pressures from pop to pop.**
- **Pop Action relief allows valve to go to full lift at set pressure. Helps with DOT regulated applications.**
- **Built in accordance with the requirements of ASME Boiler and Pressure Vessel Code. Sec. VIII Div 1.**
- **Non-rising stems allowing valves to be installed in small areas.**

9100 Series Threaded Specifications

Orifice Letter	C	D	E	F	G	H	J	K
Standard Inlet Sizes	1/2", 3/4", 1"	3/4", 1"	3/4", 1"	1 1/2", 2"	1 1/2", 2"	1 1/2", 2"	2", 3"	3"
Inlet and Outlet Connection Types Available	Male NPT x Female NPT or Female NPT x Female NPT							
Actual Orifice Diameter (in)	.281	.394	.520	.655	.775	1.050	1.350	1.625
Actual Orifice Area (in^2)	.062	.122	.212	.337	.472	.865	1.430	2.074
API Orifice Area (in^2)	- - -	.110	.196	.307	.503	.785	1.287	1.838
Pressure Ranges (psi)	15 to 2999	15 to 2999	15 to 2400	15 to 2400	15 to 2000	15 to 2000	15 to 800	15 to 750
Standard Temperature Range (°F)	-20 to 400	-20 to 400	-20 to 400	-20 to 400	-20 to 400	-20 to 400	-20 to 400	-20 to 400
ASME Flow Coefficient, K_d (Gas)	.818	.818	.818	.818	.818	.818	.818	.818
ASME Flow Coefficient, K_d (Liquid)	.707	.707	.707	.707	.707	.707	.707	.707

NOTE: Mercer Valve reserves the right to change product designs and specifications without notice.

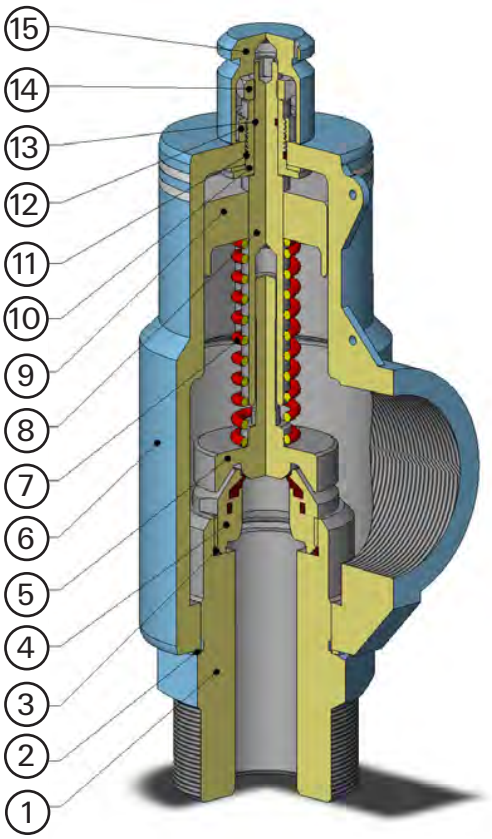
9100 Series Threaded Parts and Materials



9100 SERIES THREADED C , D , & E ORIFICES

ITEM NO	PART NAME	STANDARD MATERIALS
1	INLET BASE	CARBON STEEL
2	BASE SEAL	SOFT STEEL
3	NOZZLE O-RING	VITON
4	NOZZLE SUBASSEMBLY	STAINLESS STEEL WITH SOFT SEAT
5	DISK SUBASSEMBLY	STAINLESS STEEL
6	BODY SUBASSEMBLY	CARBON STEEL
7	SET SPRING	STAINLESS STEEL
8	ADJUSTMENT SCREW	STAINLESS STEEL
9	ADJUSTMENT BUSHING	STAINLESS STEEL
10	CENTER BUSHING	STAINLESS STEEL
11	ADJUSTMENT SCREW O-RING	BUNA N
12	CENTER BUSHING O-RING	BUNA N
13	WASHER	CARBON STEEL
14	LOCKNUT	CARBON STEEL
15	CLOSED CAP	ALUMINUM ALLOY

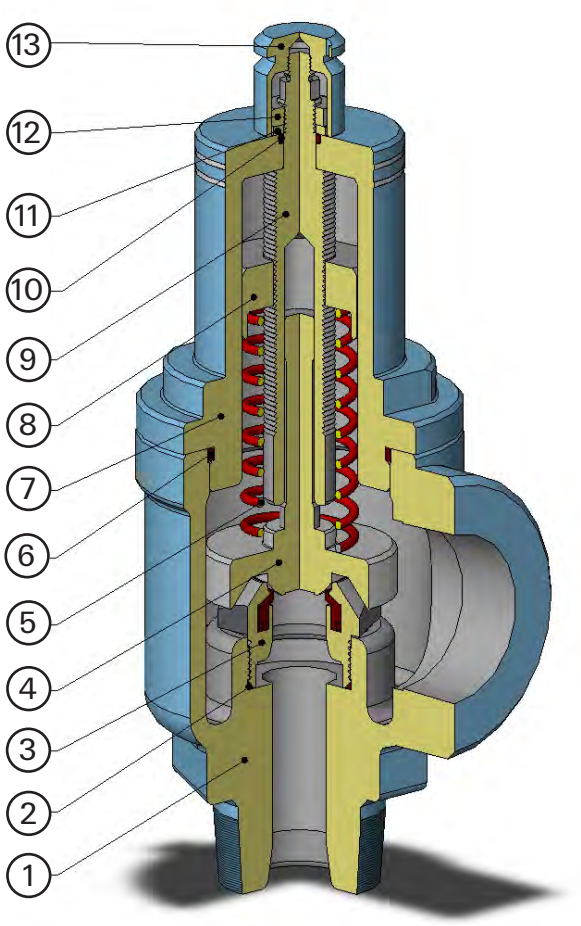
NOTE: Mercer Valve reserves the right to change product designs and specifications without notice.



9100 SERIES THREADED F & G ORIFICES

ITEM NO	PART NAME	STANDARD MATERIALS
1	INLET BASE	CARBON STEEL
2	BASE SEAL	SOFT STEEL
3	NOZZLE O-RING	VITON
4	NOZZLE SUBASSEMBLY	STAINLESS STEEL WITH SOFT SEAT
5	DISK SUBASSEMBLY	STAINLESS STEEL
6	BODY SUBASSEMBLY	CARBON STEEL
7	SET SPRING	STAINLESS STEEL
8	ADJUSTMENT SCREW	STAINLESS STEEL
9	ADJUSTMENT BUSHING	STAINLESS STEEL
10	CENTER BUSHING	STAINLESS STEEL
11	CENTER BUSHING O-RING	BUNA N
12	CENTERNUT	CARBON STEEL
13	ADJUSTMENT SCREW O-RING	BUNA N
14	LOCKNUT	CARBON STEEL
15	CLOSED CAP	ALUMINUM ALLOY

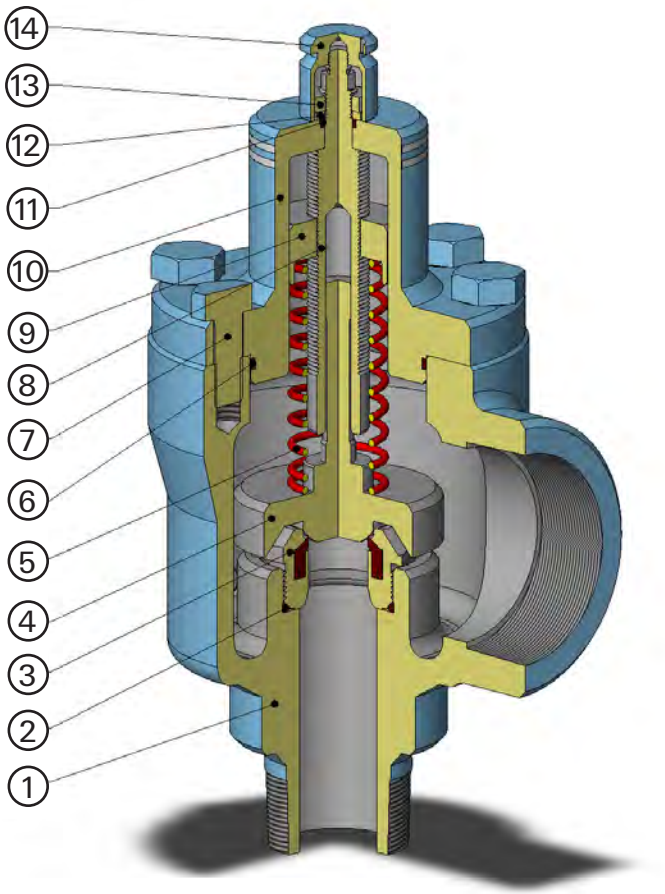
NOTE: Mercer Valve reserves the right to change product designs and specifications without notice.



9100 SERIES THREADED H ORIFICE

ITEM NO	PART NAME	STANDARD MATERIALS
1	BODY SUBASSEMBLY	CARBON STEEL
2	NOZZLE O-RING	VITON
3	NOZZLE SUBASSEMBLY	STAINLESS STEEL WITH SOFT SEAT
4	DISK SUBASSEMBLY	STAINLESS STEEL
5	SET SPRING	STAINLESS STEEL
6	BONNET O-RING	BUNA N
7	BONNET	CARBON STEEL
8	ADJUSTMENT BUSHING	STAINLESS STEEL
9	ADJUSTMENT SCREW	STAINLESS STEEL
10	ADJUSTMENT SCREW O-RING	BUNA N
11	WASHER	CARBON STEEL
12	LOCKNUT	CARBON STEEL
13	CLOSED CAP	ALUMINUM ALLOY

NOTE: Mercer Valve reserves the right to change product designs and specifications without notice.



9100 SERIES THREADED J & K ORIFICES

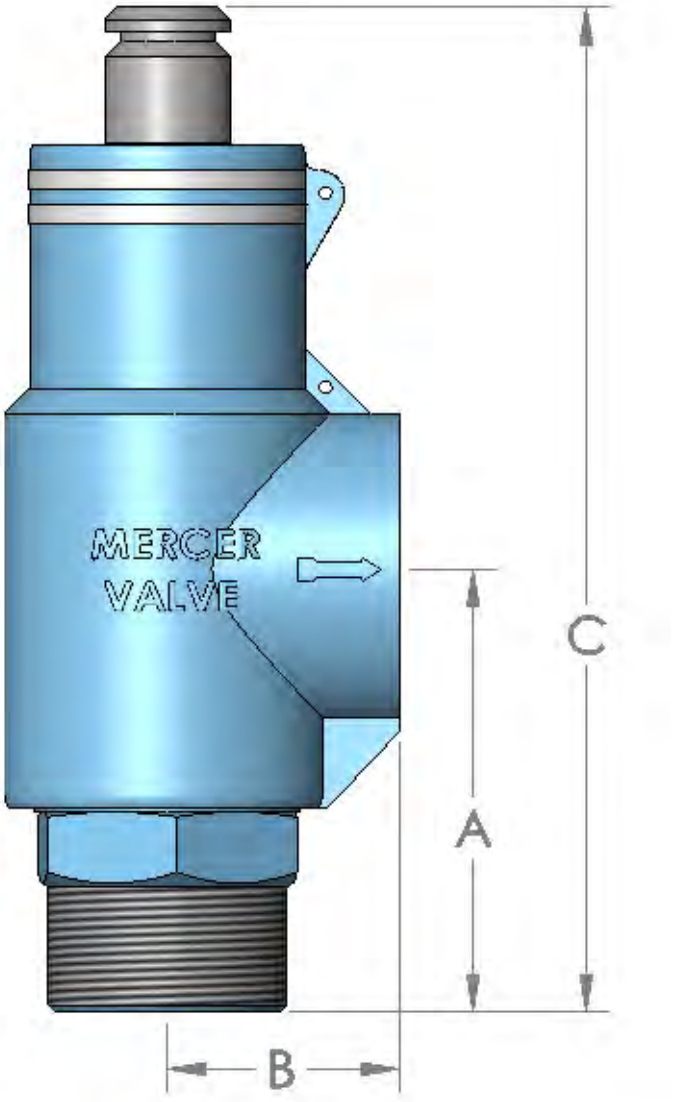
ITEM NO	PART NAME	STANDARD MATERIALS
1	BODY SUBASSEMBLY	CARBON STEEL
2	NOZZLE O-RING	VITON
3	NOZZLE SUBASSEMBLY	STAINLESS STEEL WITH SOFT SEAT
4	DISK SUBASSEMBLY	STAINLESS STEEL
5	SET SPRING	STAINLESS STEEL
6	BONNET O-RING	BUNA N
7	BONNET BOLTS	ALLOY STEEL
8	ADJUSTMENT SCREW	STAINLESS STEEL
9	ADJUSTMENT BUSHING	STAINLESS STEEL
10	BONNET SUBASSEMBLY	CARBON STEEL
11	ADJUSTMENT SCREW O-RING	BUNA N
12	WASHER	CARBON STEEL
13	LOCKNUT	CARBON STEEL
14	CLOSED CAP	ALUMINUM ALLOY

NOTE: Mercer Valve reserves the right to change product designs and specifications without notice.

INLET AND OUTLET CODE	INLET AND OUTLET SIZE	ORIFICE AVAILABLE	PRESSURE LIMIT (psi)	DIMENSIONS "A" X "B" X "C" (IN.) + 1/16	APPROX. WEIGHT (lbs.)
05	1/2" FNPT x 1" FNPT	C	15 - 2999	2-1/4 x 1-7/8 x 7-1/16	4.5
06	1/2" MNPT x 1" FNPT	C	15 - 2999	3-1/4 x 1-7/8 x 8	4.5
11	3/4" FNPT x 1" FNPT	C , D	15 - 2999	2-1/4 x 1-7/8 x 7-1/16	4.5
11	3/4" FNPT x 1" FNPT	E	15 - 2400	2-1/4 x 1-7/8 x 7-1/16	4.5
12	3/4" MNPT x 1" FNPT	C , D	15 - 2999	3-1/4 x 1-7/8 x 8	4.5
12	3/4" MNPT x 1" FNPT	E	15 - 2400	3-1/4 x 1-7/8 x 8	4.5
16	1" FNPT x 1" FNPT	C , D	15 - 2999	3-1/4 x 1-7/8 x 8	4.5
16	1" FNPT x 1" FNPT	E	15 - 2400	3-1/4 x 1-7/8 x 8	4.5
17	1" MNPT x 1" FNPT	C , D	15 - 2999	3-1/4 x 1-7/8 x 8	4.5
17	1" MNPT x 1" FNPT	E	15 - 2400	3-1/4 x 1-7/8 x 8	4.5
22	1" FNPT x 1 1/2" FNPT	C , D	15 - 2999	3-3/8 x 2-3/8 x 9	10.5
22	1" FNPT x 1 1/2" FNPT	E	15 - 2400	3-3/8 x 2-3/8 x 9	10.5
23	1" MNPT x 1 1/2" FNPT	C , D	15 - 2999	4-1/2 x 2-3/8 x 9-5/8	11
23	1" MNPT x 1 1/2" FNPT	E	15 - 2400	4-1/2 x 2-3/8 x 9-5/8	11
27	1" FNPT x 2" FNPT	C , D	15 - 2999	3-3/8 x 2-3/8 x 9	10.5
27	1" FNPT x 2" FNPT	E	15 - 2400	3-3/8 x 2-3/8 x 9	10.5
28	1" MNPT x 2" FNPT	C , D	15 - 2999	4-1/2 x 2-3/8 x 9-5/8	11
28	1" MNPT x 2" FNPT	E	15 - 2400	4-1/2 x 2-3/8 x 9-5/8	11
33	1 1/2" FNPT x 2" FNPT	F	15 - 2400	4-5/8 x 2-3/8 x 10-5/16	11.5
33	1 1/2" FNPT x 2" FNPT	G	15 - 2000	4-5/8 x 2-3/8 x 10-5/16	11.5
34	1 1/2" MNPT x 2" FNPT	F	15 - 2400	4-7/16 x 2-3/8 x 10-1/16	11
34	1 1/2" MNPT x 2" FNPT	G	15 - 2000	4-7/16 x 2-3/8 x 10-1/16	11
33	1 1/2" FNPT x 2" FNPT	H	15 - 850	3 x 3 x 10-3/4	22
34	1 1/2" MNPT x 2" FNPT	H	15 - 850	4-1/4 x 3 x 12	22.5
42	2" FNPT x 2" FNPT	F	15 - 2400	4-5/8 x 2-3/8 x 10-5/16	12
42	2" FNPT x 2" FNPT	G	15 - 2000	4-5/8 x 2-3/8 x 10-5/16	12
43	2" MNPT x 2" FNPT	F	15 - 2400	4-7/16 x 2-3/8 x 10-1/16	12
43	2" MNPT x 2" FNPT	G	15 - 2000	4-7/16 x 2-3/8 x 10-1/16	12
42	2" FNPT x 2" FNPT	H	15 - 850	3 x 3 x 10-3/4	22
43	2" MNPT x 2" FNPT	H	15 - 850	4-1/4 x 3 x 12	23
46	2" FNPT x 2 1/2" FNPT	H	15 - 850	3 x 3 x 10-3/4	22
46	2" FNPT x 2 1/2" FNPT	H	851 - 2000	3 x 3 x 13-1/8	28
47	2" MNPT x 2 1/2" FNPT	H	15 - 850	4-1/4 x 3 x 12	23
47	2" MNPT x 2 1/2" FNPT	H	851 – 2000	4-1/4 x 3 x 14-1/2	29

INLET AND OUTLET CODE	INLET AND OUTLET SIZE	ORIFICE AVAILABLE	PRESSURE LIMIT (psi)	DIMENSIONS "A" X "B" X "C" (IN.) + 1/16	APPROX. WEIGHT (lbs.)
51	2" FNPT x 3" FNPT	J	15 – 450	3-3/4 x 4-1/4 x 11-3/4	41
51	2" FNPT x 3" FNPT	J	451 – 800	3-3/4 x 4-1/4 x 15-5/16	52
52	2" MNPT x 3" FNPT	J	15 – 450	5-1/2 x 4-1/4 x 13-3/8	42
52	2" MNPT x 3" FNPT	J	451 – 800	5-1/2 x 4-1/4 x 17-1/16	53
61	3" MNPT x 3" FNPT	J	15 – 450	5-1/2 x 4-1/4 x 13-1/2	44
61	3" MNPT x 3" FNPT	J	451 – 800	5-1/2 x 4-1/4 x 17-1/4	55
61	3" MNPT x 3" FNPT	K	15 – 285	5-1/2 x 4-1/4 x 13-1/2	46
61	3" MNPT x 3" FNPT	K	286 - 750	5-1/2 x 4-1/4 x 17-1/4	57

NOTE: Mercer Valve reserves the right to change product designs and specifications without notice.



CAPACITY IN SCFM OF AIR AT 60°F AND STD ATMOSPHERIC CONDITIONS

Set Pressure (psi)	C 0.062	D 0.122	E 0.212	F 0.337	G 0.472	H 0.865	J 1.43	K 2.074
15	30	60	104	165	231	424	701	1017
20	35	69	120	191	267	489	808	1172
25	40	78	136	216	302	554	916	1328
30	44	87	152	241	338	619	1023	1483
50	65	128	222	352	493	904	1495	2168
75	90	178	309	491	688	1261	2084	3023
100	116	228	396	630	883	1617	2674	3878
125	141	278	484	769	1077	1974	3264	4733
150	167	329	571	908	1272	2331	3853	5589
200	218	429	746	1186	1661	3044	5033	7299
300	320	631	1096	1742	2440	4471	7391	10720
400	423	832	1445	2298	3218	5898	9750	14141
500	525	1033	1795	2854	3997	7324	12109	17562
600	627	1234	2145	3409	4775	8751	14467	20983
700	730	1435	2494	3965	5554	10178	16826	24403
800	832	1637	2844	4521	6332	11605	19185	
900	934	1838	3194	5077	7111	13031		
1000	1036	2039	3544	5633	7889	14458		
1100	1139	2240	3893	6189	8668	15885		
1250	1292	2542	4418	7022	9836	18025		
1500	1548	3045	5292	8412	11782	21592		
2000	2059	4051	7040	11191	15675	28726		
2400	2468	4856	8439	13415				
2600	2673	5259						
2800	2877	5661						
2999	3081	6062						

CAPACITY IN SCFM OF 0.6 SG NATURAL GAS AT 60°F AND STD ATMOSPHERIC CONDITIONS

Set Pressure (psi)	C 0.062	D 0.122	E 0.212	F 0.337	G 0.472	H 0.865	J 1.43	K 2.074
15	38	75	130	206	289	529	875	1269
20	44	86	150	238	333	610	1008	1463
25	50	97	169	269	377	691	1142	1657
30	55	109	189	301	421	772	1276	1851
50	81	159	276	439	615	1128	1864	2704
75	113	222	385	613	858	1573	2600	3771
100	145	285	495	786	1101	2018	3336	4838
125	177	347	604	959	1344	2463	4071	5905
150	208	410	713	1133	1587	2908	4807	6972
200	272	536	931	1480	2072	3798	6278	9105
300	400	787	1367	2173	3043	5577	9220	13373
400	527	1038	1803	2866	4015	7357	12163	17640
500	655	1289	2239	3560	4986	9137	15105	21908
600	782	1540	2676	4253	5957	10917	18048	26175
700	910	1791	3112	4947	6928	12697	20990	30443
800	1038	2042	3548	5640	7899	14477	23932	
900	1165	2293	3984	6333	8871	16256		
1000	1293	2544	4420	7027	9842	18036		
1100	1420	2795	4857	7720	10813	19816		
1250	1612	3171	5511	8760	12270	22486		
1500	1931	3799	6602	10494	14698	26935		
2000	2568	5054	8783	13961	19554	35835		
2400	3079	6058	10527	16735				
2600	3334	6560						
2800	3589	7062						
2999	3843	7562						

CAPACITY IN MMSCFD OF 0.6 SG NATURAL GAS AT 60ºF AND STD ATMOSPHERIC CONDITIONS

Set Pressure (psi)	C 0.062	D 0.122	E 0.212	F 0.337	G 0.472	H 0.865	J 1.43	K 2.074
15	0.05	0.11	0.19	.030	0.42	0.76	1.26	1.83
20	0.06	0.12	0.22	0.34	0.48	0.88	1.45	2.11
25	0.07	0.14	0.24	0.39	0.54	0.99	1.64	2.39
30	0.08	0.16	0.27	0.43	0.61	1.11	1.84	2.66
50	0.12	0.23	0.40	0.63	0.89	1.62	2.68	3.89
75	0.16	0.32	0.56	0.88	1.24	2.26	3.74	5.43
100	0.21	0.41	0.71	1.13	1.59	2.91	4.80	6.97
125	0.25	0.50	0.87	1.38	1.94	3.55	5.86	8.50
150	0.30	0.59	1.03	1.63	2.28	4.19	6.92	10.04
200	0.39	0.77	1.34	2.13	2.98	5.47	9.04	13.11
300	0.58	1.13	1.97	3.13	4.38	8.03	13.28	19.26
400	0.76	1.49	2.60	4.13	5.78	10.59	17.51	25.40
500	0.94	1.86	3.22	5.13	7.18	13.16	21.75	31.55
600	1.13	2.22	3.85	6.12	8.58	15.72	25.99	37.69
700	1.31	2.58	4.48	7.12	9.98	18.28	30.23	43.84
800	1.49	2.94	5.11	8.12	11.38	20.85	34.46	
900	1.68	3.30	5.74	9.12	12.77	23.41		
1000	1.86	3.66	6.37	10.12	14.17	25.97		
1100	2.05	4.02	6.99	11.12	15.57	28.54		
1250	2.32	4.57	7.94	12.62	17.67	32.38		
1500	2.78	5.47	9.51	15.11	21.17	38.79		
2000	3.70	7.28	12.65	20.10	28.16	51.60		
2400	4.43	8.72	15.16	24.10				
2600	4.80	9.45						
2800	5.17	10.17						
2999	5.53	10.89						

CAPACITY IN GPM WATER AT 60°F AND STD ATMOSPHERIC CONDITIONS

Set Pressure (psi)	C 0.062	D 0.122	E 0.212	F 0.337	G 0.472	H 0.865	J 1.43	K 2.074
15	7	14	24	38	54	99	163	236
20	8	16	27	43	61	111	184	267
25	9	17	30	48	67	123	203	295
30	10	19	33	52	73	133	221	320
50	12	24	42	67	94	172	285	413
75	15	30	52	82	115	211	349	506
100	17	34	60	95	133	244	403	584
125	20	38	67	106	149	272	450	653
150	21	42	73	116	163	299	493	716
200	25	49	84	134	188	345	570	826
300	30	60	103	164	230	422	698	1012
400	35	69	119	190	266	487	806	1169
500	39	77	134	212	297	545	901	1307
600	43	84	146	233	326	597	987	1431
700	46	91	158	251	352	645	1066	1546
800	49	97	169	269	376	689	1140	
900	52	103	179	285	399	731		
1000	55	109	189	300	421	771		
1100	58	114	198	315	441	808		
1250	62	122	211	336	470	862		
1500	68	133	231	368	515	944		
2000	78	154	267	425	595	1090		
2400	86	168	293	465				
2600	89	175						
2800	92	182						
2999	96	188						

9100 Series Threaded Product Numbering System

91 - 17 D 5 1

VALVE SERIES

91 – 9100 Series

INLET & OUTLET COMBINATION

(See Selection Table on pages 8 & 9)

ORIFICE SIZE

C to K

INLET BASE & BODY MATERIAL

5 – CARBON STEEL/WCB CARBON STEEL

6 – 316 STNLS STL/WCB CARBON STEEL

7 – 316 STNLS STL/CF3M STAINLESS STEEL

CAP TYPE

1 – CLOSED CAP
2 – OPEN LIFT LEVER
3 – CLOSED LIFT LEVER
4 – CLOSED CAP W/STAINLESS STEEL BONNET (H - K ORIFICE)
5 – OPEN LIFT LEVER W/STAINLESS STEEL BONNET (H - K ORIFICE)
6 – CLOSED LIFT LEVER W/STAINLESS STEEL BONNET (H - K ORIFICE)

CONSULT FACTORY FOR ADDITIONAL INFORMATION AND OPTIONS

NOTE: Mercer Valve reserves the right to change product designs and specifications without notice.

V 06 I 1 ___ ___

2 – DIGIT "SPECIAL" CODE
(IF APPLICABLE ASSIGNED BY MERCER)

O-RING MATERIAL

1 – STANDARD O-RINGS
(VITON & BUNA-N)

TRIM CODES

U – 316 S.S. DISK & NOZZLE (STD GAS SERVICE F,G,H,J,&K ORIFICES)*

I – 17-4 S.S. DISK & NOZZLE (STD GAS SERVICE D&E ORIFICES)

C – 440C S.S. DISK, 17-4 S.S. NOZZLE (STD GAS SERVICE C ORIFICE AND HIGH PRESSURE F,G,H,)*

L – LIQUID SERVICE 316 S.S. DISK & NOZZLE

N – SOUR GAS SERVICE 316 S.S. DISK & NOZZLE

B – SOUR LIQUID SERVICE 316 S.S. DISK & NOZZLE

SPRING CODE
(ASSIGNED BY MERCER)

SEAT MATERIAL

V – VITON 90 DURO

T – 15% GLASS FILLED TEFLON

P – VIRGIN PEEK

* = U TRIM CODE CHANGES TO C TRIM CODE AT F > 1399psi, G > 1199psi, H > 1049psi



9100 SERIES CATALOG

CORPORATE HEADQUARTERS
9609 NW 4th STREET
OKLAHOMA CITY, OK 73127
1-800-833-6402
PHONE: (405) 495-6533, FAX: (405) 495-8728
SALES@MERCERVALVE.NET

HOUSTON BRANCH OFFICE
6218 LONG DRIVE
HOUSTON, TX 77087
1-866-833-6402
PHONE: (713) 242-6960, FAX: (713) 242-6963
HOUSTON@MERCERVALVE.NET

CALGARY BRANCH OFFICE
#203, 2835 23rd St. NE
CALGARY, ALBERTA T2E 7A4
PHONE: (403) 250-5557, FAX: (403) 250-5661
CANADA@MERCERVALVE.NET

CHICAGO BRANCH OFFICE
CUSTOMER RELATIONS DEPARTMENT
P.O. Box 597
Libertyville, IL 60048
1-800-833-6402
CHICAGO@MERCERVALVE.NET

WWW.MERCERVALVE.NET

SALES
(800) 833-6402
(405) 495-6533
FAX # (405) 495-8728

ACCOUNTING
(405) 495-7178

MERCER VALVE CO., INC.
"Auto Seat Technology" ®
Post Office Box 270970
Oklahoma City, Oklahoma 73137

PURCHASING
(405) 789-2994
(405) 789-0664

ENGINEERING
(405) 495-3274

MERCER VALVE COMPANY, INC.
9100 SERIES THREADED SAFETY RELIEF VALVES

INSTALLATION, OPERATION AND MAINTENANCE MANUAL

INSTALLATION

The safety relief valve should always be installed on a tank or piping run in the vertical position with the valve outlet pointing in a horizontal direction. When screwing the valve into the inlet piping, always use the wrench flats on the inlet connection. Never put a wrench on the relief valve body.

One of the most common causes of early failure of relief valves is dirt trapped on the valve seat. Welding slag and/or piping Teflon tape are among the more common items that cause difficulty. It is recommended that all piping and tank systems be cleaned prior to installation of the relief valve.

A relief valve should be connected with the minimum amount of piping between the tank and valve. Further, all piping used must be equal or larger than the inlet pipe size of the relief valve, **never smaller**. Any restriction of the inlet to a relief valve may cause unusual valve chatter, which could result in **serious damage** to the valve. Piping restrictions can also can also cause the valve to not relieve its full capacity causing the valve not to be able to reduce the pressure increase. Outlet piping from the relief valve should be less than four (4) feet in length and never of a pipe size smaller than the outlet pipe size of the relief valve. Long runs of small diameter pipe on the outlet side of a relief valve will create valve chatter and a capacity reduction that can cause the system to not be protected.

Extreme caution is required in the outlet piping if installed where liquids, if present, could form an ice block in the piping of the relief valve body in below freezing conditions. Discharge lines must be “weathered capped” and provided with a drain hole to prevent any liquid collection in the relief valve body or outlet piping. This liquid can freeze and cause the valve to not open or reduce the capacity of the valve. If these precautions are not taken the valves will not protect the system.

Additional, important installation information is contained in Paragraph UG-135, Section VIII of the ASME Code.

OPERATION

For best performance in process work is usually obtained by setting the safety relief valve to open at least 15% above the operating pressure where possible. A greater margin is desirable. However, this setting must not exceed the maximum working pressure of the vessel. All Mercer 9100 Series Safety Relief Valves are checked for bubble-tight per API 527.

In Addition to checking the set pressure versus the maximum allowable working pressure of the vessel, also check to insure that back pressure and temperature limitations of the process are consistent with valve ratings. The fluid state, capacity, temperature, set pressure, and back pressure can all be found on the tag of the valve. Pressures and Temperatures outside the normal ranges require special materials. Further, carefully check the process fluid input capacities to insure that the relief valve capacity is **greater than** the process capacities.

DO NOT BREAK THE SEAL WIRE Breaking the seal wire invalidates the manufacture's warranty to repair or replace the valve. If resetting is required in a field emergency situation a qualified personnel with calibrated instrumentation should perform it. With a broken seal wire this valve will be considered a non ASME code valve until it has been repaired by a VR certified repair shop.

DISASSEMBLY: **The following general procedure is recommended in disassembly inspection and cleaning of the relief valve:**

1. Cut the wire seal and unscrew the cap to expose the adjustment screw.
2. Loosen the lock nut and relieve the tension on the spring by turning the adjustment screw counter clockwise. This will relieve the spring tension.
3. Secure the valve body so that it will not move
   For orifice sizes C to G, unscrew and remove the inlet base
   For orifice size of H, unscrew and remove the bonnet
   For orifice sizes J and K, unbolt and remove the bonnet
4. Inspect the replaceable seat for cuts and abrasions. If there are only minor scratches or abrasions on the seat, polish the seat area lightly with Scotch-Brite #7447. Be careful not to damage the soft seat. If the seat is damaged with deep abrasions and cuts, replace the nozzle/seat subassembly.
5. Refer to Figure 1 and measure the diameter of Ds with a precision caliper. This diameter must be in the range of values listed in Table 1. If this is not the case, replace the nozzle/seat subassembly.

TABLE 1

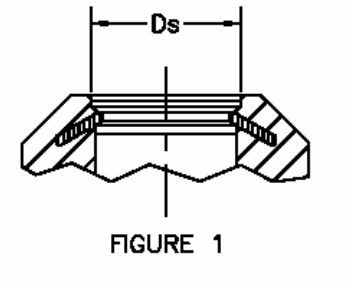


FIGURE 1

ORIFICE SIZE	DIAMETER Ds (INCHES)	
	MINIMUM	MAXIMUM
"C"	.335	.337
"D"	.480	.482
"E"	.620	.622
"F"	.778	.780
"G"	.914	.916
"H"	1.242	1.2465
"J"	1.599	1.6025
"K"	1.899	1.903

6. Remove and inspect the disk subassembly, especially the spherical surface portion that engages the seat. This surface must be clean and smooth. Polishing this surface with Scotch-Brite #7447 may restore the disk if it has only minor imperfections. If the spherical surface is damaged or scratched, replace the disk subassembly

7. Refer to Figure 2 and measure the diameter of Dd with a precision caliper. This diameter must be within the range of values listed in Table 2. If this is not the case, replace the disk subassembly.

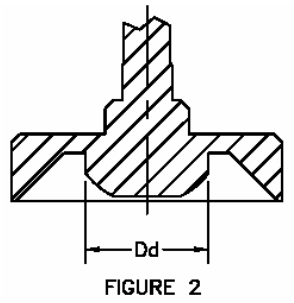


FIGURE 2

TABLE 2

ORIFICE SIZE	DIAMETER Dd (INCHES)	
	MINIMUM	MAXIMUM
"C"	.331	.333
"D"	.474	.477
"E"	.614	.616
"F"	.768	.771
"G"	.904	.906
"H"	1.228	1.231
"J"	1.580	1.583
"K"	1.876	1.880

8. Check the disk stem of the disk subassembly to insure that the surface is smooth. Polish the stem if necessary with Scotch-Brite or fine emery. If the stem is galled, replace the disk subassembly.
9. Remove the spring and inspect for wear or damage. Clean and replace the spring if necessary. Be sure the spring is straight and square. If not replace the spring.
10. Remove the adjustment screw and guide bushing by tapping on the top of the adjustment screw with a "soft" drive rod. The guide bushing is designed to "slip fit" into the internal machined bore of the body. This "slip fit" must be maintained by cleaning the outside diameter of the guide bushing and internal bore of the valve body.
11. Replace the o-ring found on the adjustment screw stem.
12. DO NOT REMOVE THE CENTER NUT OR INDEX BRACKET SUBASSEMBLY. They are permanently installed at the factory. The purpose of the index bracket subassembly is to prevent rotation of the guide bushing. A body side pin is used in the 9100 "C" AND "D" orifices in place of the index bracket.
13. Lubricate the outside diameter of the adjustment screw thread, outside diameter of the guide bushing, the adjustment screw o-ring and the internal upper machined bore of the valve body with a good lubricating grease.

REASSEMBLY: The following general procedure is recommended in reassembly and setting of the valve:

1. Before reinstalling the adjustment screw and guide bushing, position the adjustment screw with the upper end of the thread protruding 1/8" from the end of the guide bushing. Carefully "slip fit" this assembly into the body, fitting the index bracket leg or body side pin into the slotted portion of the guide bushing. Note that the guide bushing must slip into the valve bore freely but with little radial play. Remove and reclean parts if the parts do not easy fit in. DO NOT FORCE THE GUIDE BUSHING INTO THE VALVE BODY. Forcing the parts may restrict valve lift and **cause serious malfunction**.
2. Swab out the internal bore of the adjustment screw to insure that is is clean and free from obstructions like dirt and grease.
3. Before reinstalling the spring, insert the disk subassembly into the bore of the adjustment screw and simulate the valve opening operation. The disk stem must slide freely within the bore of the adjustment screw.
4. Reinstall the spring and the disk subassembly. The spring should slide over the disk freely without sticking. Make sure the correct spring is installed.
5. Install the nozzle subassembly into the inlet base or body, for whichever applies.
6. For bottom entry valves reinstall the inlet base subassembly using a new base seal. Caution, the inlet base must be tight against the base seal and body.
   For top entry valves reinstall the bonnet subassembly.
   Make sure the disk and nozzle are aligned.
7. Check the lift of the valve by inhering a properly shaped drive rod in an arbor press into the internal bore of the inlet base and pressing on the nose of the disk subassembly. Apply a slight spring tension to the valve disk. Measure the "lift" of the valve with a dial indicator. The minimum lift can be found in NB-18 on the National Board website www.nationalboard.org.
8. Reinstall the lock nut and the valve is ready for setting. Valve setting at all pressures is dangerous. All eye and ear safety precautions should be observed.
9. Resetting should be performed using the correct fluid. Gas/Vapor valves should be set with air and liquid valves should be set using water. Mercer Valve recommends that for gas/vapor valves there be approximately (1) cubic foot capacity below the valve when setting. To see other valve characteristics a larger vessel may be required. The test gauges should be at least .25% accuracy and be currently calibrated using a dead weight tester.
10. Repeated "popping" at set pressure is recommended. The valve should be popped approximately five (5) to ten (10) times during the setting process allowing full blowdowns.
11. A slight audible warning action is to be expected, starting approximately 5% below the set pressure.
12. All valves should be bubble tight at 10% below set pressure in accordance with API 527.

13. When the valve is set, tighten the lock nut securely so at least 1/4" of the stem is exposed above the lock nut. The adjustment screw must not turn when the lock nut is tightened. This will affect the set pressure. Pop the valve once more after the lock nut is tightened to verify the set pressure.
14. Reinstall the cap and a new lockwire. Close the lockwire and crimp the lead seal.

BACK PRESSURE TESTING The purpose of back pressure testing Mercer Safety Relief Valves is to check for leaks in the secondary pressure zone (the outlet side of the relief valve). This includes the body, bonnet, outlet flange and all parts included in the upper valve assembly. This is best performed before the valve seal wire has been attached.

The back pressure test is performed after the valve has been assembled and set to the correct set pressure. The test is performed by attaching a pressure source to the outlet of the valve and submerging the valve in a solution of water treated with rust inhibitor. The pressure in the secondary pressure zone is then brought to 30 psig or to what the back pressure the valve will see. This is the pressure required by the ASME BOILER AND PRESSURE VESSEL CODE, SECTION VIII. PART UG-136(d) "Production Testing by Manufacturers and Assemblers". The valve is then visually inspected for any leaks by checking for bubbles coming from any part of the valve. If any part of the valve is producing bubbles, the valve is disassembled, repaired and the valve is reassembled and retested. If no leaks are detected, the valve is stamped with the appropriate set pressure, the valve then goes to the finishing department to be painted, tagged, and prepared for shipping.

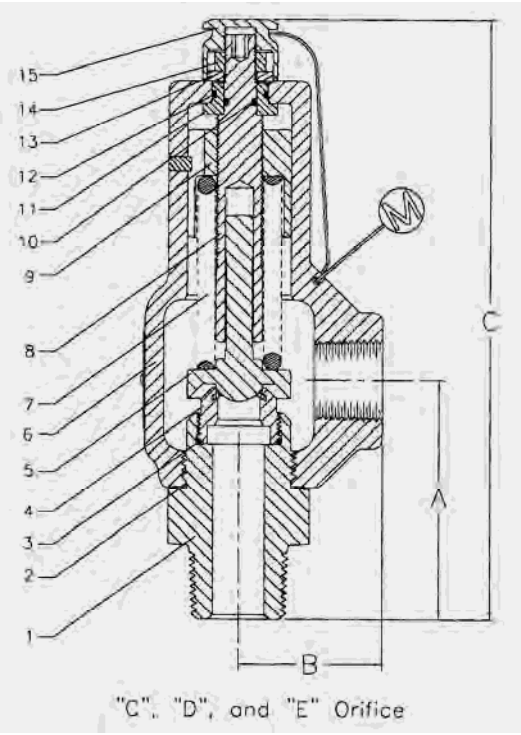
IF YOU HAVE ANY QUESTIONS OR COMMENTS ABOUT THE PRECEDING PROCEDURES, FEEL FREE TO CONTACT THE FACTORY AT (405) 495-6533 or 800-833-6402. Phones are answered 24 hours a day.

"C", "D", AND "E" ORIFICE STANDARD BILL OF MATERIALS

"C" ORIFICE DIAMETER: .281 In.
"C" ORIFICE AREA: .062 Sq.In.
SET PRESSURE RANGE: 15-2999 PSI

"D" ORIFICE DIAMETER: .394 In.
"D" ORIFICE AREA: .122 Sq.In.
SET PRESSURE RANGE: 15-2999 PSI

"E" ORIFICE DIAMETER: .520 In.
"E" ORIFICE AREA: .212 Sq.In.
SET PRESSURE RANGE: 15-2400 PSI



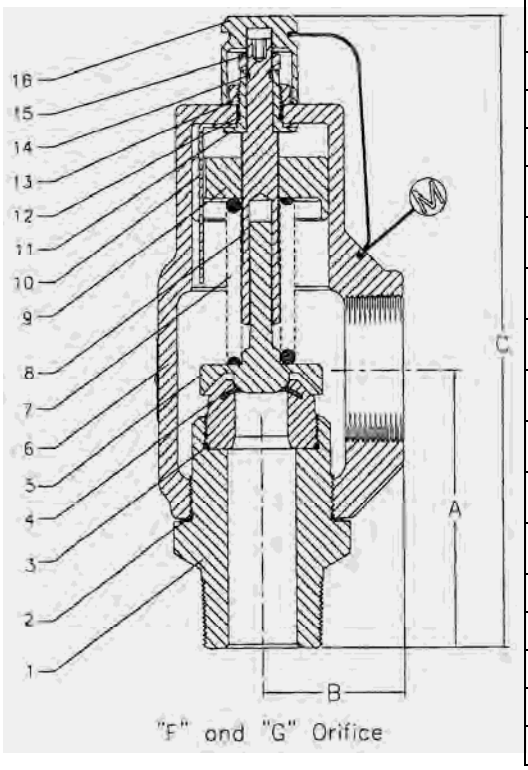
"C", "D", and "E" Orifice

"C", "D", AND "E" ORIFICE				
ITEM NO.	PART NAME	"C" ORIFICE STD MTRLS "C" TRIM CODE	"D" & "E" STD MTRLS "I" TRIM CODE	"C", "D", "E" OPTIONS "U", "L", "N", OR "B" CODE
1	Inlet Base	Carbon Steel or 316 Stainless Steel	Carbon Steel or 316 Stainless Steel	Carbon Steel or 316 Stainless Steel
2	Base Seal	Carbon Steel or 316 Stainless Steel	Carbon Steel or 316 Stainless Steel	Carbon Steel or 316 Stainless Steel
3	O'Ring	Viton	Viton	Viton
4	Nozzle Subassy	17-4 Stainless Steel with Soft Seat	17-4 Stainless Steel with Soft Seat	316 Stainless Steel with Soft Seat
5	Disk Subassy	440C Stainless Steel	17-4 Stainless Steel	316 Stainless Steel
6	Body	WCB Carbon Steel or CF3M Stainless Steel	WCB Carbon Steel or CF3M Stainless Steel	WCB Carbon Steel or CF3M Stainless Steel
7	Spring	17-7 Stainless Steel	17-7 Stainless Steel	17-7 Stainless Steel or Inconel X-750 (NACE)
8	Adjustment Screw	300 Series Stainless Steel	300 Series Stainless Steel	300 Series Stainless Steel
9	Adjustment Bushing	300 Series Stainless Steel	300 Series Stainless Steel	300 Series Stainless Steel
10	O'Ring	Buna N	Buna N	Buna N
11	Center Bushing	300 Series Stainless Steel	300 Series Stainless Steel	300 Series Stainless Steel
12	O'Ring	Buna N	Buna N	Buna N
13	Washer	Carbon Steel	Carbon Steel	Carbon Steel
14	Lock Nut	Carbon Steel	Carbon Steel	Carbon Steel
15	Cap	Anodized Aluminum	Anodized Aluminum	Anodized Aluminum

"F" AND "G" ORIFICE STANDARD BILL OF MATERIALS

"F" ORIFICE DIAMETER: .655 In.
"F" ORIFICE AREA: .337 Sq.In.
SET PRESSURE RANGE: 15-2400 PSI

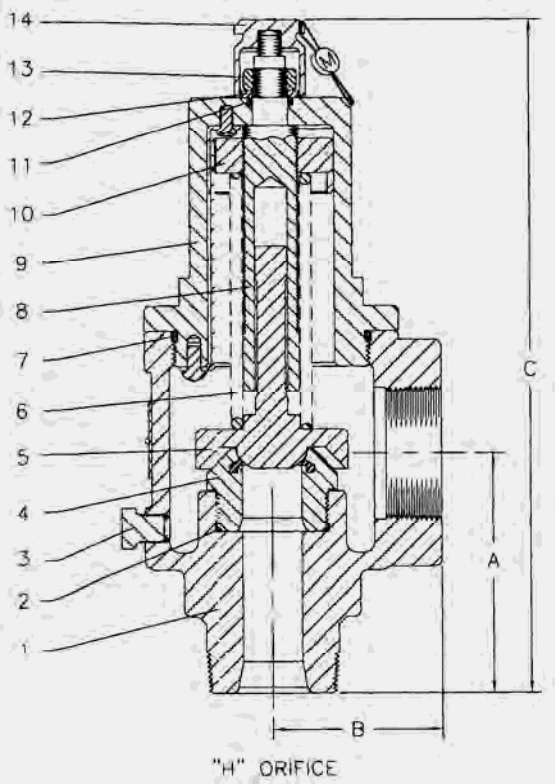
"G" ORIFICE DIAMETER: .775 In
"G" ORIFICE AREA: .472 Sq.In.
SET PRESSURE RANGE: 15-2000 PSI



"F" AND "G" ORIFICE			
ITEM	PART NAME	"F" AND "G" ORIFICE STD MTRLS "U", "L", "N", OR "B" TRIM CODE	"F" AND "G" STD MTRLS "C" TRIM CODE (High Pressure)
1	Inlet Base	Carbon Steel or 316 Stainless Steel	Carbon Steel or 316 Stainless Steel
2	Base Seal	Carbon Steel or 316 Stainless Steel	Carbon Steel or 316 Stainless Steel
3	O'Ring	Viton	Viton
4	Nozzle Subassy	316 Stainless Steel with Soft Seat	17-4 Stainless Steel with Soft Seat
5	Disk Subassy	316 Stainless Steel	440C Stainless Steel
6	Body	WCB Carbon Steel or CF3M Stainless Steel	WCB Carbon Steel or CF3M Stainless Steel
7	Spring	17-7 Stainless Steel or Inconel X-750 (NACE)	17-7 Stainless Steel
8	Adjustment Screw	300 Series Stainless Steel	300 Series Stainless Steel
9	Adjustment Bushing	300 Series Stainless Steel	300 Series Stainless Steel
10	Index Bracket	300 Series Stainless Steel	300 Series Stainless Steel
11	Center Bushing	300 Series Stainless Steel	300 Series Stainless Steel
12	O'Ring	Buna N	Buna N
13	Center Nut	Carbon Steel	Carbon Steel
14	O'Ring	Buna N	Buna N
15	Lock Nut	Carbon Steel	Anodized Aluminum
16	Cap	Anodized Aluminum	Anodized Aluminum

"H" ORIFICE STANDARD BILL OF MATERIALS

"H" ORIFICE DIAMETER: 1.050 In.
"H" ORIFICE AREA: .865 Sq.In.
SET PRESSURE RANGE: 15-2000 PSI

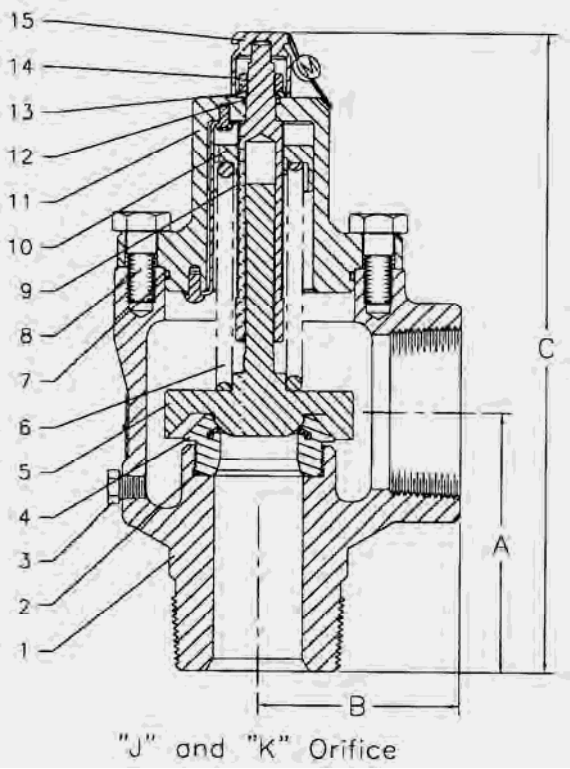


"H" ORIFICE			
ITEM	PART NAME	"H" ORIFICE STD MTRLS "U", "L", "N", OR "B" TRIM	"H" ORIFICE STD MTRLS "C" TRIM CODE (High
1	Body	WCB Carbon Steel or CF3M Stainless Steel	WCB Carbon Steel or CF3M Stainless Steel
2	O'Ring	Viton	Viton
3	Drain Plug	Carbon Steel or Stainless Steel	Carbon Steel or Stainless Steel
4	Nozzle Subassy	316 Stainless Steel with Soft Seat	17-4 Stainless Steel with Soft Seat
5	Disk Subassy	316 Stainless Steel	440C Stainless Steel
6	Spring	17-7 Stainless Steel or Inconel X-750 (NACE)	17-7 Stainless Steel
7	O'Ring	Buna N	Buna N
8	Adjustment Screw	300 Series Stainless Steel	300 Series Stainless Steel
9	Bonnet Subassy	Carbon Steel or 316 Stainless Steel	Carbon Steel or 316 Stainless Steel
10	Adjustment Bushing	300 Series Stainless Steel	300 Series Stainless Steel
11	O'Ring	Buna N	Buna N
12	Washer	300 Series Stainless Steel	300 Series Stainless Steel
13	Lock Nut	18-8 Stainless Steel	18-8 Stainless Steel
14	Cap	Anodized Aluminum	Anodized Aluminum

"J" AND "K" ORIFICE STANDARD BILL OF MATERIALS

"J" ORIFICE DIAMETER: 1.350 In.
"J" ORIFICE AREA: 1.430 Sq.In.
SET PRESSURE RANGE: 15-1800 PSI

"K" ORIFICE DIAMETER: 1.625 In.
"K" ORIFICE AREA: 2.074 Sq.In.
SET PRESSURE RANGE: 15-1500 PSI

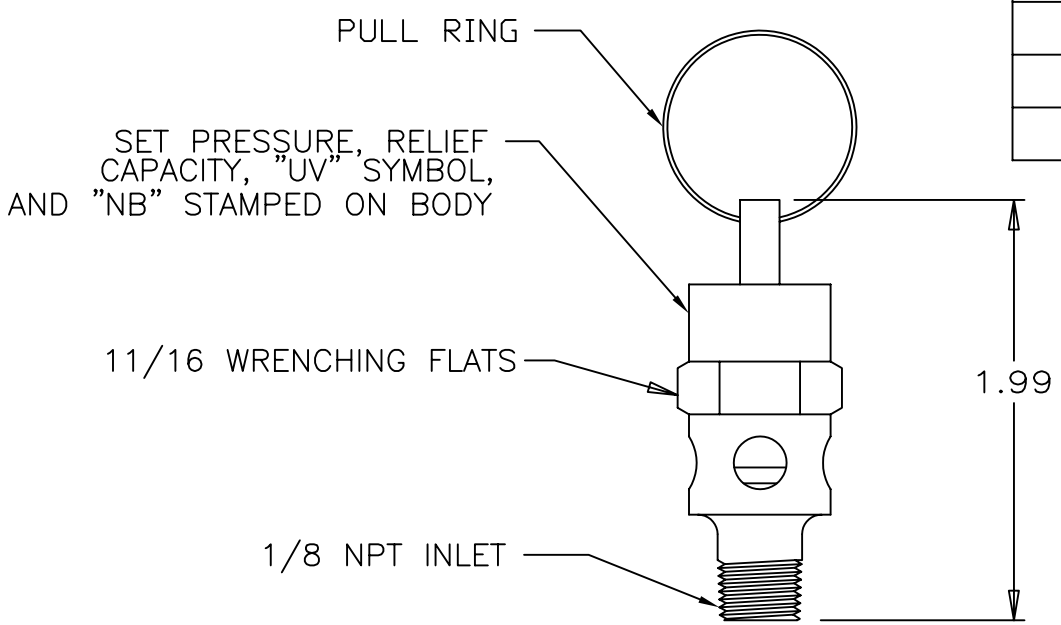


"J" and "K" Orifice

"J" AND "K" ORIFICE			
ITEM NO.	PART NAME	"J" AND "K" STD MTRLS "U", "L", "N", OR "B" TRIM	"J" AND "K" STD MTRLS "C" TRIM CODE (High Pressure)
1	Body	WCB Carbon Steel or CF3M Stainless Steel	WCB Carbon Steel or CF3M Stainless Steel
2	O'Ring	Viton	Viton
3	Drain Plug	Carbon Steel or Stainless Steel	Carbon Steel or Stainless Steel
4	Nozzle Subassy	316 Stainless Steel with Soft Seat	17-4 Stainless Steel with Soft Seat
5	Disk Subassy	316 Stainless Steel	440C Stainless Steel
6	Spring	17-7 Stainless Steel or Inconel X-750 (NACE)	17-7 Stainless Steel
7	O'Ring	Buna N	Buna N
8	Bonnet Bolt	Alloy Steel B7 or Stainless Steel B8M	Alloy Steel B7 or Stainless Steel B8M
9	Adjustment Screw	300 Series Stainless Steel	300 Series Stainless Steel
10	Adjustment Bushing	300 Series Stainless Steel	300 Series Stainless Steel
11	Bonnet Subassy	Carbon Steel or 316 Stainless Steel	Carbon Steel or 316 Stainless Steel
12	O'Ring	Buna N	Buna N
13	Washer	300 Series Stainless Steel	300 Series Stainless Steel
14	Lock Nut	18-8 Stainless Steel	18-8 Stainless Steel
15	Cap	Anodized Aluminum	Anodized Aluminum

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DATE	SYM	REVISION RECORD	ECN NO.	CK.
3/94	A	REDRAWN ON AUTOCAD		



NOTES

1. SET PRESSURE RANGE IS 25 PSI TO 350 PSI.
2. RELIEF CAPACITY IS GIVEN BY THE EQUATION
   Q = .759(1.1P + 14.7), WHERE
   Q = RELIEF CAPACITY IN SCFM, AND
   P = SET PRESSURE IN PSI
3. MATERIALS OF CONSTRUCTION
   BODY, ROD, CUP, SCREW--BRASS
   SPRING--MUSIC WIRE
   PAD--SILICONE OR FLUOROCARBON RUBBER
   PULL RING--STAINLESS STEEL
4. MAX TEMPERATURE 250° F
5. MAX INSTALLATION TORQUE = 10 FT LBS

ALL DIMENSIONS ARE IN INCHES.

TOLERANCES (EXCEPT AS NOTED)
DECIMAL ±
FRACTIONAL ±
ANGULAR ±
DATE 5/17/91

control devices inc.
711 HANLEY INDUSTRIAL COURT ST. LOUIS, MISSOURI 63144

MATERIAL
SCALE FULL
SIZE A
DRAWN BY RMH
APPROVED BY

TITLE
VALVE, ASME SAFETY, 1/8 NPT

CAD FILE C:\ACADWIN\PARTDWGS\ST2512.DWG

DRAWING NUMBER ST12 REV A

MURPHY®

by ENOVATION CONTROLS



MLS Series
Liquid Level Switches

Installation and Operations Manual

00-02-0730
2015-03-16
Section 15

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. The latest version of this manual can be found at www.fwmurphy.com.



CAUTION: MLS Series parts are not interchangeable with other Murphy liquid level products. Damage caused by using incorrect parts is not covered by our Limited Warranty.



Please read the following information before installing. A visual inspection for damage during shipping is recommended before mounting.

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.
- Please contact Enovation Controls immediately if you have any questions.

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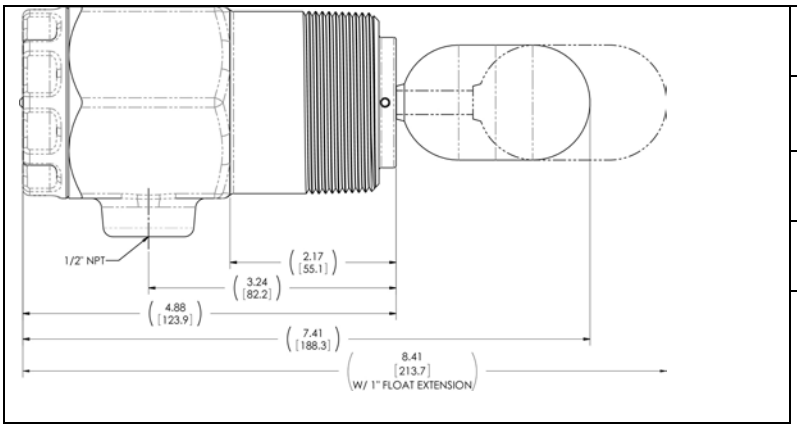
Product Information

Features

- Clean magnet design virtually eliminates iron filing accumulation onto the magnet
- Seal-free construction
- Designed for harsh gas compressor scrubber applications
- CF8 (304) cast stainless steel body and 304 stainless steel float
- MLS Series rated for 2000 psi (13.8 MPa) [138 bar] working pressure
- Electric model only available
- Improved design provides better dependability with reduced number of moving parts
- All models screw directly into the scrubber or can be mounted via external float chamber
- CSA C/US Class l, Div. 1, Grp. B, C & D locations
- Canadian Registration Number: MLS-020, MLS-015: 0F12013.2 C (all provinces and territories)

MLS-020, MLS-015

MLS Series Liquid Level Switches with 2 inch NPT and 1-1/2 inch NPT mounting are float activated to operate an electrical SPDT reed switch for alarm or shutdown of an engine or electric motor. The MLS Series connects directly into the scrubber wall and can be used with a Murphy weld collar (P/N 15050375) or Murphy external float chamber (P/N 15700799).



Thread Table - Table 1

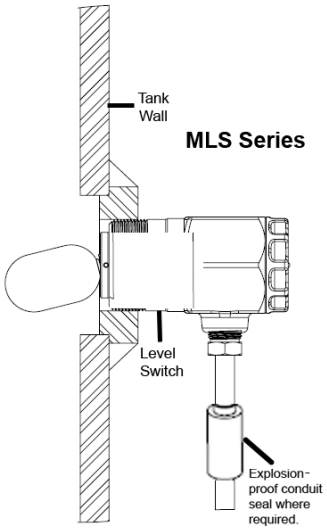
Model No	Thread A
MLS-015	1-½ inch NPT
MLS-020	2 inch NPT

NOTE: Refer to Table 2 for clearances.

Pressure Vessel Installation: MLS-020 and MLS-015

Direct Installation into the Wall of the Pressure Vessel

CAUTION: Determine that the float travel is not obstructed by the coupling in the vessel wall, internal baffles, etc.
Refer to tables 1 and 2 for application data.
INSTALLATION SHOULD BE ACCOMPLISHED BY QUALIFIED PERSONNEL ONLY.



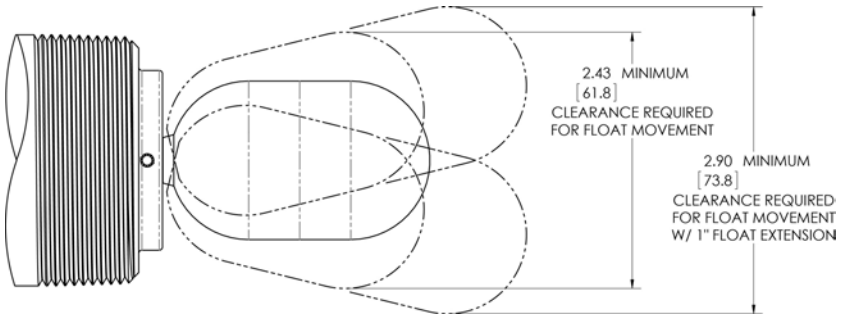
1. Make certain the float is tightly screwed onto the counter-balance.
2. Before installing the level switch, use of a pipe thread sealant is recommended. Screw the unit directly into the threaded connection in the wall of the pressure vessel.
3. Verify that the electrical connection is positioned at the bottom.

   NOTE: The word TOP is cast into the top of the body.

4. Make the electrical wiring connections according to appropriate wiring diagrams for the alarm or shutdown system to be used. The electrical connection is ½ inch-14 NPT.
5. Ensure all electrical connections are insulated, and the cover is fully installed before reconnecting electrical power.
6. Verify all pressure connections are tight before pressurizing the system.

Float Clearance Reference Tables

Pipe Data - Table 2				
Nom. Size (inches)	**O.D. (inches)**	**Schedule Number**	**Wall Thickness (inches)**	**Inside Diameter (inches)**
2.5	2.875	40STD	0.203	2.469
3	3.5	40STD	0.216	3.068
3	3.5	80XS	0.3	2.9
4	4.5	40STD	0.237	4.026
4	4.5	80XS	0.337	3.826

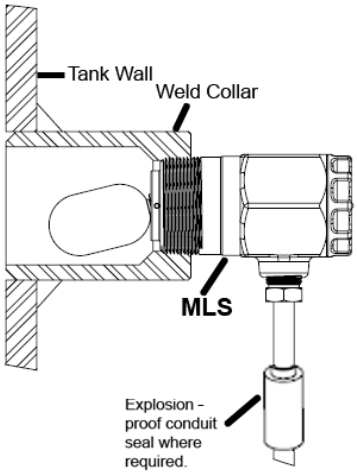


Installation with a Weld Collar

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.

> Weld collar 15050375 is not recommended with a 1 inch float extension.



Installation Using Murphy External Float Chamber

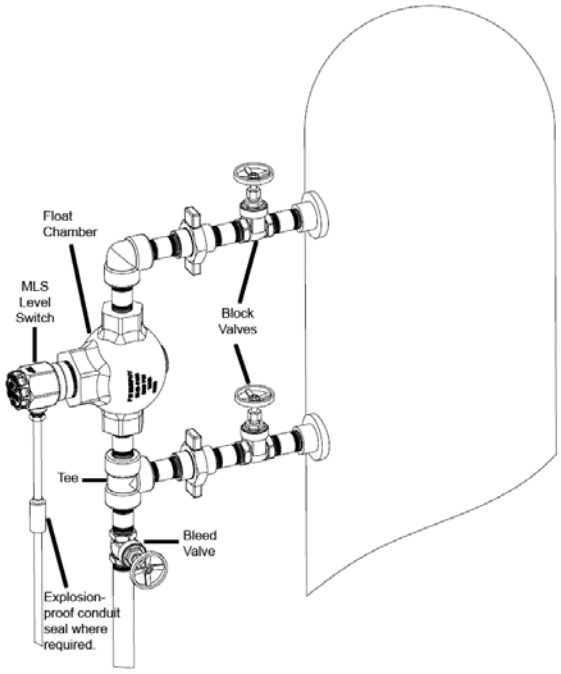
1. Install the Murphy float chamber 15051098 or 15700799 on the outside wall of the pressure vessel using 1" NPT piping. Position the 2 inch NPT threaded connection at the height where you want the level switch to operate. The 2 inch NPT threaded connection must be positioned away from the tank wall.

> **NOTE:** If using Float Chamber 15051098, best practices recommend a surface mount installation.

2. A tee and bleed valve are typically installed at the bottom of the lower 1 inch pipe riser to allow draining of the float chamber for servicing or replacement.

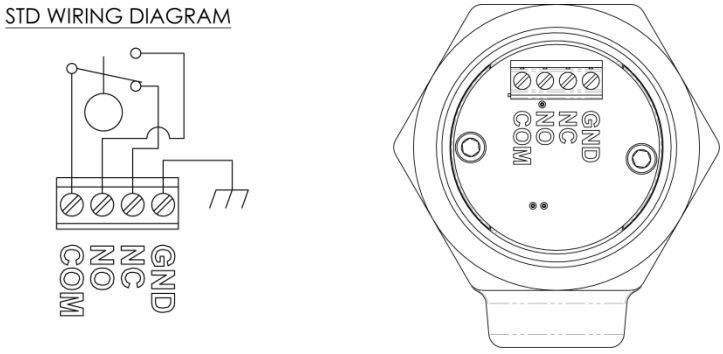
> **NOTE**: A typical installation with blocking and bleed valves is shown at right.

3. Install the MLS-020 in the 2 inch NPT connection of the float chamber. BE SURE float travel is not restricted and that the float is tight onto the counter-balance.



4. To complete the installation and wiring, follow the instructions for mounting directly into wall of the vessel and for wiring.

Electrical Wiring



Switch Rating: 30VDC/VAC @ 75 mA

Replacement Parts

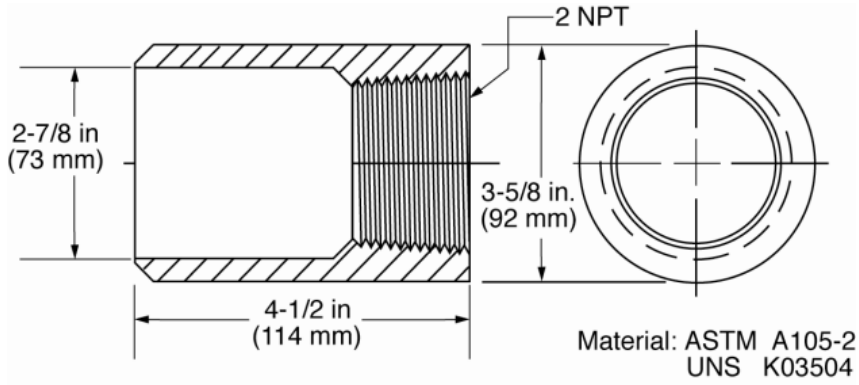
Order by part number designation.

15000531: MLS Float

Stainless Steel Float, MLS Series (not interchangeable with any other Murphy Level Switch Float)

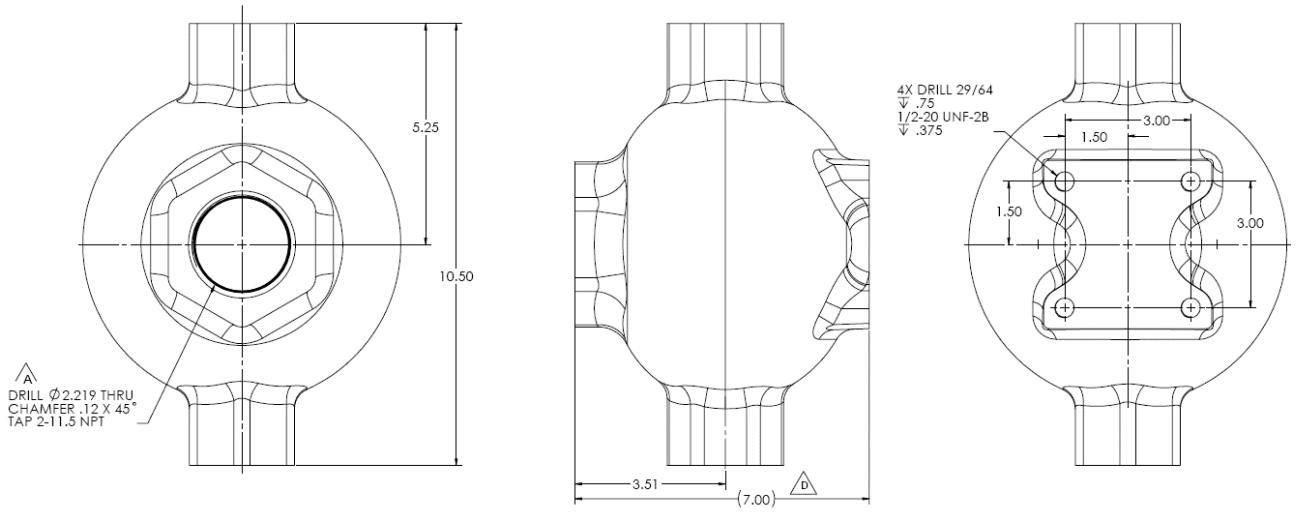
Accessories

15050375: Weld Collar



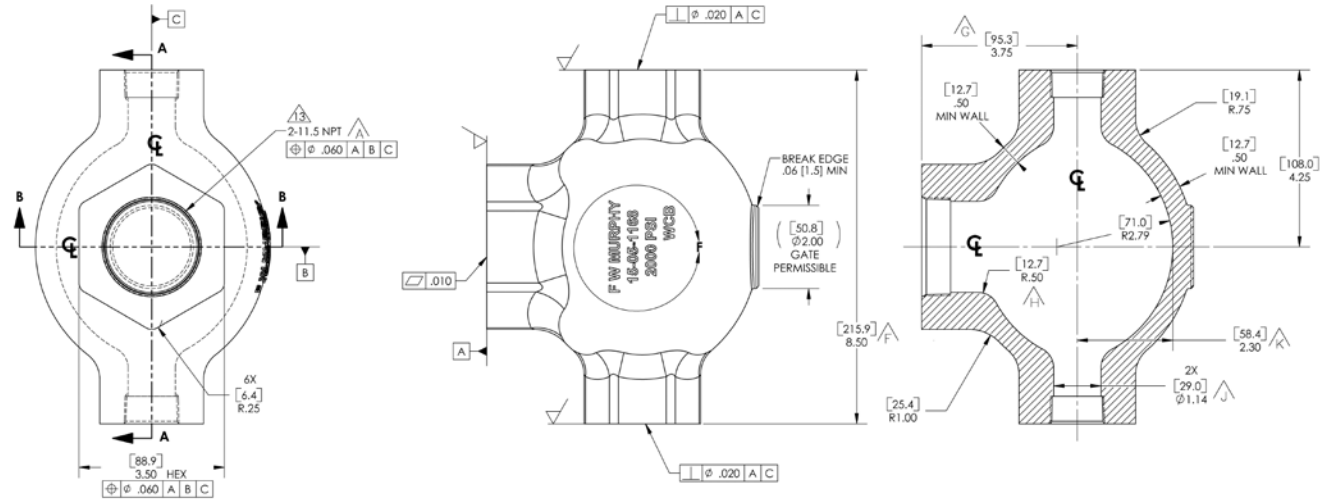
Operating pressure: 2000 psi (13.8 MPa) [138 bar].
Operating temperature: 400°F (204°C).
Not recommended with 1 inch Float Extension.

15051098: External Float Chamber



Operating pressure: 2000 psi (13.8 MPa) [138 bar]
Operating temperature: 400°F (204°C).

15700799: Series 100 External Float Chamber



Operating pressure: 2000 psi (13.8 MPa) [138 bar]
Operating temperature: 400°F (204°C).

Specifications

MLS Series

Process connection: 2” NPT (MLS-020)
1-1/2” NPT (MLS-015)
Fluid Density (SG): 0.50 min. (No Extension) 0.65 min (1” Extension)
Pressure Rating: 2000 psig (13.8 MPa)[138 bar]
Materials:
Body: ASTM A351 CF8 (304 SS)
Cover: ASTM A351 CF8 (304 SS)
Other Wetted Parts: 304 or 316 SS
Process Temperature: -20 to 300°F (-29 to 149°C)
Electrical: 30VAC/VDC 75mA Form C SPDT

Approximate Shipping Weights and Dimensions

Weight: MLS-020, 5.5lbs (2.49 kg); MLS-015, 5 lbs (2.27 kg)
Dimensions: 14 x 5 x 3.5 in. (356 x 127 x 89 mm)

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Printed in the USA

FULFLO SPECIALTIES COMPANY . . .

Pioneers in Fluid Power

Established in 1912, FULFLO was incorporated in 1933 under its present name and trademark. Patents for the original guided piston, direct-acting relief valve were obtained in 1935, coincident with the onset of fluid power systems. The need for providing large flows without excessive bulk was subsequently met by the pilot-valve-controlled relief valve, a patent on which was issued to FULFLO in 1943 (U.S. Patent No. 2,333,522).

FULFLO is located in Blanchester, Ohio just 30 miles northeast of Cincinnati, close to some of the state's largest manufacturing centers. Blanchester is served by air from Greater Cincinnati Airport and alternately from Dayton Municipal Airport.

From Cincinnati, travel Interstate 71 north to Interstate 275, east to US 28 and northeast to Blanchester.

From Dayton, travel Interstate 75 south to Route 123 and southeast to Blanchester.

If you plan to visit FULFLO, advise us of your itinerary and we will be happy to assist with transportation and hotel arrangements.

TERMS AND CONDITIONS

Product Information. Please include complete product data as described in the catalog. **Note:** All valves will be set midrange pressure of the spring, unless otherwise specified.

Shipping Information. Please include purchaser's name, complete address and requested routing. Product many be shipped via U.P.S., insured parcel post or commercial motor freight.

Guarantee. Fulflo products are guaranteed against defects in workmanship or material for one year after date of shipment. Fulflo is not liable for any damages resulting from misuse or misapplication of its product.

Specifications. For continued improvement of our product line, we reserve the right to change product specifications without prior notice.

Cancellations. Charges are based on work accomplished prior to the receipt of cancellation.

Returned Material. An RGA (Return Goods Authorization) Number **must** be issued before returning any product.

Restocking. Product returned is subject to a restocking charge. Restocking fee is 25% of List Price on standard product line. Special products are subject to additional charges.

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Prices. F.O.B. Blanchester, Ohio. Prices are subject to change without notice.

Terms. Net 30 days to buyers with approved credit: all other shipments are C.O.D.

Invoicing. Buyers will be invoiced by Fulflo Specialties, 459 E. Fancy Street, Blanchester, Ohio 45107.

Delivery. Deliveries are scheduled after receipt of orders which should include all required technical information. Shipping dates are **estimated** based on conditions prevailing at the time of quotation, but are not guaranteed. Fulflo shall not be liable for delays in delivery due to causes beyond its reasonable control. Fulflo shall not be liable for any special or consequential damages caused by or resulting from delay, failure to manufacture or deliver.

Minimum Order. Minimum order charge required is $25.00.

Expediting Fee. Orders may be subject to a 15% expediting fee.

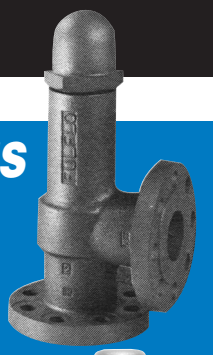
Change Order Fee. There is a $25.00 change order fee, per order.

DUE TO ENGINEERING UPGRADING, THE DIMENSIONS AND SPECIFICATIONS ARE SUBJECT TO CHANGE, BUT ARE CORRECT HERE AT TIME OF PRINTING.

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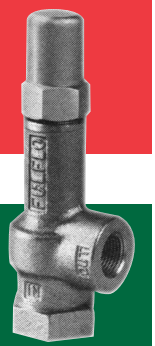
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FV-SERIES VALVES



A-SERIES VALVES



SVB SERIES VALVES

APPLICATIONS

SPECIALTY VALVES

OUR MISSION STATEMENT: ***Fulflo Specialties will strive to be the world leader in the valve manufacturing industry. Our mission is to achieve and sustain through continuous improvement, the highest quality of product and services. Fulflo will ensure that every employee, vendor, and subcontractor share a common goal of quality and reliability at an affordable price.***

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Please contact Fulflo direct for special applications. We provide special valves or modified valves to meet your application.

VALVE SIZING...Use of Performance Charts

FULFLO GUIDED PISTON VALVES

The trademark FULFLO expresses the basic principle that the relief valve must have flow capacity equal to that of the pipe lines to which it is connected. The sliding piston concept and internal design contours of FULFLO valves provide unique flow and stability characteristics for reliable performance without chatter.

FULFLO valves are designed to operate reliably at pressures as low as 2 PSI and as high as 1000 PSI. The FULFLO valve reduces velocities through all but the controlling interface of the valve thereby minimizing system power loss.

Unlike ordinary direct acting relief valves, FULFLO guided piston valves are less responsive to transient pressure surges thereby eliminating the tendency to pound, squeal or chatter. Quiet, stable, efficient performance is assured in both load regulation and system protection applications.

FULFLO valves operate effectively with all types of liquids in the full range of viscosities including hydraulic oils, water, solvents and chemicals.

FULFLO valves are not designed to be positive shut off, and will pass a minimal amount of leakage before the set pressure.

FULFLO valves are NOT designed for use with air, gas or steam.

Since the FULFLO relief valve is a flow-modulating device, pressure flow characteristics are completely different from spring loaded poppet or ball check valves. Both types remain substantially tight up to *cracking pressure*. When this pressure is exceeded, the "conventional" valve pops open with a pressure drop at very low flow and an exponential pressure rise as the flow increases.

In contrast the FULFLO valve causes a pressure rise, *over-pressure*, as soon as flow starts; pressure increases almost proportionally with flow. Springs and areas on FULFLO valves are carefully designed to minimize this over-pressure.

Both pressures are important in sizing a valve. *Cracking pressure* must be selected high enough to permit system operation at its maximum rated pressure and flow. *Over-pressure* is limited by the system's capability to withstand the additional pressure and the motor's ability to sustain the pump output at the increased pressure for the required time interval.

The over-pressure to produce a certain flow is a function of valve size and spring constant and can be determined with the aid of the over-pressure charts given for the different valve sizes. The valve performance charts are based on tests made with oil of 150 SSU viscosity at 100° F and may be used with reasonable accuracy within the conventional range of oil viscosities from 30 to 500 SSU. For operation with high viscosity fluids, consult FULFLO's engineering department.

In sizing a valve, the first attempt should be to select a valve equal in size to the pipe to which it is connected. A larger or smaller valve may be used to suit individual requirements, depending on the permissible amount of over-pressure. Assume we have selected a 3/4" valve for 17 GPM flow and a cracking pressure of 325 PSI. By referring to the pressure range chart, we find that we may use either a "YS" or a "ZS" spring.

Assuming a "YS" spring, draw a line horizontally at 17 GPM in the 3/4" valve chart, to intersect the slanted line marked "YS" and drop a vertical line to the over-pressure scale to read an over-pressure of 44 PSI. The 17 GPM will be discharged at a pressure of 325 + 44 or 369 PSI. The percentage of over-pressure would be 44/325 X 100 or 13.5%.

If a "ZS" spring is used, extend the horizontal line to the "ZS" slope and the over-pressure is 70 PSU. The pressure to pass 17 GPM would be 325 + 70 or 395 PSI and the over-pressure would be 21.5%. If the over-pressure is higher than desired for the particular application, the procedure may be repeated for the next larger size valve.

In some cases, maximum flow through a valve at a given pressure is specified. To determine the cracking pressure, assume a 3/4" valve is to pass 12 GPM at 50 PSI. A horizontal line drawn from the 12 GPM capacity to the intersection with the "WS" spring line results in an over-pressure of 14 PSI, therefore the cracking pressure must be 50 – 14 or 36 PSI, and the percentage of over-pressure of only 9 PSI, but the cracking pressure would be 14/36 x 100 or 38.8%. The use of a "US" spring would produce an over pressure of only 9 PSI but the cracking pressure would then be 50 – 9 or 41 PSI, which would exceed the rating of the "US" spring.

For sizing valves for higher viscosity than 500 SSU, the following formula is used:

$$\sqrt[4]{\frac{V2}{V1}} \times \text{area of valve for 150 SSU}$$

V1 = 150 SSU

V2 = higher viscosity

Assume we have the following application,

GPM = 10

Viscosity = 12,000 SSU

Normally for 10 GPM a 1/2" valve would be used. Referring to the orifice area chart on page 9, to find the area of a 1/2" valve. The area is .305.

$$\sqrt[4]{\frac{12000}{150}} = \sqrt[4]{80} = 2.99$$

2.99 x .305=.9120 area needed to pass 10 GPM

Again referring to the orifice area chart, we find that the area of 1¼" valve is 1.224. Therefore a 1¼" valve would be used. To find the over-pressure refer to the performance chart for a 1¼" valve.

Performance charts based on actual test results are available on request. For additional information contact THE FULFLO SPECIALTIES CO.

PIPE SIZING...Use of the Nomograph

The flow velocity, which must first be determined, is dependent on the viscosity of the fluid and the permissible flow resistance in the piping. Lower velocities are for higher viscosity fluids and/or lower pressure drops; higher velocities are for less viscous fluids and cases where higher pressure drops can be tolerated. In all cases, allowable suction velocities are much lower and the lowest velocities should be used for the more viscous fluids and/or higher suction lifts.

Suction velocities are much more critical than discharge velocities. Too high a discharge velocity may only result in excessive power loss but an excessive suction velocity may make the system inoperative or cause damage to the pump and system.

After the velocity has been selected, the nomograph chart is used to determine the inside diameter of the pipe at a given flow rate. For example, assume a flow of 17 gpm and a velocity of 12 fps for the discharge pipe is required. Draw a line from the 12 fps point on the velocity scale through the 17 gpm point on the flow rate scale and the extended line intersects the pipe inside diameter scale at 0.76 inches. This inside diameter applies to either pipe or tubing.

The correct pipe or tube size also depends on the pressure it must carry. The conversion chart for pipe sizes and schedules facilitates this section.

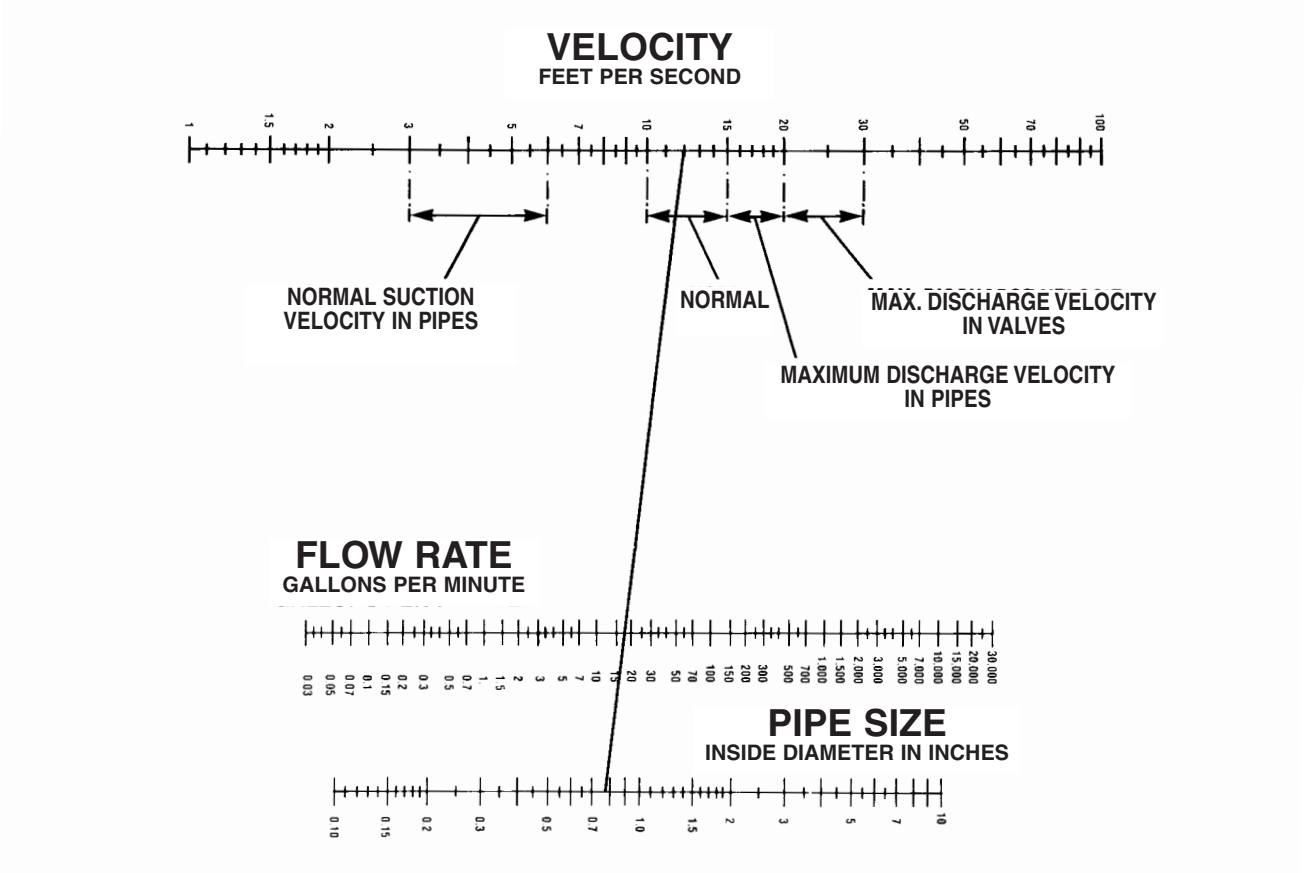
Note the different weights or piping are grouped under various schedule numbers. Approximate pressure for each schedule number may be computed from the formula.

$$\text{Pressure} = \frac{S}{1000} \times \text{schedule number}$$

S is the permissible stress to which the pipe is subjected. Thus, for a stress of 10,000 psi, the allowable pressure is equal to ten times the schedule number. Higher pressures may be carried if higher stresses are allowed.

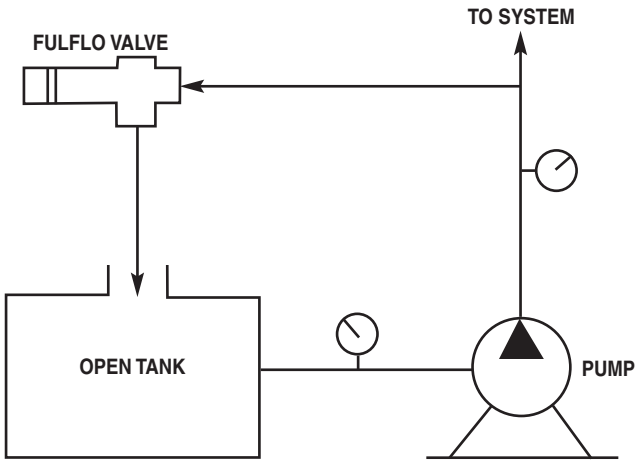
In the example, a schedule 40 pipe is more than adequate for 250 psi. Twice the wall thickness of a 3/4" schedule 40 pipe of 0.226 or 0.976". Since the actual outside diameter of a 3/4" schedule 40 pipe is 1.05", the selection of a 3/4" pipe is adequate.

A 3/4" Fulflo relief valve should be selected. Operational characteristics of this valve, that is cracking pressure and overpressure, may be determined from the performance chart precisely in the manner explained in the example. The maximum discharge pressure of 285 psi is still well below the safe carrying capacity of the pipe. The design of the Fulflo valves is such that if used within their rating and with properly selected springs, the overpressure is not sufficient to endanger system or system components.



APPLICATIONS

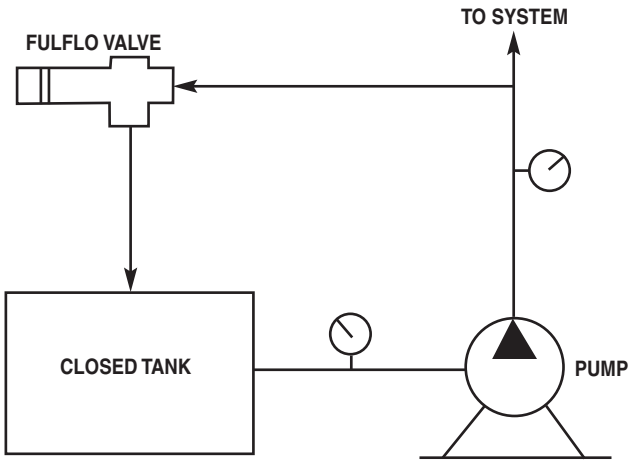
SYSTEM 1



OPEN TANK

VALVE SET PRESSURE EQUALS SYSTEM OPERATING PRESSURE

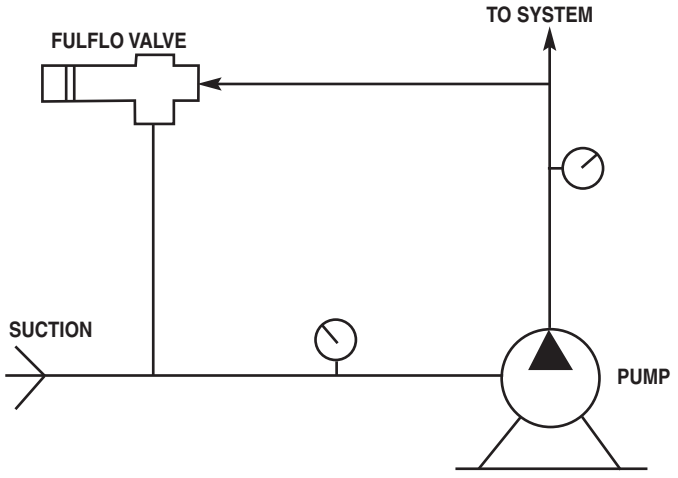
SYSTEM 2



CLOSED TANK

TANK PRESSURE + VALVE SET PRESSURE EQUALS SYSTEM OPERATING PRESSURE

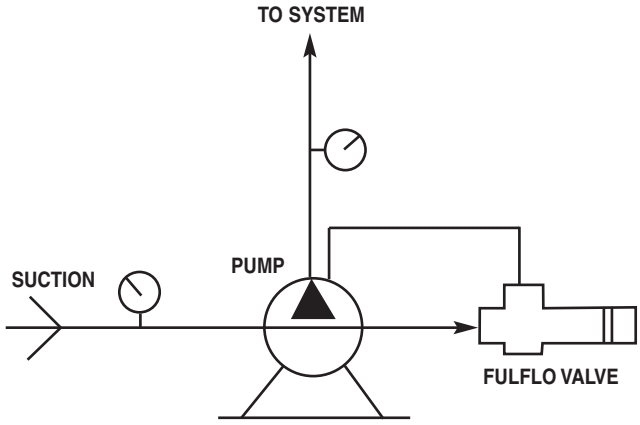
SYSTEM 3



CLOSED LOOP

SUCTION PRESSURE + VALVE SET PRESSURE EQUALS SYSTEM OPERATING PRESSURE

SYSTEM 4



PUMP INTERNAL RELIEF

FOR PUMPS WITH (2) SUCTION PORTS AND (2) DISCHARGE PORTS

SUCTION PRESSURE + VALVE SET PRESSURE EQUALS SYSTEM OPERATING PRESSURE

SPRING MATERIAL & TEMPERATURE CHART

VALVE SIZE	PART NO.	MATERIAL					MAX TEMP.				ASTM SPEC.				
		17-7PHSS	18-8SS	CHR. VANADIUM	OIL TEMP.	MUSIC WIRE	650 F	550 F	425 F	250 F	313 TYPE 631	A581 COND. A	A 231	229	228
1/4"	207-AS		•					•				•			
	207-US		•					•				•			
	207-WS		•					•				•			
	207-XS		•					•				•			
	207-YS	•					•				•				
	207-ZS	•					•				•				
	207-RS	•					•				•				
	207-TS	•					•				•				
3/8"	207-A					•				•					•
	207-U					•				•					•
	207-W				•					•				•	
	207-X				•					•				•	
	207-Y			•					•				•		
	207-Z			•					•				•		
	207-RS		•					•				•			
	207-TS		•					•				•			
1/2"	307-AS		•					•				•			
	307-US		•					•				•			
	307-WS		•					•				•			
	307-XS	•					•				•				
	307-YS	•					•				•				
	307-ZS	•					•				•				
	307-RS	•					•				•				
	307-TS	•					•				•				
	307-A					•				•					•
	307-U				•					•				•	
	307-W				•					•				•	
	307-X					•				•					•
	307-Y				•					•				•	
	307-Z				•					•				•	
	307-RS		•					•				•			
	307-TS		•					•				•			
3/4"	407-AS		•					•				•			
	407-US		•					•				•			
	407-WS		•					•				•			
	407-XS	•					•				•				
	407-YS	•					•				•				
	407-ZS	•					•				•				
	407-U				•					•				•	
	407-W				•					•				•	
	407-X			•					•				•		
	407-Y			•					•				•		
	407-Z				•					•				•	
1"	507-AS		•					•				•			
	507-US		•					•					•		
	507-WS		•					•					•		
	507-XS	•					•				•				
	507-YS	•					•				•				
	507-ZS	•					•				•				
	507-A				•					•				•	
	507-U				•					•				•	
	507-W				•					•				•	
	507-X			•					•				•		
	507-Y				•					•				•	
	507-Z				•					•				•	
	507-R			•					•				•		

VALVE SIZE	PART NO.	MATERIAL					MAX TEMP.				ASTM SPEC.				
		17-7PHSS	18-8SS	CHR. VANADIUM	OIL TEMP.	CHROME SILICON	650 F	550 F	425 F	250 F	313 TYPE 631	A581 COND. A	A 231	229	228
1 1/4"	607-AS		•					•				•			
	607-US		•					•				•			
	607-WS		•					•				•			
	607-XS	•					•				•				
	607-YS	•					•				•				
	607-ZS	•					•				•				
	607-A				•					•				•	
	607-U				•					•				•	
	607-W				•					•				•	
	607-Y				•					•				•	
	607-Z				•					•				•	
	607-R			•					•				•		
1 1/2"	707-AS		•					•				•			
	707-US		•					•				•			
	707-WS		•					•				•			
	707-XS	•					•				•				
	707YS	•					•				•				
	707-ZS	•					•				•				
	707-A				•					•				•	
	707-U				•					•				•	
	707-W				•					•				•	
	707-X				•					•				•	
	707-Y				•	•				•				•	
	707-Z				•					•				•	
	707-R				•					•				•	
2"	807-AS		•					•				•			
	807-US		•					•				•			
	807-WS		•					•				•			
	807-XS	•					•				•				
	807-YS	•					•				•				
	807-ZS	•					•				•				
	807-A				•					•				•	
	807-U				•					•				•	
	807-W				•					•				•	
	807-X				•					•				•	
	807-Y				•					•				•	
	807-Z	•					•				•				
2 1/2"	A0960D		•					•				•			
	A0961C			•					•				•		
	A0970D		•					•				•			
	A0971C			•					•				•		
	A0980D		•					•				•			
3"	A1060D		•					•				•			
	A1061C			•					•				•		
	A1070D		•					•				•			
	A1071C			•					•				•		
	A1080D		•					•				•			
4"	A1160D		•					•				•			
	A1170D		•					•				•			
	A1181D		•					•				•			
4" 3" 2 1/2"	A1190D		•					•				•			

SAE O-RING BOSS CONNECTIONS

VALVE SIZE	SAE NUMBER								
	5	6	8	10	12	16	20	24	32
3/8”	X	X	X						
1/2”		X	X	X					
3/4”				X	X				
1”					X	X	X		
1 1/4”							X	X	
1 1/2”								X	
2”									X

SAE (Society Automotive Engineers)

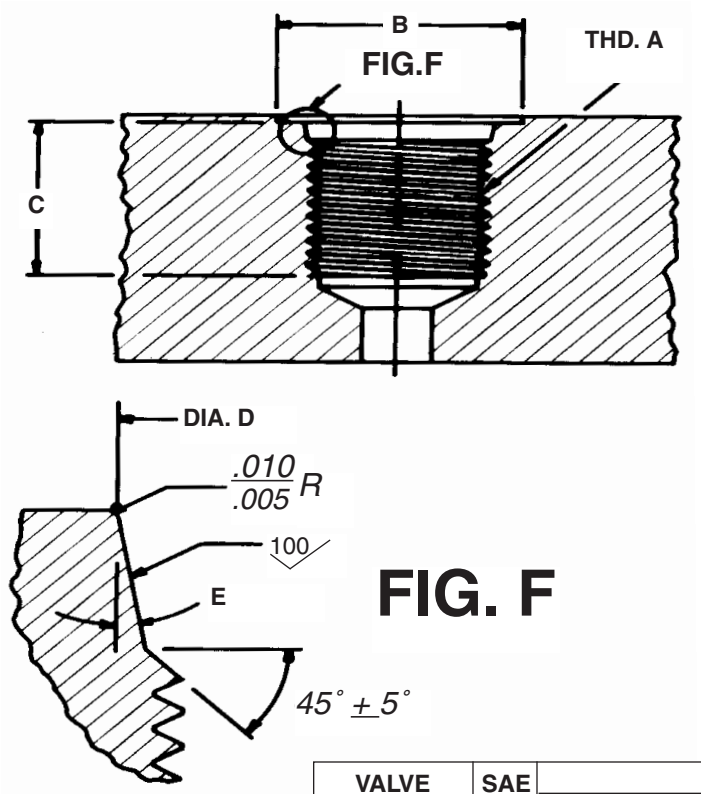


FIG. F

DIMENSIONS (INCHES)

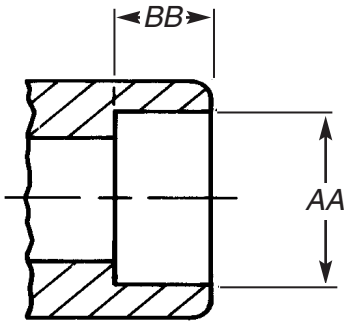
SAE NO.	A	B	C	D	E
5	1/2”-20	.937	.547	.550	12˚F
6	9/16”-18	1.000	.609	.616	12˚F
8	3/4”-16	1.218	.688	.811	12˚F
10	7/8”-14	1.375	.781	.942	15˚F
12	1 1/16”-12	1.656	.906	1.148	15˚F
16	1 5/16”-12	2.000	.906	1.398	15˚F
20	1 5/8”-12	2.312	.906	1.713	15˚F
24	1 7/8”-12	2.562	.906	1.962	15˚F
32	2 1/2”-12	3.192	.906	2.587	15˚F

VALVE SIZE	SAE NO.	MATERIAL			
		CAST IRON	BRASS	STEEL	STAINLESS
3/8”	5	SVJ-2039	SVB-2039	SVS-2039	SVSS-2039
	6	SVJ-2036	SVB-2036	SVS-2036	SVSS-2036
	8	SVJ-2042	SVB-2042	SVS-2042	SVSS-2042
1/2”	6	SVJ-3065	SVB-3065	SVS-3065	SVSS-3065
	8	SVJ-3066	SVB-3066	SVS-3066	SVSS-3066
	10	SVJ-3051	SVB-3051	SVS-3051	SVSS-3051
3/4”	10	SVJ-4041	SVB-4041	SVS-4041	SVSS-4041
	12	SVJ-4049	SVB-4049	SVS-4049	SVSS-4049
1”	12	SVJ-5084	SVB-5084	SVS-5084	SVSS-5084
	16	SVJ-5071	SVB-5071	SVS-5071	SVSS-5071
	20	SVJ-5083	SVB-5083	SVS-5083	SVSS-5083
1 1/4”	20	SVJ-6065	SVB-6065	SVS-6065	SVSS-6065
	24	SVJ-6066	SVB-6066	SVS-6066	SVSS-6066
1 1/2”	24	SVJ-7050	SVB-7050	SVS-7050	SVSS-7050
2”	32	SVJ-8047	SVB-8047	SVS-8047	SVSS-8047

SOCKET WELD & STANDARD MATERIALS

SOCKET WELD

VALVE SIZE	MODEL NUMBER		AA		BB
	STEEL	STAINLESS	MIN.	MAX.	
3/8"	SVS-2033	SVSS-2033	.685	.690	.312
1/2"	SVS-3037	SVSS-3037	.850	.855	.437
3/4"	SVS-4038	SVSS-4038	1.060	1.065	.562
1"	SVS-5024	SVSS-5024	1.325	1.330	.625
1 1/4"	SVS-6058	SVSS-6058	1.670	1.675	.750
1 1/2"	SVS-7067	SVSS-7067	1.910	1.915	.812
2"	SVS-8070	SVSS-8070	2.410	2.415	.875



ASTM/ASME SPECIFICATIONS

Adjusting Screws
Stop Rings, Glands, Bonnets
- Brass – ASTM B16
- Steel – ASTM 108-79
- Stainless Steel – ASME ASME SA479 Class 316

Caps
- Cast Iron – 401 thru 801 ASTM A 126-42 Class A
- Brass – 201-B thru 501-B ASTM B16
- Brass – 601B thru 801-B ASME B62
- Steel – All models ASTM 108-79
- Stainless Steel – All models ASME SA479 Class 316

Locknuts, Retainers
- Steel – ASTM 108-79
- Stainless Steel – ASTM A582 Class 303
- Brass – ASTM B16

Pistons
- Hardened Steel – ASTM 108-79
- 416 Stainless Steel – ASTM A 582 Cond. A
- 303 Stainless Steel – ASTM A 582 Class 303

Bodies
- Cast Iron – ASTM A126-42 Class A
- Brass – ASME B62
- Steel – ASTM A 216 Grade WCB
- Stainless Steel – ASTM A 351 CF8M

Material Codes
(Unless Otherwise Specified)
- A – 416 Stainless Steel
- J – Cast Iron (No Part # Suffix)
- B – Brass
- S – Steel
- SS – Stainless Steel

O-RING & PAD MATERIAL SPECIFICATIONS

MATERIAL	SUFFIX CODE	COMPOUND	TEMP. RANGE		ASTM SPEC.
			MIN.	MAX.	
BUNA	R	B 46	-40˚F	257˚F	D2000
ETHYLENE-PROPYLENE	EPR	E 50	-67˚F	302˚F	D2000
VITON	RV	V 14	-31˚F	437˚F	D2000
SILICONE	RS	S 71	-103˚F	482˚F	D2000
TEFLON	RT	– –	-423˚F	500˚F	D2000
NEOPRENE	RN	– –	-67˚F	284˚F	D2000
AFLAS	RA	– –	-25˚F	450˚F	D2000

MAXIMUM TEMP. OF BODIES

MATERIAL	TEMPERATURE
CAST IRON	400˚F
BRASS	400˚F
STEEL	600˚F
STAINLESS STEEL	600˚F

MAXIMUM ALLOWABLE WORKING PRESSURE

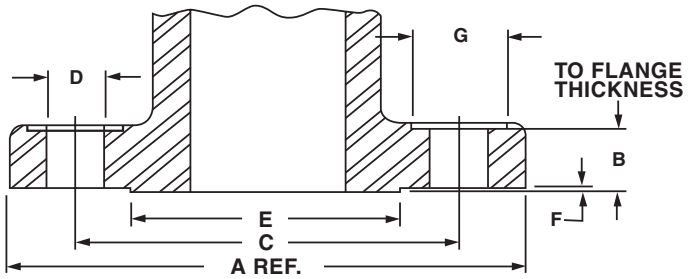
CAST IRON	1500 PSI
BRASS	1500 PSI
STEEL	2000 PSI
STAINLESS STEEL	2000 PSI

ORIFICE AREA & PISTON/BODY TOLERANCES

DIMENSIONS IN INCHES

VALVE SIZE	PISTON DIA. ±.000-.0003	AREA IN 2	BODY GO RC 3 FIT	BODY NO GO RC 3 FIT
1/4	.4985	.195	.4993	.4999
3/8	.4985	.195	.4993	.4999
1/2	.6235	.305	.6243	.6249
3/4	.7485	.440	.7493	.7499
1	.9985	.783	.9993	1.0003
1 1/4	1.2485	1.224	1.2495	1.2507
1 1/2	1.4985	1.764	1.4995	1.5007
2	1.9985	3.167	1.9997	2.0011
2 1/2	2.6500	5.515	2.6517	2.6527
3	3.1235	7.663	3.1247	3.1261
4	4.1222	13.346	4.1250	4.1262

FLANGE AND DRILLING DIMENSIONS (INCHES)



CLASS 150 (BRASS – CAST IRON – STEEL – STAINLESS STEEL)

Valve Size	A Flange Diameter	B Flange Thickness		C Bolt Circle Diameter	D Bolt Holes Diameter	E Raised Face Diameter	F Raised Face Height	G Spotface Diameter	Number of Bolts
		Brass	CI/Steel						
1”	4 1/4”	3/8”	9/16”	3 1/8”	5/8”	2”	1/16”	1.12	4
1 1/4”	4 5/8”	13/32”	1/2”	3 1/2”	5/8”	2 1/2”	1/16”	1.12	4
1 1/2”	5”	7/16”	9/16”	3 7/8”	5/8”	2 7/8”	1/16”	1.12	4
2”	6”	1/2”	5/8”	4 3/4”	3/4”	3 5/8”	1/16”	1.37	4
2 1/2”*	7”	N/A	11/16”	5 1/2”	3/4”	4 1/8”	1/16”	1.37	4
3”*	7 1/2”	N/A	3/4”	6”	3/4”	5”	1/16”	1.37	4
4”*	9”	N/A	15/16”	7 1/2”	3/4”	6 3/16”	1/16”	1.37	8

Note: Brass flanges conform to 150# ANSI B 16.24 *except* with raised face. Cast iron and steel flanges conform to 150# ANSI B 16.5 steel specifications.
*Available in Cast Iron & Steel only. 125-250 AARH flange finish (Steel & Stainless Steel only)

CLASS 250 (CAST IRON)

Valve Size	A Flange Diameter	B Flange Thickness	C Bolt Circle Diameter	D Bolt Holes Diameter	E Raised Face Diameter	F Raised Face Height	G Spotface Diameter	Number of Bolts
1”	4 7/8”	11/16”	3 1/2”	3/4”	2 11/16”	1/16”	1.37	4
1 1/4”	5 1/4”	3/4”	3 7/8”	3/4”	3 1/16”	1/16”	1.37	4
1 1/2”	6 1/8”	13/16”	4 1/2”	7/8”	3 9/16”	1/16”	1.56	4
2”	6 3/4”	7/8”	5	3/4”	4 3/16”	1/16”	1.37	8

Note: Cast iron flanges conform to 250# ANSI B 16.2 steel specifications.

CLASS 300 (BRASS – STEEL – STAINLESS STEEL)

Valve Size	A Flange Diameter	B Flange Thickness	C Bolt Circle Diameter	D Bolt Holes Diameter	E Raised Face Diameter	F Raised Face Height	G Spotface Diameter	Number of Bolts
1”	4 7/8”	11/16”	3 1/2”	3/4”	2”	1/16”	1.37	4
1 1/4”	5 1/4”	3/4”	3 7/8”	3/4”	2 1/2”	1/16”	1.37	4
1 1/2”	6 1/8”	13/16”	4 1/2”	7/8”	2 7/8”	1/16”	1.56	4
2”	6 3/4”	7/8”	5”	3/4”	3 5/8”	1/16”	1.37	8
2 1/2”	7 3/4”	1”	5 7/8”	7/8”	4 1/8”	1/16”	1.56	8
3”	8 1/2”	1 1/8”	6 5/8”	7/8”	5”	1/16”	1.56	8
4”	10”	1 1/4”	7 7/8”	7/8”	6 3/16”	1/16”	1.56	8

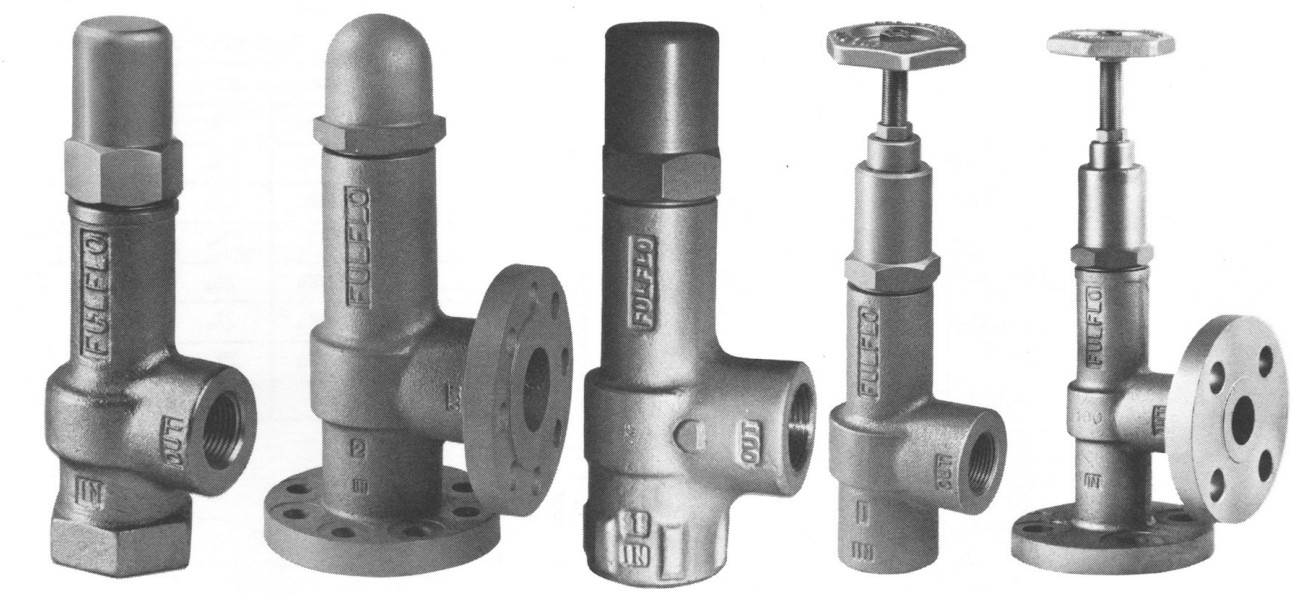
Note: Available in steel and cast iron only. Brass flanges conform to 300# ANSI B 16.24 *except* with raised face.
Steel flanges conform to 300# ANSI B 16.5 steel specifications. 125-250 AARH flange finish (Steel & Stainless Steel only)

CLASS 600 (CAST IRON – STEEL – STAINLESS STEEL

Valve Size	A Flange Diameter	B Flange Thickness	C Bolt Circle Diameter	D Bolt Holes Diameter	E Raised Face Diameter	F Raised Face Height	G Spotface Diameter	Number of Bolts
1”	4 7/8”	11/16”	3 1/2”	3/4”	2”	1/4”	1.37	4
1 1/4”	5 1/4”	13/16”	3 7/8”	3/4”	2 1/2”	1/4”	1.37	4
1 1/2”	6 1/8”	7/8”	4 1/2”	7/8”	2 7/8”	1/4”	1.56	4
2”	6 1/2”	1”	5”	3/4”	3 5/8”	1/4”	1.37	8
2 1/2”	7 3/4”	1 1/8”	5 7/8”	7/8”	4 1/8”	1/4”	1.56	8
3”	8 1/2”	1 1/4”	6 5/8”	7/8”	5”	1/4”	1.56	8
4”	10 3/4”	1 1/2”	8 1/2”	1”	6 3/16”	1/4”	1.78	8

Note: Cast iron and steel flanges conform to 600# ANSI B 16.5 steel specifications. 125-250 AARH flange finish (Steel & Stainless Steel only)
Note: Special Flanges With Drilling On Or Off Center And Smooth Or Raised Face Are Available Upon Request.

V-SERIES VALVES



Standard with Screw Connections | Standard with Flange Connections | Stainless Steel with Screw Connections | Handwheel with Screw Connections | Handwheel with Flange Connections

APPLICATION

The Fulflo "V" Series range in size from 1/4" through 2" and operate efficiently with liquids of any viscosity at pressures from 2 to 1000 P.S.I. The "V" series valves are available in flange or screw type...cartridge or handwheel in a choice of brass, cast iron, steel and stainless steel.

Widely used in a variety of applications, the "V" series valves are ideally suited in hydraulic and lubricating systems for load regulation and system protection. Special trim or packings are available for use with fire resisting fluids and other liquids of this type. Unusual applications and special requirements should be referred to our engineering staff for recommendation.

INSTALLATION

Fulflo valves can be mounted in any position. A tee may be inserted in the pump discharge line to mount the valve. The correct size of valve should be installed, preferably matching the pump discharge line. Screw the valve into the nipple in the tee, or in the case of the flange style, bolt the valve to the companion flange screwed into the nipple. When the valve is used for frequent bypassing of oil pressure, its outlet should be piped back to the tank. Care must be taken to have the discharge well below the oil level in the tank to prevent air entrainment and erratic operation.

Only if the valve is used as safety or overload relief and operates infrequently may its discharge be piped back into the pump suction line. Frequent or continuous operation under these conditions will cause excessive heating of the oil and possible damage.

SETTING VALVES

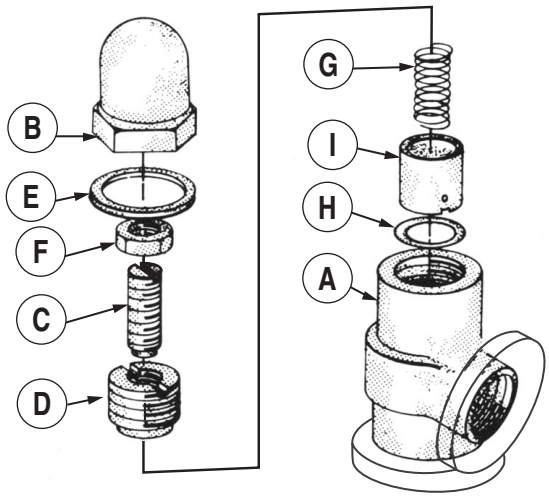
Valves may be set with a hydraulic hand pump for cracking pressure. If a test stand is available, valve should be connected to the discharge header with the pump bypass open, and the bypass gradually closed until the desired pressure registers on the gauge. Adjust valve adjusting screw until valve slightly bleeds at the set bypass pressure and lock adjusting screw.

Fulflo valves are not designed to be positive shut-off, and will pass a minimal amount of leakage before the set pressure. If a valve is required to bypass a given amount of fluid at a given pressure, a test stand having a flow meter in the pump discharge line must be available. With a valve adjusted for cracking pressure as above, continue closing bypass until the required flow registers on the flow meter and observe pressure. Readjust pressure, if necessary, to obtain desired pressure at desired flow.

MAINTENANCE

Fulflo valves provide reliable "chatter-free" operation when the system is free of abrasives and foreign matter. Continuous filtration of the liquid used is strongly recommended.

TYPICAL DISASSEMBLY OF STANDARD TYPE VALVE

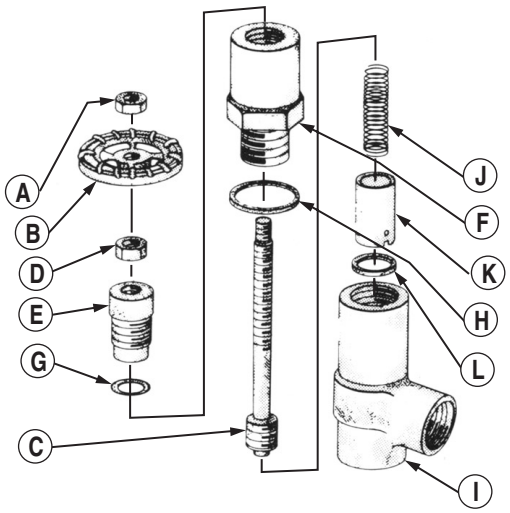


To dismantle valve for inspection or cleaning:

1. Remove cap "B"
2. Remove O-Ring "E"
3. Remove lock nut "F"
4. Remove adjusting screw "C"
5. Remove retainer "D"
6. Remove spring "G"
7. Remove piston "I"
8. Remove stop ring "H" (Not Recommended)
   (Special tooling is required to install new stop ring.)

Inspect valve bore and piston for wear and scoring. Replace broken or damaged parts. Clean all parts thoroughly and re-assemble by reversing the above procedure.

TYPICAL DISASSEMBLY OF HANDWHEEL TYPE VALVE



To dismantle the valve for inspection or cleaning:

1. Release spring tension by backing off handwheel as far as it will go.
2. Remove lock nut "A" or set screw and take off handwheel "B"
3. Remove lock nut "D"
4. Unscrew and remove gland "E"
5. Unscrew and remove bonnet "F"
6. Remove O-Ring "H"
7. Remove adjusting screw "C" (turn clockwise and pull out from bottom of bonnet "F")
8. Remove O-ring packing "G"
9. Remove spring "J"
10. Remove piston "K"
11. Remove stop ring "L" (Not Recommended)

(Special tooling is required to install new stop ring.)

Inspect valve bore and piston for wear or scoring. Replace broken or damaged parts. Clean all parts thoroughly and re-assemble by reversing the above procedure.

ASSEMBLY NUMBER IDENTIFICATION CHART

Symbol No.	Designation	Code	Description
1	Style	None H	Standard Model Handwheel Model
2	Series	V	
3	Material	J B S SS	Cast iron Brass Steel 316 Stainless Steel
4	Connections	None F	Screw Connections Flange Connections 300# Flange Class Standard (250# Flange Class - Cast Iron Standard)
5	Size	-1 -2 -3 -4 -5 -6 -7 -8	1/4” 3/8” 1/2” 3/4” 1” 1 1/4” 1 1/2” 2”
6,7,8	ASA Flange Rating	None -150 -600	300# Flange Standard (no designation required)
9	Flange Style 150# & 600# Only	A B C D	Raised Face, Staggered Bolt Centers (standard on all Flange rating) Smooth Face, Staggered Bolt Centers Raised Face, Bolts on Valve Centerline Smooth Face, Bolts on Valve Centerlne
10	O-Ring Material	R RV RS RT RA	Buna O-Ring Cap Seal (standard) Viton O-Ring Cap Seal Silicone O-Ring Cap Seal Teflon O-Ring Cap Seal (standard on VSS Series) Aflas O-Ring Cap Seal
11	Options	SP P	Steel Parts (used on cast iron only) Panel Mount on Handwheel Series
12	Piston Material	/HS /SS /3SS	Hardened Steel 416 Stainless Steel 303 Stainless Steel
13	Spring	AS US WS XS YS ZS	
14	Setting		Desired Pressure Setting

EXAMPLES:

VJ-1RVSP/HS/WS

V	J	-1	RV	SP	/HS	WS
Series	Cast Iron	1/4”	Viton O-Ring	Steel Parts	H.S. Piston	WS Spring

VJF-5R/HS/WS

V	J	F	-5	R	/HS	WS
Series	Cast Iron	Flanged	1”	Buna O-Ring	H.S. Piston	WS Spring

VJF-5-150AR/HS/WS

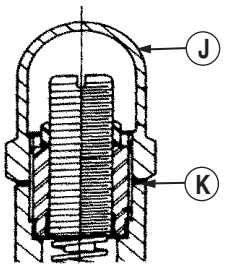
V	J	F	-5	-150	A	R	/HS	WS
Series	Cast Iron	Flanged	1”	Rating	Style	Buna O-Ring	H.S. Piston	WS Spring

NOTE: Stainless steel pistons are supplied on brass valves, unless hardened steel is specified. Hardened steel pistons are supplied on cast iron or steel unless stainless steel is specified. Buna O-Rings are supplied as standard unless other material is specified.

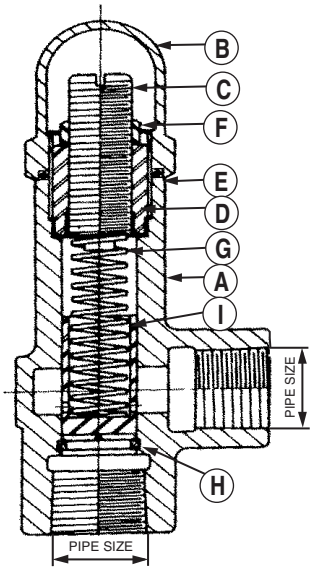
STANDARD PRESSURE RANGE CHART

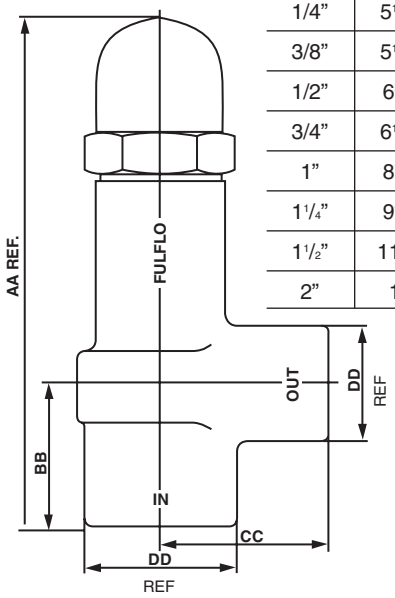
Valve Pipe Size	Valve Flange Size	SPRING PRESSURE AND IDENTIFICATION NO.															
		BLACK-AS		RED-US		GREEN-WS		YELLOW-XS		WHITE-YS		BLUE-ZS		PURPLE-TS		BROWN-RS	
		Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
1/4”		3	15	7	35	30	100	60	175	150	350	300	500	400	600	550	750
3/8”		3	15	7	35	30	100	60	175	150	350	300	500	400	600	550	750
1/2”		3	15	7	35	30	100	60	175	150	350	300	500	400	600	550	750
3/4”		3	15	7	35	30	100	60	175	150	350	300	500				
1”	1”	3	15	7	35	30	100	60	175	150	350	300	500				
1 1/4”	1 1/4”	3	15	7	35	30	100	60	175	150	350	300	500				
1 1/2”	1 1/2”	3	15	7	35	30	100	60	175	150	350	300	500				
2”	2”	3	15	7	35	30	100	60	175	150	350	250	600				

DIMENSIONS



CAP
(GASKET SEAL)





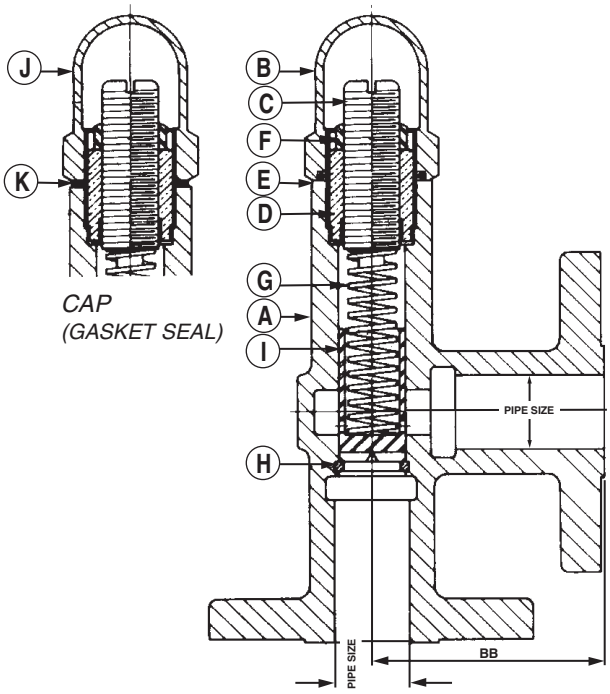
Valve Size	DIMENSIONS IN INCHES			
	AA	BB	CC	DD
1/4"	$5^{11}/_{32}$	$1^{11}/_{32}$	$1^{11}/_{32}$	$1^{3}/_{8}$
3/8"	$5^{11}/_{32}$	$1^{11}/_{32}$	$1^{11}/_{32}$	$1^{3}/_{8}$
1/2"	$6^{3}/_{16}$	$1^{11}/_{16}$	$1^{7}/_{16}$	$1^{7}/_{16}$
3/4"	$6^{15}/_{16}$	$1^{15}/_{16}$	$1^{13}/_{16}$	$1^{11}/_{16}$
1"	$8^{7}/_{32}$	$2^{9}/_{32}$	$2^{9}/_{32}$	$2^{1}/_{16}$
$1^{1}/_{4}$"	$9^{9}/_{16}$	$2^{9}/_{16}$	$2^{9}/_{16}$	$2^{1}/_{2}$
$1^{1}/_{2}$"	$11^{1}/_{16}$	$2^{11}/_{16}$	$2^{11}/_{16}$	$2^{7}/_{8}$
2"	13	3	3	$3^{1}/_{4}$

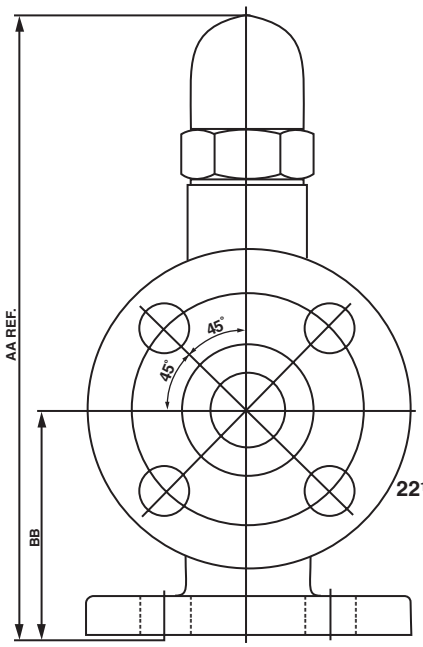
PARTS LIST

SYM.	NAME	MODEL	VALVE SIZE							
			1/4"	3/8"	1/2"	3/4"	1"	$1^{1}/_{4}$"	$1^{1}/_{2}$"	2"
A	BODY	VJ, VJ-SP VB VS VSS	100 100-B 100-S 100-SS	200 200-B 200-S 200-SS	300 300-B 300-S 300-SS	400 400-B 400-S 400-SS	500 500-B 500-S 500-SS	600 600-B 600-S 600-SS	700 700-B 700-S 700-SS	800 800-B 800-S 800-SS
B	CAP (O-RING SEAL)	VJ, VJ-SP VB VS VSS	201-SR 201-BR 201-SR 201-SSR	201-SR 201-BR 201-SR 201-SSR	301-SR 301-BR 301-SR 301-SSR	401-R 401-BR 401-SR 401-SSR	501-R 501-BR 501-SR 501-SSR	601-R 601-BR 601-SR 601-SSR	701-R 701-BR 701-SR 701-SSR	801-R 801-BR 801-SR 801-SSR
C	ADJUSTING SCREW	VJ, VB VS, VJ-SP VSS	202-B 202-S 202-SS	202-B 202-S 202-SS	302-B 302-S 302-SS	402-B 402-S 402-SS	502-B 502-S 502-SS	602-B 602-S 602-SS	702-B 702-S 702-SS	802-B 802-S 802-SS
D	RETAINER	VJ, VB VS, VJ-SP VSS	203-B 203-S 203-SS	203-B 203-S 203-SS	303-B 303-S 303-SS	403-B 403-S 403-SS	503-B 503-S 503-SS	603-B 603-S 603-SS	703-B 703-S 703-SS	803-B 803-S 803-SS
E	O-RING †	VJ, VJ-SP, VB, VS VSS	204-* 204-RT	204-* 204-RT	304-* 304-RT	404-* 404-RT	504-* 504-RT	604-* 604-RT	704-* 704-RT	804-* 804-RT
F	LOCK NUT	VJ, VJ-SP, VB, VS VSS	205-S 205-SS	205-S 205-SS	305-S 305-SS	405-S 405-SS	505-S 505-SS	605-S 605-SS	705-S 705-SS	805-S 805-SS
G	SPRING †	ALL MODELS	207-**	207-**	307-**	407-**	507-**	607-**	707-**	807-**
H	STOP RING	VJ, VB VS, VJ-SP VSS	208-B 208-S 208-SS	208-B 208-S 208-SS	308-B 308-S 308-SS	408-B 408-S 408-SS	508-B 508-S 508-SS	608-B 608-S 608-SS	708-B 708-S 708-SS	808-B 808-S 808-SS
I	PISTON †	HARDENED STEEL 416 STAINLESS STEEL 303 STAINLESS STEEL	206 206-A 206-SS	206 206-A 206-SS	306 306-A 306-SS	406 406-A 406-SS	506 506-A 506-SS	606 606-A 606-SS	706 706-A 706-SS	806 806-A 806-SS
J	CAP (GASKET SEAL)	VJ, VJ-SP VB VS	201-S 201-B 201-S	201-S 201-B 201-S	301-S 301-B 301-S	401 401-B 401-S	501 501-B 501-S	601 601-B 601-S	701 701-B 701-S	801 801-B 801-S
K	GASKET †	VJ, VB VS, VJ-SP	204 204-S	204 204-S	304 304-S	404 404-S	504 504-S	604 604-S	704 704-S	804 804-S

* See o-ring selection chart
** See spring pressure chart
† Recommended spare parts

DIMENSIONS

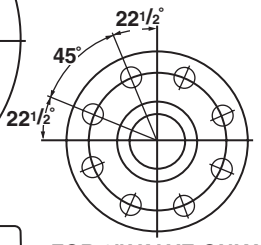




DIMENSIONS IN INCHES

Valve Size	AA	BB
1"	9 1/2"	3 1/2"
1 1/4"	10 13/16"	3 3/4"
1 1/2"	12 7/16"	4 1/16"
2"	14 9/16"	4 9/16"

Note: Dimensions reflect 150# and 300# only



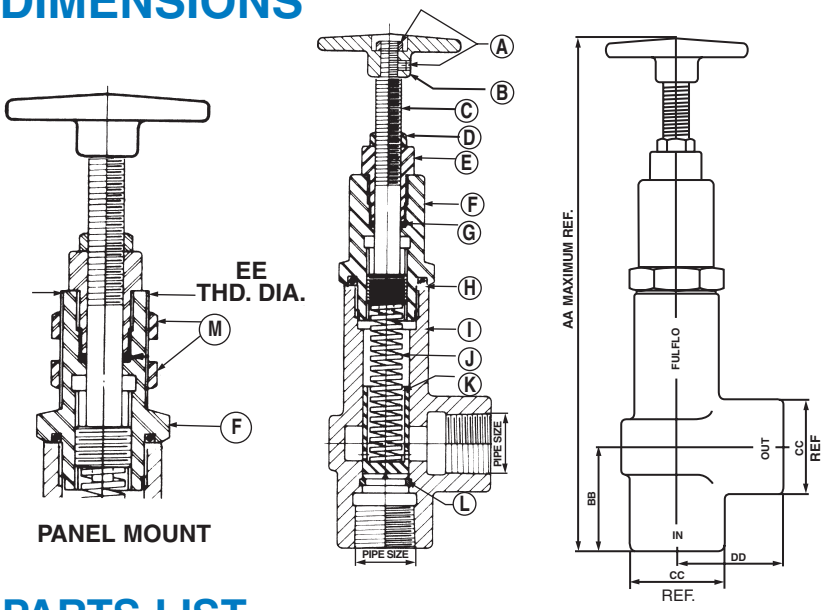
FOR 2" VALVE ONLY

PARTS LIST

SYM.	NAME	MODEL	VALVE SIZE			
			1"	1 1/4"	1 1/2"	2"
A	BODY	VJF, VJF-SP VBF VSF VSSF	500-F 500-BF 500-SF 500-SSF	600-F 600-BF 600-SF 600-SSF	700-F 700-BF 700-SF 700-SSF	800-F 800-BF 800-SF 800-SSF
B	CAP (O-RING SEAL)	VJF, VJF-SP VBF VSF VSSF	501-R 501-BR 501-SR 501-SSR	601-R 601-BR 601-SR 601-SSR	701-R 701-BR 701-SR 701-SSR	801-R 801-BR 801-SR 801-SSR
C	ADJUSTING SCREW	VJF, VBF VSF, VJF-SP VSSF	502-B 502-S 502-SS	602-B 602-S 602-SS	702-B 702-S 702-SS	802-B 802-S 802-SS
D	RETAINER	VJF, VBF VSF, VJF-SP VSSF	503-B 503-S 503-SS	603-B 603-S 603-SS	703-B 703-S 703-SS	803-B 803-S 803-SS
E	O-RING †	VJF, VJF-SP VBF, VSF VSSF	504* 504-* 504-RT	604* 604-* 604-RT	704* 704-* 704-RT	804* 804-* 804-RT
F	LOCK NUT	VJF, VJF-SP VBF, VSF VSSF	505-S 505-S 505-SS	605-S 605-S 605-SS	705-S 705-S 705-SS	805-S 805-S 805-SS
G	SPRING †	ALL MODELS	507-**	607-**	707-**	807-**
H	STOP RING	VJF, VBF VJF-SP, VSF VSSF	508-B 508-S 508-SS	608-B 608-S 608-SS	708-B 708-S 708-SS	808-B 808-S 808-SS
I	PISTON †	HARDENED STEEL 416 STAINLESS STEEL 303 STAINLESS STEEL	506 506-A 506-SS	606 606-A 606-SS	706 706-A 706-SS	806 806-A 806-SS
J	CAP (GASKET SEAL)	VJF, VJF-SP VBF VSF	501 501-B 501-S	601 601-B 601-S	701 701-B 701-S	801 801-B 801-S
K	GASKET †	VJF, VBF VJF-SP, VSF	504 504-S	604 604-S	704 704-S	804 804-S

* See o-ring selection chart
** See spring pressure chart
† Recommended spare parts

DIMENSIONS



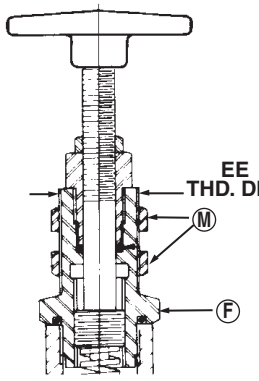
Valve Size	DIMENSIONS IN INCHES				
	AA	BB	CC	DD	EE
1/4"	8 1/8	1 11/32	1 3/16	1 3/8	7/8
3/8"	8 1/8	1 11/32	1 3/16	1 3/8	7/8
1/2"	9 5/8	1 11/16	1 7/16	1 7/16	1 1/8
3/4"	9 3/16	1 15/16	1 11/16	1 13/16	1 3/8
1"	12 7/16	2 9/32	2 1/16	2 9/32	1 3/8
1 1/4"	13 7/16	2 9/16	2 1/2	2 9/16	1 5/8
1 1/2"	17 1/16	2 11/16	2 7/8	2 11/16	2 1/4
2"	17 1/16	3	3 3/8	3	2 1/4

PARTS LIST

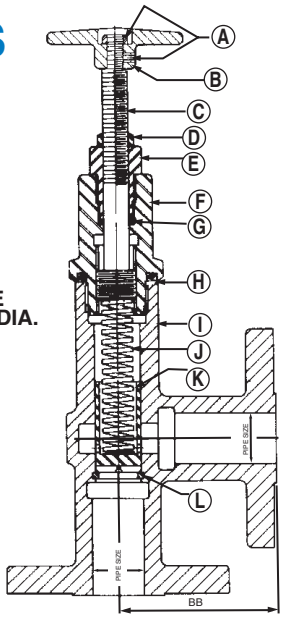
SYM.	NAME	MODEL	VALVE SIZE							
			1/4"	3/8"	1/2"	3/4"	1"	1 1/4"	1 1/2"	2"
A	LOCK NUT OR SET SCREW	ALL MODELS	1/4"-20 COMM.	1/4"-20 COMM.	1/4"-20 COMM.	205-S	205-S	1/4"-20 COMM.	1/4"-20 COMM.	1/4"-20 COMM.
B	HANDWHEEL	ALL MODELS	229	229	229	429	429	629	629	629
C	ADJUSTING SCREW	HVJ(P), HVS(P) HVB(P) HVSS(P)	222-S 222-B 222-SS	222-S 222-B 222-SS	322-S 322-B 322-SS	422-S 422-B 422-SS	522-S 522-B 522-SS	622-S 622-B 622-SS	722-S 722-B 722-SS	822-S 822-B 822-SS
D	LOCK NUT	HVJ(P), HVS(P) HVB(P) HVSS(P) only	205-S 205-S 205-SS	205-S 205-S 205-SS	205-S 205-S 205-SS	305-S 305-S 305-SS	305-S 305-S 305-SS	655-S 655-S 655-SS	655-S 655-S 655-SS	655-S 655-S 655-SS
E	GLAND	HVJ(P), HVS(P) HVB(P) HVSS(P)	225-S 225-B 225-SS	225-S 225-B 225-SS	325-S 325-B 325-SS	525-S 525-B 525-SS	525-S 525-B 525-SS	625-S 625-B 625-SS	725-S 725-B 725-SS	825-S 825-B 825-SS
F	BONNET	HVJ, HVS HVB HVSS HVJP, HVSP HVBP HVSSP	223-SR 223-BR 223-SSR 228-SR 228-BR 228-SSR	223-SR 223-BR 223-SSR 228-SR 228-BR 228-SSR	323-SR 323-BR 323-SSR 328-SR 328-BR 328-SSR	423-SR 423-BR 423-SSR 428-SR 428-BR 428-SSR	523-SR 523-BR 523-SSR 528-SR 528-BR 528-SSR	623-SR 623-BR 623-SSR 628-SR 628-BR 628-SSR	723-SR 723-BR 723-SSR 728-SR 728-BR 728-SSR	823-SR 823-BR 823-SSR 828-SR 828-BR 828-SSR
G	O-RING †	HVJ(P), HVS(P) HVB(P) HVSS(P) only	224* 224-* 224-RT	224* 224-* 224-RT	224* 224-* 224-RT	424* 424-* 424-RT	424* 424-* 424-RT	624* 624-* 624-RT	624* 624-* 624-RT	624* 624-* 624-RT
H	O-RING †	HVJ(P), HVS(P) HVB(P) HVSS(P) only	204* 204-* 204-RT	204* 204-* 204-RT	304* 304-* 304-RT	404* 404-* 404-RT	504* 504-* 504-RT	604* 604-* 604-RT	704* 704-* 704-RT	804* 804-* 804-RT
I	BODY	HVJ(P) HVB(P) HVS(P) HVSS(P)	100 100-B 100-S 100-SS	200 200-B 200-S 200-SS	300 300-B 300-S 300-SS	400 400-B 400-S 400-SS	500 500-B 500-S 500-SS	600 600-B 600-S 600-SS	700 700-B 700-S 700-SS	800 800-B 800-S 800-SS
J	SPRING †	ALL MODELS	207-**	207-**	307-**	407-**	507-**	607-**	707-**	807-**
K	PISTON †	HARDENED STEEL 416 STAINLESS STEEL 303 STAINLESS STEEL	206 206-A 206-SS	206 206-A 206-SS	306 306-A 306-SS	406 406-A 406-SS	506 506-A 506-SS	606 606-A 606-SS	706 706-A 706-SS	806 806-A 806-SS
L	STOP RING	HVJ(P), HVS(P) HVB(P) HVSS(P)	208-S 208-B 208-SS	208-S 208-B 208-SS	308-S 308-B 308-SS	408-S 408-B 408-SS	508-S 508-B 508-SS	608-S 608-B 608-SS	708-S 708-B 708-SS	808-S 808-B 808-SS
M	LOCK NUTS 2 REQ'D	HVJP, HVSP, HVBP HVSSP	505-S 505-S 505-SS	505-S 505-S 505-SS	605-S 605-S 605-SS	705-S 705-S 705-SS	705-S 705-S 705-SS	805-S 805-S 805-SS	745-S 745-S 745-SS	745-S 745-S 745-SS

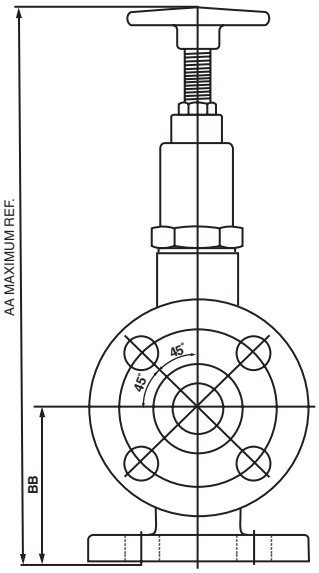
* See o-ring selection chart
** See spring pressure chart
† Recommended spare parts

DIMENSIONS



PANEL MOUNT

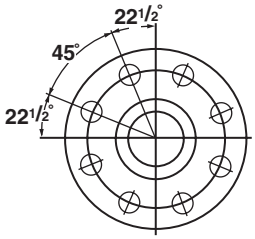




DIMENSIONS IN INCHES

Valve Size	AA	BB	EE
1"	$13^{11}/_{16}$	$3^{1}/_{2}$	$1^{3}/_{8}$
$1^{1}/_{4}$"	$14^{11}/_{16}$	$3^{3}/_{4}$	$1^{5}/_{8}$
$1^{1}/_{2}$"	$18^{7}/_{16}$	$4^{1}/_{16}$	$2^{1}/_{4}$
2"	$18^{5}/_{8}$	$4^{9}/_{16}$	$2^{1}/_{4}$

Note: Dimensions reflect 150# and 300# only



FOR 2" VALVE ONLY

PARTS LIST

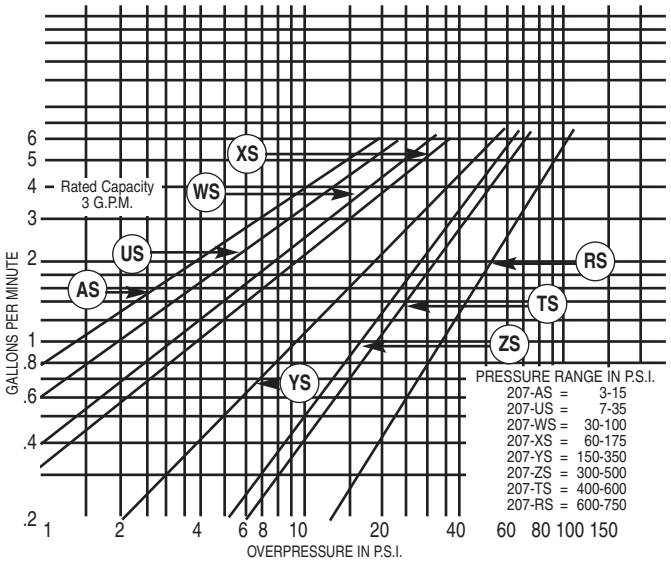
SYM.	NAME	MODEL	DIMENSIONS IN INCHES			
			1"	1¼"	1½"	2"
A	LOCK NUT OR SET SCREW	ALL MODELS	205-S	1/4"-20 COMM.	1/4"-20 COMM.	1/4"-20 COMM.
B	HANDWHEEL	ALL MODELS	429	629	629	629
C	ADJUSTING SCREW	HVJF(P) HVSF(P) HVBF(P) HVSSF(P)	522-S 522-B 522-SS	622-S 622-B 622-SS	722-S 722-B 722-SS	822-S 822-B 822-SS
D	LOCK NUT	HVJF(P), HVSF(P) HVBF(P) HVSSF(P) only	305-S 305-S 305-SS	655-S 655-S 655-SS	655-S 655-S 655-SS	655-S 655-S 655-SS
E	GLAND	HVJF(P), HVSF(P) HVBF(P) HVSSF(P)	525-S 525-B 525-SS	625-S 625-B 625-SS	725-S 725-B 725-SS	825-S 825-B 825-SS
F	BONNET	HVJF, HVSF HVBF HVSSF HVJPF, HVSPF HVBPF HVSSFP	523-SR 523-BR 523-SSR 528-SR 528-BR 528-SSR	623-SR 623-BR 623-SSR 628-SR 628-BR 628-SSR	723-SR 723-BR 723-SSR 728-SR 728-BR 728-SSR	823-SR 823-BR 823-SSR 828-SR 828-BR 828-SSR
G	O-RING †	HVJF(P), HVSF(P) HVBF(P) HVSSF(P) only	424* 424-* 424-RT	624* 624-* 624-RT	624* 624-* 624-RT	624* 624-* 624-RT
H	O-RING †	HVJF(P), HVSF(P) HVBF(P) HVSSF(P) only	504* 504-* 504-RT	604* 604-* 604-RT	704* 704-* 704-RT	804* 804-* 804-RT
I	BODY	HVJF(P) HVBF(P) HVSF(P) HVSSF(P)	500-F 500-BF 500-SF 500-SSF	600-F 600-BF 600-SF 600-SSF	700-F 700-BF 700-SF 700-SSF	800-F 800-BF 800-SF 800-SSF
J	SPRING †	ALL MODELS	507-**	607-**	707-**	807-**
K	PISTON †	HARDENED STEEL 416 STAINLESS STEEL 303 STAINLESS STEEL	506 506-A 506-SS	606 606-A 606-SS	706 706-A 706-SS	806 806-A 806-SS
L	STOP RING	HVJF(P), HVSF(P) HVBF(P) HVSSF(P)	508-S 508-B 508-SS	608-S 608-B 608-SS	708-S 708-B 708-SS	808-S 808-B 808-SS
M	LOCK NUTS 2 REQ'D	HVJFP, HVSFP, HVBFP HVSSFP	705-S 705-S 705-SS	805-S 805-S 805-SS	745-S 745-S 745-SS	745-S 745-S 745-SS

* See o-ring selection chart
** See spring pressure chart
† Recommended spare parts

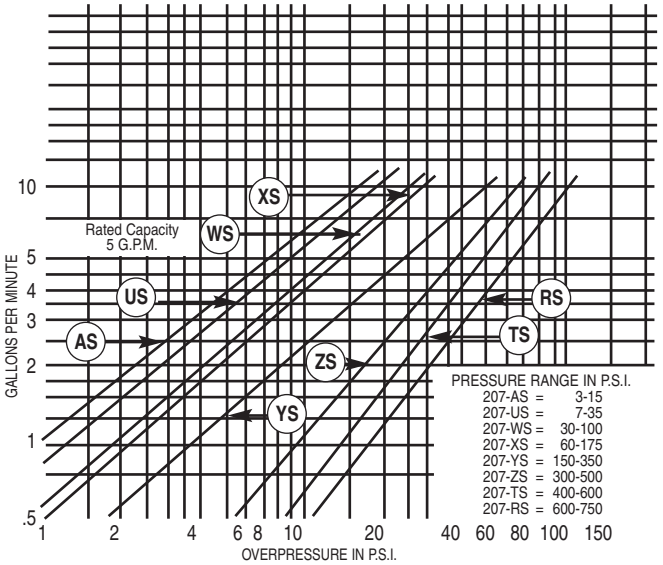
V-SERIES PERFORMANCE CHARTS

All valve tests 110˚F. to 120˚F. Oil Viscosity 150 S.S.U. at 100˚F.
(Charts good from 30 to 500 S.S.U.)

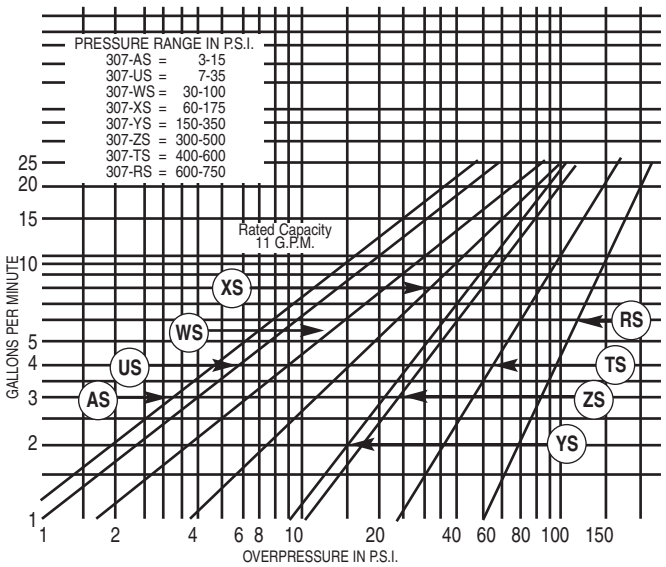
1/4" VALVE TESTS



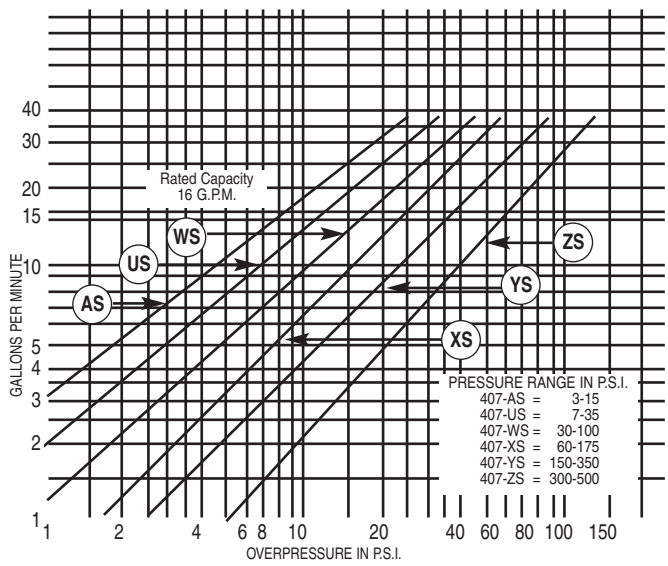
3/8" VALVE TESTS



1/2" VALVE TESTS



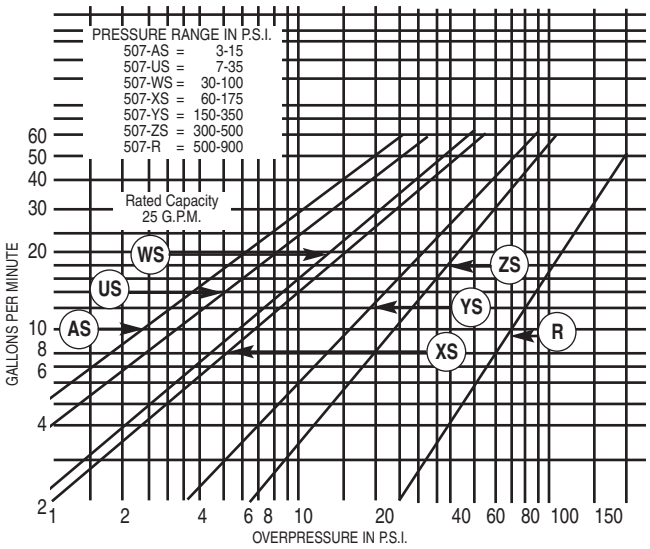
3/4" VALVE TESTS



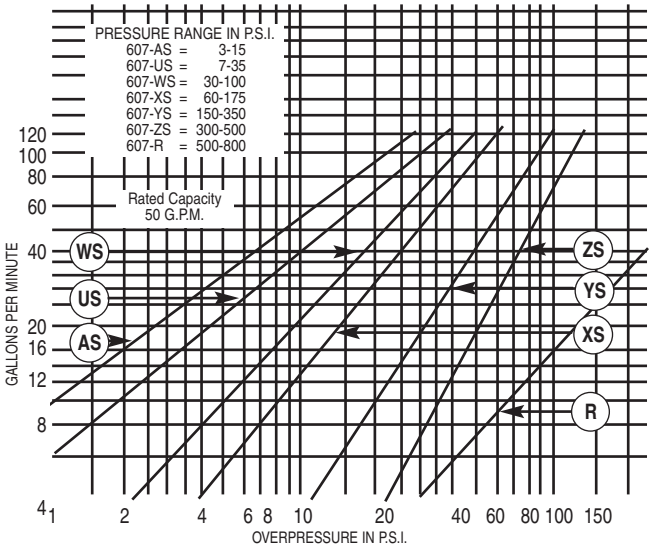
V-SERIES PERFORMANCE CHARTS

All valve tests 110˚F. to 120˚F. Oil Viscosity 150 S.S.U. at 100˚F.
(Charts good from 30 to 500 S.S.U.)

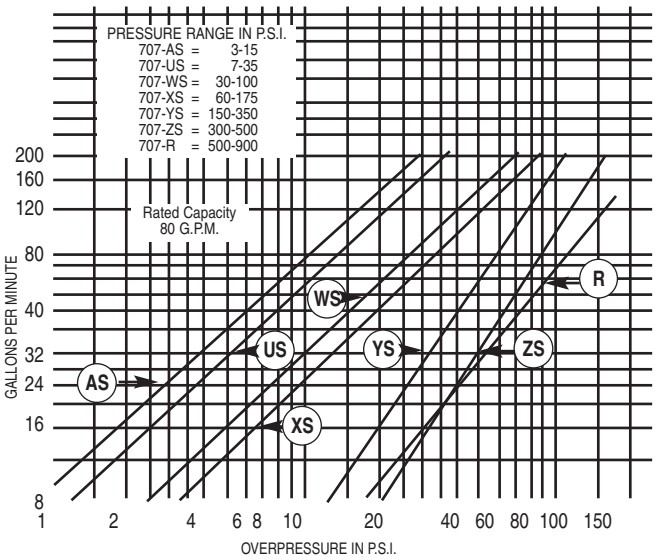
1" VALVE TESTS



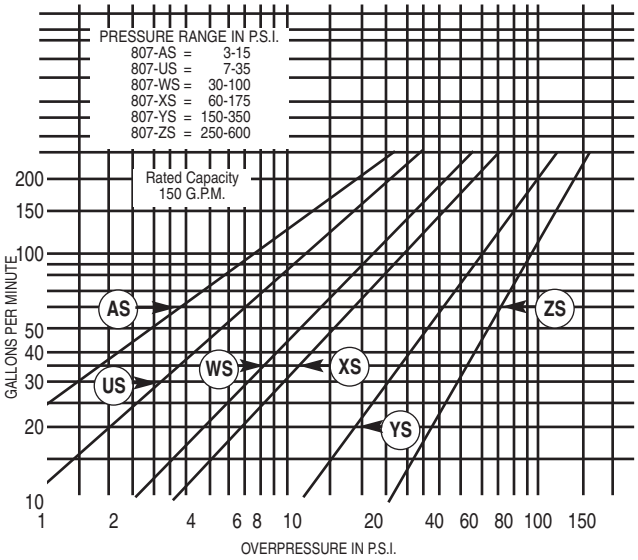
1¼" VALVE TESTS



1½" VALVE TESTS



2" VALVE TESTS



Installation & Maintenance Instructions

ASCO Red-Hat II ®

OPEN – FRAME, GENERAL PURPOSE, WATERTIGHT/EXPLOSIONPROOF SOLENOIDS

SERIES
8003G/H
8202G/H
I&M No.V6584R10
(Section 1 of 2)

— SERVICE NOTICE —

ASCO® solenoid valves with design change letter "G" or "H" in the catalog number (ex. 8210G1) have an epoxy encapsulated ASCO® Red Hat II® solenoid. This solenoid replaces some of the solenoids with metal enclosures and open – frame constructions. Follow these installation and maintenance instructions if your valve or operator uses this solenoid.

See separate instructions for basic valve.

DESCRIPTION

Catalog numbers 8003G/H and 8202G/H are epoxy encapsulated pull – type solenoids. The green solenoid with lead wires and 1/2″ conduit connection is designed to meet Enclosure Type 1 – General Purpose, Type 2 – Dripproof, Types 3 and 3S – Raintight, and Types 4 and 4X – Watertight. The black solenoid on catalog numbers prefixed "EF" or "EV" is designed to meet Enclosure Types 3 and 3S – Raintight, Types 4 and 4X – Watertight, Types 6 and 6P – Submersible, Type 7, Explosionproof Class I, Division 1 Groups A, B, C, & D and Type 9, – Dust – Ignitionproof Class II, Division 1 Groups E, F & G. The Class II, Groups F & G Dust Locations designation is not applicable for solenoids or solenoid valves used for steam service or when a class "H" solenoid is used. See *Temperature Limitations* section for solenoid identification and nameplate/retainer for service. When installed just as a solenoid and not attached to an ASCO valve, the core has a 0.250 – 28 UNF – 2B tapped hole, 0.38 or 0.63 minimum full thread.

NOTE: Catalog number prefix "EV" denotes stainless steel construction.

Solenoid catalog numbers 8202G/H1, 8202G/H3, 8202G/H5 and 8202G/H7 are epoxy encapsulated push – type, reverse – acting solenoids having the same enclosure types as previously stated for Catalog numbers 8003G/H1 and 8003G/H2.

Series 8003G/H and 8202G/H solenoids are available in:

- **Open – Frame Construction:** The green solenoid may be supplied with 1/4″ spade, screw or DIN terminals. (Refer to Figure 4)
- **Panel Mounted Construction:** These solenoids are specifically designed to be panel mounted by the customer. Refer to Figures specified in this I&M and the section on *Installation of Panel Mounted Solenoid* for details.

Optional Features For Type 1 – General Purpose Construction Only

- **Junction Box:** This junction box construction meets Enclosure Types 2, 3, 3S, 4, and 4X. Only solenoids with 1/4″ spade or screw terminals may have a junction box. The junction box provides a 1/2″ conduit connection, grounding and spade or screw terminal connections within the junction box (See Figure 5).
- **DIN Plug Connector Kit No.K236034:** Use this kit only for solenoids with DIN terminals. The DIN plug connector kit provides a two pole with grounding contact DIN Type 43650 construction (See Figure 6).

OPERATION

Series 8003G/H – When the solenoid is energized, the core is drawn into the solenoid base sub – assembly. **IMPORTANT: When the solenoid is de – energized, the initial return force for the core, whether developed by spring, pressure, or weight, must exert a minimum force to overcome residual magnetism created by the solenoid. Minimum return force for AC construction is 11 ounces, and 5 ounces for DC construction.**

Series 8202G/H – When the solenoid is energized, the disc holder assembly seats against the orifice. When the solenoid is de – energized , the disc holder assembly returns. **IMPORTANT: Initial return force for the disc or disc holder assembly, whether developed by spring, pressure, or weight, must exert a minimum force to overcome residual magnetism created by the solenoid. Minimum return force is 1 pound, 5 ounces.**

INSTALLATION

Check nameplate for correct catalog number, service, and wattage. Check front of solenoid for voltage and frequency.

⚠ WARNING: Electrical hazard from the accessibility of live parts. To prevent the possibility of death, serious injury or property damage, install the open – frame solenoid in an enclosure.

FOR BLACK ENCLOSURE TYPES 7 AND 9 ONLY

⚠ CAUTION: To prevent fire or explosion, do not install solenoid and/or valve where ignition temperature of hazardous atmosphere is less than 165° C. On valves used for steam service or when a class "H" solenoid is used, do not install in hazardous atmosphere where ignition temperature is less than 180°C. See nameplate/retainer for service.

NOTE: These solenoids have an internal non – resetable thermal fuse to limit solenoid temperature in the event that extraordinary conditions occur which could cause excessive temperatures. These conditions include high input voltage, a jammed core, excessive ambient temperature or a shorted solenoid, etc. This unique feature is a standard feature only in solenoids with black explosionproof/dust – ignitionproof enclosures (Types 7 & 9).

⚠ CAUTION: To protect the solenoid valve or operator, install a strainer or filter, suitable for the service involved in the inlet side as close to the valve or operator as possible. Clean periodically depending on service conditions. See ASCO Series 8600, 8601, and 8602 for strainers.

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Temperature Limitations

For maximum valve ambient temperatures, refer to chart. The temperature limitations listed, only indicate maximum application temperatures for field wiring rated at 90°C. Check catalog number prefix and watt rating on nameplate to determine maximum ambient temperature. See valve installation and maintenance instructions for maximum fluid temperature.

NOTE: For steam service, refer to *Wiring* section, *Junction Box* for temperature rating of supply wires.

Temperature Limitations For Series 8003G or 8202G Solenoids for use on Valves Rated at 10.1, 11.6, 17.1, or 22.6 Watts			
Watt Rating	**Catalog Number Coil Prefix**	**Class of Insulation**	**Maximum † Ambient Temp.**
10.1 & 17.1	None, FB, KF, KP SC, SD, SF, & SP,	F	125°F (51.7°C)
10.1 & 17.1	HB, HT, KB, KH, SS, ST, SU,	H	140°F (60°C)
11.6 & 22.6	None, FB,KF, KP, SC, SD, SF, & SP.	F	104°F (40°C)
11.6 & 22.6	HP, HT, KB, KH, SS, ST, SU, & SV	H	104°F (40°C)

† Minimum ambient temperature −40° F (−40° C).

Temperature Limitations for series 8002H/8003H solenoids (Catalog Numbers 8262H & 8263H valves)						
		Wattage Ratings			Max. Ambient Temperature	
Prefix①	Coil Class	AC		DC		
		60 Hz	50 Hz		(°C)	(°F)
EF, EV	FT	10.1	10.1	–	52	125
EF, EV	FB	17.1	17.1	–		
	FT	10.1	10.1	–	55	131
	FB	17.1	17.1	–		
	HT	–	–	11.6	40②	104②
	HB	–	–	22.6		
EF, EV	HT	–	–	11.6		
EF, EV	HB	–	–	22.6		
	HT	10.1	10.1	–	60③	140③
	HB	17.1	17.1	–		
EF, EV	HT	10.1	10.1	–		
EF, EV	HB	17.1	17.1	–		

① = EF, EV data applies to Explosionproof coils only.
② = DC solenoid valves can be operated at maximum ambient temperature of 55°C / 131°F with reduced pressure ratings. See valve I&M for maximum operating pressure differential ratings.
③ = Steam Service Valves have a maximum ambient temperature of 55°C / 131°F.

Positioning

This solenoid is designed to perform properly when mounted in any position. However, for optimum life and performance, the solenoid should be mounted vertically and upright to reduce the possibility of foreign matter accumulating in the solenoid base sub−assembly area.

Wiring

Wiring must comply with local codes and the National Electrical Code. All solenoids supplied with lead wires are provided with a grounding wire which is green or green with yellow stripes and a 1/2″ conduit connection. To facilitate wiring, the solenoid may be rotated 360°. For the watertight and explosionproof solenoid, electrical fittings must be approved for use in the approved hazardous locations.

⚠ CAUTION: Cryogenic Applications – Solenoid lead wire insulation should not be subjected to cryogenic temperatures. Adequate lead wire protection and routing must be provided.

Additional Wiring Instructions For Optional Features:

- **Open−Frame solenoid with 1/4″ spade terminals.**

For solenoids supplied with screw terminal connections use #12−18 AWG stranded copper wire rated at 90°C or greater. Torque terminal block screws to 10±2 in−lbs [1,0±1,2 Nm]. A tapped hole is provided in the solenoid for grounding, use a #10−32 machine screw. Torque grounding screw to 15−20 in−lbs [1,7−2,3 Nm]. On solenoids with screw terminals, the socket head screw holding the terminal block to the solenoid is the grounding screw. Torque the screw to 15−20 in−lbs [1,7−2,3 Nm] with a 5/32″ h ex key wrench.

- **Junction Box**

The junction box is used with spade or screw terminal solenoids only and is provided with a grounding screw and a 1/2″ conduit connection. Connect #12−18 AWG standard copper wire only to the screw terminals. Within the junction box use field wire that is rated 90°C or greater for connections. For steam service use 105°C rated wire up to 50 psi or use 125°C rated wire above 50 psi. After electrical hookup, replace cover gasket, cover, and screws. Tighten screws evenly in a crisscross manner.

- **DIN Plug Connector Kit No.K236034**

1. The open−frame solenoid is provided with DIN terminals to accommodate the plug connector kit.
2. Remove center screw from plug connector. Using a small screwdriver, pry terminal block from connector cover.
3. Use #12−18 AWG stranded copper wire rated at 90°C or greater for connections. Strip wire leads back approximately 1/4″ for installation in socket terminals. The use of wire−end sleeves is also recommended for these socket terminals. Maximum length of wire−end sleeves to be approximately 1/4″. Tinning of the ends of the lead wires is not recommended.
4. Thread wire through gland nut, gland gasket, washer and connector cover.

NOTE: Connector housing may be rotated in 90° increments from position shown for alternate positioning of cable entry.

5. Check DIN connector terminal block for electrical markings. Then make electrical hookup to terminal block according to markings on it. Snap terminal block into connector cover and install center screw.
6. Position connector gasket on solenoid and install plug connector. Torque center screw to 5±1 in−lbs [0,6±1,1 Nm].

NOTE: Alternating current (AC) and direct current (DC) solenoids are built differently and cannot be converted from one to the other by changing the coil.

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Installation of Solenoid

Solenoids may be assembled as a complete unit. Tightening is accomplished by means of a hex flange at the base of the solenoid.

Installation of Panel Mounted Solenoid (See Figures 1 and 2)

1. Disassemble solenoid following instruction under *Solenoid Replacement* then proceed.
2. Install solenoid base sub–assembly through customer panel. 8202H panel mounted solenoids include a retainer to adapt the solenoid base sub–assembly to the customer panel. (See Figure 2)
3. Position finger washer on opposite side of panel over solenoid base sub–assembly.
4. Replace solenoid, nameplate/retainer and red cap.
5. Make electrical hookup, see *Wiring* section.

Solenoid Temperature

Standard solenoids are designed for continuous duty service. When the solenoid is energized for a long period, the solenoid becomes hot and can be touched by hand only for an instant. This is a safe operating temperature.

MAINTENANCE

⚠ WARNING: To prevent the possibility of death, serious injury or property damage, turn off electrical power, depressurize solenoid operator and/or valve, and vent fluid to a safe area before servicing.

Cleaning

All solenoid operators and valves should be cleaned periodically. The time between cleaning will vary depending on medium and service conditions. In general, if the voltage to the solenoid is correct, sluggish valve operation, excessive noise or leakage will indicate that cleaning is required. Clean strainer or filter when cleaning the valve.

Preventive Maintenance

- Keep the medium flowing through the solenoid operator or valve as free from dirt and foreign material as possible.
- Periodic exercise of the valve should be considered if ambient or fluid conditions are such that corrosion, elastomer degradation, fluid contamination build up, or other conditions that could impede solenoid valve shifting are possible. The actual frequency of exercise necessary will depend on specific operating conditions. A successful operating history is the best indication of a proper interval between exercise cycles.
- Depending on the medium and service conditions, periodic inspection of internal valve parts for damage or excessive wear is recommended. Thoroughly clean all parts. Replace any worn or damaged parts.

Causes of Improper Operation

- **Faulty Control Circuit:** Check the electrical system by energizing the solenoid. A metallic *click* signifies that the solenoid is operating. Absence of the *click* indicates loss of power supply. Check for loose or blown fuses, open–circuited or grounded solenoid, broken lead wires or splice connections.
- **Burned–Out Solenoid:** Check for open–circuited solenoid. Replace if necessary. Check supply voltage; it must be the same as specified on nameplate/retainer and marked on the solenoid. Check ambient temperature and check that the core is not jammed.
- **Low Voltage:** Check voltage across the solenoid leads. Voltage must be at least 85% of rated voltage.

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Solenoid Replacement

1. Disconnect conduit, coil leads, and grounding wire.

NOTE: Any optional parts attached to the old solenoid must be reinstalled on the new solenoid. For 3–way construction, piping or tubing must be removed from pipe adapter.

2. Disassemble solenoids with optional features as follows:

- **Spade or Screw Terminals**
  Remove terminal connections, grounding screw, grounding wire, and terminal block (screw terminal type only).

NOTE: For screw terminals, the socket head screw holding the terminal block serves as a grounding screw.

- **Junction Box**
- Remove conduit and socket head screw (use 5/32″ hex key wrench) from center of junction box. Disconnect junction box from solenoid.
- **DIN Plug Connector**
  Remove center screw from DIN plug connector. Disconnect DIN plug connector from adapter. Remove socket head screw (use 5/32″ hex key wrench), DIN terminal adapter, and gasket from solenoid.

3. Snap off red cap from top of solenoid base sub–assembly. For 3–way construction with pipe adapter (Figure 3), remove pipe adapter, nameplate and solenoid. Omit steps 4 and 5.
4. Push down on solenoid. Then using a suitable screwdriver, insert blade between solenoid and nameplate/retainer. Pry up slightly and push to remove.

NOTE: Series 8202G/H solenoids have a spacer between the nameplate/retainer and solenoid.

5. Remove solenoid from solenoid base sub–assembly.
6. Reassemble in reverse order of disassembly. Use exploded views for identification and placement of parts.
7. Torque pipe adapter to 90 inch–pounds maximum [10,2 Nm maximum]. Then make up piping or tubing to pipe adapter on solenoid.

Disassembly and Reassembly of Solenoids

1. Remove solenoid, see *Solenoid Replacement*.
2. Remove spring washer from solenoid base sub–assembly. For 3–way construction, remove pipe adapter and plugnut gasket.
3. Unscrew solenoid base sub–assembly from valve body.
4. Remove internal solenoid parts for cleaning or replacement. Use exploded views for identification and placement of parts.
5. If the solenoid is part of a valve, refer to basic valve installation and maintenance instructions for further disassembly.
6. Torque solenoid base sub–assembly and adapter to 175±25 in–lbs [19,8±2,8 Nm].

ORDERING INFORMATION FOR ASCO SOLENOIDS

When Ordering Solenoids for ASCO Solenoid Operators or Valves, order the number stamped on the solenoid. Also specify voltage and frequency.

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Installation & Maintenance Instructions

ASCO Red-Hat II ®

OPEN – FRAME, GENERAL PURPOSE, WATERTIGHT/EXPLOSIONPROOF SOLENOIDS

SERIES
8003G/H
8202G/H

I&M No.V6584R10
(Section 2 of 2)

NOTICE: See Installation and Maintenance Instructions, I&M No. V6584R10 – Section 1 of 2 for detailed instructions.

Torque Chart

Part Name	Torque Value in Inch – Pounds	Torque Value in Newton – Meters
solenoid base sub – assembly	175 ± 25	19,8± 2,8
pipe adapter	90 maximum	10,2 maximum

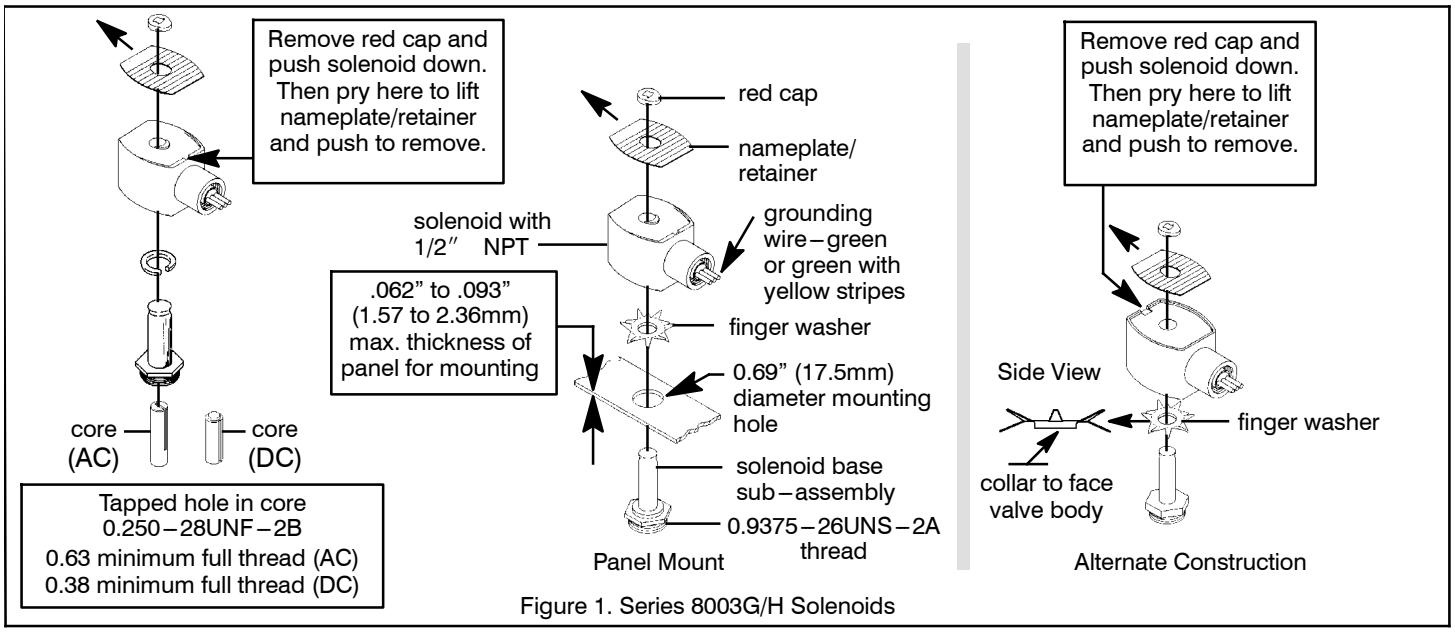


Figure 1. Series 8003G/H Solenoids

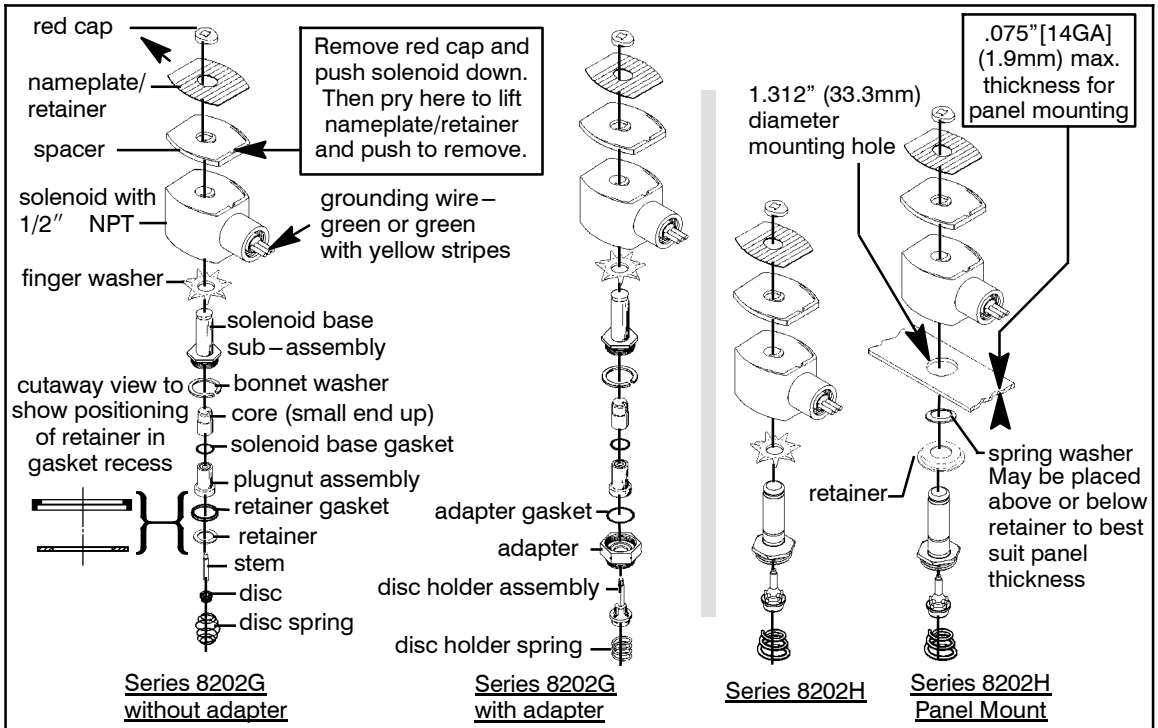


Figure 2. Series 8202G/H Solenoids

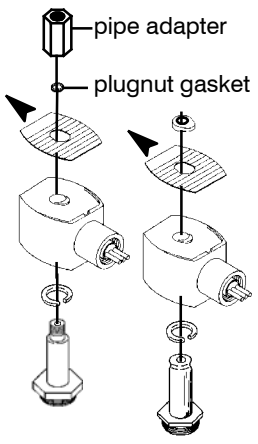


Figure 3.
Air Only Construction
Vent to Atmosphere

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Torque Chart

Part Name	Torque Value in Inch–Pounds	Torque Value in Newton–Meters
terminal block screws	10 ± 2	1,1 ± 0,2
socket head screw	15 – 20	1,7 – 2,3
center screw	5 ± 1	0,6 ± 0,1

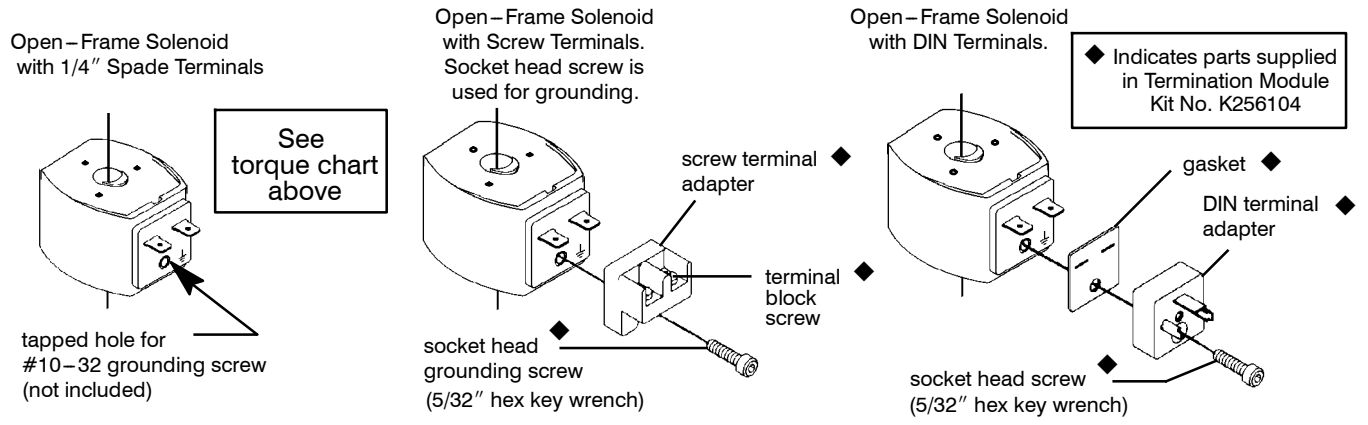


Figure 4. Open–frame solenoids

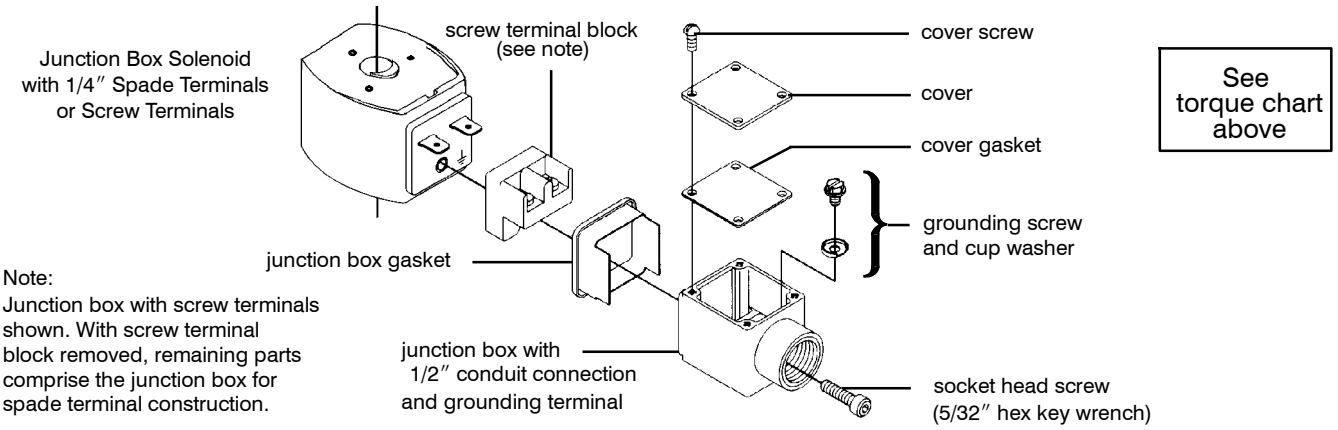


Figure 5. Junction box (optional feature)

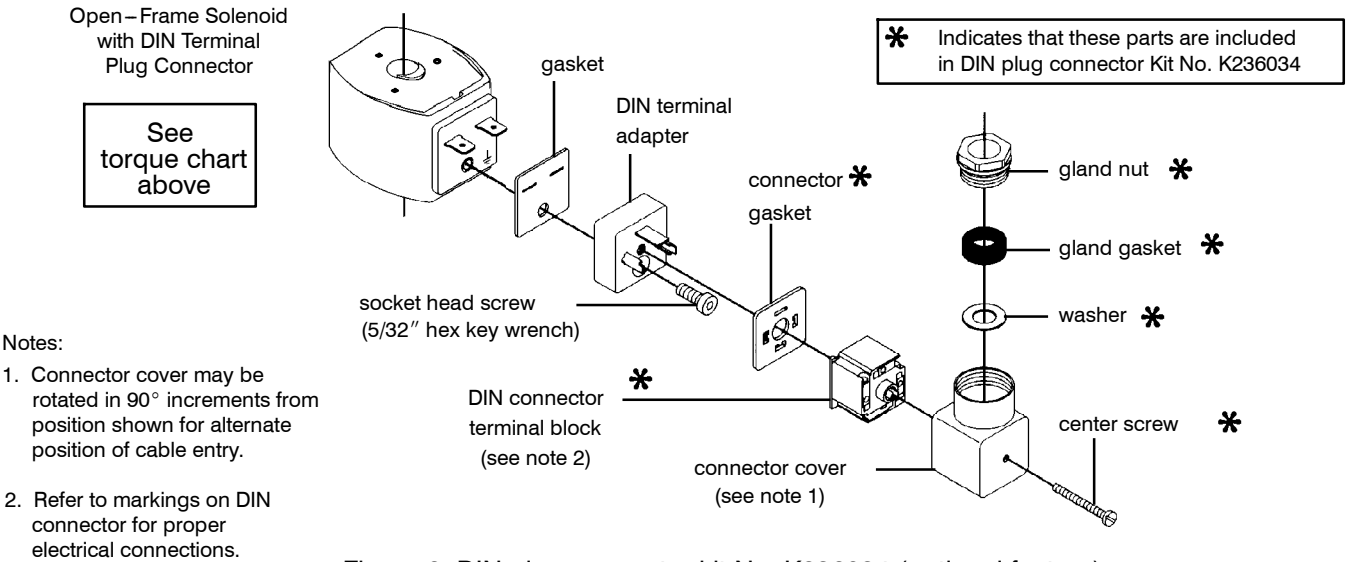


Figure 6. DIN plug connector kit No. K236034 (optional feature)

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MARLIN

High Performance Check Valves

CRANE

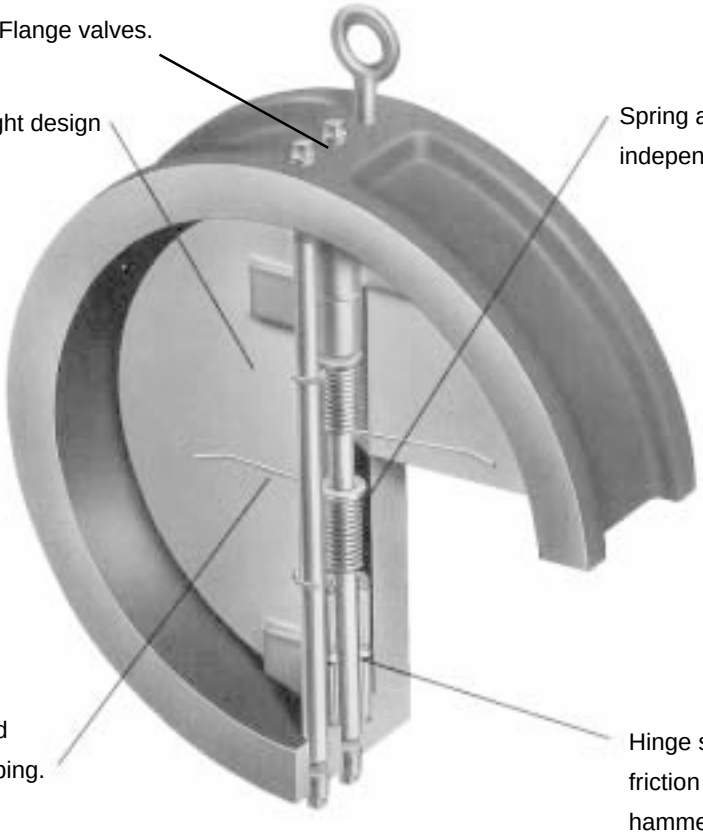
THE VALVE EXPERTS

Marlin – The High Performance Check Valve

Marlin high performance check valves are the original Mission wafer check valves introduced to the market in the late 50's. They are available in the sizes, pressure classes and configurations you need to meet the most demanding of applications. Our product range includes, but is not limited to,

- Sizes: 2" to 72"
- ASME Pressure Class 125 through 2500
- API 6A and 6D pressure classes
- DIN, JIS, BS, AS, and ISO standards are also available.
- Wafer, lug, double flanged and extended body styles
- Configurations available in retainerless style.
- Body Materials:
  Cast Iron, Ductile Iron, WCB Cast Steel, 316 Stainless Steel. All alloys.
- Resilient Seat Materials:
  EPDM, Buna-N, Neoprene, Refrigeration-grade elastomer, Viton
- Integral and overlaid metal seats also available
- End Connections:
  Raised Face, Plain Face, Ring Joint, Weld-End, Hub-End.

Retainerless valves for critical applications without pin retainer penetration through the body are available in Wafer and are standard in Lug and Double Flange valves.



Dual plate lightweight design for efficient seating and operation

Spring action closes plates independently. (6" and larger)

Long-leg spring action allows plates to open and close without seat scrubbing.

Hinge support sleeve reduces friction and minimizes water hammer through independent plate suspension (on larger sizes).

Industry Standards*	
API 594	Valve Design
API 598	Valve Pressure Testing & Inspection
ASME B16.5 & B16.47	Flanges
ASME B16.34	Pressure / Temperature Ratings
API 6D	Pipeline Valves
API 6A	Production Valves

**Marlin Valves meet or exceed these industry standards.*

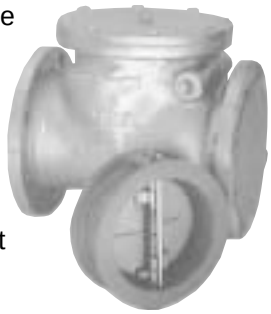
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Features and Benefits

Features	Benefits
Lightweight and Compact Wafer Design	Installs between mating flanges with 10 to 20% the weight of flanged swing checks in popular sizes - **Saves money in initial valve cost and provides lower installation cost.**
Dual Plate, Flat Seat Design	Plate heel is lifted first by design to prevent seat wear. Employs two spring-loaded plates with flat seats - **Gives superior performance and bubble-tight shutoff with resilient seats.**
Independent Spring Action	Maximum deflection of 140°, provides improved valve response and longer life - **Saves money with longer valve life and improved system performance by reducing water hammer.**
Independent Plate Suspension with Unique Hinge Design (larger sizes)	Improves valve response and reduces friction forces by 66% - **Further assurances for better performance with faster valve response.**
Simple, External Body Geometry	Configuration simplifies valve insulation - **Saves money.**
Variety of Body Designs Available - Lug and Double Flange	Provides options to suit application needs - **Eases your selection process by utilizing the industry leader as your single source.**
Wide Variety of Materials	Versatility for many services - **Satisfies more application needs.**
Flexibility in Installation Position	Provides more rigidity than pipe, eliminating concerns of pipe bending loads of flanged valves - **Safety against thermal or seismic catastrophes.**
Body Strength and Rigidity	Some sizes suitable for horizontal or vertical up positions - **Simplifies piping design, eliminates constraints that swing checks create.**
Retainerless Design Eliminates Tapped Holes in Body	For critical service applications, prevents possible escape of unwanted and/or hazardous materials to atmosphere - **Safety in critical services eliminates and/or environmental concerns. Standards in Lug and Double Flange Designs.**
Vertical Hinged Design	In horizontal position flow allows plates to function freely and full open under lower flow conditions as compared to swing check - **Reduces pressure loss, improves dynamic response and eliminates valve chatter.**
Special Valves Meet Market Needs: • **UL/FM Listed** • **Rubber or Urethane Lined** • **Hub Ends (Grayloc®)** • **Weld Ends**	Wide size range, pressure range and added options allow further market needs to be met - **Reliance on world's largest wafer check line to supply more needs.**

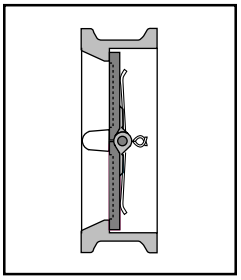
Specify Marlin Valves . . . to your advantage

Leading engineering specifiers specify Marlin for check valve applications because they provide high performance. Extensive research and testing with demonstrated performance has earned worldwide recognition, unmatched in the industry.

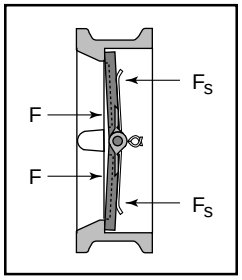


The Marlin wafer check valve design is generally stronger, lighter, smaller, more efficient and less expensive than conventional swing check valves. Its design meets API 594 which is approximately one fourth the face to face dimension and 15% to 20% the weight, on most popular sizes, making them less expensive than a swing check valve. It is much easier to install between standard gaskets and line flanges. The savings compound during installation due to ease of handling and only one set of flange studs is required. Therefore, it is more cost effective to install, and also to maintain.

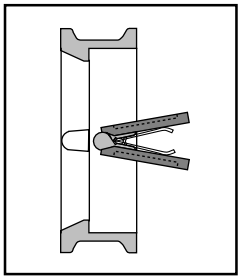
The Marlin also offers special design features that make it a high performance non-slam check valve. These include a scrub-free opening, and in most sizes a unique independent spring design as well as an independent plate support system. These features may not be found in other check valves. Other configurations offered include lug, double flange and extended body.



Plates in closed position. Top view.



Heel opens first as flow begins.



Plates fully opened (85°)

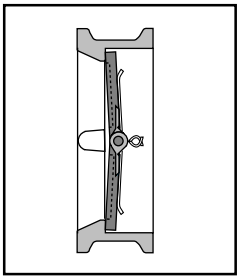
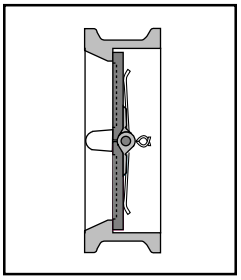


Plate toe closes first as flow decreases.



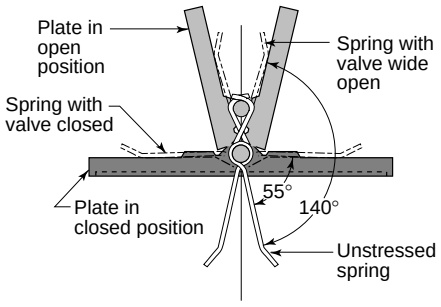
Plates fully seated for bubble-tight shutoff.

The innovative dual-plate design of the Marlin valve employs two spring-loaded plates (disc halves) suspended on a central vertical hinge pin. As flow begins, the plates open in response to a resultant force (F) which acts as the center of the sealed surface area. The contact point of the reacting spring leg's force (Fs) acts beyond the center of the plate area, causing the heel to open first. This prevents rubbing of the seal surface prior to normal plate opening, eliminating wear.

As the velocity of flow decreases, torsion spring action reacts automatically. This moves the plates closer to the body seats, reducing the distance and time of travel for closure. By having the plates closer to the body seats at the time of flow reversal, the valve dynamic response is greatly accelerated. This dramatically reduces the water hammer effect for non-slam performance.

At closing, the point of spring force causes the toe of the plates to close first. This prevents dragging of the heels of the plates and maintains seal integrity for much longer periods.

Independent Spring Design



A spring design of the Marlin valve (sizes 6" and larger) allows higher torque to be exerted against each plate with independent closing in response to the process stream. Testing has proved this action provides up to 25% improvement in valve life and 50% reduction in water hammer.

Each of the dual plates has its own spring or springs, which provide independent closing action. These independent springs undergo less angular deflection, only 140° as compared to 350° for conventional springs with two legs.

Independent Plate Suspension Design

The Marlin valve's unique hinge design reduces friction forces by 66%, which improves valve response significantly. Support sleeves are inserted through the outboard hinges so that the upper hinge is independently supported by the lower sleeve during valve operation. This allows both plates to close at the same time for quick response, and excellent dynamic performance.

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Applications

A wide variety of body designs, materials, and trim make Marlin valves exceptionally versatile and suitable for a multitude of liquid and gas fluid applications.

Some of the major markets and typical applications are depicted here.





Petroleum Refining
Hydrogen
Cracking
Steam
Crude Oil
Gasoline
Visbreakers
Naptha
Sulfur

Oil and Gas Production
Centrifugal Compressor Discharge
Fire Water Lines
Oil/Steam Separation
Steam and CO^2 Injection
Gas/Oil Gathering Systems
Flowlines
Wellheads

Petrochemicals
Ethylene
Propylene
Steam
Reboilers
Gases

Chemicals
Chlorine
Phosgene
Aromatics
Polymers
Acids
Air Separation
Caustics

Power Generation
Steam
Condensate
Boiler Feed Pumps
Cooling Towers
Service Water Recirculators
River Water Intake

Steel/Primary Metals
Quench Lines
De-Scaling
Continuous Casters
Steam
Condensate
Strippers
Electro-Galvanizing



Applications





Marine
Oil Tankers
Tanker Loading Terminals
Offshore Platforms
Sub-Sea Manifolds
Terminal Transfer Lines
Barge Unloading Lines
Shipboard Services

Pulp and Paper
Bleaching Lines
Black Liquor
Green Liquor
White Water
Steam
Chemical Recovery

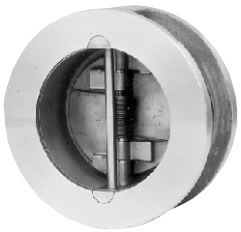
Water and Wastewater
Distribution Lines
Pumping Stations
Sewage Plant Blower Discharge
Chemical Treatment
Fire Protection Systems
HVAC Systems



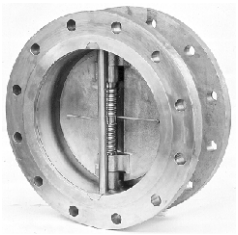
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Valve Configurations

Style MP
Retainerless Wafer
Sizes 2" – 72"
- ASME Classes 150 – 2500
- Dimensions pages 9–10



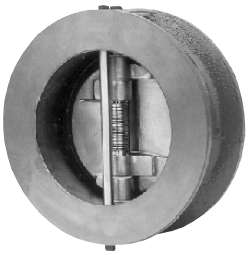
Style MLP
Retainerless Wafer Double Flange Valves
Sizes 2" – 72"
- ASME Classes 150 – 900
- Sizes & Dimensions page 11



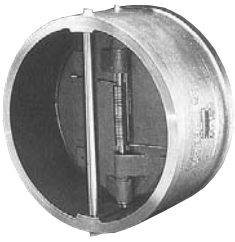
Retainerless Wafer Lug Valves
Sizes 2" – 72"
- ASME Classes 150 – 2500
- Sizes & Dimensions page 12



Style M
Wafer
Sizes 2" – 72"
- ASME Classes 125 – 2500
- Wafer Design
- Dimensions pages 9–10



Style ME
Extended Body Wafer
Sizes 6" – 54"
- ASME Classes 150 – 2500
- Designed for extremely fast opening conditions
- Sizes & Dimensions page 17



Style MR
Lined
Sizes 2" – 24"
- 150 PSI Pressure Rating
- Fully Lined Valve
- Dimensions page 20



Style MP† Retainerless Wafer Check Valves

High Performance Check Valve for Critical Applications

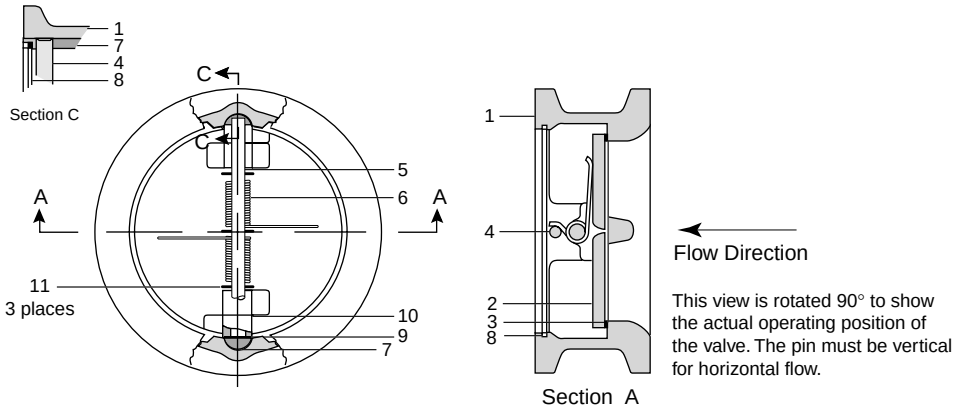


For critical applications, Style MP retainerless Marlin wafer check valves feature a one-piece body with no pin retainer penetration through the body.

These high performance valves utilize the same internal design of other Marlin valves with all the unique features and advantages built into them.

Item No.	Part No.
1	Body
2	Plate
3	Seal
4	Stop Pin
5	Hinge Pin
6	Spring*
7	Pin Insert
8	Snap Ring
9	Body Bearing
10	Plate Bearing
11	Spring Bearing

* Independent spring in valve sizes 6" and larger.



Because Retainerless Marlin wafer checks have no body penetrations potential leak paths through the valve are eliminated. This makes the Retainerless Marlin valves ideally sutied to meet the following critical service applications:

- Hydrocarbon processing
- Chemical processing
- Any industry concerned with fire hazards or environmental safety

Key features of the Marlin Style ML wafer check valve include:

- A wide selection of body and plate materials
- A choice of metal-to-metal or resilient sealing
- A full range of pressure classes and sizes
- A variety of end connections
- Designs available in ANSI, API, BS and DIN pressure ratings
- Internals easily removed for field replacement under normal inspections and maintenance procedures

The advanced design of the Marlin provides many operational benefits to the user, which combined with its more compact size and lower weight, make the Marlin Style ML an excellent alternative to a standard swing check valve.

Remarkable advantages include:

- Independent spring action (on 6" and larger) and plate suspension on larger valves
- Free release flat seats
- Springs provide superior response to flow reversal or deceleration
- Minimal water hammer
- Savings in purchase price and installation costs compared to a conventional swing check valve
- Single body design with no body cartridge

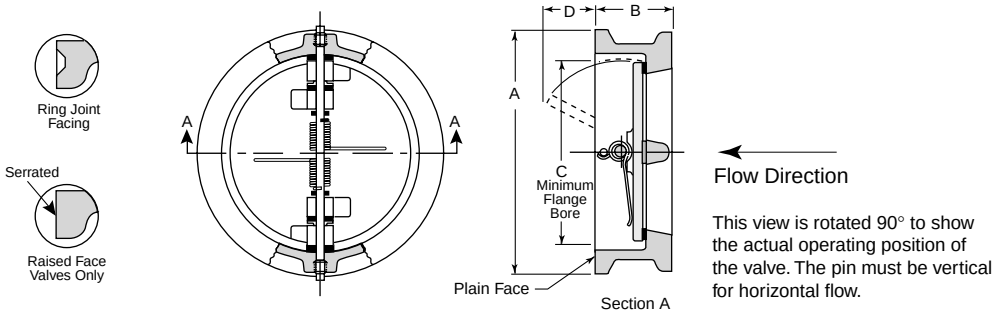
† Installation dimensions for these valves are as shown on pages 9–10.

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CRANE

Marlin Valves

Style M Installation Dimensions



Style M wafer style body valves are designed with flangeless bodies with relatively short face-to-face dimensions. They are clamped between mating flanges which are connected by studs and nuts.

ASME Class 125 (Cast Iron valves only)

Size		A		B		C		D		Weight	
in	mm	in	mm	in	mm	in	mm	in	mm	lbs.	kg.
2"	50	4 1/8	105	2 1/8	54	2 1/16	52	–	–	4	1.8
2 1/2"	65	4 7/8	124	2 1/8	54	2 15/32	63	–	–	6	2.7
3"	80	5 3/8	137	2 1/4	57	3 1/16	78	5/8	16	7	3.2
4"	100	6 7/8	175	2 1/2	64	4	102	1	25	12	5.4
5"	125	7 3/4	197	2 3/4	70	5	127	1 5/16	33	15	6.8
6"	150	8 3/4	222	3	76	6 1/16	154	1 15/16	35	20	9
8"	200	11	279	3 3/4	95	8	203	3 7/16	54	40	18
10"	250	13 3/8	340	4 1/4	108	10	254	3 3/8	70	65	29
12"	300	16 1/8	410	5 5/8	143	11 15/16	303	3 9/16	83	110	50
14"	350	17 3/4	451	7 1/4	184	12 1/2	318	3 1/16	83	183	83
16"	400	20 1/4	514	7 1/2	191	15	381	4 1/4	113	255	116
18"	450	21 5/8	549	8	203	16 7/8	429	5 3/8	137	315	143
20"	500	23 7/8	606	8 3/8	213	18 13/16	478	6 3/16	160	380	172
24"	600	28 1/4	718	8 3/4	222	22 5/8	575	8 1/4	210	575	261
30"	750	34 3/4	883	12	305	29 1/4	743	9 9/16	229	1070	486
36"	900	41 1/4	1048	14 1/2	368	35	889	12 5/16	303	1962	890
42"	1050	48	1219	17	432	41	1041	15	381	2800	1270
48"	1200	54 1/2	1384	20 5/8	524	47	1194	16 3/4	425	3920	1178
54"	1350	61	1549	21 1/4	540	51 1/2	1308	19 3/4	502	6172	2800
60"	1500	67 1/2	1715	26	660	56	1422	–	–	7800	3538
66"	1650	74 1/4	1886	31	787	65 1/4	1657	–	–	12000	5443
72"	1800	80 3/4	2051	36	914	68	1727	–	–	14000	6350

Wafer Checks are available in accordance with DIN, BS, JIS, AS and ISO Dimensions. For other sizes and pressure classes contact factory.

ASME Class 150

Size		A		B		C		D		Weight	
in	mm	in	mm	in	mm	in	mm	in	mm	lbs.	kg.
2"	50	4 1/8	105	2 3/8	60	1 15/16	49	–	–	6	3
2 1/2"	65	4 7/8	124	2 5/8	67	2 11/32	60	–	–	10	5
3"	80	5 3/8	137	2 7/8	73	2 29/32	74	1/4	6	13	6
4"	100	6 7/8	175	2 7/8	73	3 53/64	97	5/8	16	17	8
5"	125	7 3/4	197	3 3/8	86	4 13/16	122	7/8	22	27	12
6"	150	8 3/4	222	3 7/8	98	5 49/64	146	1 3/8	35	35	16
8"	200	11	279	5	127	7 5/8	194	2 1/8	54	70	32
10"	250	13 3/8	340	5 3/4	146	9 9/16	243	2 3/4	70	106	48
12"	300	16 1/8	410	7 1/8	181	11 3/8	289	3 1/4	83	172	78
14"	350	17 3/4	451	7 1/4	184	12 1/2	318	3 1/4	83	200	91
16"	400	20 1/4	514	7 1/2	191	15	381	4 7/16	113	275	125
18"	450	21 5/8	549	8	203	16 7/8	429	5 3/8	137	315	143
20"	500	23 7/8	606	8 5/8	219	18 13/16	478	6 5/16	160	435	197
24"	600	28 1/4	718	8 3/4	222	22 5/8	575	8 1/4	210	620	281
26"	650	30 1/2	775	14	356	24 1/4	616	8	203	1555	705
30"	750	34 3/4	883	12	305	29 1/4	743	9	229	1230	558
36"	900	41 1/4	1048	14 1/2	368	35	889	11 15/16	303	2017	915
42"	1050	48	1219	17	432	41	1041	15	381	2800	1270
48"	1200	54 1/2	1384	20 5/8	524	47	1194	16 3/4	425	3920	1178
54"	1350	61	1549	21 1/4	540	51 1/2	1308	19 3/4	502	6172	2800
60"	1500	67 1/2	1715	26	660	56	1422	–	–	7800	3538
66"	1650	74 1/4	1886	31	787	65 1/4	1657	–	–	12000	5443
72"	1800	80 3/4	2051	36	914	68	1727	–	–	14000	6350

Style M Installation Dimensions, cont'd

ASME Class 250

Size		A		B		C		D		Weight	
in	mm	in	mm	in	mm	in	mm	in	mm	lbs.	kg.
2"	50	4 3/8	111	2 1/8	54	1 15/16	49	3/32	2	5	2.3
2 1/2"	65	5 1/8	130	2 3/8	60	2 11/32	60	3/8	10	11	5
3"	80	5 7/8	149	2 5/8	67	2 29/32	74	9/16	14	11	5
4"	100	7 1/8	181	2 5/8	67	3 53/64	97	9/16	14	14	6.4
5"	125	8 1/2	216	3 1/4	83	4 13/16	122	1	25	29	13.2
6"	150	9 7/8	251	3 3/4	95	5 49/64	146	1 1/2	38	35	16
8"	200	12 1/8	308	5	127	7 5/8	194	2 1/8	54	75	34
10"	250	14 1/4	362	5 1/2	140	9 9/16	243	3 1/16	80	113	51
12"	300	16 5/8	422	7 1/8	181	11 3/8	289	3 1/4	83	174	79
14"	350	19 1/8	486	8 3/4	222	12 1/2	318	3 3/16	81	299	136
16"	400	21 1/4	540	9 1/8	232	14 5/16	364	4 1/8	105	380	172
18"	450	23 1/2	597	10 3/8	264	16 7/8	429	4 13/16	122	510	231
20"	500	25 3/4	654	11 1/2	292	17 15/16	456	5 3/8	136	593	269
24"	600	30 1/2	775	12 1/2	318	21 9/16	548	7 1/16	179	1010	458
30"	750	37 1/2	953	14 1/2	368	28 3/4	730	8 13/16	224	1880	853
36"	900	44	1118	19	483	35	889	11 9/16	294	3573	1608
42"	1050	50 3/4	1289	22 3/8	568	41	1041	14 3/4	375	5780	2622
48"	1200	58 3/4	1492	24 3/4	629	47	1194	16 1/2	419	6572	2981

ASME Class 300

Size		A		B		C		D		Weight	
in	mm	in	mm	in	mm	in	mm	in	mm	lbs.	kg.
2"	50	4 3/8	111	2 3/8	60	1 15/16	49	–	–	7	3
2 1/2"	65	5 1/8	130	2 5/8	67	2 11/32	60	–	–	11	5
3"	80	5 7/8	149	2 7/8	73	2 29/32	74	1/4	6	15	7
4"	100	7 1/8	181	2 7/8	73	3 53/64	97	5/8	16	18	8
5"	125	8 1/2	216	3 3/8	86	4 13/16	122	7/8	22	35	16
6"	150	9 7/8	251	3 7/8	98	5 49/64	146	1 3/8	35	45	20
8"	200	12 1/8	308	5	127	7 5/8	194	2 1/8	54	82	37
10"	250	14 1/4	362	5 3/4	146	9 9/16	243	2 3/4	70	125	57
12"	300	16 5/8	422	7 1/8	181	11 3/8	289	3 1/4	83	200	91
14"	350	19 1/8	486	8 3/4	222	12 1/2	318	3 3/16	81	325	147
16"	400	21 1/4	540	9 1/8	232	14 5/16	364	4 1/8	105	415	188
18"	450	23 1/2	597	10 3/8	264	16 7/8	429	4 13/16	122	555	252
20"	500	25 3/4	654	11 1/2	292	17 15/16	456	5 5/8	143	725	329
24"	600	30 1/2	775	12 1/2	318	21 9/16	548	7 1/16	179	1100	499
26"	650	32 7/8	835	14	356	24 3/8	619	8	203	1605	728
30"	750	37 1/2	953	14 1/2	368	28 3/4	730	9 1/16	230	2050	930
36"	900	44	1118	19	483	35	889	11 3/16	284	3573	1621
42"	1050	50 3/4	1289	22 3/8	568	41	1041	14 3/4	375	5780	2622
48"	1200	58 3/4	1492	24 3/4	629	47	1194	16 1/2	419	6572	2981

ASME Class 600

Size		A		B		C		D		Weight	
in	mm	in	mm	in	mm	in	mm	in	mm	lbs.	kg.
2"	50	4 3/8	111	2 3/8	60	1 15/16	49	–	–	7	3
2 1/2"	65	5 1/8	130	2 5/8	67	2 11/32	60	1/8	3	11	5
3"	80	5 7/8	149	2 7/8	73	2 29/32	74	1/4	6	15	7
4"	100	7 5/8	194	3 1/8	79	3 53/64	97	7/8	22	26	12
5"	125	9 1/2	241	4 1/8	105	4 13/16	122	1	25	50	22.7
6"	150	10 1/2	267	5 3/8	137	5 49/64	146	1 7/16	36	80	36
8"	200	12 5/8	321	6 1/2	165	7 5/8	194	2	51	135	61
10"	250	15 3/4	400	8 3/8	213	9 9/16	243	2 9/32	58	238	108
12"	300	18	457	9	229	11 3/8	289	3 15/32	88	333	151
14"	350	19 3/8	492	10 3/4	273	12 1/2	318	2 3/4	70	455	206
16"	400	22 1/4	565	12	305	14 5/16	364	4 5/16	110	640	290
18"	450	24 1/8	613	14 1/4	362	16 1/8	410	3 11/16	94	890	404
20"	500	26 7/8	683	14 1/2	368	17 15/16	456	5 5/16	135	1120	508
24"	600	31 1/8	791	17 1/4	438	21 9/16	548	6 9/16	167	2040	925
26"	650	34 1/8	867	18	547	24	610	7 1/4	184	2530	1148
30"	750	38 1/4	972	19 7/8	505	28 3/4	730	9 9/16	243	3375	1531
36"	900	44 1/2	1130	25	635	33 3/4	857	11 15/16	303	6300	2858
42"	1050	51	1295	27 5/8	702	39 1/2	1003	14 1/4	362	8447	3832

ASME Class 900

Size		A		B		C		D		Weight	
in	mm	in	mm	in	mm	in	mm	in	mm	lbs.	kg.
2"	50	5 5/8	143	2 3/4	70	1 11/16	43	–	–	14	6
2 1/2"	65	6 1/2	165	3 1/4	83	2 1/8	54	1/16	2	16	7
3"	80	6 5/8	168	3 1/4	83	2 5/8	67	5/16	8	24	11
4"	100	8 1/8	206	4	102	3 7/16	87	9/16	14	40	18
5"	125	9 3/4	248	–	–	4 5/16	110	–	–	–	–
6"	150	11 3/8	289	6 1/4	159	5 3/16	132	1 1/16	27	115	52
8"	200	14 1/8	359	8 1/8	206	6 13/16	173	1 13/32	36	229	104
10"	250	17 1/8	435	9 1/2	241	8 1/2	216	1 13/16	46	388	176
12"	300	19 5/8	498	11 1/2	292	10 1/8	257	2 5/16	59	540	245
14"	350	20 1/2	521	14	356	11 1/2	292	2	51	926	420
16"	400	22 5/8	575	15 1/8	384	12 13/16	325	2 5/8	67	1152	523
18"	950	25 1/8	638	17 3/4	451	14 7/16	367	2 9/16	65	1318	598
20"	500	27 1/2	699	17 3/4	451	17 15/16	456	5 5/16	135	1426	647
24"	600	33	838	19 1/2	495	21 1/2	546	5 5/8	143	2729	1238

ASME Class 1500

Size		A		B		C		D		Weight	
in	mm	in	mm	in	mm	in	mm	in	mm	lbs.	kg.
2"	50	5 5/8	143	2 3/4	70	1 11/16	43	–	–	14	6
2 1/2"	65	6 1/2	165	3 1/4	83	2 1/8	54	1/16	2	16	7
3"	80	6 7/8	175	3 1/4	83	2 5/8	67	5/16	8	25	11
4"	100	8 1/4	210	4	102	3 7/16	87	9/16	14	43	20
5"	125	10	254	–	–	4 5/16	110	–	–	–	–
6"	150	11 1/8	283	6 1/4	159	5 3/16	132	1 1/16	27	110	50
8"	200	13 7/8	352	8 1/8	206	6 13/16	173	1 13/32	36	219	99
10"	250	17 1/8	435	9 3/4	248	8 1/2	216	1 11/16	43	397	180
12"	300	20 1/2	521	12	305	10 1/8	257	2 1/4	57	725	329
14"	350	22 3/4	578	14	356	11 1/2	292	2	51	948	430
16"	400	25 1/4	641	15 1/8	384	12 13/16	325	2 5/8	67	1380	627
18"	450	27 3/4	705	18 7/16	468	13 3/4	349	2 11/16	68	1900	863
20"	500	29 3/4	756	21	533	14 3/4	375	4	102	2750	1247
24"	600	35 1/2	902	22	559	15 1/8	384	4 1/8	105	5860	2658

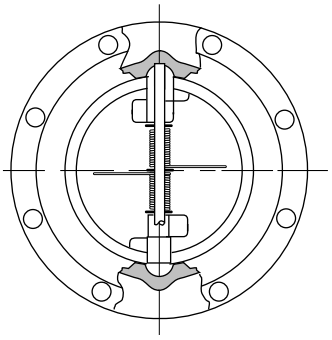
ASME Class 2500

Size		A		B		C		D		Weight	
in	mm	in	mm	in	mm	in	mm	in	mm	lbs.	kg.
2"	50	5 3/4	146	2 3/4	70	1 11/16	43	–	–	15	7
2 1/2"	65	6 5/8	168	3 1/4	83	2 1/8	54	1/16	2	22	10
3"	80	7 3/4	197	3 3/8	86	2 5/8	67	1/4	6	31	14
4"	100	9 1/4	235	4 1/8	105	3 7/16	87	7/16	11	54	25
5"	125	11	279	–	–	4 5/16	110	–	–	–	–
6"	150	12 1/2	318	6 1/4	159	5 3/16	132	1 1/16	27	190	86
8"	200	15 1/4	387	8 1/8	206	6 13/16	173	1 11/16	43	285	129
10"	250	18 3/4	476	10	254	8 1/2	216	1 13/16	46	502	228
12"	300	21 5/8	549	12	305	10 1/8	257	2 3/16	56	963	437

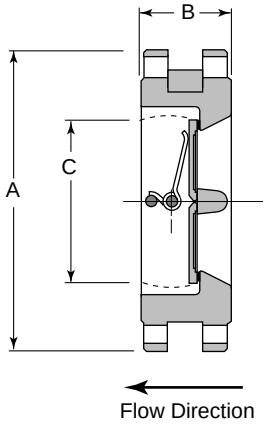
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Style MLP Double Flange Retainerless Valve Design

Double Flanged Style Valves bolt up similar to a bolted cap swing check or gate valve. Double flanged versions are offered as standard on larger size valves where the lay length of the body permits installation of two heavy nuts between the flanges. These valves are standard retainerless design.



Pin must be vertical for horizontal flow.



ASME Class 150

Size		A		B		C		Weight	
in	mm	in	mm	in	mm	in	mm	lbs.	kg.
8"	200	13 ½	343	5	127	7 5⁄8	194	93	42
10"	250	16	406	5 ¾	146	9 9⁄16	243	189	86
12"	300	19	483	7 1⁄8	181	11 3⁄8	289	218	99
14"	350	21	533	7 ¼	184	12 ½	318	274	124
16"	400	23 ½	597	7 ½	191	15	381	353	160
18"	450	25	635	8	203	16 7⁄8	428	409	185
20"	500	27 ½	699	8 5⁄8	219	18 7⁄8	480	552	250
24"	600	32	813	8 ¾	222	22 5⁄8	575	860	389
30"	750	38 ¾	984	12	305	29 ¼	743	1512	687
36"	900	46	1168	14 ½	368	35	889	2525	1145
42"	1050	53	1346	17	432	41	1041	4163	1888
48"	1200	59 ½	1511	20 5⁄8	524	47	1194	5880	2667
54"	1350	66 ¼	1683	21 ¼	539	51 ½	1308	–	–
60"	1500	73	1854	26	660	56	1422	–	–
66"	1650	80	2032	31	787	62 ½	1588	–	–
72"	1800	86 ½	2197	36	914	68	1727	–	–

ASME Class 300

Size		A		B		C		Weight	
in	mm	in	mm	in	mm	in	mm	lbs.	kg.
12"	300	20 ½	521	7 1⁄8	181	11 3⁄8	289	336	152
14"	350	23	584	8 ¾	222	12 ½	318	431	195
16"	400	25 ½	648	9 1⁄8	232	14 3⁄8	365	619	280
18"	450	28	711	10 3⁄8	264	16 1⁄8	409	850	385
20"	500	30 ½	775	11 ½	292	17 7⁄8	454	1078	488
24"	600	36	914	12 ½	318	22 1⁄8	562	1516	686
30"	750	43	1092	14 ½	368	28 ¾	730	3100	1406
36"	900	50	1270	19	483	35	864	4650	2109
42"	1050	50 ¾	1289	22 3⁄8	568	41	1041	8670	3932
48"	1200	57 ¾	1467	24 ¾	629	47	1193	9950	4513
54"	1350	65 ¼	1657	27 ¼	692	51 ½	1308	–	–
60"	1500	73	1854	32 ½	826	56	1422	–	–

ASME Class 600

Size		A		B		C		Weight	
in	mm	in	mm	in	mm	in	mm	lbs.	kg.
12"	300	22	559	9	229	11 3⁄8	289	612	277
14"	350	23 ¾	603	10 ¾	273	12 ½	318	682	309
16"	400	27	685	12	305	14 3⁄8	365	951	430
18"	450	29 ¼	743	14 ¼	362	16 1⁄8	409	1221	553
20"	500	32	813	14 ½	368	18	457	1606	728
24"	600	37	940	17 ½	445	21 9⁄16	548	2451	1111
30"	750	44 ½	1130	19 7⁄8	505	28 ¾	730	3825	1735
36"	900	51 ¾	1314	25	635	33 ¾	857	6057	2747
42"	1050	55 ¼	1403	27 5⁄8	702	39 ½	1003	9985	4529
48"	1200	62 ¾	1594	31	787	36	914	12600	5715

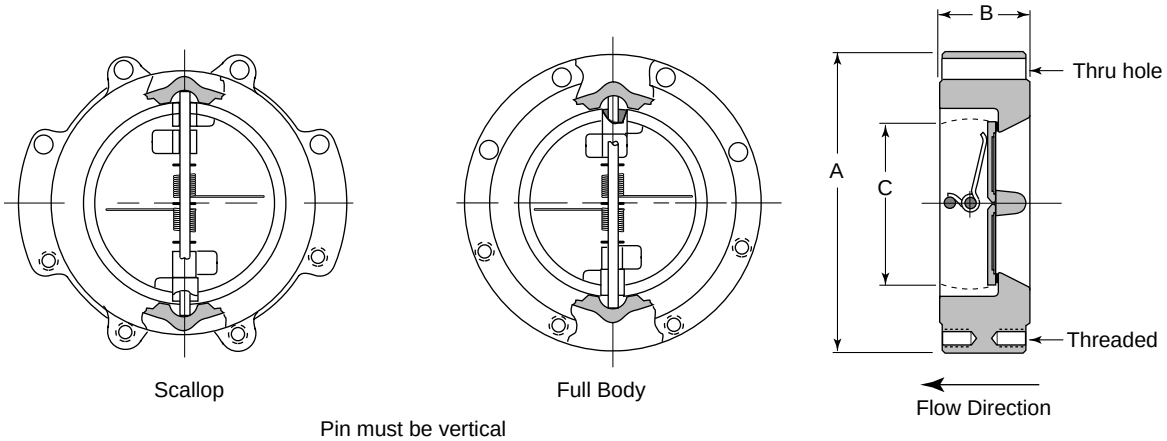
ASME Class 900

Size		A		B		C		Weight	
in	mm	in	mm	in	mm	in	mm	lbs.	kg.
12"	300	24	610	11 ½	292	10 1⁄8	257	770	349
14"	350	25 ¼	641	14	356	11 ½	292	1240	561
16"	400	27 ¾	705	15 1⁄8	384	12 7⁄8	327	1210	548
18"	450	31	787	17 ¾	451	14 ½	368	1845	835
20"	500	33 ¾	857	17 ¾	451	18	457	3940	1787
24"	600	41	1041	19 ½	495	21 ½	546	4175	1893
30"	750	48 ½	1222	25	635	26	660	6500	2948
36"	900	57 ½	1461	28	711	31	787	–	–
42"	1050	61 ½	1562	31 ½	800	36	914	–	–

Notes:
- Sizes not available in double flange design are offered as lug body design, see page 12.
- Please consult factory for other sizes and pressure classes available.
- Weights are for valves only, consult factory for weights not shown.
- Other dimensions same as wafer design, pages 9–10.

Style MLP Lug Retainerless Valve Design

Lug Style valves cover the bolting the entire length of the body. Lug valves are furnished in scallop and full body designs. Scallop is furnished whenever possible to keep weight to a minimum. These valves are standard retainerless design. Lug valves can be specified with threaded or through-hole bolting.



Scallop

Full Body

Pin must be vertical
for horizontal flow.

ASME Class 150

Size		A		B		C		Weight	
in	mm	in	mm	in	mm	in	mm	lbs.	kg.
2"	60	6 ½	165	2 ⅜	60	1 15/16	49	17	8
2 ½"	65	7 ½	191	2 ⅝	67	2 11/32	60	17	8
3"	80	8 ¼	210	2 ⅞	73	2 29/32	74	17	8
4"	100	9	229	2 ⅞	73	3 53/64	97	28	13
5"	125	10	254	3 ⅜	86	4 13/16	122	36	16
6"	150	11	279	3 ⅞	98	5 49/64	146	48	22

ASME Class 300

Size		A		B		C		Weight	
in	mm	in	mm	in	mm	in	mm	lbs.	kg.
2"	50	6 ½	165	2 ⅜	60	1 15/16	49	18	8
2 ½"	65	7 ½	191	2 ⅝	67	2 11/32	60	22	10
3"	80	8 ¼	210	2 ⅞	73	2 29/32	74	30	14
4"	100	10	254	2 ⅞	73	3 53/64	97	36	16
5"	125	11	279	3 ⅜	86	4 13/16	122	51	23
6"	150	12 ½	318	3 ⅞	98	5 49/64	146	84	38
8"	200	15	381	5	127	7 ⅝	194	135	61
10"	250	17 ½	445	5 ¾	146	9 9/16	243	270	123

ASME Class 600

Size		A		B		C		Weight	
in	mm	in	mm	in	mm	in	mm	lbs.	kg.
2"	50	6 ½	165	2 ⅜	60	1 15/16	49	18	8
2 ½"	65	7 ½	191	2 ⅝	67	2 11/32	60	22	10
3"	80	8 ¼	210	2 ⅞	73	2 29/32	74	30	14
4"	100	10 ¾	273	3 ⅛	79	3 53/64	97	50	23
6"	150	14	356	5 ⅜	137	5 49/64	146	183	83
8"	200	16 ½	419	6 ½	165	7 ⅝	194	295	134
10"	250	20	508	8 ⅜	213	9 9/16	243	540	245

ASME Class 900

Size		A		B		C		Weight	
in	mm	in	mm	in	mm	in	mm	lbs.	kg.
2"	50	8½	216	2¾	70	1 11/16	43	37	17
3"	80	9½	241	3¼	83	2⅝	67	57	26
4"	100	11½	292	4	102	3 7/16	87	98	45
6"	150	15	381	6¼	159	5 3/16	132	252	114
8"	200	18½	470	8⅛	206	6 13/16	173	441	200
10"	250	21½	546	9½	241	8½	216	787	357

ASME Class 1500

Size		A		B		C		Weight	
in	mm	in	mm	in	mm	in	mm	lbs.	kg.
2"	60	8 ½	216	2 ¾	70	1 11/16	43	37	17
3"	80	10 ½	267	3 ¼	83	2 ⅝	67	70	32
4"	100	12 ¼	311	4	102	3 7/16	87	112	51
6"	150	15 ½	394	6 ¼	159	5 3/16	132	262	119
8"	200	19	483	8 ⅛	206	6 13/16	173	488	221
10"	250	23	584	9 ¾	248	8 ½	216	917	416
12"	300	26 ½	673	12	305	10 ⅛	257	1425	646
14"	350	29 ½	749	14	356	11 ½	292	2045	928
16"	400	32 ½	826	15 ⅛	384	12 13/16	325	2600	1179
18"	450	36	914	18 7/16	468	13 ¾	349	3883	1761
20"	500	38 ¾	984	21	533	14 ¾	348	5700	2580
24"	600	46	1168	22	559	15 ⅛	384	7150	3236

ASME Class 2500

Size		A		B		C		Weight	
in	mm	in	mm	in	mm	in	mm	lbs.	kg.
2"	50	9¼	235	2 ¾	70	1 11/16	43	48	22
3"	80	12	305	3 ⅜	86	2 ⅝	67	93	42
4"	100	14	356	4 ⅛	105	3 7/16	87	152	69
6"	150	19	483	6 ¼	159	5 3/16	132	386	175
8"	200	21 ¾	552	8 ⅛	206	6 13/16	173	682	309
10"	250	26 ½	673	10	254	8 ½	216	1233	559
12"	300	30	762	12	305	10 ⅛	257	1881	853

- Weights are for valves only.
- Consult factory for additional sizes and pressure classes.
- Other dimensions same as wafer design, pages 9–10.

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DIN Valve Outside Diameter of Body

PN 6, 10, 16 (ASME Class 150)

Size		PN	A (DIN)*	
in	mm		mm	in
2"	50	6	98	3 27/32
		10	109	4 9/32
		16	109	4 9/32
2 ½"	65	6	118	4 5/8
		10	129	5 1/16
		16	129	5 1/16
3"	80	6	134	5 1/4
		10	144	5 21/32
		16	144	5 21/32
4"	100	6	154	6 1/16
		10	164	6 7/16
		16	164	6 7/16
5"	125	6	184	7 7/32
		10	194	7 5/8
		16	194	7 5/8
6"	150	6	209	8 7/32
		10	220	8 21/32
		16	220	8 21/32
8"	200	6	264	10 3/8
		10	275	10 13/16
		16	275	10 13/16
10"	250	6	319	12 17/32
		10	330	13
		16	331	13 1/32
12"	300	6	375	14 3/4
		10	380	14 15/16
		16	386	15 3/16
14"	350	6	425	16 23/32
		10	440	17 5/16
		16	446	17 17/32
16"	400	6	475	18 11/16
		10	491	19 5/16
		16	498	19 19/32
18"	450	10	541	21 9/32
		16	558	21
20"	500	6	580	22 13/16
		10	596	23 7/16
		16	620	24 13/16
24"	600	6	681	26 25/32
		10	698	27 15/32
		16	737	29
28"	700	6	786	30 15/16
		10	813	32
		16	807	31 3/4
32"	800	6	893	35 5/32
		10	920	36 7/32
		16	914	35 15/16
36"	900	6	993	39 3/32
		10	1020	40 5/32
		16	1014	39 29/32
40"	1000	6	1093	43 1/32
		10	1127	44 3/8
		16	1131	44 1/2
48"	1200	6	1310	51 9/16
		10	1344	52 15/16
		16	1345	52 15/16

PN 25, 40 (ASME Class 300)

Size		PN	A (DIN)*	
in	mm		mm	in
2"	50	25	109	4 9/32
		40	109	4 9/32
2 ½"	65	25	129	5 1/16
		40	129	5 1/16
3"	80	25	144	5 21/32
		40	144	5 21/32
4"	100	25	170	6 11/16
		40	170	6 11/16
5"	125	25	196	7 11/16
		40	196	7 11/16
6"	150	25	226	8 7/8
		40	226	8 7/8
8"	200	25	286	11 1/4
		40	293	11 17/32
10"	250	25	343	13 1/2
		40	355	13 31/32
12"	300	25	403	15 27/32
		40	420	16 17/32
14"	350	25	460	18 3/32
		40	477	18 3/4
16"	400	25	517	20 11/32
		40	549	21 19/32
18"	450	40	574	22 19/32
20"	500	25	627	24 11/16
		40	631	24 13/16
24"	600	25	734	28 7/8
		40	750	29 1/2

PN 64, 100 (ASME Class 600)

Size		PN	A (DIN)*	
in	mm		mm	in
2"	50	64	115	4 1/2
		100	121	4 3/4
2 ½"	65	64	140	5 1/2
		100	146	5 3/4
3"	80	64	150	5 29/32
		100	156	6 1/8
4"	100	64	176	6 29/32
		100	183	7 3/16
5"	125	64	213	8 3/8
		100	220	8 27/32
6"	150	64	250	9 13/16
		100	260	10 7/32
8"	200	64	312	12 9/32
		100	327	12 27/32
10"	250	64	367	14 7/16
		100	394	15 1/2
12"	300	64	427	16 25/32
		100	461	18 1/8
14"	350	64	489	19 1/4
		100	515	20 1/4
16"	400	64	546	21 15/32
		100	575	22 5/8
20"	500	64	660	25 31/32
		100	708	27 27/32
24"	600	64	768	30 7/32
		100	819	32 7/32

PN 160 (ASME Class 900)

Size		PN	A (DIN)*	
in	mm		mm	in
2"	50	160	121	4 3/4
2 ½"	65	160	146	5 3/4
3"	80	160	156	6 1/8
4"	100	160	183	7 3/16
5"	125	160	220	8 27/32
6"	150	160	260	10 7/32
8"	200	160	327	12 27/32
10"	250	160	391	15 3/8
12"	300	160	461	18 1/8

PN 250 (ASME Class 1500)

Size		PN	A (DIN)*	
in	mm		mm	in
2"	50	250	126	4 15/16
2 ½"	65	250	156	6 1/8
3"	80	250	173	6 25/32
4"	100	250	205	8 1/16
5"	125	250	245	9 5/8
6"	150	250	287	11 9/32
8"	200	250	361	14 3/16
10"	250	250	445	17 1/2
12"	300	250	542	21 5/16

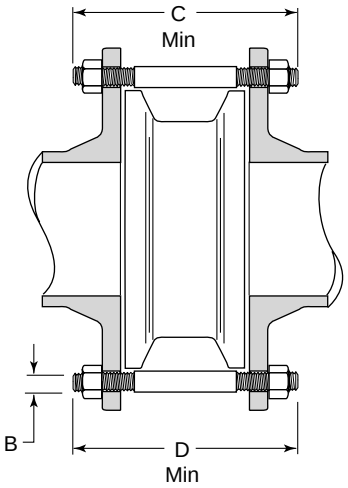
PN 320 (ASME Class 2500)

Size		PN	A (DIN)*	
in	mm		mm	in
2"	50	320	136	5 11/32
2 ½"	65	320	173	6 25/32
3"	80	320	193	7 19/32
4"	100	320	232	9 1/8
5"	125	320	277	10 29/32
6"	150	320	314	12 11/32
8"	200	320	401	15 25/32
10"	250	320	492	19 11/32

*Dimension A applies to drawing on page 9. Other dimensions for ASME Classes shown apply to these valves with DIN outside diameters.

Styles M and MP Stud Selection

Flat or Raised Face flanges



Ring Joint flanges

ASME Class 125

Valve Size		No. of Studs	B		C	
			Bolt Diameter		Flat Face	
in	mm		in	mm	in	mm
2"	50	4	5/8	16	5 1/4	133
2 1/2"	65	4	5/8	16	5 1/2	140
3"	80	4	5/8	16	5 3/4	146
4"	100	8	5/8	16	6 1/4	159
5"	125	8	3/4	19	6 3/4	171
6"	150	8	3/4	19	7	178
8"	200	8	3/4	19	8	203
10"	250	12	7/8	22	9	229
12"	300	12	7/8	22	10 1/2	267

*For larger sizes, see Class 150 table.

ASME Class 150

Valve Size		No. of Studs	B		C		D	
			Bolt Diameter		Raised Face		Ring Joint	
in	mm		in	mm	in	mm	in	mm
2"	50	4	5/8	16	5 3/4	146	6 1/4	159
2 1/2"	65	4	5/8	16	6 1/4	159	7	178
3"	80	4	5/8	16	6 3/4	171	7 1/4	184
4"	100	8	5/8	16	6 3/4	171	7 1/4	184
5"	125	8	3/4	19	7 1/2	191	8	203
6"	150	8	3/4	19	8	203	8 1/2	216
8"	200	8	3/4	19	9 1/2	241	10	254
10"	250	12	7/8	22	10 1/2	267	11	279
12"	300	12	7/8	22	12	305	12 1/2	318
14"	350	12	1	25	12 3/4	324	13 1/4	337
16"	400	16	1	25	13 1/4	337	13 3/4	349
18"	450	16	1 1/8	29	14 1/4	362	14 3/4	375
20"	500	20	1 1/8	29	15	381	15 1/2	394
24"	600	20	1 1/4	32	15 3/4	400	16 1/4	413
26"	650	24	1 1/4	32	22 3/4	578	23 1/4	591
30"	750	28	1 1/4	32	21 1/4	540	22 3/4	578
36"	900	32	1 1/2	38	26 1/4	667	39	679
42"	1050	36	1 1/2	38	28 1/2	724	-	-
48"	1200	44	1 1/2	38	33	838	-	-
54"	1350	44	1 3/4	44	35	889	-	-
60"	1500	52	1 3/4	44	-	-	-	-
66"	1650	52	1 3/4	44	-	-	-	-
72"	1800	60	1 1/8	29	-	-	-	-

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Styles M, MP and MLP Stud Selection

ASME Class 250 and 300

Valve Size		No. of Studs	B		C		D	
			Bolt Diameter		Raised Face		Ring Joint	
in	mm		in	mm	in	mm	in	mm
2"	50	8	5/8	16	6	152	6 3/4	171
2 1/2"	65	8	3/4	19	6 3/4	171	7 1/2	191
3"	80	8	3/4	19	7	178	8	203
4"	100	8	3/4	19	7 1/2	191	8 1/4	210
5"	125	8	3/4	19	8 1/4	210	9	229
6"	150	12	3/4	19	9	229	9 3/4	248
8"	200	12	7/8	22	10 1/2	267	11 1/4	286
10"	250	16	1	25	12 1/4	311	13	330
12"	300	16	1 1/8	29	14	356	14 3/4	375
14"	350	20	1 1/8	29	16	406	16 3/4	425
16"	400	20	1 1/4	32	17	432	17 3/4	451
18"	450	24	1 1/4	32	18 1/2	470	19 3/4	489
20"	500	24	1 1/4	32	19 3/4	502	20 1/2	521
24"	600	24	1 1/2	38	21 3/4	552	22 3/4	578
26"	650	28	1 5/8	41	24 1/4	616	25 1/4	641
30"	750	28	1 3/4	44	27 1/4	692	28 1/2	724
36"	900	32	2	51	32 1/4	819	15 1/2	851
42"	1050	36	2	51	36 1/2	927	37 3/4	959
48"	1200	40	2	51	40	1016	-	-

ASME Class 600

Valve Size		No. of Studs	B		C		D	
			Bolt Diameter		Raised Face		Ring Joint	
in	mm		in	mm	in	mm	in	mm
2"	50	8	5/8	16	6 3/4	171	7	178
2 1/2"	65	8	3/4	19	7 1/2	191	7 3/4	197
3"	80	8	3/4	19	8	203	8 1/4	210
4"	100	8	7/8	22	9 1/4	235	9 1/4	235
5"	125	8	1	25	10 3/4	273	11	279
6"	150	12	1	25	12 1/4	311	12 1/2	318
8"	200	12	1 1/8	29	14 1/4	362	14 1/2	368
10"	250	16	1 1/4	32	17	432	17 1/4	438
12"	300	20	1 1/4	32	18	457	18	457
14"	350	20	1 3/8	35	20 1/4	514	20 1/2	521
16"	400	20	1 1/2	38	22 1/4	565	22 1/2	572
18"	450	20	1 5/8	41	25 1/4	641	25 1/2	648
20"	500	24	1 5/8	41	26	660	26 1/4	667
24"	600	24	1 7/8	48	30 1/4	768	30 3/4	781
26"	650	28	1 7/8	48	31 1/2	800	32	813
30"	750	28	2	51	34 1/4	870	34 3/4	883
36"	900	28	2 1/2	64	41	1041	20 1/2	1060
42"	1050	28	2 3/4	70	47	1194	47 1/2	1207

ASME Class 900

Valve Size		No. of Studs	B		C		D	
			Bolt Diameter		Raised Face		Ring Joint	
in	mm		in	mm	in	mm	in	mm
2"	50	8	7/8	22	8 3/4	222	8 3/4	222
2 1/2"	65	8	1	25	9 3/4	248	9 3/4	248
3"	80	8	7/8	22	9 1/4	235	9 1/4	235
4"	100	8	1 1/8	29	11	279	11	279
6"	150	12	1 1/8	29	14	356	14 1/4	362
8"	200	12	1 3/8	35	17	432	17 1/4	438
10"	250	16	1 3/8	35	19	483	19	483
12"	300	20	1 3/8	35	21 3/4	552	21 3/4	552
14"	350	20	1 1/2	38	25	635	25 1/2	648
16"	400	20	1 5/8	41	26 3/4	679	27	686
18"	450	20	1 7/8	48	30 3/4	781	31 1/2	800
20"	500	20	2	51	31 1/2	800	32 1/4	819
24"	600	20	2 1/2	64	36 3/4	933	37 1/4	946

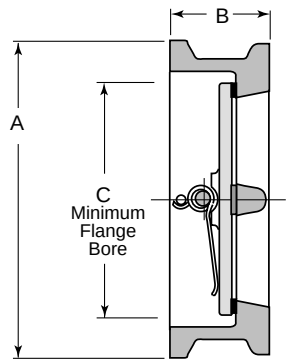
ASME Class 1500

Valve Size		No. of Studs	B		C		D	
			Bolt Diameter		Raised Face		Ring Joint	
in	mm		in	mm	in	mm	in	mm
2"	50	8	7/8	22	8 3/4	222	8 3/4	222
2 1/2"	65	8	1	25	9 3/4	248	9 3/4	248
3"	80	8	1 1/8	29	10 1/2	267	10 1/2	267
4"	100	8	1 1/4	32	12	305	12	305
6"	150	12	1 3/8	35	16 3/4	425	16 3/4	425
8"	200	12	1 5/8	41	19 3/4	502	20 1/4	514
10"	250	12	1 7/8	48	23 1/4	591	23 1/2	597
12"	300	16	2	51	27	686	27 3/4	705
14"	350	16	2 1/4	57	30 1/4	768	31 1/4	794
16"	400	16	2 1/2	64	33	838	34	864
18"	450	16	2 3/4	70	38 3/4	965	39	900
20"	500	16	3	76	43 3/4	1111	44 3/4	1137
24"	600	16	3 1/2	89	48	1219	49 1/4	1251

ASME Class 2500

Valve Size		No. of Studs	B		C		D	
			Bolt Diameter		Raised Face		Ring Joint	
in	mm		in	mm	in	mm	in	mm
2"	50	8	1	25	10	254	10	254
2 1/2"	65	8	1 1/8	29	11 1/4	286	11 1/4	286
3"	80	8	1 1/4	32	12 1/4	311	12 1/2	318
4"	100	8	1 1/2	38	14 1/4	362	14 3/4	375
6"	150	8	2	51	20	508	20 1/2	521
8"	200	12	2	51	23 3/4	603	24	610
10"	250	12	2 1/2	64	29 1/4	743	30 1/4	768
12"	300	12	2 3/4	70	33 1/4	845	34 1/4	870

API 6A Installation and Stud Selection



API Installation Dimensions - Class 3000

Size	A		B		C		Weight	
in	in	mm	in	mm	in	mm	lbs.	kg.
2 1/16"	5 5/8	143	2 3/4	70	1 11/16	43	14	6
2 9/16"	6 1/2	165	3 1/4	83	2 1/8	54	16	7
3 1/8"	6 5/8	168	3 1/4	83	2 5/8	67	25	11
4 1/16"	8 1/8	206	4	102	3 7/16	87	43	20
7 1/16"	11 3/8	289	6 1/4	159	5 3/16	132	110	50
9"	14 1/8	359	8 1/8	206	6 13/16	173	219	99
11"	17 1/8	435	9 3/4	248	8 1/2	216	397	180
13 5/8"	19 5/8	498	12	305	10 1/8	257	725	329

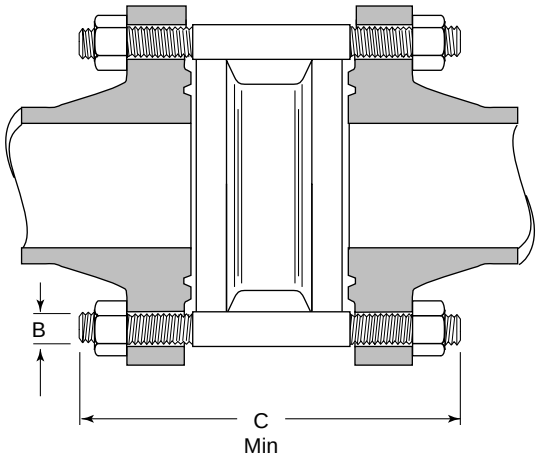
API Installation Dimensions - Class 2000

Size	A		B		C		Weight	
in	in	mm	in	mm	in	mm	lbs.	kg.
2 1/16"	4 3/8	143	2 3/4	70	1 11/16	43	14	6
2 9/16"	5 1/8	130	3 1/4	83	2 1/8	54	16	7
3 1/8"	5 7/8	149	3 1/4	83	2 5/8	67	24	11
4 1/16"	7 5/8	194	4	102	3 7/16	87	40	18
7 1/16"	10 1/2	267	6 1/4	159	5 3/16	132	115	52
9"	12 5/8	321	8 1/8	206	6 13/16	173	229	104
11"	15 3/4	400	9 1/2	241	8 1/2	216	388	176
13 5/8"	18	457	11 1/2	292	10 1/8	257	540	245

API Installation Dimensions - Class 5000

Size	A		B		C		Weight	
in	in	mm	in	mm	in	mm	lbs.	kg.
2 1/16"	5 5/8	143	2 3/4	70	1 11/16	43	15	7
2 9/16"	6 1/2	165	3 1/4	83	2 1/8	54	22	10
3 1/8"	6 7/8	175	3 3/8	86	2 5/8	67	31	14
4 1/16"	8 1/4	210	4 1/8	105	3 7/16	87	49	22
7 1/16"	11 1/8	283	6 1/4	159	5 3/16	132	190	86
9"	13 7/8	352	8 1/8	206	6 13/16	173	285	129
11"	17 1/8	435	10	254	8 1/2	216	502	228

Dimensions for 10000 and 15000 ratings available on request.



API Stud Selection - Class 3000

Size	No. of	B		C	
in	Studs	in	mm	in	mm
2 1/16"	8	7/8	22	9 1/4	235
2 9/16"	8	1	25	11 1/4	286
3 1/8"	8	7/8	22	11 1/2	292
4 1/16"	8	1 1/8	29	12	305
7 1/16"	12	1 1/8	29	15 1/4	387
9"	12	1 3/8	35	18 3/4	476
11"	16	1 3/8	35	20	508
13 5/8"	20	1 3/8	35	21 1/2	591

API Stud Selection - Class 2000

Size	No. of	B		C	
in	Studs	in	mm	in	mm
2 1/16"	8	5/8	16	8	203
2 9/16"	8	3/4	19	9	229
3 1/8"	8	3/4	19	9 1/2	241
4 1/16"	8	7/8	22	11 1/2	292
7 1/16"	12	1	25	14	356
9"	12	1 1/8	29	17	432
11"	16	1 1/4	32	19	483
13 5/8"	20	1 1/4	32	23 3/4	546

API Stud Selection - Class 5000

Size	No. of	B		C	
in	Studs	in	mm	in	mm
2 1/16"	8	7/8	22	9 1/4	235
2 9/16"	8	1	25	11 1/4	286
3 1/8"	8	1 1/8	29	12	305
4 1/16"	8	1 1/4	32	13	330
7 1/16"	12	1 3/8	35	18 3/4	476
9"	12	1 5/8	41	21	533
11"	12	1 7/8	48	24 1/2	622

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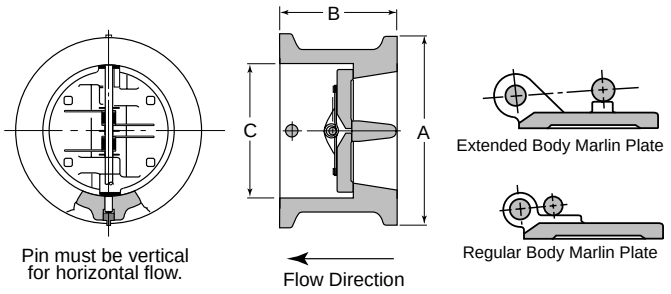
Style ME - Extended Body Wafer Check Valves

The "Extended Body" version of our Marlin Valve was designed for extremely fast opening conditions. These types of applications are generally associated with compressed gas or steam that causes damage from the explosive opening effect on the closure mechanism. This damage can render them inoperative. This is especially true with slow response valves such as swing and tilting disc check valves.



The Style ME body design has special geometry and plate configuration to allow each plate to strike the stop pin in its center of percussion. To absorb high impacts, the stop pin and hinge lugs are oversized.

Typical applications include centrifugal compressor discharge where compressors are subject to "surging," air separation plants, pipelines where compressors are mounted in parallel, and steam extraction. Style ME Marlin valves are generally not required for liquid applications.



Installation Dimensions — Pressure Classes 150–2500

ASME Class 150

Size		A		B		C		Weight	
in	mm	in	mm	in	mm	in	mm	lbs.	kg.
6"	150	8 3/4	222	4 13/16	122	6 3/8	168	46	21
8"	200	11	279	6 1/4	159	8 5/8	219	91	41
10"	250	13 3/8	340	7 1/4	184	10 3/4	273	166	75
12"	300	16 1/8	410	9	229	12 3/4	324	244	111
14"	350	17 3/4	451	8 3/8	213	14	356	260	118
16"	400	20 1/4	514	9 1/2	241	16	406	345	157
18"	450	21 5/8	549	10 3/8	264	18	457	427	194
20"	500	23 7/8	606	11 3/4	298	20	508	548	249
24"	600	28 1/4	718	13 3/4	349	24	610	874	396
26"	650	30 1/2	775	18	457	26	660	1741	790
30"	750	34 3/4	883	18	457	30	762	1544	700
32"	800	37	940	20 7/8	530	32	813	1638	743
36"	900	41 1/4	1048	21 7/8	556	36	914	2750	1247
42"	1050	48	1219	25 3/4	654	42	1067	3862	1752
48"	1200	54 1/2	1384	30 7/8	784	48	1219	6000	2722
54"	1350	61	1550	32 3/4	832	54	1372	7462	3385

ASME Class 300

Size		A		B		C		Weight	
in	mm	in	mm	in	mm	in	mm	lbs.	kg.
6"	150	9 7/8	251	4 13/16	122	6 5/8	168	61	28
8"	200	12 1/8	308	6 1/4	159	8 5/8	219	107	48
10"	250	14 1/4	362	7 1/4	184	10 3/4	273	166	75
12"	300	16 5/8	422	9	229	12 3/4	324	244	111
14"	350	19 1/8	486	10 1/4	260	14	356	407	185
16"	400	21 1/4	540	11 1/8	283	16	406	533	242
18"	450	23 1/2	597	12 1/2	318	18	457	698	317
20"	500	25 3/4	654	13 3/4	349	20	508	900	408
24"	600	30 1/2	775	16	406	24	610	1446	656
28"	700	35 7/8	911	20 1/4	514	28	711	1992	904
30"	750	37 1/2	953	20 5/8	524	30	762	2457	1115
36"	900	44	1118	25	635	36	914	3947	1790
42"	1050	50 3/4	1289	31 7/8	810	42	1067	6523	2959
48"	1200	58 3/4	1492	35	889	48	1219	7483	3394

Consult factory for additional sizes and pressure classes.

ASME Class 600

Size		A		B		C		Weight	
in	mm	in	mm	in	mm	in	mm	lbs.	kg.
8"	200	12 5/8	321	7 1/2	191	8 5/8	219	178	81
10"	250	15 3/4	400	9 7/8	251	10 3/4	273	285	130
12"	300	18	457	11 5/8	295	12 3/4	324	366	166
14"	350	19 3/8	492	12 3/4	324	14	356	485	220
16"	400	22 1/4	565	14 1/2	368	16	406	705	320
18"	450	24 1/8	613	16 3/4	425	18	457	1057	480
20"	500	26 7/8	683	17 1/2	445	20	508	1531	695
24"	600	31 1/8	791	21 1/4	540	24	610	2240	1016
28"	700	36	914	23	584	28	711	3277	1486
30"	750	38 1/4	972	26 3/4	680	30	762	3746	1699
36"	900	44 1/2	1130	31	787	36	914	7000	3175
48"	1200	54 3/4	1391	40 1/8	1019	48	1219	9972	4523

ASME Class 900

Size		A		B		C		Weight	
in	mm	in	mm	in	mm	in	mm	lbs.	kg.
6"	150	11 3/8	289	6 7/8	175	6 3/4	171	149	68
10"	250	17 1/8	435	10 1/4	260	10 3/4	273	462	210
12"	300	19 5/8	498	12 13/16	325	12 3/4	324	605	274
14"	350	20 1/2	521	14 5/8	371	14	356	1030	467
16"	400	22 5/8	575	15 1/2	394	16	406	1553	705
20"	500	27 1/2	699	19 1/2	495	20	508	1583	718
24"	600	33	838	22 1/4	565	24	610	3029	1374
30"	750	39 3/4	1010	28 7/8	734	30	762	6310	2862

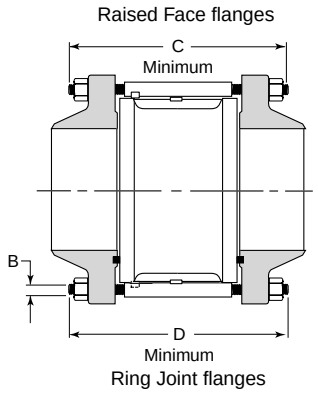
ASME Class 1500

Size		A		B		C		Weight	
in	mm	in	mm	in	mm	in	mm	lbs.	kg.
10"	250	17 1/8	435	11 1/2	292	10 3/4	273	476	216
12"	300	20 1/2	521	13 7/8	353	12 3/4	324	805	365
14"	350	22 3/4	578	14 5/8	371	14	356	1080	490
16"	400	25 1/4	641	16 1/2	419	16	406	1530	694
18"	450	27 3/4	705	20 1/4	514	18	457	2109	957
20"	500	29 3/4	756	21 7/8	556	20	508	2376	1077
24"	600	35 1/2	902	24 7/8	632	24	610	4329	1964

ASME Class 2500

Size		A		B		C		Weight	
in	mm	in	mm	in	mm	in	mm	lbs.	kg.
10"	250	18 3/4	476	11 1/2	292	10 3/4	273	577	262
12"	300	21 5/8	549	13 7/8	352	12 3/4	324	598	271

Style ME Stud Selection – Pressure Classes 150–2500





ASME Stud Selection Class 150

Valve Size		No. of Studs	B		C		D	
			Bolt Diameter		Raised Face		Ring Joint	
in	mm		in	mm	in	mm	in	mm
6"	150	8	¾	19	9	229	9 ½	241
8"	200	8	¾	19	10 ¾	273	11 ¼	286
10"	250	12	⅞	22	12	305	12 ½	318
12"	300	12	⅞	22	14	356	14 ½	368
14"	350	12	1	25	14	356	14 ½	368
16"	400	16	¾	19	14 ¾	375	15 ¼	387
18"	450	16	1 ⅛	29	16 ¾	425	17 ¼	438
20"	500	20	1 ⅛	29	18 ¼	464	18 ¾	476
24"	600	20	1 ¼	29	20 ¾	527	21 ¼	540
26"	650	24	1 ¼	32	26 ¾	679	27 ¼	692
30"	750	28	1 ¼	32	27 ¼	692	27 ¾	705
32"	800	28	1 ½	38	32	1690	32 ¾	832
36"	900	32	1 ½	32	32 ¼	819	32 ¾	832
42"	1050	36	1 ½	38	37 ¼	946	-	-
48"	1200	44	1 ½	38	43 ¼	1099	-	-
54"	1350	44	1 ¾	44	43 ½	1105	-	-

ASME Stud Selection Class 300

Valve Size		No. of Studs	B		C		D	
			Bolt Diameter		Raised Face		Ring Joint	
in	mm		in	mm	in	mm	in	mm
6"	150	12	¾	19	10	254	10 ¾	273
8"	200	12	⅞	22	11 ¾	298	12 ½	318
10"	250	16	1	25	13 ¾	349	14 ½	368
12"	300	16	1 ⅛	29	16	406	16 ¾	425
14"	350	20	1 ⅛	29	17 ½	445	18 ¼	464
16"	400	20	⅞	22	18 ½	470	19	483
18"	450	24	1 ¼	32	20 ¾	527	21 ½	546
20"	500	24	1 ¼	32	22	641	22 ¾	578
24"	600	24	1 ½	29	15 ¼	648	26 ¼	667
28"	700	28	1 ⅝	41	31	787	31 ½	800
30"	750	28	1 ¾	44	32 ¼	819	33 ½	851
36"	900	32	2	51	38 ½	978	-	-
42"	1050	32	2	51	47 ½	1206	-	-
48"	1200	40	2	51	50 ¼	1276	-	-

ASME Stud Selection Class 600

Valve Size		No. of Studs	B		C		D	
			Bolt Diameter		Raised Face		Ring Joint	
in	mm		in	mm	in	mm	in	mm
8"	200	12	1 ⅛	29	15 ¼	387	15 ¼	387
10"	250	16	1 ¼	32	18 ¼	464	18 ¾	476
12"	300	20	1 ¼	32	20 ½	521	20 ¾	527
14"	350	20	1 ⅜	35	22	559	22	559
16"	400	20	1 ⅛	29	24 ½	622	24 ½	622
18"	450	20	1 ⅝	41	30	762	30 ¼	768
20"	500	24	1 ⅝	41	29	737	29 ½	743
24"	600	24	1 ⅞	48	34 ¼	870	34 ¾	883
28"	700	28	2	51	36 ½	927	37	940
30"	750	28	2	51	42	1067	42 ½	1080
36"	900	28	2 ½	64	47	1194	-	-
48"	1050	32	2 ¾	70	62	1574	-	-

ASME Stud Selection Class 900

Valve Size		No. of Studs	B		C		D	
			Bolt Diameter		Raised Face		Ring Joint	
in	mm		in	mm	in	mm	in	mm
6"	150	12	1 ⅛	29	14 ¾	375	15	381
10"	250	16	1 ⅜	35	19 ½	495	19 ¾	502
12"	300	20	1 ⅜	35	23	584	23 ¼	591
14"	350	20	1 ½	38	25 ¾	654	26 ¼	667
16"	400	20	1 ¼	32	26 ¾	679	27	686
20"	500	20	2	51	33 ¼	844	34	864
24"	600	20	2 ½	64	39 ¾	1010	40 ¾	1035
30"	750	20	3	76	48	1219	48 ½	1232

ASME Stud Selection Class 1500

Valve Size		No. of Studs	B		C		D	
			Bolt Diameter		Raised Face		Ring Joint	
in	mm		in	mm	in	mm	in	mm
10"	250	12	1 ⅞	48	25	635	25 ¼	641
12"	300	16	2	51	29	737	29 ½	749
14"	350	16	2 ¼	57	31 ¼	794	32 ¼	819
16"	400	16	1 ½	38	34	864	35	889
18"	450	16	2 ¾	70	39 ¾	1010	41	1041
20"	500	16	3	76	43	1092	44	1118
24"	600	16	3 ½	89	49	1245	49 ¼	1251

ASME Stud Selection Class 2500

Valve Size		No. of Studs	B		C		D	
			Bolt Diameter		Raised Face		Ring Joint	
in	mm		in	mm	in	mm	in	mm
10"	250	12	2 ½	64	31	787	31 ¾	806
12"	300	12	2 ¾	70	35 ½	902	36 ½	927

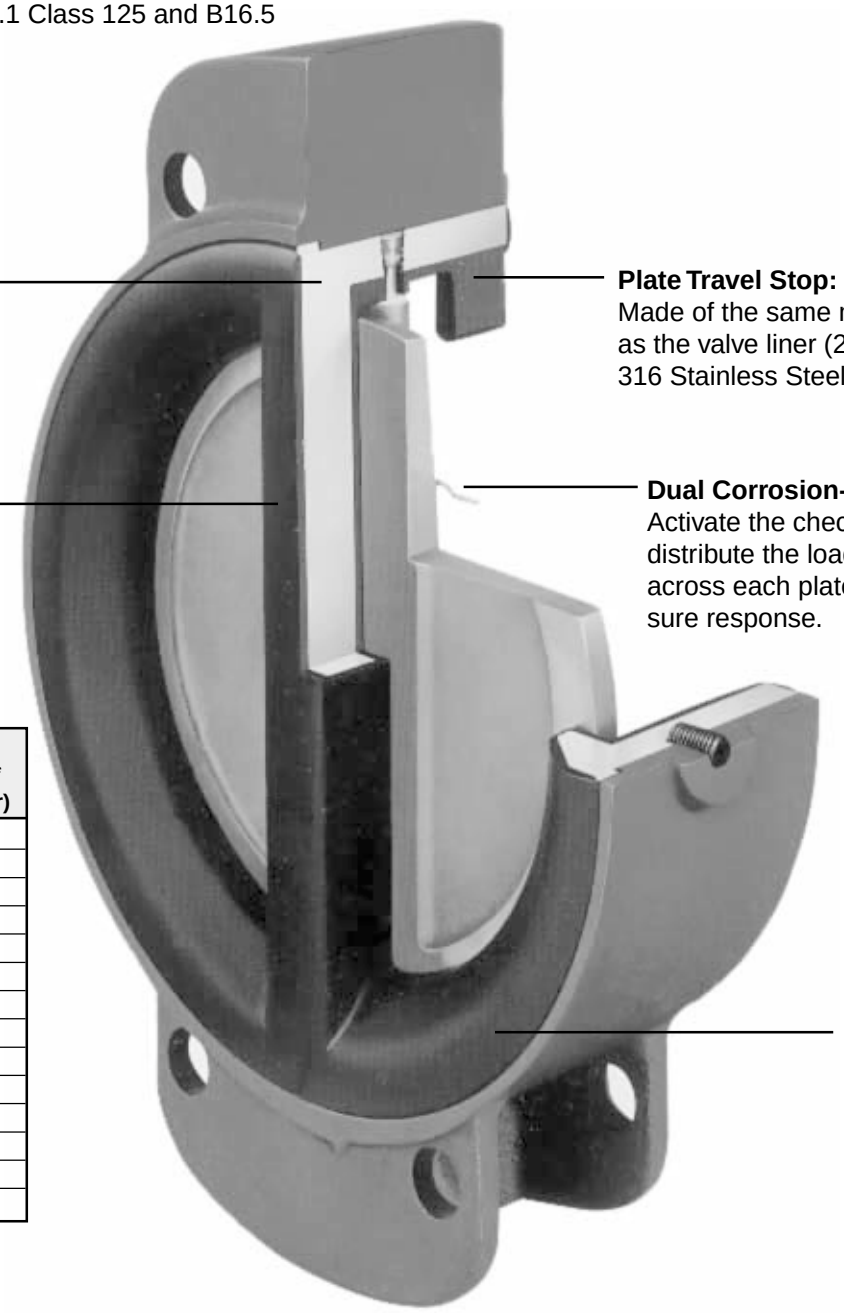
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Style MR Lined Wafer Check Valves

- Sizes from 2" to 24"
- Fully elastomer lined
- Tight shutoff from 25 psi to 150 psi (lower minimum pressure available on request)
- Dual springs distribute load force evenly for quicker response
- Compatible with ASME B16.1 Class 125 and B16.5 Class 150 flanges

Typical markets include:

- HVAC
- Chemical and Petrochemical
- Food and Beverage
- Power and Utilities
- Pulp and Paper



Fully-Lined Ductile Iron Valve Body: Maintains full rated pressure. Elastomer lining prevents flow media from contacting the body.

Valve Liner: Available in several elastomer compounds to meet most corrosive application demands

Plate Travel Stop: Made of the same material as the valve liner (2" - 12") or 316 Stainless Steel (14" - 24").

Dual Corrosion-Resistant Springs: Activate the check valve plates and distribute the load force evenly across each plate, ensuring quick sure response.

Liner Face: Negates the need for flange gaskets.

Size		Cv	Cracking Pressure* (in. of water)
in	mm		
2	50	36	10
2 ½	65	62	12
3	80	123	7
4	100	281	6
5	125	522	10
6	150	1,033	8
8	200	2,158	9
10	250	3,368	13
12	300	5,068	10
14	350	6,465	12
16	400	9,172	12
18	450	12,853	10
20	500	17,398	16
24	600	28,794	15

*Horizontal flow. Values are approximate.

Liner Temperature Ratings

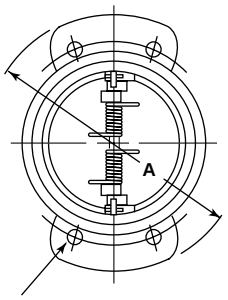
Material	Temperature Ratings (°F)
Buna-N (Standard)	-10 to +250
EPDM (Standard)	–20 to +300
Neoprene	+10 to +225
Viton-B	0 to +400
Hypalon	-50 to +275

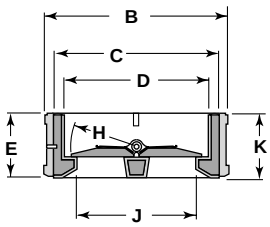
Some flow media may further restrict the published temperature limits and/or significantly reduce seat life. Consult factory for additional information.

Style MR Installation Dimensions

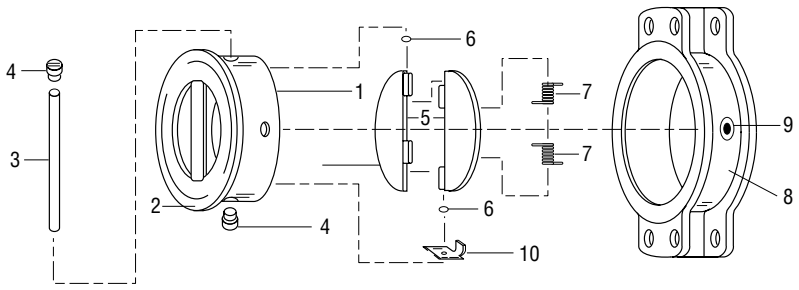
Dimensions [in (mm)] and Weights [lbs (kg)]

Valve Size	A	B	C	D	E	F	G	H	J	K	Weight
2 (50)	6.25 (158.75)	4.00 (101.60)	3.31 (84.14)	2.62 (66.68)	2.06 (52.39)	4.75 (120.65)	0.69 (17.46)	1.12 (47.63)	1.88 (47.63)	2.12 (53.98)	5 (2.27)
2 1/2 (65)	7.00 (177.80)	4.75 (120.65)	3.88 (98.43)	3.12 (79.38)	2.06 (52.39)	5.50 (139.70)	0.69 (17.46)	1.44 (36.51)	2.31 (58.74)	2.12 (53.98)	6 (2.72)
3 (80)	7.50 (190.50)	5.25 (133.35)	4.56 (115.89)	3.62 (92.08)	2.06 (52.39)	6.00 (152.40)	0.69 (17.46)	1.62 (41.28)	2.75 (69.85)	2.12 (53.98)	8 (3.63)
4 (100)	9.25 (234.95)	6.75 (171.45)	5.62 (142.88)	4.62 (117.48)	2.44 (61.91)	7.50 (190.50)	0.69 (17.46)	2.12 (53.98)	3.44 (87.31)	2.50 (63.50)	15 (6.81)
5 (125)	10.62 (269.88)	7.62 (193.68)	6.75 (171.45)	5.69 (144.46)	2.56 (19.05)	8.50 (215.90)	0.81 (20.64)	2.66 (67.47)	4.44 (112.71)	2.62 (66.68)	20 (9.08)
6 (150)	12.00 (304.80)	8.75 (222.25)	7.88 (200.03)	6.75 (171.45)	3.06 (77.79)	9.50 (241.30)	0.81 (20.64)	3.16 (80.17)	5.56 (141.29)	3.12 (79.38)	26 (11.80)
8 (200)	14.50 (368.30)	10.62 (269.88)	10.00 (254.00)	8.75 (222.25)	3.81 (96.84)	11.75 (298.45)	0.81 (20.64)	4.16 (105.57)	7.56 (192.09)	3.88 (98.43)	43 (19.52)
10 (250)	16.88 (428.63)	13.25 (336.55)	12.12 (307.98)	10.88 (276.23)	3.94 (100.01)	14.25 (361.95)	0.94 (23.81)	5.12 (130.18)	9.06 (230.19)	4.00 (101.60)	58 (26.33)
12 (300)	19.450 (495.30)	16.00 (406.40)	14.38 (365.13)	12.88 (327.03)	5.06 (128.59)	17.00 (431.80)	0.94 (23.81)	6.25 (158.75)	10.81 (274.64)	5.12 (130.18)	100 (45.40)
14 (350)	22.50 (571.50)	17.62 (447.68)	15.62 (396.88)	14.12 (358.78)	7.00 (177.80)	18.75 (476.25)	1.06 (26.99)	6.75 (171.45)	12.06 (306.39)	7.12 (180.98)	135 (61.29)
16 (400)	24.88 (631.83)	20.12 (511.18)	17.75 (450.85)	16.12 (409.58)	6.25 (158.75)	21.25 (539.75)	1.06 (26.99)	7.75 (196.85)	14.00 (355.60)	6.38 (161.93)	170 (77.18)
18 (450)	25.25 (641.35)	21.50 (546.10)	20.00 (508.00)	18.12 (460.37)	7.12 (180.97)	22.75 (577.85)	1.19 (30.16)	8.75 (222.25)	16.00 (406.14)	7.25 (184.15)	220 (99.88)
20 (500)	27.50 (698.50)	23.50 (596.90)	21.88 (555.62)	20.12 (511.17)	8.38 (212.72)	25.00 (635.00)	1.19 (30.16)	9.75 (247.65)	18.12 (469.90)	8.50 (215.90)	287 (130.30)
24 (600)	32.25 (819.15)	28.12 (714.37)	25.88 (657.22)	24.12 (612.77)	8.38 (212.72)	29.50 (749.30)	1.31 (33.34)	11.75 (298.45)	22.25 (565.15)	8.50 (215.90)	335 (152.09)





Note: Preferred mounting of check valves of any manufacturer is 5 pipe diameters downstream from the pump discharge or pipe elbow. If this is not feasible, the valve should be mounted downstream as far as possible. This is recommended to reduce the likelihood of turbulent flow through the valve, which could shorten valve life due to component vibration.



Bill of Materials

Item	Description	Materials	Optional Materials
1*	Valve Body	Ductile Iron	No option available
2*	Liner (Molded to Item 1)	Buna-N or EPDM	Neoprene, Hypalon, Viton
3	Shaft	316 Stainless Steel	Monel
4	Shaft Plug (Qty. 2)	316 Stainless Steel	Monel
5	Plate (Qty. 2)	2" 316 Stainless Steel 2 1/2"-5" Aluminum Bronze 6"-24" Ductile Iron	2"-12" Monel 2 1/2"-12" 316 Stainless Steel 6"-24" Aluminum Bronze
6	Thrust Washer (Qty. 4)	PTFE	No option available
7	Spring (Qty. 2)	Nitronic 50 (2"-6") 316 Stainless Steel (8"-24")	No option available No option available
8	Alignment Body	Cast Iron	No option available
9	Set Screw	Carbon Steel	No option available
10	Plate Travel Stop	316 Stainless Steel (14"-24")	No option available

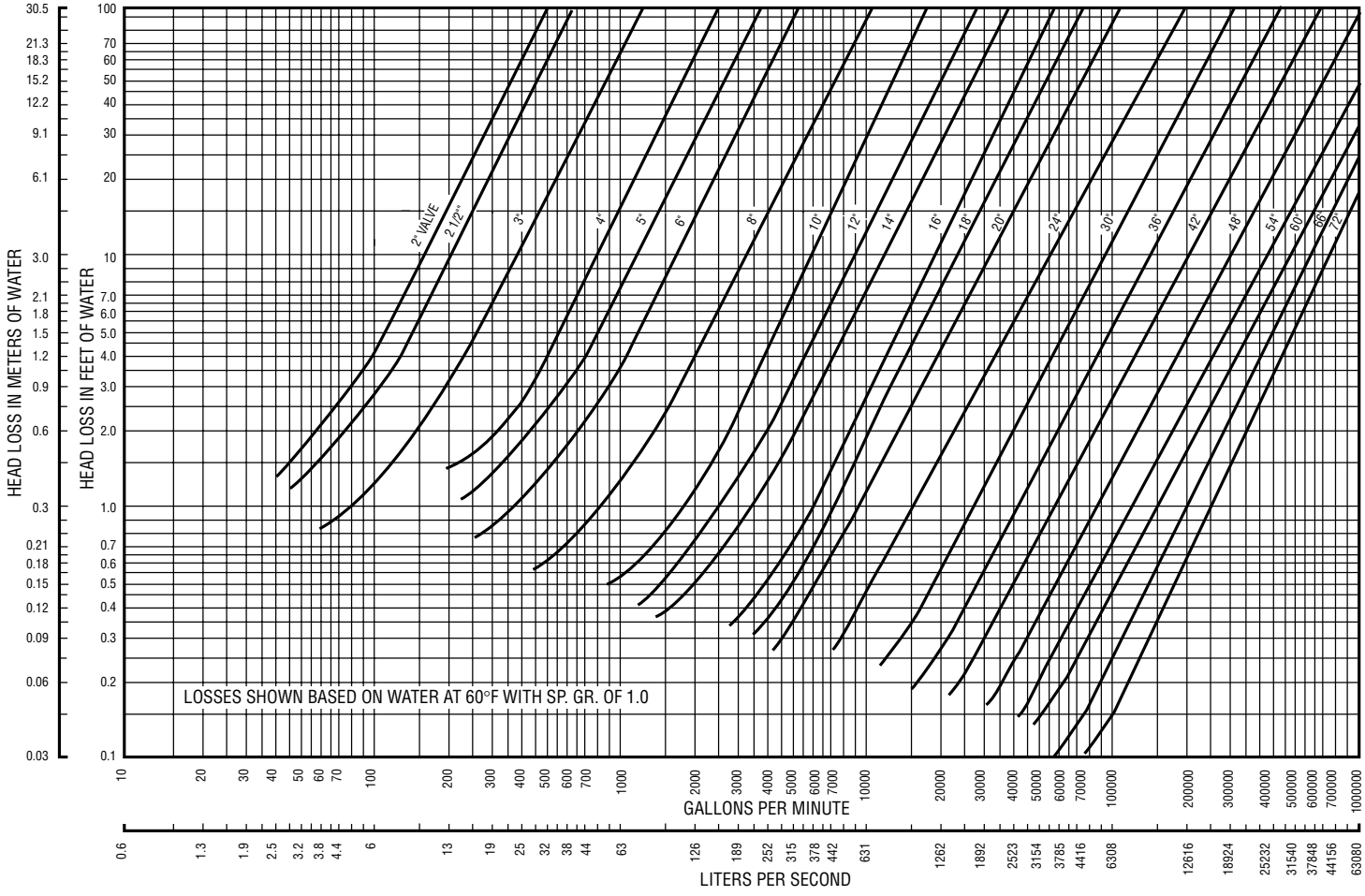
* Items 1 and 2 must be ordered together.
NOTE: Materials subject to change without notice.

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Technical Data

Pressure Loss Information

- The curves show pressure drops available with standard torque springs and the valve in horizontal flow.
- Marlin wafer checks should be installed in horizontal flow with pins vertical for best performance. For other installations, contact the factory.
- We can evaluate our dual plate checks relative to your system behavior.
- Systems with drastic flow decelerations may require higher torque springs for faster valve response and to reduce water hammer. Please consult the factory.
- Each piping system has a unique geometry which should be evaluated whenever the liquid media velocity exceeds 8 feet/second (2.4m/sec) through a swage or expansion (15° or greater included angle) directly upstream of the valve. Where practicable, a minimum of five (5) pipe diameters distance should be maintained between the valve and the pump discharge and pipe fittings (swages or expansion) for maximum service life.



Technical Data

Valve Coefficient Cv

Valve Size		Class 150-300
in	mm	
2"	50	75
2 1/2"	65	95
3"	80	191
4"	100	377
5"	127	483
6"	150	821
8"	200	1,590
10"	250	2,920
12"	300	4,470
14"	350	5,870
16"	400	8,690
18"	450	10,940
20"	500	14,290
24"	600	23,000
30"	750	37,200
36"	900	59,000
42"	1050	92,000
48"	1200	126,000
54"	1350	186,000
60"	1500	217,000
66"	1650	280,000
72"	1800	350,000

Class 150 Spring Cracking Pressure (PSI)

Valve Size		Std. Torque	Low Torque	Min. Torque
in	mm			
2"	50	0.23	0.13	0.05
2 1/2"	65	0.26	0.12	0.04
3"	80	0.21	0.16	0.04
4"	100	0.22	0.11	0.05
5"	127	0.18	0.09	0.05
6"	150	0.14	0.07	0.04
8"	200	0.19	0.10	0.04
10"	250	0.18	0.10	0.04
12"	300	0.17	0.07	0.04
14"	350	0.15	0.06	0.04
16"	400	0.16	0.08	0.03
18"	450	0.15	0.07	0.03
20"	500	0.13	0.06	0.03
24"	600	0.10	0.05	0.03
30"	750	0.08	–	–
36"	900	0.08	–	–
42"	1050	0.05	–	–
48"	1200	0.06	–	–

- Spring cracking pressure is the pressure required to lift the plates off the seat.
- Other springs available, consult factory.
- Valves 6" and larger have independent springs.

Spring & Drain Size Information

Spring Selection Guide

Spring Material	Operating Temperature Range	
	°C	°F
Inconel 600	-250 to 315	-420 to 600
Type 316 S.S.	-129 to 120	-200 to 250
Inconel X-750	-250 to 537	-420 to 1000
Monel 400	-250 to 205	-420 to 400

- Spring materials are included in trim materials as an important part of materials selection. The most common standard trim materials are shown under Ordering Information.
- For unique service conditions, different torque springs as well as other spring materials are available.

Drain Sizes
(Available when specified)

ASME Class 125 (Cast Iron) Schedule A	
2" – 8" (50mm – 200mm)	1/8" (3.18mm)
10" – 12" (250mm – 300mm)	3/8" (9.52mm)
14" & up (350mm & up)	3/4" (19.1mm)
ASME Class 150-2500 Schedule B	
2" - 2 1/2" (50mm – 65mm)	1/4" (6.35mm)
3" - 4" (75mm – 100mm)	3/8" (9.52mm)
5" (125mm)	1/2" (12.7mm)
6" & up (150 mm)	3/4" (19.1mm)

- All drain holes are located in the plane of the seal and 180° from the lift hole.

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ASME B16.34 Pressure-Temperature Ratings
Steel and Stainless Steel

Temperature		Maximum Non-Shock Service Pressure, psi and kg/cm² (ASME B16.34)											
		Class 150				Class 300				Class 600			
°C	°F	Steel [1]		316SS		Steel [1]		316SS		Steel [1]		316SS	
		kg/cm²	psi	kg/cm²	psi	kg/cm²	psi	kg/cm²	psi	kg/cm²	psi	kg/cm²	psi
-29 to 38	-20 to 100	20.0	285	19.3	275	52.0	740	50.6	720	104.0	1480	101.2	1440
93	200	18.3	260	16.9	240	47.5	675	43.6	620	94.9	1350	87.2	1240
149	300	16.2	230	15.1	215	46.0	655	39.4	560	92.4	1315	78.7	1120
204	400	14.1	200	13.7	195	44.6	635	36.2	515	89.3	1270	72.4	1030
260	500	12.0	170	12.0	170	42.2	600	33.7	480	84.4	1200	67.1	955
316	600	9.8	140	9.8	140	38.7	550	31.6	450	77.0	1095	63.6	905
343	650	8.8	125	8.8	125	37.6	535	31.3	445	75.6	1075	62.6	890
371	700	7.7	110	7.7	110	37.6	535	30.2	430	74.9	1065	60.8	865
399	750	6.7	95	6.7	95	35.5	505	29.9	425	71.0	1010	59.4	845
427	800	5.6	80	5.6	80	28.8	410	29.2	415	58.0	825	58.3	830
454	850	4.4	65	4.6	65	19.0	270	28.5	405	37.6	535	56.9	810
482	900	3.5	50	3.5	50	12.0	170	27.8	395	24.3	345	55.5	790
510	950	2.5	35	2.5	35	7.4	105	27.1	385	14.4	205	54.5	775
538	1000	1.4	20	1.4	20	3.5	50	25.7	365	7.4	105	51.0	725
Hydrostatic Shell Test		31.6	450	29.9	425	79.1	1125	77.3	1100	156.4	2225	152.9	2175
°C	°F	Class 900				Class 1500				Class 2500			
-29 to 38	-20 to 100	156.1	2220	151.8	2160	260.5	3705	253.1	3600	433.8	6170	421.8	6000
93	200	142.4	2025	130.8	1860	237.3	3375	217.6	3095	395.4	5625	362.7	5160
149	300	138.5	1970	118.1	1680	230.6	3280	196.5	2795	384.5	5470	327.6	4660
204	400	133.6	1900	108.3	1540	222.9	3170	180.7	2570	371.2	5280	300.9	4280
260	500	126.2	1795	100.9	1435	210.5	2995	168.0	2390	350.8	4990	279.8	3980
316	600	115.3	1640	95.3	1355	192.3	2735	158.5	2255	320.6	4560	264.3	3760
343	650	113.2	1610	93.5	1330	188.8	2685	156.1	2220	314.6	4475	260.1	3700
371	700	112.5	1600	91.0	1295	187.3	2665	151.8	2160	312.1	4440	253.1	3600
399	750	106.2	1510	89.3	1270	177.2	2520	148.3	2110	295.3	4200	247.5	3520
427	800	86.8	1235	87.5	1245	144.8	2060	145.9	2075	241.1	3430	243.2	3460
454	850	56.6	805	85.4	1215	94.2	1340	142.7	2030	156.8	2230	233.4	3320
482	900	36.2	515	83.0	1180	60.5	860	138.5	1970	100.5	1430	230.6	3280
510	950	21.8	310	81.5	1160	36.2	515	135.7	1930	60.5	860	226.4	3220
538	1000	10.9	155	76.6	1090	18.3	260	127.9	1820	30.2	430	213.0	3030
Hydrostatic Shell Test		235.5	3350	228.5	3250	391.9	5575	379.6	5400	652.0	9275	632.7	9000

[1] Permissible, but not recommended for prolonged use above 800°F (427°C)

Ordering Information

Figure Number System

Size	Style	Flange Series	Body Material	Disc Material	Body Seat Material	Spring Material	End Connection		Options
18"	M	300	C	S	P	S	R	—	B 3/4

DESCRIPTION: 18" Style M Wafer Design, ASME Class 300 Series, Carbon Steel Body, 316SS Disc, metal-to-metal seat, 316SS spring, raised face flanges with 3/4" drain connection

Valve Size

Nominal valve sizes are expressed in inches or millimeters.

In Inches:
For use with ASME, API and BS Flange Standards.

In Millimeters:
For use with DIN, AS or JIS rated valves.

Style

Ordering Letter	Body Type	Size Range
M	Wafer	2"–88" (50mm–2200mm)
MP	Wafer, retainerless	2"–88" (50mm–2200mm)
MR	Wafer, rubber-lined	2"–24" (50mm–600mm)
ML	Lug, slip-through	2"–88" (50mm–2200mm)
MLP	Lug, retainerless, slip-through	2"–88" (50mm–2200mm)
MT	Lug, threaded	2"–88" (50mm–2200mm)
MTP	Lug, retainerless, threaded	2"–88" (50mm–2200mm)
MW	Weld ends	6"–72" (150mm–1800mm)
ME	Extended body, wafer	6"–72" (150mm–1800mm)
MEL	Extended body, lug, slip-through	6"–72" (150mm–1800mm)
MET	Extended body, lug, threaded	6"–72" (150mm–1800mm)

*Weld-end valves also require the additional designation of the pipe schedule they are designed to fit. This is shown by a set of two or three digits between the size and style designations. See example.

Example

12" 40 MW 150 C C U W W

Pipe Schedule

Weld-End Connections

Description

12" Style M Weld End Valve for Schedule 40 pipe, ASME 150 Series with Carbon Steel body and disc, Stellite seats, and Inconel 600 spring.

Flange Series

Ordering Number	ASME Rating[1]	Ordering Number	API Rating[2]
125	125[3]	2000	2000
150	150	3000	3000
250	250[3]	5000	5000
300	300		
400	400		
600	600		
900	900		
1500	1500		
2500	2500		

1 ASME pressure-temperature ratings for steel and stainless steel flanges are listed on page 23.
2 API ratings are cold working pressure, psig.
3 Series 125 and 250 flanges are cast iron.

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Ordering Information

Body Materials

Ordering Letter	Material	Specification	Ordering Letter	Material	Specification
Z	Aluminum Bronze	ASTM B148 Alloy 952 BS 1400, Alloy AB2	M	Monel	ASTM A494, M35-1
			T	Alloy 20	ASTM A351, CN7M
C	Carbon Steel	ASTM A216, WCB, ASTM A105	Q	Hastelloy C	ASTM A494, CW2M
L	LCB Carbon Steel	ASTM A352, LCB	K	LCC Carbon-Mn Steel	ASTM A352, LCC
H	Cast Iron	ASTM A126, B / BS 1452, Gr. 220	R	304 Stainless Steel	ASTM A351, CF8
S	316 Stainless Steel	ASTM A351, CF8M	J	Alloy Steel (5% Cr)	ASTM A217, C5
F	316L Stainless Steel	ASTM A351, CF3M	J1	Alloy Steel (9% Cr)	ASTM A217, C12
G	317 Stainless Steel	ASTM 351, CG8M	B	Alloy Steel (1-1/4% Cr)	ASTM A217, WC6
E	410 Stainless Steel	ASTM A217, CA-15			

Plate Materials

Ordering Letter	Material	Specification	Ordering Letter	Material	Specification
Z	Aluminum Bronze	ASTM B148 Alloy 952 BS 1400, Alloy AB2	E	410 Stainless Steel	ASTM A217, CA-15
			M	Monel	ASTM A494, M35-1
C	Carbon Steel	ASTM A216, WCB	T	Alloy 20	ASTM A351, CN7M
S	316 Stainelss Steel	ASTM A351, CF8M	Q	Hastelloy C	ASTM A494, CW2M
F	316L Stainless Steel	ASTM A351, CF3M	K	LCC Carbon-Mn Steel	ASTM A352, LCC
G	317 Stainless Steel	ASTM 351, CG8M			

Body Seat Materials

Resilient			Metal		
Letter	**Material**	**Operating Temperature**	**Letter**	**Material**	**Operating Temperature**
N	Buna-N	–10° to 250°F	P	Metal to Metal/Integral	–450° to 1000°F
V	Viton-B	0° to 400°F	E	410 Stainless Steel*	–450° to 1000°F
G	Neoprene	+10° to 225°F	S	316 Stainless Steel*	–450° to 1000°F
H	Hypalon	–50° to 275°F	F	316L Stainless Steel*	–450° to 1000°F
D	EPDM	–20° to 300°F	M	Monel*	–325° to 500°F
			U	Stellite*	–450° to 1000°F

*Overlay materials. Temperature limitations governed by base material.

Spring Material

Letter	Material	Max. Operating Temp.
S	316 Stainless Steel	250°F
W	Inconel 600	600°F
Y	Inconel X-750	1000°F
M	Monel	450°F
Q	Hastelloy C	800°F
Z	17-7PH	550°F

End Connections

Ordering Letter	Connections
F	Plain (fits between flat-faced flanges)
R	Serrated (fits between raised-face flanges)
J	RTJ (fits between ring-type joint flanges)

Options

Designation	Configuration
BX	Indicates Schedule B drain connection of size “X” NPT downstream of valve. Refer to page 22 for drain sizes.
2XXX	First “X” indicates Radial Thrust Bearing materials. Second “X” indicates Hinge and Stop Pin materials. Third “X” indicates Hinge and Stop Pin Retainer material.
3X	Indicates disc sealing surface of material “X”.
Q1	Indicates valves meet requirements of NACE MR-01-75.

Marlin Valve Specials



Grayloc® Hub End Valves

Valves with Grayloc ends may be furnished for use with hub end, clamp-style connections. These end connections simplify installation procedures in systems that utilize them. Please contact our sales office for information regarding sizes and pressure ratings available, and other hub end connections such as Spolock, Seaboard Lloyd, etc.



Butt Weld Valves

Valves with butt weld ends may be furnished for piping systems designed for welded system components to eliminate potential joint leak paths. See Ordering Information for proper figure number designation, so that weld-end preparations match the mating pipe schedules.



UL/FM Valves

Underwriters Laboratories, Inc. approve and list the 4", 6", 8", 10" and 12" Figure U12 HMP Duo-Chek II Valves for 250 psi service in fire protection systems.

Valves are Factory Mutual Research Corporation approved.



Lined Valves

Marlin valves may be furnished with linings, when specified, for abrasion or corrosion resistance. Linings include Natural Rubber, Neoprene, Polyurethane, Armorite, Chlorobutyl and Ebonite. All body surfaces of lined valves are covered with the specified material, eliminating the need for gaskets. Hinge and stop pin holes are encapsulated to seal them against line fluids. Solid alloy valves are recommended for extremely corrosive applications.



Cryogenic Valves

Marlin wafer checks may be furnished for subatmospheric to cryogenic temperatures (-50°F through -450°F). Special materials of construction such as low temperature alloy steels, austenitic stainless steel, aluminum bronze or monel are generally required.

Coated Valves

A variety of coatings may be provided on request to resist corrosion or abrasion. Some of the commonly specified coatings include epoxies, coal tar derivatives and sacrificial zinc primers. Please discuss your requirements with your sales office.

Other Specials

Other Marlin Valve specials furnished include:

- Valves to comply with NACE MR-01-75
- Valves cleaned for liquid oxygen (LOX) service
- Valves prepared for Food Service (austenitic stainless steel)
- Special testing for valves, including radiography, magnetic particle, dye penetrant, ultrasonic, helium leak, etc.

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Additional Products

Uni-Chek®

Single-Disc Check Valves

- Sizes 2" – 36"
- ASME Classes 125–300
- Flanged, Plain, or Serrated Ends
- Cast Iron, Carbon Steel, and Stainless Steel
- Variety of external shaft options available



Noz-Chek®

Nozzle Type Check Valves

- Sizes 2" – 60"
- ASME Class 150 – 4500
- API 2000 – 15000
- Flanged, Butt Weld, Clamp Hub Ends
- Ductile Iron, Carbon Steel, Alloy Steel, and Duplex Steels
- Metal to Metal or Bubble Tight Resilient Seats

Contact the Belfast, Northern Ireland Office for Sales and Product Information.



Compac-Noz®

Nozzle Type Check Valves

- Sizes 12" – 60"
- ASME Classes 150 – 4500
- API 2000 – 15000
- Flanged, Butt Weld, Clamp Hub Ends
- Ductile Iron, Carbon Steel, Alloy Steel, and Duplex Steels
- Metal to Metal or Bubble Tight Resilient Seats

Contact the Belfast, Northern Ireland Office for Sales and Product Information.



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ST5484E 2-WIRE SEISMIC VIBRATION TRANSMITTER

Installation Manual



Flying Leads



4-Pin Terminal Block



2-Pin Terminal Block



2-Pin MIL Connector

1. OVERVIEW

The ST5484E Seismic Vibration Transmitter combines a vibration sensor and signal conditioner in a single package for sensing machinery vibration level and transmitting a proportional 4-20 mA signal directly to PLCs, DCSs, monitors, and computers. Versions with 2 wires, 4 wires, terminal blocks, or MIL-type connector are available.

The transmitter 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.

Refer to Metrix Datasheet 1004457 for specifications, ordering information, and outline dimensions.

2. MOUNTING

It is important to solidly mount the transmitter body to the machine surface. Refer to section 6 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 contact the machine surface. Transmitters with the machine thread studs must contact 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 counter bore (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 counter bore instructions.

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 five (5) 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 Metrix 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.

If installing a transmitter with one of the straight machined thread sizes, follow standard drill and tap procedures. Do not drill a hole larger that the counter bore pilot diameter before using the counter bore 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.

3. WIRING

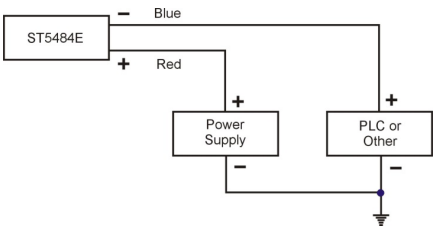
3.1 General

The ST5484E is connected like other loop powered transmitters. The following is a summary based on area designations.

CAUTION: Use of a high-speed torque screwdriver may damage the terminal blocks.

Connect the field wiring in accordance with the appropriate portion of Figure 1.

The ST5484E transmitter requires a minimum of 11 VDC for proper operation. This is the minimum voltage required at the transmitter (not the power supply), after all other voltage drops across field wiring and receiver input impedance have been accounted for with the maximum 20mA of loop current flowing. The minimum loop power supply voltage required is therefore 11 VDC plus 1 volt for each 50 Ω of total loop resistance.



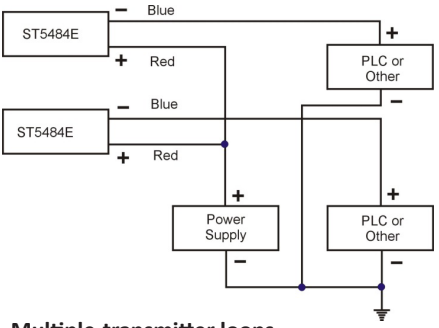


Figure 1: Single-transmitter loops **Multiple-transmitter loops**

Example:

Component	Resistance
Signal wiring	10 Ω
DC Input Impedance of receiver	250 Ω
TOTAL LOOP RESISTANCE	**260** Ω

Minimum supply voltage = 260 Ω (1 V/50 Ω) + 11 V = 16.2 VDC

The maximum loop power supply voltage that may be applied is 29.6 VDC (intrinsically safe) or 30VDC (explosion proof and non-incendive). The maximum loop resistance (RL) is calculated by the equation: **RL = 50 (VS - 11)** Ω
Example: RL = 50 (24 - 11) = 650 Ω for a 24 VDC loop supply.

3.2 Intrinsically Safe Installation In Hazardous Locations
Connect the field wiring in accordance with Metrix drawing 9426 for CSA Class I, (A,B,C & D) and Metrix drawing 9278 for IECEx / ATEX (Ex ia IIC T4 Ga) approvals. The leads must be terminated inside an enclosure with a degree of protection of at least IP20. A Metrix elbow from the 8200 series may be used for these purposes. Refer to Metrix Datasheet 1004457 for additional details on accessories. The ambient temperature range is -40°C to 100°C.

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. As such, The minimum loop power supply voltage required is 19.1 VDC plus 1 volt for each 50 Ω 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 Ω.

Example:

Component	Resistance
Signal wiring	5 Ω
DC Input Impedance of receiver	100 Ω
TOTAL LOOP RESISTANCE	**105** Ω

Minimum supply voltage = 105 (1 V/50 Ω) + 19.1 V = 21.2 VDC

3.3 Explosion-Proof Installation In Hazardous Locations (CSA)
Some models of ST5484E transmitters are CSA certified explosion-proof, CSA US/C, Class I, Div 1, Grps B-D and Class II, Div 1, Grps E-G (explosion proof). Connect the field wiring in accordance with the appropriate portion of Figure 1. Refer to section 3.1 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.

3.4 Flame-Proof Installation In Hazardous Locations (ATEX, IECEX)
Some models of ST5484E transmitters are ATEX/IECEx certified flame-proof, Ex d IIC T4 Gb. Connect the field wiring in accordance with the appropriate portion of Figure 1. Refer to section 3.1 for loop voltage and resistance requirements. All conduit and junction boxes used must be certified flame-proof for the area required by the application. Installation of the transmitter

NOTES: (UNLESS OTHERWISE SPECIFIED)

1. 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.

2. THE SAFETY BARRIER MUST CONFORM TO THE FOLLOWING:

   Voc, Vo ≤ V max, Vi
   Isc, Ii , Imax, I;
   Po ≤ Pi

3. 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.

4. THE CAPACITANCE AND EITHER THE INDUCTANCE OR INDUCTANCE TO RESISTANCE (L/R) RATIO OF THE INTERCONNECTING CABLE MUST NOT EXCEED THE FOLLOWING:

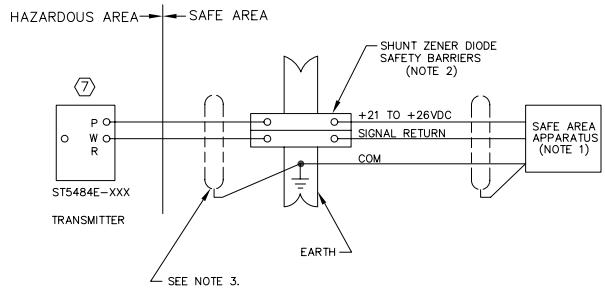
   C cable ≤ Ca − Ci
   L cable ≤ La − Li

5. 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.

6. 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.

INSTALLATION − PROXIMITY SENSOR IN HAZARDOUS LOCATION CSA



Entity Parameters
Vmax, Vi = 29.6V
Imax, Ii = 100mA
Pi = 0.74W
Ci = 70.4nF
Li = 0.5mH

AGENCY APPROVED PRODUCT
DO NOT DEVIATE FROM DOCUMENTED CONSTRUCTION OR LISTED PARTS

Verifie' et Certfie'
conforme a' l'execution

MATERIAL:
FINISH:

THIS DOCUMENT AND ALL INFORMATION HEREON IS THE PROPERTY OF METRIX INSTRUMENT CO. APPROVAL MUST BE OBTAINED BEFORE IT IS REPRODUCED OR INFORMATION HEREON IS ISSUED TO A THIRD PARTY. THIS DOCUMENT MUST BE RETURNED UPON REQUEST.

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. ALL CORNERS BROKEN TO .010 MIN RADIUS AND TOLERANCES ARE:
FRACTIONS: ±1/64 DECIMALS: .XX ±.01 .XXX ±.005
ANGLES: ±1°
SURFACE FINISH 64

ST5484E
NEXT ASSY | USED ON
APPLICATION

APPROVALS | DATE
DRAWN BY: A. Wilson | 07-25-01
CHECKED BY:
APPROVED BY:

DO NOT SCALE DRAWING

METRIX
HOUSTON, TEXAS U.S.A.

INSTALLATION
ST5484E−XXX
TRANSMITTER

SIZE D | DRAWING NO. 9426−AGENCY | REV. CD
SCALE: NONE | SHEET: 1 of 1

REVISIONS		
REV	DESCRIPTION	
A	RELEASE	

NOTES: (UNLESS OTHERWISE SPECIFIED)

1. 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.

2. THE SAFETY BARRIER MUST CONFORM TO THE FOLLOWING:

   Voc, Vo ≤ V max, Vi
   Isc, Ii ≤ Imax, Ii
   Po ≤ Pi

3. 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.

4. THE CAPACITANCE AND EITHER THE INDUCTANCE OR INDUCTANCE TO RESISTANCE (L/R) RATIO OF THE INTERCONNECTING CABLE MUST NOT EXCEED THE FOLLOWING:

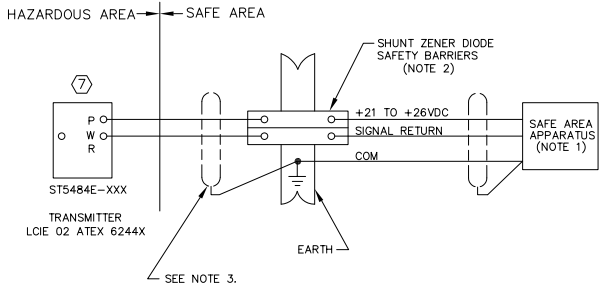
   C cable ≤ Ca − Ci
   L cable ≤ La − Li

5. 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.

6. 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.

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 Certfie'
conforme a' l'execution

MATERIAL:	UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. ALL CORNERS BROKEN TO .010 MIN RADIUS AND TOLERANCES ARE:		APPROVALS	DATE
FINISH	FRACTIONS: DECIMALS: ±1/64 .XX ±.01 .XXX ±.005 ANGLES: ±1° SURFACE FINISH 64		DRAWN BY: A. Wilson	09-09-13
			CHECKED BY:	
			APPROVED BY:	
		ST5484E NEXT ASSY USED ON		
		APPLICATION	DO NOT SCALE DRAWING	

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METRIX
HOUSTON, TEXAS U.S.A.

INSTALLATION
ST5484E−XXX
TRANSMITTER

SIZE B | DRAWING NO. 9278−AGENCY | REV. A
SCALE: NONE | SHEET 1 of 1

WARNING:
ATEX Conditions for Safe Use (Ex ia)
The ST5484E is intrinsically safe and can be used in potentially explosive atmospheres. This transmitter must only be associated to intrinsically safe certified apparatus, and this combination must be compatible as regards **intrinsic safety.**
The electrical parameters of certified equipment connected to the transmitter must meet the following criteria:

$U_o \leq 29.6$ VDC, $I_o \leq 100$mA; $P_o \leq 0.75$W
Ambient operating temperature -40°C to +100°C

must meet all of the flame-proof requirements of the local governing agency and facility safety procedures. The Metrix part 8200-001-IEC elbow is required to meet this approval.

WARNING:
ATEX Conditions for Safe Use (Ex d)
For temperature classification and safety:

- Use conduit elbow, Metrix reference 8200-001-IEC, which is a Killark product with reference: Y-3-EX.
- Ambient Operating Temperature: -40°C to +100°C

4. ELECTROMAGNETIC COMPATIBILITY

In order to meet the requirements of electromagnetic compatibility in areas of high electromagnetic interference, the field wiring must be:

- Shielded twisted pair cable enclosed in grounded metallic conduit, or
- Double shielded twisted pair cable with a metallic body cable gland fitting and with the outer shield grounded.

Use standard two-conductor, twisted pair, shielded wiring for the long run to the instrumentation enclosure. The transmitter is connected like other loop-powered end devices.

NOTE: Metrix also strongly recommends the use of our ferrite bead kit (Metrix p/n 100458) as an extra precaution against electromagnetic interference that may be induced in field wiring from subsequently bleeding into the transmitter.

5. 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. 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 “in/s” (inches per second) or “mm/s” (millimeters per second). The example below is based on a standard 1.0 in/s transmitter.

When vibration level at transmitter is…	Transmitter output will be…	PLC (or other) should read…
0.0 in/s (i.e. no vibration)	4.0 mA (± 0.1 mA)	0.00 in/sec
1.0 in/s (i.e. full scale vibration)	20.0 mA (± 0.5 mA)	1.00 in/sec

Momentary “jolts” that can occur at start-up, or during some operating condition changes, do not reflect a machine’s steady-state operating condition. To prevent such occurrences from generating nuisance alarms, program a time delay into the alarm such that the indicated vibration level must persist above the alarm setpoint for a preset period of time before an alarm is generated. 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 machine’s 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.

6. TYPICAL TRANSMITTER PLACEMENT

The ST5484E measures seismic vibration (i.e., vibration velocity) at the attachment point on the machine, using engineering units of in/s (inches per second) or mm/s (millimeters per second) depending on the selected ordering option. The transmitter’s sensitive direction is through the long axis of its cylindrical body. It will not measure side-to-side motion. Typical transmitter mounting for casing vibration measurements is in the horizontal direction at the bearing housings as depicted in Figure 2. The horizontal direction usually incurs more vibration because most machines’ foundation constrains vertical vibration more than horizontal vibration. A horizontal mounting arrangement is also depicted in Figure 3, but with additional detail showing typical accessories. When flying leads are ordered, a 24- or 72-inch length may be specified using ordering option D on the Metrix product datasheet 1004457. These leads may be cut to length and then spliced to field wiring as shown in Figure 3.

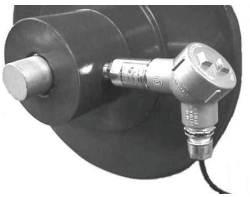


Figure 2
Typical transmitter mounting

NOTE: Hazardous area locations do not allow a splice at the location shown in Figure 3. Instead, the splice must be made in a second conduit hub (meeting splicing requirements) located at the end of flexible conduit.

When attaching conduit to the transmitter, observe the following:

- Because the transmitter is sensitive to vibration, avoid unsupported lengths of conduit and excessive mass (such as large hubs or junctions) hanging directly off the end of the transmitter. These can introduce unwanted vibrations that do not reflect actual machinery vibration and cause mechanical stresses that can lead to premature transducer failure.
- A “Y” type conduit elbow, such as the Metrix 8200 series, is preferred because it prevents the conduit from extending too far away from the transmitter, thus limiting the likelihood of breakage. It also precludes long unsupported lengths of conduit directly aligned with the transmitter’s bore (longitudinal axis) as noted in the bullet above.
- Avoid attachment of rigid conduit directly to the transmitter; instead, use a small length of flexible conduit to mechanically isolate the transmitter from vibration that might occur in rigid conduit.
- If a 1-inch to 3/4-inch reducer is used at the elbow, a smaller diameter flexible conduit can be used.

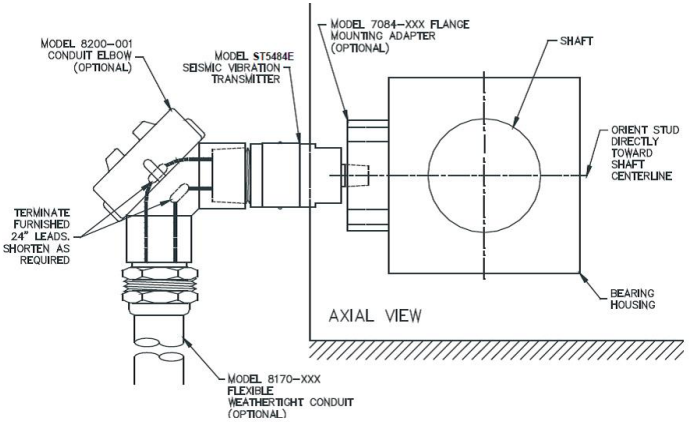


Figure 3

7. INSTALLATION BEST PRACTICES FOR RFI IMMUNITY

The ST5484E is case isolated from the loop power connection to the PLC, DCS, SCADA, or other +24 VDC alarm system. With the correct grounding scheme, this type of isolation avoids ground loops and results in good RF immunity. However, in situations which involve interference from high-powered transmitters and especially spread-spectrum type radios, the ST5484E may become vulnerable to RF noise.

Since it is often difficult to identify these situations in advance, Metrix strongly recommends utilizing the following Best Practices when installing all ST5484E transmitters in the field:

1. Twist the sensor leads together (at least 10 twists per foot).
2. Slide the twisted leads through the included ferrite core and position as close to the sensor as practical. Refer to Figures 4 and 5.
3. If possible, cut the leads short and use a shielded twisted pair. Follow step 2 in this application as well.

As shown in Figure 5, "chokes" that attenuate different frequencies can be created by looping a different number of turns through the ferrite core. More wire turns adds more inductance, attenuating progressively lower frequencies. Multiple "chokes" can be created in this manner and placed in series on the wire leads to cover a broad frequency band. Always locate the choke covering the higher frequency band closest to the sensor.

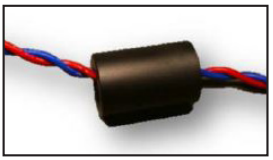


Figure 4: Leads may be simply fed straight through the ferrite core.

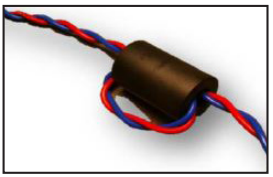


Figure 5: Leads may also be looped through the ferrite core to attenuate different frequencies. The optimal number of loops will vary by application and the interfering frequency(ies).

8. 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. Additionally, the transmitter uses a true RMS amplitude detection circuit; units

supplied with a full scale range in peak units scale the underlying RMS measurement by a factor of 1.414 to provide a “derived peak” rather than true peak measurement.

7.1 Zero Verification
In the absence of vibration the output current should be 4 mA ± 0.1 mA. If the ambient vibration exceeds 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.

7.2 Span Verification
Subject the transmitter to a known vibration within the full scale range marked on the label. If you are using a portable vibration shaker where it can be tested at full scale, the output should be 20 mA ± 0.5 mA.

9. OPTIONAL DYNAMIC OUTPUT

The transmitter can be ordered with an optional dynamic output. Transmitters supplied with this option can be identified by the presence of four flying leads instead of two (Figure 6), or four terminal connections instead of two (Figure 7).

NOTE: Additional ferrite beads along with a copy of these instructions are available free-of-charge from Metrix as a kit. Order Metrix part number 100458. The kit contains one ferrite bead and one copy of these instructions.

The dynamic output is an acceleration signal with a sensitivity of 100 mV/g, filtered to the same frequency band as used for the 4-20mA velocity measurement (refer to options E and F on the Metrix Datasheet 1004457).

Observe the following when using this output:

- Only an electrically-isolated or battery-powered portable vibration analyzer should be used when connecting to this output. Since this is 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.
- 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 which shows the nominal attenuation expected for a given input impedance.
- In all cases for all locations, the use of this signal is for temporary connection only. Permanent connection could violate hazardous location installation requirements.

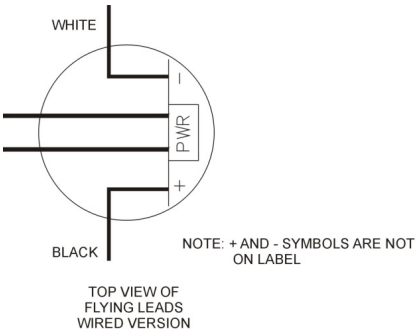


Figure 6 – Top view showing optional dynamic output connections on transmitters with flying leads

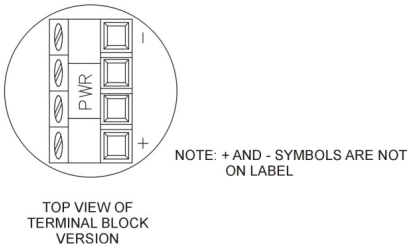


Figure 7 – Top view showing optional dynamic output connections on transmitters with terminal blocks

- Avoid impacting the transmitter or introducing other mechanical vibrations when connecting to this output. Such vibration could result in spurious alarms or machinery trips.
- When output is not in use, be sure leads cannot touch conduit or each other as this will affect the 4-20 mA current output.
- Avoid introducing electrical noise when using this output. Do not use this output with leads longer than 5m (16 feet). Use of longer leads can introduce electrical noise and attenuate high-frequency signal content that may be present in the raw acceleration signal.

Table 1

Input Impedance of Analyzer	dB Attenuation
10 MEG	0.01
5 MEG	0.02
2 MEG	0.04
1 MEG	0.09
500 K	0.18
200 K	0.43
100 K	0.84
50 K	1.61
20 K	3.57
10 K	6.10

10. SPECIFICATIONS, ORDERING INFORMATION AND OUTLINE DIMENSIONAL DIAGRAMS

Refer to Metrix product datasheet 1004457 for additional information.

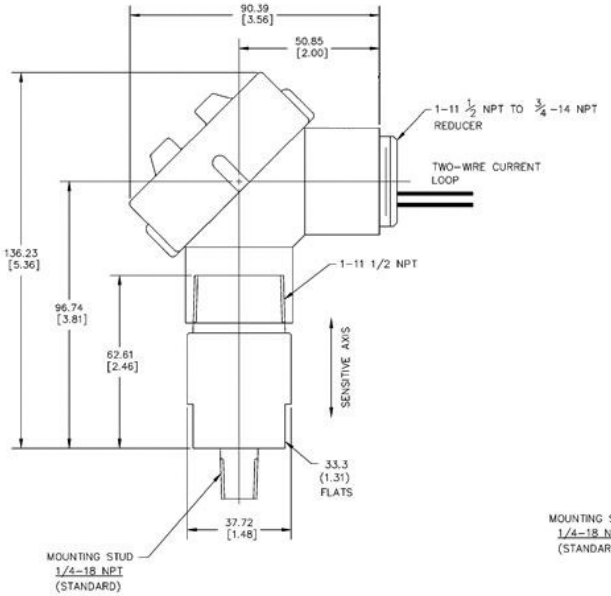


Figure 1: Outline dimensions of the ST5484E (all versions except MIL-Style Connector). Dimensions in mm [inches]. Optional* 8200-001 conduit elbow shown installed.

* **NOTE:** 8200-AAA-IEC elbow is mandatory for ATEX/IECEx/INMETRO Ex d (flameproof) approved installations.

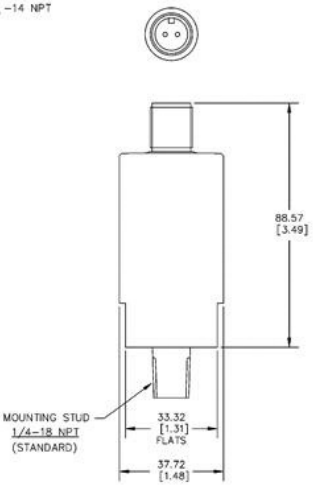


Figure 2: Outline dimensions of the ST5484E-XXX-XX4-XX (MIL-Style Connector). Dimensions in mm [inches].

11. ENVIRONMENTAL INFORMATION



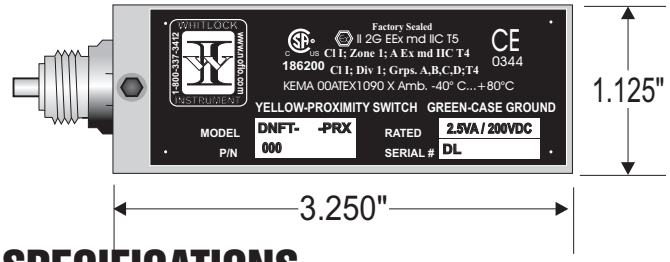
This electronic equipment was manufactured according to high quality standards to ensure safe and reliable operation when used as intended. Due to its nature, this equipment may contain small quantities of substances known to be hazardous to the environment or to human health if released into the environment. For this reason, Waste Electrical and Electronic Equipment (commonly known as WEEE) should never be disposed of in the public waste stream. The "Crossed-Out Waste Bin" label affixed to this product is a reminder to dispose of this product in accordance with local WEEE regulations. If you have questions about the disposal process, please contact Metrix Customer Service.

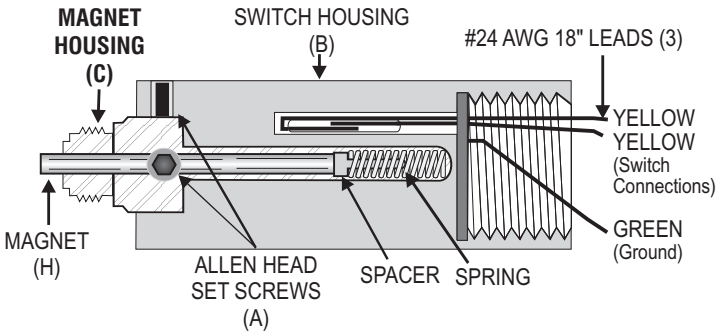
info@metrixvibration.com
www.metrixvibration.com
8824 Fallbrook Dr. Houston, TX 77064, USA
Tel: 1.281.940.1802 • Fax: 1.713.559.9421
After Hours (CST) Technical Assistance: 1.713.452.9703

PROXIMITY SWITCH

DNFT-PRX

173LIT DNFT-PRX SWI
09/09/08





SPECIFICATIONS

Part Number.....000169
000170
000171
000172

Material.....Stainless Steel, Aluminum

Temperature Range.....-40° C to +80° C

Switch Rating.....2.5 VA / 200 VDC ½ AMP
MAX 125 VAC MINIMUM BREAKDOWN 300 VDC

Epoxy Encapsulated.....UL LISTED EL-CAST

RATINGS

C SP US 186200

II 2G EEx md IIC T5
Cl I; Zone 1; A Ex md IIC T4
Cl I; Div 1; Grps. A,B,C,D;T4

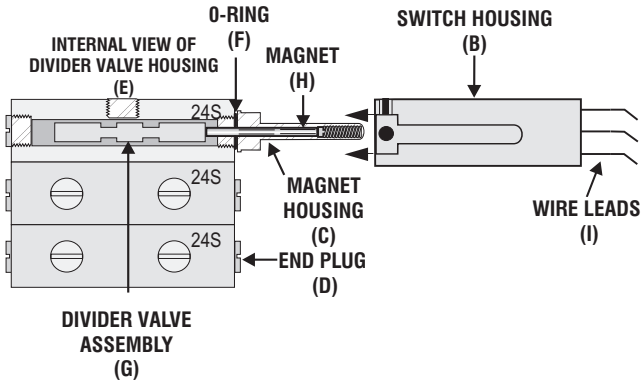
CE 0344

KEMA 00ATEX1090 X Amb. -40° C...+80°C

FOR TRABON®, LINCOLN® MANZEL® & DROPSA® DIVIDER BLOCK LUBRICATION SYSTEMS

INSTALLATION AND ADJUSTMENT PROCEDURE

1. Loosen all (2) Allen head set screws (A) on switch housing (B) and remove magnet housing (C). Do not remove magnet, spring, and spacer from magnet housing.
2. Remove end plug (D) from divider valve where proximity switch will be installed. Proximity switch can be installed on any available divider valve section.
3. Screw magnet housing (C) into end of divider valve. Torque to 15 foot pounds max. Be sure 0-ring or metal gasket (F) is in place on magnet housing (C) if required.
4. Slide switch housing (B) all the way onto magnet housing (C). Connect ohmmeter to yellow switch leads. Do not tighten set screws at this time.
5. To properly adjust switch housing (B), divider valve assembly (G) must be cycling so magnet (H) is moving back and forth. This can be achieved with lubrication system functioning or by manually pumping clean oil through divider valve assembly with a hand pump.
6. If a cycle is not detected, adjustment is made by sliding switch housing (B) out in 1/16" increments. Continuity meter connected to yellow wires will indicate a switch closure. Adjust 1/16" out until correct adjustment is confirmed. Torque set screws to 25 inch pounds max.
7. Use 10 to 12 inches of flexible conduit on the switch housing for ease of adjustment or maintenance. All conduit and connections should be appropriate for area classification. CAUTION: Conduit and fittings must be supported to avoid bending magnet assembly.



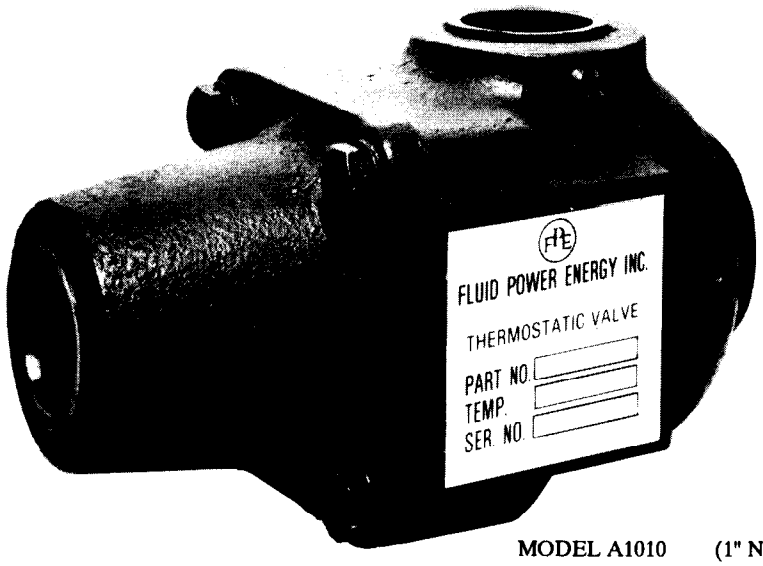
ORDERING INFORMATION

MODEL	DESCRIPTION	PART NUMBER
DNFT-D-PRX	DROPSA	000169
DNFT-L-PRX	LINCOLN - O-RING STYLE	000170
DNFT-TG-PRX	TRABON - GASKET STYLE "1994" AND EARLIER	000171
DNFT-TO-PRX	TRABON - O-RING STYLE "1995" AND LATER	000172

Manufactured and Assembled in the U.S.A. By Whitlock Instrument

*ALL TRADEMARK NAMES ARE THE PROPERTY OF THEIR RESPECTIVE COMPANIES AND ARE NOT ASSOCIATED WITH DELIRON LIMITED.

1/2" 3/4" 1" THREE-WAY THERMOSTATIC VALVE



MODEL A1010 (1" NPT)
A1110 (3/4" NPT)
A1210 (1/2"NPT)
A1010J8 (SAE #8)
A1010J12 (SAE #12)
A1010J16 (SAE #16)

FEATURES

SELF-CONTAINED • NON-ADJUSTABLE • TAMPER-PROOF • COMPACT

WIDE RANGE OF TEMPERATURES • HEAVY-DUTY • REPLACEABLE ELEMENT

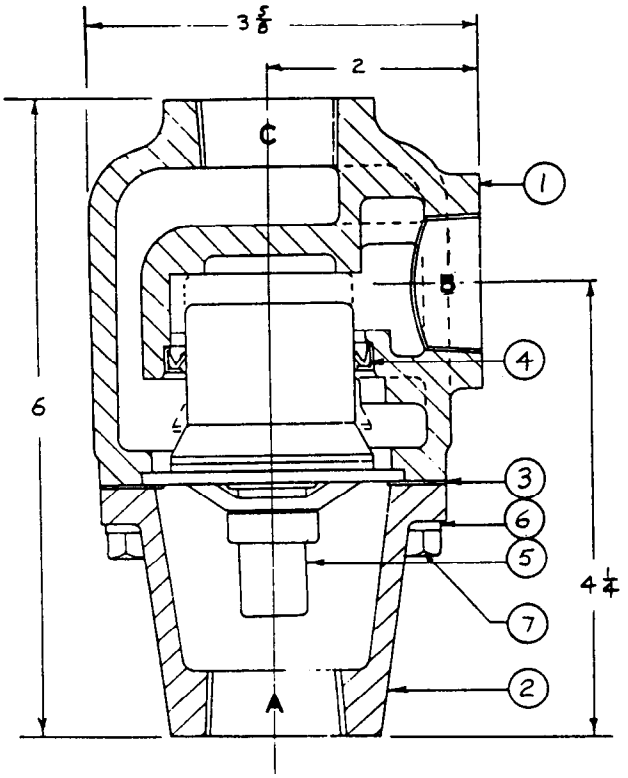
RUGGED CONSTRUCTION • OPERATE IN ANY POSITION

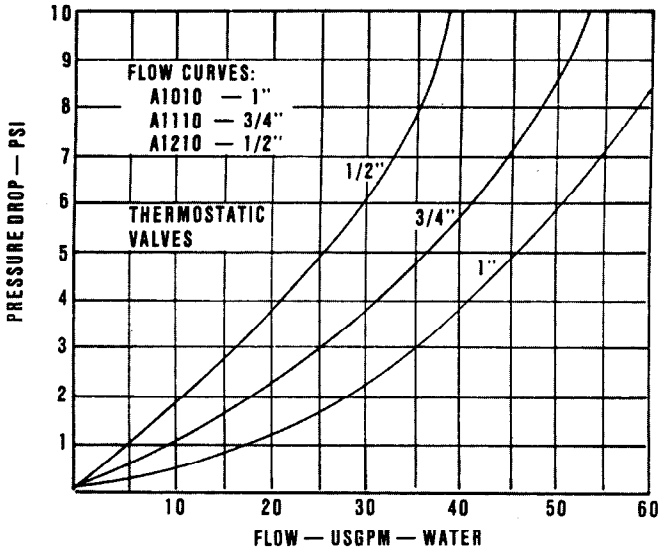
DESCRIPTION

FPE thermostatic valves utilize the principle of expanding wax, which in the semi-liquid state undergoes large expansion rates within a relatively narrow temperature range. The self-contained power element activates a stainless steel sliding sleeve which provides positive three-way valve action. All FPE thermostatic valves are factory set at predetermined temperatures; no further adjustments are necessary. A wide range of temperatures are available for water and oil temperature control applications.

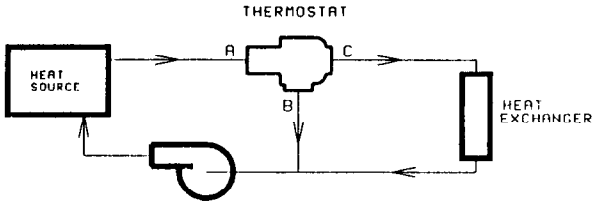
On starting, the total fluid flow is in a by-pass mode. As fluid temperature rises to the control range, some fluid is diverted to the cooling system. As fluid temperature continues to increase, more flow is diverted, and when in a fully stroked condition, all fluid flow is positively directed to the cooling system. FPE thermostatic valves may be used for either mixing or diverting applications. In normal operation, fluid temperatures are controlled to within a few degrees.

Standard FPE thermostatic valve housings are made from high quality grey iron castings; however, steel and bronze housings are available.

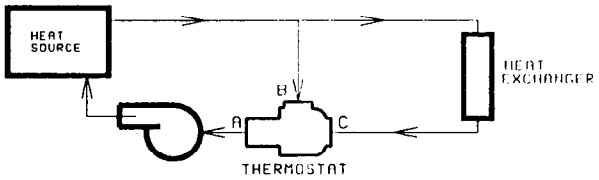




ITEM	NO.	P/N	DESCRIPTION
1	1	1010	VALVE BODY (1" NPT)
2	1	1020	VALVE COVER (1" NPT)
3	1	1572	O-RING
4	1	1071	LIP SEAL (TEFLON)
*5	1	1060	ELEMENT
6	4	1603	LOCKWASHER 5/16
7	4	1602	CAPSCREW 5/16 - 18 x 7/8
8	1	1590	NAME PLATE



DIVERTING APPLICATION



MIXING APPLICATION

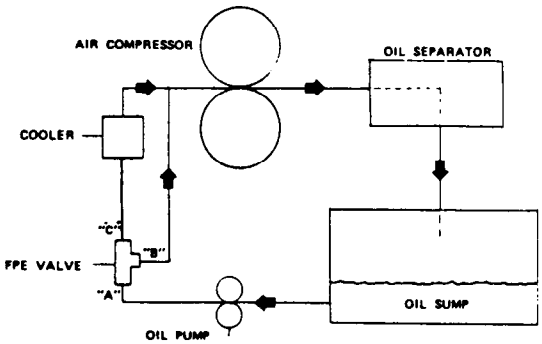
* PART NO. 1060 - CARRIES A DASH NUMBER INDICATING THE NOMINAL TEMPERATURE

PRESSURE RATINGS

MATERIAL	PRESSURE RATING	MODEL NUMBER
CAST IRON	150 PSI	A1010
STEEL	500 PSI	S1010
ALUMINUM	150 PSI	AL1010
BRONZE	150 PSI	B1010
DUCTILE IRON	250 PSI	D1010
STAINLESS STEEL	500 PSI	SS1010

PRESSURE RATINGS

MATERIAL	PRESSURE RATING	MODEL NUMBER
CAST IRON	150 PSI	A2010
STEEL	500 PSI	S2010
BRONZE	150 PSI	B2010
STAINLESS STEEL	500 PSI	SS2010



AIR COMPRESSOR APPLICATION

HOW TO ORDER: **Specify Model Number, nominal temperature desired, and housing material.**

FPE FLUID POWER ENERGY, INC.
W229 N591 Foster Court • Waukesha, WI 53186 • (262) 548-6220

FLUID POWER ENERGY, INC.
W229 N591 Foster Court • Waukesha, Wisconsin 53186 • (414) 548-6220

MATERIALS

FPE valves are available in cast iron, steel, ductile iron, aluminum and bronze. For information concerning these different materials, please contact your factory representative. Sometimes electrolysis may be encountered in a system. If this is the case, a zinc or magnesium waste plug can be installed in the valve at part A. If the valve is installed in a seawater, cast iron housings are not generally satisfactory. In this type of installation, bronze valves must be used. In mounting the valve in a system, the valve must be properly vented so that the possibility of trapping air in the valve or around the elements is eliminated. A good rule to follow on systems is to place air vents so that air can be bled from the system to a single collection point. Please note the vent lines in the different piping diagrams.

MAINTENANCE

FPE thermostatic valves probably require less maintenance than any other type of similar use. Elements in normal service should be good for 6 to 10 years. Excessive temperatures, chemical, electrolytic or cavitation attack will of course shorten the life of the elements and seats which are replaceable. Carbonates, scale and other solids must not be permitted to build up on sliding valve or sensing cup surfaces. FPE does not recommend that a large stock of spare parts be maintained at the valve installation. Most commonly used elements and seals are immediately available from FPE's stocking area representatives, or from the factory direct. Seals and composition gaskets are rated for a shelf life of one year from date of shipment. If adequately sealed from air, they may be good for longer periods. The shelf life of an FPE element is from one to two years, depending on storage conditions.

TROUBLE SHOOTING

I. SYSTEM TEMPERATURE RUNNING TOO HOT

A. Presence of foreign objects, dirt and solid buildup inside the valve (e.g. sliding piston, piston's seat, and lip seal area) may prevent proper operation of the valve. *Example*: By-pass port will not close.

B. Valve's by-pass and cooler ports (port B & C) installed backward. As port B closes due to temperature increase, flow is greatly restricted to cooler.

C. Valve is undersized, causing increase in pressure drop and possibly cavitation.

D. Thermostatic wax element may have been exposed to temperature higher than the recommended maximum temperature.

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E. Excessive pressure drop (in excess of 25psi) may cause one or more of the following conditions.:
   1. Thermostatic wax element failure.
   2. Lip seal dislocation.
   3. O-ring damage.
   4. Improper piston movement.

F. Improper system cooling capacity.

G. Improper sizing of the valve in a mixing application. If the valve is sized too large for the application it could result in poor mixing, which could cause the temperature to run either too hot or too cold.

II. SYSTEM TEMPERATURE RUNNING TOO COLD

A. Incorrect selection of valve's nominal temperature.

B. Valve's by-pass and cooler ports (port B & C) installed backward: This condition forces fluid to cooler at lower temperature.

C. Worn teflon lip seal.

D. Presence of foreign objects, dirt and solid buildup inside of valve (e.g. sliding piston, piston's seat, and lip seal area) may prevent proper operation of the valve.

E. Excessive pressure drop. Refer to part I, Item E above.

F. Thermostatic control valve is oversized.

G. Outlet temperature is not maintained due to insufficient heat rejected to coolant.

III. ADDITIONAL ITEMS THAT MAY BE CHECKED ARE:

A. System thermometers should be regularly checked to make sure that they are operational.

B. Thermometers should be located on the side of horizontal pipe runs whenever possible and particularly on oil systems

C. Thermometers should be as far as possible downstream from the valve in a mixing application.

D. The system should not have any by-passes or "sneak circuits" which prevent proper operation of thermostatic control valve.

FAX: (414) 548-6239

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Trouble Shooting continued

E. Cracked or broken valves may be caused by:
   1. Piping too short; and therefore, over-tightening bolts.
   2. Lack of expansion isolation between piping and valve.
   3. Misalignment of piping.
   4. Excessive weight.
   5. Allowing untreated water to freeze in the system.

REPAIR INSTRUCTIONS

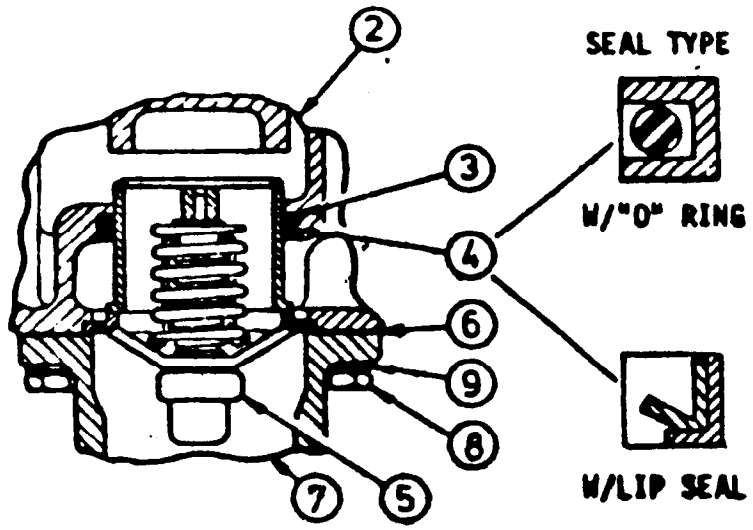
Thermostatic Valve Maintenance Kit

ELEMENT TESTING

Place element in water at a temperature 15° F. to 20° F. above its nominal setting and stir water vigorously with the element for five minutes. The temperature stamped on the side of the element is not the nominal temperature, it is the temperature at which the element is set to open. The nominal temperature is usually 10° F. to 15° F. higher than the nominal. After stirring vigorously immediately place the element in the housing. If the element is fully stroked, the seating and over-travel spring can be felt as it is pushed down. To determine if the element will close at a specific temperature, place the element in a bath of water approximately 5° F. below the start to open temperature. This is the number stamped on the element. Due to the effect of hysteris the element will close 5° F. below the start to open temperature.

ELEMENT REPLACING

Remove four capscrews (8), lockwashers (9) and separate housings ref. (2) and (7). Remove element assembly (5) and seal (4). Remove housing gasket (6). Clean housing sections, remove any scale or foreign material from seal faces. Lubricate new element seal (4) and slide in place over top of element assembly (5) into position shown in section view. Place new housing gasket (6) in recess of upper housing (2). Insert element (5) into upper housing (2) to position shown in section view. Place lower housing (7) over exposed section of element (5) against face of upper housing (2). Secure housings with capscrews (8) and lockwashers (9).



Ref. No.	Description
2	Upper Housing
3	Sleeve
4	"O" Ring or Lip Seal
5	Element Assembly
6	Gasket
7	Lower Housing
8	Capscrew
9	Lockwasher

FLUID POWER ENERGY, INC.

W229 N591 Foster Court, Waukesha, WI 53186 414/548-6200; FAX 414/548-6239

INSTALLATION AND OPERATING INSTRUCTIONS

WARNING!!! READ ALL OF THESE INSTRUCTIONS BEFORE PROCEEDING. ONLY EXPERIENCED PERSONNEL SHOULD BE ALLOWED TO INSTALL OR HANDLE THE ENCLOSED VALVE(S). ANY DAMAGE RESULTING FROM MISHANDLING OR IMPROPER INSTALLATION IS NOT COVERED BY THE MANUFACTURERS WARRANTY. FOR WARRANTY DETAILS, REFER TO THE LATEST REVISION OF CHECK-ALL VALVE MANUFACTURING COMPANY MANUFACTURER'S TERMS AND CONDITIONS **(Form #160)**.

The following instructions are meant as a guideline only. They do not cover every situation and rely on the common sense and expertise of the person installing the valve. In no way is Check-All liable for any damage to the valve, the system, or for personal injury resulting from use of these guidelines.

GENERAL INSTRUCTIONS

- Inspection. Prior to installation, inspect valves for any damage. Refer to Check-All Valve Terms and Conditions Form #160 for warranty information.
- Flow arrows. Install each check valve in the line with the arrow pointing in the direction of the flow. To verify proper installation, make sure each valve opens in the direction of desired flow. Note: From the closed position the poppet moves away from the seat in the direction of flow.
- Valve support. Valves must be adequately supported with pipe hangers, etc. to prevent additional loading on the valve body.
- Alignment & connection. Refer to ASME B31 "Pressure Piping Code" and ASME PCC-1 "Guidelines for Pressure Boundary Bolted Flange Joint Assembly" for recommended guidelines on alignment, bolt torque, etc.
- Safe connection. Valves must be adequately connected (threaded, welded, etc.) to surrounding piping to prevent unsafe discharge during filling and/or operation.
- Insert series valves. Insert series valves may not be visible after installation. It is the end user's responsibility to verify that there is adequate identification of the presence of a check valve that is installed in the system and to take any necessary precautions to avoid injuries or spills when the line is disassembled for maintenance or other reasons. Please consult the factory or your **local Check-All representative** for tagging options or further information.
- Intended Use. Valves compliant with the European Union Pressure Equipment Directive (97/23/EC) that have been classified under Sound Engineering Practice may be limited in their use. They will be identified as such with either marking on the valve body or an additional tag. If such classification is marked on an additional tag it is the end-users responsibility to reattach such identification to the installed valve or surrounding piping.

NPT PIPE THREADED VALVES: CON (CN), UN-3 (U3), UN-10 (U1), BU (BU), AND MCV (M1-M8) SERIES

Handle NPT threads on these valves carefully to avoid damage. Use an anti-seize thread sealant to prevent galling. Note: Because Bushing Series (BU) valves open into downstream connections, ensure adequate clearance for the travel of the poppet.

VALVES WITH TUBING CONNECTIONS: TCV (TV), TCVF (TF), AND MCV (M5-M8) SERIES

For a valve with flared fittings, slide the nut (not provided with the valve) onto the tubing and flare the tubing end. Tighten the nut onto the flared end of the valve. Note: Leakage can result if the flared surface is damaged. For a valve with compression fittings, first slide the nut on the tubing then the ferrule. Next, insert the tubing end into the valve fitting and tighten the nut. Note: the fittings are supplied as accessories only and as such are not governed by the European Union Pressure Equipment Directive 97/23/EC.

HVFD (HV) SERIES VALVES

Install each valve between ANSI class 150 raised face flanges with a gasket between each flanged joint and tighten the bolts per gasket manufacturer's torque recommendations.

HVFD-T (HT) SERIES VALVES

Install each valve between ANSI class 150 raised face flanges (no gaskets are necessary) and tighten the bolts only enough to ensure no leakage. Note: The valve liner may be damaged by over-tightening the bolts and/or by piping systems that add additional loads to the flanged joints.

FLANGE, LINED PIPE, AND WAFER INSERT VALVES: FIV (F1) (F6) (FP), SHR (FR), LPI (LP), AND WIV (WV) SERIES

Make sure the piping inside diameter is adequate because this type of valve extends into upstream and downstream piping. Additionally, make sure there are no obstructions that would disrupt fluid flow or interfere with poppet travel. Install each valve between ANSI raised face flanges with a gasket on each side of the valve (PTFE valves need no gaskets). Ensure that each valve is centered inside the bolt circle and tighten the bolts. Note: Plastic material valves can be damaged by over-tightening the bolts and by piping systems that add additional loads to valve flanged joints. If a valve flag with a flow arrow is attached to the valve, the tag shall not be rotated or removed so that the flow arrow on the tag remains accurate.

SANITARY AND GLASS PIPE INSERT VALVES: SIV (CB) (TC), AND GPI (GP) SERIES

Verify that ferrules (CB and TC) or flanges (GP) are correct for each valve to be installed by comparing the fit between the two. If the fit is correct, center the valve in the ferrules or flanges and tighten the clamp or bolts. A valve can be damaged by misalignment, by over tightening, and by piping system loads that affect the joint that contains the valve.

SANITARY CARTRIDGE VALVES: 3SC (3S) AND SCV (SC) SERIES

The inside diameter of the sanitary tubing must be the size listed in the catalog description of the valve. Lubricate the body o-rings, push the valve into the piping, and then secure the clamp or nut. Note: A valve may leak if piping is misaligned. Also refer to "3S Disassembly For Cleaning Instructions" **(Form #152)** and "SC Installation Instructions" **(Form #157)**. See www.checkall.com or request a copy from the factory.

UNION INSERT VALVES: UIV (UV) SERIES

Note that the union the UV is installed into must have a 45° seat and the ID must be equal to the ID of schedule 40 pipe. Center each valve in the union so the angles match and tighten the union nut enough to seal. Attach the metal identification tag to the union according to its instruction sheet.

STRAIGHT-SIDED INSERT VALVES: SSI (SI) SERIES

This series is designed to fit in a customer-designed cavity. Note: Forcing a valve into a cavity could cause the seat to deflect or warp and cause leakage.

UNIVERSAL SOCKET WELD VALVES: UN-SW (US) SERIES

This series is designed to socket-weld into a system. When welding, use standard welding procedures and safety precautions. A material data safety sheet for the body material will be provided upon request. WARNING: A valve can be damaged by excessive heat that may warp or melt the seat and cause it to leak. Use a heat sink or other means to prevent valve damage from occurring.

MAINTENANCE & INSPECTION:

- ◊ Corrosive media. For valves installed in corrosive media, Check-All recommends establishing inspection schedules to ensure the continued safe use of the valve.
- ◊ Depressurization & draining. To avoid potential hazards due to discharge, depressurize and drain the surrounding system prior to removing the valve from the system.
- ◊ Surface temperature. To avoid personal injury, do not touch surface of valves if the media within is colder or hotter than room temperature. Allow the valve to return to room temperature prior to removing from the system.
- ◊ Valve inspection. For applications that necessitate periodic valve inspection, Check-All can provide, upon request, the critical pressure boundary dimensions of valve bodies. Maintenance or other qualified personnel should also visually inspect the valves for signs of wear that could adversely affect valve performance.
- ◊ Cleaning. Care should be exercised when cleaning valves (with steam, chemicals, etc) to protect them against excessive pressure, temperature, and/or corrosion.
- ◊ Field repair. Check-All does not recommend field repair for any valve, except the 3S series. If field repair is absolutely necessary contact the factory or the local representative for instructions. A defective valve may be returned to the factory and MUST be accompanied by a completed and signed Return Material Authorization.

HAZARDS & DAMAGE DUE TO MISUSE:

- ❖ Installation next to an "ell". Do not install the valve next to the discharge of an elbow "ell" or directly after any component that could alter or disrupt the flow pattern. Check-All valves are best suited for use with fully developed flow. Although there are many factors affecting the achievement of fully developed flow (such as media, pipe roughness, and velocity), usually (10) pipe diameters of straight pipe immediately upstream of the valve is sufficient. This is particularly important after flow skewing devices such as elbows, tees, centrifugal pumps, etc.
- ❖ Shock-load applications. Do not install the valve on the discharge of a reciprocating compressor or any other element that will cause a physical and/or thermal shock-load.
- ❖ Pressure limit. Maximum allowed room temperature pressure rating is shown on the pertinent catalog pages. In the case of valves ordered with CE marks or registered in Canada (CRN), the room temperature pressure rating is marked on the valve or valve flag supplied. Over-pressurization (due to fluid heating, chemical reaction, explosion, external fire, etc) can cause failure of the valve body and/or the valve internals; therefore, other means must be taken in the surrounding system to prevent this.
- ❖ Additional loads & considerations. Pressure ratings are based on internal pressure only. Additional loadings (environmental, head pressure, line-loads, etc) on valves must be accounted for by the end-user. Valve weights are listed in the Check-All catalog or at www.checkall.com.
- ❖ Temperature limits. Allowable operating temperature limits are shown in the catalog. In the case of valves ordered with CE marks, the limitations are marked on the valve body or accompanying valve flag. Temperatures higher or lower (due to the media, chemical reactions, environmental, conduction, convection, etc) than those allowed can cause failure of the valve body and/or internals. Contact Check-All for temperature range information and reduced pressure ratings at elevated temperatures.
- ❖ Corrosive applications. Corrosion allowances are available upon request for all valves. It is the end-users responsibility to determine the suitability of the valve material for the internal and external environment in which it is used, as well as to establish inspection schedules. Refer to the latest revision of **Form #180** "Body Material Definition for Check-All Valve Products" to determine from what material valve bodies are made. Where the possibility of condensation of gaseous fluids exists, external means in the surrounding system may need to be provided for drainage and removal of deposits from low areas to avoid damage from corrosion. Carbon steel valves are supplied with an oil coating but are not plated.
- ❖ Media debris, leakage, & erosion. Check-All valves are best suited for clean, particle-free liquids or gases. Debris such as sand or fibers can prevent the valve from sealing properly, erode the body and/or internal components, or otherwise adversely affect valve travel. These particles should be filtered out prior to entering the valves.
- ❖ Valve sizing. Proper operation requires correct valve sizing. If valves are oversized for the operating conditions, trim can chatter and cause excessive wear to the entire valve. Sizing accuracy requires the valve be fully open which occurs when the pressure drop across the valve reaches or exceeds approximately three times the spring cracking pressure (five times for 3S series). If valve is undersized, pressure drop may be excessive and cause the o-ring to come out of the groove. Valves can be sized using the equations or flow charts located in the Check-All catalog or the Flow Data section of the Check-All website www.checkall.com. Contact the factory, sales@checkall.com, or **your local Check-All representative** for further information or assistance.
- ❖ Seat leakage. PTFE o-rings, plastic-to-plastic seats, and metal-to-metal seats do not have zero seat-leakage. Allowable leakage rates are listed in the Check-All catalog or at www.checkall.com in the **Application Guidelines** section.
- ❖ Decomposition of unstable media. Check-All valves are not designed to withstand excessive temperature and/or pressure beyond their marked limits due to the decomposition of unstable media.
- ❖ Fatigue life. CE marked valves have been evaluated using the ASME Boiler and Pressure Vessel Code latest revision or material manufacturer literature. Contact Check-All Valve for minimum number of cycle information. Exceeding the fatigue life of the valve may result in sudden valve failure.
- ❖ Safety accessory. Valves are not to be used as safety accessories as defined in the **Pressure Equipment Directive (PED) 97/23/EC**.
- ❖ External fire. Any risk arising from external fire must be accounted for in the surrounding system.
- ❖ Galvanic reactions. Suitability of the valve body material when connected with the surrounding piping material is the sole responsibility of the end-user. Galvanic reactions can lead to material loss that can lead to failure of the pressure boundary. Refer to **Form #180** "Body Material Definition for Check-All Valve Products" to determine from what material valve bodies are made.

Check-All Valve Mfg. Co. seeks for the highest level of quality and performance in its products. If you have comments regarding its products, the instructions, require documents referred herein, or need further assistance, please contact your local representative or:

Check-All Valve Mfg. Co.
1800 Fuller Road
West Des Moines, IA 50265 U.S.A.
Phone: 515-224-2301 – Fax: 515-224-2326
Website: **www.checkall.com** – Email: **sales@checkall.com**

PXT-K Series Pressure Transmitters



Features

- 4-20 mA Output Signal
- Piezoresistive Pressure Transmitter
- Corrosion Resistant Construction
- High Stability

The **PXT-K Series** pressure transmitters are state-of-the-art instruments providing 4-20 mA output. Each Piezoresistive Pressure Transmitter contains a transducer comprised of a piezoresistive silicon chip mounted on a glass-metal feed-through header welded into a stainless steel housing and filled with silicone oil; the very thin laser-welded stainless steel isolation-diaphragm completes the front side. Media pressure is transferred from the stainless steel isolation-diaphragm, via the oil inside the cell, to the silicon measuring chip. This construction, combined with the advanced internal signal conditioning circuitry, results in a rugged instrument with extremely small temperature error and class-leading EMI/RFI resistance.

The enclosure and all wetted parts are made of 316L stainless steel to meet NACE MR01-75.

Applications: **PXT-K Series** Pressure Transmitters can be used in applications such as Compressors, Engines, Process Control, Liquid Level and Pumps.

Specifications

Operating Pressure Range: See the part number matrix on the reverse side.

Operating Temperature: -40 to 180°F (-40 to 82°C).

Compensated Temperature Range: -20 to 160°F (-29 to 71°C).

Physical Characteristics:

Process Connection: 1/4 NPT female with 7/8” Hex Nut.

Electrical Connection (PXT-K-XXX): 1/2” NPT Male Conduit connection with 60” long cable, vented

Enclosure: NEMA 4/IP65 or better

Body: 316L Stainless Steel. Meets NACE MR01-75.

Wetted Parts: 316L stainless steel

Environmental Effect (Humidity): No effect for 0-95%, Non-condensing

Mounting: Transmitter can be installed in any axis. Transmitter position has negligible affect on performance as long as it is perpendicular to the flow being monitored.

Shock Resistance: 1000g per IEC 60068-2-6 (Mechanical Shock)

Vibration Resistance: 20G per IEC 60068-2-6 (Vibration under resonance)

Wiring Protection: Protected against reverse polarity and short circuit, 48 VDC Maximum

Supply Voltage: 8 - 30 VDC (Typically 24 VDC)

Transmitter Output: 4-20mA, two wire configurations with load characteristics

Insulation: Greater than 10MΩ @ 300 VDC

Electromagnetic Compatibility (EMC): Standards; EN 61000-6-2:2005, EN 61000-6-3:2007, EN 61326-2-3:2006

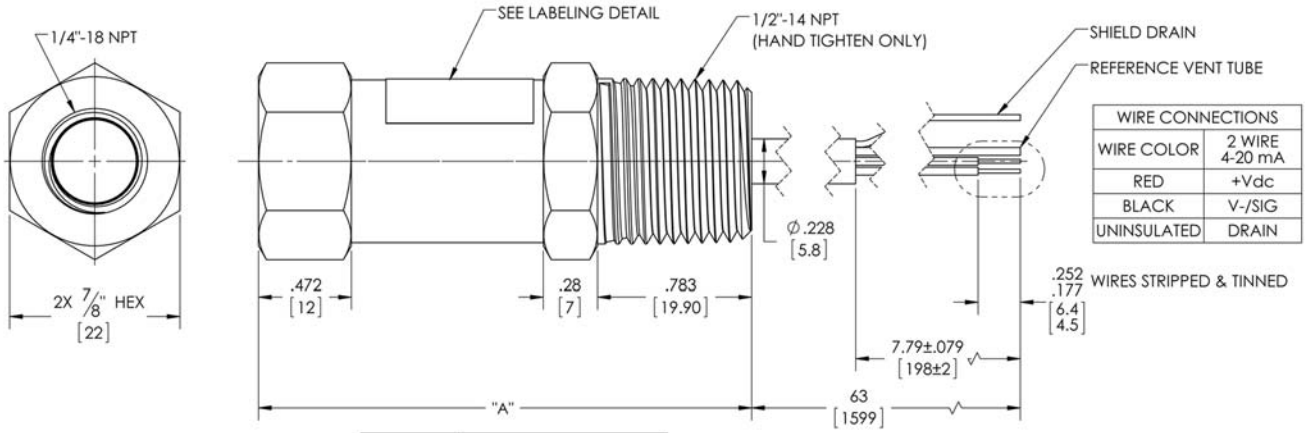
Voltage Surge/Spike Protection: Protection against a 600 Volt spike per IEC 60-2

Shipping Weight: 6.5 ounces

Applicable Standards:
US (NEC 500) Class I, Division 1, 2, Groups A, B, C, D, E, F, G, T6
NACE MR0175 Compliant with the requirements

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Product Dimensions - PXT-K

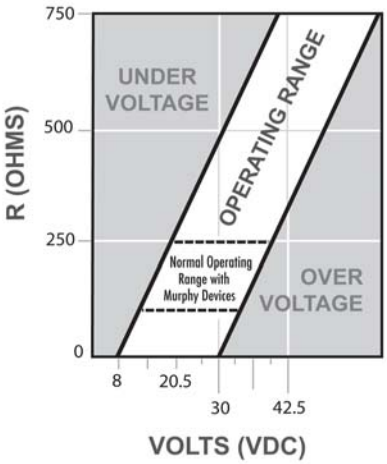


WIRE CONNECTIONS	
WIRE COLOR	2 WIRE 4-20 mA
RED	+Vdc
BLACK	V-/SIG
UNINSULATED	DRAIN

"A"	PRESSURE RANGE
2.51 ±.02	30V30WC TO 60 psig
2.82 ±.02	100 TO 2,000 psig
3.03 ±.02	3000 TO 10,000 psig

Operating Range

Supply voltage for the PXT-K must be within range of 8-30 VDC. The graph below shows the minimum supply voltage (VDC) required for a given load resistance (R).



LOOP RESISTANCE GRAPH

How to Order

PXT-K Model Number Matrix

Example: PXT-K-600

Murphy two wire pressure transmitter with flying lead connection, 0-600 psig range, 4-20 mAdc output. If no digit follows Pressure Range, it is automatically a 4-20 mAdc output signal.

Model Number:

PXT-K −□□□

RANGE

30V30WC
30V30
30V100
15 (psig)
60
100
200
300
400
600
1000
2000
3000
5000
6000
10000

PXT and PXT-K Series Pressure Transmitter Cabling Identification

The PXT Series Pressure Transmitters have been changed. Previous pressure transmitters in this series were identified as ***PXT Pressure Transmitters***. The newest version is the ***PXT-K Series Pressure Transmitters***. Identification of electrical cable color is NOT interchangeable between the two series of pressure transmitters.

This document contains information to assist you in identifying the pressure transmitter unit you have and the correct electrical cable colors to avoid wiring mistakes.

PXT SERIES	PXT-K SERIES
 Indentations on the hex coupling for controlled locking. Product has a step-down between the transmitter body and hex coupling.	 No step-down between the body and the hex coupling. No indentations on the hex coupling.

Cable Color	**Connection**	**Cable Color**	**Connection**
RED	POWER	RED	POWER
BLUE	SIGNAL	BLUE	N/A
BLACK	CASE GROUND	BLACK	SIGNAL
ORANGE, YELLOW, WHITE	N/A	ORANGE, YELLOW, WHITE	N/A
Installation Instructions	00-02-0475	Installation Manual	00-02-0840
Installation Diagram	05-08-0754	Installation Diagram	05-08-0763

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2012-05-04



PXT-K Series

Pressure Transmitters

Installation Instructions

00-02-0840
2012-06-01
Section 05

Warranty - A limited warranty on materials and workmanship is given with this FW Murphy product. A copy of the warranty may be viewed or printed by going to http://www.fwmurphy.com/warranty



This Murphy instrument is susceptible to damage when exposed to static electrical changes. To avoid this damage, observe the following:

- Disconnect all electrical power to the machine.
- Follow the lock out/tag out safety procedures of your company. Ensure the machine cannot operate during installation.
- Follow the safety warning of the machine manufacturer.
- Read and follow all installation instructions.

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. The latest version of this manual can be found at www.fwmurphy.com.

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Applicable Standards 2

Installation Warnings 2

Noise 3

Mounting 3

PXT-K & PXT Cable Color Identification 4

PXT-K Series Physical Dimensions 5

PXT-K Installation Drawing 6

Specifications 7

Model Number Matrix 8

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Introduction

The PXT-K Series pressure transmitters are state-of-the-art instruments providing 4-20 mA outputs. Each pressure transmitter contains a transducer comprised of a piezoresistive silicon chip mounted on a glass-metal feed-through header welded into a stainless steel housing and filled with silicone oil; the very thin laser-welded stainless steel isolation-diaphragm completes the front side. Media pressure is transferred from the stainless steel isolation-diaphragm, via the oil inside the cell, to the silicon-measuring chip. This construction, combined with the advanced internal signal conditioning circuitry, results in a rugged instrument with extremely small temperature error and class-leading EMI/RFI resistance.

Applicable Standards

US (NEC 500) - Class I, Division 1, 2, Groups A, B, C, D, E, F, G, T6

NACE MR0175 - Compliant with the requirements

Installation Warnings

Pulsating pressure variations such as caused by liquid or gasses under pressure can destroy any pressure transmitter and should be avoided. To avoid damaging surges and hammers, apply pressure slowly and open/close valves gradually.

To avoid damage from pressure hammer and surges, install a surge chamber or a pressure snubber. One such family of products is the Murphy PD-8100 Series pulsation dampener. Contact Murphy for details or check on www.fwmurphy.com/.

Symptoms of fluid hammer and surge damage:

a. Pressure transmitter exhibits an output at zero pressure (large zero offset).

b. Pressure transmitter output remains constant regardless of pressure.

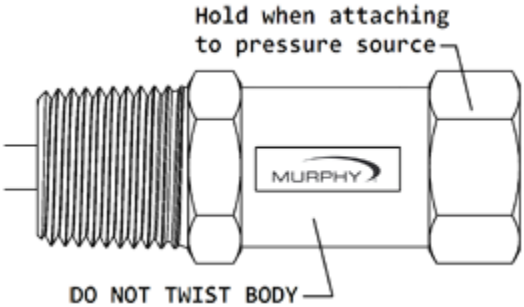
c. In severe cases, there will be no output.

Noise

For minimum noise susceptibility avoid running the transmitter cabling in a conduit that contains high voltage AC power cables or the ignition loom on an engine. Where possible avoid running the cable near inductive equipment. Shielded cable is always recommended. Typical shield/drain is isolated from the transmitter body and should be grounded on the panel end only. **However, PXT-K Series products are not constructed to be isolated and the shield/drain should not be grounded in the panel.**

Mounting

Caution: Transmitters are precision instruments. Do not install in a manner that causes side stress or is subject to excessive vibration.



Transmitters require no special mounting hardware and can be mounted in any plane with negligible position error.

Although the unit can withstand substantial vibration without damage or significant output effects, it is good practice to mount the transmitter where there is minimum vibration.

Apply Teflon tape/sealant to the pressure-fitting threads before installing. When tightening, apply a wrench to the hex wrench flats located just above the pressure fitting. **DO NOT tighten by using a pipe wrench on the housing**.

PXT-K and PXT Series Pressure Transmitter Cabling Identification

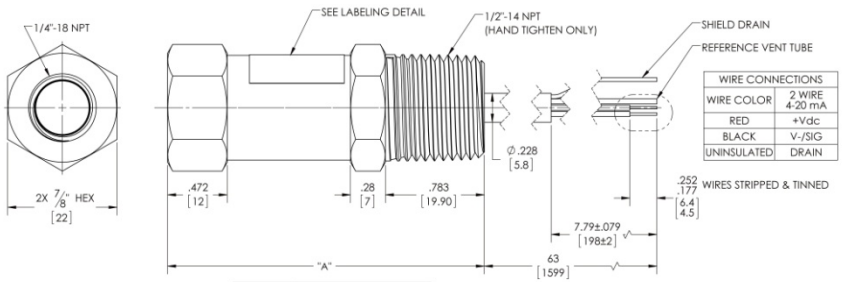
The PXT Series Pressure Transmitters have changed. Previous pressure transmitters in this series were identified as ***PXT Pressure Transmitters***. The newest version is the ***PXT-K Series Pressure Transmitters***. Identification of electrical cable color is NOT interchangeable between the two series of pressure transmitters.

The following information will assist you in identifying the pressure transmitter unit you have and the correct electrical cable colors to avoid wiring mistakes.

PXT SERIES	PXT-K SERIES
	

Cable Color	Connection	Cable Color	Connection
RED	POWER	RED	POWER
BLUE	SIGNAL	BLUE	N/A
BLACK	CASE GROUND	BLACK	SIGNAL
ORANGE, YELLOW, WHITE	N/A	ORANGE, YELLOW, WHITE	N/A
Installation Instructions	00-02-0475	Installation Manual	00-02-0840
Installation Diagram	05-08-0754	Installation Diagram	05-08-0763

PXT-K Series Physical Dimensions



WIRE CONNECTIONS	
WIRE COLOR	2 WIRE 4-20 mA
RED	+Vdc
BLACK	V-/SIG
UNINSULATED	DRAIN

"A"	PRESSURE RANGE
2.51 ±.02	30V30WC TO 60 psig
2.82 ±.02	100 TO 2,000 psig
3.03 ±.02	3000 TO 10,000 psig

Specifications

Operating Pressure Range: See the part number matrix following this section.

Operating Temperature: -40 to 180°F (-40 to 82°C).

Compensated Temperature Range: -20 to 160°F (-29 to 71°C).

Physical Characteristics:

Process Connection: 1/4 NPT female with 7/8" Hex Nut.
Electrical Connection (PXT-K-XXX): 1/2" NPT Male Conduit connection with 60" long cable, vented
Enclosure: NEMA 4/IP65 or better
Body: 316L Stainless Steel. Meets NACE MR01-75.
Wetted Parts: 316L stainless steel

Environmental Effect (Humidity): No effect for 0-95%, Non-condensing

Mounting: Transmitter can be installed in any axis. Transmitter position has negligible effect on performance as long as it is perpendicular to the flow being monitored.

Shock Resistance: 1000g per IEC 60068-2-6 (Mechanical Shock)

Vibration Resistance: 20G per IEC 60068-2-6 (Vibration under resonance)

Wiring Protection: Protected against reverse polarity and short circuit, 48 VDC Maximum

Supply Voltage: 8 - 30 VDC (Typically 24 VDC)

Insulation: Greater than 10MΩ @ 300 VDC

Electromagnetic Compatibility (EMC): Standards; EN 61000-6-2:2005, EN 61000-6-3:2007, EN 61326-2-3:2006

Voltage Surge/Spike Protection: Protection against a 600 Volt spike per IEC 60-2

Model Number Matrix

PXT-K Model Number Matrix

Example: PXT-K-600

Murphy two wire pressure transmitter with flying lead connection, 0-600 psig range, 4-20 mAdc output. If no digit follows Pressure Range, it is automatically a 4-20 mAdc output signal.

Model Number:

PXT-K −□□□

RANGE

30V30WC
30V30
30V100
15 (psig)
60
100
200
300
400
600
1000
2000
3000
5000
6000
10000

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2012-0504

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INSTALLATION INSTRUCTIONS FOR MODEL KLCE OIL LEVELCONTROLLERS

Note: For fire safe oil level controllers (KLCE-FS) see additional instructions in this work sheet covering installation of fire safe valves.

ELECTRICAL RATINGS:

15 AMP, 125/250/480 VAC
0.5 AMP, 125 VDC
0.25 AMP, 250 VDC
1/8 HP, 125 VDC
¼ HP, 250 VAC

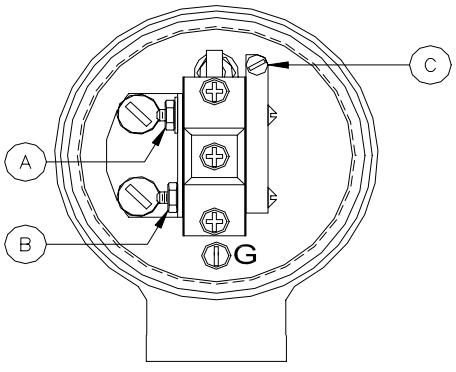
I. SWITCH ADJUSTMENTS FOR LOW LEVEL SWITCH CONFIGURATIONS: SEE FIGURE 1

- **Remove the condulet lid**
- **Loosen nuts A and B**
- **Turn screw C clockwise to lower the trip point**
- **Turn screw counterclockwise to raise the trip point**
- **After adjustment is complete, tighten nuts A and B and re-attach the lid**

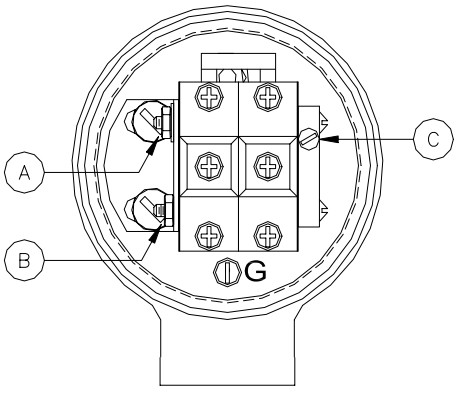
Figure 1

Class I, Div. 1, Div. 2
Groups B, C, and D
Hazardous Locations

Single Pole
Double Throw



Double Pole
Double Throw

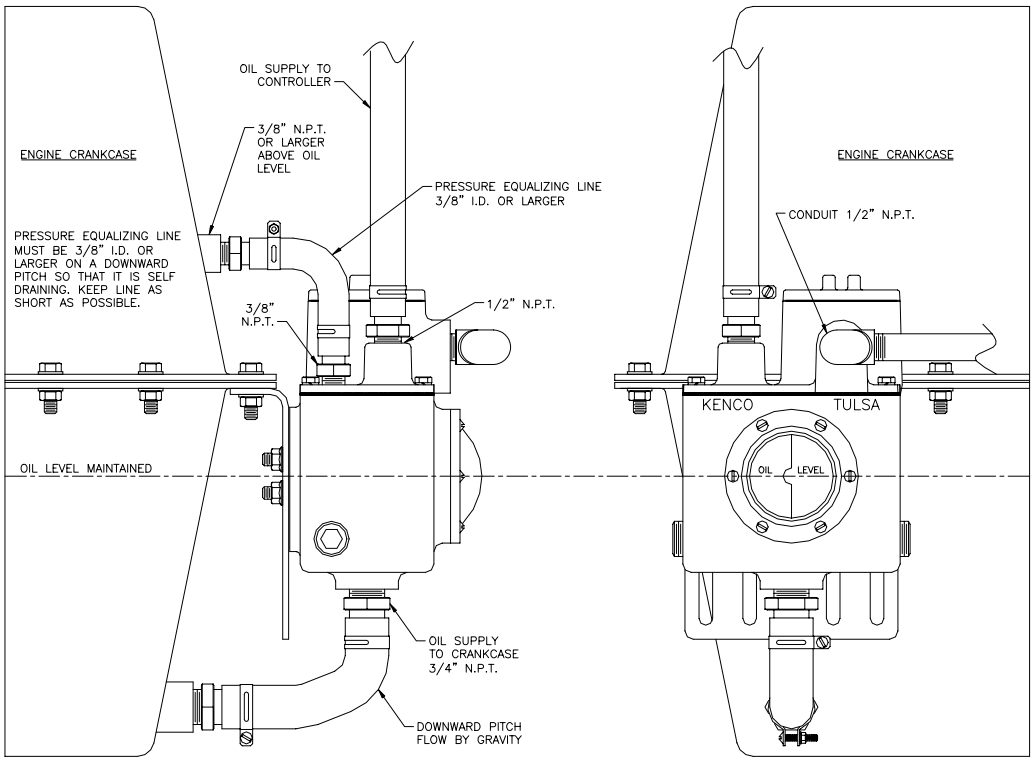


II. INSTALLATION INSTRUCTIONS FOR UNITS WITH ADAPTERS:

OIL LEVEL CONTROLLERS WITH –9 (Universal adapter), -10 (Slotted universal adapter),-12 (Pole mounted adapter) AND –FS OPTIONS

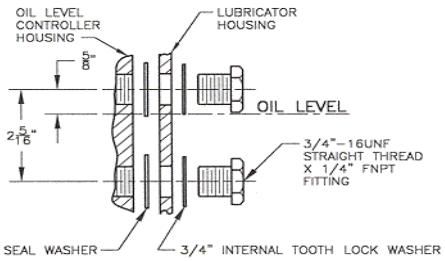
- **Set the controller so that the centerline of the sight window corresponds to the desired oil level in the crankcase.**
- **Mount the controller close to the crankcase and connect the hose from the ¾" outlet located on the controller to the crankcase. NOTE: The outlet port on the oil level controller must be located below the oil level in the crankcase.**
- **An equalizing line must be used between the controller and crankcase in order to equalize the pressure. The tubing must be a minimum of 1/2" I.D. and must be kept under 2 feet. DO NOT loop this line. It must be trap free and self draining, with a downward pitch flow by gravity.**

Figure 2: Typical Mount of –9 Adapter



OIL LEVEL CONTROLLER WITH –11 AND –11-FS OPTION (for Mechanical Lubricators): See Figure 3

Figure 3



- **Drill holes in the lubricator housing as shown, and mount the controller with the inlet located on the top side using the seal washers and mounting bolts provided.**
- **Place the seal washers between the controller and the lubricator housing.**

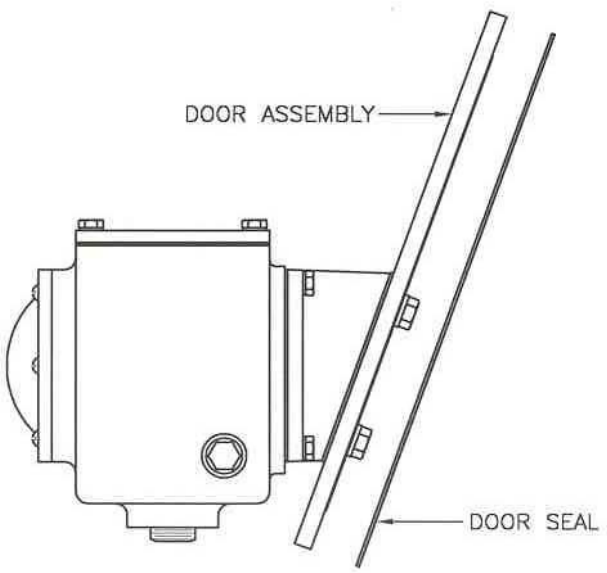
OIL LEVEL CONTROLLER WITH –14 AND –14 –FS OPTION (White Compressor)

- **Remove the triangular blind flange located on the compressor and mount the controller assembly in its place.**

OIL LEVEL CONTROLLER WITH –17 (Waukesha VHP Engines F2895, F3251, F5108, L5790 & L7042), -18 (-17 w/ meter), -27 (for newer Waukesha engines same as –17), –37 (Waukesha P9390), -38 (same as –37 w/ meter) AND –FS OPTIONS

- **Remove the cast aluminum inspection door from the engine. Remove the clamp bar from the old door.**
- **For –17, -18, -37, -38 install the o-ring into the groove of the Kenco door and replace the clamp bar on the back side of the door using the 5/8" bolts and the stat-o-seals supplied by Kenco.**
- **For –27, install the o-ring into the groove of the Kenco door and replace the clamp bar on the back side of the door using the 7/16" bolts and the stat-o-seals supplied by Kenco.**
- **Install the equalizing line between the controller cover plate and the door (Tubing and connectors supplied by Kenco).**
- **Place the controller assembly into the inspection port of the engine and tighten the center bolt(s) down.**
- **Install oil inlet line into the controller oil valve or the meter inlet port.**
- **NOTE: For the –18 model, refer to the additional instructions supplied with the 1618 Kenco Low Flow meter.**

Figure 4: -Door Assembly for –17, -18, -27, -37, -38



OIL LEVEL CONTROLLER WITH -24 (Ariel Compressor JGB, JGE, JGH, JGK, JGR, JGT, JGV, & JGW) and -48 (Ariel compressor JGC & JGD) AND –FS OPTIONS

- **Remove the sight glass located on the crankcase and replace it with the oil controller assembly using the mounting bolts and gasket supplied with the unit.**

OIL LEVEL CONTROLLERS WITH –1 (Clark MA & CFA) –2 (Clark HMB & TMB), -3 (Clark RA, HRA, HBA, HCA, HLA, TLA), -6 (Cooper-Bessemer GMW), -7 (Cooper-Bessemer GMV), -8 (Cooper-Bessemer GMX), -16 , -16-R, -16-6.25 (Cooper-Bessemer BMV & 275) AND FS OPTIONS

- **Remove the visual oil gauge assembly from the engine and replace it with the oil level controller and adapter assembly supplied with a gasket and mounting bolts when applicable.**

OIL LEVEL CONTROLLERS WITH –4 (Ingersoll-Rand SVG & KVS), -5 (Ingersoll-Rand KVG) AND FS OPTIONS

- **Remove the visual oil gauge assembly from the engine and replace it with the oil level controller and adapter assembly supplied with a gasket and mounting bolts when applicable.**
- **If an equalizing exists for the engine sight glass and detach the equalizing line from the sight glass while still attached to the engine.**
- **Install the oil controller and then reattach the equalizing line to the vent located at the top of the adapter.**

Note: It is important to insure that there are no loops in this line for it must be trap free and self draining.

III. INSTALLATION INSTRUCTIONS FOR FIRE SAFE VALVES: See Figure 5

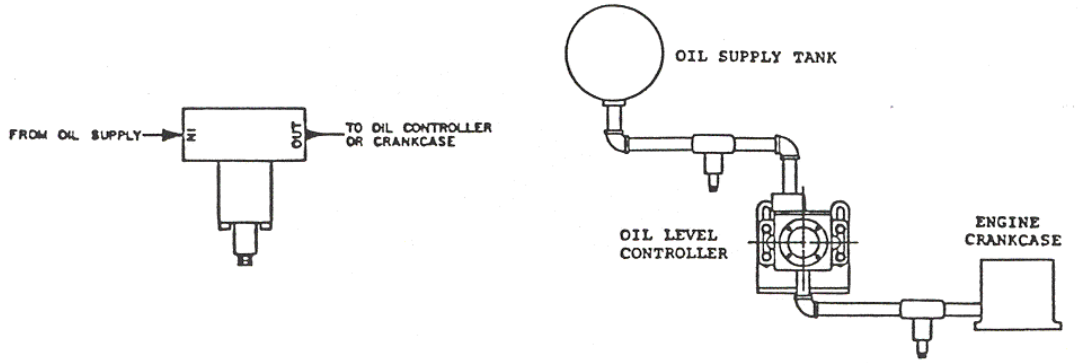
MODEL 50-FS AND 75-FS (PATENT NO. 3,877,476)

NOTE: All lines between thermal valves, supply tanks and the controller must be made of steel. DO NOT use rubber hose. The lines should be 3/4" I.D.

- **The eutectic fuse element should always be in a downward position to help the element melt when heat is applied to the valve.**
- **The 50-FS valve has 1/2" FNPT threads and should be installed in the oil supply line as close to the controller as possible. Meters, filters and pressure regulators should be installed between the controller and the 50-FS.**
- **The 75-FS valve has 3/4" FNPT threads and should be located as close to the crankcase as possible and the oil outlet line should be a minimum ¾" I.D. to insure adequate oil flow to the crankcase.**

NOTE: The 75-FS valve is not required when using –FS adapters other than –9 and –12.

FIGURE 5: FIRE SAFE VALVE INSTALLATION



IV. START-UP PROCEDURES

- **After the engine has been running for 1 hour, visually check the oil level in the sight glass. The oil level should be in the center of the sight glass.**
- **With the engine running, check the crankcase oil level. It should be the same as the oil level in the oil controller. If not, check the installation of the equalizing line (if applicable) see instruction for the equalizing line at –9.**
- **Check all piping connections for leaks and repair as needed.**

VI .SIX MONTH SUGGESTED MAINTENANCE PLAN

Switch Service

- **Test switches to insure that the switches are operating correctly.**
- **Shut the engine off.**
- **Disconnect the equalizing line (if applicable).**
- **Place a blunt rod through the vent hole on the cover plate and depress the oil float.**
- **Observe the engine panel to determine if the switches make and break contact.**
- **If the switch is functioning properly, replace the equalizing line or vent plug.**
- **If the switch does not function, it must be replaced (refer to a replacement parts list).**

627 Series Pressure Reducing Regulators

WARNING

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

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

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

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



W4793

Figure 1. *Typical 627 Direct-Operated Pressure Reducing Regulator*

Introduction

Scope of the Manual

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

Description

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

Specifications

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

WARNING

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

D101328X012

Specifications

Available Constructions

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

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

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

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

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

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

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

Body Sizes and End Connection Styles

BODY SIZES, NPS (DN)	END CONNECTION STYLES	CONSTRUCTION AVAILABLE
3/4	NPT	All
1 (DN 25)	NPT, CL150 RF, CL300 RF, CL600 RF, and Long Body	
2 (DN 50)	NPT, CL150 RF, CL300 RF, CL600 RF, and Long Body	

Maximum Inlet Pressure(1) (Body Rating)
NPT Stainless Steel: 2000 psig (138 bar)
Flanged Stainless Steel: 1440 psig (99,2 bar)
NPT Steel: 2000 psig (138 bar)
Flanged Steel: 1500 psig (103 bar)
Ductile Iron: 1000 psig (69,0 bar)

Maximum Valve Disk Inlet Pressure Rating(1)
Nylon (PA) Disk: 2000 psig (138 bar)
Nitrile (NBR) Disk: 1000 psig (69,0 bar)
Fluorocarbon (FKM) Disk: 300 psig (20,7 bar)

Maximum Operating Inlet Pressure, Pressure Differential, and Outlet Pressure Ranges(1)
See Table 1 for pressures by orifice size and spring range

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

Maximum Body Outlet Pressure(1)(2) (Types 627M, 627MR, and 627HM Only)
NPT Steel: 2000 psig (138 bar)
Flanged Steel: 1500 psig (103 bar)
Ductile Iron: 1000 psig (69,0 bar)

Orifice Sizes
See Table 1

Internal Relief Performance
Type 627R: See Table 3
Type 627LR: See Table 4
Type 627MR: Limited by field-installed control line piping

Temperature Capabilities(1)(3)
-40° to 180°F (-40° to 82°C)

Flow Coefficients
See Table 5

IEC Sizing Coefficients
See Table 6

Pressure Registration
Type 627, 627H, 627R, or 627LR: Internal
Type 627M, 627HM, or 627MR: External through 1/4 NPT control line connection in the diaphragm casing

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

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

Spring Case Vent Connection
3/4 NPT with removable screened vent assembly

Approximate Weights
Ductile Iron, Steel, or Stainless SteelCasings: 10 pounds (4 kg)
Aluminum Casings: 6.3 pounds (3 kg)

1. The pressure/temperature limits in this Instruction Manual or any applicable standard limitation should not be exceeded.
2. Types 627, 627H, 627R, and 627LR are limited by maximum diaphragm casing pressure.
3. Stainless steel body material can be used for applications in temperature ranges down to -40°F (-40°C) and are only available for Types 627, 627R, and 627H.

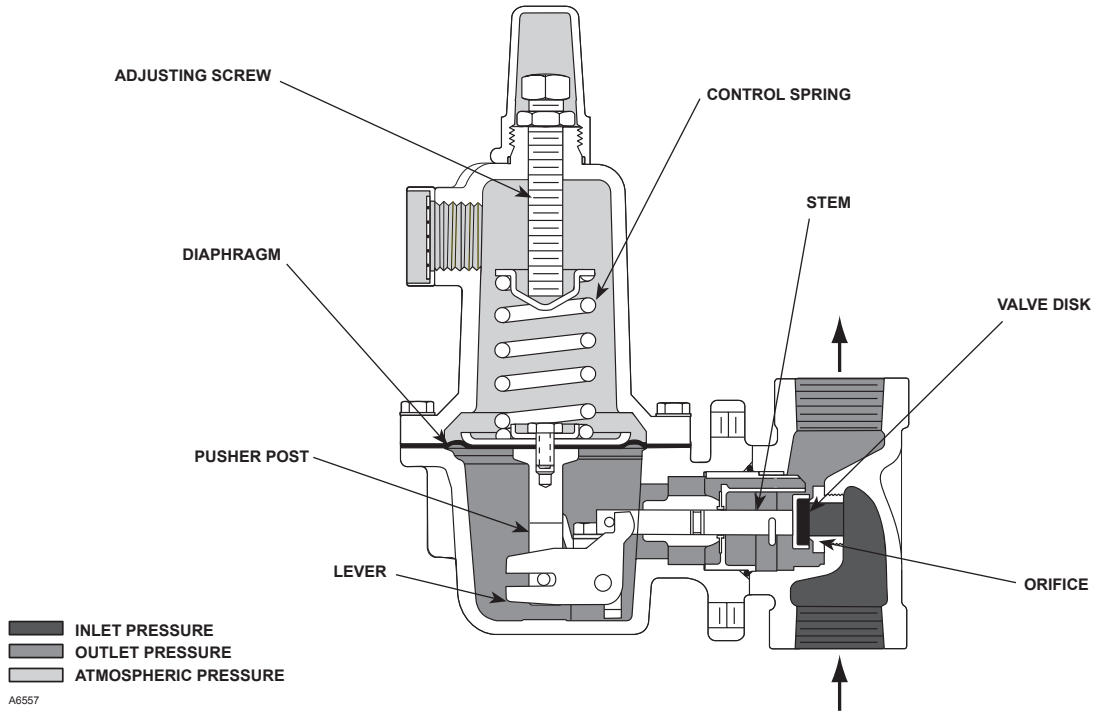


Figure 2. *Type 627 Operational Schematic*

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

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

Principle of Operation

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

Product Description

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

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

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

Table 1. *Maximum Inlet Pressures and Outlet Pressure Ranges*

TYPES	OUTLET PRESSURE RANGE, SPRING PART NUMBER, AND COLOR CODE	ORIFICE SIZE, INCHES (mm)	MAXIMUM INLET PRESSURE, PSIG (bar)[1]		
			Nylon (PA) Disk	Nitrile (NBR) Disk	Fluorocarbon (FKM) Disk
627 and 627M[3]	5[2] to 20 psig (0,34 to 1,4 bar) 10B3076X012 Yellow	3/32 (2,4) 1/8 (3,2) 3/16 (4,8) 1/4 (6,4) 3/8 (9,5) 1/2 (13)	2000 (138) 1000 (69,0) 750 (51,7) 500 (34,5) 300 (20,7) 250 (17,2)	1000 (69,0) 1000 (69,0) 750 (51,7) 500 (34,5) 300 (20,7) 250 (17,2)	300 (20,7) 300 (20,7) 300 (20,7) 300 (20,7) 300 (20,7) 250 (17,2)
	15 to 40 psig (1,0 to 2,8 bar) 10B3077X012 Green	3/32 (2,4) 1/8 (3,2) 3/16 (4,8) 1/4 (6,4) 3/8 (9,5) 1/2 (13)	2000 (138) 1500 (103) 1000 (69,0) 750 (51,7) 500 (34,5) 300 (20,7)	1000 (69,0) 1000 (69,0) 1000 (69,0) 750 (51,7) 500 (34,5) 300 (20,7)	300 (20,7) 300 (20,7) 300 (20,7) 300 (20,7) 300 (20,7) 300 (20,7)
	35 to 80 psig (2,4 to 5,5 bar) 10B3078X012 Blue	3/32 (2,4) 1/8 (3,2) 3/16 (4,8) 1/4 (6,4) 3/8 (9,5) 1/2 (13)	2000 (138) 2000 (138) 1750 (121) 1500 (103) 1000 (69,0) 750 (51,7)	1000 (69,0) 1000 (69,0) 1000 (69,0) 1000 (69,0) 1000 (69,0) 750 (51,7)	300 (20,7) 300 (20,7) 300 (20,7) 300 (20,7) 300 (20,7) 300 (20,7)
	70 to 150 psig (4,8 to 10,3 bar) 10B3079X012 Red	3/32 (2,4) 1/8 (3,2) 3/16 (4,8) 1/4 (6,4) 3/8 (9,5) 1/2 (13)	2000 (138) 2000 (138) 2000 (138) 1750 (121) 1250 (86,2) 750 (51,7)	1000 (69,0) 1000 (69,0) 1000 (69,0) 1000 (69,0) 1000 (69,0) 750 (51,7)	300 (20,7) 300 (20,7) 300 (20,7) 300 (20,7) 300 (20,7) 300 (20,7)
627R and 627MR	5[2] to 20 psig (0,34 to 1,4 bar) 10B3076X012 Yellow	3/32 (2,4) 1/8 (3,2) 3/16 (4,8) 1/4 (6,4) 3/8 (9,5) 1/2 (13)	2000 (138) 1000 (69,0) 750 (51,7) 500 (34,5) 300 (20,7) 200 (13,8)	1000 (69,0) 1000 (69,0) 750 (51,7) 500 (34,5) 300 (20,7) 200 (13,8)	300 (20,7) 300 (20,7) 300 (20,7) 300 (20,7) 300 (20,7) 200 (13,8)
	15 to 40 psig (1,0 to 2,8 bar) 10B3077X012 Green	3/32 (2,4) 1/8 (3,2) 3/16 (4,8) 1/4 (6,4) 3/8 (9,5) 1/2 (13)	2000 (138) 1500 (103) 1000 (69,0) 750 (51,7) 300 (20,7) 200 (13,8)	1000 (69,0) 1000 (69,0) 1000 (69,0) 750 (51,7) 300 (20,7) 200 (13,8)	300 (20,7) 300 (20,7) 300 (20,7) 300 (20,7) 300 (20,7) 200 (13,8)
	35 to 80 psig (2,4 to 5,5 bar) 10B3078X012 Blue	3/32 (2,4) 1/8 (3,2) 3/16 (4,8) 1/4 (6,4) 3/8 (9,5) 1/2 (13)	2000 (138) 1750 (121) 1000 (69,0) 750 (51,7) 300 (20,7) 200 (13,8)	1000 (69,0) 1000 (69,0) 1000 (69,0) 750 (51,7) 300 (20,7) 200 (13,8)	300 (20,7) 300 (20,7) 300 (20,7) 300 (20,7) 300 (20,7) 200 (13,8)
	70 to 150 psig (4,8 to 10,3 bar) 10B3079X012 Red	3/32 (2,4) 1/8 (3,2) 3/16 (4,8) 1/4 (6,4) 3/8 (9,5) 1/2 (13)	2000 (138) 1000 (69,0) 500 (34,5) 300 (20,7) 200 (13,8) 200 (13,8)	1000 (69,0) 1000 (69,0) 500 (34,5) 300 (20,7) 200 (13,8) 200 (13,8)	300 (20,7) 300 (20,7) 300 (20,7) 300 (20,7) 200 (13,8) 200 (13,8)
627LR	15 to 40 psig (1,0 to 2,8 bar) 10B3077X012 Green	3/32 (2,4) 1/8 (3,2) 3/16 (4,8) 1/4 (6,4)		1000 (69,0) 1000 (69,0) 750 (51,7) 500 (34,5)	300 (20,7) 300 (20,7) 300 (20,7) 300 (20,7)
627H and 627HM[3]	140 to 250 psig (9,7 to 17,2 bar) 10B3078X012 Blue	3/32 (2,4) 1/8 (3,2) 3/16 (4,8) 1/4 (6,4) 3/8 (9,5) 1/2 (13)	2000 (138) 2000 (138) 1750 (121) 1500 (103) 1000 (69,0) 750 (51,7)	1000 (69,0) 1000 (69,0) 1000 (69,0) 1000 (69,0) 300 (20,7) 200 (13,8)	
	240 to 500 psig (16,5 to 34,5 bar) 10B3079X012 Red	3/32 (2,4) 1/8 (3,2) 3/16 (4,8) 1/4 (6,4) 3/8 (9,5) 1/2 (13)	2000 (138) 2000 (138) 1750 (121) 1500 (103) 1000 (69,0) 750 (51,7)	1000 (69,0) 1000 (69,0) 1000 (69,0) 1000 (69,0) 1000 (69,0) 750 (51,7)	

1. For inlet pressure in excess of 1000 psig (69,0 bar), refer to the maximum body and disk pressure ratings in the Specifications section.
2. For pressure settings under 10 psig (0,69 bar), inlet pressure should be limited to approximately 100 psig (6,9 bar) so the setpoint adjustment can be obtained.
3. The unbalance forces change from the wide-open monitor mode to an active regulator mode such that the Type 627M or 627HM should have a 3/8-inch (9,5 mm) or larger orifice.

▭ - Shaded areas indicate that Fluorocarbon (FKM) and Nylon (PA) disk material are not available.

Table 2. *Maximum Spring and Diaphragm Casing Pressure*[1]

MAXIMUM PRESSURE DESCRIPTION	DIAPHRAGM CASING MATERIAL	TYPE 627, PSIG (bar)	TYPE 627R AND 627LR, PSIG (bar)	TYPE 627M, PSIG (bar)	TYPE 627MR, PSIG (bar)	TYPES 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
	Ductile iron			250 (17,2)		
	Steel, Stainless steel				250 (17,2)	800 (55,2)
Maximum pressure to spring and diaphragm casings to prevent burst of casings during abnormal operation (leak to atmosphere and internal parts damage may occur)	Die cast aluminum	375 (25,9)	375 (25,9)	Not Available	Not Available	Not Available
	Ductile iron	465 (32,1)	465 (32,1)	465 (32,1)	465 (32,1)	
	Steel, Stainless steel	1500 (103)	1500 (103)	1500 (103)	1500 (103)	1500 (103)
Maximum diaphragm casing overpressure (above setpoint) to prevent damage to internal parts	All materials	60 (4,1)	120 (8,3)	60 (4,1)	120 (8,27)	120 (8,27)

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

For extra protection, should failure conditions exist which would prevent normal operation of the regulator (for example, disk broken off or disk erosion), the pusher post contacts the lever retainer causing the relief valve assembly to open. Since the diaphragm continues to rise as downstream pressure builds, it opens the relief valve; thereby, opening the valve. This internal relief may be adequate for the application.

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

Installation

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

Note

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

Perform steps 1 through 6 for all types of regulators:

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

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 and Spring 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.

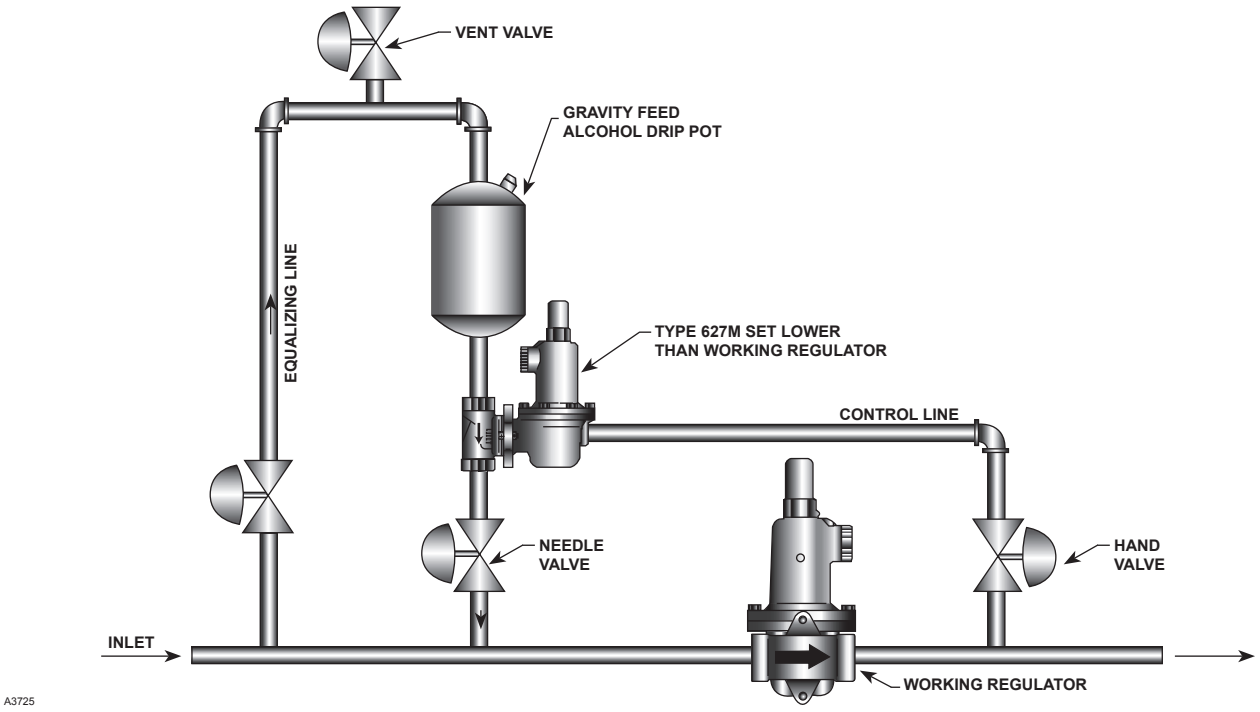


Figure 3. *De-Icer System Operational Schematic*

8. Ensure that the downstream control line piping is at least 3/8-inch (9,5 mm) or larger outside diameter tubing and connected to a straight section of outlet piping 10 diameters downstream of the regulator.
9. A hand valve should be installed in the control line. This hand valve can be used to throttle down and dampen outlet pulsations in control pressure which may cause instability or cycling of the regulator.

Remote Vent Line Installation

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

Protect the remote vent opening against entrance of rain, snow, or any other foreign material that may plug the vent or vent line and prevent proper operation of the regulator. Periodically check the vent opening to be sure it is not plugged with foreign debris.

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

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

Overpressure Protection

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

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

Table 3. *Type 627R Internal Relief Performance*[1]

OUTLET PRESSURE RANGE, SPRING PART NUMBER, AND COLOR CODE	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 (13)
5[3] to 20 psig (0,34 to 1,4 bar) 10B3076X012 Yellow	10 (0,69)	60 (4,1)	1250 (86,2)	740 (51,0)	320 (22,1)	190 (13,1)	95 (6,6)	75 (5,2)
		100 (6,9)	2000 (138)	1500 (103)	620 (42,7)	390 (26,9)	180 (12,4)	130 (9,0)
		125 (8,6)	2000 (138)	1900 (131)	830 (57,2)	480 (33,1)	220 (15,2)	160 (11,0)
		175 (12,1)	2000 (138)	2000 (138)	1100 (75,8)	670 (46,2)	320 (22,1)	220 (15,2)
		200 (13,8)	2000 (138)	2000 (138)	1300 (89,6)	770 (53,1)	360 (24,8)	260 (17,9)
		250 (17,2)	2000 (138)	2000 (138)	1600 (110)	960 (66,2)	450 (31,0)	320 (22,1)
	15 (1,0)	60 (4,1)	1000 (69,0)	620 (42,7)	260 (17,9)	170 (11,7)	90 (6,2)	70 (4,8)
		100 (6,9)	2000 (138)	1400 (96,5)	610 (42,1)	370 (25,5)	170 (11,7)	130 (9,0)
		125 (8,6)	2000 (138)	1900 (131)	810 (55,8)	480 (33,1)	220 (15,2)	160 (11,0)
		175 (12,1)	2000 (138)	2000 (138)	1100 (75,8)	670 (46,2)	320 (22,1)	220 (15,2)
		200 (13,8)	2000 (138)	2000 (138)	1300 (89,6)	770 (53,1)	360 (24,8)	260 (17,9)
		250 (17,2)	2000 (138)	2000 (138)	1600 (110)	960 (66,2)	450 (31,0)	320 (22,1)
	20 (1,4)	60 (4,1)	850 (58,6)	490 (33,8)	210 (14,5)	130 (9,0)	80 (5,5)	65 (4,5)
		100 (6,9)	2000 (138)	1300 (89,6)	600 (41,4)	360 (24,8)	170 (11,7)	120 (8,3)
		125 (8,6)	2000 (138)	1800 (124)	800 (55,2)	480 (33,1)	220 (15,2)	160 (11,0)
		175 (12,1)	2000 (138)	2000 (138)	1100 (75,8)	670 (46,2)	320 (22,1)	220 (15,2)
		200 (13,8)	2000 (138)	2000 (138)	1300 (89,6)	770 (53,1)	360 (24,8)	260 (17,9)
		250 (17,2)	2000 (138)	2000 (138)	1600 (110)	960 (66,2)	450 (31,0)	320 (22,1)
15 to 40 psig (1,0 to 2,8 bar) 10B3077X012 Green	15 (1,0)	60 (4,1)	1000 (69,0)	380 (26,2)	210 (14,5)	130 (9,0)	80 (5,5)	65 (4,5)
		100 (6,9)	2000 (138)	1300 (89,6)	590 (40,7)	350 (24,1)	170 (11,7)	120 (8,3)
		125 (8,6)	2000 (138)	1800 (124)	800 (55,2)	470 (32,4)	220 (15,2)	160 (11,0)
		175 (12,1)	2000 (138)	2000 (138)	1100 (75,8)	640 (44,1)	320 (22,1)	220 (15,2)
		200 (13,8)	2000 (138)	2000 (138)	1300 (89,6)	780 (53,8)	370 (25,5)	260 (17,9)
		250 (17,2)	2000 (138)	2000 (138)	1600 (66,2)	960 (66,2)	450 (31,0)	320 (22,1)
	20 (1,4)	60 (4,1)	630 (43,4)	200 (13,8)	150 (10,3)	100 (6,9)	70 (4,8)	65 (4,5)
		100 (6,9)	2000 (138)	1200 (82,7)	550 (37,9)	330 (22,8)	160 (11,0)	120 (8,3)
		125 (8,6)	2000 (138)	1700 (117)	760 (52,4)	450 (31,1)	210 (14,5)	160 (11,0)
		175 (12,1)	2000 (138)	2000 (138)	1100 (75,8)	630 (43,4)	320 (22,1)	220 (15,2)
		200 (13,8)	2000 (138)	2000 (138)	1300 (89,6)	770 (53,1)	360 (24,8)	260 (17,9)
		250 (17,2)	2000 (138)	2000 (138)	1600 (66,2)	960 (66,2)	460 (31,7)	320 (22,1)
	30 (2,1)	100 (6,9)	2000 (138)	950 (65,5)	450 (31,1)	260 (17,9)	140 (9,7)	110 (7,6)
		125 (8,6)	2000 (138)	1500 (103)	670 (46,2)	400 (27,6)	190 (13,1)	150 (10,3)
		175 (12,1)	2000 (138)	2000 (138)	1000 (69,0)	610 (42,1)	300 (20,7)	220 (15,2)
		200 (13,8)	2000 (138)	2000 (138)	1200 (82,7)	760 (52,4)	360 (24,8)	260 (17,9)
		250 (17,2)	2000 (138)	2000 (138)	1600 (110)	970 (66,9)	460 (31,7)	320 (22,1)
	40 (2,8)	100 (6,9)	1500 (103)	700 (48,3)	330 (22,8)	200 (13,8)	120 (8,3)	108 (7,4)
		125 (8,6)	2000 (138)	1300 (89,6)	560 (38,6)	340 (23,4)	180 (12,4)	140 (9,7)
		175 (12,1)	2000 (138)	1800 (124)	1000 (69,0)	550 (37,9)	290 (20,0)	220 (15,2)
		200 (13,8)	2000 (138)	2000 (138)	1200 (82,7)	730 (50,3)	350 (24,1)	250 (17,2)
		250 (17,2)	2000 (138)	2000 (138)	1600 (110)	970 (66,9)	460 (31,7)	320 (22,1)

1. The internal relief performance values are obtained by removing the disk assembly.
2. For inlet pressures in excess of 1000 psig (69,0 bar), refer to the maximum body and disk pressure ratings in the Specifications section.
3. For pressure settings under 10 psig (0,69 bar), inlet pressure should be limited to approximately 100 psig (6,9 bar) so the setpoint adjustment can be obtained.

▭ - Shaded areas indicate maximum inlet pressures allowed during system malfunction only. Table 1 gives the maximum inlet pressure for normal regulator operation.

- continued -

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.

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

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

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

OUTLET PRESSURE RANGE, SPRING PART NUMBER, AND COLOR CODE	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][3]					
			Orifice Size, Inches (mm)					
			3/32 (2,4)	1/8 (3,2)	3/16 (4,8)	1/4 (6,4)	3/8 (9,5)	1/2 (13)
35 to 80 psig (2,4 to 5,5 bar) 10B3078X012 Blue	40 (2,8)	125 (8,6)	2000 (138)	1100 (75,8)	500 (34,5)	300 (20,7)	170 (11,7)	140 (9,7)
		150 (10,3)	2000 (138)	1600 (110)	750 (51,7)	440 (30,3)	230 (15,9)	180 (12,4)
		175 (12,1)	2000 (138)	2000 (138)	980 (67,6)	580 (40,0)	290 (20,0)	220 (15,2)
		200 (13,8)	2000 (138)	2000 (138)	1200 (82,7)	720 (49,6)	340 (23,4)	250 (17,2)
		250 (17,2)	2000 (138)	2000 (138)	1600 (110)	940 (64,8)	450 (31,0)	320 (22,1)
	50 (3,4)	125 (8,6)	1400 (96,5)	820 (56,5)	400 (27,6)	230 (15,9)	150 (10,3)	140 (9,7)
		150 (10,3)	2000 (138)	1400 (96,5)	650 (44,8)	370 (25,5)	210 (14,5)	170 (11,7)
		175 (12,1)	2000 (138)	1900 (131)	700 (48,3)	530 (36,5)	270 (18,6)	210 (14,5)
		200 (13,8)	2000 (138)	2000 (138)	1100 (75,8)	670 (46,2)	330 (22,8)	240 (16,5)
		250 (17,2)	2000 (138)	2000 (138)	1500 (103)	920 (63,4)	430 (29,6)	320 (22,1)
	60 (4,1)	125 (8,6)	900 (62,1)	450 (31,0)	270 (18,6)	190 (13,1)	140 (9,7)	130 (9,0)
		150 (10,3)	1700 (117)	1100 (75,8)	540 (37,2)	300 (20,7)	190 (13,1)	160 (11,0)
		175 (12,1)	2000 (138)	1700 (117)	780 (53,8)	470 (32,4)	250 (17,2)	200 (13,8)
		200 (13,8)	2000 (138)	2000 (138)	1000 (69,0)	610 (42,1)	310 (21,4)	230 (15,9)
		250 (17,2)	2000 (138)	2000 (138)	1400 (96,5)	880 (60,7)	420 (29,0)	310 (21,4)
	70 (4,8)	150 (10,3)	1200 (82,7)	850 (58,6)	430 (29,6)	250 (17,2)	170 (11,7)	160 (11,0)
		175 (12,1)	2000 (138)	1400 (96,5)	670 (46,2)	400 (27,6)	230 (15,9)	190 (13,1)
		200 (13,8)	2000 (138)	2000 (138)	920 (63,4)	550 (37,9)	280 (19,3)	230 (15,9)
		250 (17,2)	2000 (138)	2000 (138)	1300 (89,6)	830 (57,2)	400 (27,6)	310 (21,4)
	80 (5,5)	150 (10,3)	800 (55,2)	500 (34,5)	300 (20,7)	200 (13,8)	160 (11,0)	150 (10,3)
		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)
70 to 150 psig (4,8 to 10,3 bar) 10B3079X012 Red	70 (4,8)	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)
		250 (17,2)	2000 (138)	2000 (138)	1100 (75,8)	680 (46,9)	360 (24,8)	290 (20,0)
	80 (5,5)	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)
	100 (6,9)	200 (13,8)	1500 (103)	250 (17,2)	240 (16,5)	230 (15,9)	210 (14,5)	210 (14,5)
		250 (17,2)	2000 (138)	1600 (110)	770 (53,1)	520 (35,9)	320 (22,1)	270 (18,6)
	125 (8,6)	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)	1200 (82,7)	260 (17,9)	260 (17,9)	260 (17,9)	260 (17,9)	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 (69,0 bar), refer to the maximum body and disk pressure ratings in the Specifications section.
3. For pressure settings under 10 psig (0,69 bar), inlet pressure should be limited to approximately 100 psig (6,9 bar) so the setpoint adjustment can be obtained.

▭ - Shaded areas indicate maximum inlet pressures allowed during system malfunction only. Table 1 gives the maximum inlet pressure for normal regulator operation.

Table 4. *Type 627LR Internal Relief Performance[1]*

OUTLET PRESSURE RANGE, SPRING PART NUMBER, AND COLOR CODE	OUTLET PRESSURE SETTING, 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)
15 to 40 Psig (1,03 to 2,8 bar) 10B3077X012 Green	30 (2,1)	55 (3,8)	500 (34,4)	270 (18,6)	110 (7,6)	80 (5,5)
		60 (4,1)	850 (58,6)	480 (33,0)	200 (13,8)	120 (8,3)
		66 (4,5)	1000 (69,0)	660 (45,5)	290 (20,0)	175 (12,0)
	40 (2,8)	66 (4,5)	380 (26,2)	190 (13,1)	85 (5,9)	80 (5,5)
		70 (4,8)	700 (48,2)	370 (25,5)	150 (10,3)	115 (7,9)
		75 (5,1)	1000 (69,0)	560 (38,6)	240 (16,4)	160 (11,0)

1. The internal relief performance values are obtained by removing the disk assembly.
2. For inlet pressures in excess of 1000 psig (69,0 bar), refer to the maximum body and disk pressure ratings in the Specifications section.

Table 5. *Flow Coefficients*

ORIFICE, INCH (mm)	3/4 NPT			NPS 1 (DN 25) BODY			NPS 2 (DN 50) BODY		
	Wide-Open C_g for External Relief Sizing	Wide-Open C_v for External Relief Sizing	C_1	Wide-Open C_g for External Relief Sizing	Wide-Open C_v for External Relief Sizing	C_1	Wide-Open C_g for External Relief Sizing	Wide-Open C_v for External Relief Sizing	C_1
3/32 (2,4)	6.9	0.24	29.2	6.9	0.24	28.5	6.9	0.23	29.7
1/8 (3,2)	12.5	0.43	29.1	12.5	0.43	29.4	12.5	0.42	29.5
3/16 (4,8)	29	1.01	28.6	29	0.93	31.2	29	1.02	28.5
1/4 (6,4)	50	1.63	30.6	50	1.71	29.3	52	1.66	31.3
3/8 (9,5)	108	2.99	36.1	108	3.42	31.6	115	3.39	33.9
1/2 (13)	190	4.87	39.0	190	5.29	35.9	200	5.01	39.9

Table 6. *IEC Sizing Coefficients*

ORIFICE SIZE, INCH (mm)	X_T			F_D	F_L
	3/4 NPT Body	NPS 1 (DN 25) Body	NPS 2 (DN 50) Body		
3/32 (2,4)	0.539	0.514	0.558	0.50	0.85
1/8 (3,2)	0.536	0.547	0.539		0.79
3/16 (4,8)	0.517	0.616	0.514		0.85
1/4 (6,4)	0.592	0.543	0.620		0.87
3/8 (9,5)	0.824	0.632	0.727		0.89
1/2 (13)	0.962	0.815	1.01		0.86

Table 7. *Maximum Torque Values*

KEY NUMBER(1)	DESCRIPTION	MAXIMUM TORQUE, FOOT-POUNDS (N•m)
2	Orifice	25 (34)
3	Cap screw (with aluminum diaphragm casing)	16 (22)
	Cap screw (with ductile iron or steel/stainless steel diaphragm casing)	25 (34)
18	Lever cap screw	7 (9,5)
22	Diaphragm connector nut	17 (23)
26	Guide retainer (for Types 627R, 627LR, and 627MR only)	3 (4,1)
37	Spring case cap screw (with aluminum or ductile iron diaphragm casing)	7 (9,5)
	Spring case cap screw (with steel/stainless steel diaphragm casing)	35 (47)
46	Diaphragm cap screw (with Type 627 or 627M)	7 (9,5)
	Diaphragm cap screw (with Type 627H or 627HM)	14 (19)

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

Adjustment

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

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

Note

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

Refer to Figures 7 through 13 for key number locations.

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

Shutdown

WARNING

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

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

Maintenance

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

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

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

WARNING

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

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

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

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

Body Area Maintenance Procedures

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



Figure 4. *Relief Indicator*

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

Replacing the Disk Assembly or Orifice

1. To inspect and replace the disk assembly (key 9) or orifice (key 2), remove the cap screws (key 3, Figure 5), and separate the diaphragm casing (key 5) from the body (key 1).
2. Inspect and, if necessary, remove the orifice (key 2). If removed, coat the threads of the replacement orifice with lubricant and torque to 25 foot-pounds (34 N•m).
3. Inspect the disk assembly and, if necessary, remove the hair pin clip (key 13) that holds the disk assembly (key 9) in place. If replacing the disk assembly is the only maintenance required, skip to step 16.

Replacing the Stem Assembly

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

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

4. Use steps 5 through 8 to remove and replace the stem assembly.
5. Remove the boost body (key 6), stabilizer (key 7), and stem guide (key 8) from the diaphragm casing (key 5). Unhook and remove the stem (key 10) from the diaphragm casing (key 5).

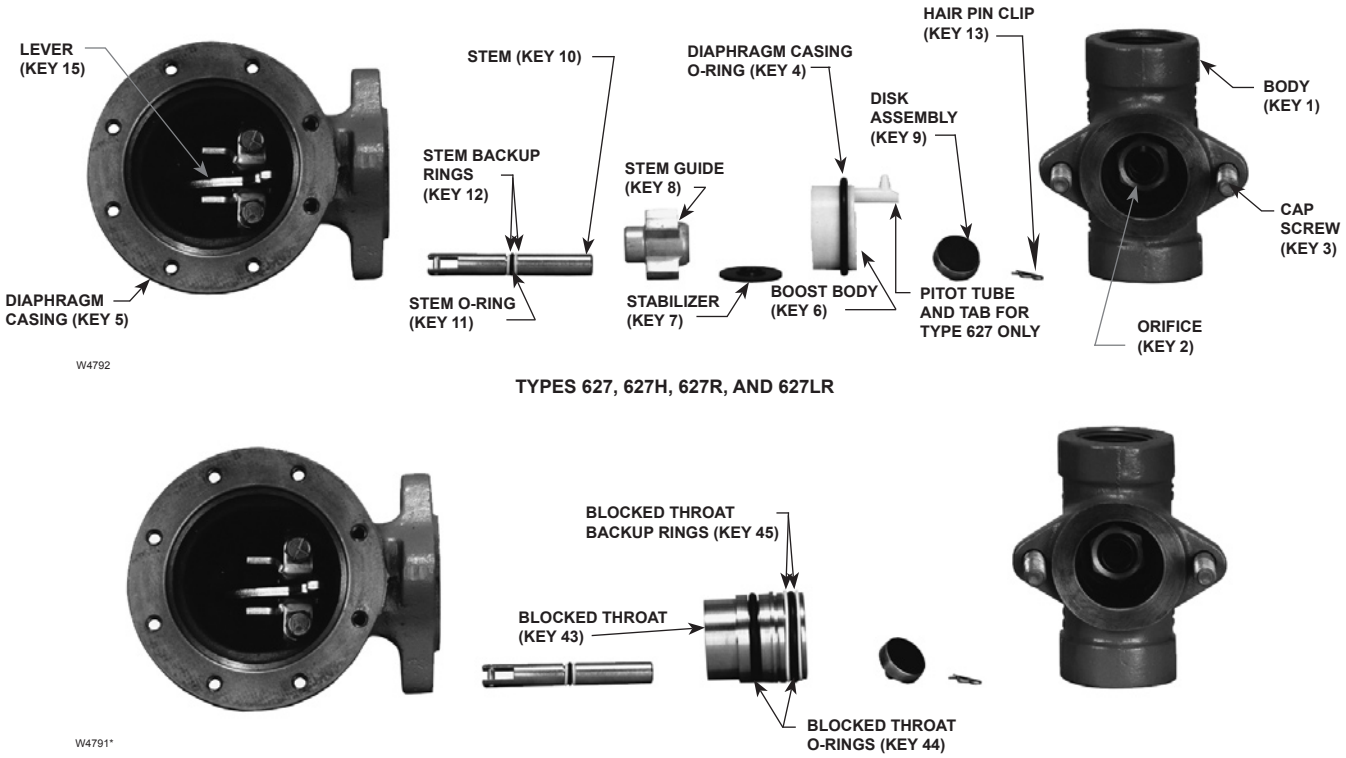


Figure 5. *Stem Assemblies*

6. Remove and inspect the diaphragm casing O-ring (key 4, Figure 7, 8, 9, or 12) and replace it if necessary.
7. Apply lubricant to a replacement diaphragm casing O-ring (key 4, Figure 7, 8, 9, or 12) and install it onto the boost body (key 6). Skip to step 14.
8. For the Type 627 or 627H regulators, be sure to insert the pitot tube (tab) into the outlet side of the body (see Figure 7 or 12). Skip to step 14.

Perform steps 9 through 19 for Types 627M, 627HM, and 627MR Regulators only:

9. Use steps 10 through 14 to remove and replace the stem assembly.
10. To remove the blocked throat (key 43), insert a screw driver blade into the groove provided in the throat and pry it out of the diaphragm casing (key 5). Inspect and replace parts as necessary.
11. Inspect and, if necessary, replace the blocked throat O-rings (key 44, Figure 5) and back-up rings (key 45, Figure 5).
12. Apply lubricant to replacement blocked throat O-rings (key 44) and back-up rings (key 45).
13. Apply lubricant to the replacement stem O-ring (key 11) and stem back-up rings (key 12) and install them on the stem (key 10).
14. For assembly, lubricate the stem (key 10) and insert the diaphragm casing (key 5) and hook it on the lever (key 15).
15. Lubricate the contact points of the lever (key 15).
16. Insert parts into the diaphragm casing (key 5) that were removed in steps 5 and 6 or step 10 (see Figure 5).
17. Install the disk assembly (key 9), line up the hole in the disk assembly and stem (key 10) and insert the hair pin clip (key 13).
18. Position the diaphragm casing plus attached parts in relation to the body (key 1) so that they are correct for the application.
19. 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).

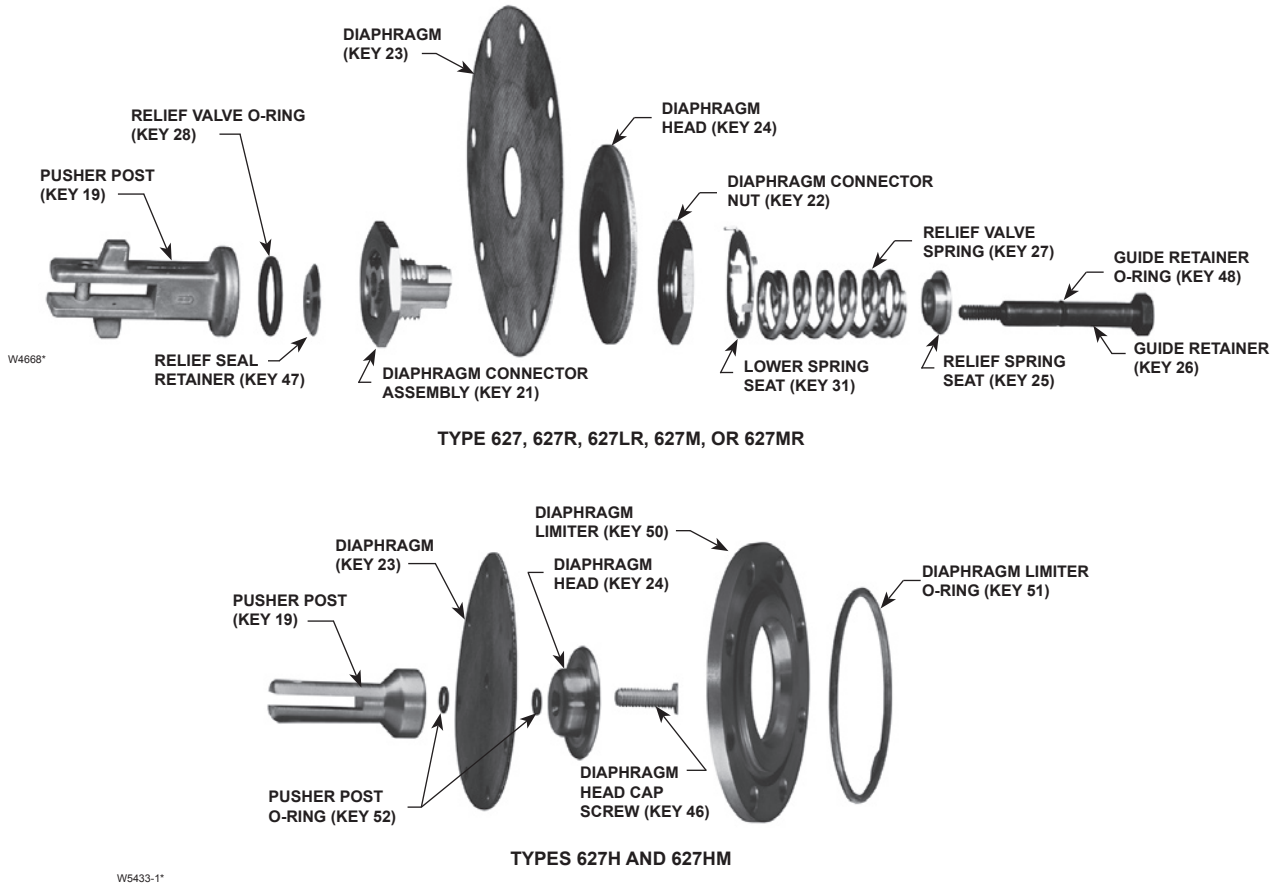


Figure 6. *Diaphragm Assemblies*

20. It may be necessary to reposition the diaphragm spring case to prevent rain, ice, and foreign debris from entering the spring case. Refer to the Diaphragm and Spring Case Area Maintenance Procedures, steps 1, 2, and 21 through 25.

Diaphragm and Spring Case Area Maintenance Procedures

These procedures are for gaining access to the control spring, diaphragm assembly, and lever assembly. All spring pressure must be released from the diaphragm casing before these steps can be performed.

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

1. Remove the adjusting screw cap (key 36), loosen the lock nut, and turn the adjusting screw (key 35) counterclockwise until all compression is removed from the control spring (key 32).
2. Remove the spring case cap screws (key 37), the nameplates, and lift off the spring case (key 29). If changing the control spring (key 32) or repositioning the spring case (key 29) is the only maintenance required, install the replacement control spring or rotate the spring case so it is correct for the application. Skip to step 21. For diaphragm area maintenance, continue with step 3.
3. Remove the diaphragm limiter O-ring and diaphragm limiter (keys 51 and 50, on the Type 627H or 627HM only). Remove the diaphragm assembly by tilting it so that the pusher post (key 19) slips off the lever (key 15).
4. If it is necessary to replace the lever assembly, remove the lever cap screws (key 18).
5. Install the replacement lever (key 15) into the lever retainer (key 16) by inserting the lever pin (key 17). Secure the lever assembly into the diaphragm casing with the cap screws (key 18) and torque the cap screws to 7 foot-pounds (9,5 N•m).

   If it is necessary to perform maintenance on the diaphragm assembly, continue with steps 6 through 11 and step 20 for Types 627, 627H, 627M, and 627HM regulators, or steps 12 through 19 for Types 627R, 627LR, and 627MR regulators.

Perform steps 6 through 11 for Types 627, 627H, 627M, and 627HM Regulators only:

6. For Types 627, 627H, 627M, and 627HM regulators (Figures 5 and 6), use steps 7 through 11 to disassemble and reassemble the diaphragm assembly.
7. Remove the diaphragm head cap screw (key 46), lower spring seat (key 31, Type 627 or 627M only), and diaphragm head (key 24). On the Type 627H or 627HM, remove the pusher post O-rings (key 52). Separate the diaphragm (key 23) from the pusher post (key 19).
8. Install the diaphragm (key 23), in reverse order in step 7, on the pusher post (key 19), insert and finger tighten the diaphragm head cap screw (key 46).
9. Hook the pusher post on the lever (key 15), then turn the diaphragm (key 23) to match the holes in the diaphragm with the holes in the spring casing.
10. Unhook the pusher post from the lever and torque the diaphragm head cap screw (key 46) to 7 foot-pounds (9,5 N•m) for the Type 627 or 627M. On the Type 627H or 627HM, torque the diaphragm head cap screw to 14 foot-pounds (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.

Perform steps 12 through 19 for Types 627R, 627LR, and 627MR Regulators only:

12. For Types 627R, 627LR, and 627MR regulators (Figure 6), use steps 13 through 19 to disassemble and reassemble the diaphragm assembly.
13. Remove the guide retainer (key 26) and separate the diaphragm parts. Refer to Figure 6 for the sequence of parts.
14. To remove the diaphragm (key 23), remove the diaphragm connector nut (key 22) and lift off the diaphragm head (key 24) and diaphragm (key 23) from the connector assembly (key 21). Do not attempt to disassemble the connector assembly (key 21).
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 apply lubricant. Also, install the relief seal retainer (key 47), diaphragm connector assembly (key 21, with attached parts) relief spring (key 27), upper relief spring seat (key 33), and guide retainer (key 26). Torque the guide retainer (key 26) to 3 foot-pounds (4,1 N•m).
18. Hook the pusher post (with attached parts) on the lever (key 15) to check the alignment of the holes in the diaphragm with the holes in the spring casing. If the holes do not line up, unhook the pusher post from the lever, hold the pusher post, and rotate the diaphragm to the correct position.
19. Install the lower spring seat (key 31) over the relief spring so it rests flat on the connector nut (key 22).
20. Insert the diaphragm assembly into the diaphragm casing (key 5) and hook the pusher post on the lever (key 15).
21. Install the control spring (key 32) and upper spring seat (key 33), and apply lubricant to the upper spring seat (key 33).
22. Install the spring case (key 29) so that the screened vent assembly (key 30) is in the correct position for the application. Place the nameplates over the screw holes, insert the spring case cap screws (key 37), and finger tighten.
23. Screw in the 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 (9,5 N•m) of torque.
25. If necessary, refer to the installation and/or the Startup and Adjustment procedures.
26. Install the adjusting locknut (key 34) after regulator adjustment.

Parts Ordering

When corresponding with your local Sales Office about this equipment, always reference the equipment serial number or FS number that can be found on the nameplate.

When ordering replacement parts, reference the key number of each needed part as found in the following parts list. Separate kits containing all recommended spare parts are available.

Parts List

Note

In this parts list, parts marked NACE are intended for corrosion-resistant service as detailed in the NACE International Standard MR0175.

Key	Description	Part Number
	Type 627 Parts Kit with Aluminum/Nitrile (NBR) trim (includes keys 4, 9, 11, 12, and 23)	R627X000A12
	Type 627 Parts Kit with Stainless steel/ Nitrile (NBR) trim (includes keys 4, 9, 11, 12, and 23)	R627X000S12
	Type 627H Parts Kit with SST/Nylon (PA) trim	R627HX00S12
	Type 627R Parts Kit with Aluminum/ Nitrile (NBR) trim (includes keys 4, 9, 11, 12, 23, 28, and 48)	R627RX00A12
	Type 627R Parts Kit with Stainless steel/ Nitrile (NBR) trim (includes keys 4, 9, 11, 12, 23, 28, and 48)	R627RX00S12
1	Body	
	Ductile iron	
	1000 psig (69,0 bar) maximum inlet pressure	
	3/4 NPT	30B3046X012
	1 NPT	30B3048X012
	2 NPT	30B3096X012
	Ductile iron (NACE)	
	1000 psig (69,0 bar) maximum inlet pressure	
	1 NPT	39B2451X012
	2 NPT	39B0414X012
	Steel	
	2000 psig (138 bar) maximum inlet pressure	
	3/4 NPT	30B3050X012
	1 NPT	30B3051X012
	2 NPT	30B7452X012
	Steel (NACE)	
	2000 psig (138 bar) maximum inlet pressure	
	1 NPT	39B0412X012
	2 NPT	39B0415X012
	Steel, CL600 RF flanged	
	1500 psig (103 bar) maximum inlet pressure	
	NPS 1 (DN 25)	40B6754X012
	NPS 2 (DN 50)	40B6756X012
	Steel, CL300 RF flanged	
	750 psig (51,7 bar) maximum inlet pressure	
	NPS 1 (DN 25)	41B8978X012
	NPS 2 (DN 50)	41B8080X012
	Steel, CL150 RF flanged	
	290 psig (20,0 bar) maximum inlet pressure	
	NPS 1 (DN 25)	43B8656X022
	NPS 2 (DN 50)	44B0666X012
	Steel, BWE	
	1000 psig (69,0 bar) maximum inlet pressure	
	NPS 1 (DN 25)	33B6723X012
	NPS 2 (DN 50)	38B1688X012
	Steel, PN 16/25/40 RF	
	580 psig (40,0 bar) maximum inlet pressure	
	NPS 1 (DN 25)	44B0386X012
	NPS 2 (DN 50)	44B3342X012
1	Body (continued)	
	Stainless Steel†, NPT	
	2000 psig (138 bar) maximum inlet pressure	
	3/4 NPT	30B3050X062
	1 NPT	30B3051X092
	2 NPT	30B7452X052
	Stainless Steel†, CL150 RF flanged	
	275 psig (18,9 bar) maximum inlet pressure	
	NPS 1 (DN 25)	43B8656X052
	NPS 2 (DN 50)	44B0666X022
	Stainless Steel†, CL300 RF flanged	
	720 psig (49,6 bar) maximum inlet pressure	
	NPS 1 (DN 25)	41B8978X072
	NPS 2 (DN 50)	41B8080X072
	Stainless Steel†, CL600 RF flanged	
	1440 psig (99,2 bar) maximum inlet pressure	
	NPS 1 (DN 25)	40B6754X102
	NPS 2 (DN 50)	40B6756X062
	Stainless Steel†, PN 16/25/40 RF	
	580 psig (40,0 bar) maximum inlet pressure	
	NPS 1 (DN 25)	44B0386X032
	NPS 2 (DN 50)	44B3342X032
2*	Orifice	
	Aluminum	
	3/32-inch (2,4 mm) size	0R044109022
	1/8-inch (3,2 mm) size	1A936709012
	3/16-inch (4,8 mm) size	00991209012
	1/4-inch (6,4 mm) size	0B042009012
	3/8-inch (9,5 mm) size	0B042209012
	1/2-inch (13 mm) size	1A928809012
	303 Stainless steel	
	3/32-inch (2,4 mm) size	0R044135032
	1/8-inch (3,2 mm) size	1A936735032
	3/16-inch (4,8 mm) size	00991235032
	1/4-inch (6,4 mm) size	0B042035032
	3/8-inch (9,5 mm) size	0B042235032
	1/2-inch (13 mm) size	1A928835032
	316 Stainless steel, NACE construction only	
	3/32-inch (2,4 mm) size	0R0441X0012
	1/8-inch (3,2 mm) size	1A9367X0022
	3/16-inch (4,8 mm) size	009912X0012
	1/4-inch (6,4 mm) size	0B0420X0012
	3/8-inch (9,5 mm) size	0B0422X0012
	1/2-inch (13 mm) size	1A9288X0012
3	Cap Screw (not shown), (2 required)	
	627 Series	
	For Ductile iron/Steel diaphragm case	1A560724052
	For Aluminum diaphragm case (not applicable for Types 627H and 627HM)	1A352524052
	Type 627 Only	
	For Ductile iron/Steel diaphragm case	1A5607X0052
	For Aluminum case with Steel diaphragm case	10A3869X012
	For SST Case and body	1A5607X0052
	For Aluminum Case and SST body	10A3869X022
4*	Diaphragm Case O-ring	
	Nitrile (NBR) For Type 627, 627H, or 627R only	17A2325X022
	Fluorocarbon (FKM)	
	For Types 627, 627R, and 627LR only	10A0037X012
5	Diaphragm Case	
	For Type 627, 627R, or 627LR	
	Aluminum without 1/8-inch (3,2 mm) gauge tap	40B3084X012
	Aluminum with 1/8-inch (3,2 mm) gauge tap for 627 Series (except Types 627H and 627HM)	11B5380X012
	Ductile iron without 1/8-inch (3,2 mm) gauge tap	30B3053X012
	Ductile iron with 1/8-inch (3,2 mm) gauge tap for 627 Series (except Types 627H and 627HM)	31B0641X012

*Recommended spare part.
Delrin® is a mark owned by E.I. du Pont de Nemours and Co.
† Stainless steel body material can be used for applications in temperature ranges down to -40°F (-40°C) and are only available for Types 627, 627R, and 627H.

Key	Description	Part Number
5	Diaphragm Case (continued)	
	For Type 627, 627R, or 627LR	
	Steel	30B3104X012
	Ductile iron with 1/4 NPT gauge tap for 627 Series (except Types 627H and 627HM)	39A5987X012
	Steel with 1/4 NPT gauge tap for 627 Series (except Type 627H)	30B8734X012
	For Type 627M or 627MR	
	Ductile iron	39A5987X012
	Steel	30B8734X012
	For Type 627H, Steel	30B3104X012
	For Type 627, Stainless Steel	30B3104X082
	For Type 627HM, Steel	30B8734X012
6	Boost Body (not for Type 627M, 627HM, or 627MR), Delrin®	
	For Type 627 or 627H	30B3056X012
	For Type 627R or 627LR	30B3057X012
7	Stabilizer	
	Nitrile (NBR)	
	For Types 627, 627H, 627R, and 627LR only	10B3060X012
	Fluorocarbon (FKM)	
	For Types 627, 627R, and 627LR only	10B3060X022
8	Stem Guide (for Types 627, 627H, 627R, and 627LR only), Powdered metal	20B3061X012
9*	Disk Assembly (for all Orifice Size)	
	Aluminum holder and Nitrile (NBR) disk	1C4248X0212
	303 Stainless steel holder and Nitrile (NBR) disk	1C4248X0202
	Aluminum holder and Nylon (PA) disk	1C4248X00A2
	303 Stainless steel holder and Nylon (PA) disk	1C4248X0062
	316 Stainless steel holder and Nylon (PA) disk	1C4248X0262
	316 Stainless steel holder and Nitrile (NBR) disk	1C4248X0252
	303 Stainless steel holder and Fluorocarbon (FKM) disk	1C4248X0052
	Aluminum holder and Fluorocarbon (FKM) disk	1C4248X0182
	316 Stainless steel holder and Fluorocarbon (FKM) disk	1C4248X0192
10	Stem	
	303 Stainless steel	10B3059X012
	316 Stainless steel (NACE)	10B3059X022
11*	Stem O-ring	
	Nitrile (NBR)	1D687506992
	Fluorocarbon (FKM) For Types 627, 627R, 627LR, 627M, and 627MR only	1N430406382
12*	Stem Backup Ring, Polytetrafluoroethylene (PTFE) (2 required)	1K786806992
13	Hair Pin Clip, Stainless steel	10B3058X012
14	Drive Pin, Plated steel	1H3671X0012
15	Lever, Plated steel	20B3063X012
16	Lever Retainer, Plated steel	30B3097X012
17	Lever Pin	
	Stainless steel	10B3083X012
	316 Stainless steel (NACE)	10B3083X022
18	Lever Cap Screw (2 required)	
	Plated steel	10B7454X012
	316 Stainless steel (NACE)	1B2905X0012
19	Pusher Post, Aluminum	
	For Type 627 or 627M	10B3098X012
	For Type 627R, 627LR or 627MR	10B3098X022
	For Type 627H or 627HM,	
	416 Stainless steel	10B3098X032
	Stainless steel (NACE)	10B3098X102
21	Diaphragm Connector (for Type 627R, 627LR or 627MR only), Stainless steel	28B8832X012
22	Diaphragm Connector Nut (for Type 627R, 627LR or 627MR only), Stainless steel	10B7449X012
23*	Diaphragm	
	Nitrile (NBR)	
	For Type 627 or 627M with Aluminum or Ductile iron diaphragm case	10B3069X012
	For Type 627 or 627M with Steel diaphragm case	10B8735X012
23*	Diaphragm (continued)	
	For Type 627R, 627LR, or 627MR with Aluminum or Ductile iron diaphragm case	10B3068X012
	For Type 627R, 627LR, or 627MR with Steel diaphragm case	10B8736X012
	For Type 627H or 627HM with Steel diaphragm case (diaphragm is Neoprene (CR) with Nylon (PA) fabric)	12B0178X012
	Fluorocarbon (FKM)	
	For Types 627R, 627LR, and 627MR with Steel case	10B8736X022
	For Types 627 and 627M with Steel case	10B8735X042
	For Types 627R, 627LR, and 627MR with Ductile Iron and Aluminum Casing	10B3068X022
	For Types 627 and 627M with Ductile Iron and Aluminum Casing	10B3069X032
24	Diaphragm Head, Plated steel	
	For Type 627 or 627M, Plated steel	1D666428982
	For Type 627R, 627LR or 627MR, Plated steel	10B3071X012
	For Type 627H or 627HM, 416 Stainless steel	12B0175X012
25	Relief Spring Seat (For Type 627R or 627MR only), Steel	10B7446X012
26	Guide Retainer (For Type 627R, 627LR or 627MR only), Stainless steel	10B7450X012
27	Relief Spring (For Type 627R or 627MR only),	
	Plated steel	10B6757X012
	For Type 627LR	1B541327022
28*	Relief Seal O-ring	
	Nitrile (NBR)	
	For Type 627R, 627LR, or 627MR only	1J108506992
	Fluorocarbon (FKM)	
	For Types 627R, 627LR, and 627MR only	1J1085X0042
29	Spring Case	
	For Type 627, 627R, or 627LR	
	Aluminum	40B3086X012
	Ductile iron	30B3055X012
	Steel	30B3102X012
	Stainless Steel (Types 627 and 627R only)	30B3102X092
	For Type 627M or 627MR	
	Ductile iron	30B3055X012
	Steel	30B3102X012
	For Type 627H or 627HM	
	Steel	30B3102X012
	Stainless steel (Type 627H only)	30B3102X092
30	Screened Vent Assembly, Plastic	10B3093X012
31	Lower Spring Seat, Plated steel	
	For Type 627 or 627M	1D666625072
	For Type 627R, 627LR or 627MR	20B3073X012
32	Control Spring, Plated steel	
	5 to 20 psig (0,34 to 1,4 bar), Yellow	10B3076X012
	15 to 40 psig (1,0 to 2,8 bar), Green	10B3077X012
	35 to 80 psig (2,4 to 5,5 bar), Blue	10B3078X012
	70 to 150 psig (4,8 to 10,3 bar), Red	10B3079X012
	140 to 250 psig range (9,7 to 17,2 bar), Blue, used for Type 627H or 627HM	10B3078X012
	240 to 500 psig range (16,5 to 34,5 bar), Red, used for Type 627H or 627HM	10B3079X012
33	Upper Spring Seat, Plated steel	1D667125072
34	Locknut, Plated steel	1D667728982
35	Adjusting Screw, Plated steel	
	For Type 627, 627M, 627H, or 627HM	10B3081X012
	For Type 627R, 627LR, or 627MR	10B3080X012
36	Adjusting Screw Cap, Plastic	20B3082X012
37	Spring Case Cap Screw, Plated steel (8 required)	
	For Aluminum or ductile iron diaphragm case	1A391724052
	For Steel diaphragm case	1A368324052
	For Stainless steel case and body	1A3683X0062
	For Aluminum case and SST body	1A3917X0062
	For Type 627H/HM, steel diaphragm case	1A346424052
	For Type 627H, Stainless steel case and body	1A3464X0022

*Recommended spare part.

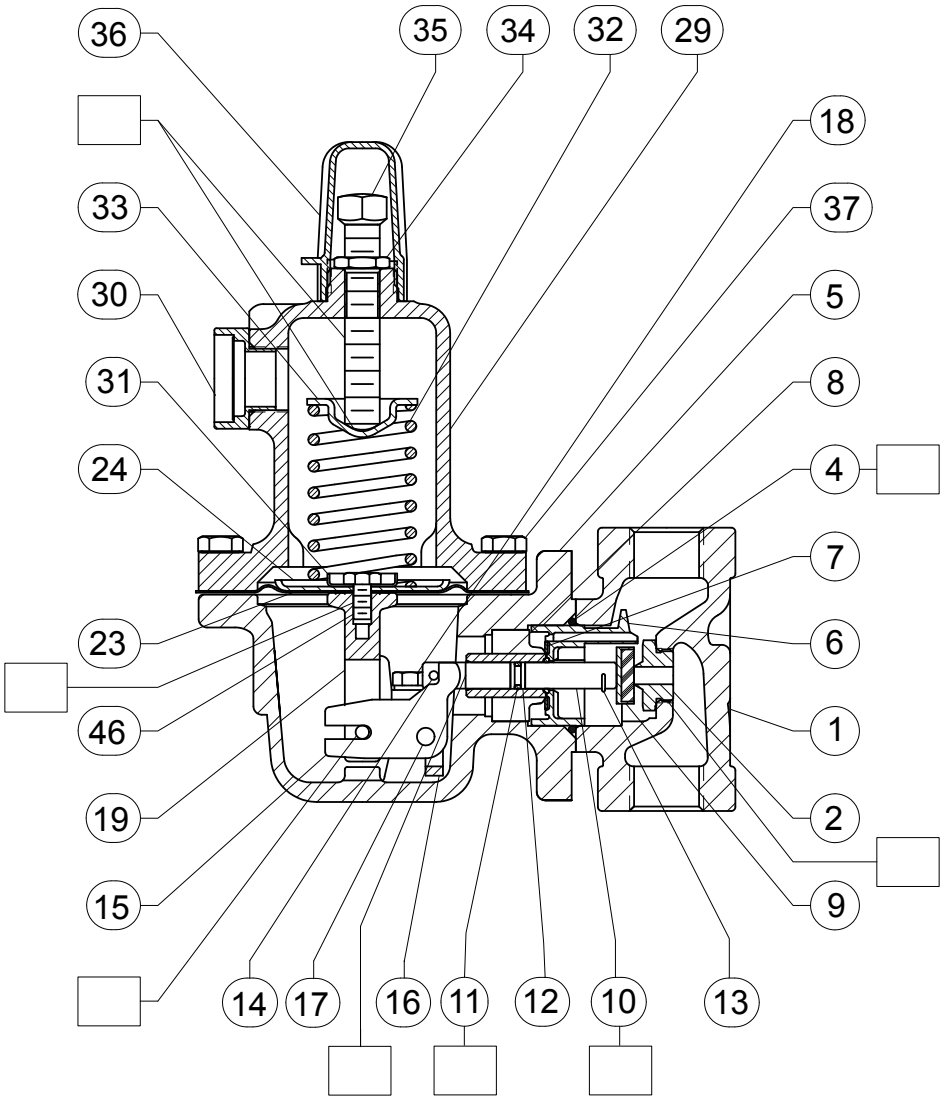
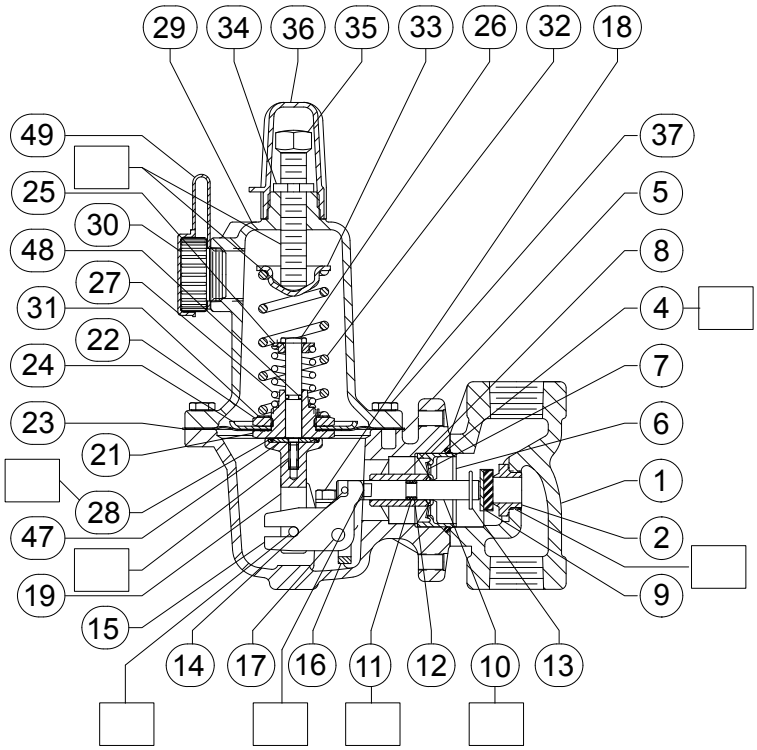


Figure 7. *Type 627 Regulator Assembly*

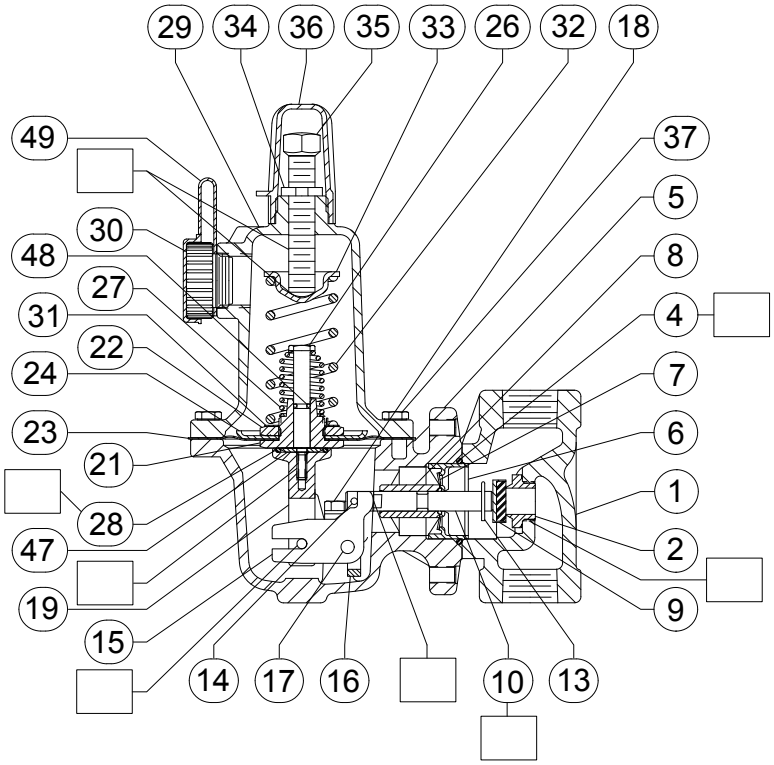
Key	Description	Part Number
43	Blocked Throat (For Type 627M, 627HM, or 627MR only), Stainless steel	10B3085X012
44*	Blocked Throat O-ring	
	Nitrile (NBR) For Type 627M, 627HM, or 627MR only (2 required)	1E264306992
	Fluorocarbon (FKM) For Types 627M and 627MR only	1E2643X0022
45*	Blocked Throat Backup Ring (For Type 627M, 627HM, or 627MR only), PTFE (2 required)	10B3106X012
46	Diaphragm Head Cap Screw, Steel	
	For Type 627 or 627M	1B290524052
	For Type 627H or 627HM	1C379124052
47	Relief Seal Retainer (For Type 627R, 627LR or 627MR only), Stainless steel	10B7445X012
48*	Guide Retainer O-ring	
	Nitrile (NBR) For Type 627R, 627LR, or 627MR only	1D682506992
	Fluorocarbon (FKM) For Types 627R, 627LR, and 627MR only	1N423906382
49	Relief Indicator (For Type 627R, 627LR or 627MR only), Rubber (not shown)	30B3100X012
50	Diaphragm Limiter (For Types 627H and 627HM only)	22B0176X012
51*	Diaphragm Limiter O-ring	
	For Types 627H and 627HM only	1K877606992
52*	Pusher Post O-ring (2 required)	
	For Types 627H and 627HM only	1C853806992
58	Pipe Plug, Zinc	1D8293T0022
67	Drive Screw, 18-8 Stainless steel	1A368228982
72	Pipe Plug, Zinc-plated steel	1A767524662

*Recommended spare part.



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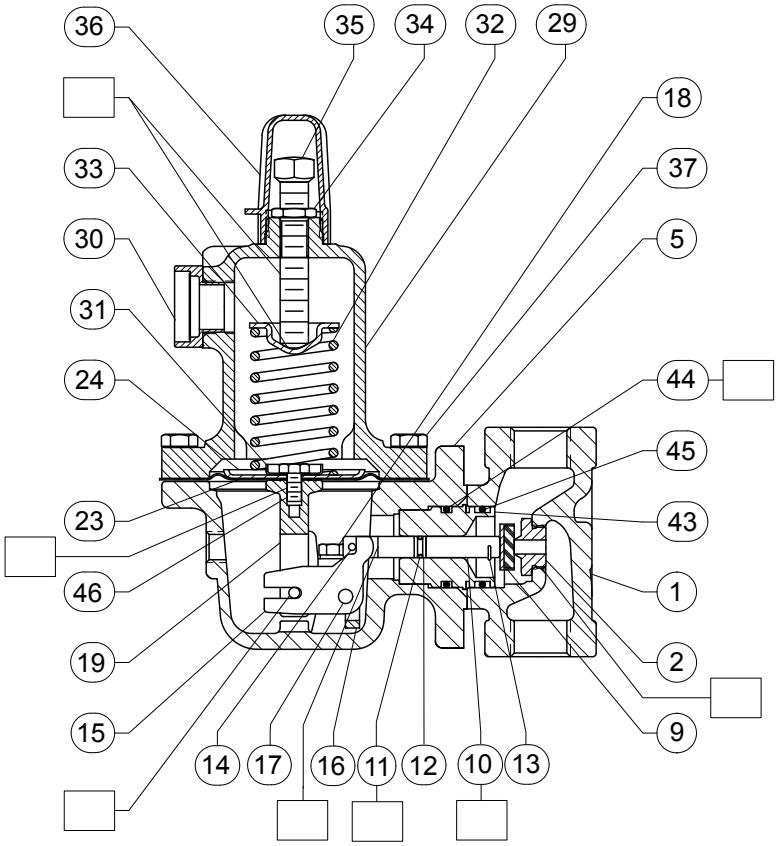
Figure 8. *Type 627R Regulator Assembly*



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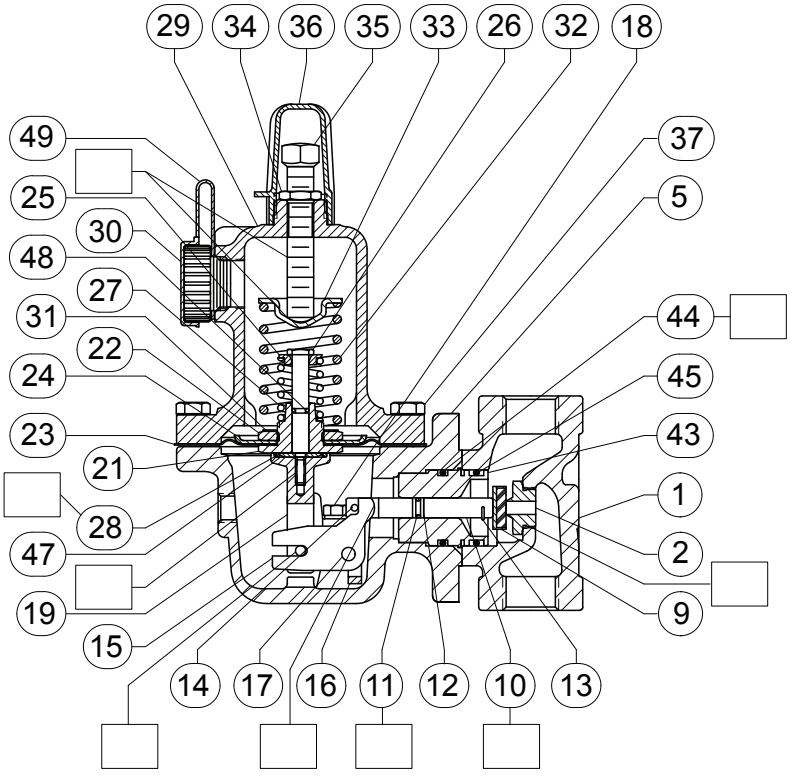
□ **APPLY LUBRICANT**
PARTS NOT SHOWN: 3

Figure 9. *Type 627LR Regulator Assembly*



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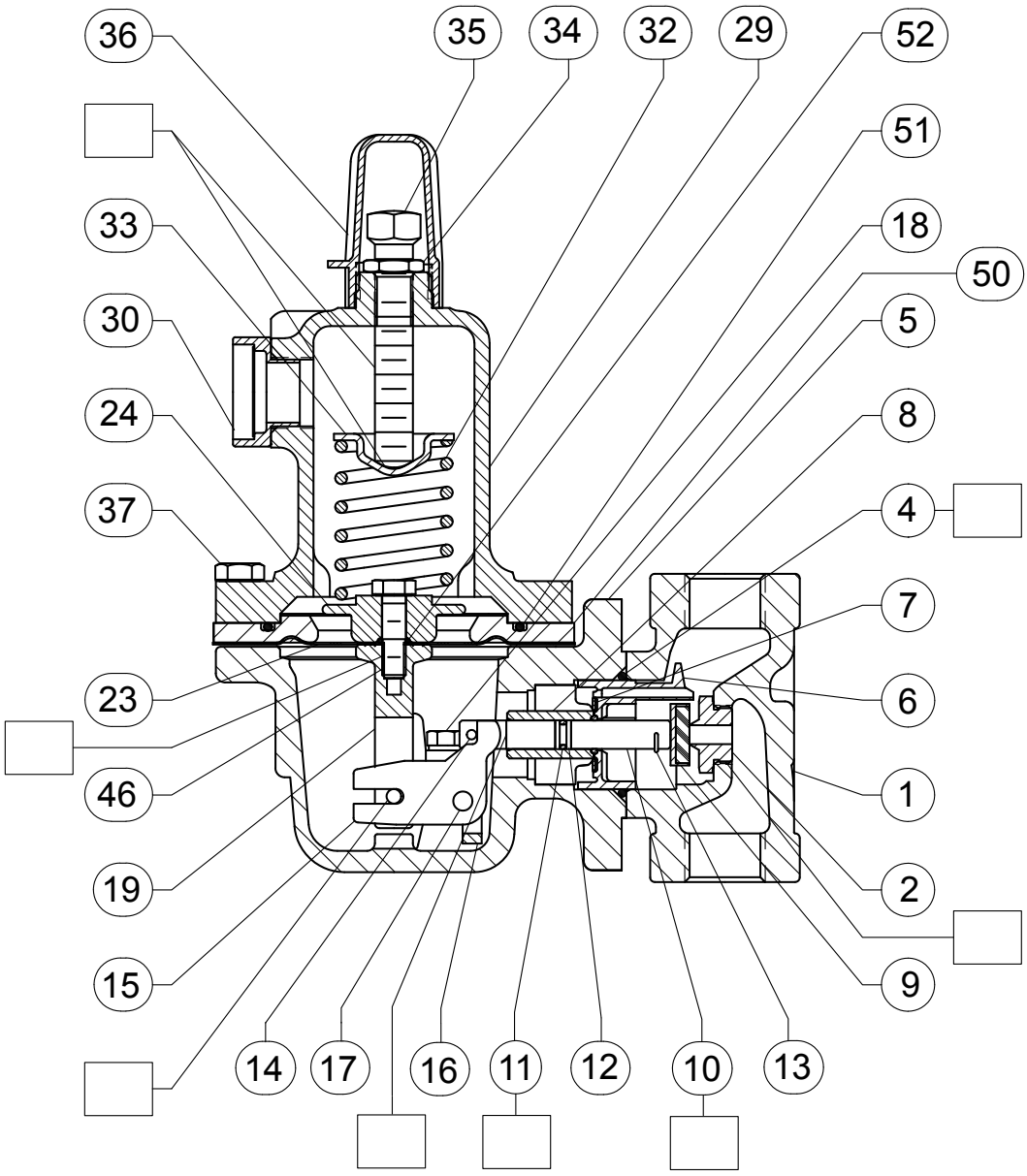
Figure 10. *Type 627M Regulator Assembly*



30B6434_E

☐ **APPLY LUBRICANT**
PARTS NOT SHOWN: 3

Figure 11. *Type 627MR Regulator Assembly*



31B5374_D

□ **APPLY LUBRICANT**
PARTS NOT SHOWN: 3

Figure 12. *Type 627H Regulator Assembly*

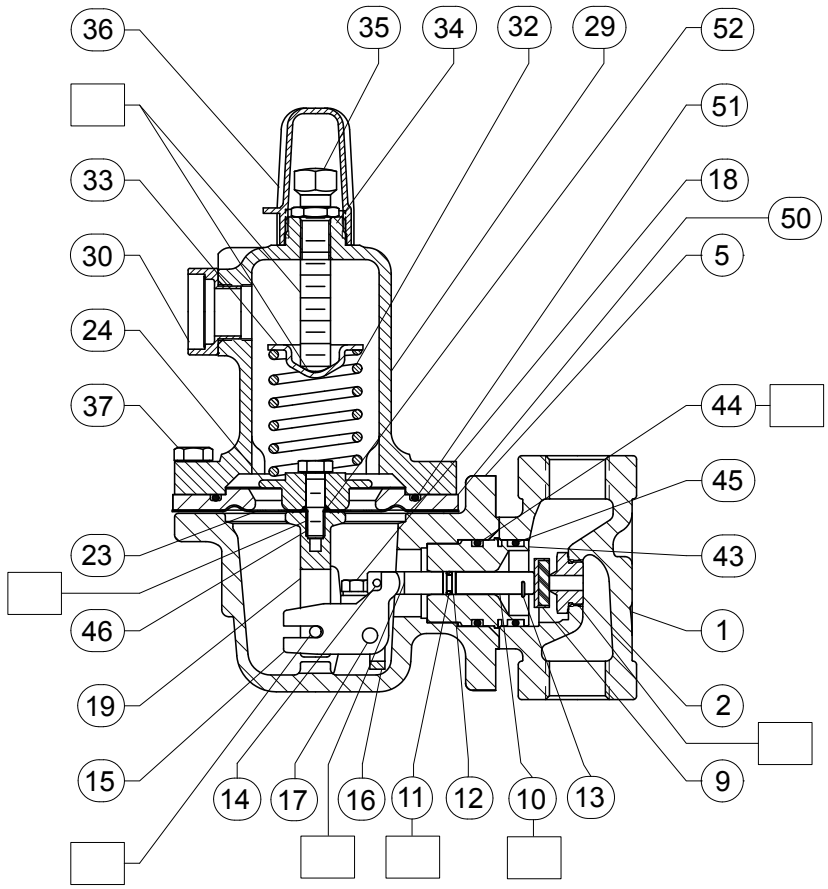


Figure 13. *Type 627HM Regulator Assembly*

Industrial Regulators

Emerson Process Management
Regulator Technologies, Inc.

USA - Headquarters
McKinney, Texas 75069-1872 USA
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Outside U.S. 1-972-548-3574

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ACCESSORIES



Oasis Valves

Distributed by Tulsa Gas Technologies

BALL VALVE PRODUCT CLASS

- Anti-blowout stem design
- Body made from certified origin billet stainless steel Compact and light design
- Full bore ball aperture - no freezing due to expanding gas High quality surface finishes
- Longest wearing bearing parts
- Quality gas tight threads
- Very high duty cycle life

The OASIS© 700 series valve design has a unique anti-blowout stem assembly enabling the valve to be used in very high-pressure gas applications. The valve body is fully machined out of billet stainless steel. The resulting unit is extremely strong and robust with an operating reliability an order of magnitude greater than forged or cast competitors.

The valve is lighter and more compact than comparable units making it preferred in confined applications like compressor and dispenser units. The valve is a full-bore flow control device (the inside bore of the ball is the same as the connecting pipe work), which is a critical issue when handling compressed gas. Partial bore valves cannot handle the gas flow rates of the Oasis valve without freezing and becoming inoperable.

The valve components are machined in very high spec CNC lathes and machining centres, the resulting surface finishes are free of blemishes and scouring. The close and consistent fits of the moving parts ensure low and even wear on the bearing parts. All wear parts are easily exchanged with Oasis provided service kits. The accuracy of Oasis manufacturing ensures all machined threads meet stringent gas operating standards.

A combination of superior materials and complex design has resulted in a valve that does not distort even under four times working pressure. The trueness of the valve under working conditions enables the valve to seal correctly every on-off cycle. In multi-cycle trials the valve has out-performed competitors by a factor of ten.



Manual Valve Kit

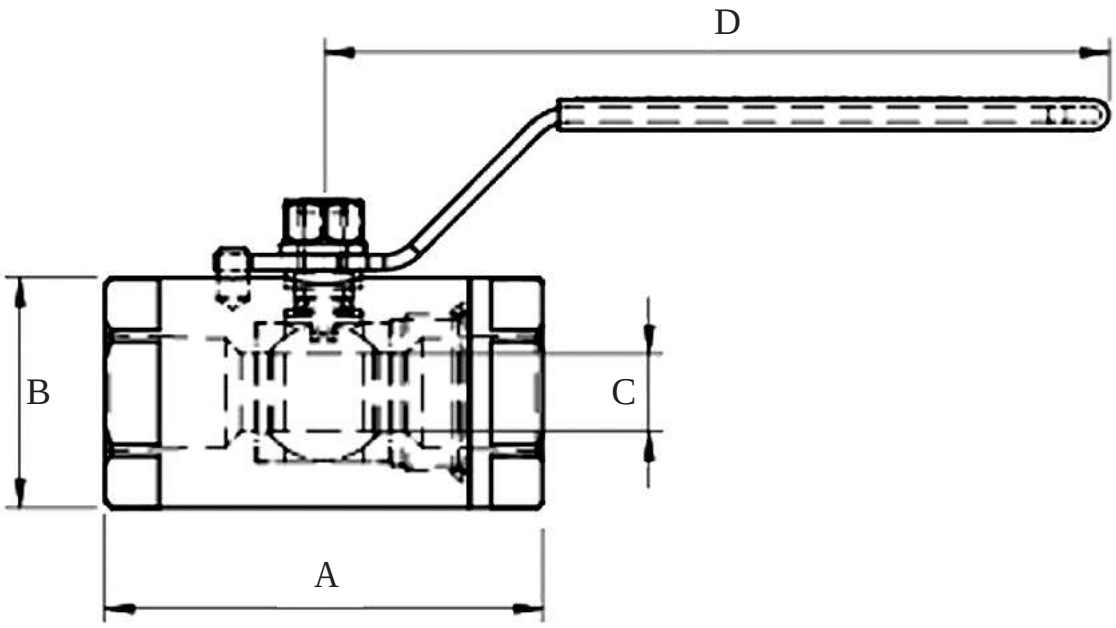


Panel Mount Valve Kit

PRODUCT

BV700

Ball Valves 700 Series



Duty:

The 700 series ball valve is an all stainless steel bar stock two-piece serviceable valve. An anti-blowout stem design allows for high pressure operation in long term service. Fully CNC machined seats ensure minimal but even seat wear. Superior materials and finishes are used resulting in very long valve life even in rapid repetitive cycle applications. Service kits are readily available. This series of valves are rated and safety tested at four times working pressures.

Applications:

Natural Gas, Compress Air, Water Treatment, Chemical Handling, Liquid Petroleum Gas, Temperature Rated Food Handling.

Working Pressure: 6,000psi
Burst Pressure: 24,000psi

Thread Options:

- SAE
- NPT
- BSP

Or as required by customer

Item Code	Nominal Size	A	B	C	D
BV704	.5” (20mm)	2.87” (73mm)	1.49” (38mm)	0.51” (13mm)	5.19” (130mm)
BV706	.75” (20mm)	3.94” (100mm)	2.17” (55mm)	0.79” (20mm)	6.97”(177mm)
BV708	1” (25mm)	4.25” (108mm)	2.72” (69mm)	1.02” (26mm)	6.97”(177mm)

Component Name	Material Standard
Body	316 Stainless steel
Cap	316 Stainless steel
Stern	316 Stainless steel
Ball	316 Stainless steel
Seat	Delrin AF
Thrust waster	Delrin AF
Stem o-ring	Nitrile
Cap o-ring	Nitrile

Available from:
TULSA GAS TECHNOLOGIES, INC.
4809 S. 101 E. Ave. • Tulsa, OK 74146 • 918-665-2641 • FAX 918-665-2657

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01	Introduction	04	Installation	07	Packaging & Storage
02	Technical Specs	05	Operation	08	Warnings
03	Parts Identification	06	Maintenance	09	Assistance

01 Introduction

This manual provides information on installation, operation, and maintenance procedures and related instructions for the ROTEX Infinity ECV Series spring return and double acting pneumatic actuators.

02 Technical Specifications

MOUNTING: In accordance with ISO 5211/DIN 3337/VDI/VDE 3845 NAMUR.

DIMENSIONS: As per Rotex Infinity Technical Brochure.

MATERIALS OF CONSTRUCTION: See Section 03 of this manual.

OPERATING PRINCIPLE (Standard Mode):

Double Acting:

Both ports A and B are used as inlet ports.
When air is supplied to Port A, the pistons #3 are moved *away from each other*, and the pinion #4 is rotated CCW.
When air is supplied through Port B, the pistons come closer and return to their home position, rotating the pinion CW.

Spring Return [Fail Closed]:

Port A is used as inlet.
When air is supplied to Port A, the pistons #3 are moved away from each other, the springs #16 are compressed, and the pinion #4 is rotated CCW.
When the air is exhausted through Port A, the springs return the pistons to the home position, rotating the pinion CW.

OPERATING MEDIUM:

Air or non-corrosive gas compatible with the internal materials of construction.
Dry or lubricated.
Gas must be clean and filtered to minimum 100 micron level.

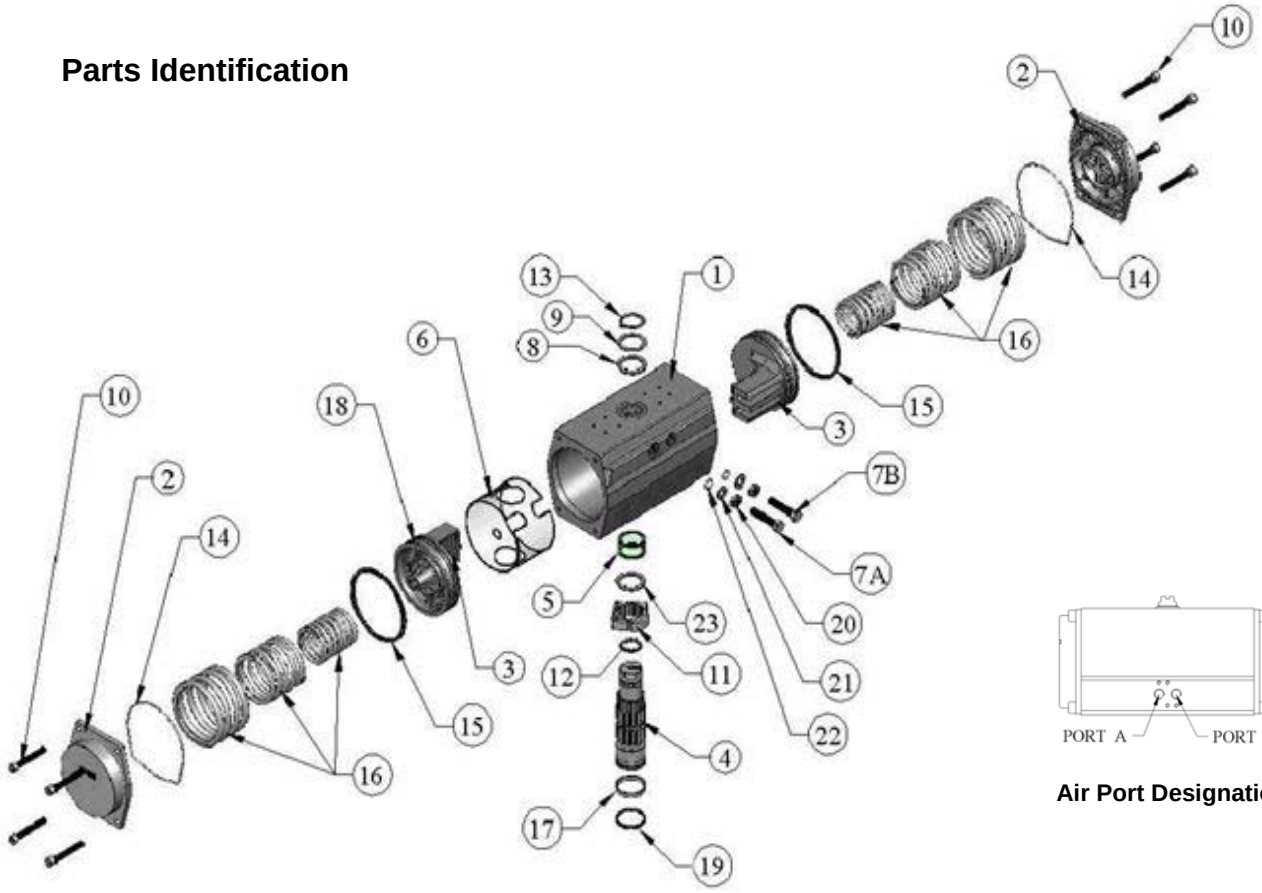
OPERATING CONDITIONS:

Maximum 120 psi, 180º F (8.3 Bar, 82º C)

OPERATING CONTROLS:

Stroke adjustment using stroke adjustment screws #7A/7B.

03 Parts Identification



Air Port Designation

PART NO	DESCRIPTION	MATERIAL OF CONSTRUCTION	PART NO	DESCRIPTION	MATERIAL OF CONSTRUCTION
1	BODY	ALUMINUM	12	TOP PINION SEAL	POLYETHYLENE
2	END COVER	ALUMINUM	13	EXTERNAL CIRCLIP	SPRING STEEL
3	PISTON WITH RACK	ALUMINUM	14	COVER SEAL	BUNA
4	PINION	STEEL/EN	15	PISTON SEAL	POLYETHYLENE
5	TOP PINION BEARING	POLYACETAL	16	SPRINGS	SPRING STEEL GR3
6	CENTER BORE SLEEVE	POLYACETAL	17	BOTTOM PINION BEARING	POLYACETAL
7A	STROKE ADJUSTMENT SCREW	STEEL	18	PISTON BEARING	POLYACETAL
7B	STROKE ADJUSTMENT SCREW	STEEL	19	BOTTOM PINION SEAL	POLYETHYLENE
8	WASHER	POLYACETAL	20	LOCK NUT	STEEL
9	WASHER	304SS	21	WASHER	STEEL
10	HEX SOCKET SCREW	304SS	22	O RING	NBR
11	CAM INSERT	STEEL	23	CAM WASHER [1]	POLYACETAL

[1] Cam washer only on ECV Models 80, 110, 125, and 175

04 Installation

NOTES:

N1 > Ensure the installation meets the legal and regulatory requirements of the country and state of use.
N2 > Until the actuator is installed, keep it in its original packaging and stored between 40º F and 120º F (4º C and 49º C).
N3 > Ensure the operating medium meets the above requirements.
N4 > Use proper rigging to handle the actuators weighing more than 60 lb (27 kg) to avoid personal injury.

04.1 Mounting

STEP 1 Keep the valve on which the actuator is to be mounted in home position, until the installation is complete. Ensure that valve is secure.
STEP 2 Fix the brackets on the valve.
STEP 3 Ensure the coupling slides on the stem smoothly without any play.
STEP 4 Check the other end of the coupling with the actuator for the length of engagement.
STEP 5 Mount the actuator *(Refer Note N4 above)* on the bracket with fasteners.
STEP 6 Tighten all the fasteners to the torque as recommended by the fastener manufacturer.

04.2 Adjustment of End Stops

NOTES:

N1 > All actuators are factory set to 0 and 90 degrees. Even minor adjustments of the stroke adjustment screws (#7A and 7B) will result in over travel or incomplete travel of the pinion.
N2> Only loosen the lock nut. Don't remove it fully.
N3> Don't tighten the stroke adjustment screw #7A or 7B more than the maximum limit of adjustment – if over-tightened, the screw may hit the piston #3 and cause damage.

CLOSING: For 0 Degrees, Adjust #7B
Turn counter-clockwise to travel further (over travel)
Turn clockwise to limit the travel.
When adjustment is set, tighten lock nut #20 on adjustment screw.

OPENING: For 90 Degrees, Adjust #7A
Turn counter-clockwise to travel further (over travel)
Turn clockwise to limit the travel.
When adjustment is set, tighten lock nut #20 on adjustment screw.

SAFETY CHECK FOR STROKE ADJUSTMENT SCREW POSITION:
Keep the piston in the home position.
Tighten the stroke adjustment screw (clockwise direction) until the screw touches the inner wall of the piston. This is the maximum safe limit of adjustment of the stroke adjustment screw.

05 Operation

STEP 1 Provide air connections using proper fittings.
STEP 2 Air supply must meet specifications on page 1.
STEP 3 Ensure air supply pressure is regulated to ensure maximum air supply is not exceeded.
STEP 4 Supply air to the actuator through a solenoid or manual air valve.

06 Maintenance

06.1 Recommended Servicing

At 1,000,000 Cycles:

Apply grease on seals #1/6/12/14/15/19. DO NOT APPLY EXCESSIVE GREASE.
Apply grease on rack #3 and pinion #4. DO NOT APPLY EXCESSIVE GREASE.
Replace all plastic #5/6/18 and rubber parts #12/14/15/19.
Inspect springs # 16 for any rust or deformity. Replace if necessary.

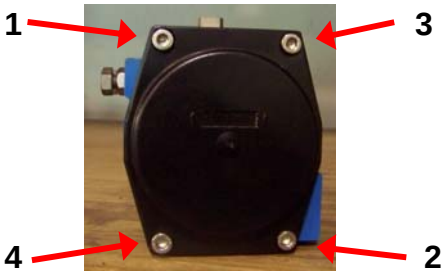
NOTES:

N1 > Carry out maintenance involving disassembling of actuator in a safe indoor place free from dust, water.
N2 > Ensure that air supply has been disconnected.
N3 > Ensure proper lifting procedures are followed when moving or lifting actuators.
N4 > DO NOT use accessory mounting holes on top of actuator for lifting.
N5 > If actuator is spring return, ensure actuator is in the failed position and spring are de-energized before disassembling.

06.2 End Cap Bolting Details

Actuators sizes ECV32 – ECV175

Actuators of these sizes have (4) end cap bolts on each end. All bolts are the same length. When gradually and evenly loosening, or tightening these bolts, use the following sequence;



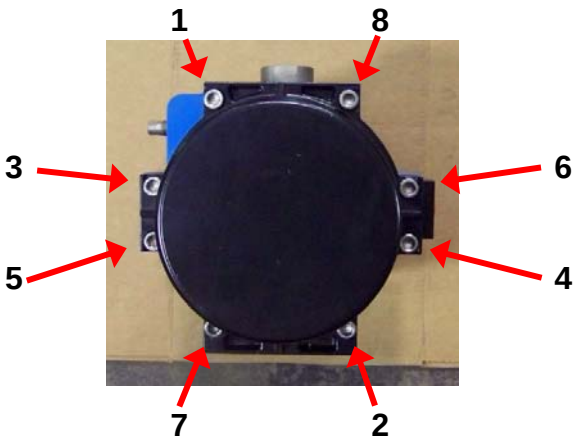
Actuators sizes ECV200 – ECV350

Actuators of these sizes have (8) end cap bolts on each end.

NOTE: Bolts in positions 1, 8, 7, and 2 are SHORTER than the side bolts in positions 3, 5, 6, and 4.

When removing the bolts, the sequence 1, 2, 3, 4, 5, 6, 7, 8, should be followed to GRADUALLY and evenly loosen the bolts, bearing in mind that the 1, 8, 7, and 2 bolts are shorter. Bolts 3, 5, 6, and 4. are longer, and should be removed **last**, to ensure that spring tension is released safely.

When reinstalling bolts, the longer bolts 3, 5, 6, and 4 will have to be started first and gradually and evenly tightened. When the end cap is close enough to engage the shorter bolts 1, 8, 7, and 2, follow the sequence 1, 2, 3, 4, 5, 6, 7, 8 to gradually and evenly tighten the bolts.





**REFERENCE ONLY:
Shows bolts 1, 8, 7, 2
are shorter**

06.3 Disassembly

Refer to the view on page 2 and details on page 5.

Step 1 Loosen the lock nuts #20, back out or remove stroke adjustment screws #7A and 7B, washers #21, and o-rings #22.
Step 2 Loosen the cover bolts # 10 on each end cap gradually and evenly in sequence indicated in the detail information on page 5.

CAUTION: Spring return actuator end caps are under spring tension. Caution must be used when removing end cap bolts and end caps. It is suggested that the actuator be put into a press during removal of end caps to ensure safe release of spring tension.

CAUTION: See End Cap Bolting Details on Page 5 for important notes.

Step 3 Rotate the pinion #4 in the counter-clockwise direction until the pinion becomes free.

NOTE: NEVER attempt to remove pistons from actuator body using air pressure when the end caps have been removed!!

Step 4 Pull the piston out from each side by holding with pliers.
Step 5 Remove external circlip # 13 and then washers #8 and #9.
Step 6 Tap the pinion gently from the top using a rubber mallet until the pinion is approximately half way into the body.
Step 7 Remove the top pinion seal #12 and the top pinion bearing #5.
Step 8 Remove the cam stop ring #11 and washer #23.
Step 9 Pull the pinion the rest of the way out of the body.
Step 10 Check the pinion bearing #5 for its condition.
Step 11 If removal and replacement of the pinion bearings is required, *carefully* push the pinion bearing off with the help of a screw driver and remove from the body.
Step 12 Push and remove the center bore sleeve #6.
Step 13 Remove the bottom pinion bearing #17, the bottom pinion seal #19, and the end cap seals #14.
Step 14 Change the necessary parts.

It is recommended that <u>all</u> wear parts are changed as a complete set, even if some of them are found to be in good condition. This will ensure uniform wear of the parts and assure smooth performance of the actuator.

06.4 Assembly for DOUBLE ACTING and STANDARD MODE SPRING RETURN (Fail Closed) Actuators

NOTES:

N1 > Follow the sequences as given below to ensure proper assembly.
N2 > Use only the recommended accessories and lubricants.
N3> Do not apply excessive lubricant – excess lubricant will inhibit proper operation of V-seals.
N4> Assembly instructions in this section are for double acting and standard mode spring return (fail closed / fail clockwise) actuators. For assembly notes on reverse mode spring return actuators (fail open / fail counter-clockwise) see notes in section 06.5.

Step 1 Clean all the parts.
Step 2 Insert center bore sleeve #6 into the body #1.
Step 3 Ensure that the hole in the center bore sleeve is aligned with port A.
Step 4 Fit bottom pinion bearing #17 and bottom pinion seal #19 on to the pinion #4. Apply recommended grease over the pinion bearing surface #17 and on the bottom pinion seal #19. Apply a thin coat all over the surface; DO NOT APPLY EXCESSIVE GREASE.
Step 5 Insert pinion carefully into the body #1 from the bottom, approximately half way.
Step 6 Install the cam stop ring #11 and polyacetal cam washer #23 on top of pinion.
Step 7 Install top pinion seal #12 on pinion and apply a light layer of grease.
Step 8 Install top pinion bearing #5 on into the body.
Step 9 Push the pinion through the top bearing and into the body.
Apply gentle force while rotating the piston to facilitate the insertion.
Step 10 Install polyacetal washer #8, SS washer #9, and external circlip #13 on top of pinion.
Step 11 Check for free rotation of pinion.
Step 12 Apply recommended grease over the bore of the body and over the interior of the center bore sleeve; avoid excess grease.
Step 13 Rotate the pinion so that the dot on the pinion is positioned close to the single dot on the top pad of the actuator body. Accurate pinion alignment can now take place by lining the center of the slot on the top of the pinion with the single dot on the body. (See Figure 1, page 8)
Step 14 Insert the pistons, pressing only until the seals enter the body. Push in both the pistons simultaneously.

Extreme caution should be used as piston seals are slid into the actuator body. Misalignment of piston seals during this step WILL result in damage to the seal and air leak paths.

Step 15 Ensure both the pistons are engaged in the same position.
Same amount of gap between the face of each piston and the end of the body will confirm this.
Step 16 For spring return actuators, insert the springs #16.

When assembling springs and end caps on spring return actuators, it is necessary to have the actuator body in the vertical position. This is required to ensure that springs remain properly aligned and centered during assembly.

Step 17 Fix the seals #14 on the left and right end caps and install on to body.
Ensure the air ports on the end caps are aligned properly.
Lubricate end cap bolts with anti-sieze product.
Ensure uniform tightening of end cap bolts, following sequence noted on page 5.

Step 18 Install stroke adjustment screws #7a and 7B with o-rings #22, washers #21, and lock nuts #20.
Step 19 Apply air to Port A to move pistons to the extended 90 degree position.
Step 20 Adjust stroke adjustment screw #7A for the 90 degree position, turning clockwise until the screw is barely touching the piston. Tighten the lock nut.
Step 21 For spring return actuators, release the air pressure, for double acting actuators, apply air to Port B. This will bring the pistons back to the 0 degree position.
Step 22 Adjust the stroke adjustment screw #7B for the 0 degree position, turning clockwise until the bolt is barely touching the piston. Tighten the lock nut.
Step 23 Apply air as required to stroke the actuator several times to confirm that the stroke adjustment screws are set correctly and ensure that there is no air leakage from any of the seals.
Step 24 Re-install or repack for storage (see section 7 for Packaging and Storage).

Figures 1 and 2:

Assembly diagram for use with Section 06.4 Step 13 and Section 06.5 Step 13. Assembly diagrams shown here are for reference to ensure the pinion is positioned in the correct general quadrant for the Fail Closed or Fail Open modes.

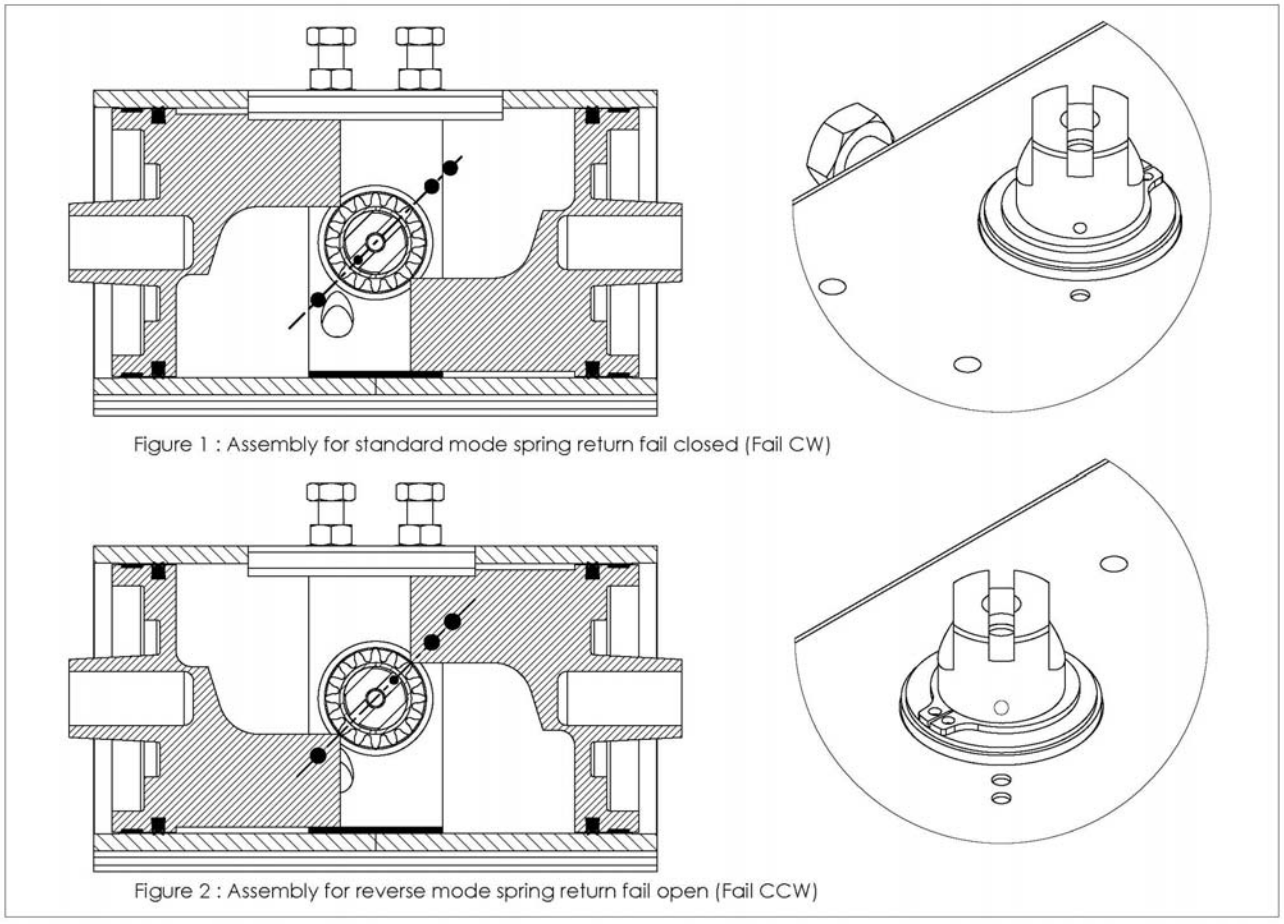


Figure 1 : Assembly for standard mode spring return fail closed (Fail CW)

Figure 2 : Assembly for reverse mode spring return fail open (Fail CCW)

06.5 Assembly for REVERSE MODE SPRING RETURN (Fail Open) Actuators

NOTES:

N1 > Follow the sequences as given below to ensure proper assembly.
N2 > Use only the recommended accessories and lubricants.
N3> Do not apply excessive lubricant – excess lubricant will inhibit proper operation of V-seals.
N4> Assembly instructions in this section are for spring return actuators in the reverse mode (fail open / fail CCW). For assembly notes on standard mode spring return actuators (fail closed / fail clockwise) see notes in section 06.4.

Step 1 Clean all the parts.
Step 2 Insert center bore sleeve #6 into the body #1.
Step 3 Ensure that the hole in the center bore sleeve is aligned with port A *(refer view).*
Step 4 Fit bottom pinion bearing #17 and bottom pinion seal #19 on to the pinion #4. Apply recommended grease over the bearing surface and on the O ring - uniformly and a thin coat all over the surface; avoid excess grease.
Step 5 Insert pinion carefully into the body from the bottom, approximately half way.
Step 6 Install the stop ring #11 and polyacetal washer #23 on top of pinion.
Step 7 Install top pinion seal #12 on pinion and apply a light layer of grease.
Step 8 Install top pinion bearing #5 on pinion.
Step 9 Push the pinion the rest of the way into the body.
Apply gentle force while rotating the piston to facilitate the insertion.
Step 10 Install polyacetal washer#8, SS washer #9, and external circlip #13 on top of pinion.
Step 11 Check for free rotation of pinion.
Step 12 Apply recommended grease over the bore of the body and over the interior of the center bore sleeve; avoid excess grease.
Step 13 Rotate the pinion so that the dot on the pinion is positioned close to the two dots on the top pad of the actuator body. Accurate pinion alignment can now take place by lining the center of the slot on top of the pinion with the two dots on the body. (See Figure 2, page 8).
Step 14 Insert the pistons, pressing only until the seals enter the body. Push in both the pistons simultaneously.

Extreme caution should be used as piston seals are slid into the actuator body. Misalignment of piston seals during this step WILL result in damage to the seal and air leak paths.

Step 15 Ensure both the pistons are engaged in the same position.
Same amount of gap between the face of each piston and the end of the body will confirm this.
Step 16 Insert the springs #16.

When assembling springs and end caps on spring return actuators, it is necessary to have the actuator body in the vertical position. This is required to ensure that springs remain properly aligned and centered during assembly.

Step 17 Fix the seals #14 on the left and right end caps and install on to body.
Ensure the air ports on the end caps are aligned properly.
Ensure uniform tightening of end cap bolts, following sequence noted on page 5.

Step 18 Install stroke adjustment screws #7A and 7B with o-rings #22, and lock nuts #20.
Step 19 Apply air to Port A to move pistons to the extended 0 degree position.
Step 20 Adjust stroke adjustment screw #7B for the 90 degree position, turning clockwise until the screw is barely touching the piston. Tighten the lock nut.
Step 21 Release the air pressure to bring the pistons back to the 90 degree position.
Step 22 Adjust the stroke adjustment screw #7A for the 0 degree position, turning clockwise until the screw is barely touching the piston. Tighten the lock nut.
Step 23 Apply air as required to stroke the actuator several times to confirm that the stroke adjustment screws are set correctly and ensure that there is no air leakage from any of the seals.
Step 24 Re-install or repack for storage (see section 07 for Packaging and Storage).

07 Packaging and Storage

When not in use, actuators should be kept in a sealed plastic bag in a cardboard box to prevent moisture or dust from contacting product. Boxes should be stored in a dry place free from water and dust.

Store at temperature between 40º and 120º F (4º C and 49º C).

Locate in an area to avoid damage by impact.

08 Warnings

Use only genuine spares parts supplied by ***Rotex.***

Use only the recommended accessories and lubricants.

Install, operate and maintain as per the instructions and recommendations of this manual.

Any **deviation** from the above warnings will cease the responsibilities of ***Rotex.***

09 Assistance

For technical questions or assistance, contact any authorized distributor of ***Rotex*** or:

Rotex Controls, Inc

21 Sullivan Parkway, Fort Edward, NY 12828

Tel: (888) 813 – 9772 Fax: (866) 478 – 9620

sales@rotexcontrols.com

SEC *Millenium* Hydrocarbon Gas Detector

Instruction and Operation Manual

Sensor Electronics Corporation
5500 Lincoln Drive
Minneapolis, Minnesota 55436 USA
(952) 938-9486 Fax (952) 938-9617
Email sensor@minn.net **Web site www.sensorelectronics.com**

Part Number 71-4000 Version 092501

Sensor Electronics Corporation

Sensor Electronics Corporation (SEC) designs and manufactures innovative fixed system gas detection equipment, for combustible gases, oxygen, carbon dioxide and toxic gases.

Commitment

Our quality and service are uncompromising. We back each of our products with a two-year warranty on all materials and workmanship. We offer technical support, user training and on-site service and maintenance of equipment to meet the needs of our customers.

Gas Detection Service

Individually designed maintenance packages are available for specific customer needs. Service begins with verification of the system installation that includes an initial system check and calibration. We then offer customer training programs (on-site and at factory) to insure that technical personnel fully understand operation and maintenance procedures. When on-the-spot assistance is required, service representatives are available to handle any questions or problems immediately.

Warranty

Sensor Electronics Corporation (SEC) warrants products manufactured by SEC to be free from defects in workmanship and materials for a period of two (2) years from date of shipment from the factory. Any parts returned freight pre-paid to the factory and found defective within the warranty would be repaired or replaced, at SEC's option. SEC will return repaired or replaced equipment pre-paid lowest cost freight. This warranty does not apply to items, which by their nature are subject to deterioration or consumption in normal service. Such items may include:
Fuses and Batteries.
Warranty is voided by abuse including rough handling, mechanical damage, alteration or repair. This warranty covers the full extent of SEC liability and SEC is not responsible for removal, replacement costs, local repair costs, transportation costs or contingent expenses incurred without prior written approval. Sensor Electronics Corporation's obligation under this warranty shall be limited to repair or replacement of any product that has been returned to Sensor Electronics Corporation for warranty consideration. This warranty is expressly in lieu of any and all other warranties expressed or implied, and all other obligations or liabilities on the part of Sensor Electronics Corporation including but not limited to, the fitness for a particular purpose. In no event shall Sensor Electronics Corporation be liable for direct, incidental, or consequential loss or damage of any kind connected with the use of it's products or failure to function or operate properly.

Year 2000 Compliance

All Sensor Electronics products have been tested and are certified by Sensor Electronics to accurately process date/time and date/time related data from, into and between the 20^{th} and 21^{st} centuries. Sensor Electronics products neither contain nor create any logical or mathematical inconsistency, will not malfunction, and will not cease to function when processing date/time data.
Please contact Sensor Electronics for further information.

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II. GENERAL DESCRIPTION

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Installation and Startup

IV. CALIBRATION

V. MAINTENANCE

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I. SPECIFICATIONS

Model:

Sensor Electronics Corporation SEC MILLENIUM Infrared Hydrocarbon Gas Detector

Available gases:

Methane	Hexane	Jet A
Ethane	Diesel	Ethanol
Ethylene	Gasoline	Methanol
Ethylene Oxide	Green Earth	Butane
Propane	DF 2000	Hexane

Please note *that this list is not all-inclusive. The SEC MILLENIUM can be calibrated for most hydrocarbons, provided a calibration gas is available. For more please contact Sensor Electronics Corporation.*

Part Number: 142-0280

Detection Method:
Diffusion
Optional sample draw (requires a minimum of 1 liter per minute flow rate)

Output (analog):
4-20 mA (Source type), max. 1000 Ohm load at 24 VDC supply voltage

Response Time:
T50 < 5 seconds
T90 < 10 seconds

Construction:
316 stainless steel.
Class 1, Division 1, Groups B, C and D

Accuracy:
+/- 3% LFL, 0 to 50% LFL (Lower Flammable Limit)
+/- 5% LFL, 51 to 100% LFL

Operating Temperature Rating:
-40° to +70°C at 0 to 99% RH (non-condensing)

Operating Voltage:
24 VDC ⎓ Operating range: 18 to 32 VDC measured at the detector head

Power Consumption: 5 Watts Max.

Max. Current Draw: (at 24 VDC)
Average: 210 mA
Peak: 400 mA

Approvals: CSA, For -40C to +50C operation, Performance Tested

Installation Category: Cat. I, Pollution Degree 2

II GENERAL DESCRIPTION

CONVENTIONS

The following conventions are used in this manual.

⚠ Warning Statement

⎓ VDC (DC Voltage)

SEC MILLENIUM

The SEC MILLENIUM Infrared gas detector is a microprocessor based intelligent gas detector that continuously monitors combustible hydrocarbon gases and vapors within the Lower Flammable Limit (LFL).

The SEC MILLENIUM is ideally suited for use in harsh environments and where the cost of required maintenance for conventional catalytic detectors is prohibitive. The SEC MILLENIUM Infrared gas detector will perform reliably in the presence of silicone and other catalytic poisoning agents and can also operate in oxygen free environments or where high background gas levels are present. There are no known poisons that affect this technology.

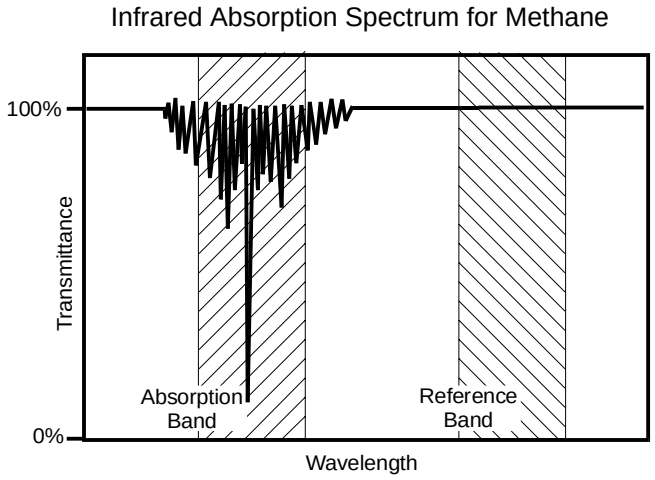
The SEC MILLENIUM is a stand-alone device providing a continuos 4 to 20 mA output.

Features

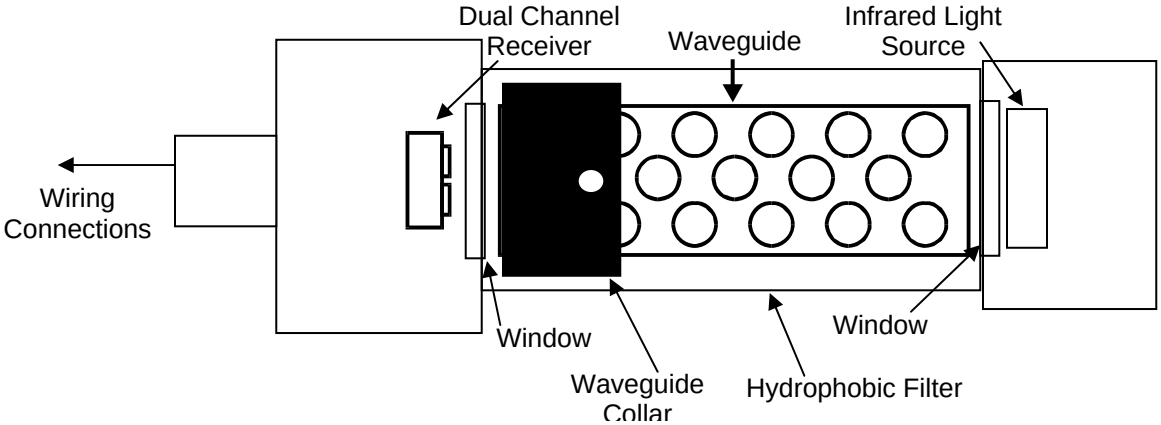
- Requires no routine calibration to ensure proper operation.
- Continuous self-test automatically indicates a fault, with fail to safe operation.
- A multi-layered filtering system protects optics from dirt and water ingress.
- Straight optical path eliminates the need for mirrors or reflective surfaces, such as mirrors or beam splitters.
- Performs well in the presence of high concentrations or constant background levels of hydrocarbons and in oxygen depleted atmospheres.
- Highly resistant to poisoning and etching.
- Standard 4 to 20 mA output (current source)
- Explosion proof housing designed for harsh environments.
- Smart Calibration AutoAC™ circuit.

Infrared Detection Technology

The SEC MILLENIUM Infrared gas detector uses infrared absorption technology for detecting combustible hydrocarbon gases. Gases absorb infrared light only at certain wavelengths. The concentration of a gas can be measured by the difference of two channels (wavelengths), a reference and a measurement channel. The SEC MILLENIUM uses a collimated infrared light source that passes through a waveguide, at the end of the waveguide is a dual channel receiver. The dual channel receiver measures the intensity of two specific wavelengths, one at an absorption wavelength and another outside of the absorption wavelength. The gas concentration is determined by a comparison of these two values.



The dual channel receiver is a single wafer, double filtered, dual receiver with an internal optical barrier. The elements are perfectly matched resulting in overall stability and superior performance throughout the entire temperature range.



Using a dual channel receiver there is no need to use any special lenses or beam splitters to achieve the different measurement bands.

The SEC MILLENIUM utilizes a unique patent pending feature, the AutoAC™ circuit. The AutoAC™ circuit is an automatic analog control circuit, which allows the SEC MILLENIUM to be calibrated for any combustible hydrocarbon, provided that a calibration quality level of the gas is available. This eliminates setting dipswitches or changing out sensors for different types of hydrocarbons, simply calibrate the unit with a calibration gas of the specific gas to be detected.

The optics can be easily disassembled for cleaning. This does not require powering the unit down and does not compromise the units' explosion proof rating. The device will self compensate for dirty optics until a point in which the optical surfaces are completely obscured.

There are no consumable components contained in this product.

III. OPERATION

Installation and Startup

Warning: The user shall be made aware that if the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

The first step in the installation process is to establish a mounting location for the SEC MILLENIUM. Select a location that is typical of the atmosphere to be monitored or close to the anticipated source of a dangerous gas.

It is very important that the SEC MILLENIUM be properly located to enable it to provide maximum protection. The most effective number and placement of sensors vary depending on the conditions of the application. When determining where to locate sensors the following factors should be considered.

- What are the characteristics of the gas that is to be detected? Is it lighter or heavier than air? If it is lighter than air the sensor should be placed above the potential gas leak. Place the sensor close to the floor for gases that are heavier than air or for vapors resulting from flammable liquid spills. Note that air currents can cause a gas that is heavier than air to rise. In addition, if the temperature of the gas is hotter than ambient air or mixed with gases that are lighter than air, it could also rise.

- How rapidly will the gas diffuse into the ambient air? Select a location for the sensor that is close to the anticipated source of a gas leak.

- Wind or ventilation characteristics of the immediate area must also be considered. Movement of air may cause gas to accumulate more heavily in one area than in another. The detector should be placed in the areas where the most concentrated accumulation of gas is anticipated. For outdoor applications with strong wind conditions, it may require the sensors to be mounted closer together and on the down wind side, to the anticipated area of a gas leak. Also take into consideration for indoor applications, the fact that many ventilation systems do not operate continuously.

- The sensor should be accessible for maintenance.

- Excessive heat or vibration can cause premature failure of any electronic device and should be avoided if possible.

- Follow all national and local installation codes and practices**.**

The SEC MILLENIUM has a ¾" NPT threaded connector for mounting the detector to a junction box. SEC can provide a junction box with terminals for this purpose.

A user-supplied junction box can be used providing it has the appropriate sized NPT conduit entries. The junction box must be suitable for use in the application and location in which it is being installed. After the device has been installed, a calibration is required. Refer to the Calibration section of this manual.

Wiring connections
Red wire: 18 to 32 VDC ⎓
Black wire: DC Common
Blue wire: 4 to 20 mA output
White wire: Smart Calibration Wire (data wire)
Earth Ground: Male 10-32 Stud on SEC Millenium cap, see figure 1.

Wire sizing:
0 to 500 feet, recommended wire gauge size 16 AWG
501 to 1000 feet, recommended wire gauge size 14 AWG

Shielded cable is recommended. Wiring should be installed in medal conduit with no other cabling in the same conduit.

Warm-up
When power is applied to the detector, it enters a one (1) minute warm-up mode. The output current will be 0.8 mA during the warm up time period. At the end of the warm-up period with no faults present, the detector automatically enters the normal operating mode (4 mA). If a fault is present after warm-up, the detector current output will indicate a fault. See the following chart for fault code status.

Normal

In the normal operating mode, the 4 to 20 mA signal levels correspond to the detected gas concentration. The detector continuously checks for system faults or initiation of calibration and automatically changes to the appropriate mode.

The 4 to 20 mA output of the SEC MILLENIUM is a non-isolated current source.

Current Output and Corresponding Status

Current Output	Status.
0-20 mA	Normal measuring mode
0.0 mA	Unit Fault
0.2 mA	Reference channel fault
0.4 mA	Analytical channel fault
0.8 mA	Unit warm up
1.0 mA	Optics fault
1.2 mA	Zero drift fault
1.6 mA	Calibration fault
2.0 mA	Unit spanning
2.2 mA	Unit zeroing
4.0 mA	Zero gas level (0%LEL)
5.6 mA	(10%LEL)
8.0 mA	(25%LEL)
12 mA	(50%LEL)
16 mA	(75%LEL)
20 mA	Full scale (100% LEL)
20.1- 23 mA	Over-range (> 100% LEL)

Once the fault is cleared the SEC MILLENIUM will atomatically resume normal operation.

IV. CALIBRATION

SEC MILLENIUM

The SEC MILLENIUM is factory calibrated zeroed and spanned. *Unlike catalytic sensors it does not require routine span gas calibration to ensure proper operation.*

The SEC MILLENIUM can be calibrated for almost any hydrocarbon using a calibration gas of the hydrocarbon that is to be detected (target gas). The SEC MILLENIUM is required to be spanned with gas only one time with the target gas. Typically this is done at the factory, but it is possible to field span the device by connecting the SEC MILLENIUM to a computer and using a software package provided by SEC. Please contact the factory for further details.

A typical field calibration only requires the use of zero air (or 99.99% nitrogen). *If the sensor is located in an area that is known to be free of the hydrocarbon gases then ambient air can be used as a zero reference.*

If zero air is used for the calibration, there is a fitting on the bottom of the sensor for a 1/8" ID tubing connection.

Before beginning calibration use the SEC MILLENIUM Insulation Tube to cover outer cylinder holes and connect a clean air source to the sensor's calibration port for a minimum of 3 minutes. To enter into the calibration mode the calibration wire must be connected to negative (common of the power supply) for ten (10) seconds, upon release the sensor will automatically enter the zero calibration routine. The electronics will automatically adjust the sensor's signal to the new zero reference level. (Applying span gas is not necessary because of the SEC MILLENIUM's unique software algorithms). During the zero calibration routine, the current output of the SEC MILLENIUM will go to 2.2 mA. Although this can be accomplished manually, installation of a switch (contact closure) can accomplish the zeroing procedure. It is recommended that this switch be a momentary type switch to prevent it from inadvertently being left in the calibrate position. If after 20 seconds the calibration lead has not been removed from common, the SEC MILLENIUM will ignore the signal and continue operation as normal.

The SEC MILLENIUM can be spanned in the field if the customer wishes to change the target hydrocarbon gas. Please contact factory for additional equipment information and pricing for SEC PC IR Link Package)

V. MAINTENANCE

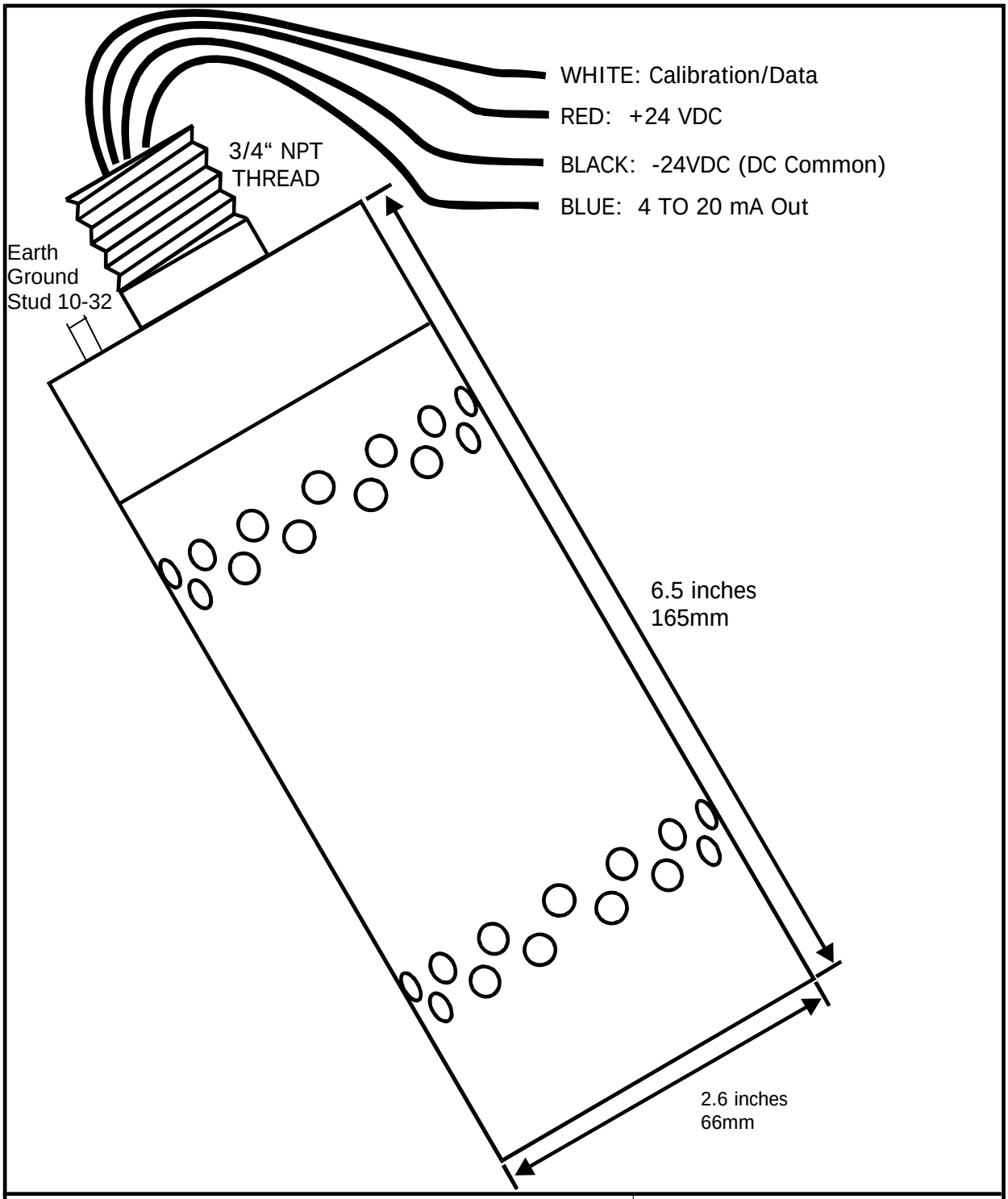
The SEC MILLENIUM does not normally require cleaning of the optics. However if the unit is operating in a very dirty or dusty environment the optical path might become obscured. If the obscuration is severe enough to affect the units accuracy, the unit will activate an "Optics Fault" will. To clear an Optics Fault, first try a calibration. If the calibration does not correct the fault condition, try to clean the optics. The outer barrel (tube with two sets of holes) can be removed (unscrewed) to inspect the cleanliness of the hydrophobic filter. The hydrophobic filter is a Teflon coated stainless steel mesh that keeps moisture and particulates out of the optical path. A setscrew holds the filter to the MILLENIUM's housing. Once the hydrophobic filter is removed, the internal waveguide tube should be inspected for cleanliness. The waveguide and waveguide collar can be removed by inserting rigid instruments such as Allen wrenches into one hole of the waveguide and one hole of the collar. Turning the two instruments in opposite directions will loosen the waveguide allowing the collar to be screwed down on to the waveguide until it can be removed from the SEC MILLENIUM housing. This will allow the windows of the SEC MILLENIUM to be cleaned. Dust can be removed using compressed air. Hard or oily deposits can be removed using Isopropyl alcohol and cotton tipped swabs. Wipe any film or residue or film left by the alcohol on the windows with a clean dry cotton swab. The internal electro polished wave-guide tube can be cleaned the same way. Be careful not to leave any particles of the cleaning swab in the waveguide. The waveguide holes can collect pieces of the cleaning swab. After reassembling the unit (the waveguide and collar should be very tight to both ends of the SEC MILLLENIUM housing after installation. Once the unit is completely reassembled and power is reapplied, the SEC MILLENIUM must be calibrated. Refer to the calibration section of this manual.

VI. Parts List

Part Number	Description
142-0280	Replacement Sensor SEC MILLENIUM
190-1001	SEC 2001 Sensor Separation Kit
142-0877	SEC Insulation Tube
142-0497	SEC MILLENIUM Replacement Hydrophobic Filter
142-0297	SEC MILLENIUM Wave Guide Tube
142-0570	SEC MILLENIUM Wave Guide Tube Collar
142-0636	SEC PC IR Link Kit

VII. Drawing Section

Figure #	Title
Figure 1	Wiring Diagram, SEC MILLENIUM
Figure 2	SEC Sensor Separation Kit

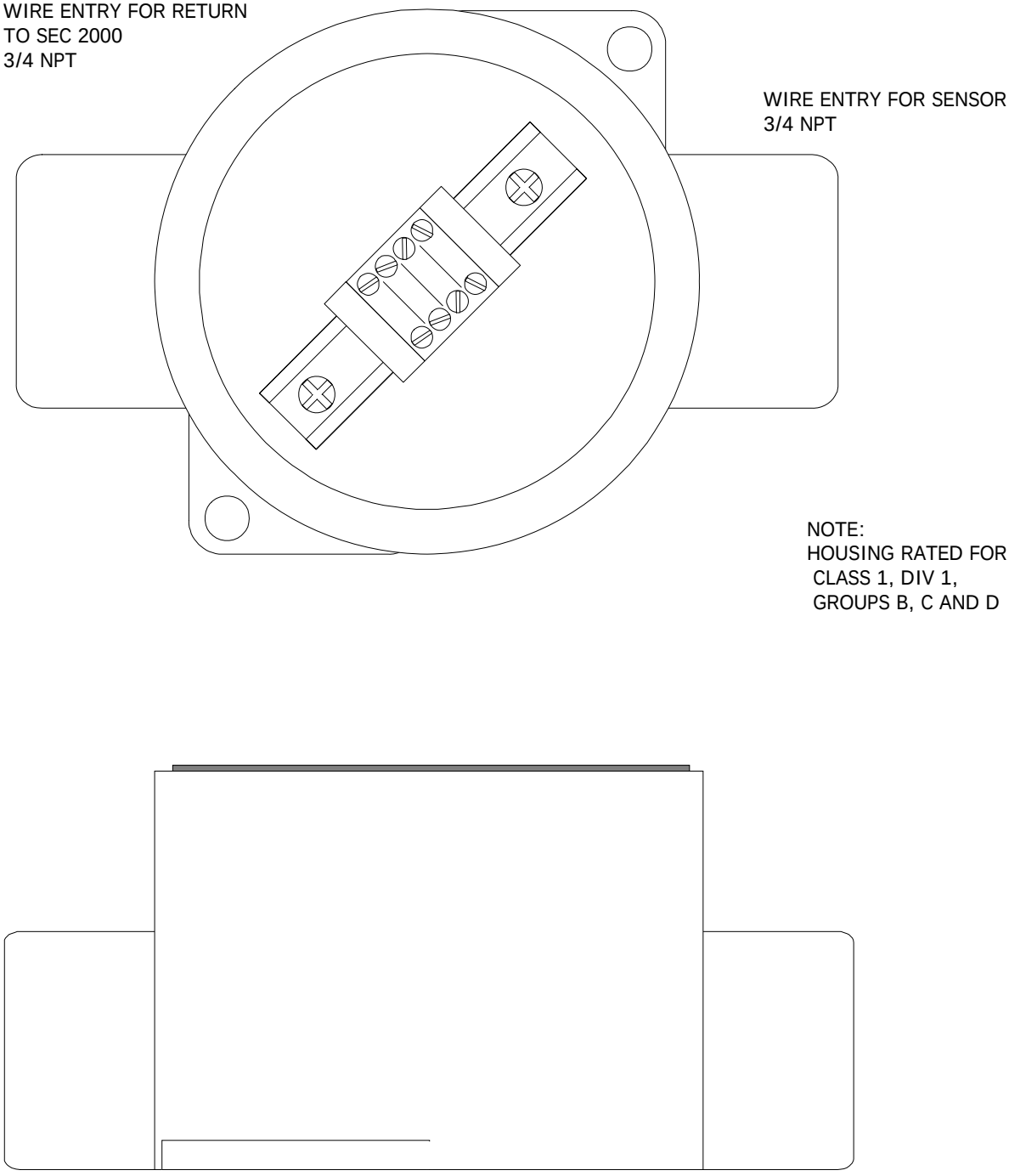


SENSOR ELECTRONICS CORPORATION

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WIRING DIAGRAM
MILLENIUM SENSOR

FIGURE 1



SENSOR ELECTRONICS CORPORATION

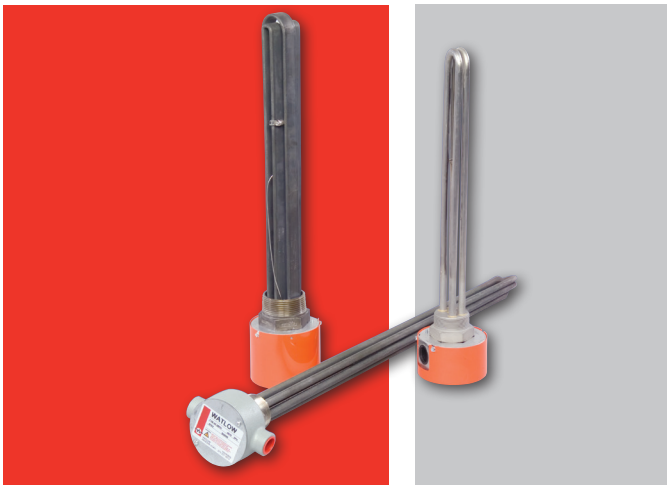
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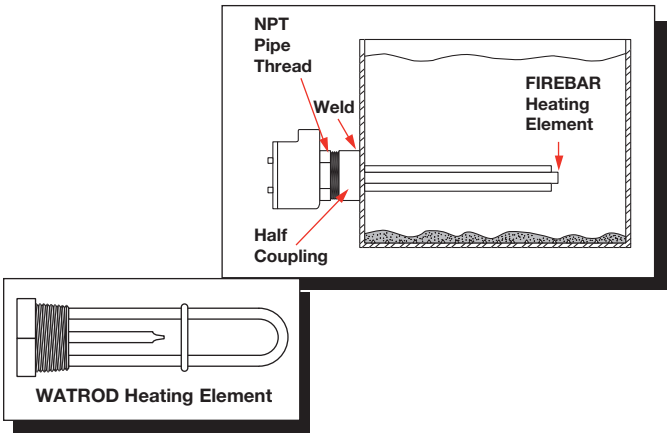
SEC SENSOR
SEPARATION KIT

FIGURE 2

Screw Plug Immersion Heaters

Ideal for Direct Immersion Heating of Liquids





Screw plug immersion heaters are ideal for direct immersion heating of liquids, including all types of oils and heat transfer solutions.

Available in a variety of sizes, Watlow® screw plug immersion heaters feature both WATROD™ round and FIREBAR® flat tubular elements.

Heating elements are hairpin bent and either welded or brazed into the screw plug—depending on element sheath and plug material compatibility.

General purpose terminal enclosures are standard; with optional moisture resistant, explosion resistant and explosion/moisture resistant enclosures available to meet specific application needs.

Optional thermostats provide convenient process temperature regulation.

Performance Capabilities

- Watt densities up to 120 W/in^2 (18.6 W/cm^2)
- Wattages up to 38 kilowatts
- UL® and CSA component recognition up to 480VAC and 600VAC respectively
- Alloy 800/840 sheath temperatures up to 1600°F (870°C)
- Passivated 316 stainless steel sheath temperatures up to 1200°F (650°C)
- 304 stainless steel sheath temperatures up to 1200°F (650°C)
- Steel sheath temperatures up to 750°F (400°C)

Features and Benefits

A variety of element sheath and screw plug materials
- Meets a variety of application needs

Integral thermowells
- Provides convenient temperature sensor insertion and replacement without draining the fluid being heated

Terminal enclosures
- Provides ability to be rotated to simplify connection with existing conduits

Welding or brazing WATROD and FIREBAR elements to the screw plug
- Provides a pressure tight seal

WATROD hairpins are repressed (recompacted)
- Maintains magnesium oxide density, dielectric strength, heat transfer and life

2 1/2 in. (64 mm) NPT screw plug assemblies feature element support(s)
- Ensures proper spacing for maximizing heater performance and life

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WATLOW®

Typical Applications

- Water:
  - Deionized
  - Demineralized
  - Clean
  - Potable
  - Process
- Industrial water rinse tanks
- Vapor degreasers
- Hydraulic oil, crude, asphalt
- Lubricating oils at API specified watt densities
- Air and gas flow
- Caustic solutions
- Chemical baths
- Anti-freeze (glycol) solutions
- Paraffin

Specifications

- **Screw plug and element sizes:**

1 in. NPT	0.260 and 0.315 in. WATROD
1 1/4 in. NPT	0.260 and 0.315 in. WATROD 1 in. FIREBAR
2 in. NPT	0.430 and 0.475 in. WATROD
2 1/2 in. NPT	0.430 and 0.475 in. WATROD 1 in. FIREBAR

- **Phase capability**:

1 in. NPT	1-Phase
1 1/4, 2, 2 1/2 in., NPT	1- or 3-Phase

UL® and CSA component recognition under File E52951 and 31388 respectively.

Options

Terminal Enclosures

General purpose terminal enclosures, without thermostats, are available on all screw plug immersion heaters. To meet specific application requirements, Watlow offers the following optional terminal enclosures:

- General purpose with single- or double-pole thermostat
- Moisture-resistant or corrosion-resistant available with optional single- or double-pole thermostat
- Explosion-resistant Class 1, Groups B, C and D explosion resistant available with optional single- or double-pole thermostat
- Explosion and moisture-resistant combination available with optional single- or double-pole thermostat

Note: Unless otherwise stated on the accompanying illustrations, both WATROD and FIREBAR screw plugs are centered on the terminal enclosure. To order, add the suffix letter(s) to the screw plug heater's base part number. Also, specify class and group, if applicable.

CSA Certified Enclosures

CSA certified moisture and/or explosion-resistant terminal enclosures protect wiring in hazardous gas environments. These terminal enclosures, covered under CSA File number 61707, are available on all WATROD and FIREBAR screw plug immersion heaters. For additional information, contact a Watlow representative.

To order, specify **CSA certified enclosure**, **process temperature** (°F), maximum **working pressure** of application (psig), **media** being heated and heater **mounting orientation** (horizontal or vertical) and **screw plug size**.

ASME Pressure Vessel Code Welding

Screw plug assemblies can be provided with an ASME Section VIII, Div. I pressure vessel stamp upon request.

Pilot Light

The optional pilot light gives the operator visual indication of heater on or off power status.

The PL10 pilot light is configured to a maximum 250VAC and supplied with 6 in. (152 mm) leads.

The PL11 pilot light is rated for 480VAC and supplied with 4 in. (102 mm) leads.

Pilot lights may be attached to either single- or double-pole thermostats with general purpose enclosure only.

Thermostats

To provide process temperature control, Watlow offers optional single-pole, single-throw (SPST) and double-pole, single-throw (DPST) thermostats.

Unless otherwise specified, thermostats are mounted inside the terminal enclosure. Please verify that the thermostat's sensing bulb O.D. is compatible with the screw plug's thermowell I.D.

Thermocouples

Type J or K thermocouples offer extremely accurate sensing of process and/or sheath temperatures. A thermocouple may be inserted into the thermowell or attached to the heater's sheath.

Thermocouples are supplied with 120 in. (3048 mm) leads (longer lead lengths available). Unless otherwise specified, thermocouples are supplied with temperature ranges detailed on the *Thermocouple Types* chart.

Using a thermocouple requires an appropriate temperature and power controller, these must be purchased separately. Watlow offers a wide variety of temperature and power controllers to meet virtually all applications. Temperature controllers can be configured to accept process variable inputs, too. Contact a Watlow representative for details.

To order, specify **Type J** or **K** thermocouple and lead length. Indicate if the thermocouple is for **process temperature sensing** or heater sheath **high-limit protection**. Please specify if the screw plug will be mounted **vertical** or **horizontal** in the tank. **If vertical, indicate if the housing is on top or bottom**.

If the screw plug heater is mounted in an in-line circulation heating application, indicate flow direction relative to the heater's enclosure.

Options *(Continued)*

Thermocouple Types

ASTM Type	Conductor Characteristics Positive	Conductor Characteristics Negative	Recommended Temperature Range °F	Recommended Temperature Range (°C)
J	Iron (Magnetic)	Constantan (Non-Magnetic)	0 to 1000	(-20 to 540)
K	Chromel® (non-magnetic)	Alumel® (Magnetic)	0 to 2000	(-20 to 1100)

Note: Type J and Type K thermocouples are rated 32 to 1382°F and 32 to 2282°F (0-750°C and 0-1250°C), respectively. Watlow does not recommend exceeding temperature ranges shown on this chart for the tubular product line.

Wattages and Voltages

Watlow routinely supplies screw plug immersion heaters with 120 to 480VAC as well as wattages from 250 watts to 38kW. If required, Watlow may configure heaters with voltages and wattages outside these parameters. For more information on special voltage and wattage configurations, contact a Watlow representative.

Sheath Materials

The following sheath materials are available on WATROD and FIREBAR heating elements:

Standard Sheath Materials

WATROD	Alloy 800/840 316 SS Steel
FIREBAR	Alloy 800

Extended Sheath Materials

WATROD	304 and 321 SS Alloy 400 and 600 Titanium Hastelloy C276
FIREBAR	304 SS Alloy 800

External Finishing

Passivation

During the manufacturing process, particles of iron or tool steel may become embedded in the stainless steel or alloy sheath. If not removed, these particles may corrode, produce rust spots and/or contaminate the process. For critical applications, passivation will remove free iron from the sheath. To order, specify **passivation**.

Other Finishes

Bright annealing available to meet cosmetic demands.

Screw Plug Materials

The following screw plug materials are available:

To order, specify **screw plug size** and **material**.

Standard Screw Plug Materials

WATROD	316 SS Steel Brass
FIREBAR	304 SS

Extended Screw Plug Materials

WATROD	304, 304H, 316H, 321 SS Titanium Alloy 400 and 600 Hastelloy C276 Alloy 800/840

Screw Plug Sizes

Including European

- **NPT**– ¾, 1, 1¼, 2, 2½ in.

To order, specify **size**, **style** (NPT) and material.

- **Gas (Gas Pipe Standard)** – G1¼, G1½, G2 in. (brass only)
- **BSP (British Standard Pipe)** – 1½, 2 in. (stainless steel only)

Contact a Watlow representative for sizes and materials not listed.

Screw Plug to Flange Adapters

Screw plug to flange adapters permit replacing flange heaters with screw plug heaters. To order, specify the appropriate part number.

Screw Plug to Flange Adapter Sizes	Material	Estimated Shipping Wt. lbs	Estimated Shipping Wt. (kg)	Delivery	Part Number
1¼ to 3 in.-150#	Steel	13	(5.9)	RS	**125X3SA**
2½ to 3 in.-150#	Steel	11	(5.0)	RS	**250X3SA**
2½ to 4 in.-150#	Steel	16	(7.3)	RS	**250X4SA**
2½ to 5 in.-150#	Steel	25	(11.3)	RS	**250X5SA**
2½ to 6 in.-150#	Steel	33	(15.0)	RS	**250X6SA**

RAPID SHIP

- **RS** - Next day shipment up to 3 pieces

Watlow® and FIREBAR® are registered trademarks of Watlow Electric Manufacturing Company.
WATROD™ is a trademark of Watlow Electric Manufacturing Company.
UL® is a trademark of Underwriter's Laboratories, Inc.
Alumel® and Chromel® are registered trademarks of Hoskins Manufacturing Company.

To be automatically connected to the nearest North American Technical Sales Office:

1-800-WATLOW2 • www.watlow.com • inquiry@watlow.com

International Technical Sales Offices: Australia, +61 3 9335 6449 • **China,** +86 21 3532 8532 • **France,** +33 1 41 32 79 70
Germany, +49 (0) 72 53 / 94 00-0 • **India,** +91 40 6661 2700 • **Italy,** +39 024588841 • **Japan,** +81 3 3518 6630 • **Korea,** +82 2 2628 5770
Malaysia, +60 3 8076 8745 • **Mexico,** +52 442 217 6235 • **Singapore,** +65 6773 9488 • **Spain,** +34 91 675 12 92
Taiwan, +886 7 288 5168 • **United Kingdom,** +44 (0) 115 964 0777

Pre Installation

- Check to make sure that heater received is the same as that ordered.
- Watlow heaters are built to comply with UL and CSA dielectric requirements, it may be necessary due to atmospheric conditions / humidity, to perform a dielectric test prior to startup. (Refer to **megohm test** under **Installation** section)

Safety

Electric heaters are inherently dangerous!! Care should be taken to read and completely understand the Installation and Maintenance manual before installing and wiring the heater. Any installation and maintenance performed on the heater shall be done by a qualified electrician, in accordance with the "National Electric Code" and other electrical codes as they apply. It is the users responsibility to ensure that the heater being used is properly selected and installed in the application.



The Caution Symbol (exclamation point) alerts you to a **"CAUTION"**, a safety or functional hazard which could affect your equipment or its performance.



The warning symbol (lightning bolt) alerts you to a **"WARNING"**, a safety hazard which could affect you and the equipment

Installation

Proper heater selection and installation will result in efficient heat transfer, safe operation, and long heater life.

1. Megohm precheck

During shipping and/or storage, the possibility of moisture absorption by the insulation material within the element is possible. To ensure proper megohm values a minimum 500 VDC megohm meter (Megger) should be used to ensure that the megohm reading between the heater terminal and the heater sheath is more than 10 megohms when the unit is at room temperature.

If a low megohm value exists, two alternative methods can be used to remedy the situation. The best method is to remove all terminal hardware and bake out the heater at no higher than 250°F (120°C) overnight or until an acceptable reading is reached. The second method is to energize the unit at low voltage in air until the megohm is at an acceptable reading. Care should be taken to prevent the heater sheath from exceeding 750°F (398°C) for Incoloy® and steel elements and 400°F (204°C) for copper elements.

2. Protection of heater elements from over temperature

The use of temperature controls to regulate heating process and prevent heater over temperature is highly recommended to ensure safe heater operation. It is the users responsibility to ensure safety of the installation.



<u>WARNING</u>: ***Install high temperature control protection in systems where an over temperature fault condition could present a fire hazard or other hazard. Failure to install temperature control protection where a potential hazard exists could result in damage to equipment and property, and injury to personnel.***

Failure of components in a temperature control loop, such as the sensor, heater control relay or main temperature control, can result in damage to a product in process, a melt down of a heater, and / or damaging fire.

To protect against this possibility, over temperature protection must be provided to interrupt or remove power from the heater circuit. **A bulb and capillary thermostat is not recommended for this function since it may not respond quickly enough to adequately protect the heater. In cases where the thermostat bulb gets too hot before the system is turned off, the thermostat bulb could rupture. This could result in the thermostat remaining in the "ON" condition since there is insufficient fluid to move contacts apart.** We recommend the temperature protection have appropriate third party approval, and be applied in the classification for which it was tested and approved.

In immersion applications, to help prevent premature failure and a potentially hazardous condition in cases where consequences of failure may be severe, use an appropriate third party approved liquid level protection device. The liquid level should be such that the entire heater is fully submerged with enough liquid above the heater to adequately dissipate heat from itself as under normal operating conditions. Consult your local authorized sales representative for specific recommendations for your application.

3. Termination / Environment

In order to maintain termination integrity, the termination should be kept below 250°F (121°C) or the maximum temperature rating of the end seal. Keep terminations clean, dry and tight.

DANGER: HAZARD OF FIRE. Electric heaters are capable of developing high temperatures so extreme care should be taken to locate heaters in safe environments. Mounting heaters in atmospheres containing combustible gases and vapors should be avoided. According to article 501 of the NEC, the maximum surface temperature of the heater shall not exceed 80 % of the auto-ignition of the surrounding atmosphere when the heater is continuously energized. Care should also be taken to keep combustible materials far enough away to be free of the effects of high temperatures.

4. Wiring



WARNING; HAZARD OF ELECTRIC SHOCK. Any installation involving electric heaters must be grounded to earth to eliminate shock hazard.

Electrical wiring to the heaters must be installed in accordance with the National Electric Code and any state and local electrical code by qualified personnel.

Line voltage must be equal to or less than rating stamped on the heater assembly.

5. Miscellaneous

For immersion applications, extend the heated section completely into the media being heated at all times to maximize heat transfer and heater reliability.

Do not locate the end of heated length within a bend unless the radius is 3 inches or longer.

The cold end junction must be located a minimum of one inch from any bend. If these parameters are not followed, the heater may fail prematurely.

For FIREBAR® elements, Watlow does not recommend field bending of the elements. However, if the element must be bent in the field, please consult your local Watlow sales engineer or authorized distributor for assistance.

Start Up

Before energizing the heater the following items should have been checked with the heater power disconnected:

1. Immersed section of heater is completely covered by liquid in immersion applications
2. Electrical termination is tight
3. Proper disconnecting means and fusing have been installed
4. The voltage rating of the heater is the same as that being applied
5. Megohm is within acceptable limits
6. Proper temperature controls and safety limiting devices are in place
7. Heater is securely installed in appliaction

After applying power to the heater make sure that the system is being controlled properly before leaving it to run unattended. Failure to do this could result in overheating resulting in personnel danger and fire.

Troubleshooting

PROBLEM	Cause / Correction
No power available to heater	Check disconnect switch to ensure it is in the "ON" position and that fuses are not blown. Replace fuses if they are blown
Fuses blowing	Check heater electrical rating. Applied voltage may be wrong Check fuse rating. Fuses should be at least 25% more than full load amperage. Disconnect heater power source. Check the heater resistance to ground. This should be no less than 1 Megohm. Refer to Megohm checking.
Not enough power	Check line voltage to ensure it is within specification Check full line current if voltage is correct. If line current is lower, the heater may be wired wrong or has open elements
Application not heating to desired temperature	Not enough Kw or incorrect voltage being applied Too much heat loss, higher wattage heater may be required

Preventative Maintenance



CAUTION: HAZARD OF ELECTRIC SHOCK. TURN ALL POWER TO HEATER OFF, USE APPROPRIATE DISCONNECT LOCKOUTS AND ALLOW SYSTEM/HEATER TO COOL BEFORE PERFORMING ANY MAINTENANCE

Check line connections to make sure they are tight, free of oxide build-up, and that no dust or dirt build-up is present.

Liquid immersed units should be removed from tank and checked periodically for scale build-up. Clean as required. Scale can cause high sheath temperature and result in inefficiency and shortened life.

Replacement Parts

Reference the Watrod or FIREBAR® part number on the heater when ordering replacement parts.
Recommended spare parts would be : a Watrod or FIREBAR® heater

Contact your local Watlow distributor for ordering replacement parts. Check the Yellow Pages under "Electrical Heating Elements" in the largest industrial area nearest you.

Warranty

Watlow warrants its products against defects in material and workmanship for 12 months from the date of delivery for custom products and 18 months for stock products providing such products are properly applied, used and maintained. Watlow does not warrant any product against damage from corrosion, contamination, misapplication, improper specification or operating conditions beyond our control. The terms of this warranty are the exclusive terms available to any person. No person has authority to bind the Company to representation or warranty other than this warranty. Watlow is not liable for incidental or consequential damages resulting from use of the product whether a claim for such damages is based upon warranty, contract, negligence or other fault. Should any product fail under these warranty conditions it will be repaired or replaced at no charge. Advanced authorization must be obtained within 30 days of failure.

Return Policy

1. Call Watlow Industries at 573-221-2816, for a Return Material Authorization (RMA) number before returning any item for repair or replacement. The following information is needed to process a returned heater expeditiously:

    - Customer name
    - Contact Name
    - Part number
    - Quantity
    - Reason for return
    - Application information
    - Customer account number
    - Phone Number
    - P.O. number
    - MSDS sheet of material(s) that came in contact with heater, if used.

    2. Prior approval and an RMA number is needed when returning any unused product for credit. Make sure the RMA number is on the outside of the carton, and on all paperwork. Return all material Freight Prepaid basis.

    3. Stock heaters and accessories which have not been used or modified can be returned to the plant for a 20% restocking charge. Modified stock units can only be returned, if they are not permanently modified, for a minimum 30% restocking charge.

    4. All
    5. stock and modified stock must have a date code no later than 2 years from the date of shipment.

REVISIONS

LEVEL	DESCRIPTION	INITIALS	DATE
1.00	SEE PART COMMENTS		
2.00	HAN2838	TBR	06-11-08

User's guide

Guia del usuário

Manual do usuário



SSW 07
SOFT-STARTER

Soft-Starter

Arrancador Suave

Chave de Partida Soft-Starter

SOFT-STARTER
MANUAL

Series: SSW-07

0899.5318 E/2

12/2006

The information below describes the revisions in this manual.

Revision	Description	Chapter
1	First Edition	-
2	General Revision	-

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SAFETY INSTRUCTIONS

This Manual contains the necessary information for the correct use of the Soft-Starter SSW07.
It was written to be used by qualified personnel with suitable training or technical qualifications to operate this type of equipment.

1.1 SAFETY NOTICES IN THE MANUAL

The following safety notices will be used in the text.



DANGER!
Failure to observe the recommended procedures may lead to serious or fatal injuries and considerable material damage.



ATTENTION!
Failure to observe the recommended procedures in this notice may lead to material damage.



NOTE!
Important information for the correct understanding and good function of the product.

1.2 SAFETY NOTICES ON THE PRODUCT

The following symbols may be attached to the product as a safety notice.



High Voltages



Components are sensitive to electrostatic discharge. Do not touch them.



Mandatory connection to ground protection (PE)

1.3 PRELIMINARY RECOMMENDATIONS



DANGER!
Only personnel with suitable qualification and familiar with the Soft-Starter SSW-07 and associated equipment should plan or implement the installation, startup, operation and maintenance of this equipment.
These personnel must follow all safety instructions in this Manual and/or defined by local regulations.
Failure to follow these safety instructions may result in personnel injury and/or equipment damage.



NOTE!
In this Manual, qualified personnel are those trained to:

1. Install, ground, power-up, and operate the Soft-Starter SSW-07 according to this Manual and the required safety procedures;
2. Use protection equipment according to established regulations;
3. Give First Aid.



DANGER!
Always disconnect the general power supply before touching any electrical component associated to the Soft-Starter SSW-07.
High voltage may be present even after the power supply is disconnected. Wait at least 3 minutes for the total discharge of the capacitors.
Always connect the equipment's heatsink to the protection ground (PE), at the proper connection point.



ATTENTION!
All electronic cards have component that are sensitive to electrostatic discharges. Do not touch these components or connectors directly.
If necessary, first touch the grounded metallic heat sink or wear a suitable ground strap.

Do not apply any high voltage test on the Soft-Starter SSW-07!
If necessary, contact the manufacturer.



NOTE!
Soft-Starters SSW-07 may interfere with other electronic equipment. Follow the measures in Chapter 3 to reduce these effects.



NOTE!
Read this Manual completely before installing or operating the Soft-Starter SSW-07.

GENERAL INFORMATION

2.1 ABOUT THE MANUAL

This manual presents the soft-starter installation, how to start it up, its main technical characteristics and how to identify and correct the most common problems. The manuals listed next must be consulted in order to get more information regarding the functions, accessories and working conditions:

☑ Programming Manual, with a detailed description of the parameters and its functions;
☑ RS232 / RS485 Communication Manual.

These manuals are supplied in electronic format on the CD-ROM that accompanies the soft-starter, or can be obtained at WEG's web site: http://www.weg.net.

2.2 ABOUT THE SSW-07 SOFT-STARTER

The Soft-Starter SSW-07 is a high performance product that permits the start control of the three phase AC induction motors. Thus, it prevents mechanical shocks on the load and current peaks in the supply line.

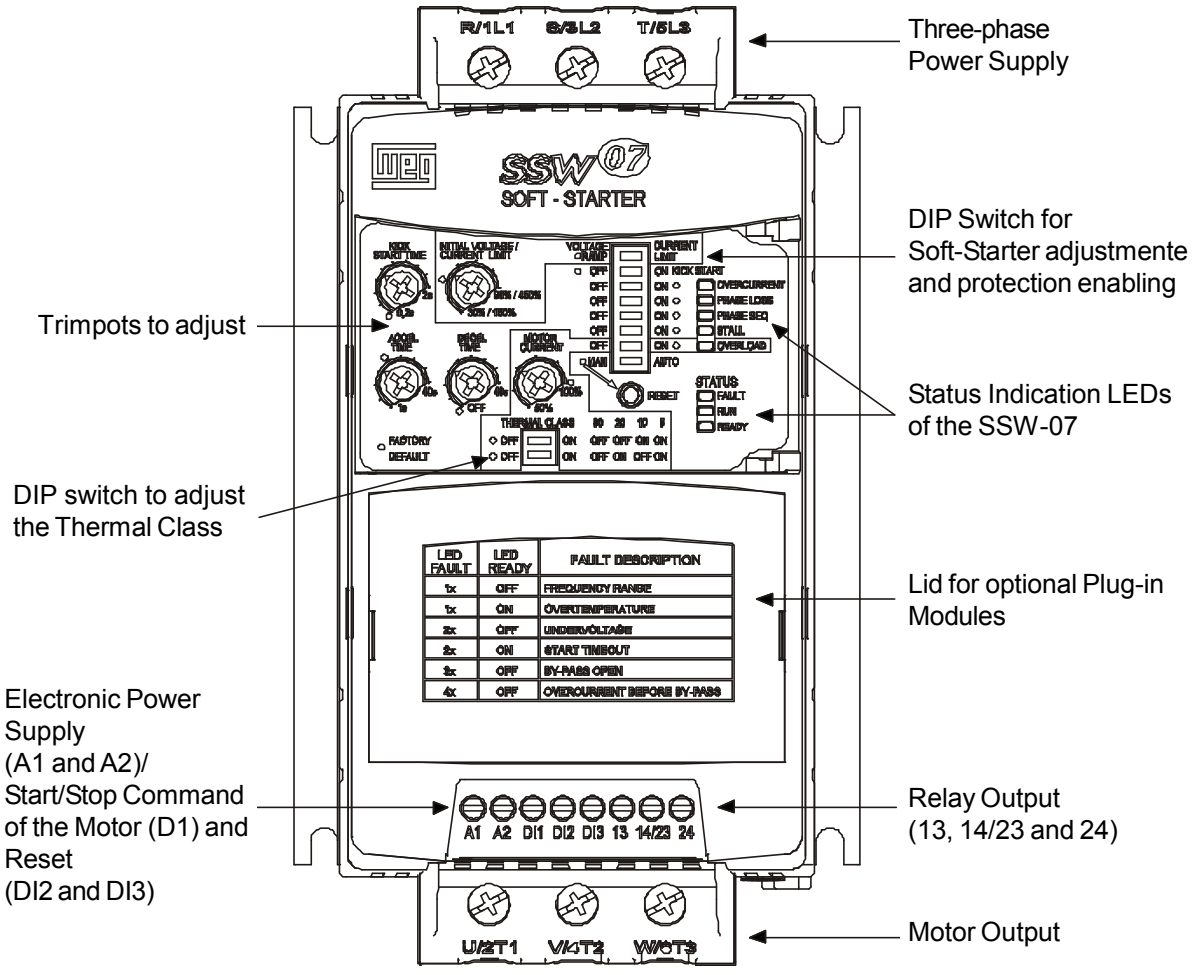


Figure 2.1 - *Frontal view of the SSW-07*

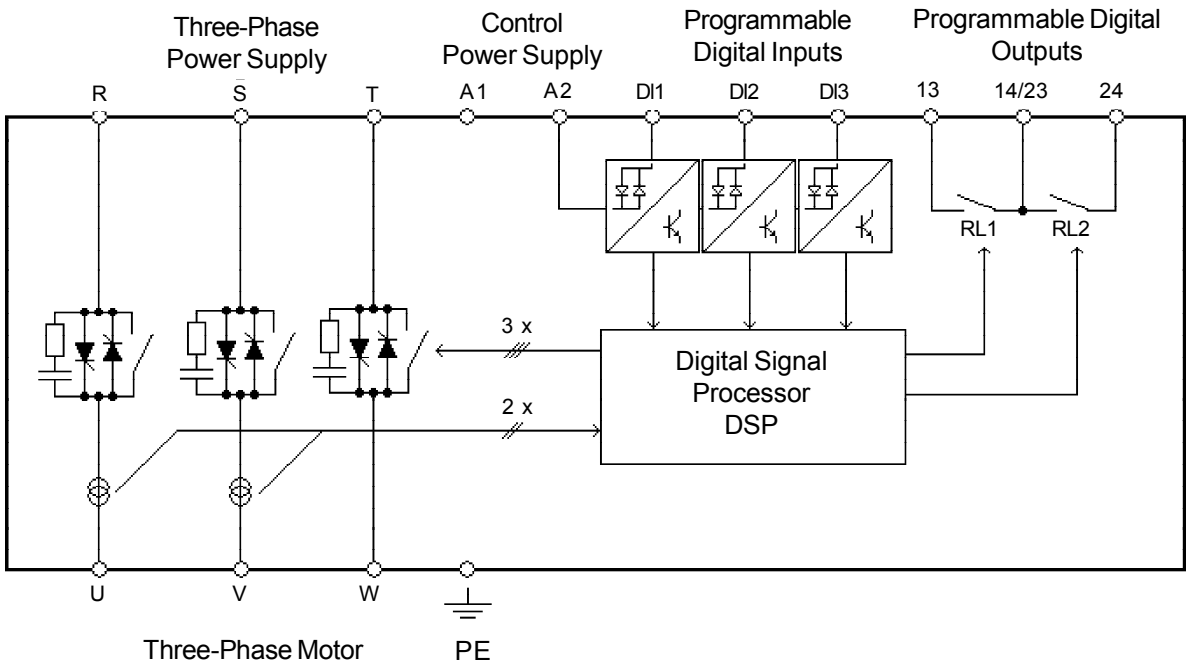


Figure 2.2 - *Soft-Starter SSW-07 block diagram*

2.3 SOFT-STARTER SSW-07 IDENTIFICATION PLATE

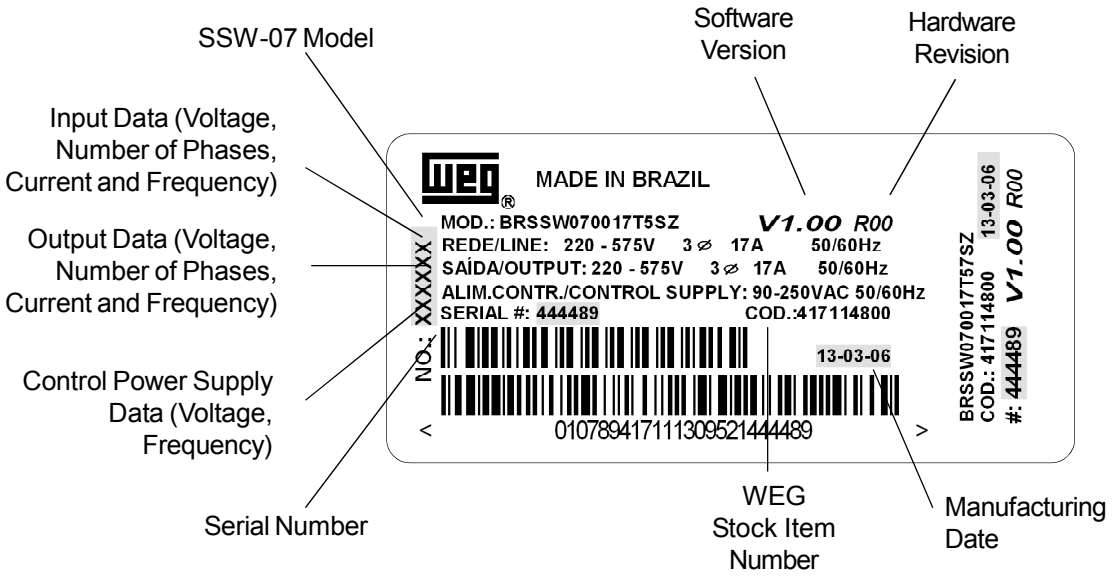


Figure 2.3 *- Soft-Starter SSW-07 identification plate*

Position of the Identification Plate on the Soft-Starter SSW-07:

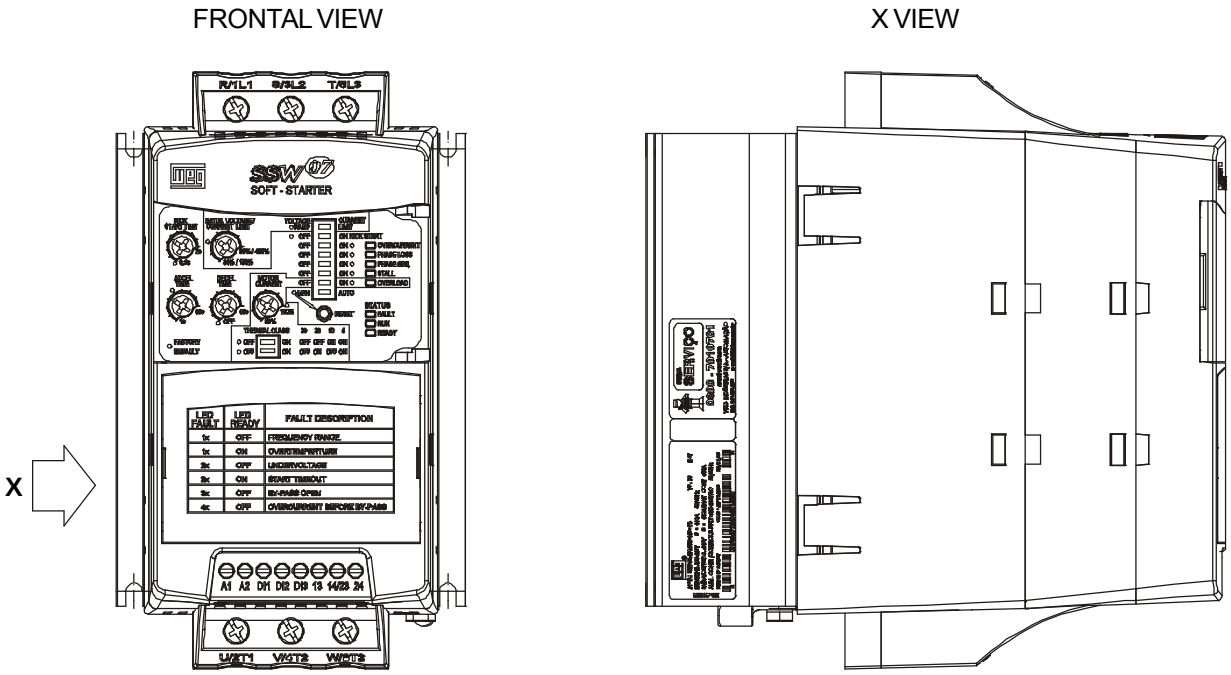


Figure 2.4 *– Detail of the Soft-Starter SSW-07 identification plate*

HOW TO SPECIFY THE SSW-07 MODEL:

EN	SSW07	0017	T	5	S	- -	- -	- -	Z
Market/Manual BR = Brazil PT = Portugal EN = English SP = Spanish	WEG Soft-Starter Series SSW-07	SSW-07 Rated Current 0017 = 17A 0024 = 24A 0030 = 30A 0045 = 45A 0061 = 61A 0085 = 85A 0130 = 130A 0171 = 171A 0200 = 200A	Three-Phase Power Supply	220-575 Vac	Optional: S = Standard O = with Optional	Degree of Protection Blank = Standard IP=IP20 (1)	Special Hardware Blank = Standard	Special Software Blank = Standard	End of Code

(1) Only for models 130A to 200A.

NOTE!

The option field (S or O) defines if the Soft-Starter SSW-07 will be a standard version or if it will include any optional. If standard, the code ends here.

Always put the letter Z at the end. For example:

ENSSW070017T5SZ = Standard Soft-Starter SSW-07 with 17A and 220V to 575V to three-phase input with Manual in English.

If there is any optional, the fields must be filled out in the correct sequence until the code is completed with the letter Z.

The standard product as defined by this code is described as:

☑ Degree of Protection: IP20 from 17A to 85A and IP00 from 130A to 200A.

2.4 RECEIVING AND STORAGE

The Soft-Starter SSW-07 is supplied in a cardboard box. On the outside of the package there is an identification plate which is identical to the one placed on the Soft-Starter SSW-07.
To open the package:
1- Put it on a table;
2- Open the package;
3- Take out the soft-starter.

Check if:
☑ The Identification plate of the Soft-Starter SSW-07 matches the model purchased:

☑ Damage has occurred during transport. If so, contact the carrier immediately.

☑ If the Soft-Starter SSW-07 is not installed immediately, store it in its package in a clean and dry place (temperature between -10ºC and 65º C), (14ºF and 149ºF).

SSW-07 Model	Height H mm (in)	Width L mm (in)	Depth P mm (in)	Volume cm^3 (in^3)	Weight kg (lb)
SSW-070017 SSW-070024 SSW-070030	221 (8.70)	180 (7.09)	145 (5.71)	5768 (352.2)	1.65 (3.64)
SSW-070045 SSW-070061 SSW-070085	260 (10.24)	198 (7.80)	245 (9.65)	12613 (770.8)	3.82 (8.42)
SSW-070130 SSW-070171 SSW-070200	356 (14.02)	273 (10.75)	295 (11.61)	28670 (1750)	8.36 (18.43)

Table 2.1 *- Dimensions of the package in mm (in)*

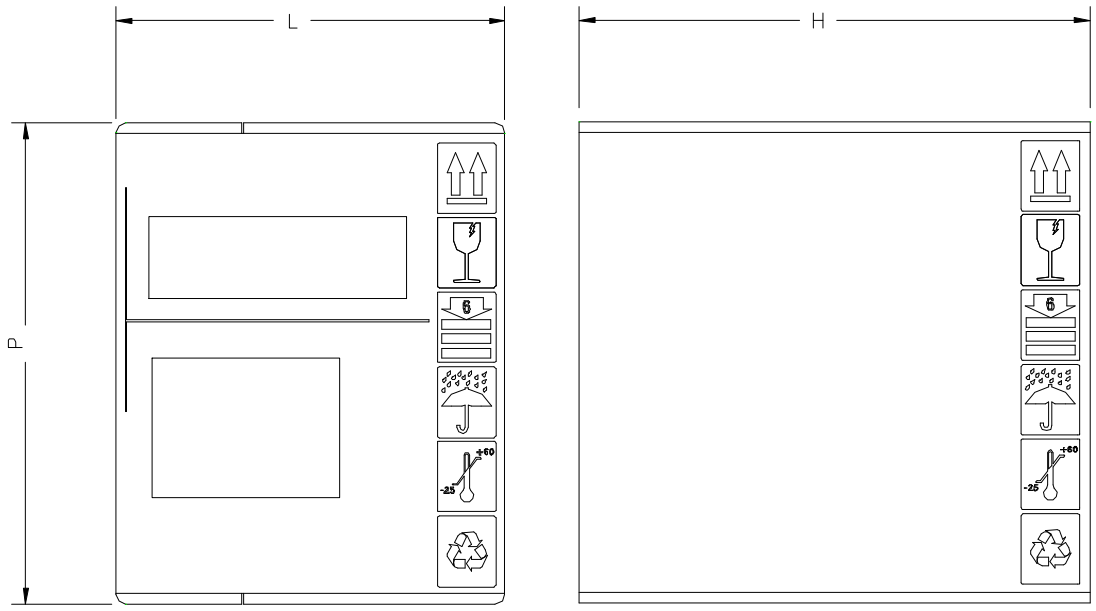


Figure 2.5 - *Dimensions of the package*

INSTALLATION AND CONNECTION

This chapter describes the procedures for the electrical and mechanical installation of the Soft-Starter SSW-07. The guidelines and suggestions must be followed for the correct operation of the Soft-Starter SSW-07.

3.1 MECHANICAL INSTALLATION

3.1.1 Environmental Conditions

The location of the Soft-Starters SSW-07 is an important factor to assure the correct operation and high product reliability.

Avoid:

☑ Direct exposure to sunlight, rain, high moisture and sea air ;
☑ Exposure to gases or explosive and corrosive liquids;
☑ Exposure to excessive vibration, dust or any metallic and/or oil particles in the air.

Allowed Environmental Conditions:

☑ Surrounding air Temperature: 0ºC to 55ºC (32ºF to 131ºF) - nominal conditions.
☑ Relative air humidity: 5% to 90%, with no-condensation.
☑ Maximum altitude: 1,000m (3,300ft) above sea level - nominal conditions. From, 1,000m to 4,000m (3,300ft to 13,200ft) above sea level – current reduction of 1% for each 100m (330ft) above 1,000m (3,300ft).
☑ Pollution degree: 2 (according to the UL508).
Normally, only non conductive pollution. Condensation must not cause conduction in the particles in the air.

3.1.2 SSW-07 Soft-Starter Dimensions

The external dimensions and mounting holes are shown in figure 3.1 and table 3.1. below.

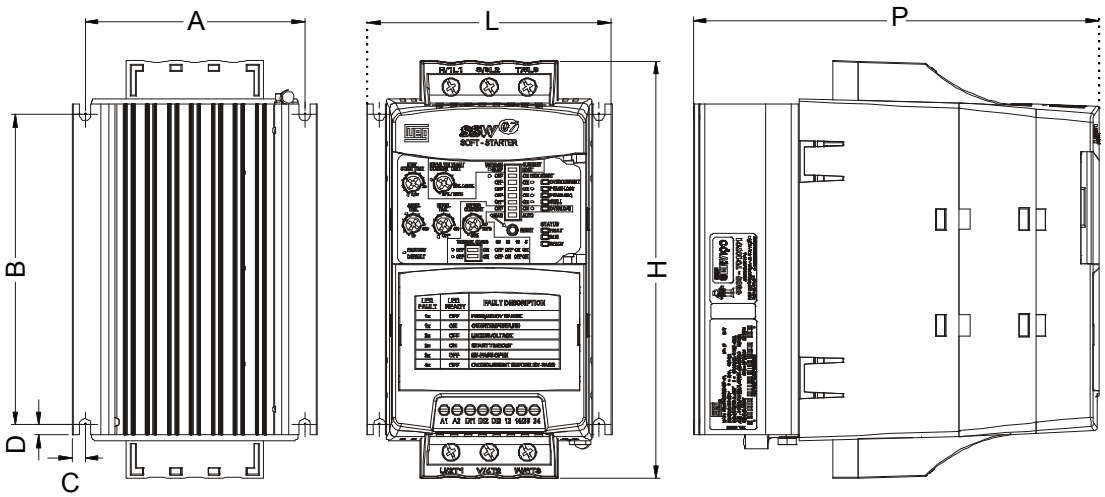


Figure 3.1 - *SSW-07 dimensions*

Model SSW-07	Height H mm (in)	Width L mm (in)	Depth P mm (in)	A mm (in)	B mm (in)	C mm (in)	D mm (in)	Mounting screw	Weight kg (lb)	Degree of Protection
SSW-070017 SSW-070024 SSW-070030	162 (6.38)	95 (3.74)	157 (6.18)	85 (3.35)	120 (4.72)	5 (0.20)	4 (0.16)	M4 (5/32")	1.3 (2.9)	IP20
SSW-070045 SSW-070061 SSW-070085	209 (8.2)	141 (5.57)	202 (7.94)	132 (5.2)	149 (5.87)	4.7 (0.19)	3.4 (0.13)	M4 (5/32")	3.3 (7.28)	IP20
SSW-070130 SSW-070171 SSW-070200	276 (10.9)	218 (8.6)	220 (8.66)	207 (8.15)	213 (8.39)	6 (0.24)	3.5 (0.14)	M4 (3/16")	7.6 (16.8)	IP00 *

* IP20 with optional kit for size 3.

Table 3.1 *- Installation data with dimensions in mm (in)*

3.1.3 Mounting Specifications

To install the Soft-Starter SSW-07 leave at least the free spaces surrounding the Soft-Starter as in figure 3.2 below. The dimensions of these free spaces are described in table 3.2.

Model SSW-07	A mm (in)	B mm (in)	C mm (in)
SSW-070017 SSW-070024 SSW-070030	50 (2)	50 (2)	30 (1.2)
SSW-070045 SSW-070061 SSW-070085	80 (3.2)	80 (3.2)	30 (1.2)
SSW-070130 SSW-070171 SSW-070200	100 (4)	100 (4)	30 (1.2)

Table 3.2 *- Recommended free spaces*

Install the Soft-Starter SSW-07 in the vertical position according to the following recommendations:

1) Install on a reasonably flat surface;
2) Do not put heat sensitive components immediately above the Soft-Starter SSW-07.



ATTENTION!
If a Soft-Starter SSW-07 is installed on top of another use the minimum distance A + B and diverge from the top Soft-Starter the hot air that comes from the one beneath it.



ATTENTION!
Independent conduits or cable trays must be planned for physic separation of signal, control and power cables. (Refer to item 3.2 Electric installation).

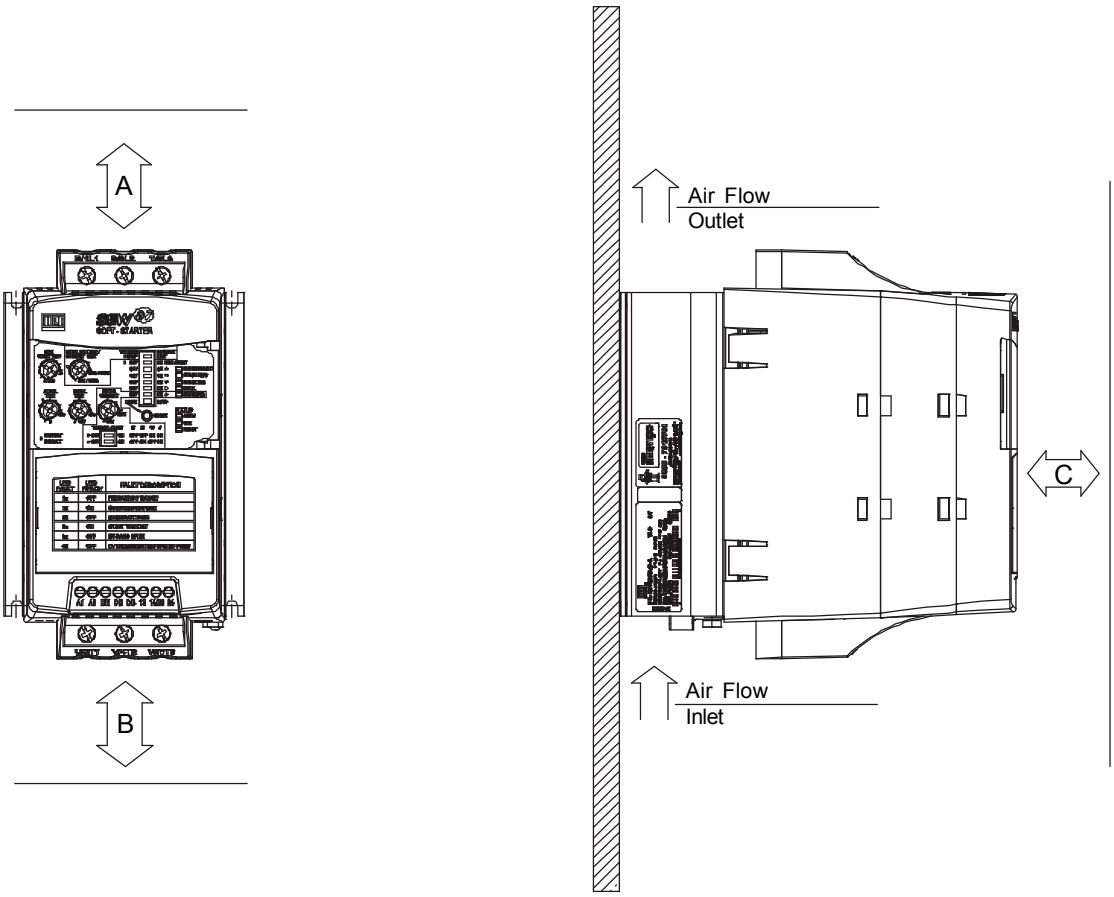


Figure 3.2 *- Free spaces for ventilation*

3.1.3.1 Mounting Inside a Panel

For Soft-Starters SSW-07 installed in panels or closed metallic boxes exhaustion/cooling is required so the temperature does not exceed the maximum allowed. See dissipated nominal power in table 3.3.

Model SSW-07	Dissipated Power in the electronics (W)	Average Power dissipated 10 starts/h 3 x in @ 30s (W)	Total Average Power dissipated 10 starts/h 3 x in @ 30s (W)
SSW-070017	12	15.3	27.3
SSW-070024	12	21.6	33.6
SSW-070030	12	27	39
SSW-070045	12	41	53
SSW-070061	12	55	67
SSW-070085	12	77	89
SSW-070130	12	117	129
SSW-070171	12	154	166
SSW-070200	12	180	192

Table 3.3 *- Dissipated power for ventilator panel dimensioning*

3.1.3.2 Mounting on Surface

Figure 3.3 shows the installation of the Soft-Starter SSW-07 on the surface of a mounting panel.

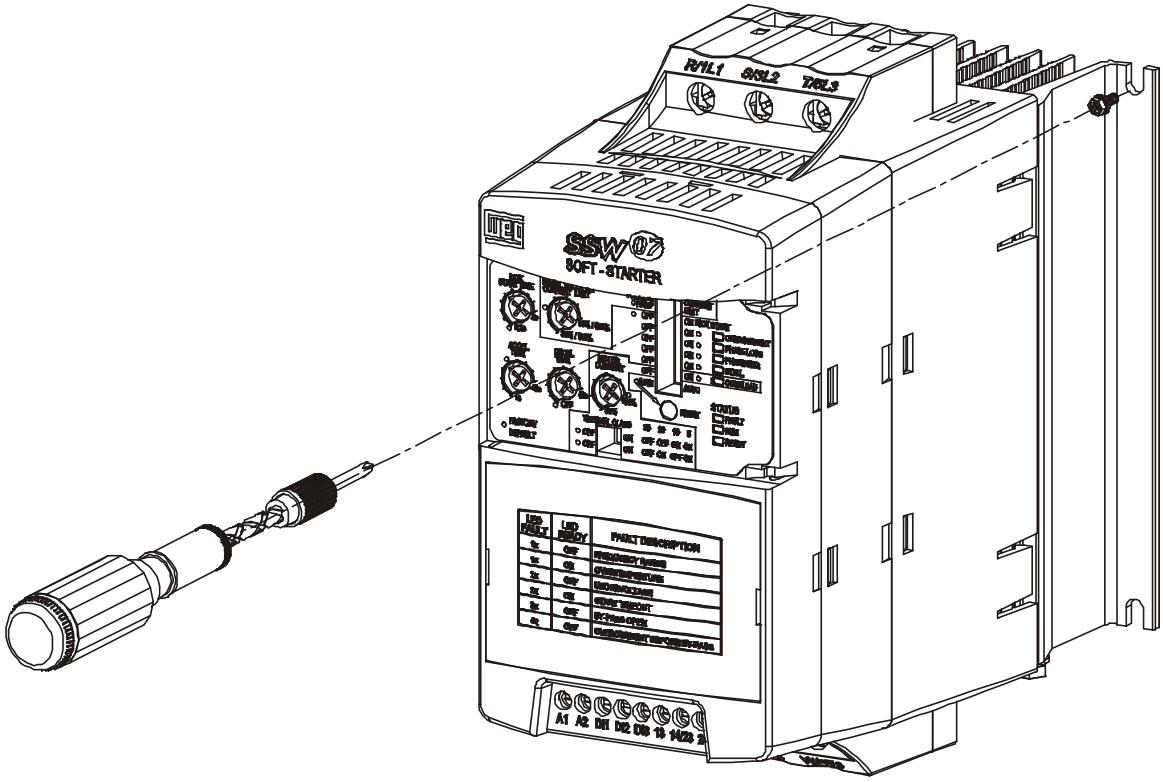


Figure 3.3 *- Installation procedures of the Soft-Starter SSW-07 on a surface*

3.2 ELECTRICAL INSTALLATION

DANGER!
The Soft-Starter SSW-07 cannot be used as an emergency stop device.

DANGER!
Be sure that the AC input power is disconnected before making any terminal connection.

ATTENTION!
The information below may be used as a guide to achieve a proper installation. Follow also the applicable local standards for electrical installations.

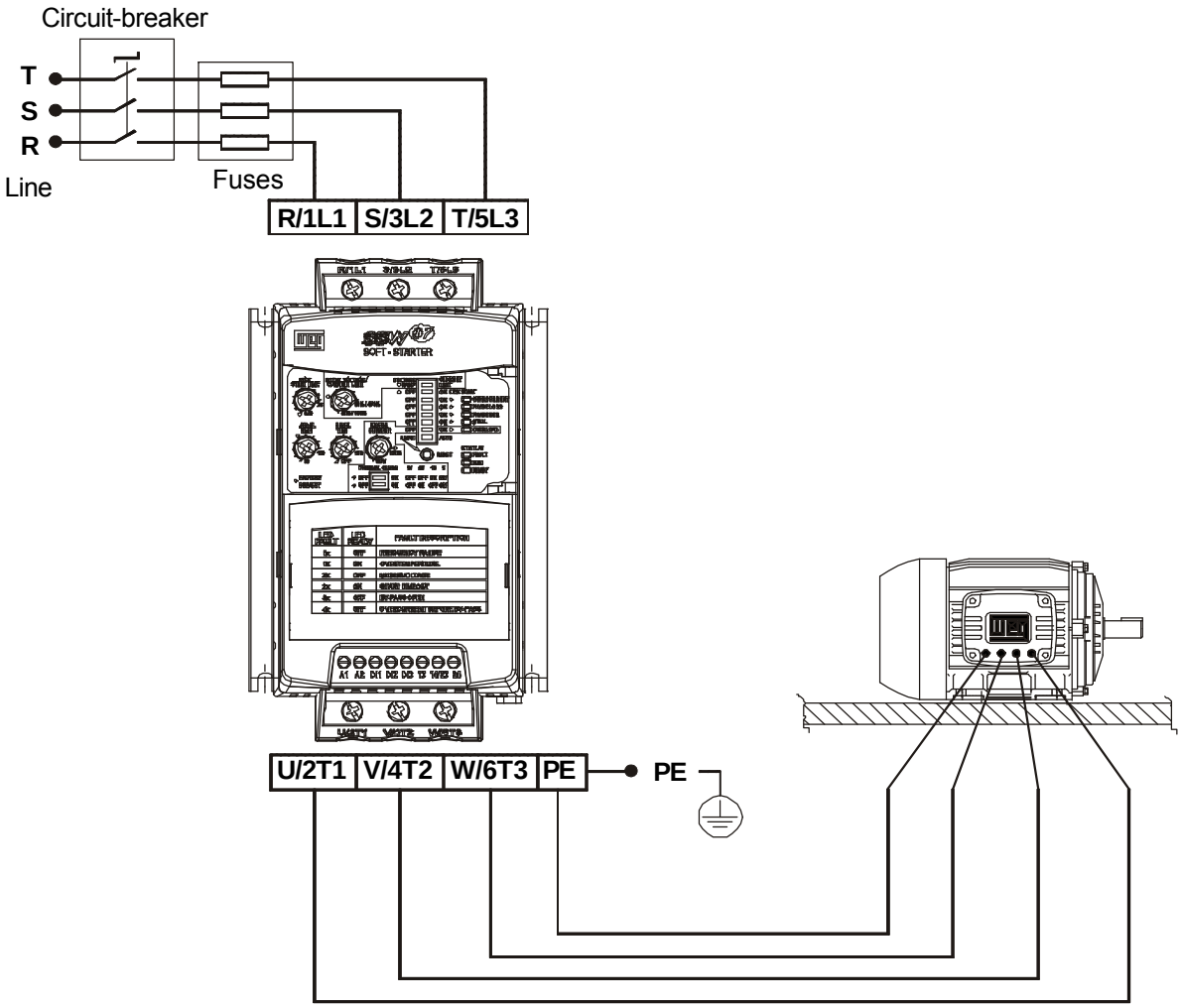


Figure 3.4 *- Standard power/grounding connections*

3.2.1 Power Terminals

The power connection terminals can be of different sizes and configurations depending on the Soft-Starter SSW-07 model as shown in figures 3.5 and 3.6.

Terminals:
R / 1L1, S / 3L2 and T / 5L3 : AC supply line
U / 2T1, V / 4T2 and W/ 6T3: Motor connection

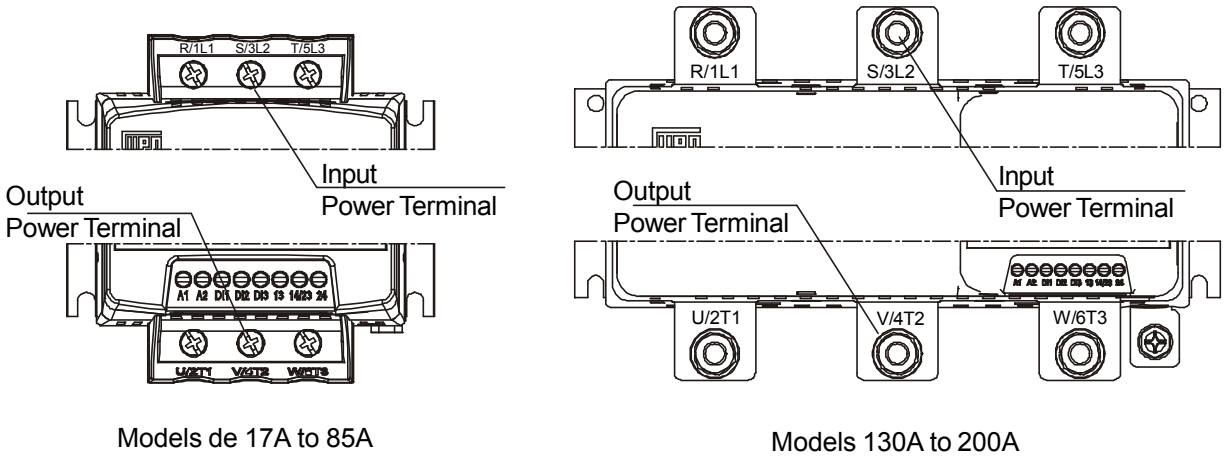


Figure 3.5 *- Power terminals*

Model SSW-07	Enclosure Size	Line/Motor		Grounding	
		Screw/ terminal	Torque Nm (in lb)	Screw	Torque Nm (in lb)
SSW-070017 SSW-070024 SSW-070030	Size 01	Terminal	3 (27)	M4 (5/32")	4.5 (40)
SSW-070045 SSW-070061 SSW-070085	Size 02	Terminal	5.5 (49)	M5 (3/16")	6 (53)
SSW-070130 SSW-070171 SSW-070200	Size 03	M8 (5/16")	19 (168)	M6 (1/4")	8.3 (73)

Table 3.4 *- Maximum torque for power connection*

3.2.2 Location of the Grounding and Control Connections

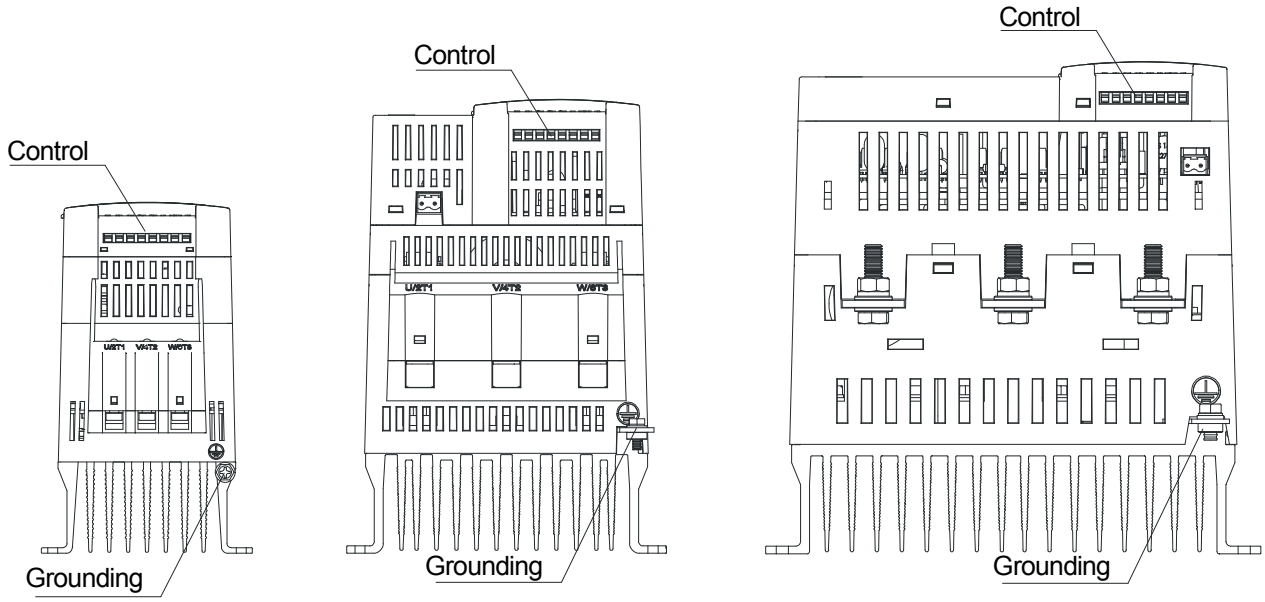


Figure 3.6 *- Location of the grounding and control connections*

3.2.3 Recommended Power and Grounding Cables

The described specifications in table 3.5 are valid only for the following conditions:

☑ Copper wires with PVC 70ºC (158ºF) insulation for ambient temperature of 40ºC (104ºF), installed in perforated and not agglomerated conduits.

☑ Naked or silver coated copper busbars with round edges with 1mm radius with ambient temperature of 40ºC (104ºF).



NOTE!
For correct cable dimensioning, consider the installation condition and the maximum permitted line voltage drop.

Model SSW-07	SSW-07 Rated Current (A)	Power Cables (mm^2)	Grounding Cable (mm^2)
SSW-070017	17	2.5	6
SSW-070024	24	4	6
SSW-070030	30	6	6
SSW-070045	45	10	6
SSW-070061	61	16	10
SSW-070085	85	25	10
SSW-070130	130	50	16
SSW-070171	171	70	25
SSW-070200	200	95	35

Table 3.5 *- Minimum cable gauge specification*

3.2.4 Power Supply Connection to the Soft-Starter SSW-07



DANGER!
The AC input must be compatible with the voltage range of the Soft-Starter SSW-07.



DANGER!
Provide a power supply disconnecting switch for the Soft-Starter SSW-07. This disconnecting switch must disconnect the AC input voltage to the Soft-Starter SSW-07 whenever necessary (for example: during maintenance services).
If a disconnected switch or a contactor is inserted in the motor supply line never operate these devices with the motor running or when the Soft-Starter SSW-07 is enabled.

ATTENTION!
Over-voltage control in the line that supplies the Soft-Starter must be made using over-voltage protections of 680Vac (phase to phase connection) and energy absorption capacity of 40 joules.

NOTE!
Use the wire sizes and fuses recommended in tables 3.5, 3.6 and 3.7. The connector tightening torque is indicated in table 3.4. Use only copper wires 70°C, (158°F).

3.2.4.1 Power Supply Capacity

The Soft-Starter SSW-07 is suitable to be used in a circuit capable of supplying not more than X (as per table 3.6) symmetrical rms amperes, Y maximum volts when protected by ultra-rapid fuses.

Model SSW-07	Y = 220V-575V X (kA)
SSW-070017	5
SSW-070024	5
SSW-070030	5
SSW-070045	5
SSW-070061	5
SSW-070085	10
SSW-070130	10
SSW-070171	10
SSW-070200	10

Table 3.6 *- Maximum current capacity of the power supply*

3.2.4.2 Recommended Fuses

The fuses used at the input should be ultra-rapid fuses with I²t lower or equal to 75% of the indicated SCR value (A²s). These fuses will protect the SCR against short-circuit. Standard fuses can be used instead of ultra-rapid fuses. These will protect the installation against short-circuit but will not protect the SCR.

Model SSW-07	Rated Current (A)	I²t of the SCR (A²s)	Circuitry Fuses
SSW-070017	50A (DIII)	720	6A (Type D)
SSW-070024	80A (aR)	4000	
SSW-070030	80A (aR)	4000	
SSW-070045	100A (aR)	8000	
SSW-070061	125A (aR)	10500	
SSW-070085	200A (aR)	51200	
SSW-070130	315A (aR)	97000	
SSW-070171	450A (aR)	168000	
SSW-070200	500A (aR)	245000	

Table 3.7 *- Recommended fuses*

3.2.5 Soft-Starter SSW-07 Connection to the Motor

DANGER!
Power factor correction capacitors must never be installed at the output of the Soft-Starter SSW-07. (U / 2T1, V / 4T2 and W / 6T3).

ATTENTION!
To ensure that the protections based on the current reading and display operate correctly, for example the overload, the motor rated current must not be lower than 50% of the rated Soft-Starter SSW-07 current.

NOTE!
Use the wire sizes and fuses recommended in tables 3.5, 3.6 and 3.7. The connector tightening torque is indicated in table 3.4. Use only copper wires.

NOTE!
The Soft-Starter SSW-07 is provided with electronic protection against motor overload. This protection must be set according to the specific motor. When several motors are connected to the same Soft-Starter SSW-07 use individual overload relays for each motor.

3.2.5.1 Standard Three-Wire Connection

Line current of the Soft-Starter SSW-07 is equal to the motor current.

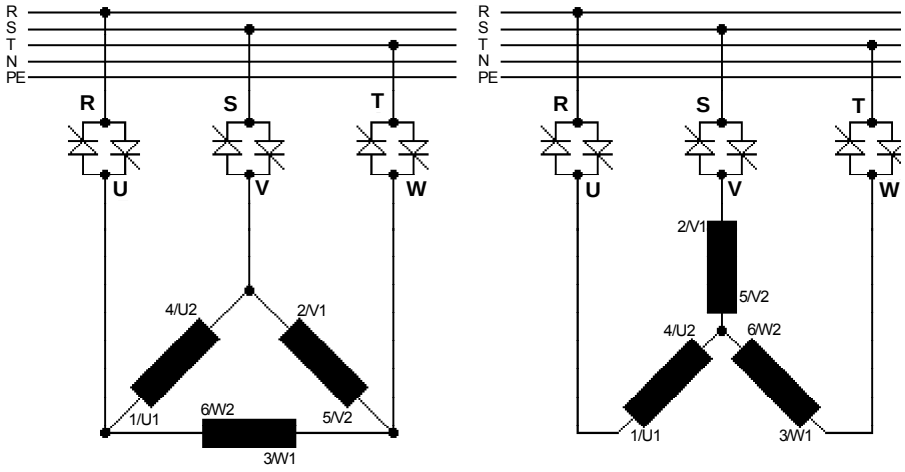


***Figure 3.7** - Soft-Starter SSW-07 with standard connection*

3.2.6 GROUNDING CONNECTIONS

DANGER!
The Soft-Starter must be grounded for safety purposes (PE).
The ground connection must comply with the local regulations. For grounding use cables with cross sections as indicated in table 3.5.
Make the ground connection to a grounding bar or to the general grounding point (resistance ≤10 ohms).

DANGER!
The AC input for the Soft-Starter SSW-07 must have a ground connection.

DANGER!
Do not use the neutral conductor for grounding purpose. Use dedicated ground contuctor.

ATTENTION!
Do not share the ground wiring with other equipment that operate with high current (for examples: high voltage motors, welding machines, etc.). When several Soft-Starters SSW-07 are used, observe figure 3.8.

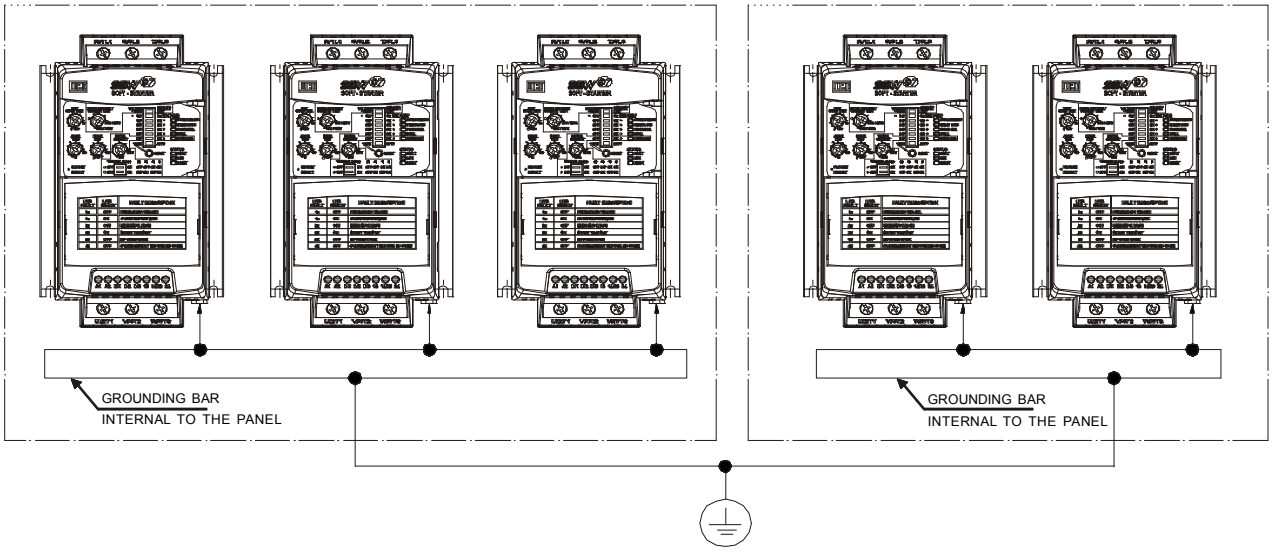


Figure 3.8 *- Grounding connections for more than one Soft-Starter SSW-07*

EMI - Electronic Interference
The Soft-Starter SSW-07 is developed to be used in industrial systems (Class A) as per Norm EN60947-4-2.
It's necessary to have a distance of 0,25m (10in) between the Soft-Starter SSW-07 and the cables between the Soft-Starter SSW-07 and the motor. Example: CLP wiring, temperature controllers, thermocouple cables, etc.

Grounding of the Motor frame

Always ground the motor frame. Ground the motor in a panel where the Soft-Starter SSW-07 is installed. The Soft-Starter SSW-07 output wiring to the motor must be installed separately from the input wiring as well as from the control and signal wiring.

3.2.7 Control and Signal Connections

The control connections (digital inputs and relay outputs) are made through the terminals (see figure 3.9).

Terminal	Description	Specifications	Torque Nm (in lb)
A1	Electronics Supply	Voltage: 110 a 240 Vac (-15% a +10%)	
A2		Current: 140mA Max.	
Terminal	**Factory Default**	**Specifications**	
DI1	Starts/Stops Motor	3 isolated digital inputs	
DI2	Fault reset	Voltage: 110 a 240 Vac (-15% a +10%)	0.5 (4.5)
DI3	Fault reset	Current: 2 mA Max.	
13	Relay 1 output - Operation	Contact capacity:	
14 / 23	Relay common point	Voltage: 250Vac	
24	Relay 2 output - Full voltage	Current: 1A	

Table 3.8 - *Description of the control connector pins*

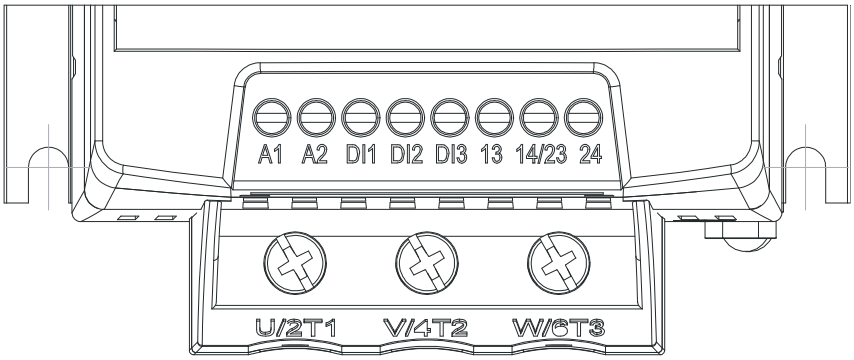


Figure 3.9 - *Control terminals of the Soft-Starter SSW-07*

3.3 RECOMMENDED SET-UPS

Some recommended set-ups are shown here and they can be completely or partly used.

The main warning notes for all the recommended set-ups are shown below and are described in the schemes by their respective numbers.

NOTES!

(1) For the protection of the whole electrical installation it is necessary to use fuses or circuit breakers. The use of ultra-rapid fuses is not required for the operation of the Soft-Starter SSW-07 but they are recommended for the complete SCR protection;

(2) The transformer "T1" is optional and must be used when there is a difference between the line voltage and the electronic power voltage;

(3) To protect the motor from damage by possible short-circuits in the power circuit of the Soft-Starter SSW-07 use an isolating contactor (K1) or circuit-breaker (Q1);

(4) Start push-button.

(5) Stop push-button.

(6) Remember that when the command via two-wire digital input is used (the switch is normally open with retention) every time the power supply is restored after any fault the motor will start immediately if the switch remains closed;

(7) In case of maintenance of the Soft-Starter SSW-07 or the motor it is necessary to remove the input fuses or disconnect the power supply to ensure the complete equipment disconnection from the power supply;

(8) The emergency stop can be used by disconnecting the electronics power supply.

(9) Shunt trip for the Q1 power isolation circuit breaker.



ATTENTION!
On the first energization, if a contactor or a circuit breaker with undervoltage release were not used for the power section isolation, apply power first to the control, adjust the trimpots necessary for the SSW-07 start-up, and only after this apply voltage to the power section;

3.3.1 Recommended Set-up with Command via Two-wire Digital Inputs and Isolation Contactor

*** See note 3.3**

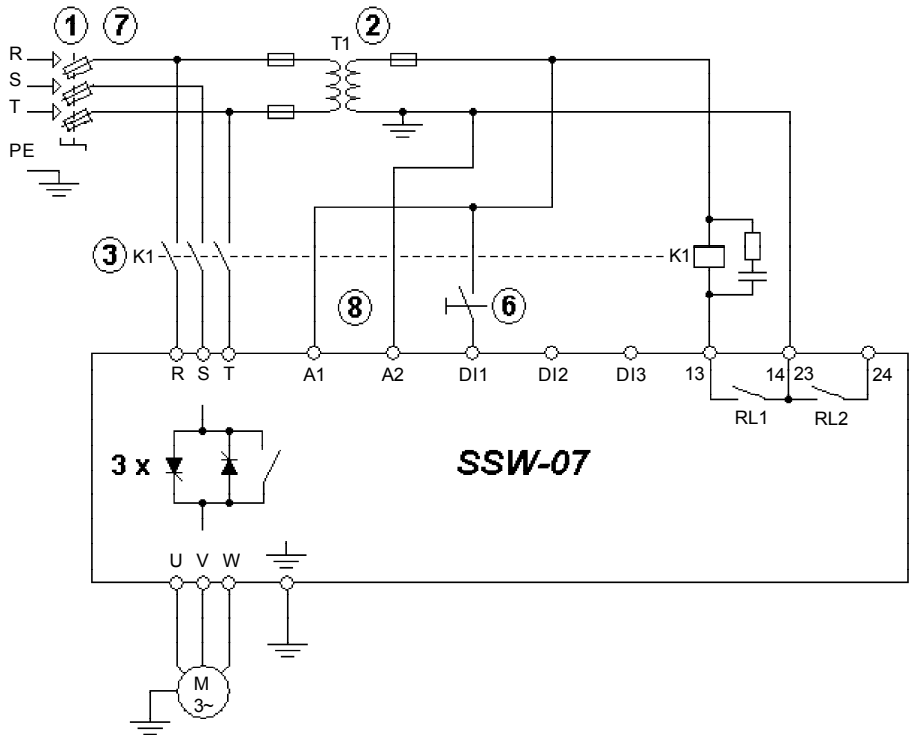


Figure 3.10 *- Recommended set-up with commands via two-wire digital inputs and isolation contactor*

3.3.2 Recommended Set-up with Command via Three-wire Digital Inputs and Isolation Contactor

*** See note 3.3**

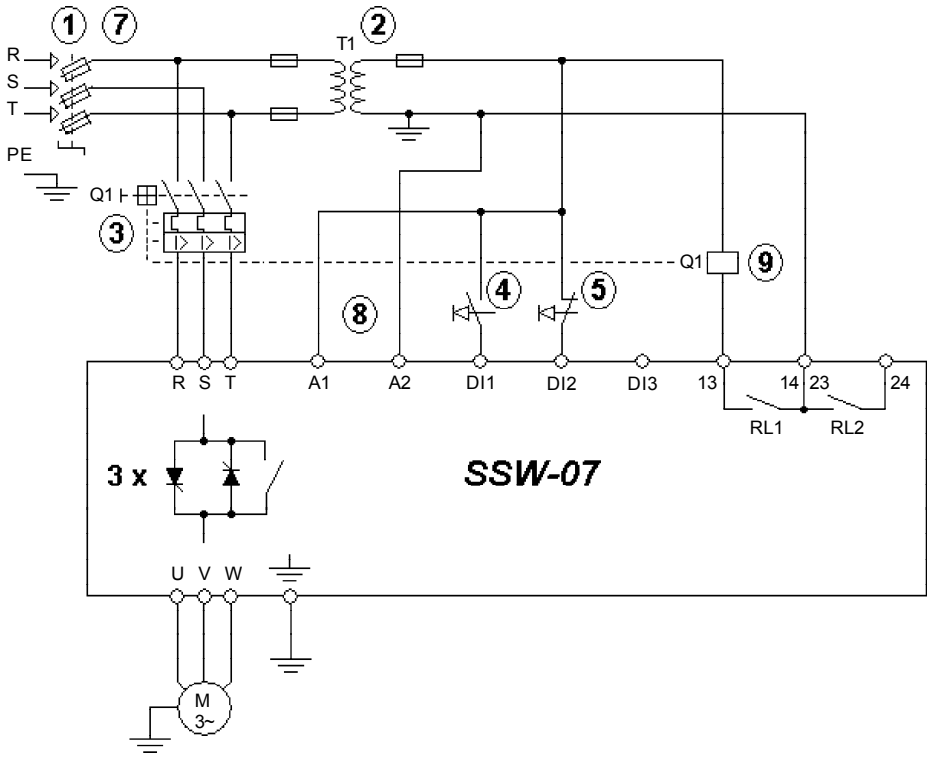
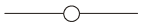
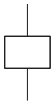
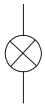
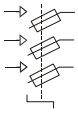


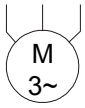
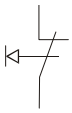
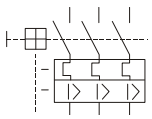
Figure 3.11 *- Recommended set-up with commands via three-wire digital inputs and a circuit-breaker*

NOTE!
It's necessary to program the digital input DI2 for the three-wire command function. See item 4.10.

NOTE!
The RL1 shall be set to the "No fault" function. See item 4.12.

3.3.3 Symbols

	Electrical connection between two signals
	Connection terminals
	Relay or contactor coil
	Normally open contact (NO)
	Indicator light
	Circuit-breaker (opens under load)
	Resistor
	Capacitor

	Fuse
	Thyristor/SCR
	Three-phase motor
	Emergency button
	Transformer
	N.O Contact (with retention)
	Normally closed (NC) push-button
	Normally open (NO) push-button
	Circuit-breaker with undervoltage release

SETTING THE SSW-07

This chapter describes how to make the necessary settings for the correct functioning of the SSW-07.

4.1 CONTROL TYPE SETTING

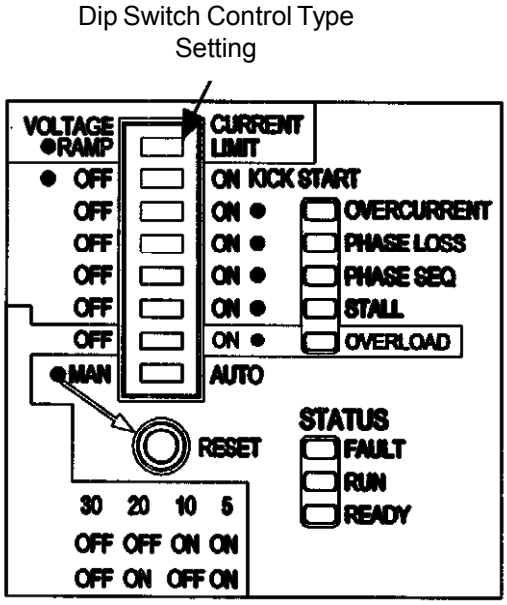


Figure 4.1 *- Control type setting*

Select the type of starting control that best adapts to the application.

Voltage Ramp Starting:
This is the most commonly used method. Very easy to program and set.
The SSW-07 Soft-Starter imposes the voltage applied to the motor.
Generally applied to loads with a lower initial torque or a square torque.
This kind of control can be used as an initial working test.

Current Limit Starting:
The maximum current level is maintained during the start, being set according to the application necessities.
Generally applied to loads with a higher initial torque or a constant torque.
This kind of control is used to adapt the start to the capacity limits of the supply network.

4.2 KICK START

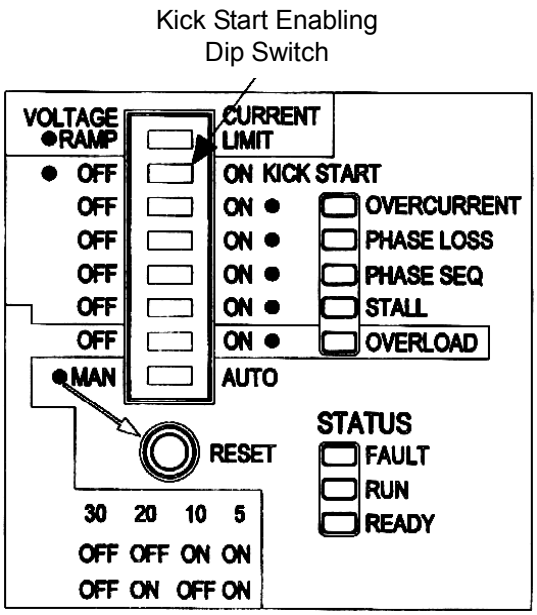


Figure 4.2 *- Kick start enabling*

Soft-Starter SSW-07 offers a kick start function for loads that present a large initial resistance to movement.
This function is enabled through the Kick Start dip switch. The duration of the voltage pulse is set through the trimpot Kick Start Time.
The voltage pulse applied is of 80% Un during the programmed trimpot kick start time.

NOTE!
Use this function only for specific applications and where necessary.

4.3 INITIAL VOLTAGE SETTING

Set the initial voltage to a value that the motor starts to run as soon as the start command is given to the SSW-07.

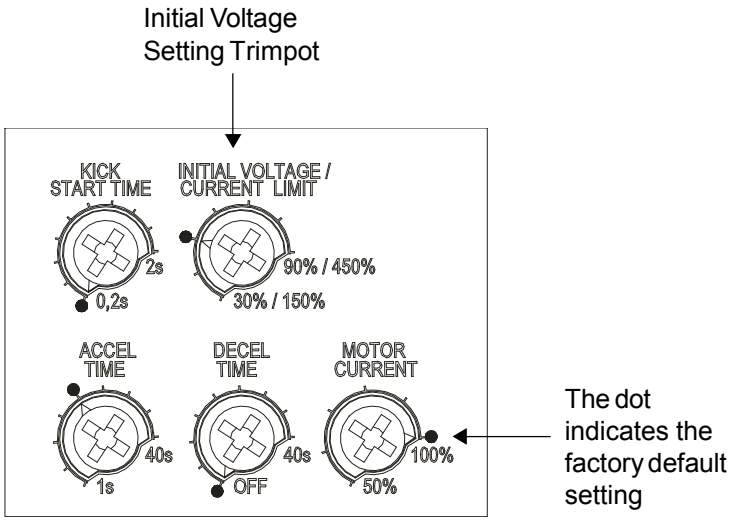


Figure 4.3 *- Initial voltage setting*

NOTE!
The Initial Voltage trimpot has an initial voltage setting function only when the kind of control is programmed to start with a voltage ramp.

4.4 CURRENT LIMIT SETTING

This setting defines the maximum limit of the current during motor starting in percentage of the rated current of the Soft-Starter.
If the current limit is reached during the start of the motor, Soft-Starter SSW-07 will maintain the current at this limit until the motor reaches nominal speed.
If the current limit is not reached, the motor will start immediately.
The current limitation should be set to a level that the motor acceleration can be observed, otherwise the motor will not start.

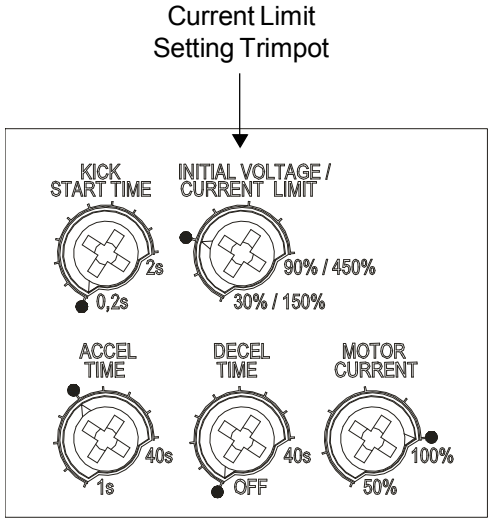


Figure 4.4 *- Current limit setting*

NOTE!
If at the end of the acceleration ramp (set at the Trimpot Acceleration Time), total voltage is not reached, a current limitation Fault will be shown. This fault is indicated through the Fault LED flashing 2 times with the Ready LED on.

The trimpot Current Limit has a Current Limit setting function only when the kind of control is programmed to start with a Current Limit.

4.5 ACCELERATION RAMP TIME SETTING

When Soft-Starter SSW-07 is programmed to Voltage Ramp control, this is the voltage increment ramp time.

When Soft-Starter SSW-07 is programmed to Current Limit control, this time is used as the maximum starting time, working as a protection against blocked rotors.

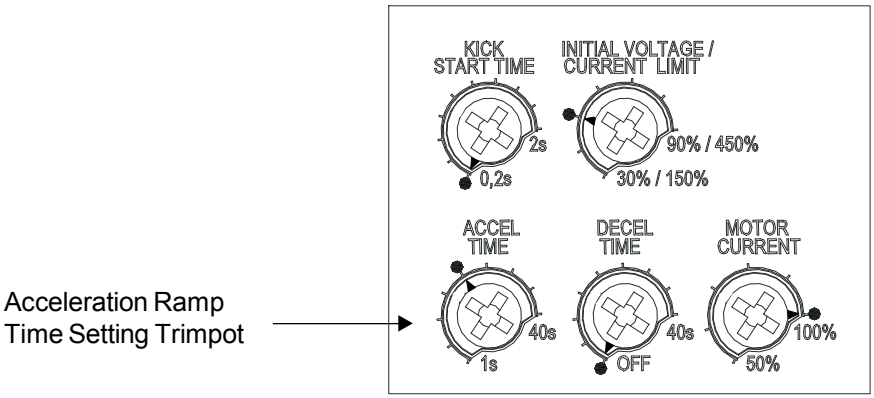


Figure 4.5 *- Acceleration ramp time setting*

NOTE!
The programmed acceleration time is not the exact motor acceleration time, but the time of the voltage ramp or the maximum starting time. The motor acceleration time depends on the motor characteristics and the load.

Please consider that in cases where the relation of the SSW-07 current and the motor rated current is 1.00, the maximum time that the SSW-07 can work with 3 x In is 30 seconds.

4.6 DECELERATION RAMP TIME SETTING

Enables and sets the time of voltage decrease.
This setting should be used only for the deceleration of pumps to reduce the water hammer. This setting must be made to achieve the best pump performance.

NOTE!
This function is used to lengthen the normal deceleration time of a load and not to force a lower time than that imposed by the load itself.

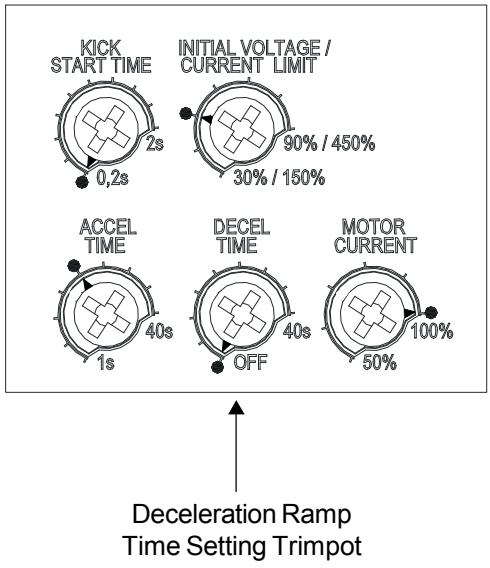


Figure 4.6 *- Deceleration ramp time setting*

4.7 MOTOR CURRENT SETTING

This setting defines the ratio of the SSW-07 current and the motor current. The value of the setting is very important since it defines the protection of the motor driven by the SSW-07. The setting of this function interferes directly in the following motor protections:
-Overload;
-Overcurrent;
-Locked rotor;
-Phase loss.

Calculation Example:
SSW-07 Used: 30A
Motor Used: 25A

Trimpot for the Motor Current Setting

$$\text{Motor Current Setting} = \frac{I_{motor}}{I_{SSW\text{-}07}}$$

$$\text{Motor Current Setting} = \frac{25A}{30A}$$

Motor Current Setting = 0.833

Therefore it must be set at 83%

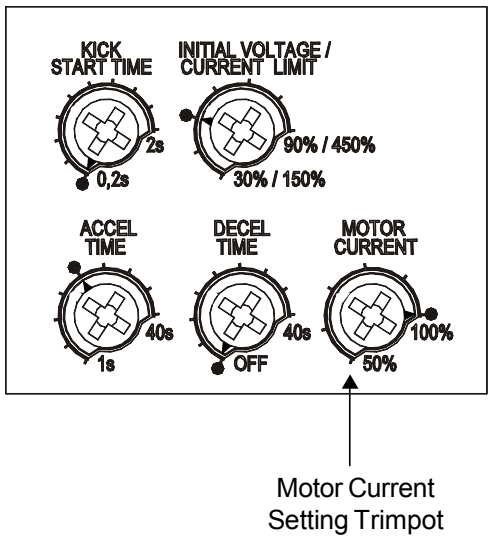


Figure 4.7 *- Motor current setting*

4.8 MOTOR ELECTRONIC OVERLOAD PROTECTION

The motor electronic overload protection simulates the heating and cooling of the motor, also known as thermal image. This heating simulation uses as input data the True rms current. The curve with the working time in motor overload is defined in figure 4.8.

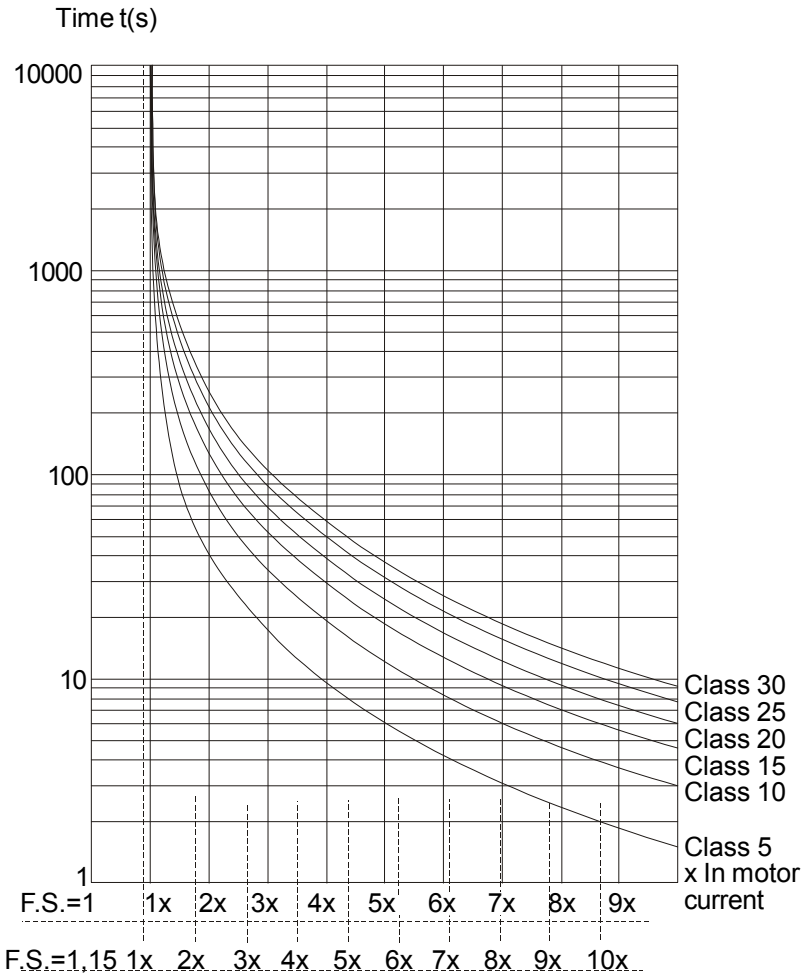


Figure 4.8 *- Thermal classes of motor protection in cold condition*

Motor Current	Class 30	Class 20	Class 10
3xIn	101.2s	67.5s	33.7s
5xIn	36.1s	24s	12s
7xIn	18.3s	12.2s	6.1s

Table 4.1 *- Motor protection thermal class time in cold condition at F.S.=1*

Motor Current	Class 30	Class 20	Class 10
3xIn	135.1s	90.1s	45.1s
5xIn	47.7s	31.8s	15.9s
7xIn	24.3s	16.2s	8.1s

Table 4.2 *- Motor protection thermal class time in cold condition at F.S.=1.15*

NOTES!

☑ When SSW-07 is without the electronic supply voltage (A1 and A2), the thermal image is saved internally. When the supply (A1 and A2) is re-established, the thermal image value returns to the value prior to the electronic supply loss.

☑ The RESET of the electronic overload protection can be set to manual function (man). In this case the RESET must be made via digital input 2 (DI2) or through the RESET key. If the RESET setting is set to automatic (auto), the fault condition will automatically be reset after the equipment cooling time;

☑ Upon disabling the electronic overload protection, the thermal image is reset at zero.

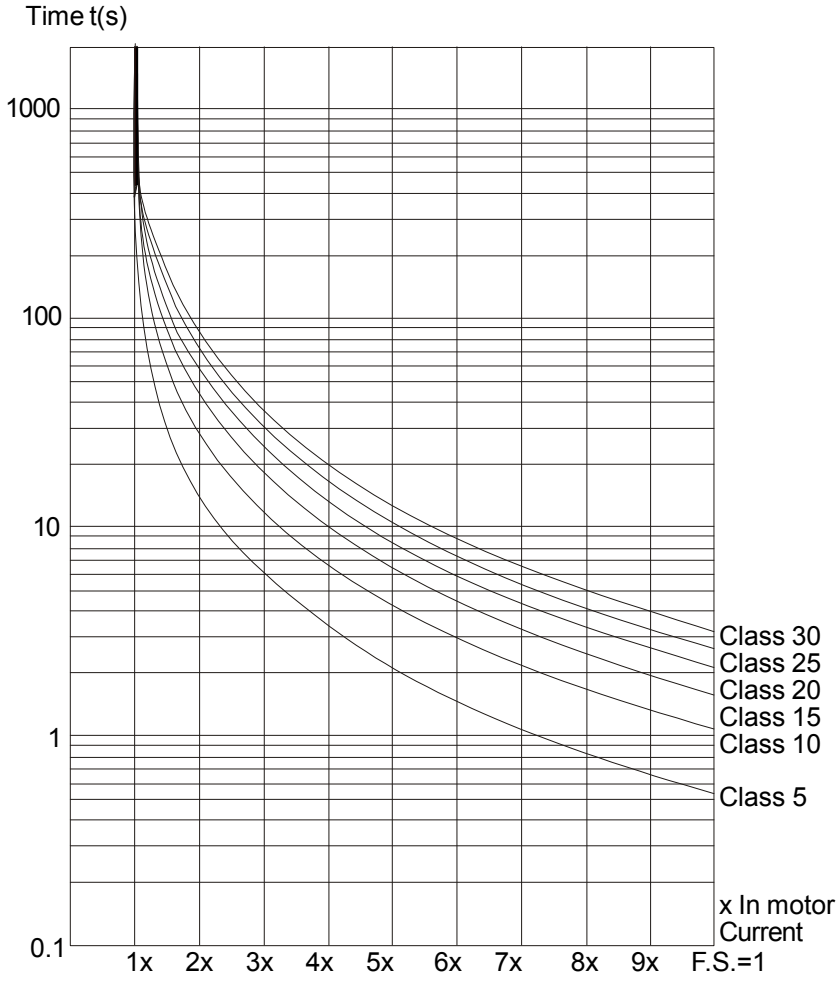


Figure 4.9 *- motor protection thermal classes in hot condition at 100% In*

Motor Current	Class 30	Class 20	Class 10
3xIn	34.4s	23.6s	11.8s
5xIn	12.6s	8.4s	4.2s
7xIn	6.4s	4.2s	2.1s

Table 4.3 *- Motor protection thermal class time in hot condition*

Current in % of motor In	Factor
0% (cold condition)	1
20%	0.87
40%	0.74
60%	0.61
80%	0.48
100% (for the load)	0.35

Table 4.4 *- Multiplication factor of the thermal class times in cold condition to obtain the thermal class times in hot condition*

4.9 RESET

A fault condition can be reset using the RESET key at the front of the SSW-07 or through a push-button (0.5 seconds) at DI3 (digital input for RESET). Another way to reset the SSW-07 is by switching On/Off the electronic power supply (A1 and A2).



NOTE!
The SSW-07 also allows for the possibility of automatic RESET by enabling this function through the Dip-Switch (auto):

☑ Automatic RESET occurs after 15 minutes in the following conditions:
-Overcurrent;
-Phase loss;
-Blocked rotor;
-Overcurrent before By-pass;
-Frequency out of range;
-Contact of the internal By-pass relay is open;
-Power control supply undervoltage;
-External fault.
☑ For incorrect phase sequence there is no automatic RESET.
☑ For electronic overload of the motor there is a specific algorithm for the automatic RESET time.

4.10 DI2 DIGITAL INPUT SETTING

In the factory default, the DI2 digital input has its function programmed for the reset of faults. DI2 can also be programmed to work as a three wire control.
The three wire control allows the Soft-Starter to be commanded through two digital inputs, DI1 as an ON input and DI2 as an OFF input. This allows for the direct placement of two push buttons. See item 3.3.2.
To change the DI2 digital input, follow the instructions below:

1. To enter in programming mode, maintain the reset key at the front of the SSW-07 pressed for 5 seconds. Maintain the reset key pressed during programming;

2. When in programming mode, two LEDs will switch-on (overcurrent and phase loss), indicating that DI2 is programmed for fault Reset. When three LEDs switch-on (overcurrent, phase loss and phase sequence), it indicates that the DI2 is programmed for three wire commands;
3. To change the programming to three wire commands, move the overcurrent dip-switch and return to the previous position. The three LEDs will switch-on, indicating that DI2 is programmed for three wire commands;
4. To change the DI2 programming to fault Reset, move the kick start dip-switch and return to the previous position. Two LEDs will switch-on, indicating that the DI2 is programmed for fault Reset;
5. Programming is concluded when the reset key is released.

4.11 DIGITAL OUTPUT RELAY OPERATION

☑ The relay of the Operation Function closes its N.O. contact (13-14/23) every time the SSW-07 receives the enable command. This contact is only opened at the end of the deceleration ramp (when it is set via trimpot) or when the SSW-07 receives the disable command.

☑ The relay of the Full Voltage Function closes the N.O. contacts (14/23-24) every time the SSW-07 applies 100% of the voltage to the driven motor. This contact opens when the SSW-07 receives the disable command.

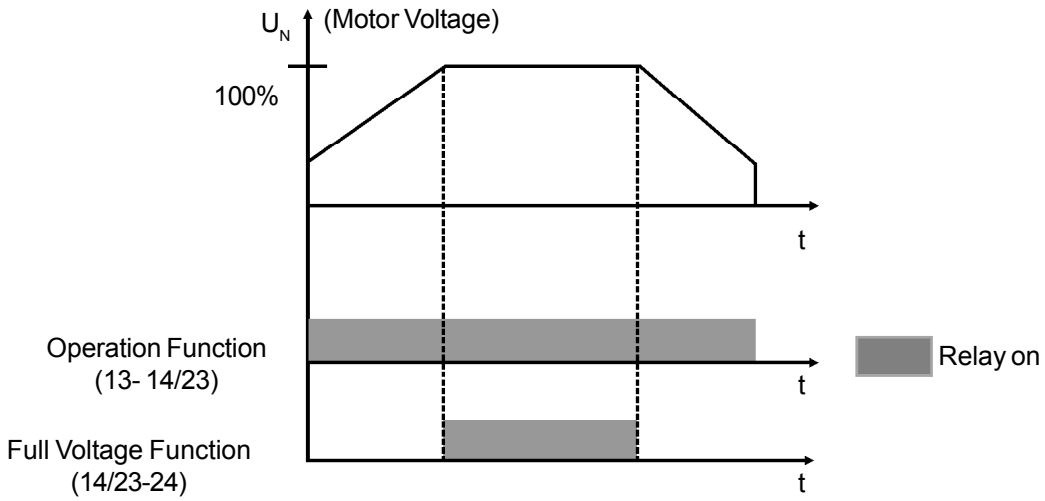


Figure 4.10 *- Digital output relay operation*

4.12 RELAY OUTPUT RL1 PROGRAMMING

In the factory default programming, the relay output RL1 has its function programmed for “Operation”. RL1 (13/14) can be also be programmed for the “No Fault” function. This function allows the installation of a circuit breaker with an undervoltage release at the SSW-07 input. Refer to figure 3.3.2. In order to change the relay output RL1 programming follow these instructions:

1. For entering the programming mode keep the reset key, at the SSW-07 front cover, pressed during 5 seconds, keeping it also pressed throughout the programming;

2. When in the programming mode two LED's go on (Overcurrent and Phase Loss), indicating that DI2 is programmed for Error Reset. If three LED's go on (Overcurrent, Phase Loss and Phase Sequence), it indicates that DI2 is programmed for three-wire command. If the Overload LED goes on, then the RL1 function is "No Fault", otherwise the function is "Operation";
3. To modify the RL1 function change the Overload dip switch and put it back in the previous position. The Overload LED will indicate the new programmed function:
   - Overload LED off: "Operation" function;
   - Overload LED on = "No Fault" function.

PROGRAMMING INFORMATION AND SUGGESTIONS

This chapter helps the user to set the types of starting controls according to their applications.

5.1 APPLICATIONS AND PROGRAMMING

ATTENTION!
Tips and important notes for each type of starting control.

ATTENTION!
To know the correct programming of the parameters, have your load data on hand and use the WEG (Soft-Starter) Dimensioning Software available at WEG's home page (http://www.weg.net).
If you are unable to use the software mentioned above, you can follow some practical concepts described in this chapter.

Shown below are some characteristic curves with current and starting torque behavior according to some kinds of controls.

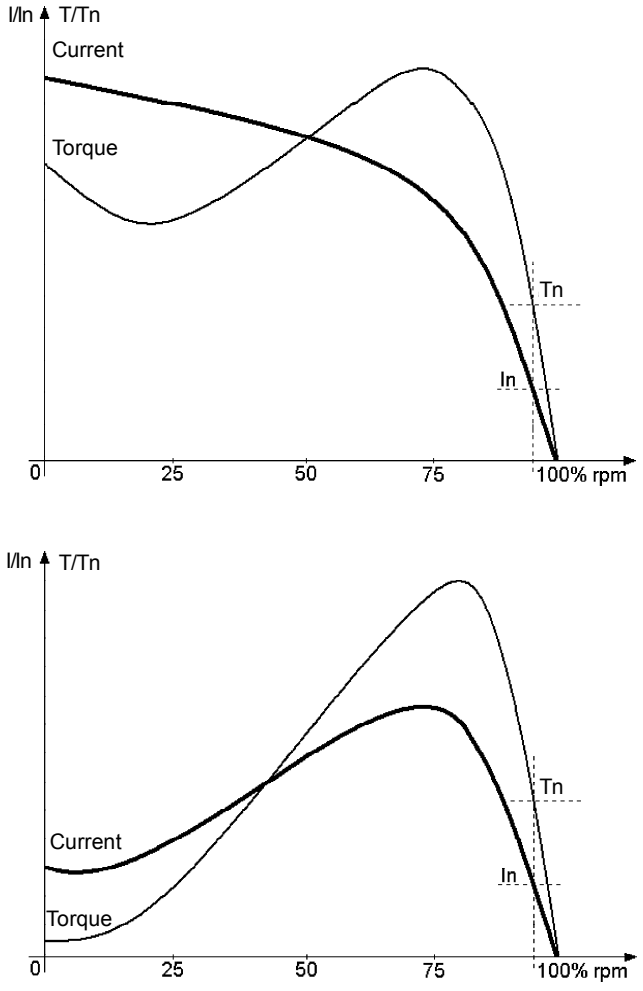


Figure 5.1 *- Characteristic curves of torque and current in a direct on-line start and by voltage ramp*

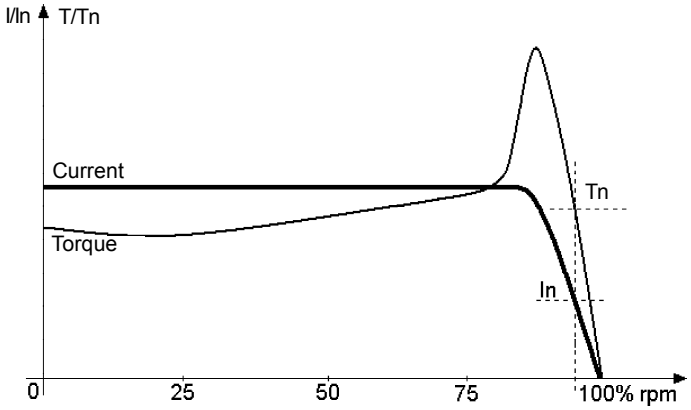


Figure 5.2 *- Characteristic curves of torque and current in a current limitation start*

The following items show characteristic curves with the starting torque behavior according to some types of loads and their suggested controls.

5.1.1 Voltage Ramp Starting

1) Set the value of the initial voltage to a low value;
2) When a load is applied to the motor, set the initial voltage to a value that makes the motor rotate smoothly from the instant it is started.
3) Set the acceleration time with the necessary start time, initially with short times, 10 to 15 seconds, and afterwards try to find the best starting condition for you load.

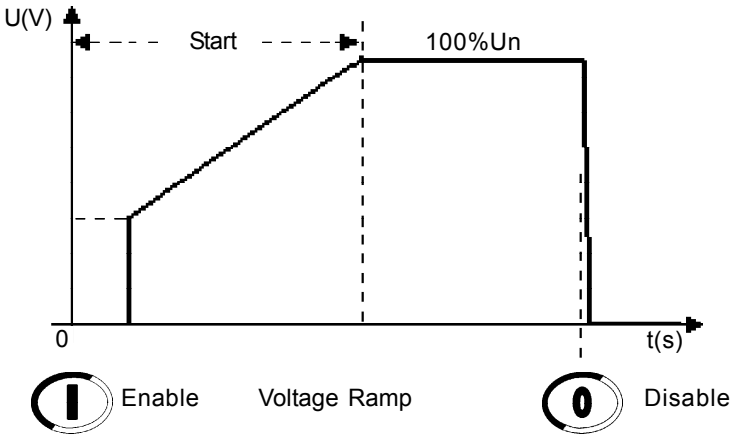


Figure 5.3 *- Voltage ramp starting*

NOTES!

☑ With long starting times, or when the motor is without a load, vibration can occur during the start of the motor, therefore lower the starting time;

☑ If faults occur during the start, check all the connections from the Soft-Starter to the supply network, motor connections, supply network voltage levels, fuses and circuit breakers.

5.1.2 Current Limit Starting

1) To start with a current limitation it is necessary to start with a load. Initial test without load can be done with a voltage ramp;
2) Set the acceleration time with the necessary starting time, initially with short times, 20 to 25 seconds. This time will be used as the blocked rotor time in case the motor does not start;
3) Set the current limit according to the conditions that your electric installation allows, as well as to the values that supply enough torque to start the motor. It can initially be programmed with values between 2x and 3x the rated current of the motor (In of the motor).

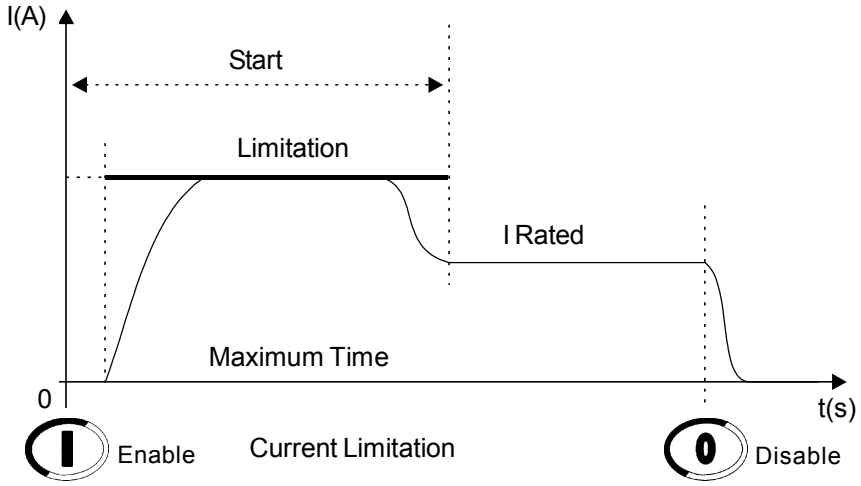


Figure 5.4 *- Current Limit Starting*

NOTES!

☑ If the current limit is not reached during the start, the motor will start immediately;
☑ Very low Current Limit values do not provide sufficient torque to start the motor. Always keep the motor rotating once it is started.
☑ For loads that need a higher initial starting torque, the kick start function can be used;
☑ If faults occur during the start, check all the connections from the Soft-Starter to the supply network, motor connections, supply network voltage levels, fuses and circuit breakers.

5.2 PROTECTION AND PROGRAMMING

5.2.1 Suggestion on how to program the thermal class

1) Initially start at the standard thermal class, sometimes, but without the motor overheating;

2) Determine the correct starting time. Find an average of the current using a multmeter with a current probe to measure it;
A current average can be found for any type of starting control;

For example:
Starting an 80A motor using a voltage ramp. The current starts at 100A and goes to 300A, returning afterwards to the rated value in 20 seconds.
(100A + 300A)/2 = 200A
200A/80A = 2.5 x In of the motor
Therefore: 2.5 x In @ 20 seconds.

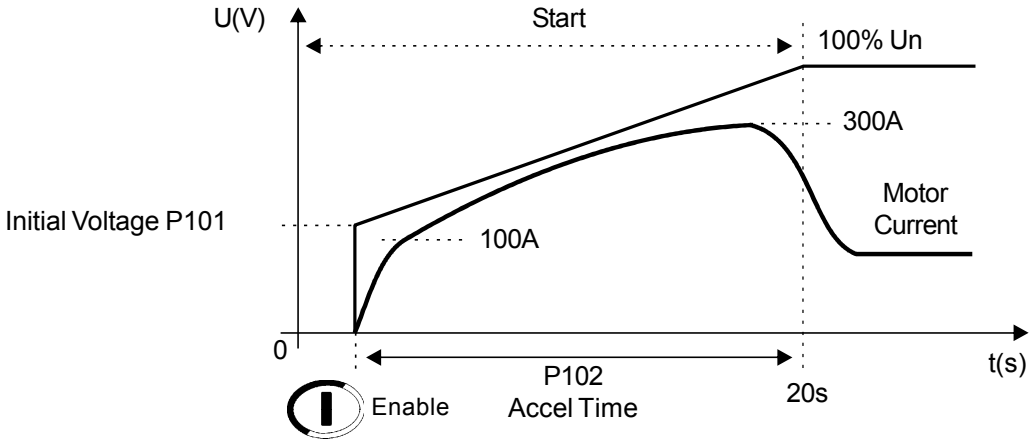


Figure 5.5 *- Typical current curve during a voltage ramp start*

3) Use this time to find the minimum class necessary to start the motor in cold condition. In the overload protection chapter it is possible to check the thermal class curves of the motor in cold condition.

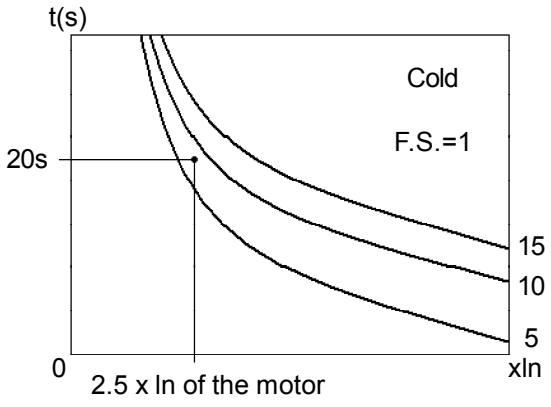


Figure 5.6 *- Checking the minimum class of curves in cold condition*

Therefore the minimum class necessary to start the motor is Class 10. Class 5 has an inferior time for this current.
This class allows motor starting in cold condition.

4) To know which thermal class is necessary to start the motor in hot condition, it is necessary to know up to what the motor can handle. For this, one needs to know the blocked rotor time that the motor can withstand.

NOTE!
To correctly program the Thermal Class that will protect your motor it is essential to have in hands the stall time of the motor. This information is available in the motor manufacturer's catalogue.

With the stall time it is possible to find the maximum thermal class that will protect the motor to start in hot condition. In the overload protection chapter, it is possible to check the thermal class curves of the motor in hot condition.
For example: 6.6 x In @ 6s.

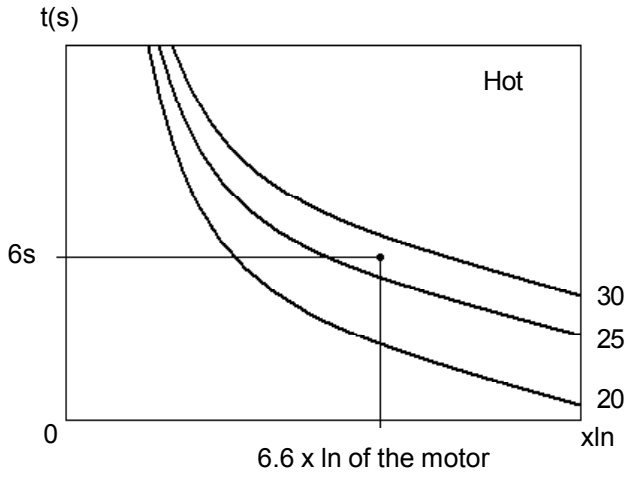


Figure 5.7 *- Checking the maximum class of curves in hot condition*

Therefore the maximum thermal class that will protect the motor is Thermal Class 25, Class 30 has a higher time for this current.
This class permits the start of the motor in hot condition, in other words, in any condition.

NOTE!
Remember that this protection has as a standard the Three Phase IP55 Standard WEG Motor, therefore if your motor is different, then do not program the thermal class to its maximum, instead, program it near its minimum thermal class to start.

Example of how setting the thermal class:

Motor data:
Power: 50Hp
Voltage: 380V
Rated Current (In): 71A
Service Factor (S.F.): 1.00
Ip/In: 6.6
Stall time: 12s in hot condition
Speed-1770rpm

Motor + load starting data:
Starting by Voltage Ramp, starting current average:
3 x the rated current of the motor during 25s (3 x In @ 25s).

1) In the graph, figure 4.8 in cold condition, one can see the minimum Thermal Class that will allow the start with a reduced voltage:
   For 3 x In of the motor @25s, the next highest is adopted: Class 10.
2) In the graph, figure 4.9 in hot condition, one can see the maximum Thermal Class that the motor can stand due to the stall time in hot condition:
   For 6.6 x In of the motor @ 12s, the next lowest is adopted. Class 30.

One now knows that Thermal Class 10 allows a start and Thermal Class 30 is the maximum limit. Thus, a Thermal Class between the two should be adopted, according to the quantity of starts per hour and the interval of time between stopping and re-starting the motor.

The closer to Class 10, the more protected the motor will be, the fewer the starts per hour and the greater the interval of time must be between stopping and re-starting the motor.

The closer to Class 30, the closer it gets to the maximum limit of the motor, thus there can be more starts per hour and lower intervals of time between stopping and re-starting the motor.

5.2.2 Time Reduction from Cold to Hot Starting

To determine the working times of the thermal classes in hot condition, when the motor is running at full voltage with a current lower that 100% of the In of the motor, use the multiplication factor in table 4.4, according to the current percentage that the motor is operating.
For example:
A motor is running with 80% In and is turned off.
Immediately afterwards it is turned back on.
The starting sequence is 3 x In of the motor @ 25s.
The Thermal Class selected is Class 10 with 33.7s @ 3 x In of the motor.
In the table, the setting factor to 80% In of the motor is 0.48.

The final working time will be: 0.48 x 33.7s = 16.2s, in other words, the time was reduced from 33.7s during a start in cold condition to 16.2s for a start in hot condition. A new start will not be allowed before the thermal image of the motor decreases, in other words, cools down.

5.2.3 Service Factor

When the Service Factor (S.F.) is different from 1.00 and if there is a need to use it, one can check in the graph, in cold condition, the points for S.F.=1.15 and in the table for S.F.=1.15.

If one wishes to know the thermal protection working times for other S.F. values just move the x In line of the motor to the left.

$$\frac{1}{S.F.} \times N \times In = New_Line \cdot N \times In$$

N= Number of motor rated current times.

Examples:
Considering the line of 3xIn with S.F.=1.00 to S.F=1.25.

$$\frac{1}{1.25} \times 3 \times In = 2.40 \times In$$

The new line of 3xIn with S.F.= 1.25 must be situated in 2.40xIn

Considering the line of 3xIn with S.F.=1.00 to S.F.=1.15.

$$\frac{1}{1.15} \times 3 \times In = 2.61 \times In$$

The new line of 3xIn with S.F.= 1.15 must be situated in 2.61xIn

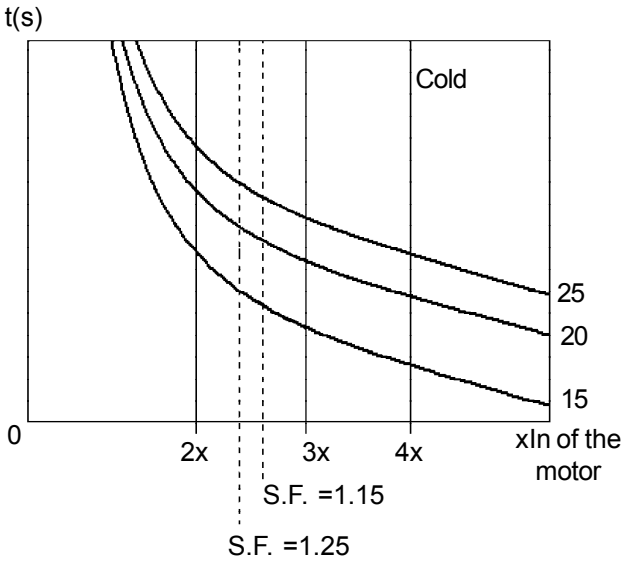


Figure 5.8 *- Using the S.F. to find the new time*

If the HMI or serial communication is unavailable to program the service factor parameter, t is necessary to use the rated current of the motor as the In of the motor x S.F. In this case, the Motor Current trimpot must be programmed considering the service factor.

$$Motor_Current = \frac{In_of_Motor \times S.F.}{In_of_SSW} \times 100$$

Example:
Motor with 80A and S.F.=1.25
SSW-07 of 130A

$$\frac{80 \times 1.25}{130} \times 100 = 77\%$$

The motor current trimpot must then be set to 77%.

NOTE!
The example and equation above must only be used when the service factor is used, and if the parameter of the service factor is not programmable via HMI or serial communication.

SOLUTION AND TROUBLESHOOTING

6.1 FAULTS AND POSSIBLE CAUSES

When a fault is detected, the Soft-Starter is disabled and the Fault Code is displayed by flashing LEDs. To restart the Soft-Starter after a fault has occured it must be reset. In general, resetting can be done as follows:

☑ Disconnecting and reapplying the AC power (power-on reset);
☑ Pressing the "RESET" key in the SSW-07 front panel (RESET key);
☑ Automatically by the automatic RESET. Enable this function via Dip-Switch (auto);
☑ Via digital input DI2 or DI3;

Protection Description and Fault Display	Activation Description	Probable Causes	Reset
Phase loss or Undercurrent **E03** (LED Phase Loss Flashing)	At starting: It occurs when there is no voltage in the power supply terminals (R/1L1, S/3L2 and T/5L3) or when the motor is disconnected. At full voltage: It trips when the current stays below the programmed value longer than the programmed time. Referring the motor nominal current. When the parameters are set with the factory default values, then this protection trips after elapsing 1 second with phase loss either at the input or at the output (motor). It trips when the current circulating through the SSW-07 is less than 20% of the value adjusted at the Motor Current trimpot.	Percentage values programmed as maximum acceptable limit. In hydraulic pump applications, it may be running with no load. Phase loss in the three-phase network. Short-circuit or thyristor or By-pass fault. Motor not connected. Motor connection is incorrect Loose contact in the connections. Starting problems with the input contactor. Input fuses are blown. Undersized input transformer. Incorrect programming of the Motor Current Trimpot. Motor current consumption lower than required for phase loss protection to work.	Power-on Reset key Auto-reset DIx
Over temperature in the power section **E04** (LED Fault) flashes once (LED Ready) On	When the heatsink temperature is superior to the limit. Also works when the temperature sensor is not connected.	Shaft load too high. Elevated number of successive starts. Internal temperature sensor not connected.	Power-on Reset key Auto-reset DIx.

Table 6.1 *- Faults and possible causes*

Protection Description and Fault Display	Activation Description	Probable Causes	Reset
Electronic motor overload **E05** (LED Overload) Flashing	When the times given by the programmed thermal class curves exceed the limit.	Incorrect setting of the "Motor Current" trimpot (motor current set). The set value is too low for the motor being used. Starting sequence greater than allowed. Programmed thermal class too low. Time between stopping and restarting lower than that permitted by the motor power refrigeration time. Load on the motor shaft too high. Thermal protection value saved when the control is turned off and brought back when turned back on.	Power-on Reset key Auto-reset DIx.
Excessive time with current limit during the start **E62** (LED Fault) flashes twice (LED Ready) On	When the starting time is longer than the time set in the acceleration ramp trimpot. Active only with current limit starting.	Programmed time for the acceleration ramp inferior to what is needed. Value of the programmed current limitation too low. Motor locked, rotor blocked.	Power-on Reset key Auto-reset DIx.
Rotor blocked **E63** (LED Stall) Flashing	Activates before full voltage, if the current is greater than twice the rated motor current.	Programmed acceleration ramp time lower than the actual acceleration time. Motor shaft is locked The transformer that supplies the motor can be saturating and taking too much time to recover from the starting current.	Power-on Reset key Auto-reset DIx.
Overcurrent **E66** (LED Overcurrent) Flashing	It is only monitored when the SSW-07 is at 100% of the voltage. When the parameters are set with the factory default values this protection trips when the motor current exceeds 3 times the value adjusted in the trimpot (Motor Current) for a time longer than 1 second.	Short-circuit between phases. Momentary motor overload. Motor shaft is **locked**, rotor blocked.	Power-on Reset key Auto-reset DIx.
Incorrect phase sequence **E67** (LED Phase Seq.) Flashing	When the sequence of synchronism signals interruptions does not follow the RST sequence.	Network phase sequence inverted at the input. May have been changed in another place of the supply network.	Power-on Reset key DIx.

Table 6.1 (cont.) *- Faults and possible causes*

Protection Description and Fault Display	Activation Description	Probable Causes	Reset
Undervoltage in the control supply **E70** (LED Fault) flashes twice (LED Ready) Off	Activates when the control supply voltage is lower than 93 Vac.	Electronics supply lower than the minimum value. Electronics power supply with loose contact. Electronics power supply fuse blown.	Power-on Reset key Auto-reset DIx.
Internal By-pass relay contact Open **E71** (Led Fault) flashes 3 times (LED Ready) Off	When there is a fault with the internal by-pass relay contacts at full voltage.	Loose contact in the starting cables of the Internal By-pass relays. Defective By-pass relay contacts due to an overload	Power-on Reset key Auto-reset DIx.
Overcurrent before the By-pass **E72** (LED Fault) flashes 4 times (LED Ready) off	Activates before the closing of the By-pass if the current is greater than: 37.5A for the SSW models up to 30A; 200A for the SSW models from 45 to 85A; 260A for the SSW model of 130A; 400A for the SSW models from 171 and 200A.	The time programmed for the acceleration ramp is shorter than the actual acceleration time. Rated motor current higher than the current that can be supported by the Soft-Starter. Motor shaft is locked, rotor blocked.	Power-on Reset key Auto-reset DIx.
Frequency out of tolerance **E75** (LED Fault) flashes 1 times (LED Ready) Off	When the limit is higher or lower than the limits of 45 to 66Hz.	The line frequency is out of range. When the Soft-Starter + motor are being supplied by a generator that is not supporting the full load regime or the start of the motor.	Power-on Reset key Auto-reset DIx.

Table 6.1 (cont.) *- Faults and possible causes*

OBSERVATIONS:

In the case of E04 (over temperature), it is necessary to wait a little before resetting, in order to cool down.

In the case of E05 (motor overload), it is necessary to wait a little before resetting, in order to cool down.

6.2 TROUBLESHOOTING

Problem	Points to check	Corrective action
Motor does not run	Wrong wiring	Check all the power and command connections. For example: The DIx digital inputs programmed as enabling or external fault must be connected to AC supply.
	Wrong programming	Check if the parameters are with the correct values for the application
	Fault	Check if the Soft-Starter is not blocked to a detected fault condition
Motor does not reach rated speed	Motor stall	Increase the current limit level with the control to limit the current.
Motor rotation oscillates (fluctuates)	Loose connections	Switch the Soft-Starter and the power supply off and tighten all the connections. Check all the internal connections of the Soft-Starter to make sure they are well connected.
Motor rotation: Too high or too low	Motor nameplate data	Check if the motor used is in accordance to the application.
LEDs off	Check the power supply voltage of the control card (A1 and A2)	Rated values must be inside the following limits: Umin. = 93.5Vac Umax.= 264Vac
Vibration during acceleration	Soft-Starter Settings	Reduce the acceleration ramp time. Reduce the pedestal voltage setting.

Table 6.2 *- Solving the most frequent problems*

NOTE!
When contacting WEG for service or technical assistance, please have the following data on hand:

☑ Model of the Soft-Starter;
☑ Serial number, production date and hardware revision present in the identification label of the product (see item 2.4);
☑ Installed software version (see item 2.2);
☑ Application and programming data.

For explanations, training or service, please contact WEG Automação Service Department.

6.3 PREVENTIVE MAINTENANCE



WARNING!
Always disconnect the general power supply before touching any electric component associated to the Soft-Starter SSW-07.

Do not run any high voltage tests on the Soft-Starter SSW-07! If necessary, consult the manufacturer.

Do not use megometers to test thyristors.

Periodic inspections of Soft-Starters SSW-07 and installations are necessary to avoid operating problems due to unfavorable environmental conditions like high temperature, humidity, dust, vibrations or due to the aging of the components.

Component	Abnormality	Corrective Action
Terminals, Connectors	Loose screws	Tightening(1)
	Loose connectors	
Fans / Ventilation Systems	Dirty fans	Cleaning(1)
	Abnormal noise	Substitute fan
	Fan always off	
	Abnormal vibration	
	Dust in the air filters	Cleaning or substitution(2)
Power Module / Power Connections	Accumulated dust, oil, humidity, etc.	Cleaning(1)
	Screws with loose connections	Tightening(1)

Table 6.3 *- Periodic inspections after putting into use*

OBS:
(1) Every six months.
(2) Twice a month.

OPTIONS AND ACCESSORIES

This chapter describes the optional devices that can be used with Soft-Starter SSW-07. They are: ventilation kit and IP20 kit.

Optional Description	WEG Part Number
Plug-in Local Keypad	417114750
Remote Keypad Kit	417114751
1m SSW-07 - Remote HMI Connection Cable	0307.7827
2m SSW-07 - Remote HMI Connection Cable	0307.7828
3m SSW-07 - Remote HMI Connection Cable	0307.7829
5m SSW-07 - Remote HMI Connection Cable	0307.8113
7,5m SSW-07 - Remote HMI Connection Cable	0307.8114
10m SSW-07 - Remote HMI Connection Cable	0307.8115
Plug-in Kit for Profibus Communication	417114752
Plug-in Kit for DeviceNet Communication	417114753
Plug-in Kit for RS-232 Communication	417114754
3m RS-232 Connection Cable	0307.8320
10m RS-232 Connection Cable	0307.8321
Plug-in Kit for RS-485 Communication	417114755
Ventilation Kit for Size 2 (Currents from 45 to 85 A)	417114756
Ventilation Kit for Size 3 (Currents from 130 to 200 A)	417114757
IP20 Kit for Size 3 (Currents from 130 to 200 A)	417114758
Plug-in Kit for Motor PTC	417114759

Table 7.1 - *Optional description*

NOTE!
Please, check the availability of the accessorie.

7.1 IP20 KIT

The IP-20 KIT is used to protect against touching the energized parts.

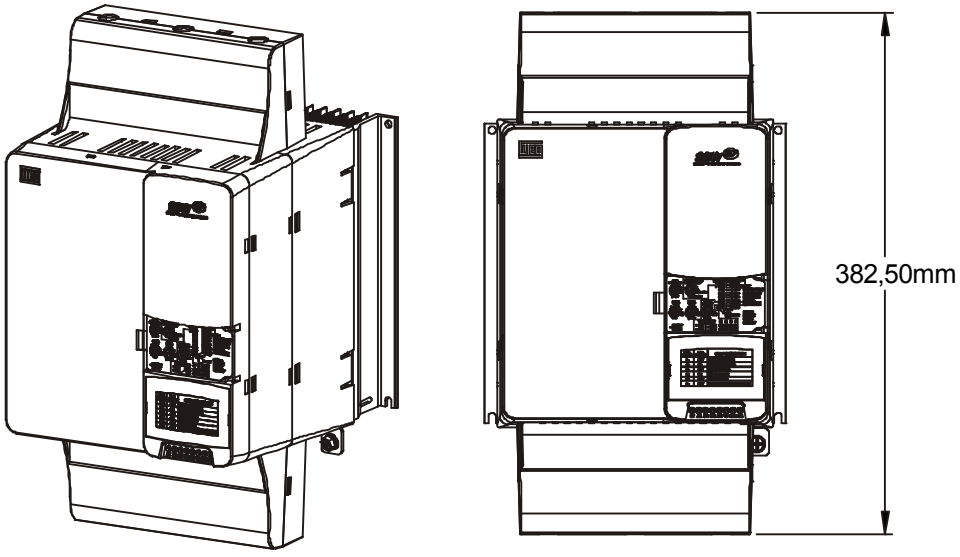


Figure 7.1 *- IP20 kit*

TECHNICAL CHARACTERISTICS

This chapter describes the electric and mechanical technical characteristics of the Soft-Starter SSW-07 line.

8.1 RATED POWERS AND CURRENTS ACCORDING TO UL508

Model SSW-07	SSW-07 Rated current SSW-07	Motor voltage 220/230V		Motor voltage 380/400V		Motor voltage 440/460V		Motor voltage 575V	
	(A)	(hp)	(kW)	(hp)	(kW)	(hp)	(kW)	(hp)	(kW)
SSW-070017	17	5	3.7	7.5	5.5	10	7.5	15	11
SSW-070024	24	7.5	5.5	10	7.5	15	11	20	15
SSW-070030	30	10	7.5	15	11	20	15	25	18.5
SSW-070045	45	15	11	25	18.5	30	22	40	30
SSW-070061	61	20	15	30	22	40	30	50	37
SSW-070085	85	30	22	50	37	60	45	75	55
SSW-070130	130	50	37	75	55	100	75	125	90
SSW-070171	171	60	45	100	75	125	90	150	110
SSW-070200	200	75	55	100	75	150	110	200	150

Table 8.1 *- Powers and currents according to UL508, temperature of 55°C, (131°F)*

8.2 RATED POWERS AND CURRENTS FOR STANDARD IP55, IV POLE WEG MOTOR

Model SSW-07	SSW-07 Rated current SSW-07	Motor voltage 220/230V		Motor voltage 380/400V		Motor voltage 440/460V		Motor voltage 575V	
	(A)	(hp)	(kW)	(hp)	(kW)	(hp)	(kW)	(hp)	(kW)
SSW-070017	17	6	4.5	10	7.5	12.5	9.2	15	11
SSW-070024	24	7.5	5.5	15	11	15	11	20	15
SSW-070030	30	10	7.5	20	15	20	15	30	22
SSW-070045	45	15	11	30	22	30	22	40	30
SSW-070061	61	20	15	40	30	50	37	60	45
SSW-070085	85	30	22	60	40	60	45	75	55
SSW-070130	130	50	37	75	56	100	75	125	90
SSW-070171	171	60	45	125	90	125	90	175	132
SSW-070200	200	75	55	125	90	150	110	200	150

Table 8.2 *- Powers and currents for WEG motors, room temperature of 55°C, (131°F)*



NOTE!
The maximum powers indicated in table 8.1 are based on 3 x rated current of Soft-Starter SSW-07 during 30s and 10 starts per hour (3xIn @ 30s).

8.3 POWER DATA

Power Supply	Power Voltage (R/1L1, S/3L2, T/5L3)	(220 to 575)Vac (-15% to +10%), or (187 to 632)Vac
	Frequency	(50 to 60)Hz (±10%), or (45 to 66)Hz
Capacity	Maximum number of starts per hour (without ventilation)	10 (1 every 6 minutes; models from 17A to 30A) 3 (1 every 20 minutes; models from 45A to 200A)
	Maximum number of starts per hour with optional ventilation Kit	10 (1 every 6 minutes; models from 45A to 200A)
	Start cycle	3 x In of the SSW-07 during 30 seconds
Thyristors (SCRs)		Reverse voltage with 1600V maximum peak
Overvoltage category		III (UL508/EN61010)

8.4 ELECTRONICS AND PROGRAMMING DATA

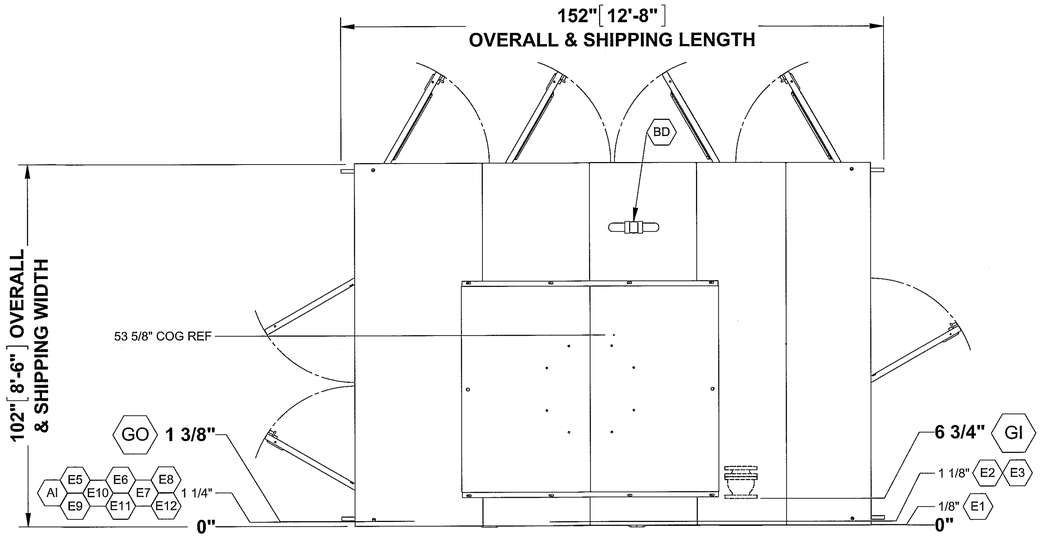
Power Supply	Control voltage Connector X1A (1.2)	☑ (110 to 240)Vac (-15% to +10%), or (94 to 264)Vac
	Frequency	☑ (50 to 60)Hz (±10%), or (45 to 66)Hz
	Consumption	☑ Max. 140mA
Control	Method	☑ Voltage ramp; ☑ Current limitation.
Inputs	Digitals	☑ 03 Isolated digital inputs; ☑ Minimum upper level: 93Vac; ☑ Maximum lower level: 10Vac; ☑ Maximum voltage: 264Vac; ☑ Input current: 1.1mA @ 220V; ☑ Programmable functions.
Outputs	Relay	☑ 02 relays with NO contacts, 240Vac, 1A, and programmable functions.
Safety	Protection	☑ Overcurrent; ☑ Phase loss; ☑ Inverted phase sequence; ☑ Heatsink overtemperature; ☑ Motor overload; ☑ External fault; ☑ Open By-pass contact; ☑ Blocked rotor; ☑ Frequency out of range; ☑ Electronic supply undervoltage.

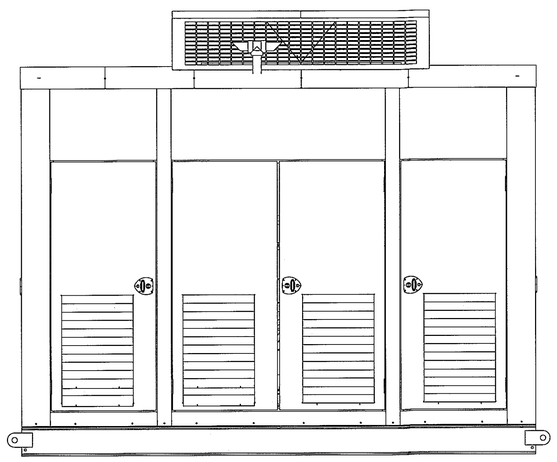
REFERENCE DRAWINGS

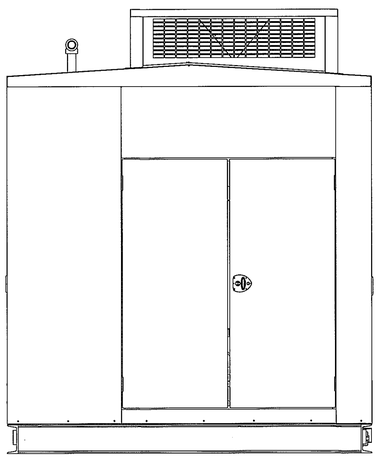


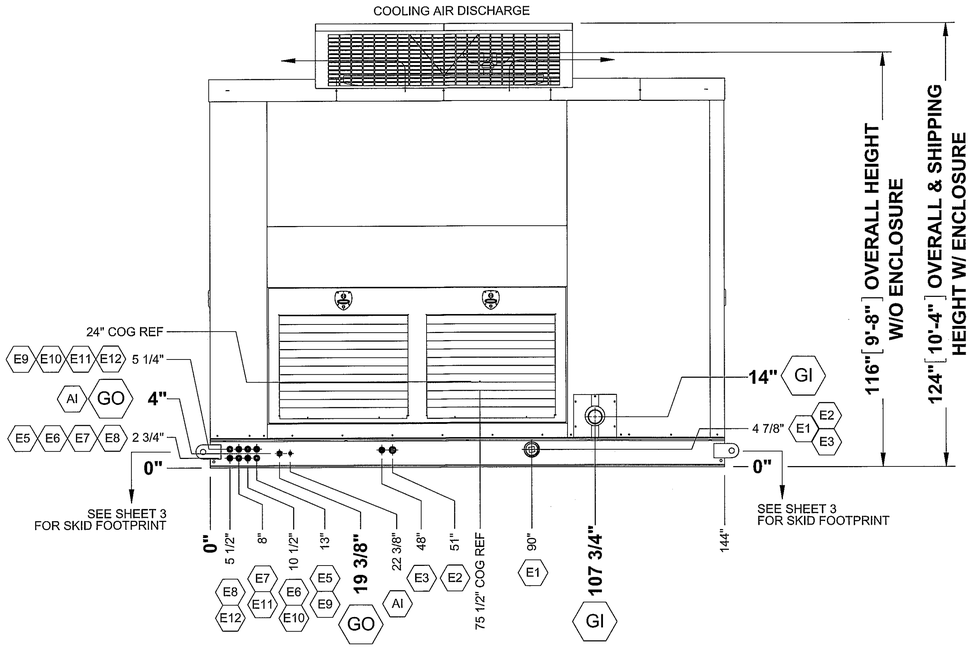
SCHEDULE OF OPENINGS

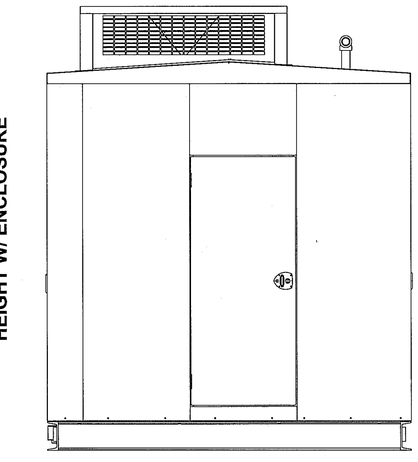
MARK	QTY.	SIZE	DESCRIPTION	LOCATION
GI	1	4" - 150# RF	PROCESS GAS INLET	SHEET #1
GO	1	3/4" SEAL-LOK	PROCESS GAS OUTLET	SHEET #1
AI	1	1/2" OD	INSTRUMENT SUPPLY INLET	SHEET #1
BD	1	2" S/80	BLOWDOWN AND RELIEF OUTLET	SHEET #1
E1	1	3" NPT	MAIN MOTOR CONDUIT ENTRY	SHEET #1
E2	1	1" NPT	COOLER AND PRELUBE CONDUIT ENTRY	SHEET #1
E3	1	3/4" NPT	HEATER CONDUIT ENTRY	SHEET #1
E4	1	3/4" NPT	SPARE CONDUIT ENTRY (NOT SHOWN)	SHEET #1
E5	1	3/4" NPT	ESD CIRCUIT CONDUIT ENTRY	SHEET #1
E6	1	3/4" NPT	MOTOR CONTROL PANEL CONDUIT ENTRY	SHEET #1
E7	1	3/4" NPT	PANEL COMMUNICATION CONDUIT ENTRY	SHEET #1
E8	1	3/4" NPT	PANEL POWER CONDUIT ENTRY	SHEET #1
E9	1	3/4" NPT	BIO-GAS PRESSURE TRANSDUCER	SHEET #1
E10	1	3/4" NPT	DRIVE BUFFER PANEL SOLENOIDS	SHEET #1
E11	1	3/4" NPT	SEND PRESSURE TRANSDUCER SIGNALS FROM BUFFER PANEL	SHEET #1
E12	1	3/4" NPT	POWER FAST FILL DISPENSER	SHEET #1
OM	1	2" NPT	OIL MAKE-UP INLET	SHEET #2
TD	1	1/2" OD	BLOWDOWN TANK DRAIN	SHEET #2
CD	1	1/2" OD	COMPRESSOR SUMP, PACKING AND DISTANCE PIECE DRAIN	SHEET #2











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UNIT COMPONENT WEIGHTS	
COMPONENT	WEIGHT IN LBS.
ENCLOSURE	2,425 LBS
COMPLETE UNIT	14,500 LBS

NOTE:

1. COMPRESSOR PACKAGE MUST BE EARTH GROUNDED, MINIMUM 2 PLACES.
2. TYPICAL DOOR SWING: 30"

TOLERANCE NOTE
UNLESS OTHERWISE NOTED:
1) FRACTIONS ±1"
2) ANGLES ±1°
3) OVERALL & SHIPPING DIMENSIONS ARE MAXIMUM

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NO.	REVISION	BY	CK'D	APP'D	DATE
0	ISSUE FOR CONSTRUCTION	JO	JO	DLD	6/12/17

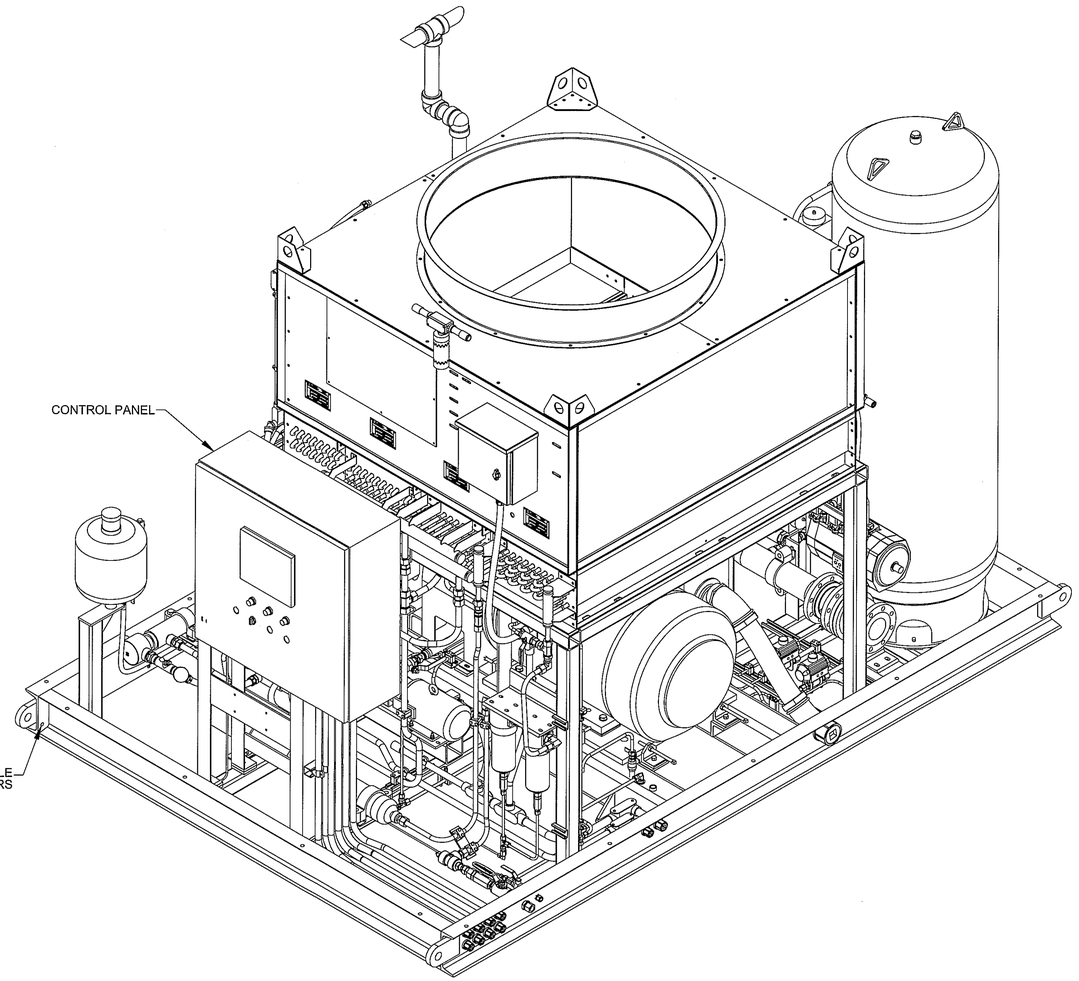
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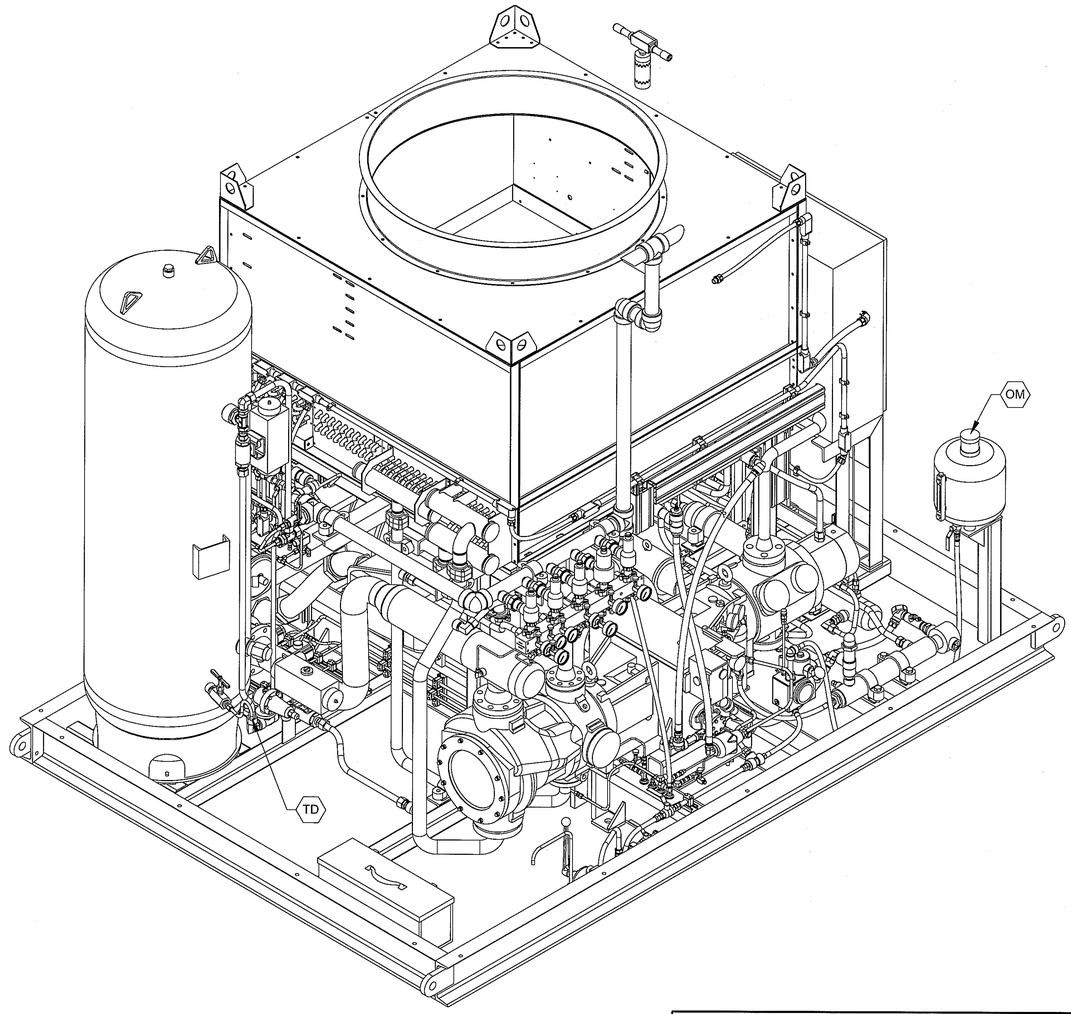
J-W POWER COMPANY
LONGVIEW, TEXAS, USA

EA-200-4 UNIT 7351 COMPRESSOR INSTALLATION

SHT 1 OF 4

P/N | DWG. 335-29521 | REV. 0





NOTE:

EQUIPMENT SHOWN FOR REFERENCE ONLY
- CUSTOMER'S CONFIGURATION MAY VARY

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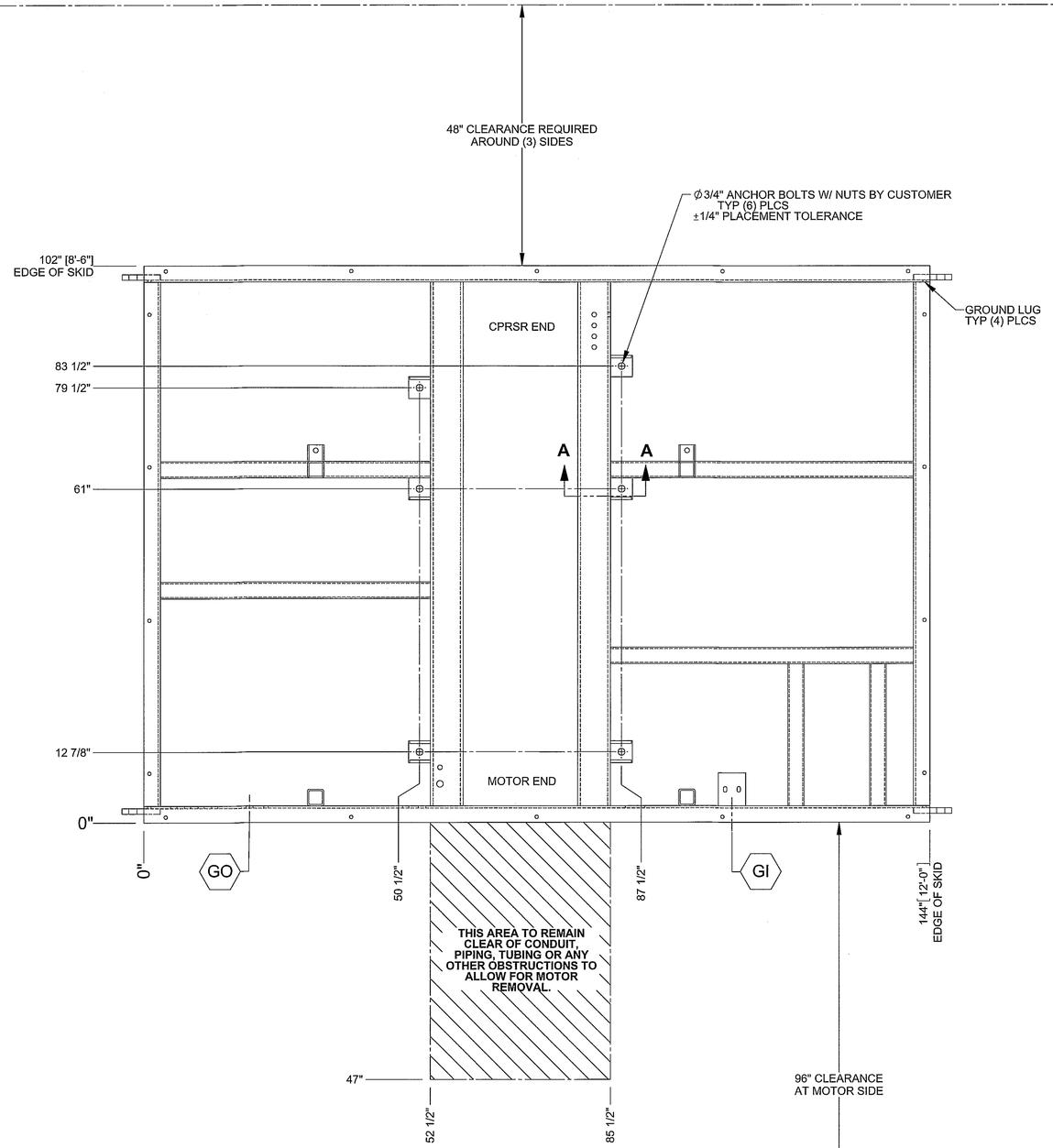
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JO	JO	DLD	6/9/17	NONE

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LONGVIEW, TEXAS, USA

EA-200-4 UNIT 7351 COMPRESSOR INSTALLATION

SHT 2 OF 4

P/N	DWG. 335-29521	REV. 0



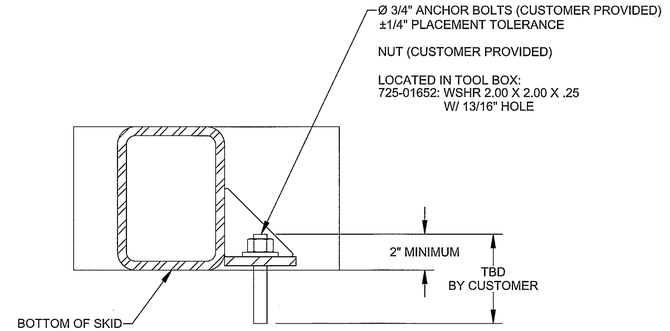
SKID FOOTPRINT

VIEW IS FROM TOP OF SKID LOOKING DOWN
CONCRETE PAD WITH ANCHOR BOLTS REQUIRED

(ANCHOR BOLTS MUST BE INSTALLED IN CONCRETE BEFORE UNIT IS SET)

NOTE:

1. COMPRESSOR PACKAGE MUST BE EARTH GROUNDED, MINIMUM 2 PLACES.



ANCHOR BOLT DETAIL

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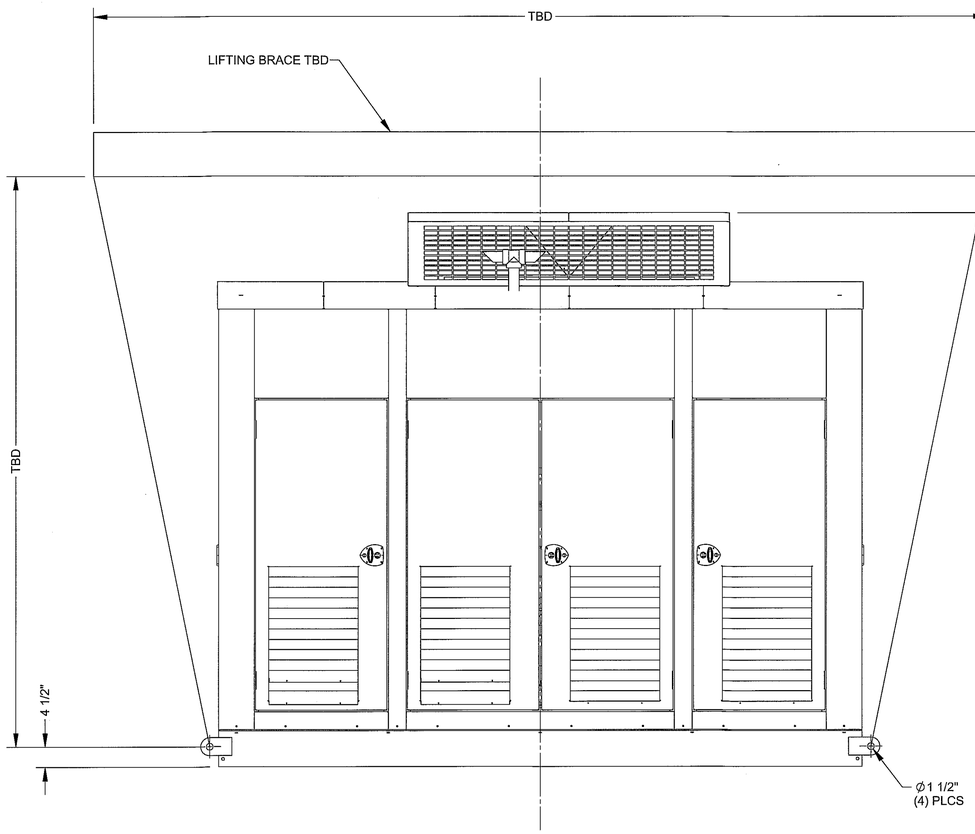
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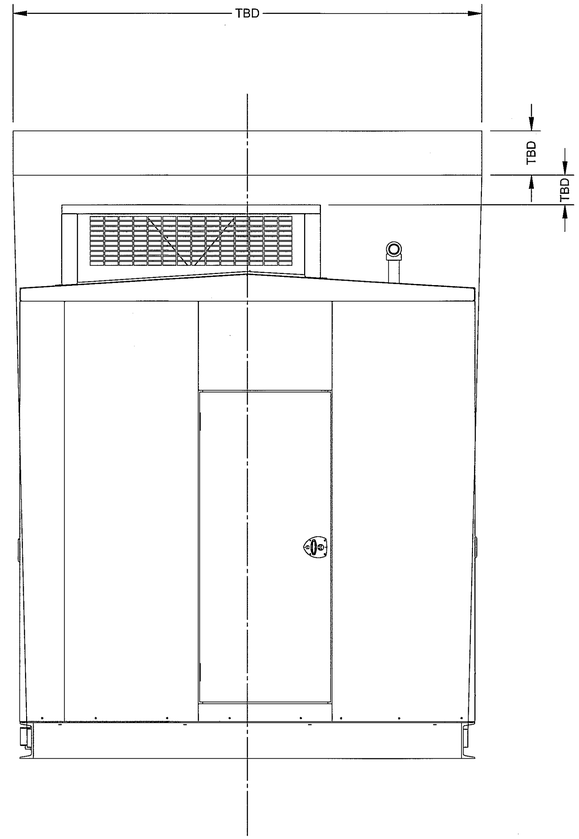
EA-200-4 UNIT 7351 COMPRESSOR INSTALLATION

NO.	REVISION	BY	CK'D	APP'D	DATE
0	ISSUE FOR CONSTRUCTION	JO	JO	DLD	6/12/17

SHT 3 OF 4

DRWN	CK'D	APP'D	DATE	SCALE	P/N	DWG.	REV.
JO	JO	DLD	6/9/17	1 : 12		335-29521	0





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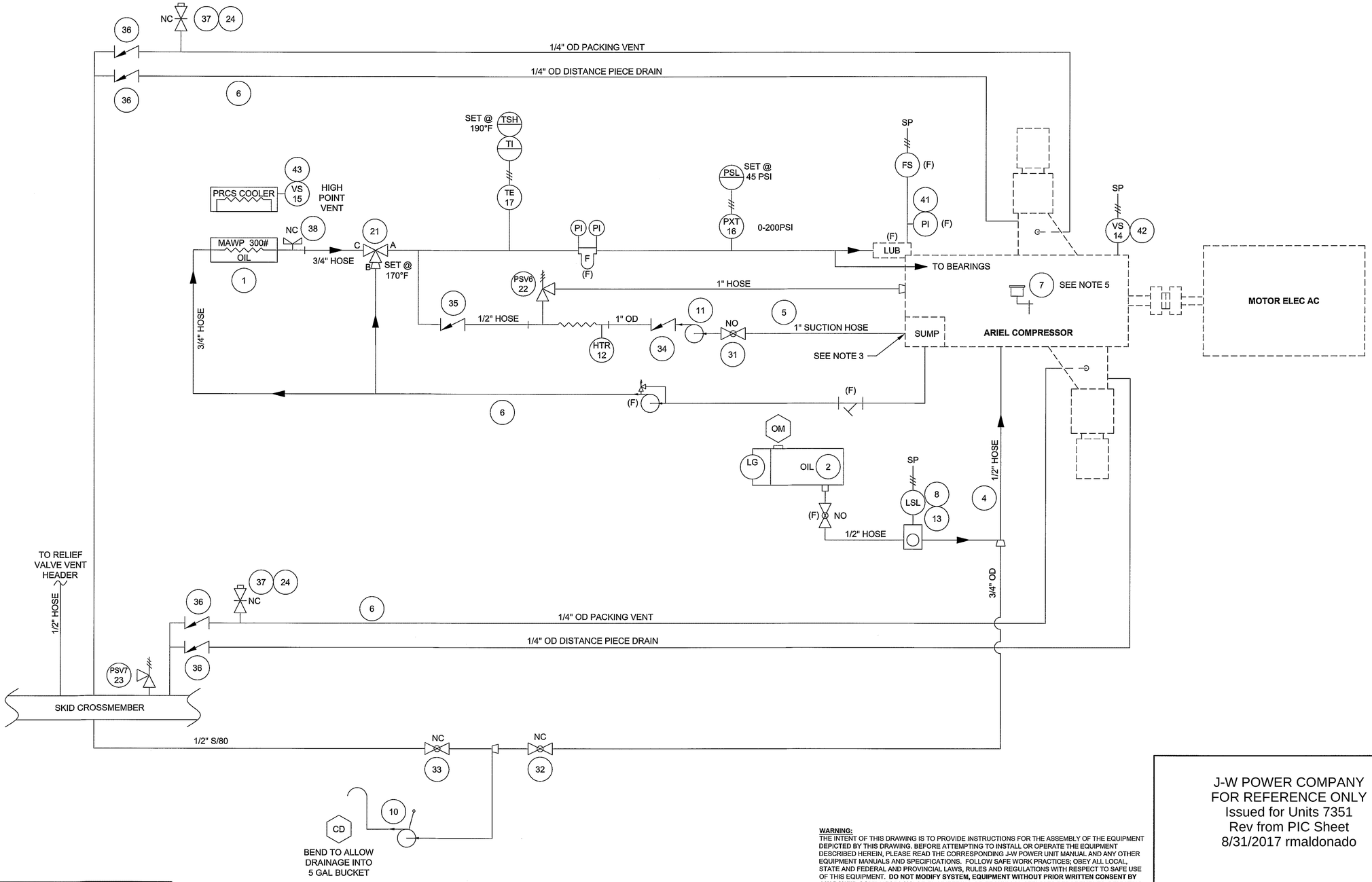
EA-200-4 UNIT 7351 COMPRESSOR INSTALLATION

NO.	REVISION	BY	CK'D	APP'D	DATE
0	ISSUE FOR CONSTRUCTION	JO	JO	DLD	6/12/17

DRWN	CK'D	APP'D	DATE	SCALE	P/N	DWG.	REV.
JO	JO	DLD	6/9/17	1 : 20		335-29521	0

360-04089 -- TRIM OIL EA CNG W/TC2000W HTR C1000/C2000

Seq Nbr	Component	Description			Qty Per	UM
0	335-26472	TRIM OIL EA CNG			1.00	D
1	329-01127	CLR OIL 300# MAWP	THERMAL TRAN M-30	*	1.00	EA
2	330-02070	TANK OIL 5 GAL KENCO	5G-44-RP-BREATHER	*	1.00	EA
4	338-01836	SPOOL OIL	C-1000 / C-2000		1.00	EA
5	338-02448	SPOOL PRELUBE CPRSR	W/HTR W/TC C2000		1.00	EA
5	338-02465	SPOOL PRELUBE CPRSR	W/HTR W/TC C1000		1.00	EA
6	338-02294	SPOOL ARIEL CYL VENT	DRAIN TBG .25 JGP CNG		1.00	EA
7	338-00862	SPOOL FRAME VENT CAP	ARIEL FRAME JGMPQA		1.00	EA
8	339-00165	KIT VENT OIL LVL CONT			1.00	EA
10	766-00257	PUMP HAND SEMI-ROTARY	GORMAN RUPP 0.75 NPT	*	1.00	EA
11	766-00243	PUMP OIL ASSY 1HP 3.2GPM	3/60/460/1200/145T	*	1.00	EA
12	370-00099	HEATER OIL IMMRSN	2000W 480VAC 3PH 2 NPT	*	1.00	EA
13	593-00334	CONT LEVEL OIL W/ LSL	KLCE-12		1.00	EA
14	581-00573	XMTR VIB VEL 0-3.0IPS PK	ST5484E-132-114-02 .5NPT		2.00	EA
16	712-01164	XDCR PRESS 0- 200 PSIG	4-20mA 24VDC M12 CNTR		1.00	EA
17	612-00200	THERMOCOUPLE .25 K TYPE	4 LG O.B/DRN/SHLD25'LD	*	1.00	EA
21	635-02173	VA THERMO .75 FPT FPE	A-1110 SET @ 170 F		0.00	EA
22	635-03196	VA RLF OIL PRESS 1.00	FNPT VJ-5RHSUS 15# @180	*	1.00	EA
23	635-03541	VA RLF .25 50# BRASS	250 DEG F ST25-1A050		1.00	EA
24	326-00025	VENT SCREEN .25 NPT BRZ			2.00	EA
31	635-01454	VA BALL 1.0 2000# FNPT	CS 2PC FP LCK SS TRIM	*	1.00	EA
32	635-01453	VA BALL .75 2000# FNPT	CS 2PC FP LCK SS TRIM	*	1.00	EA
33	635-01452	VA BALL .50 2000# FNPT	SS 2PC FP LCK SS TRIM	*	1.00	EA
34	635-00621	VA CHK 1.0 FNPT 200#	WOG HORIZ SWING BRNZ		1.00	EA
35	635-01103	VA CHK .50 FNPT 300#	SWING BRNZ 600# WOG	*	1.00	EA
36	635-00623	VA CHK .25 MNPT 1#CRK	6000# MAWP 4M-C4L-1-SS		4.00	EA
37	635-02539	VA NDL .25 MxF 5000#	@350F ROUND RED KNOB	*	2.00	EA
38	635-40215	VA PETCOCK .25 MNPT	BRASS 150#		1.00	EA
39	635-03155	VA BALL .50 2160# FNPT	SS 3WAY FP LOCKABLE	*	1.00	EA
41	332-02167	GUARD GAUGE	ARIEL LUBE SYSTEM		1.00	EA
43	332-01752	BRKT MTG F/VIB XDCR	1/2 NPT (2) 5/8 @ 4		1.00	EA
43	332-01893	BRKT MTG F/VIB XDCR	1/2 NPT F/CNG COOLER		1.00	EA



PRESSURE RELIEF VALVE IDENTIFICATION

ITEM	J-W PART NO	DESCRIPTION	SET PRESSURE
PSV6	635-03196	1" VJ-5RUS	15 PSIG
PSV7	635-03541	ST25-1A050	50 PSIG

SCHEDULE OF OPENINGS

MARK	QTY	SIZE	DESCRIPTION
CD	1	1/2" OD	COMPRESSOR & DRIP TANK DRAIN
OM	1	2" NPT	OIL MAKEUP INLET

NOTES:
1. ALL NPT CONNECTIONS ARE TO BE PLUGGED.
2. SEE DWG #335-17114 FOR LEGEND.
3. CONNECT TO 1" NPT PORT ON DRIVE END OF COMPRESSOR.
4. NO - NORMALLY OPEN DURING UNIT OPERATION.
   NC - NORMALLY CLOSED DURING UNIT OPERATION.
5. FRAME BREATHER RELOCATED OUTSIDE OF ENCLOSURE ON PACKAGES WITH BLOWDOWN TANK RATING ABOVE 440PSI.

ALL TUBING USED IN NATURAL GAS SERVICE TO MEET THESE MINIMUM REQUIREMENTS.

1/4" x .049 316 SST SEAMLESS

3/8" x .065 316 SST SEAMLESS

1/2" x .083 316 SST SEAMLESS

3/4" x .109 316 SST SEAMLESS

1" x .095 316 SST SEAMLESS

WARNING:
THE INTENT OF THIS DRAWING IS TO PROVIDE INSTRUCTIONS FOR THE ASSEMBLY OF THE EQUIPMENT DEPICTED BY THIS DRAWING. BEFORE ATTEMPTING TO INSTALL OR OPERATE THE EQUIPMENT DESCRIBED HEREIN, PLEASE READ THE CORRESPONDING J-W POWER UNIT MANUAL AND ANY OTHER EQUIPMENT MANUALS AND SPECIFICATIONS. FOLLOW SAFE WORK PRACTICES; OBEY ALL LOCAL, STATE AND FEDERAL AND PROVINCIAL LAWS, RULES AND REGULATIONS WITH RESPECT TO SAFE USE OF THIS EQUIPMENT. **DO NOT MODIFY SYSTEM, EQUIPMENT WITHOUT PRIOR WRITTEN CONSENT BY J-W POWER COMPANY PACKAGE ENGINEERING OR TECHNICAL SERVICES DEPARTMENTS. DEVIATING FROM THE DESIGN DEPICTED ON THE UNIT SPECIFIC DRAWINGS MAY RESULT IN POOR PERFORMANCE, EQUIPMENT DAMAGE, PROPERTY DAMAGE, HUMAN INJURY OR DEATH.**

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NO.	REVISION	BY	CK'D	APP'D	DATE
3	REMOVE THERMOCOUPLE AT HEATER	JO	AG	JO	1/4/17
2	ADDED HAND PUMP	KD	JO	JO	9/29/16
1	ADDED 3-WAY VALVE	JO	PJ	PJ	12/01/14
0	ISSUE FOR CONSTRUCTION	GF	PJ	JO	7/31/14

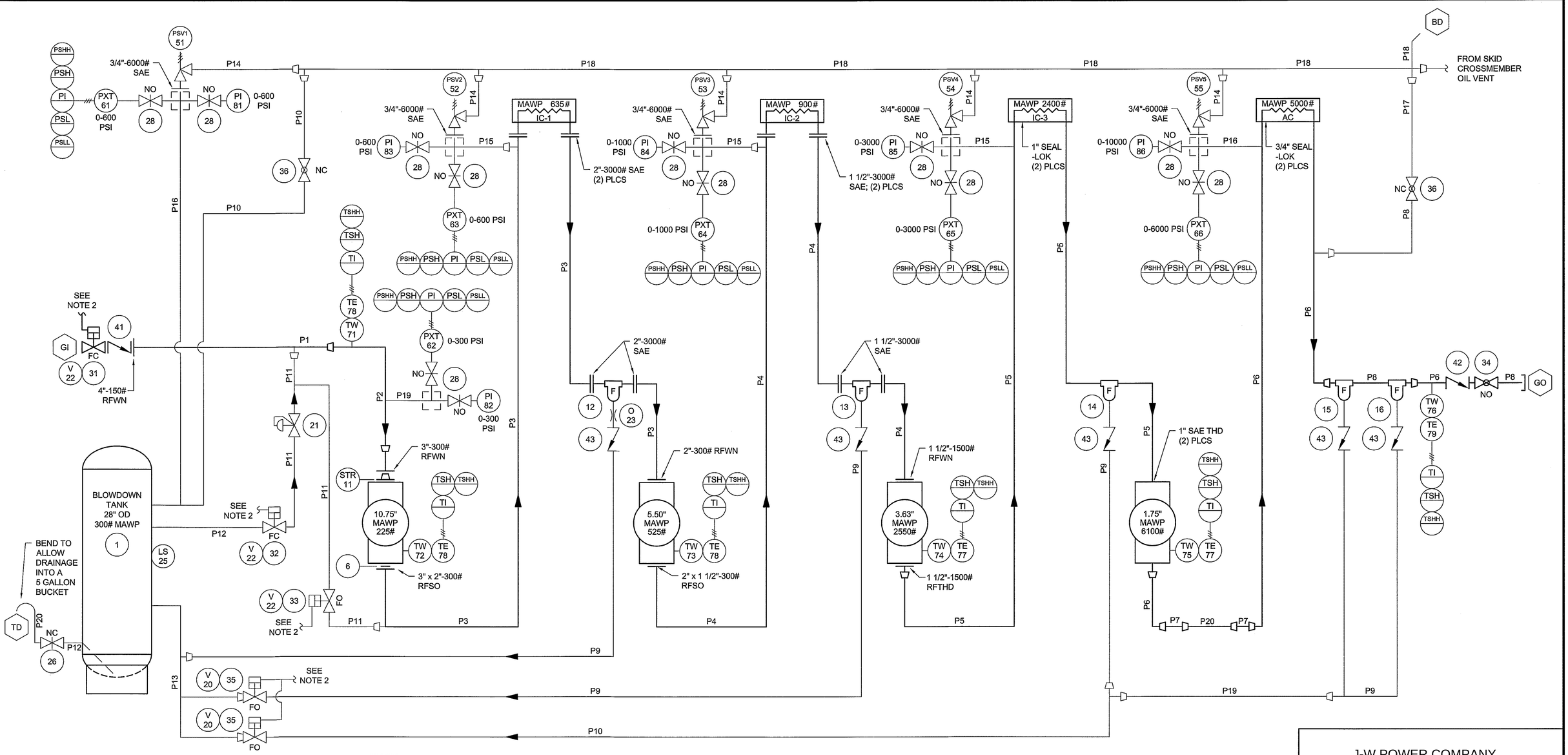
J-W POWER COMPANY
LONGVIEW, TEXAS, USA

TRIM OIL EA CNG W/TC 2000W HTR C1000/C2000

DRWN	CK'D	APP'D	DATE	SCALE	P/N	DWG.	REV.
GF	PJ	JO	7/31/14	NONE	360-04089	335-26472	3

Seq Nbr	Component	Description		Qty Per	UM
0	335-23549	PLAN & EL CONSTRUCTION		1.00	D
0	335-26022	TRIM PRCS GAS EA- 200-4		1.00	D
0	635-03539	PLATE LOCKING VA BALL	OASIS BV706-LH 3/4 & 1	1.00	EA
0	635-03540	PLATE LOCKING VA BALL	OASIS BV703-LH 3/8 & 1/2	2.00	EA
1	330-02029	TANK BLWDN 28 300#V	72 S/S 1-NPT x 2-NPT	1.00	EA
2	336-02572	SPOOL PRCS GAS	EA- 200-4 996-00007	1.00	EA
3	338-02315	SPOOL FLTR DR C2000 4STG	.75 (2)VA&ORF	1.00	EA
4	338-02131	SPOOL RLF VA VENT 2	CNG OPTION C 4STG 62 RSO	1.00	EA
5	338-02354	SPOOL TANK DRAIN	C-2000	1.00	EA
6	198-00326	PL ORF 3.0- 300# RF	2.250 BORE .125 304SS *	1.00	EA
11	670-00050	STR 3 150/300# BSKT	200%CS #40SST OUT XH *	1.00	EA
12	252-01289	FLTR CLSC 2.0 SAE/ORB WS	500#HS8S100WSN NO DPG *	1.00	EA
13	252-01248	FLTR CLSC 1.0 SAE/ORB	FINITE 5000# JS4C-WSN	1.00	EA
14	252-01248	FLTR CLSC 1.0 SAE/ORB	FINITE 5000# JS4C-WSN	1.00	EA
15	252-01238	FLTR CLSC 1.0 SAE/ORB	FINITE 5000# JS4C-10CN *	1.00	EA
16	252-01237	FLTR CLSC 1.0 SAE/ORB	FINITE 5000# JS4C-4CN *	1.00	EA
20	733-30150	VENT SCREEN .12 NPT BRZ	CLIPPARD 15080	2.00	EA
21	626-00734	RGLTR PRESS 1 627 DI	.50 ORF 15-40# SPR	1.00	EA
22	326-00025	VENT SCREEN .25 NPT BRZ		3.00	EA
23	640-01268	FTG TBG 6 LOHL6-S .015	VG109 9200# SEAL-LOK *	1.00	EA
25	712-01056	SW LEVEL MLS-020	2.00 NPT 2000# @ 300F	1.00	EA
26	635-00944	VA GLOBE 1.00 FNPT10000#	@ 600F WOG .437 ORF *	1.00	EA
28	635-02539	VA NDL .25 MxF 5000#	@350F ROUND RED KNOB *	12.00	EA
31	635-02811	VA BALL 4.0 150# FP	W/ACTR VELAN/BETTIS *	1.00	EA
32	635-02751	VA BALL 1.0 2000# FNPT	W/ACTR FC SS *	1.00	EA
33	635-03129	VA BALL 1.0 2000# FNPT	W/ACTR FO *	1.00	EA
34	635-03258	VA BALL .75 6000# SAE	BV706-4S6ADDN-1000 *	1.00	EA
35	635-03260	VA BALL .50 6000# SAE	ACT FO BV7044S6LDDN012M*	2.00	EA
36	635-03257	VA BALL .50 6000# SAE	BV704-4S6LDDN-1000 *	2.00	EA
41	635-02812	VA CHK 4 150#RF WAFER	316SS CRANE 4G15SPFR73 *	1.00	EA
42	635-03587	VA CHK .75 6000# @ 400F	#12SAE THD VG109 65#SPR*	1.00	EA
43	635-03162	VA CHK .38 6000# @ 400F	#6 SAE THD VG109 O-RING*	5.00	EA
51	635-03010	VA RLF .75 300# 350F	MERCER 91-62E61T11I1 *	1.00	EA
52	635-03008	VA RLF .75 225# 350F	MERCER 91-62D61T07I1 *	1.00	EA
53	635-03012	VA RLF .75 525# 350F	MERCER 91-62C61T09C1 *	1.00	EA
54	635-03019	VA RLF .75 2000# 350F	MERCER 91-62C61P13C1 *	1.00	EA

Seq Nbr	Component	Description		Qty Per	UM
55	635-03024	VA RLF .75 5000# 350F	MERCER 91-62C61P5641 *	1.00	EA
61	712-01166	XDCR PRESS 0- 600 PSIG	4-20mA 24VDC M12 CNTR	1.00	EA
62	712-01165	XDCR PRESS 0- 300 PSIG	4-20mA 24VDC M12 CNTR	1.00	EA
63	712-01166	XDCR PRESS 0- 600 PSIG	4-20mA 24VDC M12 CNTR	1.00	EA
64	712-01167	XDCR PRESS 0-1000 PSIG	4-20mA 24VDC M12 CNTR	1.00	EA
65	712-01169	XDCR PRESS 0-3000 PSIG	4-20mA 24VDC M12 CNTR	1.00	EA
66	712-01170	XDCR PRESS 0-6000 PSIG	4-20mA 24VDC M12 CNTR	1.00	EA
71	612-00104	THERMOWELL .50NPT x .25	CPRSN 4.00 IN 304SS	1.00	EA
72	612-00104	THERMOWELL .50NPT x .25	CPRSN 4.00 IN 304SS	1.00	EA
73	612-00104	THERMOWELL .50NPT x .25	CPRSN 4.00 IN 304SS	1.00	EA
74	612-00103	THERMOWELL .50NPT X .25	CPRSN 3.00 IN 304SS	1.00	EA
75	612-00104	THERMOWELL .50NPT x .25	CPRSN 4.00 IN 304SS	1.00	EA
76	612-00021	THERMOWELL .50NPT X .25	CPRSN 1.25 IN 304SS	1.00	EA
77	612-00047	THERMOCOUPLE .25 K TYPE	6 LG O.B/DRN/SHLD15'LD*	2.00	EA
78	612-00049	THERMOCOUPLE .25 K TYPE	6 LG O.B/DRN/SHLD20'LD*	3.00	EA
79	612-00200	THERMOCOUPLE .25 K TYPE	4 LG O.B/DRN/SHLD25'LD*	1.00	EA
81	581-00446	GA PRESS 0- 600 PSI	2.5 WIKA 233.53 .25 CBM*	1.00	EA
82	581-00456	GA PRESS 0- 300 PSI	2.5 WIKA 233.54 .25 CBM*	1.00	EA
83	581-00446	GA PRESS 0- 600 PSI	2.5 WIKA 233.53 .25 CBM*	1.00	EA
84	581-00447	GA PRESS 0- 1000 PSI	2.5 WIKA 233.53 .25 CBM*	1.00	EA
85	581-00448	GA PRESS 0- 3000 PSI	2.5 WIKA 233.53 .25 CBM*	1.00	EA
86	581-00449	GA PRESS 0- 10000 PSI	2.5 WIKA 233.53 .25 CBM*	1.00	EA



PRESSURE RELIEF VALVE IDENTIFICATION

ITEM	J-W PART NO	DESCRIPTION	SET PRESSURE
PSV1	635-03010	MERCER 91-62E61T11I1	300 PSI
PSV2	635-03008	MERCER 91-62D61T07I1	225 PSI
PSV3	635-03012	MERCER 91-62C61T09C1	525 PSI
PSV4	635-03019	MERCER 91-62C61P13C1	2000 PSI
PSV5	635-03024	MERCER 91-62C61P5641	5000 PSI

SCHEDULE OF OPENINGS

MARK	QTY	SIZE	DESCRIPTION
GI	1	4"-150# RF	PROCESS GAS INLET
GO	1	3/4" NPT	PROCESS GAS OUTLET
BD	1	2" XH/80	BLOWDOWN & RELIEF OUTLET
TD	1	1/2" OD	BLOWDOWN TANK DRAIN

WARNING:
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PIPE & TUBING SCHEDULE

MARK	SPOOL	SIZE	MAT'L	MAWP
P1	S1	4" S/80	SA-106-C	225# @ 300°F
P2	S1	6" S/80	SA-106-C	225# @ 300°F
P3	D1 , S2	2" S/80	SA-106-C	225# @ 350°F
P4	D2 , S3	1 1/2" S/160	SA-106-B	645# @ 350°F
P5	D3 , S4	1" OD x .095	316SS SML TBG	2400# @ 350°F
P6	D4 , FNL	3/4" OD x .109	316SS SML TBG	5000# @ 350°F
P7	D4	4" XXH	SA-106-C	5000# @ 350°F
P8	FNL	SEAL-LOK	----	5000# @ 350°F
P9	DRAIN	3/8" OD x .065	316SS SML TBG	5000# @ 350°F
P10	DRAIN, VENT	1/2" OD x .083	316SS SML TBG	5000# @ 350°F

PIPE & TUBING SCHEDULE

MARK	SPOOL	SIZE	MAT'L	MAWP
P11	AUX, BYPASS	1" OD x .095	316SS SML TBG	300# @ 350°F
P12	AUX, DRAIN	1" S/80	SA-106-B	300# @ 350°F
P13	DRAIN, RLF	3/4" OD x .109	316SS SML TBG	2400# @ 350°F
P14	RLF	1" S/80	SA-106-B	----
P15	RLF	1" OD x .095	316SS SML TBG	2400# @ 350°F
P16	RLF	3/4" OD x .109	316SS SML TBG	5000# @ 350°F
P17	BLWDN	1/2" OD x .083	316SS SML TBG	5000# @ 350°F
P18	RLF , BLWDN	2" S/80	SA-106-C	----
P19	DRAIN, PXT	1/4" OD x .049	316SS SML TBG	5000# @ 350°F
P20	DRAIN	1/2" OD x .083	316SS SML TBG	----

NOTES:
1. ALL TUBING IS 316SS SEAMLESS UNLESS NOTED.
2. SEE SEPARATE INSTRUMENT SCHEMATIC FOR SUPPLY/CONTROL TO VALVES.
3. SEE SEPARATE DWG: 335-17114 FOR SYMBOL AND ANNOTATION LEGEND.
4. ALL RF ANSI FLANGES ARE TO HAVE FLEXITALLIC TYPE "CG" GASKETS.
5. ALL NPT CONNECTIONS ARE TO BE PLUGGED.

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NO.	REVISION	BY	CK'D	APP'D	DATE
5	D2, S3 CHANGED FROM 900# TO 645#	TL	%	%	5/12/17
4	UPDATE TBG CALLOUTS AND ADD ITEM 20	JO	JO	DLD	9/29/16
3	UPDATED THERMOCOUPLES / WELLS	RLJ	SP	DLD	8/19/15
0	ISSUE FOR CONSTRUCTION	JO	MT	PJ	4/7/14

J-W POWER COMPANY
LONGVIEW, TEXAS, USA

TRIM PRCS GAS
EA-200-4

DRWN	CK'D	APP'D	DATE	SCALE	P/N	DWG.	REV.
JO	MT	PJ	4/4/2014	NONE	360-04041	335-26022	5

996-00007

360-03988 -- TRIM INSTR GAS W/TNK CNGOPT C FROM PRIORITY PNL

Seq Nbr	Component	Description		Qty Per	UM
0	335-25689	TRIM INSTR GAS W/TNK CNG		1.00	C
1	326-00025	VENT SCREEN .25 NPT BRZ		1.00	EA
2	338-02368	SPOOL DRAIN .50	OPTION C IN-SKID TANK	1.00	EA
3	338-02575	SPOOL GAS SUPPLY TO	ACTR VALVES C-2000	1.00	EA
4	581-00364	GA PRESS 0- 160 PSI	2.5 WIKA 233.53 .25 LM *	2.00	EA
5	587-00273	SW PRESS H117-702	SET @ 90 PSIG FALLING *	1.00	EA
6	626-00741	RGLTR PRESS .25 P39	0-120 BELGAS	1.00	EA
7	635-00623	VA CHK .25 MNPT 1#CRK	6000# MAWP 4M-C4L-1-SS	2.00	EA
8	635-01451	VA BALL .25 2000# FNPT	SS 2PC FP LCK SS TRIM *	2.00	EA
9	635-01452	VA BALL .50 2000# FNPT	SS 2PC FP LCK SS TRIM *	2.00	EA
10	635-02501	VA SOL 3WAY .25 FNPT 24	VDC ASCO EF8320G184 *	4.00	EA
11	635-02539	VA NDL .25 MxF 5000#	@350F ROUND RED KNOB *	3.00	EA
13	635-03155	VA BALL .50 2160# FNPT	SS 3WAY FP LOCKABLE *	1.00	EA
14	635-03133	VA RLF .50 120# 80F	MERCER 91-06D51V06I1	1.00	EA
15	712-01164	XDCR PRESS 0- 200 PSIG	4-20mA 24VDC M12 CNTR	0.00	EA

PRESSURE SOURCE	
2-STAGE BUILD:	SUCTION
3-STAGE BUILD:	1ST STG DISCHARGE
4-STAGE BUILD:	2ND STG DISCHARGE

NOTE:

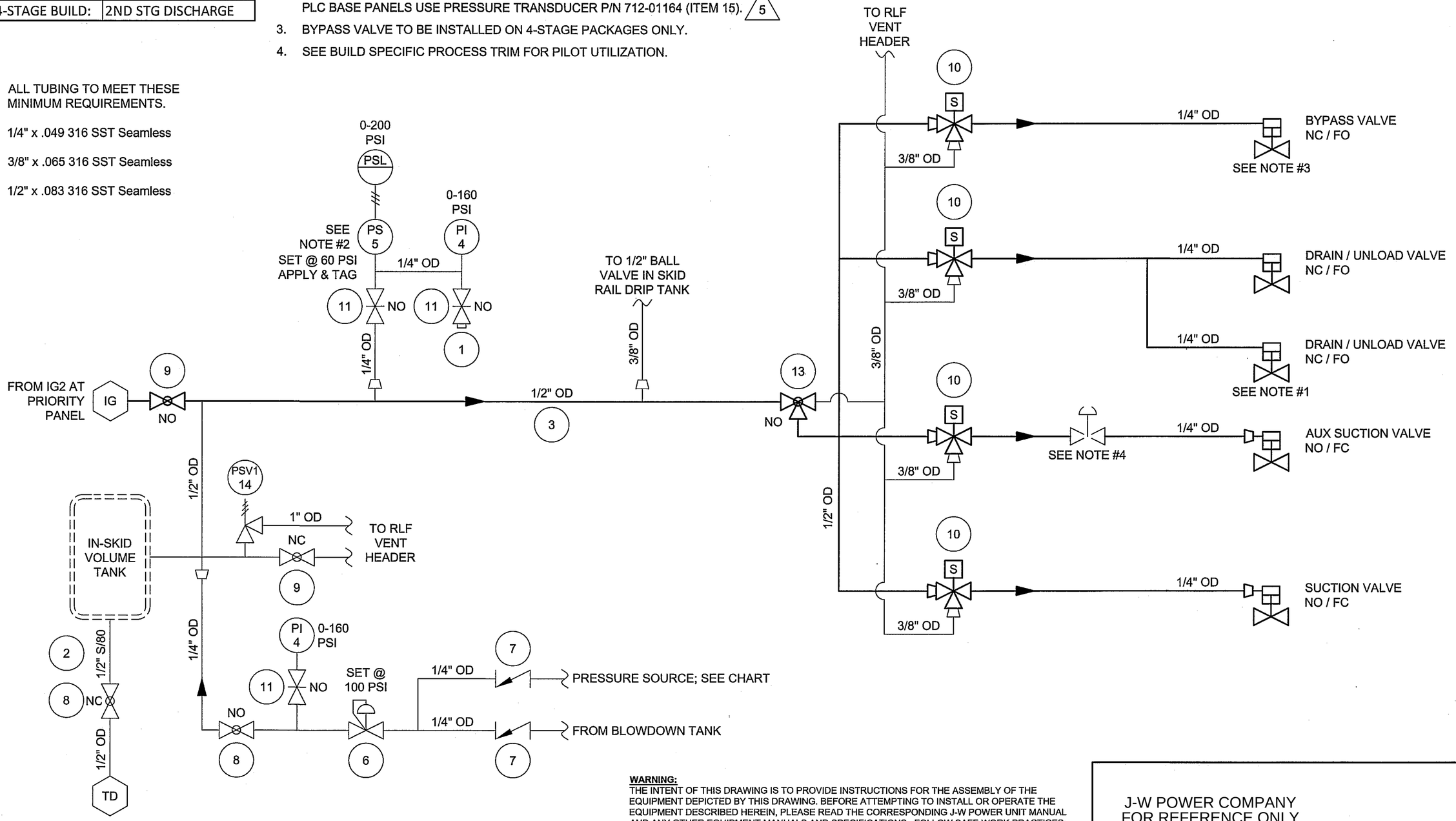
1. SECOND DRAIN / UNLOAD VALVE TO BE INSTALLED ON 4-STAGE PACKAGES ONLY.
2. CENTURION PANELS UTILIZE PRESSURE SWITCH P/N 587-00273 (ITEM 5), PLC BASE PANELS USE PRESSURE TRANSDUCER P/N 712-01164 (ITEM 15). △5
3. BYPASS VALVE TO BE INSTALLED ON 4-STAGE PACKAGES ONLY.
4. SEE BUILD SPECIFIC PROCESS TRIM FOR PILOT UTILIZATION.

ALL TUBING TO MEET THESE MINIMUM REQUIREMENTS.

1/4" x .049 316 SST Seamless

3/8" x .065 316 SST Seamless

1/2" x .083 316 SST Seamless



PRESSURE RELIEF VALVE IDENTIFICATION			
ITEM	J-W PART NO	DESCRIPTION	SET PRESSURE
PSV1	635-03133	MERCER 91-06D51V06I1	120 PSIG

SCHEDULE OF OPENINGS			
MARK	QTY	SIZE	DESCRIPTION
IG	1	1/2" OD	INSTRUMENT SUPPLY INLET
TD	1	1/2" OD	VOLUME TANK DRAIN

WARNING:
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NO.	REVISION	BY	CK'D	APP'D	DATE
5	UPDATE NOTE #2 XDCR P/N	JO	KV	JO	3/26/15
4	ADD NOTES #3 & #4	JO	PJ	PJ	12-08-15
3	UPDATE PSV OUTLET SIZE	ZJT	PJ	PJ	6/18/14
0	ISSUE FOR CONSTRUCTION	JC	GF	PJ	2-04-14

J-W POWER COMPANY
LONGVIEW, TEXAS, USA

TRIM INSTR GAS W/TNK CNG OPT C FROM PRIORITY PNL

DRWN	JC	CK'D	GF	APP'D	PJ	DATE	2-04-14	SCALE	NONE	P/N	360-03988	DWG.	335-25689	REV.	5

MOTOR STARTER PANEL (MCP)	C4 UNIT CONTROL PANEL (UCP)	Power Type	FUNCTION	CONDUIT RUN
75HP Thru 250HP SoftStart Panels DWG # **335-25174**	P/N **328-00680** DWG # **335-25873**			
FU1	TB7#5	[120vAC]	Soft Start Power	Conduit between MCP and UCP COMPRESSOR SKID CONDUIT ENTRY "E6"
1C2	TB7#6	[Neutral]	Soft Start Neutral	
1C3	TB7#9	[120vAC]	Main Motor Run Command	
1C4	TB7#7	[120vAC]	Soft Start Reset	
1C5	TB7#21	[120vAC]	Main Motor Run Feedback	
1C6	TB7#25	[120vAC]	Soft Start Fault	
2C4	TB7#15	[120vAC]	Cooler Motor Run Command	
3C3	TB7#23	[120vAC]	Lube Motor Run Feedback	
3C4	TB7#13	[120vAC]	Lube Motor Run Command	
1T1		[480vAC]	Main Motor Power Wiring	Conduit between MCP & Compressor Skid COMPRESSOR SKID CONDUIT ENTRY "E1"
1T2		[480vAC]		
1T3		[480vAC]		
GND		[Ground]		
2T1		[480vAC]	Cooler Motor Power Wiring	Conduit between MCP & Compressor Skid COMPRESSOR SKID CONDUIT ENTRY "E2"
2T2		[480vAC]		
2T3		[480vAC]		
GND		[Ground]		
3T1		[480vAC]	Prelube Motor Power Wiring	Conduit between MCP & Compressor Skid COMPRESSOR SKID CONDUIT ENTRY "E2"
3T2		[480vAC]		
3T3		[480vAC]		
GND		[Ground]		
4T1		[480vAC]	Heater Power (3 Phase Option)	Conduit between MCP & Compressor Skid COMPRESSOR SKID CONDUIT ENTRY "E3"
4T2		[480vAC]		
4T3		[480vAC]		
GND		[Ground]		
	TB1#L	[120vAC]	Unit Panel Power	Conduit between UCP & AC Breaker Panel (Supplied by others) COMPRESSOR SKID CONDUIT ENTRY "E8"
	TB1#N	[Neutral]		
	TB1#G	[Ground]		
1L1		[480vAC]	Main Motor, Cooler Motor, Prelube Motor & 3 Phase Heater (option) Power Supply Wiring	Conduit between MCP & 480vAC Breaker Panel (Supplied by others)
1L2		[480vAC]		
1L3		[480vAC]		
GND		[Ground]		

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J-W POWER COMPANY *LONGVIEW, TEXAS, USA*	
DIAG WIRING SITE INTERCONNECT	
CENTURION PANEL(UCP)/MOTOR CONTROL PANEL (MCP)	
DWG # 335-26130	REV 1
Approved By:	CAM
Page 1 of 1	DATE: 03/20/15


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