# Mako Industries
# Vapor Extraction Package
# Operation and Maintenance Manual

## GENERAL INFORMATION FOR UNIT

The Vapor Extraction Blower Package is used for the remediation of soils with volatile organic compounds, which are present from leakage or spillage. The unit is most effective when the soil vapor concentration yield is nominally between 50 and 500 parts per million by volume.

Soil vapors are extracted with the blower through the entrained liquid separator, which removes the majority of the water brought up from the soil during the vacuum extraction process. Dilution air is added if necessary and the vapors proceed to the carbon adsorption chambers.

The unit is described more thoroughly in the technical specification section of this document.

## TECHNICAL SPECIFICATIONS

- **VOC Processing Capability:** The Vapor Extraction Package up to 1,000 ppmv of BTEX type VOC's including MTBE.

## Major Components

- **Entrainment Separator:** The Entrainment Separator is provided to remove water that is brought up during vapor extraction from the vapor stream. It has a tangential inlet that cyclonically separates the water from the vapors with 99% + efficiency. It also has a demister element to remove incoming particulate and water droplets.
- **Vacuum Blower:** The Vacuum Blower extracts the vapors from the soil and can produce vacuum levels from 1 inch of water to 350 inches of water. The pump is powered by a motor, which is sized to provide enough horsepower to generate the flow required at the specified vacuum level for the system. (see your specific quotation and specifications for exact blower / horsepower for your unit).
- **Control Panel:** The Control Panel contains a main disconnect, on/off switches, operator interface lights, controllers, chart recorder, fuses, motor starters, relays and wiring. The panel is a NEMA 4 type for outdoor use.

- **Auto Drain Pump:** A Liquid Pump is provided to remove the water accumulated in the entrainment separator. The pump is activated when the water reaches the high liquid level switch and shuts off when it reaches the low-level switch. The pump transfers the water to a receptacle provided by the client at the site.
- **Liquid Level Switches:** Liquid Level Switches are provided on the entrainment separator and the oil seal tank. A High Liquid Level Switch activates the liquid transfer pump when it is triggered.

## Treatment System
## SYSTEM WARNINGS

**The Treatment System utilizes high temperatures, high voltages and flammable vapors to operate. All personnel operating the Treatment System must be trained in the operation and maintenance of the system as well as the safety devices provided with the system.**

1. **Do not attempt to bypass any of the safety interlocks provided in an attempt to operate the unit. Unless authorized by Mako personnel for diagnostic purposes only. Bypassing safety switches will void the warranty and can cause major damage to equipment and personnel.**
2. **Do not modify or bypass the transformers, fuse blocks, or controllers in order to make the system operational unless authorized by Mako personnel.**
3. **Do not remove any equipment from the unit in order to make the unit operational.**
4. **Keep all body parts clear of the exhaust stack, oxidizer chamber, burner, air intake valves and moving parts due to burns from high temperature conditions and severe bodily injury situations that can occur as a result of body contact with these parts.**
5. **Do not restrict, block or close the exhaust stack during operation.**
6. **Disconnect incoming voltage to the unit control panel before attempting to work on the panel or other electrical components on the unit. Use a voltage meter to determine that the power is off. Have only qualified personnel work on the electrical components, preferably a qualified electrician.**
7. **Shutdown the system and contact Mako immediately if you are experiencing any unsafe conditions.**

# SYSTEM INSTALLATION AND START-UP

**Follow each step listed here in exactly the order listed. For your safety, do not skip any steps or perform any steps out of order.**

**Installation:**

1. Operate the unit on a level dry surface.
2. Connect the properly rated electrical supply with a ground from the generator to the control panel main disconnect using a qualified electrician.
3. Check voltage, wire size and amperage rating of electricity installed, making sure that it matches the manufacturers panel specifications and electrical drawings for your specific system before proceeding.
4. Check 120-volt power circuit to see that controllers are powered up.
5. Check rotation of the Vacuum blower, combustion blower and liquid transfer pump making sure they are correct.

**Start-up Procedures:**

1. Verify that the **"Main Disconnect Switch"** on the control panel is in the **"Off"** position.
2. Open the system control panel door and have a qualified electrician verify that the voltage at top of the **"Main Disconnect"** is set to the specified voltage.
3. With the control panel door closed and latched, turn the **"Main Disconnect"** switch to the **"On"** position.
4. Turn the **"Control Power"** switch to the **"On"** position.
5. Push the **"Start"** button, the vacuum blower should come on after pushing the Start Button.
6. Press the **"Limits Reset"** Button the limits operational light should come on if all limits are in a safe condition.

# System Alarms

1. **High Water Alarm Entrained Liquid Tank:** Water level is above the high/high level switch in the entrained liquid separator. Blower immediately shuts off and unit is shutdown.
2. **Process Air Flow Alarm:** Process air is not enough or the blower is off. Unit closes the process valve and shuts off the heating element. Unit shuts down in 30 minutes and needs to be manually reset.

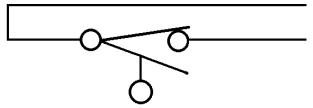
# MAINTENANCE SHEDULE

- Check Blower — Monthly
  (Maintenance procedure in product bulletin)
- Grease Motor fittings — Monthly
  (Use grease gun on zirk fittings, give two pumps to the fittings)
- Check Panel Wire connections — Monthly
  (Tighten them if necessary)
- Check Entrainment Separator Filter — Tri-Yearly
  (Remove Entrainment Separator lid, clean or replace as needed)
- Clean out Entrainment Separator — Weekly
  (Use clean water to rinse sides and remove hand clean out for debris)
- Clean Level Switches and Site Glass — Weekly
  (Use clean water to rinse out debris)
- Check Water Pump — Monthly
  (Insure proper operation)
- Check Flow Transmitter — Weekly
- Check level switches — Monthly
  (Insure proper operation)

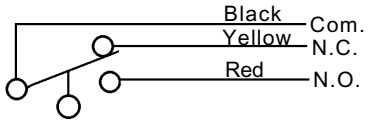
## Electrical Data . . .

Standard snap-action switch is a 20VA, SPST, hermetically sealed,magnetically actuated, make-and-break type. Normally open or normally closed operation is selectable by inverting floats on unit stem. A level station with SPDT 3-wire switch is available as a separate component if required.

### Typical Wiring Diagrams



**SPST Switch N.O. or N.C. (Dry). Selectable by Inverting Float.**




**SPDT Switch in N.C. (Dry) Position**

### Switch Ratings . . . Max. Resistive Load

| VA | Volts | Amps AC | Amps DC |
|---|---|---|---|
| 20 | 0-30 | .4 | .3 |
| | 120 | .17 | .13 |
| | 240 | .08 | .06 |

### Important Points!

Product must be maintained and installed in strict accordance with the National Electrical Code and GEMS product catalog and instruction bulletin. Failure to observe this warning could result in serious injuries or damages.

An appropriate explosion-proof enclosure or intrinsically safe interface device must be used for hazardous area applications involving such things as *(but not limited to)* ignitable mixtures, combustible dust and flammable materials.

Pressure and temperature limitations shown on individual catalog pages and drawings for the specified level switches must not be exceeded. These pressures and temperatures take into consideration possible system surge pressures/temperatures and their frequencies.

Selection of materials for compatibility with the media is critical to the life and operation of GEMS level switches. Take care in the proper selection of materials of construction; particularly wetted materials.

Life expectancy of switch contacts varies with applications. Contact GEMS if life cycle testing is required.

Ambient temperature changes do affect switch set points, since the specific gravity of a liquid can vary with temperature.

Level switches have been designed to resist shock and vibration; however, shock and vibration should be minimized.

Liquid media containing particulate and/or debris should be filtered to ensure proper operation of GEMS products.

Electrical entries and mounting points may require liquid/vapor sealing if located in an enclosed tank.

Level switches must not be field repaired.

Physical damaged sustained by the product may render it unserviceable.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P/N 72946
Rev. L


# Fabri-Level Switch Kit

## Instruction Bulletin No. 72946

Fabri-Level Kits contain all components for complete assembly of a 1- or 2-station level switch unit for pipe-plug mounting in your tank. Each kit contains: 1 Tube Connector, 1 Mounting Plug, 2 Level Stations (Switch, Tube, Float), 2 Extension Tubes, 1 Tube End Fitting, 3 Tube Unions.

**Specifications . . .**

Conduit Thread: 1/2" NPT-F
Tube/Fitting Size: 1/2" O.D.
Max. No. Levels per Stem: 6
Mounting Attitude: Vertical ± 30°
Fitting Ferrule:
Buna N Floats: Nylon
Stainless Floats: 316 Stainless Steel

N.O. or N.C. operation of the SPST switch is selectable by inverting the float(s) on the unit stem. **Note: SPDT circuits must have "N.O." toward lead wires. SPDT floats are not reversible.** Two 10" lengths of tube are furnished to space level stations as desired.

| Switch | Material | Oper. Temp. Water | Oper. Temp. Oil | Min. Sp. Gr. | Pres. (Max.PSI) | Mtg. NPT | Part Number |
|---|---|---|---|---|---|---|---|
| SPST 20 VA | Brass Fittings, Buna N Floats | To 180°F (82.2°C) | -40°F to +230°F | .55 | 150 | 2" | 24576 |
| | | | | .75 | | 1-1/4" | 26128 |
| | 316 SS Fittings, Buna N Floats | | (-40°C to +110°C) | .75 | | 1-1/4" | 26130 |
| | | | | 55 | | 2" | 26675 |
| | All 316 SS | -40°F to +275°F (-40°C to +135°C) | | .80 | 750 | 2" | 24577 |

CE This product is suitable for Class I and Class II applications only, per the requirements of standard EN60730 and any additional specific requirements for a particular application or medium being sensed. Class I compliance of metal bodied units requires a ground connection between the metal body and the earthing system of the installation. Class I compliance of plastic bodied units in contact with a conductive medium requires that the medium be effectively earthed so as to provide an earthed barrier between the unit and accessible areas. For Class III compliance, a supply at safety extra-low voltage (SELV) must be provided. Please consult the Factory for compliance information on specific part numbers.

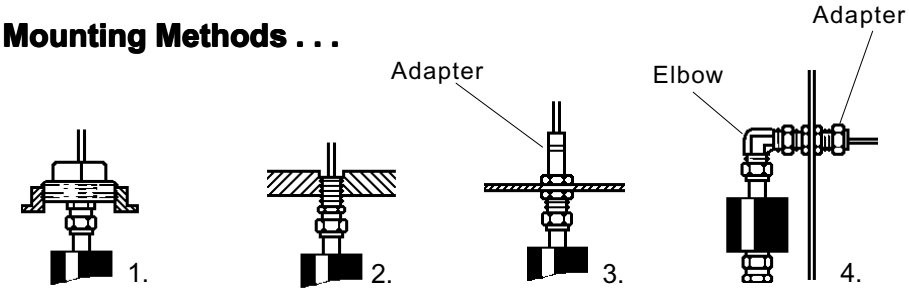
### Installation and Maintenance . . .

Installation can be from top, bottom or side of tank, as shown below. Usually installed as nearly vertical as possible, units will operate reliably as much as 30o from the vertical. Only two wrenches are needed to assemble. From one to six level stations may be spaced as desired on a single unit. You merely follow **"Assembly Instructions"**, install in tank, connect electrical leads and your "tailor-made" unit is ready for use . . . in any media compatible with Brass and Buna N or 316 Stainless Steel - the two material options available.

**Installation and Maintenance (Cont.)**

Maintenance requirements are minimal and usually limited to occasional clean-up of scum or scale accumulation.

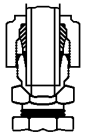
## Mounting Methods . . .



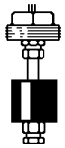

1. 1-1/4" or 2" NPT pipe plug. Top or bottom mount, boss or thickwall tank. Permits unit insertion from outside.

2. 3/8" NPT-M tube connector. Top or bottom mount from inside. Boss or thickwall tank.

3, 4. Top-mount through sheet metal cover, or with 90° elbow for mounting unit from inside of tank.



**Pressure-type fittings** form positive seal. Tube cannot turn, wires cannot twist during tightening. Nylon ferrule for brass units, SS ferrule for stainless units. 13/16" and 7/8" HEX fittings.



**2" NPT mounting plug** permits entire unit to be inserted in tank from outside. 1/2" NPT-F provides direct electrical conduit connection. A 1-1/4" NPT mounting plug is also available.

## Assembly Instructions . . .

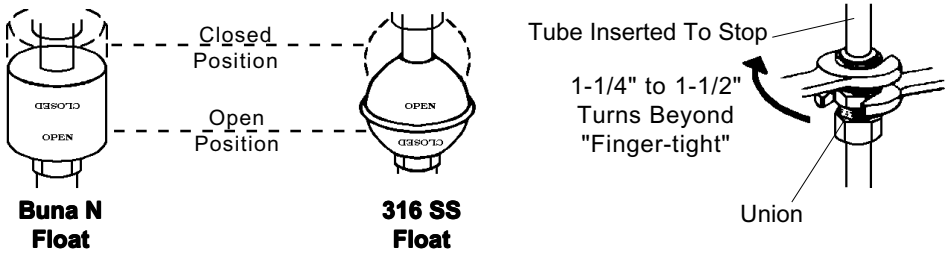
1. Assemble unit, observing the following sketches and information.

**a/ Extension Tubes (When Required):** Cut to proper length. Tubes 36" long are available as components, or use any 1/2" tubing of suitable non-magnetic material.

**b/ Level Stations:** Assemble floats on switch tubes for desired switch operation, as shown. Feed level station wires through switch tubes of each level station, toward mounting plug. **Note: Floats are shown in normally open (dry) position. To reverse operation, invert floats.** (See next page)

**Note**

**SPDT circuits must have "N.O." towards lead wire end of switch tube. SPDT floats are not reversible.**

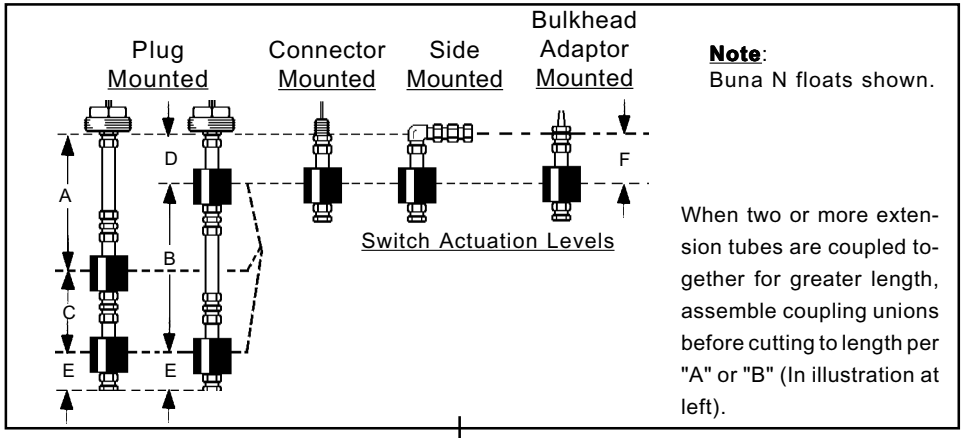



c/ **Coupling Components Together**: Insert tubes to limit in fittings and tighten "finger-tight". After checking entire unit, wrench-tighten as illustrated. **Important: Always assemble entire unit "finger-tight" first, then check level locations and switch operation (N.O. or N.C.) before final tightening.**

2. **Install Unit in Tank:** Fabri-Level units with 1 1/4" or 2" NPT mounting plugs are installed through a boss or tapped hole from outside of tank. Units with alternate mountings are installed from the inside.

3. **Electrical Leads:** Leads are readily identified for connection; i.e., switch leads nearest mounting end of unit project the farthest, etc. **CAUTION: See "Switch Ratings" before connecting power to Fabri-Level unit.**

## Actuation Level Dimensional Data . . .




**Note**:
Buna N floats shown.

When two or more extension tubes are coupled together for greater length, assemble coupling unions before cutting to length per "A" or "B" (In illustration at left).

**For Units with Buna N Floats . . .**

A. Min. with tube extension: 4-3/4"
Cut tube to length: "A" minus 2-7/8"
B. Min. with tube extension: 6-5/16"
Cut tube to length: "B" minus 4-15/16"
C. 4-1/4": Closest that levels can be.
D. 2-5/8": Highest possible level.
E. 2-1/8": Lowest possible level.
F. 2-7/8": Minus tank wall thickness.

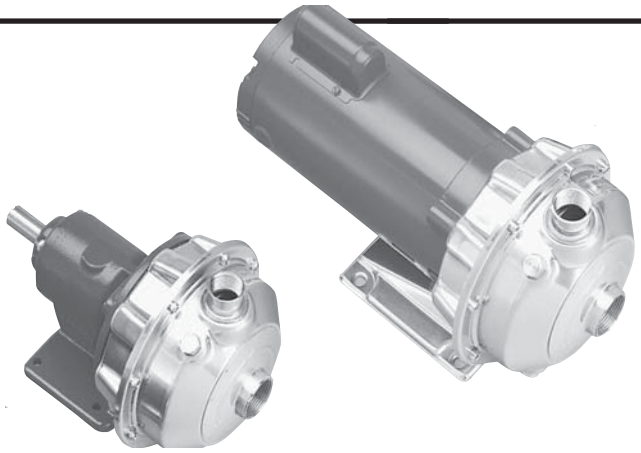
**For Units with 316 Stainless Floats . . .**

A. Min. with tube extension: 4-1/2"
Cut tube to length: "A" minus 2-5/8"
B. Min. with tube extension: 6-5/8"
Cut tube to length: "B" minus 4-11/16"
C. 4-1/2": Closest that levels can be.
D. 2-3/8": Highest possible level.
E. 2-5/8": Lowest possible level.
F. 2-5/8": Minus tank wall thickness.

G&L Pumps

# Installation, Operation and Maintenance Instructions

# Model NPE/ NPE-F



**DESCRIPTION & SPECIFICATIONS:**

The Models NPE (close-coupled) and NPE-F (frame-mounted) are end suction, single stage centrifugal pumps for general liquid transfer service, booster applications, etc. Liquid-end construction is all AISI Type 316 stainless steel, stamped and welded. Impellers are fully enclosed, non-trimable to intermediate diameters. Casings are fitted with a diffuser for efficiency and for negligible radial shaft loading.

Close-coupled units have NEMA 48J or 56J motors with C-face mounting and threaded shaft extension. Frame-mounted units can be coupled to motors through a spacer coupling, or belt driven.

## 1. Important:

**1.1.** Inspect unit for damage. Report any damage to carrier/dealer immediately.

**1.2.** Electrical supply must be a separate branch circuit with fuses or circuit breakers, wire sizes, etc., per National and Local electrical codes. Install an all-leg disconnect switch near pump.

**CAUTION**

**Always disconnect electrical power when handling pump or controls.**

**1.3.** Motors must be wired for proper voltage. Motor wiring diagram is on motor nameplate. Wire size must limit maximum voltage drop to 10% of nameplate voltage at motor terminals, or motor life and pump performance will be lowered.

**1.4.** Always use horsepower-rated switches, contactor and starters.

**1.5.** Motor Protection

**1.5.1.** Single-phase: Thermal protection for single-phase units is sometimes built in (check nameplate). If no built-in protection is provided, use a contactor with a proper overload. Fusing is permissible.

**1.5.2.** Three-phase: Provide three-leg protection with properly sized magnetic starter and thermal overloads.

**1.6.** Maximum Operating Limits:

| | |
|---|---|
| Liquid Temperature: | 212º F (100º C) with standard seal.<br>250º F (120º C) with optional high temp seal. |
| Pressure: | 75 PSI. |
| Starts Per Hour: | 20, evenly distributed. |

**1.7.** Regular inspection and maintenance will increase service life. Base schedule on operating time. Refer to Section 8.

## 2. Installation:

**2.1.** General

**2.1.1.** Locate pump as near liquid source as possible (below level of liquid for automatic operation).

**2.1.2.** Protect from freezing or flooding.

**2.1.3.** Allow adequate space for servicing and ventilation.

**2.1.4.** All piping must be supported independently of the pump, and must "line-up" naturally.

**CAUTION**

**Never draw piping into place by forcing the pump suction and discharge connections.**

**2.1.5.** Avoid unnecessary fittings. Select sizes to keep friction losses to a minimum.

**2.2.** Close-Coupled Units:

**2.2.1.** Units may be installed horizontally, inclined or vertically.

**CAUTION**

**Do not install with motor below pump. Any leakage or condensation will affect the motor.**

**2.2.2.** Foundation must be flat and substantial to eliminate strain when tightening bolts. Use rubber mounts to minimize noise and vibration.

**2.2.3.** Tighten motor hold-down bolts before connecting piping to pump.

**2.3.** Frame-Mounted Units:

**2.3.1.** It is recommended that the bedplate be grouted to a foundation with solid footing. Refer to Fig.1.

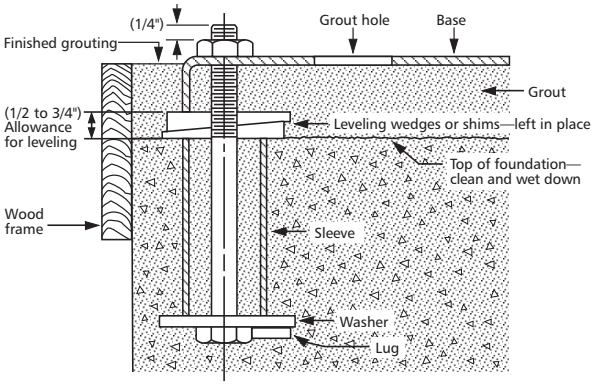



**Figure 1**

Goulds Pumps

ITT Industries

**2.3.2.** Place unit in position on wedges located at four points (two below approximate center of driver and two below approximate center of pump). Adjust wedges to level unit. Level or plumb suction and discharge flanges.

**2.3.3.** Make sure bedplate is not distorted and final coupling alignment can be made within the limits of movement of motor and by shimming, if necessary.

**2.3.4.** Tighten foundation bolts finger tight and build dam around foundation. Pour grout under bedplate making sure the areas under pump and motor feet are filled solid. Allow grout to harden 48 hours before fully tightening foundation bolts.

**2.3.5.** Tighten pump and motor hold-down bolts before connecting the piping to pump.

## 3. Suction Piping:

**3.1.** Low static suction lift and short, direct, suction piping is desired. For suction lift over 10 feet and liquid temperatures over 120 F, consult pump performance curve for Net Positive Suction Head Required.

**3.2.** Suction pipe must be at least as large as the suction connection of the pump. Smaller size will degrade performance.

**3.3.** If larger pipe is required, an eccentric pipe reducer (with straight side up) must be installed at the pump.

**3.4.** Installation with pump below source of supply:

**3.4.1.** Install full flow isolation valve in piping for inspection and maintenance.

**CAUTION**

**Do not use suction isolation valve to throttle pump.**

**3.5.** Installation with pump above source of supply:

**3.5.1.** Avoid air pockets. No part of piping should be higher than pump suction connection. Slope piping upward from liquid source.

**3.5.2.** All joints must be airtight.

**3.5.3.** Foot valve to be used only if necessary for priming, or to hold prime on intermittent service.

**3.5.4.** Suction strainer open area must be at least triple the pipe area.

**3.6.** Size of inlet from liquid source, and minimum submergence over inlet, must be sufficient to prevent air entering pump through vortexing. See Figs. 2-5

**3.7.** Use 3-4 wraps of Teflon tape to seal threaded connections.

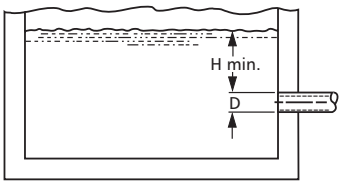



**Figure 2**

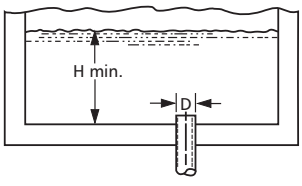



**Figure 3**

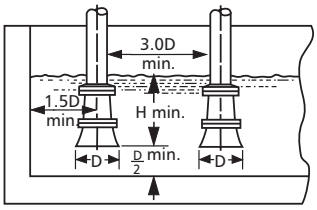



**Figure 4**

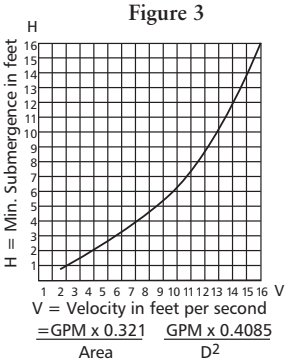



**Figure 5**

## 4. Discharge Piping:

**4.1.** Arrangement must include a check valve located between a gate valve and the pump. The gate valve is for regulation of capacity, or for inspection of the pump or check valve.

**4.2.** If an increaser is required, place between check valve and pump.

**4.3.** Use 3-4 wraps of Teflon tape to seal threaded connections.

## 5. Motor-To-Pump Shaft Alignment:

**5.1.** Close-Coupled Units:

**5.1.1.** No field alignment necessary.

**5.2.** Frame-Mounted Units:

**5.2.1.** Even though the pump-motor unit may have a factory alignment, this could be disturbed in transit and must be checked prior to running. See Fig. 6.

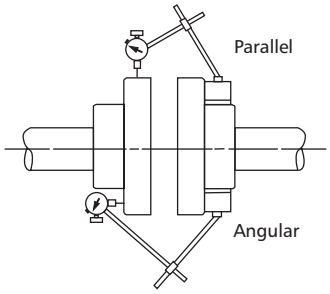



**Figure 6**

**5.2.2.** Tighten all hold-down bolts before checking the alignment.

**5.2.3.** If re-alignment is necessary, always move the motor. Shim as required.

**5.2.4.** Parallel misalignment - shafts with axis parallel but not concentric. Place dial indicator on one hub and rotate this hub 360 degrees while taking readings on the outside diameter of the other hub. Parallel alignment occurs when Total Indicator Reading is .005", or less.

**5.2.5.** Angular misalignment - shafts with axis concentric but not parallel. Place dial indicator on one hub and rotate this hub 360 degrees while taking readings on the face of the other hub. Angular alignment is achieved when Total Indicator Reading is .005", or less.

**5.2.6.** Final alignment is achieved when parallel and angular requirements are satisfied with motor hold-down bolts tight.

**CAUTION**

**Always recheck both alignments after making any adjustment.**

## 6. Rotation:

**6.1.** Correct rotation is right-hand (clockwise when viewed from the motor end). Switch power on and off quickly. Observe shaft rotation. To change rotation:

**6.1.1.** Single-phase motor: Non-reversible.

**6.1.2.** Three-phase motor: Interchange any two power supply leads.

## 7. Operation:

**7.1.** Before starting, pump must be primed (free of air and suction pipe full of liquid) and discharge valve partially open.

**CAUTION**

**Pumped liquid provides lubrication. If pump is run dry,rotating parts will seize and mechanical seal will be damaged. Do not operate at or near zero flow. Energy imparted to the liquid is converted into heat. Liquid may flash to vapor. Rotating parts require liquid to prevent scoring or seizing.**

**7.2.** Make complete check after unit is run under operating conditions and temperature has stabilized. Check for expansion of piping. On frame-mounted units coupling alignment may have changed due to the temperature differential between pump and motor. Recheck alignment.

## 8. Maintenance:

**8.1.** Close-Coupled Unit. Ball bearings are located in and are part of the motor. They are permanently lubricated. No greasing required.

**8.2.** Frame-Mounted Units:

**8.2.1.** Bearing frame should be regreased every 2,000 hours or 3 month interval, whichever occurs first. Use a #2 sodium or lithium based grease. Fill until grease comes out of relief fittings, or lip seals, then wipe off excess.

**8.2.2.** Follow motor and coupling manufacturers' lubrication instructions.

**8.2.3.** Alignment must be rechecked after any maintenance work involving any disturbance of the unit.

## 9. Disassembly:

Complete disassembly of the unit will be described. Proceed only as far as required to perform the maintenance work needed.

**9.1.** Turn off power.

**9.2.** Drain system. Flush if necessary.

**9.3.** Close-Coupled Units: Remove motor hold-down bolts.

Frame-Mounted Units: Remove coupling, spacer, coupling guard and frame hold-down bolts.

**9.4.** Disassembly of Liquid End:

**9.4.1.** Remove casing bolts (370).

**9.4.2.** Remove back pull-out assembly from casing (100).

**9.4.3.** Remove impeller locknut (304).

**CAUTION**

**Do not insert screwdriver between impeller vanes to prevent rotation of close-coupled units. Remove cap at opposite end of motor. A screwdriver slot or a pair of flats will be exposed. Using them will prevent impeller damage.**

**9.4.4.** Remove impeller (101) by turning counter-clockwise when looking at the front of the pump. Protect hand with rag or glove.

**CAUTION**

**Failure to remove the impeller in a counter-clockwise direction may damage threading on the impeller, shaft or both.**

**9.4.5.** With two pry bars 180 degrees apart and inserted between the seal housing (184) and the motor adapter (108), carefully separate the two parts. The mechanical seal rotary unit (383) should come off the shaft with the seal housing.

**9.4.6.** Push out the mechanical seal stationary seat from the motor side of the seal housing.

**9.5.** Disassembly of Bearing Frame:

**9.5.1.** Remove bearing cover (109).

**9.5.2.** Remove shaft assembly from frame (228).

**9.5.3.** Remove lip seals (138 & 139) from bearing frame and bearing cover if worn and are being replaced.

**9.5.5.** Use bearing puller or arbor press to remove ball bearings (112 & 168).

## 10. Reassembly:

**10.1.** All parts should be cleaned before assembly.

**10.2.** Refer to parts list to identify required replacement items. Specify pump index or catalog number when ordering parts.

**10.3.** Reassembly is the reverse of disassembly.

**10.3.1.** Impeller and impeller locknut assembled onto motor shaft with 10 ft-lbs of torque.

**10.4.** Observe the following when reassembling the bearing frame:

**10.4.1.** Replace lip seals if worn or damaged.

**10.4.2.** Replace ball bearings if loose, rough or noisy when rotated.

**10.4.3.** Check shaft for runout. Maximum permissible is .002" T.I.R.

**10.5.** Observe the following when reassembling the liquid-end:

**10.5.1.** All mechanical seal components must be in good condition or leakage may result. Replacement of complete seal assembly, whenever seal has been removed, is good standard practice.

It is permissible to use a light lubricant, such as glycerin, to facilitate assembly. Do not contaminate the mechanical seal faces with lubricant.

**10.5.2.** Inspect casing O-ring (513) and replace if damaged. This O-ring may be lubricated with petroleum jelly to ease assembly.

**10.5.3.** Inspect guidevane O-ring (349) and replace if worn.

**CAUTION**

**Do not lubricate guidevane O-ring (349). Insure it is not pinched by the impeller on reassembly.**

**10.6.** Check reassembled unit for binding. Correct as required.

**10.7.** Tighten casing bolts in a star pattern to prevent O-ring binding.

## 11. Trouble Shooting Chart:

MOTOR NOT RUNNING
(See causes 1 thru 6)

LITTLE OR NO LIQUID DELIVERED:
(See causes 7 thru 17)

POWER CONSUMPTION TOO HIGH:
(See causes 4, 17, 18, 19, 22)

EXCESSIVE NOISE AND VIBRATION:
(See causes 4, 6, 9, 13, 15, 16, 18, 20, 21, 22)

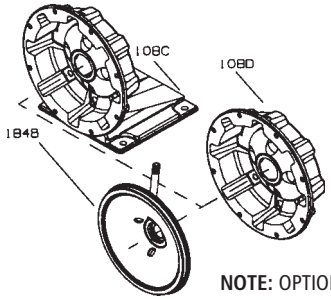
PROBABLE CAUSE:

1. Tripped thermal protector
2. Open circuit breaker
3. Blown fuse
4. Rotating parts binding
5. Motor wired improperly
6. Defective motor
7. Not primed
8. Discharge plugged or valve closed
9. Incorrect rotation
10. Foot valve too small, suction not submerged, inlet screen plugged.
11. Low voltage
12. Phase loss (3-phase only)
13. Air or gasses in liquid
14. System head too high
15. NPSHA too low:
    Suction lift too high or suction losses excessive.
    Check with vacuum gauge.
16. Impeller worn or plugged
17. Incorrect impeller diameter
18. Head too low causing excessive flow rate
19. Viscosity or specific gravity too high
20. Worn bearings
21. Pump or piping loose
22. Pump and motor misaligned

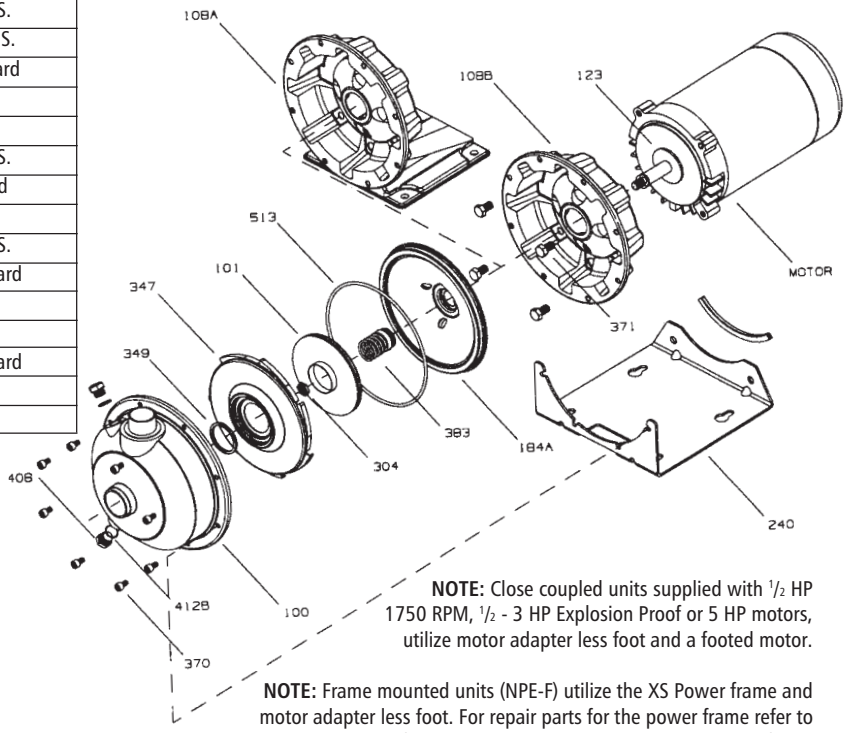
## NPE Standard Repair Parts List

| Item No. | Description | Materials of Construction |
|---|---|---|
| 100 | Casing | AISI 316L Stainless Steel |
| 101 | Impeller | |
| 108A | Motor adapter with foot | |
| 108B | Motor adapter less foot | |
| 108C | Motor adapter with foot and Flush | |
| 108D | Motor adapter less foot with Flush | |
| 123 | Deflector | BUNA-N |
| 184A | Seal housing std. | AISI 316L S.S. |
| 184B | Seal housing with seal flush | |
| 240 | Motor support | 300 S.S. |
| | Rubber channel | Rubber |
| 304 | Impeller locknut | AISI 316 S.S. |
| 347 | Guidevane | AISI 316L S.S. |
| 349 | Seal-Ring, guidevane | Viton Standard |
| | | EPR |
| | | BUNA |
| 370 | Socket head screw, casing | AISI 410 S.S. |
| 371 | Bolts, motor | Steel/plated |
| 383 | Mechanical seal | |
| 408 | Drain and vent plug, casing | AISI 316 S.S. |
| 412B | O-Ring, drain plugs | Viton, standard |
| | | EPR |
| | | BUNA |
| 513 | O-Ring, casing | Viton, standard |
| | | EPR |
| | | BUNA |

| Item 383 Mechanical Seal (⅝" seal) | | | | |
|---|---|---|---|---|
| Rotary | Stationary | Elastomers | Metal Parts | Part No. |
| Carbon | Sil-Carbide | EPR | 316SS | 10K18 |
| | | Viton | | 10K55 |
| Sil-Carbide | | EPR | | 10K81 |
| | | Viton | | 10K62 |




**NOTE:** OPTIONAL SEAL FLUSH COMPONENTS




**NOTE:** Close coupled units supplied with ½ HP 1750 RPM, ½ - 3 HP Explosion Proof or 5 HP motors, utilize motor adapter less foot and a footed motor.

**NOTE:** Frame mounted units (NPE-F) utilize the XS Power frame and motor adapter less foot. For repair parts for the power frame refer to the XS-Power frame repair parts page in the parts section of your catalog. To order the power frame complete order item 14L61

### GOULDS PUMPS LIMITED WARRANTY

This warranty applies to all water systems pumps manufactured by Goulds Pumps.

Any part or parts found to be defective within the warranty period shall be replaced at no charge to the dealer during the warranty period. The warranty period shall exist for a period of twelve (12) months from date of installation or eighteen (18) months from date of manufacture, whichever period is shorter.

A dealer who believes that a warranty claim exists must contact the authorized Goulds Pumps distributor from whom the pump was purchased and furnish complete details regarding the claim. The distributor is authorized to adjust any warranty claims utilizing the Goulds Pumps Customer Service Department.

**The warranty excludes:**

(a) Labor, transportation and related costs incurred by the dealer;
(b) Reinstallation costs of repaired equipment;
(c) Reinstallation costs of replacement equipment;
(d) Consequential damages of any kind; and,
(e) Reimbursement for loss caused by interruption of service.

**For purposes of this warranty, the following terms have these definitions:**

(1) "Distributor" means any individual, partnership, corporation, association, or other legal relationship that stands between Goulds Pumps and the dealer in purchases, consignments or contracts for sale of the subject pumps.
(2) "Dealer" means any individual, partnership, corporation, association, or other legal relationship which engages in the business of selling or leasing pumps to customers.
(3) "Customer" means any entity who buys or leases the subject pumps from a dealer. The "customer" may mean an individual, partnership, corporation, limited liability company, association or other legal entity which may engage in any type of business.

**THIS WARRANTY EXTENDS TO THE DEALER ONLY.**



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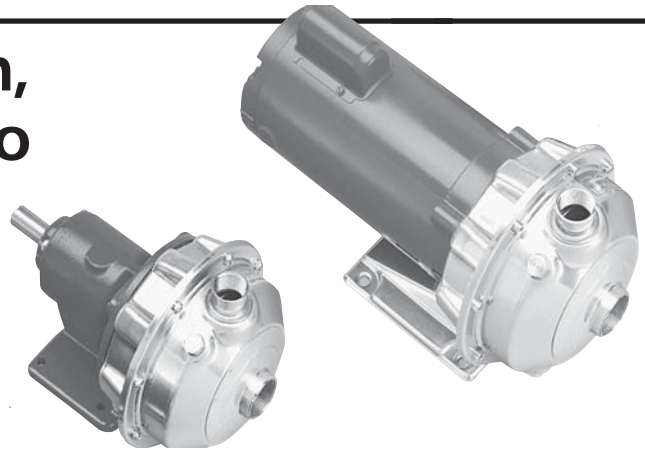
# Instrucciones De Instalación, Operación Y Mantenimiento

# Modelo NPE/NPE-F



**DESCRIPCIÓN Y ESPECIFICACIONES:**

Los modelos NPE (compacto) y NPE-F (montado en marco) son bombas centrífugas de una etapa, de succión axial para el servicio de transferencia de líquidos en general, aplicaciones de refuerzo de presión, etc. La construcción del extremo sumergido es toda de AISI (Instituto Norteamericano del Hierro y el Acero) de acero inoxidable Tipo 316, estampada y soldada. Los impulsores son totalmente cerrados, y no se pueden recortar a diámatros intermedios. Las carcasas están equipadas con un difusor para eficiencia y que las cargas radiales sean negligibles en el eje.

Las unidades compactas tienen motores NEMA 48J o 561, con montaje de cara C y extensión roscada del eje. Las unidades montadas en marco se pueden acoplar a los motores a través de un espaciador de acoplamiento, o ser accionadas por correa.

## 1. Importante:

**1.1.** Inspeccione si la unidad tiene daños. Informe inmediatamente de cualquier daño al transportista o al agente.

**1.2.** La alimentación eléctrica debe ser un circuito separado con los fusibles o interruptores automáticos, tamaños de alambres, etc., de acuerdo con los Códigos Eléctricos Nacional y Local. Instale un interruptor de desconexión en todos los alambres cerca de la bomba.

**PRECAUCIÓN**

**Siempre desconecte la corriente eléctrica cuando maneje la bomba o los controles.**

**1.3.** El cableado de los motores debe ser adecuado para la tensión. El diagrama del cableado del motor está en la placa del fabricante del motor. El tamaño del los alambres debe limitar la máxima caída de tensión al 10% de la tensión de la placa del fabricante en los terminales del motor, o la vida del motor y el rendimiento de la bomba se disminuirán.

**1.4.** Siempre use interruptores, contactores y arrancadores con clasificación de potencia nominal.

**1.5.** Protección del motor

**1.5.1.** Monofásico: La protección térmica en las unidades monofásicas a veces está incorporada (verifique la placa del fabricante). Si no se provee protección incorporada, use un contactor con la sobrecarga apropiada. Se permite usar fusible.

**1.5.2.** Trifásico: proporcione protección en los tres alambres con arrancador magnético de tamaño apropiado y sobrecargas térmicas.

**1.6.** Límites máximos de operción:

| | |
|---|---|
| Temperatura del líquido: | 212º F (100º C) con sello estándar. 250º F (120º C) con sello de alta temperatura opcional. |
| Presión: | 75 lib/pulg$^2$. |
| Arranques por hora: | 20, distribuidos uniformemente. |

**1.7.** La inspección y el mantenimiento regular aumentarán la vida de servicio. Establezca el programa de acuerdo al tiempo de funcionamiento. Refiérase a la Sección 8.

## 2. Instalación:

**2.1.** Generalidades

**2.1.1.** Coloque la bomba tan cerca de la fuente del líquido como sea posible (debajo del nivel del líquido para operación automática).

**2.1.2.** Proteja de la congelación o inundación.

**2.1.3.** Deje espacio libre adecuado para el servicio y la ventilación.

**2.1.4.** Toda la tubería debe estar soportada independientemente de la bomba, y debe "estar alineada" naturalmente.

**PRECAUCIÓN**

**Nunca estire la tubería en el lugar forzando las conexiones de la succión y descarga de la bomba.**

**2.1.5.** Evite los accesorios innecesarios. Seleccione los tamaños para mantener las pérdidas de fricción al mínimo.

**2.2.** Unidades compactas:

**2.2.1.** Estas unidades pueden instalarse horizontalmente, inclinadas o verticalmente.

**PRECAUCIÓN**

**No instale con el motor debajo de la bomba. Cualquier fuga o condensación afectará al motor.**

**2.2.2.** La cimentación debe ser plana y substancial para eliminar las deformaciones cuando se aprieten los pernos. Use montajes de goma para minimizar el ruido y las vibraciones.

**2.2.3.** Apriete los pernos de sujeción del motor antes de conectar la tubería a la bomba.

**2.3.** Unidades montadas en marco:

**2.3.1.** Se recomienda enlechar la plancha de asiento a un cimiento con zapata sólida. Vea la Fig. 1.

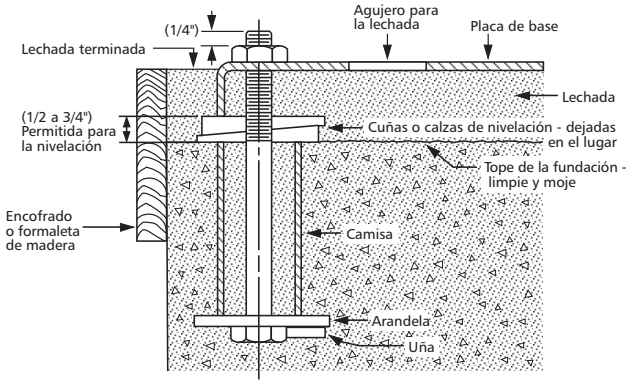



**Figura 1**

Goulds Pumps

ITT Industries

**2.3.2.** Coloque la unidad en posición sobre las cuñas ubicadas en cuatro puntos, (dos aproximadamente debajo del centro del motor y dos aproximadamente debajo del centro de la bomba). Ajuste las cuñas para nivelar la unidad. Nivele o ponga vertical las bridas de succión y de descarga.

**2.3.3.** Asegúrese de que la placa de base no esté distorsionada y se pueda hacer la alineación final del acoplamiento dentro de los límites del movimiento del motor y poniendo calzas, si fuera necesario.

**2.3.4.** Apriete con los dedos los pernos de la cimentación y construya la presa alrededor de la cimentación. Vierta la lechada debajo de la placa de base asegurándose de que las áreas debajo de la bomba y de la pata del motor estén bien rellenas. Deje que la lechada fragüe por 48 horas antes de apretar totalmente los pernos de la cimentación.

**2.3.5.** Apriete los pernos de sujeción de la bomba y del motor antes de conectar la tubería a la bomba.

## 3. Tubería de succión:

**3.1.** Es deseable tener una tubería de succión directa, corta y una altura de aspiración estática baja. Para alturas de succión superiores a 10 pies y temperaturas del líquido superiores a 120º F, consulte la curva de rendimiento de la bomba para ver la Altura de Succión Positiva Neta requerida.

**3.2.** La tubería de succión debe ser por lo menos tan grande como la conexión de succión a la bomba. Un tamaño más pequeño disminuirá el rendimiento.

**3.3.** Si se requiere una tubería más grande, se debe instalar una reducción excéntrica (con el lado recto hacia arriba), en la bomba.

**3.4.** Instalación con la bomba abajo de la fuente de alimentación:

**3.4.1.** Instale en la tubería una válvula de aislación de todo el caudal para la inspección y mantenimiento.

**PRECAUCIÓN**

**No use la válvula de aislación de succión para estrangular la bomba.**

**3.5.** Instalación con la bomba arriba de la fuente de alimentación:

**3.5.1.** Evite las bolsas de aire. Ninguna de las partes de la tubería debe ser más alta que la conexión de succión de la bomba. Incline la tubería hacia arriba, partiendo de la fuente del líquido.

**3.5.2.** Todas las juntas deben ser estancas.

**3.5.3.** La válvula de pie debe usarse solamente si es necesario para el cebado o para mantener el cebado durante el servicio intermitente.

**3.5.4.** El área abierta del colador de succión debe ser por lo menos el triple del área de la tubería.

**3.6.** El tamaño de la entrada de la fuente del líquido, y la inmersión mínima sobre la succión, deben ser suficientes para impedir la entrada de aire a la bomba a través de vórtices. Vea las Figuras 2 a 5.

**3.7.** Use 3 a 4 vueltas de cinta de Teflon para sellar las conexiones roscadas.

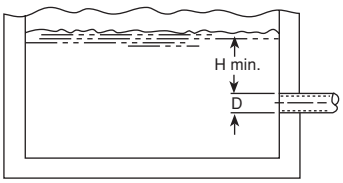



Figura 2

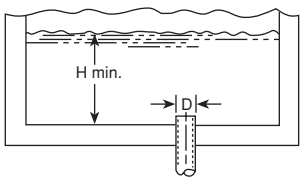



Figura 3

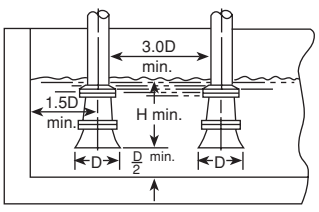



Figura 4

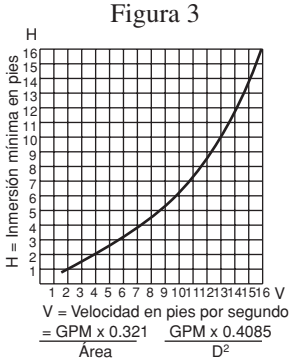



Figura 5

## 4. Tubería de descarga:

**4.1.** La disposición debe incluir una válvula de retensión ubicada entre una válvula de compuerta y la bomba. La válvula de compuerta es para la regulación de la capacidad o para la inspección de la bomba o de la válvula de retención.

**4.2.** Si se requiere un aumentador, instale entre la válvula de retención y la bomba.

**4.3.** Use 3 a 4 vueltas de cinta de Teflón para sellar las conexiones roscadas.

## 5. Alineación del eje del motor al de la bomba:

**5.1.** Unidades compactas:

**5.1.1.** No se necesita alinear en el campo.

**5.2.** Unidades montadas en marco:

**5.2.1.** Aunque la unidad del motor y bomba pueda tener una alineación de fábrica, ésta pudo haberse alterado en tránsito y debe verificarse antes de hacer funcionar. Vea la Figura 6.

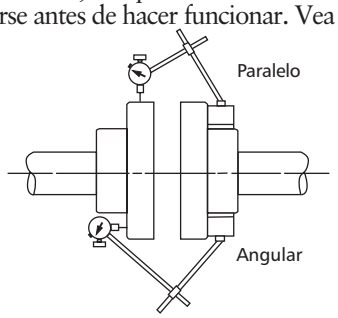



**Figura 6**

**5.2.2.** Apriete todos los pernos de sujeción antes de verificar la alineación.

**5.2.3.** Si es necesario realinear, siempre mueva el motor. Ponga calzas según se requiera.

**5.2.4.** Mala alineación paralela (ejes con ejes paralelos pero no concéntricos). Ponga el indicador de cuadrante en un cubo y gire este cubo 360º mientras hace lecturas en el diámetro exterior del otro cubo. La alineación paralela se obtiene cuando la lectura indicada total es de 0,005" (0,127 mm) o menos.

**5.2.5.** Mala alineación angular (ejes con ejes concéntricos pero no paralelos). Ponga el indicador de cuadrante en un cubo y gire este cubo 360º mientras hace lecturas en la cara del otro cubo. La alineación angular se obtiene cuando la lectura indicada total es de 0,005" (0,127 mm) o menos.

**5.2.6.** La alineación final se obtiene cuando se satisfacen los requerimientos de alineación paralela y angular, con los pernos de sujeción del motor apretados.

**PRECAUCIÓN**

**Siempre vuelva a verificar ambas alineaciones después de hacer cualquier ajuste.**

## 6. Rotación:

**6.1.** La rotación correcta es a la derecha (en sentido dextrorso cuando se mira desde el extremo del motor). Encienda y apague la corriente rápidamente. Observe la rotación del eje. Para cambiar la rotación:

**6.1.1.** Motores monofásicos: No reversibles.

**6.1.2.** Motores trifásicos: Intercambie dos cualesquiera de los conductores de alimentación de potencia.

## 7. Operación:

**7.1.** Antes de arrancar, se debe cebar la bomba (la tubería de succión llena de líquido y sin aire), y abrir parcialmente la válvula de descarga.

**PRECAUCIÓN**

**El líquido bombeado proporciona lubricación. Si se hace funcionar la bomba en seco, las partes que giran se agarrotarán y se dañará el sello mecánico. No haga funcionar con caudal muy bajo o cerca de cero. La energía impartida al líquido se convierte en calor y el líquido puede convertirse en vapor. Las partes giratorias requieren líquido para impedir la formación de estrías o el agarrotamiento.**

**7.2.** Haga una verificación completa después de que haya funcionado la unidad bajo condiciones de operación y se haya estabilizado la temperatura. Verifique la expansión de la tubería. En las unidades montadas en marco la alineación del acoplamiento pudo haber cambiado debido a la diferencial de temperatura entre el motor y la bomba. Vuelva a verificar la alineación.

## 8. Mantenimiento:

**8.1.** Unidad compacta. Los cojinetes de bolas están colocados adentro y son parte del motor. Están lubricados permanentemente y no requieren engrase.

**8.2.** Unidades montadas en marco:

**8.2.1.** El marco del cojinete se debe volver a engrasar cada 2.000 horas o a intervalos de 3 meses, el que ocurra primero. Use una grasa #2 con base de sodio o litio. Llene hasta que la grasa salga de las graseras o de los sellos de reborde, luego limpie el exceso.

**8.2.2.** Siga las instrucciones de lubricación del fabricante del motor y del acoplamiento.

**8.2.3.** La alineación se debe volver a verificar después de cualquier trabajo de mantenimiento que implique alguna alteración de la unidad.

## 9. Desmontaje:

Se describirá el desmontaje completo de la unidad. Prosiga solamente hasta donde se requiera para realizar el trabajo de mantenimiento necesario.

**9.1.** Apague la alimentación eléctrica.

**9.2.** Drene el sistema. Lave con chorro, si es necesario.

**9.3.** Unidades compactas: Quite los pernos de sujeción del motor. Unidades montadas en marco: Quite el acoplamiento, el espaciador, el resguardo del acoplamiento y los pernos de sujeción del marco.

**9.4.** Desmontaje del extremo sumergido:

**9.4.1.** Quite los pernos (370) de la carcasa.

**9.4.2.** Quite el conjunto de desmontaje de la caja de rodamientos de la carcasa (100).

**9.4.3.** Quite la tuerca de seguridad (304) del impulsor.

**PRECAUCIÓN**

**No inserte un destornillador entre los álabes del impulsor para impedir la rotación de las unidades compactas. Quite la tapa en el lado opuesto del motor. Se expondrá una ranura del destornillador o un par de filos normales al eje. Usándolos impedirá daños al impulsor.**

**9.4.4.** Quite el impulsor (101) girando en sentido sinistrorso mirando al frente de la bomba. Protéjase las manos con telas o guantes.

**PRECAUCIÓN**

**No quitar el impulsor en sentido sinistrorso puede dañar las roscas en el impulsor, el eje o en ambos.**

**9.4.5.** Con dos barras de hacer palanca separadas en 180 grados e insertadas entre el alojamiento del sello (184) y el adaptador del motor (108), cuidadosamente separe las dos partes. La unidad giratoria del sello mecánico (383) debe salir del eje con el alojamiento del sello.

**9.4.6.** Empuje afuera el asiento estacionario del sello mecánico, del lado del motor del alojamiento del sello.

**9.5.** Desmontaje del marco del cojinete:

**9.5.1.** Quite la tapa (109) del cojinete.

**9.5.2.** Quite el conjunto del eje del marco (228).

**9.5.3.** Quite los sellos de reborde (138 y 139) del marco del cojinete y de la tapa del cojinete si están desgastados y se están cambiando.

**9.5.5.** Use un extractor de cojinetes o prensa de eje para quitar los cojinetes de bolas (112 y 168).

## 10. Reensamble:

**10.1.** Todas las piezas deben limpiarse antes del montaje.

**10.2.** Consulte la lista de piezas para identificar las piezas necesarias para la reparación. Especifique la bomba o el número de catálogo cuando pida las piezas.

**10.3.** Reensamblar o volver a montar es lo contrario de desmontar.

**10.3.1.** El impulsor y la contratuerca del impulsor se instalan en el eje del motor con una torsión de 10 pie-lbs.

**10.4.** Observe lo siguiente cuando vuelva a montar el marco del cojinete:

**10.4.1.** Cambie los sellos de reborde si están desgastados o dañados.

**10.4.2.** Cambie los cojinetes de bolas si están flojos, ásperos o ruidosos al girarlos.

**10.4.3.** Verifique si el eje está descentrado. El máximo permisible es una lectura de indicador total de 0,002".

**10.5.** Observe lo siguiente cuando vuelva a montar el extremo sumergido:

**10.5.1.** Todos los componentes del sello mecánico deben estar en buenas condiciones o pueden haber fugas. Es buena práctica estándar cambiar todo el conjunto del sello en cualquier momento en que se haya quitado el sello.
Se permite usar un lubricante ligero, tal como glicerina, para facilitar el montaje. No contamine las caras del sello mecánico con lubricante.

**10.5.2.** Inspeccione el anillo en O (513) de-la carcasa y cámbielo si está dañado. Este anillo en O puede lubricarse con vaselina para facilitar el montaje.

**10.5.3.** Inspeccione el anillo en O (349) del álabe director y cámbielo si está desgastado.

**PRECAUCIÓN**

**No lubrique el anillo en O (349) del álabe director. Asegúrese de que no esté pellizcado por el impulsor al volver a montar.**

**10.6.** Verifique la unidad que volvió a montarse viendo si está agarrotada. Corrija según se requiera.

**10.7.** Apriete los pernos de la carcasa en un patrón de estrella para impedir que se trabe el anillo en O.

## 11. Investigación de averías:

MOTOR NO FUNCIONA:
(Vea las causas 1 a 6)

ENTREGA POCO O NADA DE LÍQUIDO:
(Vea las causas 7 a 17)

CONSUMO MUY ALTO DE CORRIENTE:
(Vea las causas 4, 17, 18, 19, 22)

EXCESIVO RUIDO Y VIBRACIONES:
(Vea las causas 4, 6, 9, 13, 15, 16, 18, 20, 21, 22)

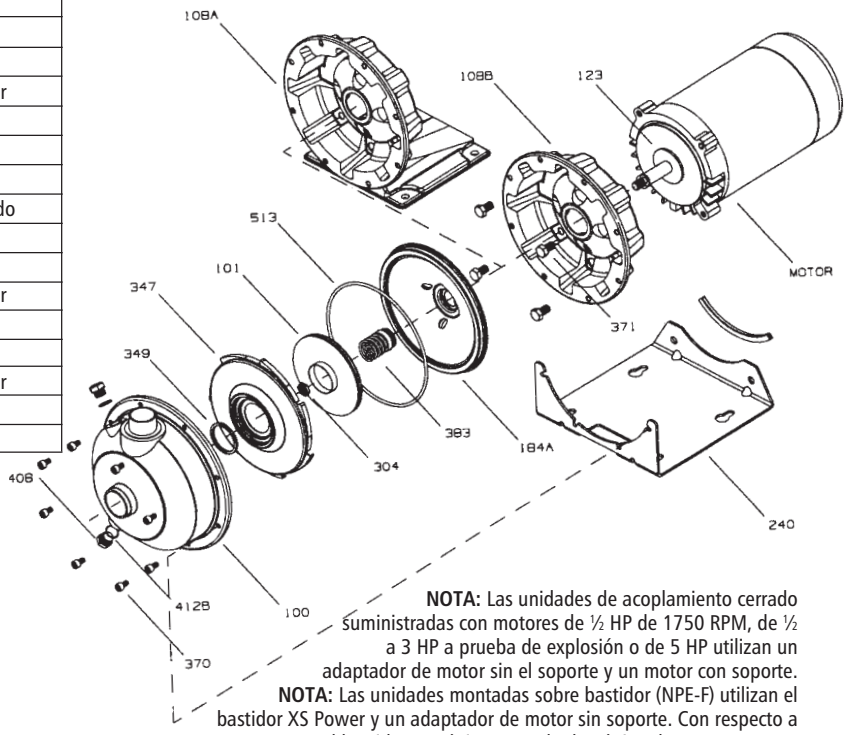
CAUSA PROBABLE:

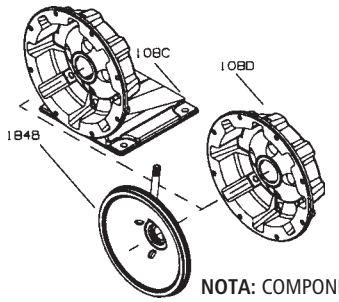
1. Protector térmico del motor disparado
2. Interruptor automático abierto
3. Fusible quemado
4. Partes giratorias agarrotadas
5. Motor mal conectado
6. Motor defectuoso
7. Bomba no cebada
8. Taponada la descarga o cerrada la válvula
9. Rotación incorrecta
10. Válvula de pie demasiado pequeña, succión no sumergida, taponada la malla de entrada.
11. Tensión baja
12. Pérdida de fase (trifásico solamente)
13. Aire o gases en el líquido
14. Demasiado alta la altura o carga del sistema
15. Demasiado baja la $ASPN_D$; (altura de succión positiva neta disponible);
    Demasiado alta la altura de aspiración o excesivas las pérdidas. Verifique con un calibrador de vacío.
16. Impulsor desgastado o taponado
17. Incorrecto el diámetro del impulsor
18. Demasiado baja la altura de descarga causando caudal excesivo
19. Demasiado alta la viscosidad o gravedad específica
20. Cojinetes desgastados
21. Bomba o tubería flojas
22. Bomba y motor mal alineados

## Lista de repuestos estándar NPE

| Pieza No. | Descripción | Materiales de Construcción |
|---|---|---|
| 100 | Carcasa | Acero inoxidable AISI 3161 |
| 101 | Impulsor | |
| 108A | Adaptador del motor con soporte | |
| 108B | Adaptador del motor sin soporte | |
| 108C | Adaptador del motor con soporte y a ras | |
| 108D | Adaptador del motor sin soporte a ras | |
| 123 | Deflector | BUNA-N |
| 184A | Caja del sello, estándar | AISI 316L S.S. |
| 184B | Caja del sello con sello a ras | |
| 240 | Apoyo para el motor | 300 S.S. |
| | Canal de caucho | Caucho |
| 304 | Contratuerca del impulsor | AISI 316 S.S. |
| 347 | Álabe de guía | AISI 316L S.S. |
| 349 | Anillo de sellado, álabe de guía | Viton, estándar |
| | | EPR |
| | | BUNA |
| 370 | Tornillo de cabeza hueca, carcasa | AISI 410 S.S. |
| 371 | Pernos, del motor | Acero/enchapado |
| 383 | Sello mecánico | |
| 408 | Tapón de drenaje y venteo, carcasa | AISI 316 S.S. |
| 412B | Anillo en O, tapón de drenaje | Viton, estándar |
| | | EPR |
| | | BUNA |
| 513 | Anillo en O, carcasa | Viton, estándar |
| | | EPR |
| | | BUNA |

| Art. 383 Sellos mecánicos (sello de ⅝") | | | | |
|---|---|---|---|---|
| Giratorio | Estacionario | Elastómeros | Partes Metálicas | Pieza No. |
| Carbono | Carbono de silicio | EPR | 316SS | 10K18 |
| | | Viton | | 10K55 |
| Carbono de silicio | | EPR | | 10K81 |
| | | Viton | | 10K62 |




**NOTA:** COMPONENTES OPCIONALES DEL SELLO A RAS

**NOTA:** Las unidades de acoplamiento cerrado suministradas con motores de ½ HP de 1750 RPM, de ½ a 3 HP a prueba de explosión o de 5 HP utilizan un adaptador de motor sin el soporte y un motor con soporte.
**NOTA:** Las unidades montadas sobre bastidor (NPE-F) utilizan el bastidor XS Power y un adaptador de motor sin soporte. Con respecto a repuestos para el bastidor mecánico, consulte la página de repuestos para bastidor XS-Power en la sección de partes de su catálogo. Para ordenar el bastidor mecánico completo, pida el artículo 14L61.

### GARANTÍA LIMITADA DE GOULDS PUMPS

Esta garantía es aplicable a todas las bombas para sistemas de agua fabricadas por Goulds Pumps.

Toda parte o partes que resulten defectuosas dentro del período de garantía serán reemplazadas sin cargo para el comerciante durante dicho período de garantía. Tal período de garantía se extiende por doce (12) meses a partir de la fecha de instalación, o dieciocho (18) meses a partir de la fecha de fabricación, cualquiera se cumpla primero.

Todo comerciante que considere que existe lugar a un reclamo de garantía deberá ponerse en contacto con el distribuidor autorizado de Goulds Pumps del cual adquiriera la bomba, y ofrecer información detallada con respecto al reclamo. El distribuidor está autorizado a liquidar todos los reclamos por garantía a través del Departamento de Servicios a Clientes de Goulds Pumps.

**La presente garantía excluye:**

(a) La mano de obra, el transporte y los costos relacionados en los que incurra el comerciante;
(b) los costos de reinstalación del equipo reparado;
(c) los costos de reinstalación del equipo reemplazado;
(d) daños emergentes de cualquier naturaleza; y
(e) el reembolso de cualquier pérdida causada por la interrupción del servicio.

**A los fines de esta garantía, los términos "Distribuidor", "Comerciante" y "Cliente" se definen como sigue:**

(1) "Distribuidor" es aquel individuo, sociedad, corporación, asociación u otra entidad jurídica que opera entre Goulds Pumps y el comerciante para la compra, consignación o contratos de venta de las bombas en cuestión.
(2) "Comerciante" es todo individuo, sociedad, corporación, asociación u otra entidad jurídica que realiza negocios de venta o alquiler-venta (leasing) de bombas a clientes.
(3) "Cliente" es toda entidad que compra o que adquiere bajo la modalidad de leasing las bombas en cuestión de un comerciante. El término "cliente" puede significar un individuo, una sociedad, una corporación, una sociedad de responsabilidad limitada, una asociación o cualquier otra entidad jurídica con actividades en cualquier tipo de negocios.

**LA PRESENTE GARANTÍA SE EXTIENDE AL COMERCIANTE ÚNICAMENTE**

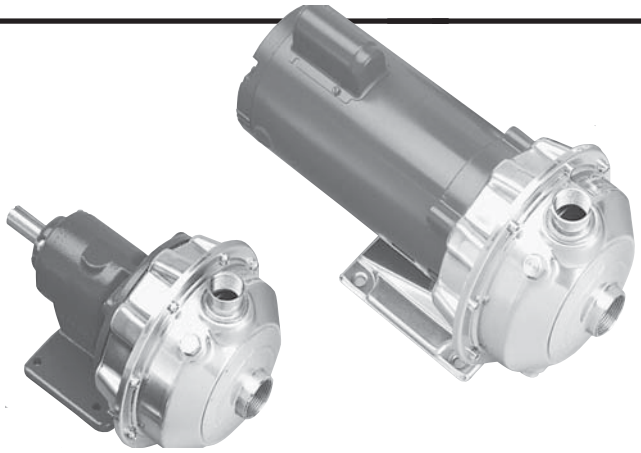


Goulds Pumps
ITT Industries

G&L Pumps

# Directives d'installation, d'utilisation et d'entretien

# Modèles NPE et NPE-F



## DESCRIPTION ET CARACTÉRISTIQUES

Les pompes modèles NPE monobloc (sur moteur) et NPE-F (sur palier) sont des pompes centrifuges à un étage et à orifice d'aspiration en bout, utilisées pour le transfert général de liquides, l'augmentation de pression, etc. La tête de pompage est tout en inox AISI du type 316 estampé ou soudé. La roue, fermée, ne peut être réduite à un diamètre moindre par usinage. Le corps de pompe est muni d'un diffuseur pour en améliorer le rendement et diminuer la charge radiale de l'arbre.

Les NPE sont montées sur des moteurs NEMA 48J ou 56J à bride de fixation en C et à bout d'arbre fileté. Les pompes montées sur palier peuvent être entraînées par accouplement ou par courroie.

## 1. Informations importantes

**1.1.** Inspecter l'appareil et signaler immédiatement tout dommage au transporteur ou au détaillant.

**1.2.** L'alimentation en électricité doit être assurée par un circuit de dérivation distinct dont les fusibles ou les disjoncteurs, le calibre des fils, etc. sont conformes aux prescriptions du code provincial ou national de l'électricité. Poser un sectionneur tout conducteur prés de la pompe.

**ATTENTION**

**On doit toujours couper le courant lorsque l'on effectue quelque travail que ce soit sur la pompe ou les commandes.**

**1.3.** Le câblage d'alimentation du moteur doit convenir à la tension de fonctionnement. Le schéma de câblage se trouve sur la plaque signalétique du moteur. Les fils doivent avoir un calibre limitant la chute de tension maximale, aux bornes du moteur, à 10 % de la valeur de tension indiquée sur la plaque signalétique, sinon la durée de vie du moteur et les performances de la pompe diminueront.

**1.4.** Il faut toujours employer des contacteurs et des démarreurs conçus pour les puissances nominales en horse-power (hp).

**1.5.** Protection du moteur

**1.5.1.** Moteurs monophasés — Ces moteurs sont parfois munis d'une protection thermique intégrée (consulter la plaque signalétique). Dans le cas contraire, utiliser un contacteur à protection appropriée contre les surcharges. Les dispositifs fusibles sont permis.

**1.5.2.** Moteurs triphasés — Employer une protection trois conducteurs appropriée contre les surcharges thermiques ainsi qu'un démarreur magnétique convenant à la charge électrique.

**1.6.** Limites d'utilisation maximales :

| | |
|---|---|
| Température du liquide : | 100 °C (212 °F), avec joint standard ; 120 °C (250 °F), avec joint pour hautes températures en option. |
| Pression : | 517 kPa (75 lb/po$^2$). |
| Démarrages par heure : | 20, répartis uniformément. |

**1.7.** Une inspection et un entretien réguliers augmenteront la durée de vie de l'appareil. Établir un programme d'entretien et d'inspection basé sur le temps de fonctionnement. Voir la section 8.

## 2. Installation

**2.1.** Généralités

**2.1.1.** Placer la pompe aussi prés de la source de liquide que possible, mais plus bas pour assurer l'amorçage automatique.

**2.1.2.** Protéger l'appareil contre les inondations et le gel.

**2.1.3.** Laisser assez d'espace pour l'entretien et l'aération.

**2.1.4.** La tuyauterie doit posséder ses propres supports et « s'aligner » correctement sur la pompe.

**ATTENTION**

**Poser la tuyauterie de façon à n'appliquer aucune contrainte sur les raccords d'aspiration et de refoulement de la pompe.**

**2.1.5.** Ne poser aucun accessoire ni raccord de tuyauterie superflu. Choisir le calibre qui réduit les pertes de charge par frottement au minimum.

**2.2.** Pompes montées sur moteur :

**2.2.1.** Les pompes peuvent être installées sur une surface horizontale, inclinée ou verticale.

**ATTENTION**

**Ne pas placer le moteur plus bas que la pompe afin de le protéger contre les fuites et l'eau de condensation.**

**2.2.2.** L'assise doit être plane et solide pour empêcher que le serrage des boulons ne cause de contraintes. Monter l'appareil sur cautchouc pour réduire le bruit et les vibrations au minimum.

**2.2.3.** Serrer les boulons de fixation du moteur avant de raccorder la tuyauterie à la pompe.

**2.3.** Pompes montées sur palier :

**2.3.1.** Il est recommandé de remplir de coulis le vide entre la plaque de base et la dalle reposant sur une semelle de fondations solide (v. fig. 1).

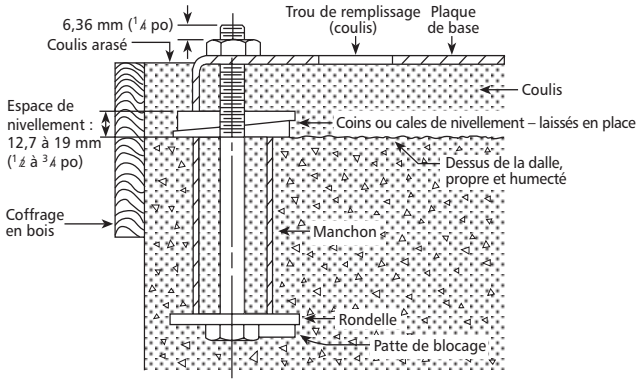



**Figure 1**

Goulds Pumps

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**2.3.2.** Placer l'appareil sur des coins de nivellement situés en quatre points distincts : deux sous le centre approximatif du moteur et deux sous celui de la pompe. Régler la position de l'appareil de manière à ce que la bride des raccords d'aspiration et de refoulement soit de niveau (avec un fil à plomb ou un niveau).
**2.3.3.** S'assurer que la plaque de base n'est pas déformée et que l'alignement final de l'accouplement est possible dans les limites de déplacement ou de calage du moteur.
**2.3.4.** Serrer les boulons d'ancrage à la main et construire un coffrage autour de la plaque de base. Verser du coulis sous la plaque et s'assurer qu'il n'y a aucun creux sous la plaque-support de la pompe et du moteur. Laisser le coulis durcir pendant 48 heures avant de serrer les boulons d'ancrage à fond.
**2.3.5.** Serrer les boulons de fixation de la pompe et du moteur avant de raccorder les tuyaux à la pompe.

## 3. Tuyauterie d'aspiration

**3.1.** Une hauteur géométrique d'aspiration réduite et une tuyauterie directe et courte sont souhaitables. Si la hauteur d'aspiration dépasse 3 m (10 pi), et la température du liquide, 49 °C (120 °F), consulter la courbe de débit de la pompe pour obtenir la hauteur nette d'aspiration requise (NPSHR).
**3.2.** Le calibre du tuyau d'aspiration doit être au moins égal à celui du raccord d'aspiration de la pompe pour éviter une perte de performances.
**3.3.** S'il faut un tuyau plus gros, on doit installer prés de la pompe un raccord excentré (le côté non oblique en haut).
**3.4.** Pompe placée plus bas que la source de liquide :

**3.4.1.** Poser un robinet d'isolement à passage intégral sur le tuyau d'aspiration pour l'inspection et l'entretien.

**ATTENTION**

**Ne pas employer le robinet d'isolement pour réduire la section de passage vers la pompe.**

**3.5.** Pompe placée plus haut que la source de liquide :
**3.5.1.** Afin de prévenir les poches d'air, aucun élément de la tuyauterie d'aspiration ne devrait être plus haut que le raccord d'aspiration de la pompe. Incliner la tuyauterie vers le haut à partir de la source de liquide.
**3.5.2.** Chaque joint doit être étanche.
**3.5.3.** N'employer un clapet de pied que s'il est nécessaire pour amorcer la pompe ou la maintenir amorcée durant les arrêts.
**3.5.4.** La section de passage de la crépine du tuyau d'aspiration doit être au moins le triple de celle du tuyau.
**3.6.** Le diamètre (*d*) et la hauteur d'immersion minimale (*h* min.) de l'entrée du tuyau d'aspiration doivent être suffisants pour empêcher l'aspiration d'air par vortex (v. fig. 2 à 5).
**3.7.** Enrouler les filets des raccords de 3 ou 4 couches de ruban de téflon pour les étancher.

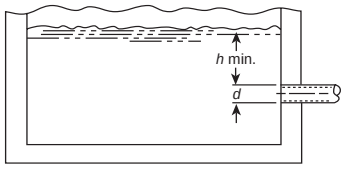



Figure 2

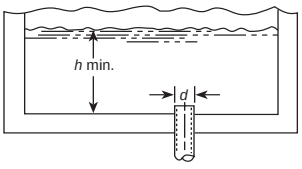



Figure 3

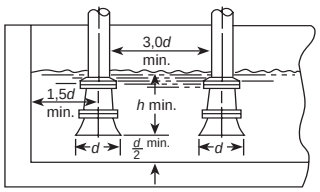



Figure 4

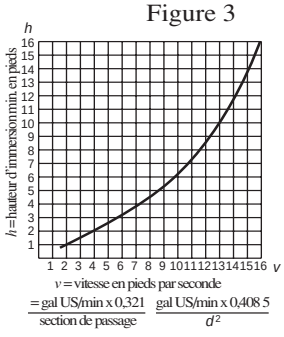



Figure 5

## 4. Tuyauterie de refoulement

**4.1.** L'installation doit comporter un robinet-vanne, ainsi qu'un clapet de non-retour placé entre le robinet-vanne el la pompe. Le robinet-vanne sert à la régularisation du débit et à l'inspection de la pompe et du clapet de non-retour.
**4.2.** Si un raccord agrandisseur est nécessaire, le poser entre le clapet de non-retour et la pompe.
**4.3.** Enrouler les filets des raccords de 3 ou 4 couches de ruban de téflon pour les étancher.

## 5. Alignement des arbres — moteur et pompe

**5.1.** Pompes montées sur moteur :
**5.1.1.** Aucun alignement sur place n'est requis.
**5.2.** Pompes montées sur palier :
**5.2.1.** Les arbres ont été alignés en usine, mais le transport peut parfois les désaligner. On doit donc vérifier l'alignement avant la mise en service de la pompe (v. fig. 6).

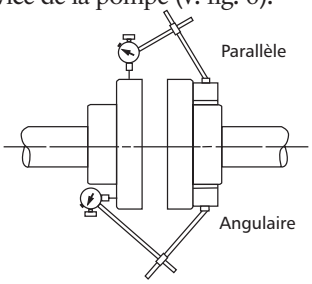



**Figure 6**

**5.2.2.** Serrer tous les boulons de fixation avant de vérifier l'alignement.
**5.2.3.** Si un alignement est nécessaire, on ne doit déplacer que le moteur. Employer des cales au besoin.
**5.2.4.** Désalignement parallèle (arbres parallèles mais non concentriques) — Fixer sur un moyeu un comparateur à cadran que l'on tourne de 360° le long de la périphérie de l'autre moyeu tout en notant l'amplitude de déplacement de l'aiguille. L'alignement est correct si le faux-rond total est de 0,127 mm (0,005 po) ou moins.
**5.2.5.** Désalignement angulaire (arbres concentriques mais non parallèles) — Fixer sur un moyeu un comparateur à cadran que l'on tourne de 360° le long du plateau de l'autre moyeu tout en notant l'amplitude de déplacement de l'aiguille. L'alignement est correct si le faux-rond total est de 0,127 mm (0,005 po) ou moins.
**5.2.6.** L'alignement final convient lorsqu'il satisfait aux exigences relatives à l'alignement parallèle et angulaire (après le serrage à fond des boulons de fixation du moteur).

**ATTENTION**

**On doit toujours vérifier les deux types d'alignement après chaque réglage.**

## 6. Rotation

**6.1.** La rotation appropriée s'effectue en sens horaire (vers la droite, vue de l'extrémité du moteur). Couper et rétablir le courant rapidement pour observer le sens de rotation de l'arbre. Changer le sens de rotation comme suit.
**6.1.1.** Moteur monophasé : irréversible.
**6.1.2.** Moteur triphasé : intervertir deux des conducteurs du moteur.

## 7. Utilisation

**7.1.** Avant la mise en service, on doit amorcer la pompe (pour en faire sortir l'air), remplir de liquide le tuyau d'aspiration et entrouvrir le robinet de refoulement.

**ATTENTION**

**Les liquides pompés servent de lubrifiant. Si la pompe tournait à sec, les pièces mobiles gripperaient, et la garniture mécanique se détériorerait. Ne pas faire marcher la pompe quand le débit est nul ou presque, car le liquide absorberait la chaleur produite par frottement et pourrait se changer rapidement en vapeur. Les pièces mobiles doivent être lubrifiées par le liquide pour ne pas se détériorer ni gripper.**

**7.2.** Faire fonctionner l'appareil dans des conditions de service normales jusqu'à ce que sa température se soit stabilisée, puis vérifier tout le système. Vérifier également si la tuyauterie se dilate. Dans le cas des pompes sur palier, la différence de température entre le moteur et la pompe peut causer le désalignement de l'accouplement. Vérifier l'alignement de nouveau.

## 8. Entretien

**8.1.** Dans le cas des pompes montées sur moteur, les roulements sont situés à l'intérieur du moteur et sont lubrifiés à vie. Aucun graissage n'est requis.

**8.2.** Pompes montées sur palier :

**8.2.1.** Les roulements de palier devraient être graissés toutes les 2 000 heures ou tous les trois mois, soit la période prenant fin la première. Employer une graisse au lithium ou au sodium nº 2. Remplir le roulement jusqu'à ce que la graisse sorte par les garnitures ou par les joints à lèvres, puis essuyer le surplus.

**8.2.2.** Suivre les directives de lubrification du fabricant du moteur et de l'accouplement.

**8.2.3.** Vérifier l'alignement de nouveau après tout travail d'entretien nécessitant le déplacement de l'appareil.

## 9. Démontage

Le démontage complet de la pompe est décrit ci-dessous. Ne démonter que ce qui permet d'effectuer l'entretien nécessaire.

**9.1.** Couper le courant.

**9.2.** Vidanger le système. Le rincer au besoin.

**9.3.** Dans le cas des pompes montées sur moteur, enlever les boulons de fixation de ce dernier. Quant aux pompes montées sur palier, enlever la bague et le carter d'accouplement ainsi que les boulons de fixation du palier.

**9.4.** Démontage de la tête de pompage :

**9.4.1.** Enlever les vis de fixation (370) du corps de pompe.

**9.4.2.** Écarter l'ensemble d'entraînement de la roue d'avec le corps de pompe (100).

**9.4.3.** Enlever l'écrou autofreiné (304) de la roue.

**ATTENTION**

**Ne pas insérer de tournevis entre les aubes de la roue pour l'empêcher de tourner : enlever le couvercle d'extrémité du moteur et utiliser la fente ou les méplats de blocage de l'arbre ; on préviendra ainsi l'endommagement de la roue.**

**9.4.4.** Dévisser la roue (101) dans le sens antihoraire (vu du devant de la pompe). Se protéger les mains avec un linge ou des gants.

**ATTENTION**

**Toute tentative de dévissage dans le sens horaire peut endommager les filets de la roue ou de l'arbre, ou des deux.**

**9.4.5.** Retirer le logement de garniture (184) avec soin au moyen de deux leviers placés dans un angle de 180º entre le logement et l'adaptateur de moteur (108). L'élément mobile de la garniture mécanique (383) devrait sortir de l'arbre avec le logement.

**9.4.6.** Pousser l'élément fixe de la garniture mécanique hors du logement.

**9.5.** Démontage du palier :

**9.5.1.** Enlever le couvercle de palier (109).

**9.5.2.** Sortir l'arbre (122) du palier (228).

**9.5.3.** Si les joints à lèvres (138 et 139) sont usés et doivent être remplacés, les retirer du palier et du couvercle de palier.

**9.5.5.** À l'aide d'un arrache-roulement ou d'une presse à mandriner, extraire les roulements (112 et 168).

## 10. Remontage

**10.1.** Chaque pièce devrait être nettoyée avant le remontage.

**10.2.** Voir la liste de pièces pour déterminer celles qui sont requises. Préciser le numéro de pièce ou de catalogue de la pompe lorsque l'on commande des pièces.

**10.3.** Le remontage se fait dans l'ordre inverse du démontage.

**10.3.1.** Visser la roue et son écrou autofreiné sur l'arbre de moteur. Les serrer à 10 lbf·pi.

**10.4.** Observer les directives suivantes pendant le remontage du palier :

**10.4.1.** Remplacer les joints à lèvres s'ils sont usés ou endommagés.

**10.4.2.** Remplacer les roulements à billes s'ils ont du jeu, s'ils ne tournent pas rond ou s'ils sont bruyants.

**10.4.3.** Vérifier si l'arbre comporte des faux-ronds : le faux-rond maximal admissible est de 0,051 mm (0,002 po).

**10.5.** Observer les directives suivantes pendant le remontage de la tête de pompage :

**10.5.1.** Tous les éléments de la garniture mécanique doivent être en bon état pour empêcher les fuites. Le remplacement de la garniture en entier est une pratique courante appropriée chaque fois que la garniture est enlevée. On peut utiliser de la glycérine ou un autre lubrifiant léger pour faciliter la pose de la garniture, dont on ne doit pas contaminer la surface avec le lubrifiant.

**10.5.2.** Inspecter le joint torique (513) du corps de pompe et le remplacer s'il est endommagé. On peut employer du pétrolatum (vaseline) pour en faciliter la pose.

**10.5.3.** Inspecter le joint torique (349) du diffuseur et le remplacer s'il est endommagé.

**ATTENTION**

**Ne pas lubrifier le joint torique (349) du diffuseur. S'assurer que le joint n'est pas pincé par la roue au cours du remontage.**

**10.6.** Une fois la pompe remontée, vérifier s'il y a grippage. Apporter les corrections nécessaires.

**10.7.** Serrer les vis de fixation du corps de pompe en étoile pour prévenir le coincement du joint torique.

## 11. Diagnostic des anomalies

NON-FONCTIONNEMENT DU MOTEUR
(V. causes probables 1 à 6)

DÉBIT DE LIQUIDE FAIBLE OU NUL
(V. causes probables 7 à 17)

CONSOMMATION D'ÉNERGIE EXCESSIVE
(V. causes probables 4, 17, 18, 19 et 22)

VIBRATION ET BRUIT EXCESSIFS
(V. causes probables 4, 6, 9, 13, 15, 16, 18, 20, 21 et 22)

CAUSES PROBABLES :

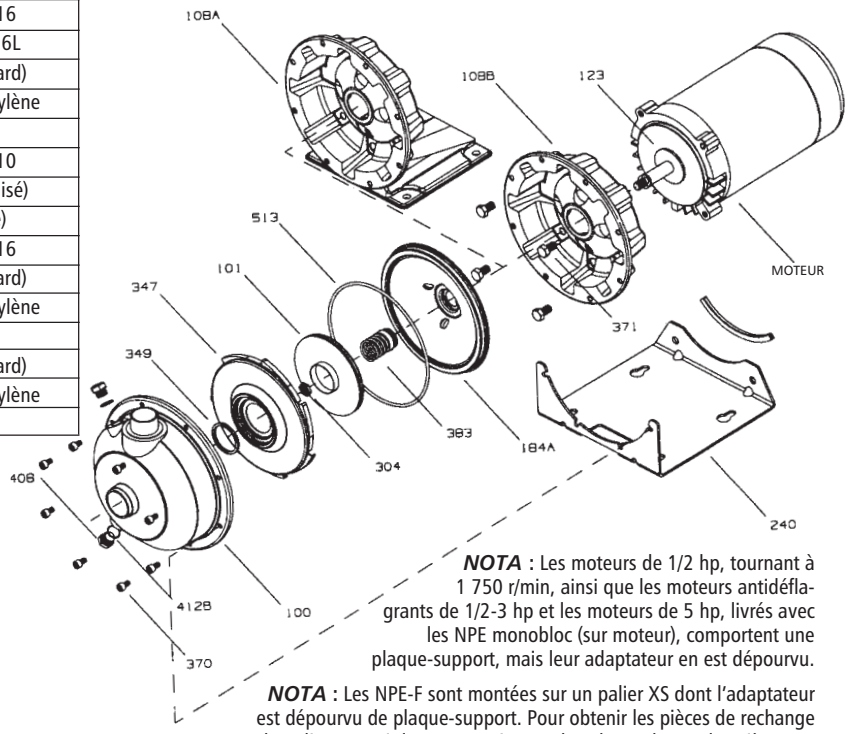
1. Protecteur thermique déclenché
2. Disjoncteur ouvert
3. Fusible sauté
4. Pièces mobiles grippées
5. Moteur mal connecté
6. Moteur défectueux
7. Pompe non amorcée
8. Tuyau de refoulement obstrué ou robinet fermé
9. Mauvais sens de rotation
10. Clapet de pied trop petit, entrée de tuyau d'aspiration non immergée, crépine de tuyau d'aspiration obstruée.
11. Basse tension électrique
12. Perte de phase (moteurs triphasés seulement)
13. Présence d'air ou de gaz dans le liquide
14. Hauteur de charge trop élevée du système
15. Hauteur nette d'aspiration disponible (NPSHA) trop faible — hauteur ou perte d'aspiration excessives — à vérifier avec un vacuomètre
16. Roue usée ou engorgée
17. Diamètre de roue inapproprié
18. Hauteur de charge trop faible : débit excessif
19. Viscosité ou densité trop élevées
20. Roulements usés
21. Pompe ou tuyauterie mal assujetties
22. Pompe et moteur désalignés

## Liste de pièces de rechange de la NPE standard

| Nº d'article | Description | Matériau |
|---|---|---|
| 100 | Corps de pompe | Inox AISI 316L |
| 101 | Roue | |
| 108A | Adaptateur de moteur et plaque-support | |
| 108B | Adaptateur de moteur sans plaque-support | |
| 108C | Adaptateur de mot., plaque-supp. et rinceur | |
| 108D | Adaptateur de moteur et rinceur sans plaque-supp. | |
| 123 | Déflecteur | Buna-N |
| 184A | Logement de garniture standard | Inox AISI 316L |
| 184B | Logement de garniture et rinceur | |
| 240 | Plaque-support (moteur) | Inox 300 |
| | Profilé en U | Caoutchouc |
| 304 | Écrou autofreiné (roue) | Inox AISI 316 |
| 347 | Diffuseur | Inox AISI 316L |
| 349 | Joint d'étanchéité (diffuseur) | Viton (standard) |
| | | Éthylène-propylène |
| | | Buna |
| 370 | Vis à pans creux (corps de pompe) | Inox AISI 410 |
| 371 | Vis (moteur) | Acier (galvanisé) |
| 383 | Garniture mécanique | (Voir table) |
| 408 | Bouchons — vidange et MAL (corps de pompe) | Inox AISI 316 |
| 412B | Joints toriques (bouchons) | Viton (standard) |
| | | Éthylène-propylène |
| | | Buna |
| 513 | Joint torique (corps de pompe) | Viton (standard) |
| | | Éthylène-propylène |
| | | Buna |

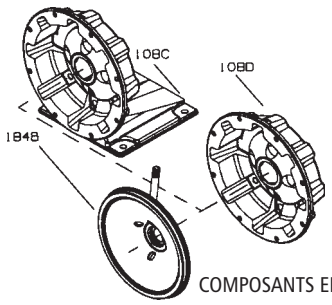
MAL = mise à l'air libre

| Garnitures mécaniques (⅝ po) — article nº 383 | | | | |
|---|---|---|---|---|
| Élément mobile | Élément fixe | Élastomère | Métal | Nº de pièce |
| Carbone | Carbure de silicium | Éthyl.-propyl. | Inox 316 | 10K18 |
| | | Viton | | 10K55 |
| Carbure de silicium | | Éthyl.-propyl. | | 10K81 |
| | | Viton | | 10K62 |




***NOTA*** : Les moteurs de 1/2 hp, tournant à 1 750 r/min, ainsi que les moteurs antidéflagrants de 1/2-3 hp et les moteurs de 5 hp, livrés avec les NPE monobloc (sur moteur), comportent une plaque-support, mais leur adaptateur en est dépourvu.

***NOTA*** : Les NPE-F sont montées sur un palier XS dont l'adaptateur est dépourvu de plaque-support. Pour obtenir les pièces de rechange du palier XS, voir la page pertinente dans le catalogue des pièces. Le numéro d'article pour commander le palier complet est le 14L61.




COMPOSANTS EN OPTION AVEC RINCEUR DE GARNITURE

### GARANTIE LIMITÉE DE GOULDS PUMPS

La présente garantie s'applique à chaque pompe de système d'alimentation en eau fabriquée par Goulds Pumps.

Toute pièce se révélant défectueuse sera remplacée sans frais pour le détaillant durant la période de garantie suivante expirant la première : douze (12) mois à compter de la date d'installation ou dix-huit (18) mois à partir de la date de fabrication.

Le détaillant qui, aux termes de cette garantie, désire effectuer une demande de règlement doit s'adresser au distributeur Goulds Pumps agréé chez lequel la pompe a été achetée et fournir tous les détails à l'appui de sa demande. Le distributeur est autorisé à régler toute demande par le biais du service à la clientèle de Goulds Pumps.

**La garantie ne couvre pas :**

a) les frais de main-d'œuvre ou de transport ni les frais connexes encourus par le détaillant ;
b) les frais de réinstallation de l'équipement réparé ;
c) les frais de réinstallation de l'équipement de remplacement ;
d) les dommages indirects de quelque nature que ce soit ;
e) ni les pertes découlant de la panne.

**Aux fins de la présente garantie, les termes ci-dessous sont définis comme suit :**

1) « Distributeur » signifie une personne, une société de personnes, une société de capitaux, une association ou autre entité juridique servant d'intermédiaire entre Goulds Pumps et le détaillant pour les achats, les consignations ou les contrats de vente des pompes en question.
2) « Détaillant » veut dire une personne, une société de personnes, une société de capitaux, une association ou autre entité juridique dont les activités commerciales sont la vente ou la location de pompes à des clients.
3) « Client » signifie une entité qui achète ou loue les pompes en question chez un détaillant. Un « client » peut être une personne, une société de personnes, une société de capitaux, une société à responsabilité limitée, une association ou autre entité juridique se livrant à quelque activité que ce soit.

**CETTE GARANTIE SE RAPPORTE AU DÉTAILLANT SEULEMENT.**



Visitez notre site (www.goulds.com).


Imprimé aux É.-U.

Goulds Pumps

ITT Industries

# TRAVAINI PUMPS USA

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Phone: 203-938-0108
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**n SOUTH EAST**
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Fax: 480-545-0704
E-mail: west@travaini.com


www.travaini.com

TRAVAINI PUMPS USA

Liquid Ring & Rotary Vane Vacuum Pumps and Systems


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TRAVAINI PUMPS USA

Liquid Ring & Rotary Vane Vacuum Pumps and Systems

# DynaSeal™ Liquid Ring Vacuum Systems

www.travaini.com

# DynaSeal™

## The versatile, reliable vacuum pump system designed with the customer in mind.

Travaini Pumps, USA, is one of the world's leading manufacturers of liquid ring vacuum pumps and systems. The simplicity in design offers excellent reliability and low maintenance. Environmental laws and severe restrictions on water usage together with the ever-increasing costs of disposal created the need for a closed loop system. Travaini answers this need with the **DynaSeal**™ system offering years of experience and know-how in the application of different sealing fluids other than water to achieve solutions for a broad variety of harsh environments.

Twenty (20) years ago, our engineers realized the need for environmentally friendly, waterless systems when they developed the first air-cooled, closed loop, liquid ring vacuum pump system using oil as the sealing liquid.

Today, thousands of our vacuum pumps installed in those first systems are still operating after thousands of hours of trouble-free operation. – "A Proven Design".

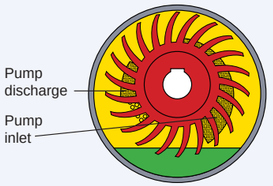


Figure 1

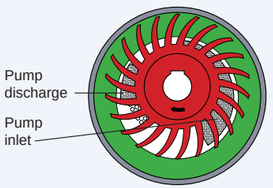


Figure 2

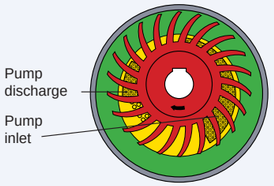


Figure 3

## Principle of Operation

A multi-bladed impeller mounted on a shaft is positioned eccentrically in a cylindrical housing, partially filled with liquid. Portplates with inlet and discharge openings are positioned on each side of the impeller (Figure 1). As the impeller rotates, centrifugal force pushes the liquid outward, forming a liquid ring (Figure 2). Looking at the YELLOW area of the impeller chambers (Figure 3), we see that on the right hand side, from the top down, the chamber volume increases as the liquid ring moves outward, creating a vacuum in the impeller chamber. on the left hand side, the volume decreases as the liquid moves inward, increasing the pressure in the chambers until the discharge takes place through the discharge opening. A continuous flow of fresh sealing liquid is supplied to the pump.

## Seal Fluid Technology

In our ongoing search for better solutions, we can offer alternative sealing fluids that are environmentally friendly. Unlike other types of vacuum pumps, our liquid ring design requires no internal lubrication because there is no metal to metal contact between rotating and stationary parts and the bearings are located external to the pumping chamber. This allows for more diversity when choosing the sealing fluid because the lubricating properties of the fluid are not critical.

The Travaini **DynaSeal**™ system offers a simple, low maintenance design with low noise and vibration levels, as well as reduced operating costs.

Count on Travaini for in-depth experience, technology and innovation. Our extensive inventory of pumps and replacement parts can, in most instances, be shipped the same day. Superior service is our #1 goal.

**DynaSeal™, you can't beat the system.**



# DynaSeal™ Benefits

### DynaSeal™ Standard Specifications:
≥ 15" Hg Vacuum; 60-120° F Ambient Temperatures; 180° F Inlet Gas Temperature Max; 180° F Discharge Gas/Oil Temperature; If conditions differ, consult factory for recommended design modifications.

### 200° F Inlet Gas – Consult factory.

### Capacity Range Standards
15-1000 ACFM. Larger systems available **upon request**.

### Low Noise Level.
Unlike rotary screw vacuum pumps, which run at rotor speeds as high as 9000-rpm, **DynaSeal™** systems operate at conservative speeds (1750-rpm) resulting in low noise levels (75-80 dBA at 3-ft.) acceptable to the environment without the need for sound enclosures.

### Minimal Maintenance.
**DynaSeal™** systems typically only require an oil change and replacement of discharge filter every 10,000 hours under normal operating conditions. No other maintenance is required except for periodic greasing of bearings.

### Not affected by carry-over of soft solids or liquids.
**DynaSeal™** systems can handle carry-over of soft solids and liquids without damage to the system components. We do however recommend to install an inlet filter/strainer or knock-out pot in those applications where a high carry-over of either solids or liquids is expected.

### Designed for continuous operation.
**DynaSeal™** systems are designed for continuous operation over the full vacuum range without overheating.

### Automatic Temperature Control.
Prevents low temperature operation, reduces accumulation of water and other liquids in the reservoir and decreases the risk of bacteria growth. This optional feature is very important in hospital and other intermittent duty applications.

### Low Vibration.
**DynaSeal™** systems require no special foundations or anti-vibration mountings as a standard.

### High-Quality Manufacturing Standards.
Travaini pumps are manufactured under ISO 9001 quality control standards.

### Quality Control
**DynaSeal™** systems are a "proven design". Combine this with our inline quality procedures and outgoing inspection, this provides you with the leading quality in the industry.

### Custom Solutions
**DynaSeal™** systems can be provided in single or multiple system configurations with programmable controllers to meet your specific requirements. Explosion proof designs for those stringent environments. Wide range of materials including stainless steel, copper, etc.

# DynaSeal™

## Air-cooled Liquid Ring Vacuum Systems


**Made in the USA.** DynaSeal™ systems are designed, built, and tested at our facility in Yorktown, Virginia.

## Typical System Features & Options

**1 ADVANCED LIQUID RING VACUUM PUMP DESIGN** Offers high efficiency, reliability and minimum maintenance. External bearings and ample clearance between rotating parts eliminate the need for internal lubrication.

**2 ELECTRIC CONTROL PANEL** Each system includes a NEMA 12 electrical control panel complete with magnetic starter and overload protection, 110-volt control circuit and hour meter as standard. Wiring to motor and control switches is completed at the factory.

**3 HIGH TEMPERATURE SWITCH** Shuts unit down at 225˚F in case oil flow to unit is interrupted.

**4 BACK PRESSURE GAUGE** Shows condition of demister element and if element requires service. It also indicates back pressure from piping system.

**5 AIR/OIL SEPARATOR** Includes a highly efficient demister element to remove oil mist from discharge air. Exhaust is 99.9% oil-free.

**6 OIL RESERVOIR** Mounted overhead for positive oil flow pressure and sized for adequate oil capacity, cooling and efficient separation by internal baffles. A sight gauge complete with temperature gauge is included.

**7 INLET CHECK VALVE** Properly sized and suitable for vacuum.

**8 HIGH EFFICIENCY AIR-COOLED HEAT EXCHANGER** Allows system to operate at moderate temperatures with ambient temperatures as high as 110˚. Water-cooled units are available.

**9 PUMP OR MOTOR-MOUNTED COOLING FAN** Provides high air flow for maximum cooling without the need for a separate fan motor, except for units of 50-hp and larger which have electric-drive fan units.

**10 SOLENOID VALVE** Shuts down oil flow to pump when unit is stopped.

**11 MONOBLOCK MOTOR MOUNTING DESIGN** Standard up to 25-hp, eliminates misalignment problems by flange mounting to a standard NEMA C-face motor. (TEFC motors with a 1.15 service factor are standard) a heavy-duty flexible coupling ensures trouble-free service.

**12 MANUAL UNLOADER VALVE WITH FILTER SILENCER** Aids in vacuum unloading and/or relief of the pump prior to start-up and shutdown. (Electric unloading–optional)

**13 VACUUM RELIEF VALVE WITH SILENCER (OPTIONAL)** Field adjustable to control maximum vacuum level.

**14 TEMPERATURE CONTROL VALVE (OPTIONAL)** Allowing the system to reach operating temperature very quickly which is important especially for outdoor installations and intermittent duties.

**15 HIGH AND LOW OIL LEVEL SWITCH (OPTIONAL)** To protect pump from loss of oil.

**EXPLOSION PROOF DESIGN** (Optional)

### DynaSeal™ Systems are used extensively in industries such as:

- Hospitals, healthcare and pharmaceutical
- Solvent and vapor recovery
- Soil remediation
- Wood working and wood impregnation
- Electronics and semi-conductors
- Printing and paper converting
- Food and meat processing
- Plastics, automotive and aircraft
- Sterilization and impregnation
- Plus numerous others

# The "Mini" Series

## Models – TRO-075VM, TRO-110VM AND TRO-160VM

### Latest concept of our patented DynaSeal™ System

### Features:

- Space Saving
- Vastly Improved Mist Elimination
- Cost Savings
- 3 Models Available

1

Using our 3 monoblock vari-ported pump designs, models TRM 40-110, 40-150, and 40-200, we offer these three systems, 5, 7.5, and 10 hp, configured to incorporate the above features.

2

The traditional oil sealed systems has a footprint almost twice the length and 50% wider than the "MINI" Series. By incorporating the monoblock pump design, we have developed the "MINI" package to fit within equipment or locations that require economies of space.

3

Traditional oil-sealed packages have been designed to handle vacuums beyond 15" HgV, as the majority of applications require. Below 15" HgV, the coalescing filters are not designed to fully handle the oil mist. The new "MINI" Series was designed to coalesce from 0-30" Hg vacuum through our unique filter element and specially formulated synthetic oil.

4

The simplicity of the "MINI" design has resulted in reduced costs which allow us to pass the savings on to you, our customers. Cost is always a priority without sacrificing the quality you've come to expect from Travaini products.

# Standard DynaSeal™ Models

| System Model | Nominal Capacity ACFM | Motor HP | Maximum End Vacuum in. Hg | Approximate Dimensions (in) L x W x H | Approximate Weight (Lbs) |
|---|---|---|---|---|---|
| TRO015H | 15 | 2 | 29 | 38 x 17 x 40 | 340 |
| TRO015S | 15 | 1.5 | 26 | 38 x 17 x 40 | 340 |
| TRO035S | 35 | 3 | 26 | 38 x 17 x 40 | 340 |
| TRO035H | 35 | 3 | 29 | 38 x 17 x 40 | 340 |
| TRO050H | 50 | 5 | 29.5 | 38 x 17 x 40 | 435 |
| TRO075S | 75 | 5 | 27 | 43 x 17 x 40 | 530 |
| TRO075-VM** | 75 | 5 | 29 | 32 X 25 X 43 | 500 |
| TRO110V | 110 | 7.5 | 29.5 | 55 x 25 x 51 | 920 |
| TRO110-VM** | 110 | 7.5 | 29 | 32 X 25 X 43 | 540 |
| TRO140H | 140 | 10 | 29.5 | 55 x 25 x 51 | 1005 |
| TRO160V | 160 | 10 | 29.5 | 65 x 26 x 51 | 1070 |
| TRO160-VM** | 160 | 10 | 29 | 32 X 25 X 43 | 570 |
| TRO200V | 200 | 15 | 29.5 | 65 x 26 x 56 | 1300 |
| TRO200H | 200 | 15 | 29.5 | 65 x 26 x 56 | 1325 |
| TRO250H | 250 | 20 | 29.5 | 65 x 26 x 56 | 1350 |
| TRO300V | 300 | 20 | 29.5 | 65 x 26 x 56 | 1355 |
| TRO300H | 300 | 25 | 29.5 | 65 x 26 x 56 | 1430 |
| TRO400S | 380 | 25 | 28 | 83 x 35 x 64 | 1900 |
| TRO425H | 425 | 40 | 29.5 | 83 x 35 X 64 | 2250 |
| TRO500S | 500 | 40 | 28 | 83 x 35 x 64 | 2150 |
| TRO700S* | 700 | 50 | 26 | 80 X 63 X 58 | 3550 |
| TRO750H* | 750 | 50 | 29.5 | 80 X 63 X 58 | 3750 |
| TRO900S* | 900 | 60 | 26 | 80 X 63 X 58 | 3650 |
| TRO950H* | 950 | 60 | 29.5 | 80 X 63 X 58 | 4016 |
| TRO1000S* | 1000 | 75 | 26 | 80 X 63 X 58 | 3750 |
| TRO1000H* | 1050 | 100 | 29.5 | 80 X 63 X 58 | 4302 |

**VM = Mini Series
*PUMPS ARE V-belt driven.

### DynaSeal™ Standard Specifications:

≥ 15" Hg Vacuum; 60-120° F Ambient Temperatures; 180° F Inlet Gas Temperature Max; 180° F Discharge Gas/Oil Temperature; If conditions differ, consult factory for recommended design modifications.

- Explosion proof designs are available upon request.
- **Larger capacity systems are available upon request.**
- **DynaSeal™** systems are available in multiple pump configurations with a wide range of optional accessories.
- **DynaSeal™** systems can be customized per O.E.M. specification and for special applications.
- **DynaSeal™** systems are sold and serviced through a nation-wide distributor network.

BLOWERS EXHAUSTERS COMPRESSORS

ROOTS™

US $3.00, Canada $4.50

# UNIVERSAL RAI® & RAM™ SERIES

## CONTENTS



## DO THESE THINGS TO GET THE MOST FROM YOUR ROOTS™ BLOWER

- ❑ Check shipment for damage. If found, file claim with carrier and notify ROOTS.
- ❑ Unpack shipment carefully, and check contents against Packing List. Notify ROOTS if a shortage appears.
- ❑ Store in a clean, dry location until ready for installation. Lift by methods discussed under INSTALLATION to avoid straining or distorting the equipment. Keep covers on all openings. Protect against weather and corrosion if outdoor storage is necessary.
- ❑ Read OPERATING LIMITATIONS and INSTALLATION sections in this manual and plan the complete installation.
- ❑ Provide for adequate safeguards against accidents to persons working on or near the equipment during both installation and operation. See SAFETY PRECAUTIONS.
- ❑ Install all equipment correctly. Foundation design must be adequate and piping carefully done. Use recommended accessories for operating protection.
- ❑ Make sure both driving and driven equipment is correctly lubricated before start-up. See LUBRICATION.
- ❑ Read starting check points under OPERATION. Run equipment briefly to check for installation errors and make corrections. Follow with a trial run under normal operating conditions.
- ❑ In event of trouble during installation or operation, do not attempt repairs of ROOTS furnished equipment. Notify ROOTS, giving all nameplate information plus an outline of operating conditions and a description of the trouble. Unauthorized attempts at equipment repair may void ROOTS warranty.
- ❑ Units out of warranty may be repaired or adjusted by the owner. It is recommended that such work be limited to the operations described in this manual, using ROOTS™ parts. Good inspection and maintenance practices should reduce the need for repairs.

**NOTE**: Information in this manual is correct as of the date of publication. ROOTS reserves the right to make design or material changes without notice, and without obligation to make similar changes on equipment of prior manufacture.

For your nearest ROOTS Office, dial our Customer Service Hot Line toll free; 1 877 363 ROOT(S) (7668) or direct 281-966-4700.

DRESSER®
Roots

IRB-180-102
Rev. 12/02

**ROOTS™ products are sold subject to the current General terms of Sale, GTS-5001 and Warranty Policy WP-5020. Copies are available upon request.**
**Contact your local ROOTS Office or ROOTS Customer Service Hot Line 1.877.363.ROOT(S) (7668).**

## SAFETY PRECAUTIONS

It is important that all personnel observe safety precautions to minimize the chances of injury. Among many considerations, the following should be particularly noted:

- Blower casing and associated piping or accessories may become hot enough to cause major skin burns on contact.
- Internal and external rotating parts of the blower and driving equipment can produce serious physical injuries. Do not reach into any opening in the blower while it is operating, or while subject to accidental starting. Protect external moving parts with adequate guards.
- Disconnect power before doing any work, and avoid bypassing or rendering inoperative any safety or protective devices.
- If blower is operated with piping disconnected, place a strong coarse screen over the inlet and avoid standing in the discharge air stream. **CAUTION: Never cover the blower inlet with your hand or other part of body.**
- Stay clear of open inlet piping (suction area) of pressure blowers, and the open discharge blast from vacuum blowers.
- Stay clear of the blast from pressure relief valves and the suction area of vacuum relief valves.
- Use proper care and good procedures in handling, lifting, installing, operating and maintaining the equipment.
- Casing pressure must not exceed 25 PSI (1725 mbar) gauge. Do not pressurize vented cavities from an external source, nor restrict the vents without first consulting ROOTS.
- Do not use air blowers on explosive or hazardous gases.
- Other potential hazards to safety may also be associated with operation of this equipment. All personnel working in or passing through the area should be trained to exercise adequate general safety precautions.

## OPERATING LIMITATIONS

A ROOTS™ blower or exhauster must be operated within certain approved limiting conditions to enable continued satisfactory performance. Warranty is contingent on such operation.

Maximum limits for pressure, temperature and speed are specified in TABLE 1 for various models & sizes of blowers & exhausters. These limits apply to all units of normal construction, when operated under standard atmospheric conditions. Be sure to arrange connections or taps for thermometers and pressure or vacuum gauges at or near the inlet and discharge connections of the unit. These, along with a good tachometer, will enable periodic checks of operating conditions.

**PRESSURE** – The pressure rise, between inlet and discharge, must not exceed the figure listed for the specific unit frame size concerned. Also, in any system where the unit inlet is at a positive pressure above atmosphere a maximum case rating of 25 PSI gauge (1725 mbar) should not be exceeded without first consulting the ROOTS. Never should the maximum allowable differential pressure be exceeded.

On vacuum service, with the discharge to atmospheric pressure, the inlet suction or vacuum must not be greater than values listed for the specific frame size.

**TEMPERATURE** – Blower & exhauster frame sizes are approved only for installations where the following temperature limitations can be maintained in service:

- Measured temperature rise must not exceed listed values when the inlet is at ambient temperature. Ambient is considered as the general temperature of the space around the unit. This is not outdoor temperature unless the unit is installed outdoors.
- If inlet temperature is higher than ambient, the listed allowable temperature rise values must be **reduced** by 2/3 of the difference between the actual measured inlet temperature and the ambient temperature.
- The average of the inlet and discharge temperature must not exceed 250°F. (121°C).

**SPEED** – These blowers & exhausters may be operated at speeds up to the maximum listed for the various frame sizes. They may be direct coupled to suitable constant speed drivers if pressure/temperature conditions are also within limits. At low speeds, excessive temperature rise may be a limiting factor.

**Special Note:** The listed maximum allowable temperature rise for any particular blower & exhauster may occur well before its maximum pressure or vacuum rating is reached. This may occur at high altitude, low vacuum or at very low speed. The units' operating limit is always determined by the maximum rating reached first. It can be any one of the three: Pressure, Temperature or Speed.

# INSTALLATION

ROOTS™ blowers & exhausters are treated after factory assembly to protect against normal atmospheric corrosion. The maximum period of internal protection is considered to be one year under average conditions, if shipping plugs & seals are not removed. Protection against chemical or salt water atmosphere is not provided. Avoid opening the unit until ready to start installation, as corrosion protection will be quickly lost due to evaporation.

If there is to be an extended period between installation and start up, the following steps should be taken to ensure corrosion protection.

- ❑ Coat internals of cylinder, gearbox and drive end bearing reservoir with Nox-Rust VCI-10 or equivalent. Repeat once a year or as conditions may require. Nox-Rust VCI-10 is petroleum soluble and does not have to be removed before lubricating. It may be obtained from Daubert Chemical Co., 2000 Spring Rd., Oak Brook, Ill. 60521.
- ❑ Paint shaft extension, inlet and discharge flanges, and all other exposed surfaces with Nox-Rust X-110 or equivalent.
- ❑ Seal inlet, discharge, and vent openings. It is not recommended that the unit be set in place, piped to the system, and allowed to remain idle for extended periods. If any part is left open to the atmosphere, the Nox-Rust VCI-10 vapor will escape and lose its effectiveness.
- ❑ Protect units from excessive vibration during storage.
- ❑ Rotate shaft three or four revolutions every two weeks.
- ❑ Prior to start up, remove flange covers on both inlet and discharge and inspect internals to insure absence of rust. Check all internal clearances. Also, at this time, remove gearbox and drive end bearing cover and inspect gear teeth and bearings for rust.

Because of the completely enclosed unit design, location of the installation is generally not a critical matter. A clean, dry and protected indoor location is preferred. However, an outdoor location will normally give satisfactory service. Important requirements are that the correct grade of lubricating oil be provided for expected operating temperatures, and that the unit be located so that routine checking and servicing can be performed conveniently. Proper care in locating driver and accessory equipment must also be considered.

Supervision of the installation by a ROOTS Service Engineer is not usually required for these units. Workmen with experience in installing light to medium weight machinery should be able to produce satisfactory results. Handling of the equipment needs to be accomplished with care, and in compliance with safe practices. Unit mounting must be solid, without strain or twist, and air piping must be clean, accurately aligned and properly connected.

**Bare-shaft Units:** Two methods are used to handle a unit without base. One is to use lifting lugs bolted into the top of the unit headplates. Test them first for tightness and fractures by tapping with a hammer. In lifting, keep the direction of cable pull on these bolts as nearly vertical as possible. If lifting lugs are not available, lifting slings may be passed under the cylinder adjacent to the headplates. Either method prevents strain on the extended drive shaft.

**Packaged Units:** When the unit is furnished mounted on a baseplate, with or without a driver, use of lifting slings passing under the base flanges is required. Arrange these slings so that no strains are placed on the unit casing or mounting feet, or on any mounted accessory equipment. **DO NOT** use the lifting lugs in the top of the unit headplates.

Before starting the installation, remove plugs, covers or seals from unit inlet and discharge connections and inspect the interior completely for foreign material. If cleaning is required, finish by washing the cylinder, headplates and impeller thoroughly with a petroleum solvent. Turn the drive shaft by hand to make sure that the impellers turn freely at all points. Anti-rust compound on the connection flanges and drive shaft extension may also be removed at this time with the same solvent. Cover the flanges until ready to connect piping.

## Mounting

Care will pay dividends when arranging the unit mounting. This is especially true when the unit is a “bare-shaft” unit furnished without a baseplate. The convenient procedure may be to mount such a unit directly on a floor or small concrete pad, but this generally produces the least satisfactory results. It definitely causes the most problems in leveling and alignment and may result in a “Soft Foot” condition. Correct soft foot before operation to avoid unnecessary loading on the casing and bearings. Direct use of building structural framing members is not recommended.

For blowers without a base, it is recommended that a well anchored and carefully leveled steel or cast iron mounting plate be provided. The plate should be at

least 1 inch (25 mm) thick, with its top surface machined flat, and large enough to provide leveling areas at one side and one end after the unit is mounted. It should have properly sized studs or tapped holes located to match the unit foot drilling. Proper use of a high quality machinist's level is necessary for adequate installation.

With the mounting plate in place and leveled, set the unit on it without bolting and check for rocking. If it is not solid, determine the total thickness of shims required under one foot to stop rocking. Place half of this under each of the diagonally-opposite short feet, and tighten the mounting studs or screws. Rotate the drive shaft to make sure the impellers turn freely. If the unit is to be direct coupled to a driving motor, consider the height of the motor shaft and the necessity for it to be aligned very accurately with the unit shaft. Best unit arrangement is directly bolted to the mounting plate while the driver is on shims of at least 1/8 inch (3mm) thickness. This allows adjustment of motor position in final shaft alignment by varying the shim thickness.

## Aligning

When unit and driver are factory mounted on a common baseplate, the assembly will have been properly aligned and is to be treated as a unit for leveling purposes. Satisfactory installation can be obtained by setting the baseplate on a concrete slab that is rigid and free of vibration, and leveling the top of the base carefully in two directions so that it is free of twist. The slab must be provided with suitable anchor bolts. The use of grouting under and partly inside the leveled and shimmed base is recommended.

It is possible for a base-mounted assembly to become twisted during shipment, thus disturbing the original alignment. For this reason, make the following checks after the base has been leveled and bolted down. Disconnect the drive and rotate the unit shaft by hand. It should turn freely at all points. Loosen the unit foot hold-down screws and determine whether all feet are evenly in contact with the base. If not, insert shims as required and again check for free impeller rotation. Finally, if unit is direct coupled to the driver, check shaft and coupling alignment carefully and make any necessary corrections.

In planning the installation, and before setting the unit, consider how piping arrangements are dictated by the unit design and assembly. Drive shaft rotation must be established accordingly and is indicated by an arrow near the shaft.

Typical arrangement on vertical units has the drive shaft at the top with counterclockwise rotation and discharge to the left. Horizontal units are typically arranged with the drive shaft at the left with counterclockwise rotation and discharge down. See Figure 3 and 4 for other various unit arrangements and possible conversions.

When a unit is DIRECT COUPLED to its driver, the driver RPM must be selected or governed so as not to exceed the maximum speed rating of the unit. Refer to Table 1 for allowable speeds of various unit sizes. A flexible type coupling should always be used to connect the driver and unit shafts.

Coupling halves must be accurately aligned, and a sufficient gap between shaft ends provided so that side strains and end thrust on either shaft are avoided or minimized. This will require considerable care in the mounting of the driver. The two shafts must be in as near perfect alignment in all directions as possible, and the gap must be established with the motor armature on its electrical center if end-play exists.

The following requirements of a good installation are recommended. Coupling halves must be fitted to the two shafts with a line to line thru .001" interference fit. Coupling halves must be warmed up, so that only light tapping is required to install them. Maximum deviation in offset alignment of the shafts should not exceed .005" (.13 mm) total indicator reading, taken on the two coupling hubs. Maximum deviation from parallel of the inside coupling faces should not exceed .001" (.03 mm) when checked at six points around the coupling.

When a unit is BELT DRIVEN, the proper selection of sheave diameters will result in the required unit speed. This flexibility can lead to operating temperature problems caused by unit speed being too low. Make sure the drive speed selected is within the allowable range for the specific unit size, as specified under Table 1.

Belt drive arrangements usually employ two or more V-belts running in grooved sheaves. Installation of the driver is less critical than for direct coupling, but its shaft must be level and parallel with the unit shaft. **The driver should be mounted on the inlet side of a vertical unit (horizontal piping) and on the side nearest to the shaft on a horizontal unit.** The driver must also be mounted on an adjustable base to permit installing, adjusting and removing the V-belts. To position the driver correctly, both sheaves need to be mounted on their shafts and the nominal shaft center distance known for the belt lengths to be used.

Install the unit sheave so that its inner hub face is not more than 1/8 inch (3mm) from the drive end cover. See page 18 for minimum sheave diameter and maximum sheave width. The shaft fit should be such that the sheave can be worked into place by hand or by very light tapping. A tight or driving fit can damage a bearing, and may cause internal unit damage by forcing the impeller out of its normal operating position. A loose fit or wobbly sheave will cause vibration, and may result in shaft breakage.

**CAUTION:** Couplings as well as sheave bushings must have a slight slide fit with the unit shaft such that they can be installed in place by hand. Any force used to install them could change unit end clearance resulting in unit damage. If interference fit is desired for the coupling, the coupling hub should be heated and shrunk on the shaft. For engine drives, use "locktite" between the coupling hubs and the shafts and on the threads of the coupling set screws.

The driver sheave should also be mounted as close to its bearing as possible, and again should fit the shaft correctly. Position the driver on its adjustable base so that 2/3 of the total movement is available in the direction away from the unit, and mount the assembly so that the face of the sheave is accurately in line with the unit sheave. This position minimizes belt wear, and allows sufficient adjustment for both installing and tightening the belts. After belts are installed, adjust their tension in accordance with the manufacturer's instructions. However, only enough tension should be applied to prevent slippage when the unit is operating under load. Excessive tightening can lead to early bearing failures or shaft breakage.

Before operating the drive under power to check initial belt tension, first remove covers from the unit connections. Make sure the interior is still clean, then rotate the shaft by hand. Place a coarse screen over the inlet connection to prevent anything being drawn into the unit while it is operating, and avoid standing in line with the discharge opening. Put oil in the sumps per instructions under **LUBRICATION.**

## Piping

Before connecting piping, remove any remaining anti-rust compound from Unit connections. Clean pipe should be no smaller than unit connections. In addition, make sure it is free of scale, cuttings, weld beads, or foreign material of any kind. To further guard against damage to the unit, especially when an inlet filter is not used, install a substantial screen of 16 mesh backed with hardware cloth at or near the inlet connections. Make provisions to clean this screen of collected debris after a few hours of operation. It should be removed when its usefulness has ended, as the wire will eventually deteriorate and small pieces going into the unit may cause serious damage.

Pipe flanges or male threads must meet the unit connections accurately and squarely. DO NOT attempt to correct misalignment by springing or cramping the pipe. In most cases this will distort the unit casing and cause impeller rubbing. In severe cases it can prevent operation or result in a broken drive shaft. For similar reasons, piping should be supported near the unit to eliminate dead weight strains. Also, if pipe expansion is likely to occur from temperature change, installation of flexible connectors or expansion joints is advisable.

Figure 2 represents an installation with all accessory items that might be required under various operating conditions. Inlet piping should be completely free of valves or other restrictions. When a shut-off valve can not be avoided, make sure a full size vacuum relief is installed nearest the unit inlet. This will protect against unit overload caused by accidental closing of the shut-off valve.

Need for an inlet silencer will depend on unit speed and pressure, as well as sound-level requirements in the general surroundings. An inlet filter is recommended, especially in dusty or sandy locations. A discharge silencer is also normally suggested, even though Whispair units operate at generally lower noise levels than conventional rotary blowers. Specific recommendations on silencing can be obtained from ROOTS.

Discharge piping requires a pressure relief valve, and should include a manual unloading valve to permit starting the unit under no-load conditions. Reliable pressure/vacuum gauges and good thermometers at both inlet and discharge are recommended to allow making the important checks on unit operating conditions. The back-pressure regulator shown in Figure 2 is useful mainly when volume demands vary while the unit operates at constant output. If demand is constant, but somewhat lower than the unit output, excess may be blown off through the manual unloading valve.

In multiple unit installations where two or more units operate with a common header, use of check valves is mandatory. These should be of a direct acting or free swinging type, with one valve located in each line between the unit and header. Properly installed, they will protect against damage from reverse rotation caused by air and material back-flow through an idle unit.

After piping is completed, and before applying power, rotate the drive shaft by hand again. If it does not move with uniform freedom, look for uneven mounting, piping strain, excessive belt tension or coupling misalignment.

**DO NOT** operate the unit at this time unless it has been lubricated per instructions.

# LUBRICATION

**LUBRICATION: For Units with a Grease Lubricated Drive End**

A simple but very effective lubrication system is employed on the drive shaft end bearings. Hydraulic pressure relief fittings are provided to vent any excess grease, preventing pressure build-up on the seals. A restriction plug and metering orifice prevent loss of lubricant from initial surges in lubricant pressure but permit venting excess lubricant under steadily rising pressures.

When servicing drive end bearings, use a NLGI #2 premium grade grease with 300°F (149°C) service temperature and moisture resistance and good mechanical stability. Using a pressure gun, slowly force new lubricant into each drive end bearing housing until traces of clean grease comes out of the relief fitting.

After a long shutdown, it is recommended that the grease fittings be removed, the old grease flushed out with kerosene or #10 lubricating oil, drained thoroughly, and bearings refilled with new grease. Be sure grease relief fittings are reinstalled. Grease should be added using a hand operated grease gun to the drive end bearings at varying time intervals depending on duty cycle and RPM. Table 4 has been prepared as a general greasing schedule guide based on average operating conditions. More frequent intervals may be necessary depending on the grease operating temperature and unusual circumstances. ROOTS™ synthetic grease (ROOTS P/N T20019-) is highly recommended.

**LUBRICATION: For Units with Splash Lubrication on Both Ends**

Bearings and oil seals are lubricated by the action of the timing gears or oil slingers which dip into the main oil sumps causing oil to splash directly on gears and into bearings and seals. A drain port is provided below each bearing to prevent an excessive amount of oil in the bearings. Seals located inboard of the bearings in each headplate effectively retain oil within the sumps. Any small leakage that may occur should the seals wear passes into a cavity in each vented headplate and is drained downward.

Oil sumps on each end of the blower are filled by removing top vent plugs, Item (21), and filling until oil reaches the middle of the oil level sight gauge, Item (37), or the overflow plug.

Initial filling of the sumps should be accomplished with the blower not operating, in order to obtain the correct oil level. Approximate oil quantities required for blowers of the various models and configurations are listed in Table 3. Use a good grade of industrial type non-detergent, rust inhibiting, anti-foaming oil and of correct viscosity per Table 2. ROOTS™ synthetic oil (ROOTS P/N 813-106-) is highly recommended.

The oil level should not fall below the middle of the site gauge when the blower is idle. It may rise on the gauge during operation, to an extent depending somewhat on oil temperature and blower speed.

Proper lubrication is usually the most important single consideration in obtaining maximum service life and satisfactory operation from the unit. Unless operating conditions are quite severe, a weekly check of oil level and necessary addition of lubricant should be sufficient. During the first week of operation, check the oil levels in the oil sumps about once a day, and watch for leaks. Replenish as necessary. Thereafter, an occasional check should be sufficient. It is recommended that the oil be changed after initial 100 hours of operation. Frequent oil changing is not necessary unless the blower is operated in a very dusty location. Normal life expectancy of petroleum based oils is about 2000 hours with an oil temperature of about 200°F (93°C). As the oil temperature increases by increments of 15-18°F (8°C - 10°C), the life is reduced by half. Example: Oil temperatures of 230-236°F (110°C - 113°C) will produce life expectancy of 1/4 or 500 hours. Therefore, it is considered normal to have oil change periods of 500 hours with petroleum based oils.

# OPERATION

Before operating a blower under power for the first time, recheck the unit and the installation thoroughly to reduce the likelihood of avoidable troubles. Use the following procedure check list as a guide, but consider any other special conditions in the installation.

- ❑ Be certain that no bolts, tools, rags, or debris have been left in the blower air chamber or piping.
- ❑ If an outdoor intake without filter is used, be sure the opening is located so it cannot pick up dirt and is protected by a strong screen or grille. Use of the temporary protective screen as described under INSTALLATION is strongly recommended.
- ❑ Recheck blower leveling, drive alignment and tightness of all mounting bolts if installation is not recent. If belt drive is used, adjust belt tension correctly.
- ❑ Turn drive shaft by hand to make sure impellers still rotate without bumping or rubbing at any point.
- ❑ Make sure oil levels in the main oil sumps are correct.
- ❑ Check lubrication of driver. If it is an electric motor, be sure that power is available and that electrical overload devices are installed and workable.
- ❑ Open the manual unloading valve in the discharge air line. If a valve is in the inlet piping, be sure it is open.
- ❑ Bump blower a few revolutions with driver to check that direction of rotation agrees with arrow near blower shaft, and that both coast freely to a stop.

After the preceding points are cleared, blower is ready for trial operation under “no-load” conditions. The following procedure is suggested to cover this initial operation test period.

a. Start blower, let it accelerate to full speed, then shut off. Listen for knocking sounds, both with power on and as speed slows down.

b. Repeat above, but let blower run 2 or 3 minutes. Check for noises, such as knocking sounds.

c. Operate blower for about 10 minutes unloaded. Check oil levels. Observe cylinder and headplate surfaces for development of hot spots such as burned paint, indicating impeller rubs. Be aware of any noticeable increase in vibration.

Assuming that all trials have been satisfactory, or that necessary corrections have been made, the blower should now have a final check run of at least one hour under normal operating conditions. After blower is restarted, gradually close the discharge unloading valve to apply working pressure. At this point it is recommended that a good pressure gauge or manometer be connected into the discharge line if not already provided, and that thermometers be in both inlet and discharge lines. Readings from these instruments will show whether pressure or temperature ratings of the blower are being exceeded.

During the final run, check operating conditions frequently and observe the oil levels at reasonable intervals. If excessive noise or local heating develops, shut down immediately and determine the cause. If either pressure rise or temperature rise across the blower exceeds the limit specified in this manual, shut down and investigate conditions in the piping system. Refer to the **TROUBLESHOOTING CHECKLIST** for suggestions on various problems that may appear.

The blower should now be ready for continuous duty operation at full load. During the first few days make periodic checks to determine whether all conditions remain steady, or at least acceptable. This may be particularly important if the blower is supplying air to a process system where conditions can vary. At the first opportunity, stop the blower and clean the temporary inlet protective screen. If no appreciable amount of debris has collected, the screen may be removed. See comments under **INSTALLATION**. At this same time, verify leveling, coupling alignment or belt tension, and mounting bolt tightness.

Should operating experience prove that blower capacity is a little too high for the actual air requirements, a small excess may be blown off continuously through the manual unloading or vent valve. Never rely on the pressure relief valve as an automatic vent. Such use may cause the discharge pressure to become excessive, and can also result in failure of the valve itself. If blower capacity appears to be too low, refer to the **TROUBLESHOOTING CHECKLIST**.

## Vibration Assessment Criteria

With measurements taken at the bearing locations on the housings, see chart below for an appropriate assessment guide for rotary lobe blowers rigidly mounted on stiff foundations.

In general, blower vibration levels should be monitored on a regular basis and the vibration trend observed for progressive or sudden change in level. If such a change occurs, the cause should be determined through spectral analysis.

As shown on the chart below, the level of all pass vibration will determine the need to measure discrete frequency vibration levels and the action required.

| All Pass Vibration (in/sec) | Discrete Frequency Vibration (in/sec) | Action |
|---|---|---|
| 0.45 or less | N/R | Approved |
| Greater than 0.45 but 1.0 or less | 0.45 or less @ any frequency | Approved |
| | Greater than 0.45 @ any frequency | ROOTS™ Approval Required |
| Greater than 1.0 | Less than 1.0 | ROOTS™ Approval Required |
| | Greater than 1.0 | ROOTS™ Approval Required |

## OPERATING CHARACTERISTICS

ROOTS™ rotary blowers and exhausters, as covered in this manual, are available in basic frame sizes ranging from 2 inch to 7 inch gear diameter. Various models, within this gear diameter range, are available with different case lengths to produce reasonable steps in flow capacity. The shorter case lengths have lower volumetric capacities, but are capable of operating against higher pressures. All models are available for air service and there are specifically designed models for gas service.

The basic ROOTS™ rotary lobe blower is a positive displacement type unit. Flow capacity is determined by frame size, operating speed and pressure conditions. It employs two impellers mounted on parallel shafts rotating in opposite directions within a cylinder closed at the ends by head-plates. As the impellers rotate, gas is drawn into one side of the cylinder and forced out the opposite side. The pressure or vacuum developed depends on the resistance of the piping and process system.

The unit is a precision engineered product with very fine clearances between the rotating impellers and stationary case. Since there is no actual contact between these surfaces, internal lubrication is not required. Clearances are maintained by a pair of accurately machined timing gears, mounted on the two shafts extended outside the blower casing.

Operation of the familiar basic rotary lobe blower is illustrated in FIGURE 1, where air flow is left to right from inlet to discharge with the top impeller rotating clockwise. In Position 1 it is delivering a known volume (B) to the discharge, while space (A) between the lower impeller and cylinder wall is being filled. Counterclockwise rotation of this impeller then traps equal volume (A) in Position 2, and further rotation delivers it to the discharge in Position 3.

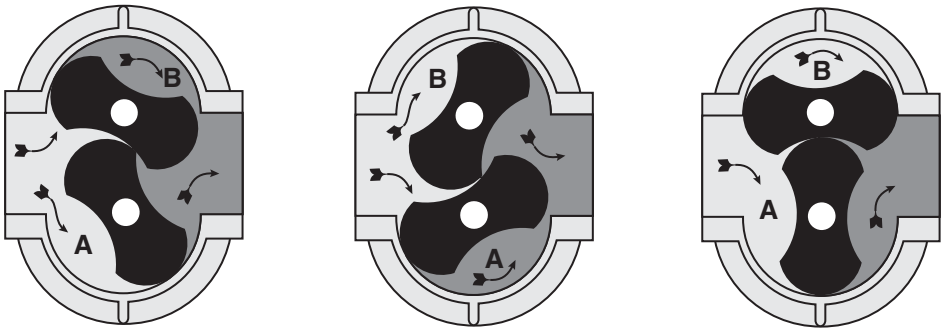
One complete revolution of the driving shaft alternately traps four fixed and equal volumes of air (two by each impeller) and pushes them through to the discharge. The volume capacity of a lobe blower operating at a constant speed therefore remains relatively independent of reasonable inlet of discharge pressure variations. To change capacity, it is necessary either to change speed of rotation or blow off some of the discharge air.

No attempt should ever be made to control capacity by means of a throttle valve in the intake or discharge piping. This will not only increase the power load on the driver, but can also overload and seriously damage the blower. If a possibility does exist that flow to the blower inlet may be cut off during normal operation of a process, then an adequate vacuum relief valve must be installed near the blower. A pressure type relief valve in the discharge line near the blower is required for protection against cut-off or blocking in this line. Refer to FIGURE 3 for a complete piping schematic.

When a belt drive is installed, blower speed can usually be adjusted to obtain desired capacity by changing the diameter of one or both sheaves. In a direct coupled arrangement a variable speed motor or transmission is required, or excess air may be blown off through a manually controlled unloading valve and silencer. If returned to the blower inlet, the air must be cooled to 100°F (38°C) through a by-pass arrangement to maintain acceptable blower temperatures.

Before making any change in blower capacity, or operating conditions, contact ROOTS for specific information applying to your particular blower. In all cases, operating conditions must be maintained within the approved range of pressures, temperatures and speeds as stated under **LIMITATIONS.** The air blower must not be used to handle liquids or solids as serious damage to the rotating parts may result.

### FIGURE 1 – FLOW THROUGH A BASIC ROTARY LOBE BLOWER




**POSITION 1** **POSITION 2** **POSITION 3**

## TROUBLESHOOTING

| Trouble | Item | Possible Cause | Remedy |
|---|---|---|---|
| No flow | 1 | Speed too low | Check by tachometer and compare with published performance |
| | 2 | Wrong rotation | Compare actual rotation with Figure 1 or 2<br>Change driver if wrong |
| | 3 | Obstruction in piping | Check piping, valves, silencer to assure open flow path |
| Low capacity | 4 | Speed too low | See item 1, If belt drive, check for slippage and readjust tension |
| | 5 | Excessive pressure rise | Check inlet vacuum and discharge pressure and compare with Published performance |
| | 6 | Obstruction in piping | See item 3 |
| | 7 | Excessive slip | Check inside of casing for worn or eroded surfaces causing excessive clearances |
| Excessive power | 8 | Speed too high | Check speed and compare with published performance |
| | 9 | Excessive pressure rise | See Item 5 |
| | 10 | Impeller rubbing | Inspect outside of cylinder for high temperature areas, then check for impeller contact at these points. Correct blower mounting, drive alignment |
| | 11 | Scale, sludge, rust or product build up | Clean blower appropriately |
| Overheating of | 12 | Inadequate lubrication | Check oil sump levels in gear and drive end headplates |
| bearing or gears | 13 | Excessive lubrication | Check oil levels. If correct, drain and refill with clean oil of recommended grade |
| | 14 | Excessive pressure rise | See Item 5 |
| | 15 | Coupling misalignment | Check carefully. Realign if questionable |
| | 16 | Excessive belt tension | Readjust for correct tension |
| Vibration | 17 | Misalignment | See Item 15 |
| | 18 | Impellers rubbing | See Item 10 |
| | 19 | Worn bearings/gears | Check gear backlash and condition of bearings, and replace as indicated |
| | 20 | Unbalanced or rubbing impeller | Scale or process material may build up on casing and impellers, or inside impellers. Remove build-up to restore original clearances and impeller balance |
| | 21 | Driver or blower loose | Tighten mounting bolts securely |
| | 22 | Piping resonances | Determine whether standing wave pressure pulsations are present in the piping |
| | 23 | Scale/sludge build-ups | Clean out interior of impeller lobes to restore dynamic balance |
| | 24 | Casing strain | re-work piping alignment to remove excess strain |
| Driver stops, or will not start | 25 | Impeller stuck | Check for excessive hot spot on headplate or cylinder. See item 10. Look for defective shaft bearing and/or gear teeth |
| | 26 | Scale, sludge, rust or product build-up | Clean blower appropriately |
| Excessive breather | 27 | Broken seal | Replace seals |
| Blow-by or excessive oil leakage to vent area | 28 | Defective O-ring | Replace seals and O-ring |

# MAINTENANCE & REPLACEMENTS: UNIVERSAL RAI® SERIES BLOWERS

A good program of consistent inspection and maintenance is the most reliable method of minimizing repairs to a blower. A simple record of services and dates will help keep this work on a regular schedule. Basic service needs are:

- Lubrication
- Checking for hot spots
- Checking for increases or changes in vibration and noise
- Recording of operating pressures and temperatures

Above all, a blower must be operated within its specified rating limits, to obtain satisfactory service life.

A newly installed blower should be checked often during the first month of full-time operation. Attention thereafter may be less frequent assuming satisfactory performance. Lubrication is normally the most important consideration and weekly checks of lubricant levels in the gearbox and bearing reservoirs should be customary. Complete oil change schedules are discussed under **LUBRICATION**.

Driver lubrication practices should be in accordance with the manufacturer's instructions. If direct connected to the blower through a lubricated type coupling, the coupling should be checked and greased each time blower oil is changed. This will help reduce wear and prevent unnecessary vibration. In a belted drive system, check belt tension periodically and inspect for frayed or cracked belts.

In a new, and properly installed, unit there is no contact between the two impellers, or between the impellers and cylinder or headplates. Wear is confined to the bearings (which support and locate the shafts) the oil seals, and the timing gears. All are lubricated and wear should be minimal if clean oil of the correct grade is always used. Seals are subject to deterioration as well as wear, and may require replacement at varying periods.

Shaft bearings are designed for optimum life under average conditions with proper lubrication and are critical to the service life of the blower. Gradual bearing wear may allow a shaft position to change slightly, until rubbing develops between impeller and casing. This will cause spot heating, which can be detected by observing these surfaces. Sudden bearing failure is usually more serious. Since the shaft and impeller are no longer supported and properly located, extensive general damage to the blower casing and gears is likely to occur.

Oil seals should be considered expendable items, to be replaced whenever drainage from the headplate vent cavity becomes excessive or when the blower is disassembled for any reason. Sealing effectiveness can vary considerably from seal to seal and is also affected to surprising degree by shaft finish under the seal lip. Because of these normal variables, minor seal leakage should not be considered as indicating seal replacement.

Timing gear wear, when correct lubrication is maintained, should be negligible over a period of years. Gear teeth are cut to provide the correct amount of backlash, and gears correctly mounted on the shafts will accommodate a normal amount of tooth wear without permitting contact between lobes of the two impellers. However, too high an oil level will cause churning and excessive heating. This is indicated by unusually high temperature at the bottom of the gear housing. Consequent heating of the gears will result in loss of tooth-clearance , backlash and rapid wear of the gear teeth usually will develop. Continuation of this tooth wear will eventually produce impeller contacts (knocking), and from this point serious damage will be unavoidable if blower operation is continued. A similar situation can be produced suddenly by gear tooth fracture, which is usually brought on by sustained overloading or momentary shock loads.

Problems may also develop from causes other than internal parts failure. Operating clearances within a blower are only a few thousandths of an inch. This makes it possible for impeller interference or casing rubs to result from shifts in the blower mounting, or from changes in piping support. If this type of trouble is experienced, and the blower is found to be clean, try removing mounting strains. Loosen blower mounting bolts and reset the leveling and drive alignment. Then tighten mounting again, and make sure that all piping meets blower connections accurately and squarely Foreign materials in the blower will also cause trouble, which can only be cured by disconnecting the piping and thoroughly cleaning the blower interior.

A wide range of causes & solutions for operating troubles are covered in the **TROUBLE SHOOTING CHECKLIST**. The remedies suggested should be performed by qualified mechanics with a good background, using procedures detailed in this manual. Major repairs generally are to be considered beyond the scope of maintenance, and should be referred to ROOTS.

Warranty failures should not be repaired at all, unless specific approval has been obtained through ROOTS before starting work. Unauthorized disassembly within the warranty period will void the warranty.

It is recommended that major repairs be performed at an authorized ROOTS facility. However, it is recognized that this may not always be practical. If a blower is out of warranty, mechanical adjustments and parts replacement may be undertaken locally at the owner's option and risk. It is recommended that ROOTS™ parts be used to insure fit and suitability. The maintenance of a small stock of on-hand spare parts can eliminate possible delays. When ordering parts give item numbers and their word descriptions from the appropriate sectional drawings. Also specify quantities required and the blower model and serial number from the nameplate.

Repairs or adjustments are best performed by personnel with good mechanical experience and the ability to follow the instructions in this manual. Some operations involve extra care, patience, and a degree of precision work. This is especially true in timing impellers and in handling bearings. Experience indicates that high percentages of bearing failures are caused by dirt contamination before or during assembly. Therefore, the work area should be cleaned before starting disassembly, and new or re-usable parts protected during progress of the work.

In the following repair procedures, numbers shown in brackets ( ) correspond to the item numbers used in sectional drawings. It is recommended that the procedures be studied carefully and completely, with frequent reference to the drawings, before starting work. This will produce better efficiency through an understanding of what work is to be done, and the order of doing it. Before disassembly, mark all parts so that they may be returned to original locations or relative positions.

Requirements for special tools will depend on the work to be done. If impeller clearances and float are to be checked or re-set, a dial indicator and a set of long feeler gauges will be needed. Work involving removal of the timing gears cannot be accomplished without a suitable puller.

Design of ROOTS™ blower is simple, and most repair operations are straightforward. For this reason, the following procedures are intended mainly to indicate a preferred work order and to call out points to be observed. Where special operations are required, detailed coverage is given.

### A – Replacing Timing Gears

1. Drain all oil from the gearhouse by removing drain plug (21) in the bottom. Remove gearhouse by taking out all cap screws (23) in its flange. It may be necessary to bump the sides with a wood block or mallet to break the flange joint.
2. Reach through one of the blower pipe connections and place a chalk mark on the strip of one impeller and the mating waist of the other, so that they may easily be returned to their original relative positions.
3. **GEAR REMOVAL:** CAUTION: Do not remove gear nuts (17) completely before the gears are unseated from the taper fits or damage/injury may result. For this operation, the impellers should be wedged, as shown in Table 5. Back off gear clamping nuts (17) about 1/4". Use a suitable puller or wedge. As the puller set screw is torqued, the puller will have a tendency to turn and contact teeth of the other gear. To prevent this contact, hold the puller corner nut with a wrench while torquing the set screw. Once the gear is unseated, remove the puller. Remove gear nuts (17) and the gear.
4. **GEAR INSTALLATION:** Place impellers in correct position as previously marked. Be sure shafts and gear bores are clean, oil free and free of scratches. Clean the shaft tapered fits. Place hardwood wedges as shown in Table 5. Install drive gear (4) and gear nut (17). Tighten the drive gear nut to the torque given below. Blower assembly must be fastened down for torquing operation.
5. Installing driven gear (4) – Insert a long, metal feeler gauge between the impellers' lobes at the fronts or backs as shown below. Feeler gauge thickness to be a middle value from Table 5 for fronts and backs. Install nut (17). Tighten lightly with a small wrench, then check front and back clearances against Table 5 for each 45° position. Both fronts and backs should be about the same and within the specified range in Table 5. Adjust gear position, if necessary, then insert the corrected feeler gauge and wedges and use a torque wrench to tighten the gear nut to the torque specified in below. Remove wedges and rotate the drive shaft by hand to make sure there are no gear tight spots or impeller contacts. **CAUTION**! *Keep fingers away from impellers and gears.*

## UNIVERAL RAI® SERIES BLOWER GEAR NUT TORQUE

| Frame Size | Torque | |
|---|---|---|
| | lb.-ft. | (kg-m) |
| 22, 24, | 60 | (8.3) |
| 32, 33, 36 | 110 | (15.2) |
| 42, 45, 47 | 190 | (26.3) |
| 53, 56, 59 | 250 | (34.6) |
| 65, 68, 615 | 400 | (55.3) |
| 76, 711, 718 | 550 | (76.1) |

6. Check the end clearances between impellers and headplates. Adjust clearances per B-15 below.

7. When clearances are correct, clean and re-install the gearhouse. Check condition of flange gasket (7) and replace if questionable. Fill gearhouse to correct level with proper grade oil.

**B – Replacing Shaft Bearings and Impellers**

Remove coupling or sheave from the drive shaft. Drain and remove gearhouse, and pull the timing gears. If gears are to be re-used, mark them so they may be returned to the same shafts.

1. Break corners and deburr the keyway. Remove bearing end cover at the drive end. Remove bearing clamp plates (34).

2. Make single and double identifying punch marks on the mating edges of headplate and cylinder flanges at the two ends of the blower.

3. At the drive end, drive out the two dowel pins and remove all capscrews holding headplate to cylinder. By inserting jacking screws into the two threaded flange holed, and turning them in evenly, the headplate will be separated from the cylinder. As the headplate comes off the shafts it will bring bearings with it. 2-1/2" and 3-1/2" gear diameter units do not have tapped holes for jack screws in the drive end headplates. Remove dowel pins and all capscrews holding headplate to cylinder and foot on the drive end. Support unit under gear end cylinder flange with the shafts vertical. Using soft metal block against gear end shafts, push them out of gear end headplate.

4. For 2-1/2" and 3-1/2" gear diameter units, support the drive end headplate on the underside, and using soft metal block against drive end shafts, push them out of drive end headplate.

   For 4", 6" & 7" gear diameter units, from the gear end, using a wood or soft metal block against the ends of the shafts, drive them out of the head plate. If they are to be reused, protect them from damage in this operation.

5. If blower interior surfaces need cleaning, it may be advisable to separate the gear end headplate from the cylinder. Use the same general procedure as employed at the drive end.

6. Working from the back (flat) face of each head plate, push or tap out the bearings and seals. Use a round bar or tube that will pass through the shaft clearance holes in the headplates. All lip seals will be damaged during removal and must be replaced.

7. Clean bearing and seal pockets in headplates and remove burrs or rough edges. (Apply a thin coating of sealant on seal O.D.) Press new seals (27) into gear end headplate using a round tube or bar with recessed end that will bear on the outer metal edge of seal enclosure. Seal lip should point toward the driving tool. Seals to be flush without board bore face. Apply a light coat of oil or grease to the seal lips. In a similar fashion, install lip seals into the drive end headplate.

8. Place cylinder on a flat surface. Assemble gear end headplate to cylinder after checking flange punch marks. Drive in the two locating dowel pins before tightening flange screws. Also install gear end foot using the same longer cap screws (32) and washers (41). (On 6" & 7" UNIVERSAL RAI® blower install both gear end feet.)

9. Place the assembly horizontally on steel blocks with gear end headplate on bottom. The height of the blocks should be sufficient to clear gear end shaft extensions. Assemble impellers into the cylinder with the drive shaft (longer shaft) in same location as in original assembly. Before starting the shafts through the headplate holes, make sure shaft ends have no sharp or rough edges to damage seal lips. Position impellers at 90° to each other in the cylinder, using lobe-and-waist match marks if original impellers are being re-installed. Install drive end headplate and feet in same manner as gear end.

10. It is recommended that new bearings be used for rebuild. Apply thin film of machine oil on the shaft bearing fit, bearing I.D., and headplate bearing bore. Install drive end bearings into headplate. Use a tube with flanged end that will contact both bearing faces simultaneously. Refer to Assembly Drawing for proper bearing depths.
    **NOTE:** *Cylindrical drive bearing should be installed with inner race large shoulder facing outboard.*

11. Place blower on its feet on a flat surface. Loosen feet capscrews (32) and square up unit. Re-tighten capscrews (32). Clamp unit down to a solid base for further assembly.

12. Oil the gear end bearing fits as described previously. Install 2-1/2" thru 5" blower gear end bearings flush with the headplate bearing shoulders using proper drivers. On 6" & 7" gear diameter units, install thrust washer (29) in bearing bores then install gear end bearings so they protrude 1/16" (1.6mm) above headplate surface.

13. Install bearing clamp plates (34). On 6" & 7" gear diameter units, blower impeller end clearances are also to be set during this step. Install clamp plates (34) with capscrews (31) making sure that the gap between the clamp plates and the headplate is even all around. At the same time, set end clearances per Table 5.

14. Install gears and time impellers as in (A).

15. For setting end clearances on 2-1/2" thru 5" gear diameter units, special tools, thrust adjuster fork and thrust adjuster saddle are required. Refer to Table 5 for installation of tools. The flat side of the saddle rests against the bearing inner race and the flat side of the fork rests against the back side of the gear. Install a shim, with thickness equal to gear end clearance (Table 5), between the impeller and the gear end headplates. Tap on top of the fork until the shim becomes snug. Remove the shim and check end clearances. To increase gear end clearance, tap on the end of the gear end shaft with a soft metal mallet. Set end clearances for 6" & 7" by turning capscrews (31) evenly in or out.

16. Install drive end cover (5) after packing bearing cavities with suitable grease. Replace drive shaft seal. Lip must point toward (33) the bearing. Exercise care not to damage the lip as it passes over shaft keyway.

17. Install gasket item (7). Install the gear house after cleaning out the inside. Tighten gear box cap screws (23) evenly. Fill with correct grade of oil until oil flows out through oil level hole. Grease drive and bearings. (See Lubrication.)

18. Reinstall coupling or belt sheave making sure that they have a slight slide fit with the shaft and could be installed by hand.

# TECHNICAL SUPPLEMENT

**for 32, 33, 36, 42, 45, 47, 53, 56, 59, 65, 68, 615**
**UNIVERAL RAI®-G BLOWERS**

ROOTS™ Universal RAI™-G rotary positive gas blowers are a design extension of the basic Universal RAI™ blower model. URAI™-G blower uses (4) mechanical seals in place of the standard in board lip seals to minimize gas leakage into the atmosphere. The seal vent chambers are plugged. These units are intended for gases which are compatible with cast iron case material, steel shafts, 300/400 series stainless steel and carbon seal components, viton o-rings and the oil/grease lubricants. If there are any questions regarding application or operation of this gas blower, please contact factory.

**Precaution:** ***URAI™-G blowers: Care must be used when opening the head plate seal vent chamber plugs ( 43) as some gas will escape–if it is a pressure system, or the atmospheric air will leak in-if the system is under vacuum. There is a possibility of some gas leakage through the mechanical seals. This leakage on the gear end will escape through the gear box vent, and on the drive end, through the grease release fittings. If the gas leakage is undesirable, each seal chamber must be purged with an inert gas through one purge gas hole (43 ) per seal . There are two plugged purge gas holes(1/8 NPT) provided per seal. The purge gas pressure must be maintained one psi above the discharge gas pressure. Also, there exists a possibility of gear end oil and drive end grease leakage into the gas stream.***

The lubricants selected must be compatible with the gas. Mechanical Seal Replacement: Disassemble the blower. During disassembly, damage to mechanical seals is very likely. During rebuild, always use new mechanical seals. Prior to any assembly, make sure that all parts are completely clean and free from nicks and scratches.

(1) Place head plate on an assembly table with seal bores pointing up. Coat the OD of the stationary seal element and install it with carbon facing up in the seal bore with a seal driver that is guided by the bearing bore. Drive the seal flush with front face of the seal bore. Repeat this procedure for all four seals. Apply a light coating of lubricating oil on the sealing surface. Protect sealing faces during assembly from any damage.

(2) Apply teflon based sealant on the cylinder flanges before installing head plates. Continue the assembly procedure as outlined up to bearing installation. Before installation of the bearings, the seal mating rings need to be installed. Apply light film of lubricating oil on mating ring o-rings and sealing faces. Slide mating rings on the shaft and up to carbon faces making sure that no damage to the o-rings occur during installation (break sharp shaft corners to avoid damage to the o-rings during initial preparation). Install bearings all the way against the back bearing bore shoulders.

(3) Complete the rest of the assembly.Make sure all plugged holes are sealed with teflon thread liquid sealant.

**Note:** On 6" gear diameter units, shims (44) are used between the bearing clamp plates and the head plate on the gear end.

Also, on size 32 and 42, washers with embedded o-rings are used on the center head plate to cylinder bolts.

***After the assembly is completed, plug the blower inlet and discharge connections and run static soap bubble. Leak test to assure leak free assembly.***

For satisfactory operation of mechanical seals, synthetic lubricants are recommended (Check suitability to gases before using.)

**Oils:**
(1) ROOTS™ GT Synthetic Lubricant ROOTS P/N 13-106-001 (1) one quart ISO-220

(2) Mobil SHC 600 Series Lubricating Oils

**Grease:**
ROOTS™ Synthetic Grease – NLGI # 2
ROOTS P/N T20-019-001 (1) one 14 oz tube

# MAINTENANCE & REPLACEMENTS: RAM™ SERIES BLOWERS

A good program of consistent inspection and maintenance is the most reliable method of minimizing repairs to a blower. A simple record of services and dates will help keep this work on a regular schedule. Basic service needs are:

- Lubrication
- Checking for hot spots
- Checking for increases or changes in vibration and noise
- Recording of operating pressures and temperatures

Above all, a blower must be operated within its specified rating limits, to obtain satisfactory service life.

A newly installed blower should be checked often during the first month of full-time operation. Attention thereafter may be less frequent assuming satisfactory performance. Lubrication is normally the most important consideration and weekly checks of lubricant levels in the gearbox and bearing reservoirs should be customary. Complete oil change schedules are discussed under **LUBRICATION**.

Driver lubrication practices should be in accordance with the manufacturer's instructions. If direct connected to the blower through a lubricated type coupling, the coupling should be checked and greased each time blower oil is changed. This will help reduce wear and prevent unnecessary vibration. In a belted drive system, check belt tension periodically and inspect for frayed or cracked belts.

In a new, and properly installed, unit there is no contact between the two impellers, or between the impellers and cylinder or headplates. Wear is confined to the bearings (which support and locate the shafts) the oil seals, and the timing gears. All are lubricated and wear should be minimal if clean oil of the correct grade is always used. Seals are subject to deterioration and wear, and may require replacement at varying periods.

Piston ring seals (28) are designed to operate without rubbing contact, once temperature and thermal growth have stabilized. The stationary rings will rub the rotating sleeve (38) briefly as a result of temperature cycles that occur during the startup and shutdown of the unit. The sleeves are hardened and the rings are coated with dry lubricant that provides for temporary break in wear. Replace piston ring seals if they become excessively worn or inspection shows more than .010" (.25mm) axial clearance between ring and groove.

Shaft bearings are designed for optimum life under average conditions with proper lubrication and are critical to the service life of the blower. Gradual bearing wear may allow a shaft position to change slightly, until rubbing develops between impeller and casing. This will cause spot heating, which can be detected by observing these surfaces. Sudden bearing failure is usually more serious. Since the shaft and impeller are no longer supported and properly located, extensive general damage to the blower casing and gears is likely to occur.

Oil seals should be considered expendable items, to be replaced whenever drainage from the headplate vent cavity becomes excessive or when the blower is disassembled for any reason. Sealing effectiveness can vary considerably from seal to seal and is also affected to surprising degree by shaft finish under the seal lip. Because of these normal variables, minor seal leakage should not be considered as indicating seal replacement.

Timing gear wear, when correct lubrication is maintained, should be negligible over a period of years. Gear teeth are cut to provide the correct amount of backlash, and gears correctly mounted on the shafts will accommodate a normal amount of tooth wear without permitting contact between lobes of the two impellers. However, too high an oil level will cause churning and excessive heating. This is indicated by unusually high temperature at the bottom of the gear housing. Consequent heating of the gears will result in loss of tooth-clearance , backlash and rapid wear of the gear teeth usually will develop. Continuation of this tooth wear will eventually produce impeller contacts (knocking), and from this point serious damage will be unavoidable if blower operation is continued. A similar situation can be produced suddenly by gear tooth fracture, which is usually brought on by sustained overloading or momentary shock loads.

Problems may also develop from causes other than internal parts failure. Operating clearances within a blower are only a few thousandths of an inch. This makes it possible for impeller interferences or casing rubs to result from shifts in the blower mounting, or from changes in piping support. If this type of trouble is experienced, and the blower is found to be clean, try removing mounting strains. Loosen blower mounting bolts and reset the leveling and drive alignment. Then tighten mounting again, and make sure that all piping meets blower connections accurately and squarely Foreign materials sucked into the blower will also cause trouble, which can only be cured by disconnecting the piping and thoroughly cleaning the blower interior.

A wide range of causes & solutions for operating troubles are covered in the **TROUBLE SHOOTING CHECKLIST**. The remedies suggested should be performed by qualified mechanics with a good background, using procedures detailed in this manual. Major repairs generally are to be considered beyond the scope of maintenance, and should be referred to ROOTS.

Warranty failures should not be repaired at all, unless specific approval has been obtained through a Sales Office or the factory before starting work. Unauthorized disassembly within the warranty period will void the warranty.

It is recommended that major repairs be performed at an authorized ROOTS facility. However, it is recognized that this may not always be practical. If a blower is out of warranty, mechanical adjustments and parts replacement may be undertaken locally at the owner's option and risk. It is recommended that ROOTS™ parts be used to insure fit and suitability. The maintenance of a small stock of on-hand spare parts can eliminate possible delays. When ordering parts give Item numbers and their word descriptions from sectional drawings and parts lists. Also specify quantities wanted and the blower size and serial number from the nameplate.

Repairs or adjustments are best performed by personnel with good mechanical experience and the ability to follow the instructions in this manual. Some operations involve extra care, patience, and a degree of precision work. This is especially true in timing impellers and in handling bearings. Experience indicates that high percentages of bearing failures are caused by dirt contamination before or during assembly. Therefore, the work area should be cleaned before starting disassembly, and new or re-usable parts protected during progress of the work.

In the following repair procedures, numbers shown in brackets ( ) correspond to the Item numbers used in assembly drawings, and parts lists. It is recommended that the procedures be studied carefully and completely, with frequent reference to the drawings, before starting work. This will produce better efficiency through an understanding of what work is to be done, and the order of doing it. Before disassembly, mark all parts so that they may be returned to original locations or relative positions.

Requirements for special tools will depend on the work to be done. If impeller clearances and float are to be checked or re-set, a dial indicator and a set of long feeler gauges will be needed. Work involving removal of the timing gears cannot be accomplished without a puller suitable. Heat must be used during bearing and sleeve installation.

Design of ROOTS™ blower is simple, and most repair operations are straightforward. For this reason, the following procedures are intended mainly to indicate a preferred work order and to call out points to be observed. Where special operations are required, detailed coverage is given.

## DISASSEMBLY OF DRIVE END

1. Remove the sheave or coupling and key from the drive shaft. File off any burrs or sharp edges along the keyway.
2. Drain oil by removing drain plug (22).
3. Remove the flange screws (75). Tap the drive end cover to loosen it, then slide it along the shaft care fully to avoid damaging the lip seal (33) on the drive shaft keyway. Remove the gasket (7). Remove oil slinger (40) and cap screw (60).
4. Remove bearing clamp plates (34) by unscrewing capscrews (32) and removing lock washers (35). Keep shim halves (10) together exactly as removed by tagging them with each clamping plate.
5. Remove the headplate – remove all capscrews (23) holding headplate to the cylinder. Insert jacking screws into the four threaded flange holes and turn them in evenly. The headplate will separate from the cylinder. The lip seals (27), and bearing outer race and rollers, are removed with the headplate and can be pressed out later.
6. Remove the bearing inner race and sleeve (38) from the shaft with aid of a bearing puller by inserting the puller jaws in the groove in the sleeve and applying the jacking screw against the end of the shaft. Protect the threaded hole and the end of the shaft with a small, flat spacer between the shaft and the puller.

## DISASSEMBLY OF GEAR END

1. Drain oil completely from the gearbox sump by removing plugs (22) in bottom of the headplate (1).
2. Loosen all flange screws (75) in the gearbox and remove all but two upper screws. Bump the gear box to break the joint if it cannot be pulled free by hand, then remove the last two screws and lift off the gearbox. Remove gasket (7).
3. Removing gears: CAUTION**:** Do not remove gear nuts (31) completely before the gears are unseated from the taper fits or damage/injury may result. Be sure that each gear is marked for return to the same shaft in the same angular position and that the gears have match marks for the teeth. For this operation, the impellers should be wedged as shown in Figure 8. Back off nuts (31) and slinger (46). The timing gears (4) have two 1/2" – 13 holes for pulling purposes. Use a suitable puller.
4. Remove bearing clamp plates (54) by unscrewing capscrews (32) and removing lock washers. Group the shims (10), the wavy spring washers (29) with each clamp plate and tag for ease of reassembly.
5. Remove the headplate – remove all capscrews 23) holding the headplate to the cylinder. Insert jacking screws into the four (4) threaded flange holes and turn them in evenly. They headplate will separate from the cylinder. The lip seals (27), and bearing outer race and rollers, are removed with the headplate and can be pressed out later.

   **For RAM™-J WHISPAIR™ gas pump units:**
   The gear end headplate which is removed next requires a different approach from the drive end. On this end, the shafts are forced from the bearing bore by using a bar across the end of the shaft with threaded rods to the headplate. Once the headplates are removed from the assembly, the seal housings can be pressed or driven from

the headplate bores. Generally, new seals will be required prior to reassembly.

6. Remove the bearing inner race and sleeve (38) from the shaft with the aid of a bearing puller by inserting the puller jaws in the groove in the sleeve and applying the jacking screw against the end of the shaft. Protect the threaded hole and the end of the shaft with a small, flat spacer between the shaft and the puller.

**ASSEMBLY**

Prior to any assembly operation, it is essential that all parts are completely clean and free from nicks and scratches.

Prior to assembly, lightly coat the groove in the sleave with slip plate. ROOTS P/N813-314-000.

1. Assembly of Piston ring seals (28) – To avoid scratching the lip seal surface, install the Piston ring seals (28) in the sleeves (38) from the end nearest the groove before assembling the sleeve on the shaft.

   Unhook the gap joint and expand the ring while sliding it to the groove, then compress it so one end of the hook joint slides over the other. Move the ring in the groove to be sure it is free.

   **NOTE:** *Care must be taken not to scratch or dent the sleeve surface since it is the sealing surface for the lip seal.*

2. Installation of sleeves (38) – heat the sleeve to 300° F. (149°C) then quickly slide it on the shaft tightly against the impeller. If the sleeve hangs up during assembly, it can be pressed into place using a tubular pressing tool with square, clean ends.

3. Assembly of seals (27) in headplate (1) – Place headplate flat with seal bores up. Be sure the pressing tool face is clean and square and there is a smooth, clean entering bevel in the headplate. Lubricate the seal lips. Place seal over the bore with lip facing up, then press the seal evenly until it is flush with bore face.

   **For Gas Sealed Units:** Assemble mechanical seals (27) in headplate – (**CAUTION:** *Care must be used to avoid damaging the carbon face. Before proceeding with this step, you should have a piloted seal driver which is designed to clear the carbon face.*) with headplate positioned horizontally with seal bores up. Be sure the pressing tool face is clean and square and there is a smooth, clean entering bevel in the headplate. Place the seal over the bore with carbon facing up. Then press the seal evenly on its steel shell using the piloted seal driver until the driver seats against the stop.

4. Assembly of impellers (12 and 13) to headplate (1) – Place gear end headplate flat on 3 in. (76 mm) blocks with the smallest bores facing up. Inspect entering bevels to be sure they are smooth and clean. Locate the drive impeller correctly (top for vertical units and toward the driver for horizontal units). Place the seal ring gaps toward the inlet for pressure applications and towards dis charge for vacuum applications. Insert the impeller shafts in the headplate so the impellers rest on the headplate. Use care to avoid damaging the lip seals.

5. Assembly of cylinder (11) to gear end headplate (1) – Install dowel pins (16) and secure cylinder to headplate with capscrews (23). Torque to 35 ft.-lbs (4.5 Kg-m). Then, install drive end headplate (1) and dowel pins (16) and secure with capscrews (23). Install feet (76) & 77) to both headplates and secure with capscrews (66). Torque to 35 ft.-lbs. (4.5 kg-m).

   **For Gas Sealed Units:** Use a Teflon sealant between headplate and cylinder joint. Assemble rotating seal – apply a light coating of oil to the O-ring and seal face. Then with flute side out install the rotating seat tight to the shaft sleeve. Check and record seal compression – With the seal body in place and the impeller against the opposite headplate, check that seal compression is adequate. This can be checked using a depth gauge or dial indicator from the face of the head plate to the face of the mating ring. First, measure this distance while the carbon is out at its full length. Then, push the mating ring back against its stop and measure it again. The difference between these measurements is the compression. This can be done easily with finger pressure as the spring force is only 10 lbs. The correct travel is given below (record actual compression on clearance sheets).

**SEAL COMPRESSION**

| Frame | Minimum | Maximum |
|---|---|---|
| 400 | .047” | .097” |
| 600 | .108” | .151” |

* Prior to to assembly, lightly coat the groove in the sleave(38) with slip plate. ROOTS™ P/N 813-314-000

6. Installation of bearings (14) – Heat bearing inner race to 300°F (149°C) in an oven or hot oil; then slide it onto the shaft so the bearing shoulder is snugly against the sleeve. Note: Be sure to install the shaft shim (70) behind the shaft sleeve before installing the drive end drive bearing inner race. This is required to compensate for the oil leader for shimming. Insert the bearing outer race and rollers in each bore and tap lightly in place. Spray bearings with lubricant.

7. Measure and record the end clearances between the impellers and drive headplate using long feeler gauges. Then, subtract the allowed average drive end clearance. See Table 6. The result is the space required between clamping plates (34) and bearing outer race. Place shims (10) as required to get this clearance. Then, fasten the clamping

plates to the headplate with capscrews (32) and lock washers (35).

8. Installation of gear end bearings (14) – Turn the blower so that the gear end headplates is up. Heat bearing inner race to 300°F (149°C) in an oven or hot oil; then slide it onto the shaft so that the bearing shoulder is snugly against the sleeve. Insert the bearing outer race and rollers in each bore and tap lightly into place.

9. Measure and record the end clearance between the impellers and gear end headplate, then subtract the allowed average gear end clearance. See Table 6. The result is the space required between clamping plate (54) and bearing outer race. Place shims (10) as required to get this clearance. Then fasten the clamping plates (54) to the headplate using capscrews (32) and lock washers (35). Do not install wavy-spring washers (29) at this time, as a final check of clearances is required first.

10. Final check of end clearances and float – Using long feeler gauges, check the clearance between the impellers and drive end headplate. See Table 6. Place the blower assembly on its feet and correct shimming as required. Then, force the impellers as close to the gear end headplate as possible, and check the clearance between impellers and gear end headplate for agreement with Table 6. Adjust shimming on the gear end as required. With unit securely fastened down, use a dial indicator to measure the impeller float. Again push the impeller to one end of the cylinder. With indicator firmly mounted, place contact point on the end of the shaft just pushed and set dial on zero. Force the impeller to the opposite end (toward indicator). Indicator reading will be a measurement of the impeller float. Repeat process on second impeller and compare float to Table 6. Adjust shimming at bearing clamp plates to obtain both float and end clearances specified in Table 6.

    Finally, after clearances and float have been corrected and checked, remove the gear end clamping places (54) and install wavy-spring washers (29) and reinstall shims (10) and clamping plates (54). Be sure oil feed grooves are up and toward bearings.

11. Installing drive gear (4) – Be sure shafts and gear bores are clean and free of scratches. Oil gear nut threads lightly. Place hardwood wedges as shown in Figure 8. Install gear (4) and nut (31) so match mark at the tooth is at the line of engagement. Tighten the drive gear to the torque given below. Blower assembly must be fastened down for torquing operation.

12. **Left side discharge machine**
    Installing driven gear (14) – Insert a long metal feeler gauge between the impellers' lobes at the fronts as shown in Table 6. Feeler gauge thickness to be a middle value from Table 6 for fronts.

13. **Right side discharge machine**
    Installing driven gear (4) – Insert a long metal feeler gauge between the impellers' lobes at the backs. Feeler gauge thickness to be minimum value from Table 6 for backs.

### RAM™ SERIES BLOWER GEAR NUT TORQUE

| Frame Size | Torque | |
|---|---|---|
| | lb.-ft. | (kg-m) |
| 404, 406, 409, 412, 418 | 400 | (56) |
| 616, 624 | 630 | (88) |

### RAM™ SERIES BLOWER OIL SLINGER SCREW TORQUE

| Frame Size | Torque | |
|---|---|---|
| | lb.-ft. | (kg-m) |
| 404, 406, 409, 412, 418 | 75 | (10) |
| 616, 624 | 140 | (19) |

Align the gear so the tooth match marks agree with the drive gear, then install slinger (46) and nuts (31). Tighten lightly with a small wrench, then check front and back clearances against Table 6 for each 45° position. Both fronts should be about the same and backs should about equal and be within the specified range in Table 6. Adjust gear position if necessary, then insert the corrected feeler gauge and wedges and use a torque wrench to tighten the gear nut to the torque specified above. Remove wedges and rotate the drive shaft by hand to make sure there are no gear tight spots or impeller contacts. **CAUTION: Keep fingers away from impeller end gears.**

Install gearbox (3) with gasket (7) and tighten the capscrews (75) evenly to 10 ft.-lbs. (1.3 kg-m).

Install drive end oil slinger (40) and capscrew (60), apply Locktite to threads and torque to value specified above.

Install drive end cover (5) and gasket (7) with drive lock pins (17) in place, being careful not to dent or scratch drive shaft lip seal surface. Tighten capscrews (75) evenly. Check seal bore for concentricity with shaft using an indicator; reposition drive lock pins, if necessary. Install seal (33) with lip facing inward, using care to avoid tearing or scratching seal on shaft keyway. Use a pressing tool with clean, square ends to insure correct positioning of the seal. For hydrodynamic style seals, the shaft rotation is critical for correct installation and proper sealing. Match the directional arrow shown on the seal faces with the required shaft rotation. An installation protective sleeve is required to protect seal lip during installation.

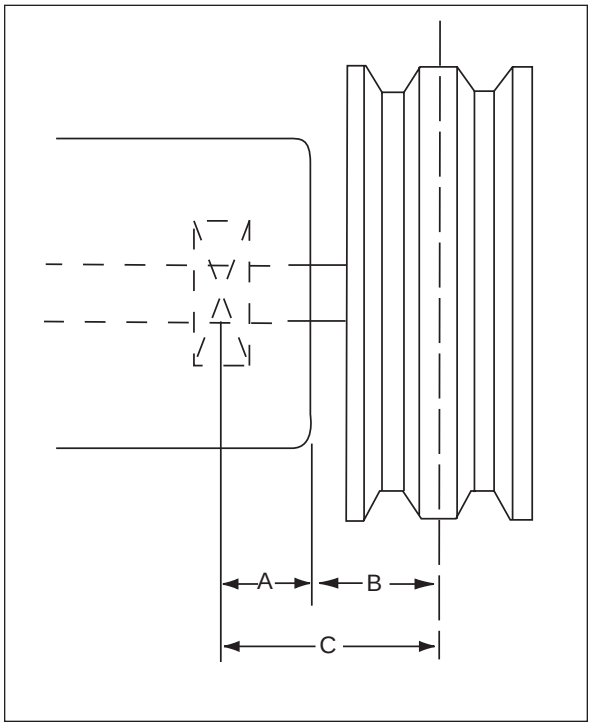
Install vent plug (21) in each headplate.

Replace oil drain plugs (22) and refill drive end and gear sumps with proper grade of oil as discussed under **LUBRICATION**.

Install drive sheave or coupling half and install blower, refer to **INSTALLATION instructions**.

# FIGURE 2

## ALLOWABLE OVERHUNG LOADS FOR V-BELT DRIVES UNIVERSAL RAI®/URAI™-J UNITS




$$\text{Belt Pull lbs} = \frac{252100 \bullet \text{Motor HP}}{\text{Blower RPM} \bullet \text{Sheave Diameter}}$$

C = Distance between drive bearing center line and sheave center line (A+B)

$$B = \left(1/8\text{”} + \frac{\text{Sheave Width}}{2}\right)$$

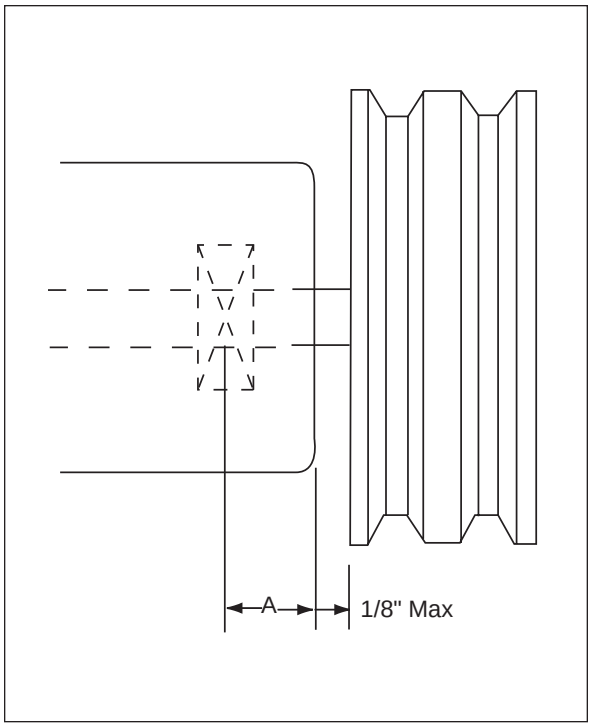
Shaft Load (lb.in) = Belt Pull • C

| Frame Size | Dimension “A” | Max Allowable Shaft Load (lb-in.) |
|---|---|---|
| 22, 24 | 0.61 | 80 |
| 32, 33, 36 | 0.80 | 300 |
| 42, 45, 47 | 1.02 | 640 |
| 53, 56, 59 | 1.13 | 1,110 |
| 65, 68, 615 | 1.36 | 1,550 |
| 76, 711, 718 | 1.16 | 2,300 |

**NOTE:** Arc of sheave belt contact on the smaller sheave not to be less than 170°

Driver to be installed on the inlet side for vertical units, and on the drive shaft side for horizontal units.

## ALLOWABLE OVERHUNG LOADS FOR V-BELT DRIVES 400 - 600 RAM™ UNITS




$$\text{Belt Pull lbs} = \frac{27500 \bullet \text{Motor HP}}{\text{Blower RPM} \bullet \text{Sheave Diameter}}$$

$$\text{Shaft Load (lb.in)} = \text{Belt Pull} \bullet \left(A + 1/8\text{”} + \frac{\text{Sheve Width}}{2}\right)$$

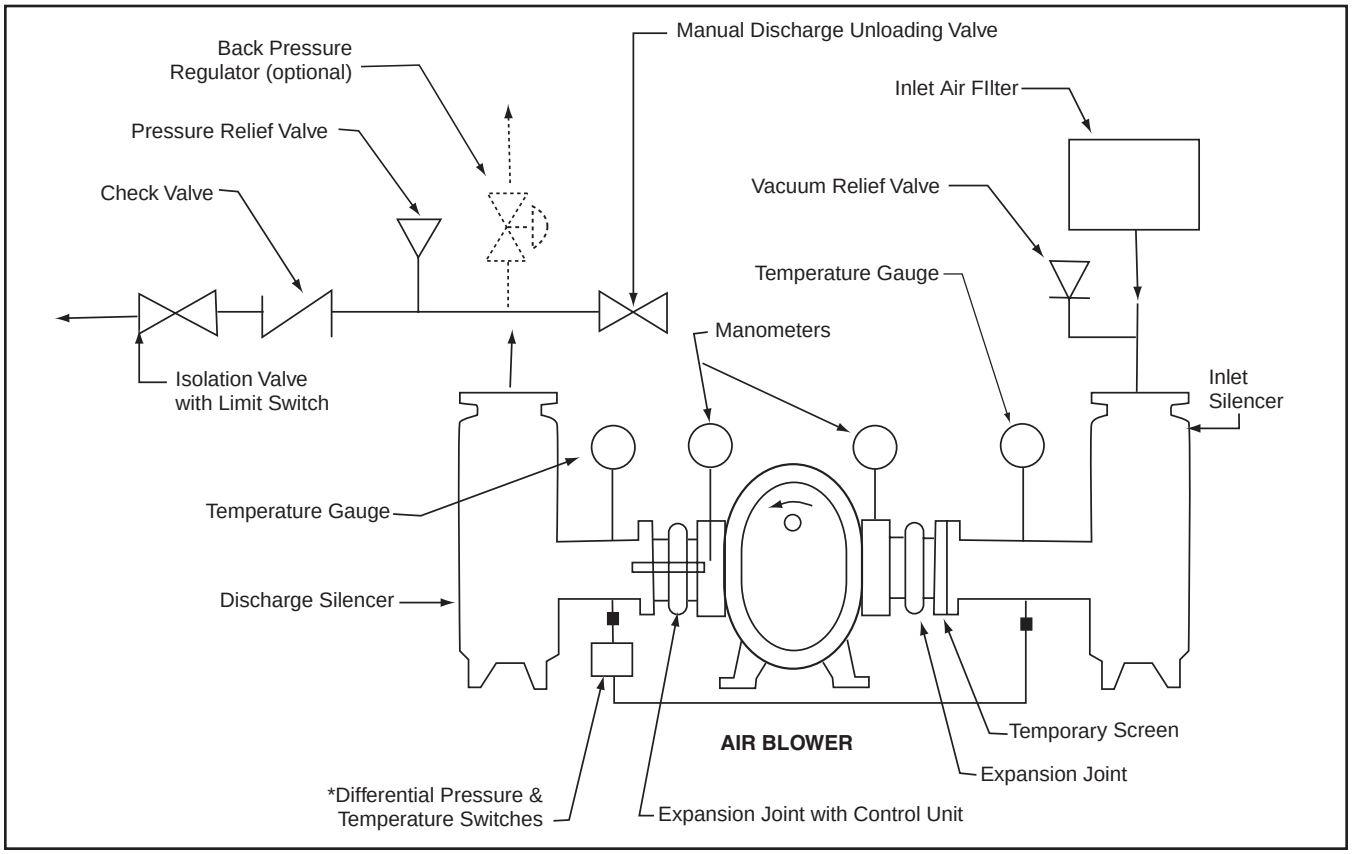
| | Dimension “A” | | |
|---|---|---|---|
| Frame Size | Standard Unit | Bottom Drive or Double Shaft Seal | Max Allowable Shaft Load (lb-in.) |
| 404, 406 | 1.90 | 2.11 | 3,200 |
| 409, 412, 418 | 1.90 | 2.11 | 3,200 |
| 616, 624 | 2.11 | 2.67 | 7,975 |

**NOTE:** Arc of sheave belt contact on the smaller sheave not to be less than 170°

Driver to be installed on the inlet side for vertical units, and on the drive shaft side for horizontal units.

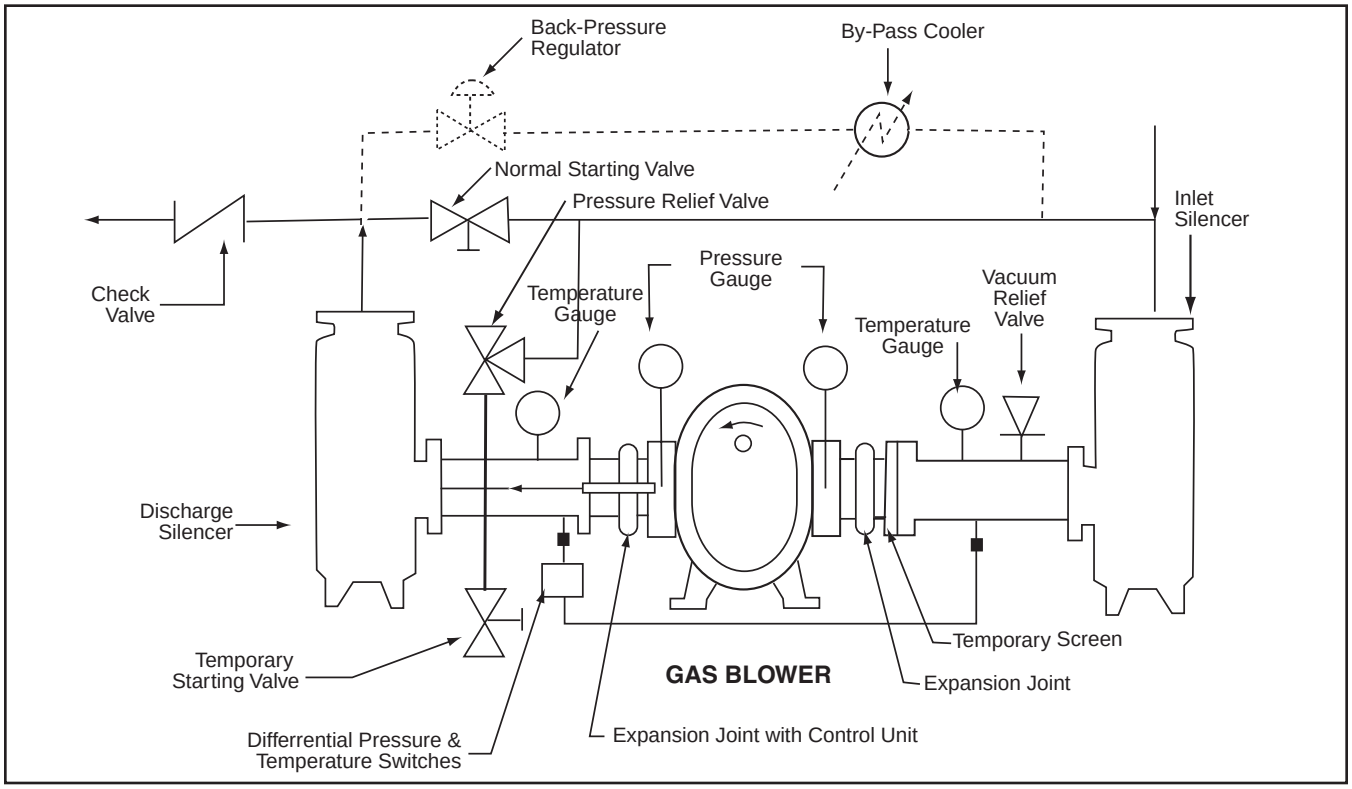
# FIGURE 3

## AIR BLOWER INSTALLATION WITH ACCESSORIES




Above are suggested locations for available accessories.

## GAS BLOWER INSTALLATION WITH ACCESSORIES




Above are suggested locations for available accessories.

# FIGURE 4

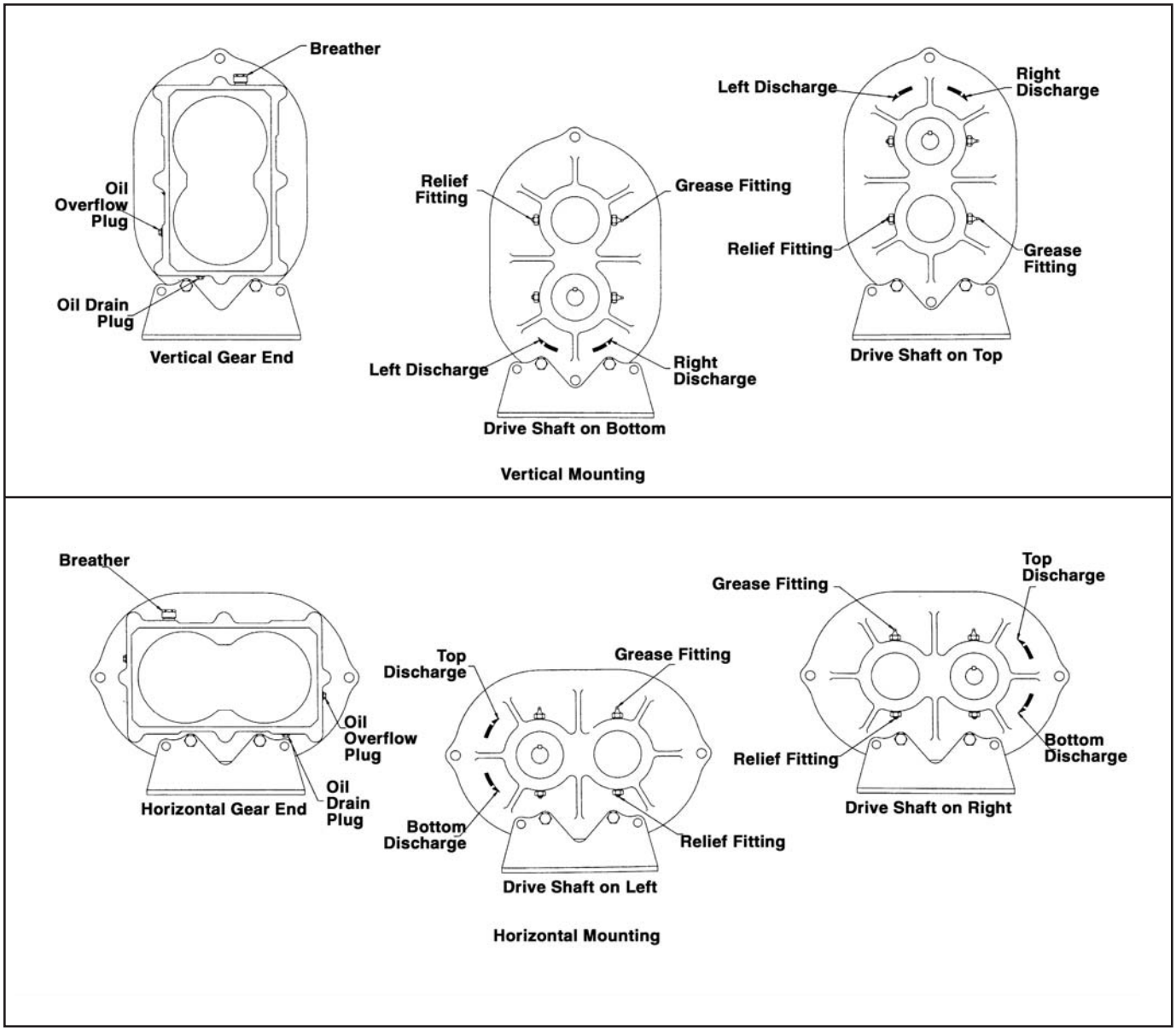
## BLOWER ORIENTATION CONVERSION

| Model | Reversible Rotation | Whispair Design |
|---|---|---|
| Universal RAI | yes | no |
| URAI-J | no | yes |
| URAI-G | yes | no |
| RAM | yes | no |
| RAM-J | no | yes |
| RAM-GJ | no | yes |

**Special Note:** WHISPAIR™ models are designed to operate with only one shaft rotation direction to take full advantage of the Whispair feature. Therefore, a WHISPAIR™ blower should be operated in the following combinations only.

- **CCW Rotation:** Bottom Shaft; Right side discharge or a Left Shaft; Bottom discharge
- **CCW Rotation:** Top Shaft; Left side discharge or a Right Shaft; Top discharge
- **CW Rotation:** Bottom Shaft; Left side discharge or a Right Shaft Bottom discharge
- **CW Rotation:** Top Shaft; Right side discharge or a Left Shaft Top discharge

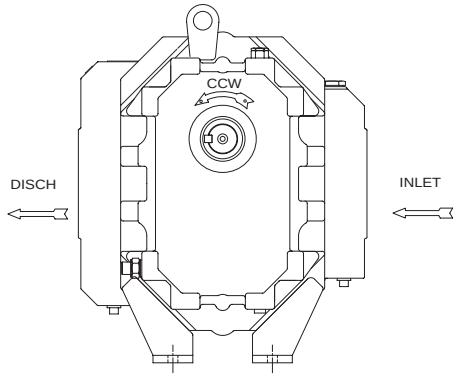
## BLOWER ORIENTATION AND LUBRICATION POINTS: UNIVERSAL RAI® & URAI™-G GAS BLOWERS



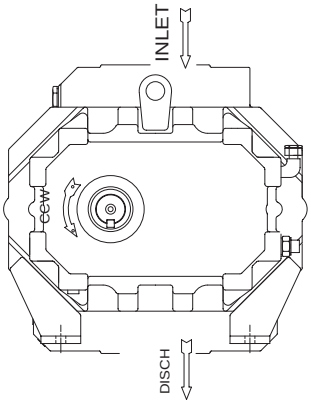
# FIGURE 5

## BLOWER ORIENTATION CONVERSION - WHISPAIR™ UNITS

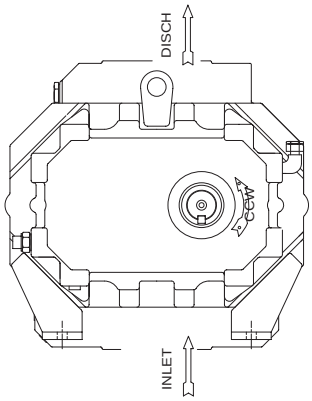
1. STANDARD ARRANGEMENT ( 3-WAY UNIVERSAL)
   EXTERNAL SIGHT GLASSES (37) & BREATHERS (21) MUST BE RELOCATED AS SHOWN.
   FEET (76&77) & LIFTING LUGS (63) MUST BE RELOCATED AS SHOWN.




TOP DRV, L.S. DISCH

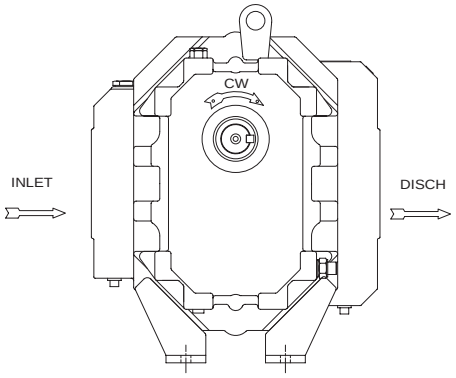



L.H. DRV, BTM DISCH

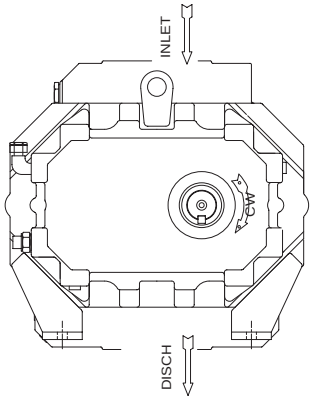



R.H. DRV, TOP DISCH

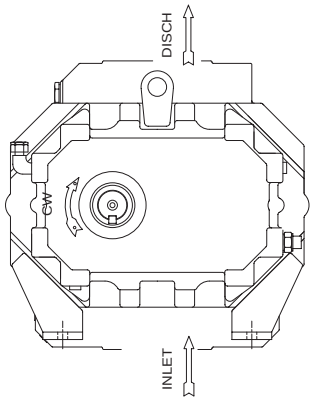
2. NON-STANDARD ARRANGEMENT ( 3-WAY UNIVERSAL)
   CYLINDER (11) MUST BE UNBOLTED FROM HEADPLATES (1) AND DISCHARGE RELOCATED AS SHOWN. **MUST HAVE AUTHORIZATION FOR CONVERSION SO NOT TO VOID WARRANTY.**
   EXTERNAL SIGHT GLASSES (37) & BREATHERS (21) MUST BE RELOCATED ALSO.
   FEET (76&77) & LIFTING LUGS (63) MUST BE RELOCATED AS SHOWN




TOP DRV, R.S. DISCH

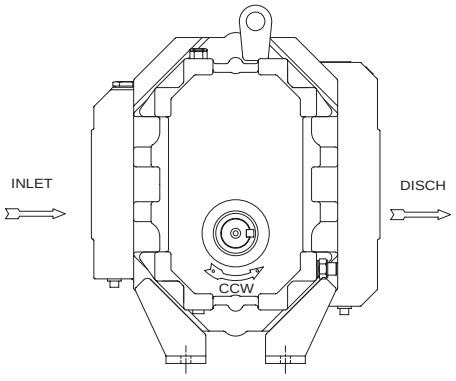



R.H. DRV, BTM DISCH

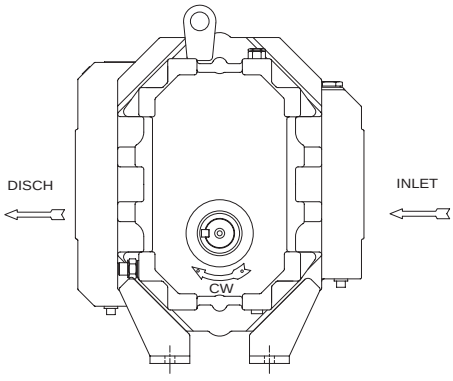



L.H. DRV, TOP DISCH

3. BOTTOM DRIVE SHAFT ARRANGEMENT "SPECIAL ORDER" (3-WAY UNIVERSAL)
   **SPECIAL OGE OIL SLINGER REQUIRED FOR ASSEMBLY.**
   MAY BE CONVERTED TO HORIZONTAL CONFIGURATION AS PREVIOUSLY SHOWN.




BTM DRV, R.S. DISCH




BTM DRV, L.S. DISCH

## TABLE 1 -

### URAI™-J WHISPAIR™ & URAI™-G GAS BLOWER, MAXIMUM ALLOWABLE OPERATING CONDITIONS

| Frame Size | Gear Diameter (Inch) | Speed RPM | Temp. Rise F° | (C°) | Delta Pressure PSI | (mbar) | Inlet Vacuum INHG | (mbar) |
|---|---|---|---|---|---|---|---|---|
| 22 | 2.5 | 5275 | 225 | (125) | 12 | (227) | 15 | (500) |
| 24 | 2.5 | 5275 | 210 | (117) | 7 | (483) | 15 | (500) |
| 32 | 3.5 | 3600 | 240 | (133) | 15 | 1034 | 16 | (539) |
| 33 | 3.5 | 3600 | 225 | (125) | 12 | (827) | 15 | (500) |
| 36 | 3.5 | 3600 | 225 | (125) | 7 | (483) | 15 | (500) |
| 42 | 4.0 | 3600 | 240 | (133) | 15 | (1034) | 16 | (539) |
| 45 | 4.0 | 3600 | 225 | (125) | 10 | (690) | 16 | (539) |
| 47 | 4.0 | 3600 | 225 | (125) | 7 | (483) | 15 | (500) |
| 53 | 5.0 | 2850 | 225 | (125) | 15 | (1034) | 16 | (539) |
| 56 | 5.0 | 2850 | 225 | (125) | 13 | (896) | 16 | (539) |
| 59 | 5.0 | 2850 | 225 | (125) | 7 | (483) | 15 | (500) |
| 65 | 6.0 | 2350 | 250 | (130) | 15 | (1034) | 16 | (539) |
| 68 | 6.0 | 2350 | 240 | (133) | 14 | (965) | 16 | (539) |
| 615 | 6.0 | 2350 | 130 | ( 72) | 7 | (483) | 12 | (405) |
| 76 | 7.0 | 2050 | 250 | (139) | 15 | (1034) | 16 | (539) |
| 711 | 7.0 | 2050 | 225 | (125) | 10 | (690) | 16 | (539) |
| 718 | 7.0 | 2050 | 130 | ( 72) | 6 | (414) | 12 | (405) |

### RAM™, RAM™-J WHISPAIR™ BLOWER, RAM™-GJ GAS BLOWER
### MAXIMUM ALLOWABLE OPERATING CONDITIONS

| Frame Size | Gear Diameter (Inch) | Speed RPM | Temp. Rise F° | (C°) | Delta Pressure PSI | (mbar) | Inlet Vacuum INHG | (mbar) |
|---|---|---|---|---|---|---|---|---|
| 404 | 4.5 | 4000 | 240 | (133) | 18 | (1241) | 16 | (539) |
| 406 | 4.5 | 4000 | 240 | (133) | 18 | (1241) | 16 | (539) |
| 409 | 4.5 | 4000 | 240 | (133) | 18 | (1241) | 16 | (539) |
| 412 | 4.5 | 4000 | 240 | (133) | 15 | (1034) | 16 | (539) |
| 418 | 4.5 | 4000 | 240 | (133) | 10 | (690) | 16 | (539) |
| 616 | 6.0 | 3000 | 230 | (128) | 15 | (1034) | 16 | (539) |
| 624 | 6.0 | 3000 | 230 | (128) | 10 | (690) | 16 | (539) |

# TABLE 3

## RECOMMENDED OIL GRADES

| Ambient Temperature °F (°C) | Viscosity Range SSU at 100°F | ISO No. | Approximate SAE No. |
|---|---|---|---|
| Above 90° (32°) | 1000-1200 | 320 | 60 |
| 32° to 90° (0° to 32°) | 700-1000 | 220 | 50 |
| 0° to 32° (-18° to 0°) | 500-700 | 150 | 40 |
| Below 0° (-18°) | 300-500 | 100 | 30 |

## UNIVERSAL RAI®, URAI™-J, URAI™-G OIL SUMP CAPACITIES

| Frame Size | Capacity Fl. Oz. (Liters) | |
|---|---|---|
| | Vertical | Horizontal |
| 22 | 3.4 (.1) | 6.1 (.18) |
| 24 | 3.4 (.1) | 6.1 (.18) |
| 32 | 8.5 (.25) | 16.0 (.47) |
| 33 | 8.5 (.25) | 16.0 (.47) |
| 36 | 8.5 (.25) | 16.0 (.47) |
| 42 | 12.7 (.37) | 22.8 (.67) |
| 45 | 12.7 (.37) | 22.8 (.67) |
| 47 | 12.7 (.37) | 22.8 (.67) |
| 53 | 16.0 (.47) | 27.6 (.82) |
| 56 | 16.0 (.47) | 27.6 (.82) |
| 59 | 16.0 (.47) | 27.6 (.82) |
| 65 | 28.3 (.84) | 52.1 (1.54) |
| 68 | 28.3 (.84) | 52.1 (1.54) |
| 615 | 28.3 (.84) | 52.1 (1.54) |
| 76 | 32.3 (.96) | 59.5 (1.76) |
| 711 | 32.3 (.96) | 59.5 (1.76) |
| 718 | 32.3 (.96) | 59.5 (1.76) |

## RAM™, RAM™-J & RAM™-GJ OIL SUMP CAPACITIES

| Orientation | Gearbox | | Drive End | |
|---|---|---|---|---|
| | Fl. Oz. | (Liters) | Fl. Oz. | (Liters) |
| 400 (Horizontal) | 36 | 1.06 | 19 | .56 |
| 400 (Vertical) | 18 | .52 | 9 | .27 |
| 600 (Horizontal) | 95 | 2.81 | 50 | 1.48 |
| 600 (Vertical) | 55 | 1.63 | 28 | 0.83 |

# TABLE 4

## SUGGESTED BEARING GREASING INTERVALS

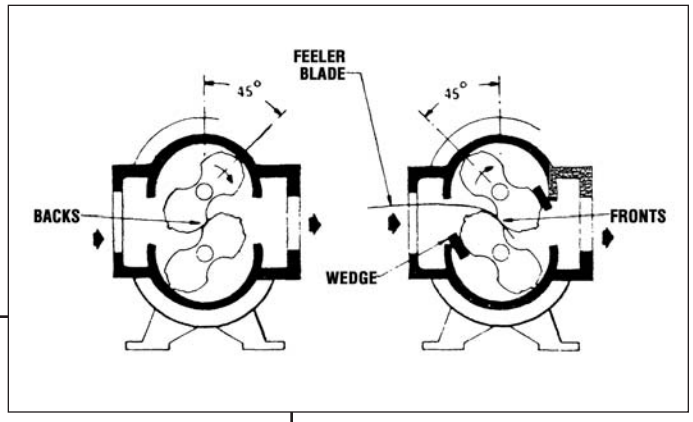
| Speed In RPM | Operating Hours Per Day | | |
|---|---|---|---|
| | 8 | 16 | 24 |
| | Greasing Intervals in Weeks | | |
| 750-1000 | 7 | 4 | 2 |
| 1000-1500 | 5 | 2 | 1 |
| 1500-2000 | 4 | 2 | 1 |
| 2000-2500 | 3 | 1 | 1 |
| 2500-3000 | 2 | 1 | 1 |
| 3000 and up | 1 | 1 | 1 |

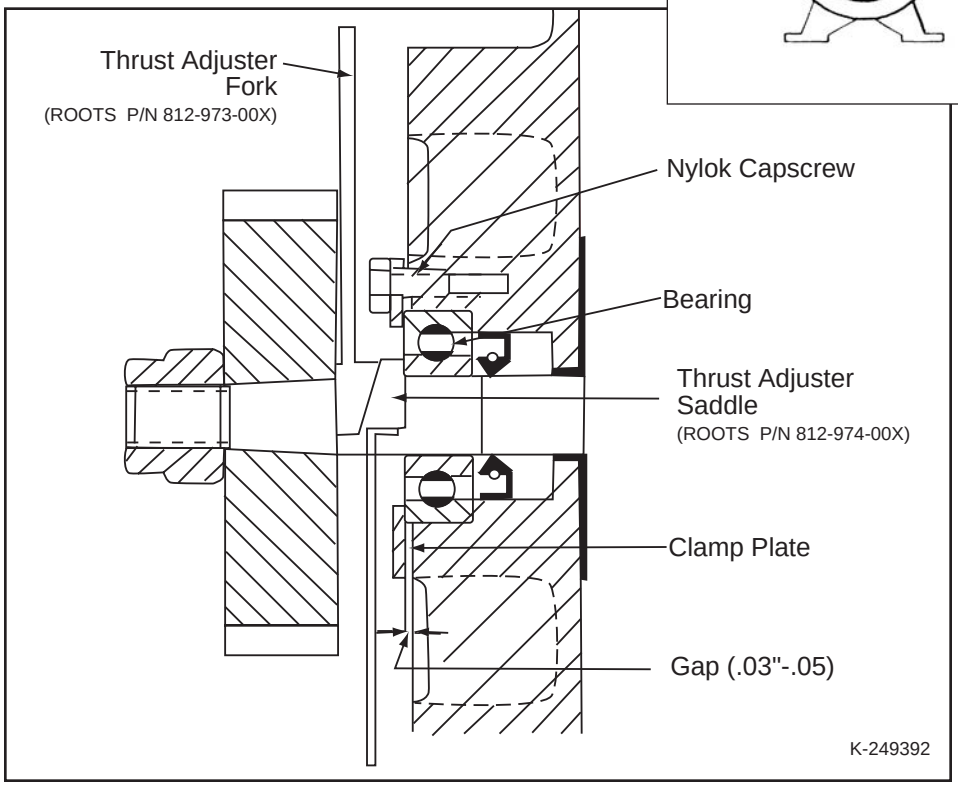
## TABLE 5

### NORMAL CLEARANCES FOR UNIVERSAL RAI® AND URAI™-J, URAI™-G BLOWERS - INCHES (MM)

| Frame Size | Impeller Ends | | | Cylinder | | Impeller |
|---|---|---|---|---|---|---|
| | Total | Drive End Minimum | Gear End Minimum | Inlet & Discharge | Center Center | * Fronts/Backs |
| 22 | .006/.010 (.15-.25) | .003 (.08) | .003 (.08) | .004/.005 (.10-.13) | .002/.003 (.05-.08) | .007/.01 (.18-.25) |
| 24 | .006/.010 (.15-.25) | .003 (.08) | .003 (.08) | .004/.006 (.10-.15) | .002/.003 (.05-.08) | .007/.01 (.18-.25) |
| 32 | .006/.011 (.15-.28) | .003 (.08) | .003 (.08) | .004/.006 (.10-.15) | .002/.003 (.05-.08) | .01/.012 (.25-.30) |
| 33 | .006/.011 (.15-.28) | .003 (.08) | .003 (.08) | .004/.006 (.10-.15) | .002/.003 (.05-.08) | .01/.012 (.25-.30) |
| 36 | .006/.011 (.15-.28) | .003 (.08) | .003 (.08) | .004/.006 (.10-.15) | .002/.003 (.05-.08) | .01/.012 (.25-.30) |
| 42 | .008/.011 (.20-.28) | .004 (.10) | .004 (.10) | .005/.007 (.13-.18) | .003/.004 (.08-.10) | .009/.012 (.23-.30) |
| 45 | .008/.013 (.20-.33) | .004 (.10) | .004 (.10) | .005/.007 (.13-.18) | .003/.004 (.08-.10) | .012/.015 (.30-.38) |
| 47 | .008/.013 (.20-.33) | .004 (.10) | .004 (.10) | .005/.007 (.13-.18) | .003/.004 (.08-.10) | .012/.015 (.30-.38) |
| 53 | .008/.011 (.20-.28) | .004 (.10) | .004 (.10) | .005/.008 (.13-.20) | .003/.004 (.08-.10) | .011/.013 (.28-.33) |
| 56 | .008/.013 (.20-.33) | .004 (.10) | .004 (.10) | .005/.008 (.13-.20) | .003/.004 (.08-.10) | .015/.017 (.38-.43) |
| 59 | .008/.013 (.20-.33) | .004 (.10) | .004 (.10) | .005/.008 (.13-.20) | .003/.004 (.08-.10) | .015/.017 (.38-.43) |
| 65 | .012/.016 (.30-.40) | .008 (.20) | .004 (.10) | .006/.008 (.15-.20) | .006/.008 (.15-.20) | .010/.014 (.25-.36) |
| 68 | .014/.018 (.36-.46) | .010 (.25) | .004 (.10) | .006/.008 (.15-.20) | .006/.008 (.15-.20) | .010/.014 (.25-.36) |
| 615 | .014/.018 (.36-.46) | .010 (.25) | .004 (.10) | .006/.008 (.15-.20) | .006/.008 (.15-.20) | .010/.014 (.25-.36) |
| 76 | .012/.016 (.30-.40) | .008 (.13) | .004 (.10) | .006/.008 (.15-.20) | .006/.008 (.15-.20) | .013/.015 (.33-.38) |
| 711 | .014/.018 (.36-.46) | .010 (.25) | .004 (.10) | .006/.008 (.15-.20) | .006/.008 (.15-.20) | .013/.015 (.33-.38) |
| 718 | .014/.018 (.36-.46) | .010 (.25) | .004 (.10) | .006/.008 (.15-.20) | .006/.008 (.15-.20) | .013/.015 (.33-.38) |

*** IMPELLER TIMING FOR STANDARD ROTATION VIEWED FROM GEAR END**




**THRUST SETTING, 2-1/2" THRU 5" UNIVERSAL RAI® BLOWERS**

# TABLE 6

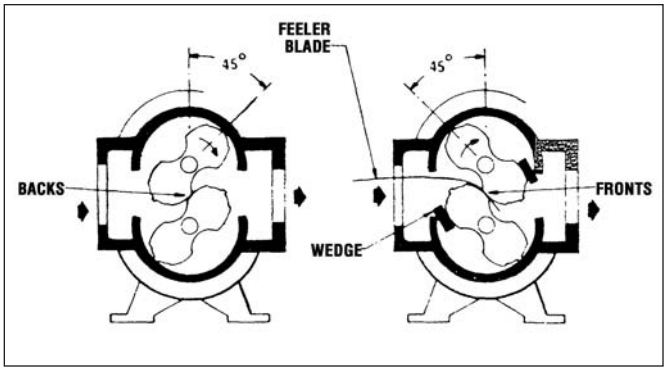
## NORMAL CLEARANCES FOR RAM™-J & RAM™-GJ WHISPAIR™ BLOWERS - INCHES (MM)

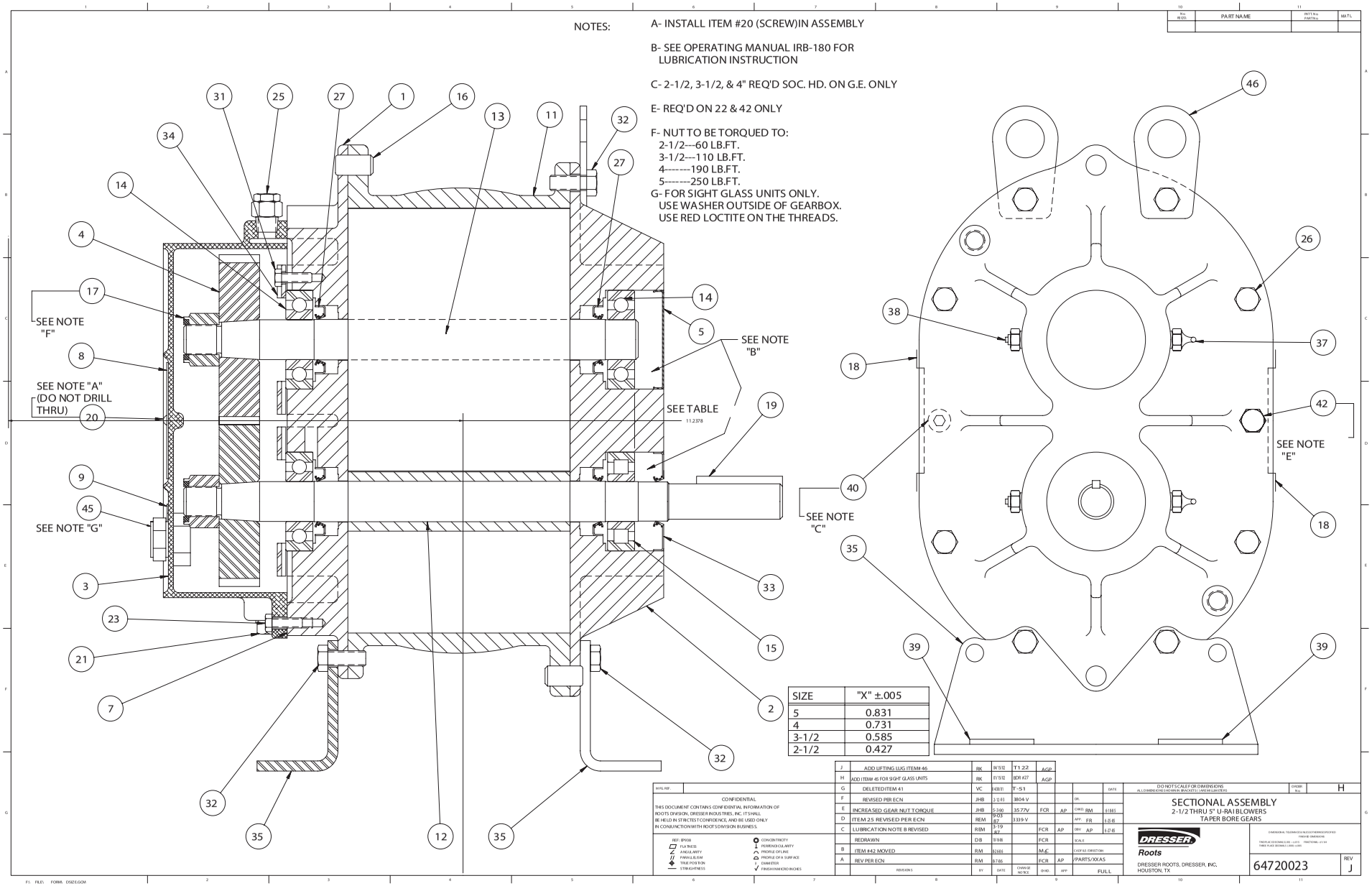
| Blower Frame Size | * Impeller Lobes at 45° | | End Clearance | | | Impeller Tips to Cylinders | | |
|---|---|---|---|---|---|---|---|---|
| | Fronts | Backs | Each End Without Wavy Spring | Gear End Without Spring Installed | Required End Float | Inlet | Center | Discharge |
| | Min-Max | Min-Max | Min-Max | Min-Max | Minimum | Min-Max | Min-Max | Min-Max |
| 404 | .012-.014 | .006-.009 | .003-.005 | .003-.008 | .003 | .004-.006 | .002-.004 | .002-.004 |
| | (.31-.36) | (.15-.23) | (.08-.13) | (.10-.15) | (.08-.20) | (.08) | (.05-.10) | (.05-.10) |
| 406 | .012-.014 | .006-.009 | .003-.005 | .007-.012 | .006 | .005-.007 | .003-.005 | .002-.004 |
| | (.31-.36) | (.15-.23) | (.08-.13) | (.15-.30) | (.13) | (.13-.18) | (.08-.13) | (.05-.10) |
| 409 | .013-.015 | .006-.009 | .003-.005 | .013-.018 | .008 | .005-.007 | .003-.005 | .002-.004 |
| | (.33-.38) | (.15-.23) | (.08-.13) | (.31-.43) | (.17) | (.13-.18) | (.08-.13) | (.05-.10) |
| 412 | .013-.015 | .006-.009 | .003-.005 | .016-.021 | .011 | .006-.008 | .004-.006 | .004-.006 |
| | (.33-.38) | (.15-.23) | (.08-.13) | (.36-.48) | (.28) | (.15-.20) | (.10-.15) | (.10-.15) |
| 418 | .013-.015 | .006-.009 | .003-.005 | .022-.027 | .017 | .008-.010 | .004-.006 | .004-.006 |
| | (.33-.38) | (.15-.23) | (.08-.13) | (.51-.64) | (.38) | (.20-.25) | (.10-.15) | (.10-.15) |
| 616 | .012-.014 | .006-.008 | .004-.006 | .017-.022 | .011 | .009-.011 | .004-.006 | .002-.005 |
| | (.31-.36) | (.15-.20) | (.10-.15) | (.38-.51) | (.28) | (.23-.28) | (.10-.15) | (.05-.13) |
| 624 | .012-.015 | .006-.009 | .004-.006 | .024-.029 | .018 | .013-.015 | .005-.007 | .002-.005 |
| | (.31-.36) | (.15-.23) | (.10-.15) | (.61-.74) | (.46) | (.33-.38) | (.13-.18) | (.05-.13) |

## NORMAL CLEARANCES FOR RAM™ BLOWERS - INCHES (MM)

| Blower Frame Size | * Impeller Lobes at 45° | | End Clearance | | | Impeller Tips to Cylinders | | |
|---|---|---|---|---|---|---|---|---|
| | Fronts | Backs | Each End Without Wavy Spring | Gear End Without Spring Installed | Required End Float | Inlet | Center | Discharge |
| | Min-Max | Min-Max | Min-Max | Min-Max | Minimum | Min-Max | Min-Max | Min-Max |
| 404 | .009-.013 | .009-.013 | .003-.005 | .003-.008 | .003 | .004-.006 | .002-.004 | .004-.006 |
| | (.23-.33) | (.23-.33) | (.08-.13) | (.08-.20) | (.08) | (.10-.15) | (.05-.10) | (.10-.15) |
| 406 | .009-.013 | .000-.013 | .003-.005 | .007-.012 | .006 | .005-.007 | .003-.005 | .005-.007 |
| | (.23-.33) | (.23-.33) | (.08-.13) | (.15-.30) | (.13) | (.13-.18) | (.08-.13) | (.13-.18) |
| 409 | .010-.014 | .010-.014 | .003-.005 | .013-.018 | .008 | .005-.007 | .003-.005 | .005-.007 |
| | (.25-.36) | (.25-.36) | (.08-.13) | (.31-.43) | (.17) | (.13-.18) | (.08-.13) | (.13-.18) |
| 412 | .010-.014 | .010-.014 | .003-.005 | .016-.021 | .011 | .006-.008 | .004-.006 | .006-.008 |
| | (.25-.36) | (.25-.36) | (.08-.13) | (.36-.48) | (.28) | (.15-.20) | (.10-.15) | (.15-.20) |
| 418 | .010-.014 | .010-.014 | .003-.005 | .022-.027 | .017 | .008-.010 | .004-.006 | .008-.010 |
| | (.25-.36) | (.25-.36) | (.08-.13) | (.51-.64) | (.38) | (.20-.25) | (.10-.15) | (.20-.25) |
| 616 | .011-.013 | .011-.013 | .004-.006 | .017-.022 | .011 | .009-.011 | .004-.006 | .009-.011 |
| | (.28-.33) | (.28-.33) | (.10-.15) | (.38-.51) | (.28) | (.23-.28) | (.10-.15) | (.23-.28) |
| 624 | .011-.013 | .011-.013 | .004-.006 | .024-.029 | .018 | .013-.015 | .005-.007 | .013-.015 |
| | (.28-.33) | (.28-.33) | (.10-.15) | (.61-.74) | (.46) | (.33-.38) | (.13-.18) | (.33-.38) |

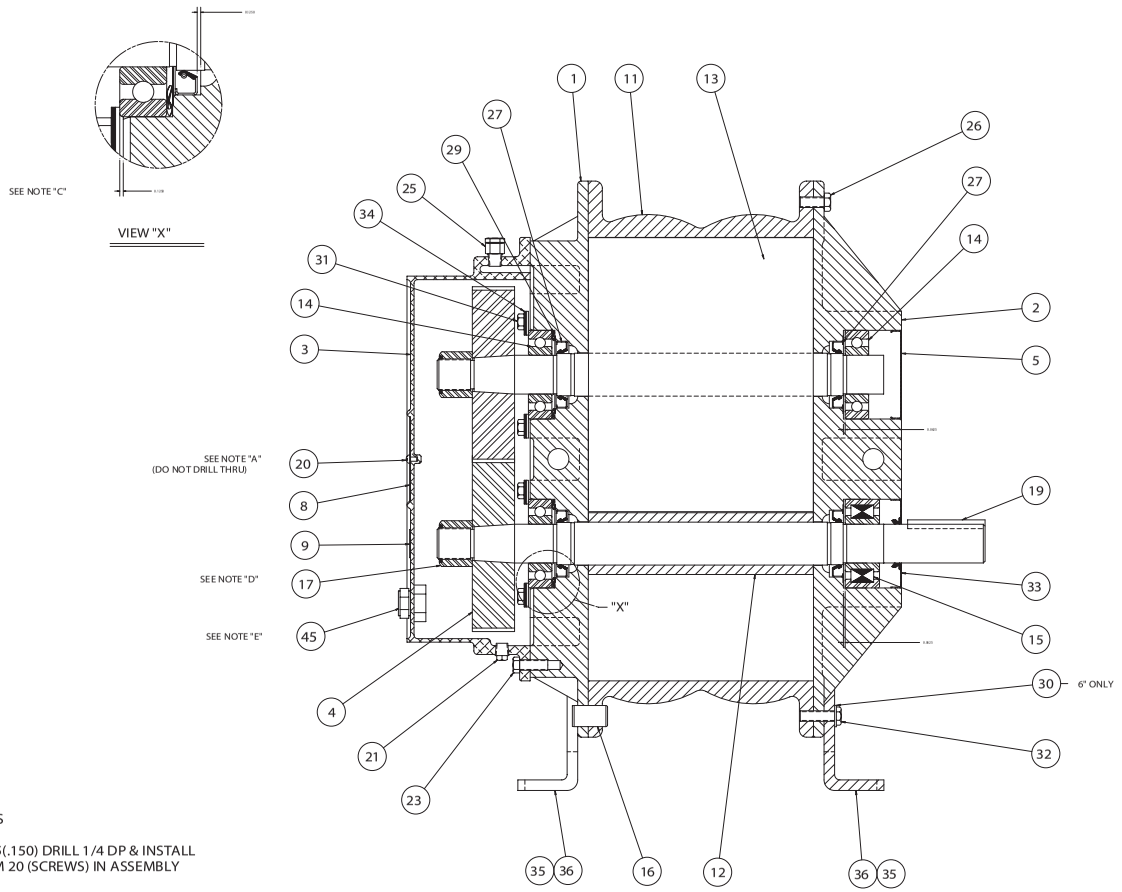
## * IMPELLER TIMING FOR STANDARD ROTATION VIEWED FROM GEAR END

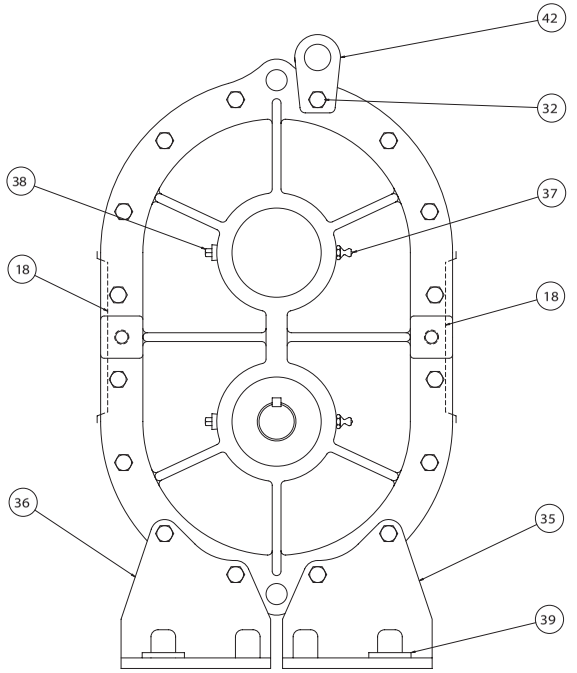







## ASSEMBLY OF UNIVERSAL RAI® SERIES, AIR BLOWERS, 2-1/2" THRU 5" GEAR DIAMETER



NOTES

A #25(.150) DRILL 1/4 DP & INSTALL ITEM 20 (SCREWS) IN ASSEMBLY

B SEE OPERATING MANUAL IRB-180 FOR LUBRICATION INSTRUCTION

C INSTALL BEARINGS AS SHOWN BEFORE SETTING END CLEARANCE

D NUT TO BE TORQUED TO:
6"---400 LB. FT.
7"---550 LB. FT.

E FOR SIGHT GLASS UNITS ONLY.
USE WASHER OUTSIDE OF GEARBOX.
USE RED LOCTITE ON THE THREADS.

| PART NAME | PATT No. FARR No. | MATL. |
|---|---|---|
| | | |

55-1242-2

MFG. REF. REF. 862-600-023

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REF: EP938
FLATNESS
STRAIGHTNESS
CONCENTRICITY
PERPENDICULARITY
PROFILE OF LINE
PROFILE OF A SURFACE
DIAMETER
FINISH IN MICROINCHES

| | | | | | | | | | DATE |
|---|---|---|---|---|---|---|---|---|---|
| | ORIGINAL LOST/REDRAWN ON CAD | DAC | 4-21-1993 | | | | | DR. | |
| E | IN RELEASED GEAR NUT TORQUE | REM | 9-8-1995 | 3577-V | FCR | AGP | CH'D REM | | 12-8-1995 |
| D | REMOVED ITEM #43 | REM | 11-4-1998 | 3389-V | | | APP. FCR | | 1-12-1999 |
| C | ITEM 25 REVISED | REM | 9-8-1995 | 3339-V | | AGP | DRV AP | | 8-8-1996 |
| B | ADDED ITEM #43 | REM | 3-10-1997 | | | | SCALE | | |
| A | ADDED 7" | REM | 2-20-1997 | | | | CAD FILE / DIRECTORY | | |
| | REDRAWN | DB | 11-27-1996 | | | | /PARTS/XXAS | | |
| | REVISIONS | BY | DATE | CHANGE NOTICE | CHK'D. | APP. | NTS | | |

DO NOT SCALE FOR DIMENSIONS
ALL DIMENSIONS IN DECIMAL INCHES TO 3 PLACES UNLESS NOTED.

CHK'D BY

SECTIONAL ASSEMBLY
FOR 6" & 7" U-RAI BLOWER
WITH TAPER GEAR FIT

DRESSER Roots
DRESSER ROOTS, DRESSER, INC.
HOUSTON, TX

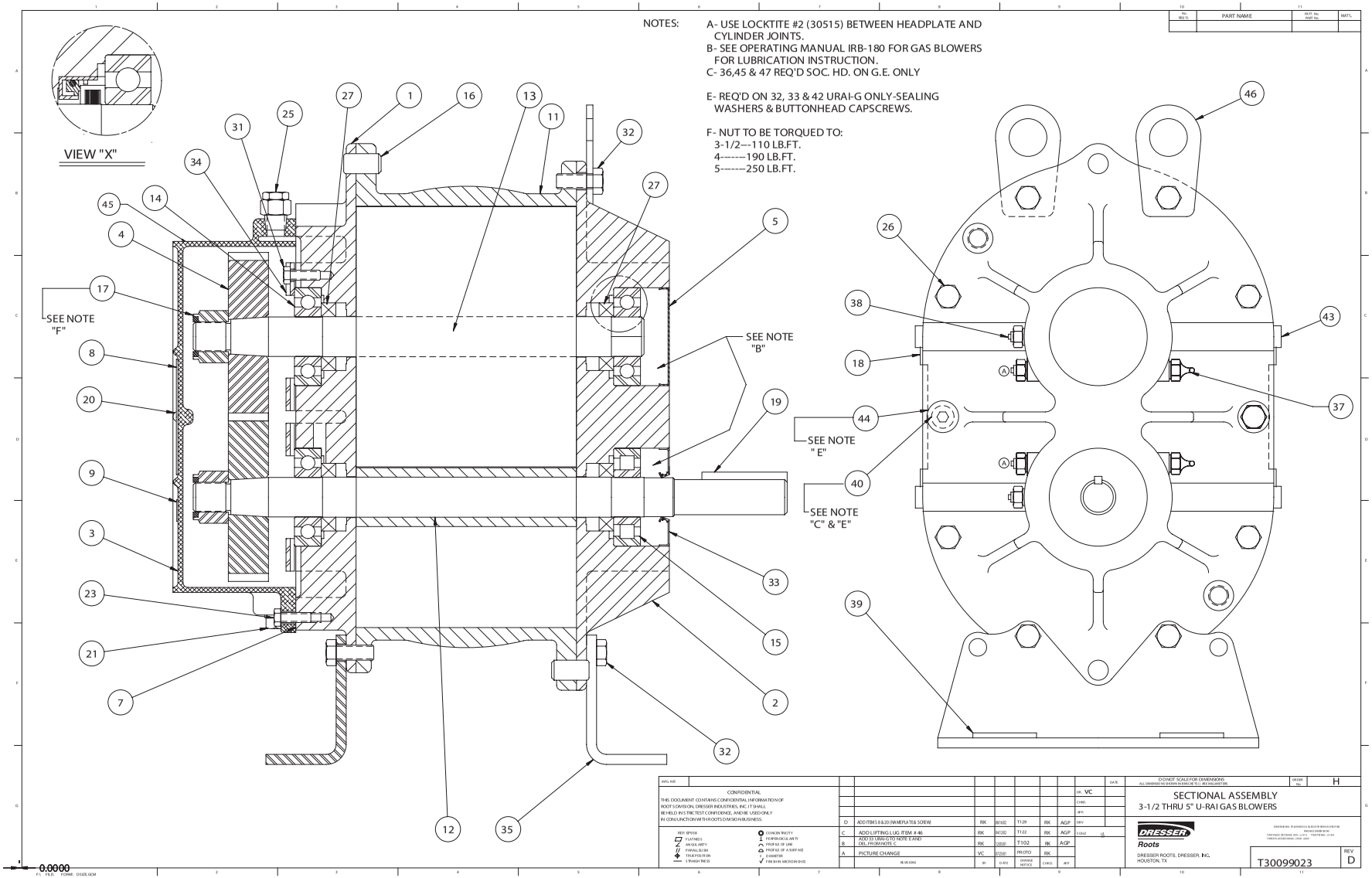
DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED
FRACTIONAL DIMENSIONS
PROFILE DECIMALS (.XX) = ±.010
THREE PLACE DECIMALS (.XXX) = ±.005
FRACTIONAL = ±1/64

64792023

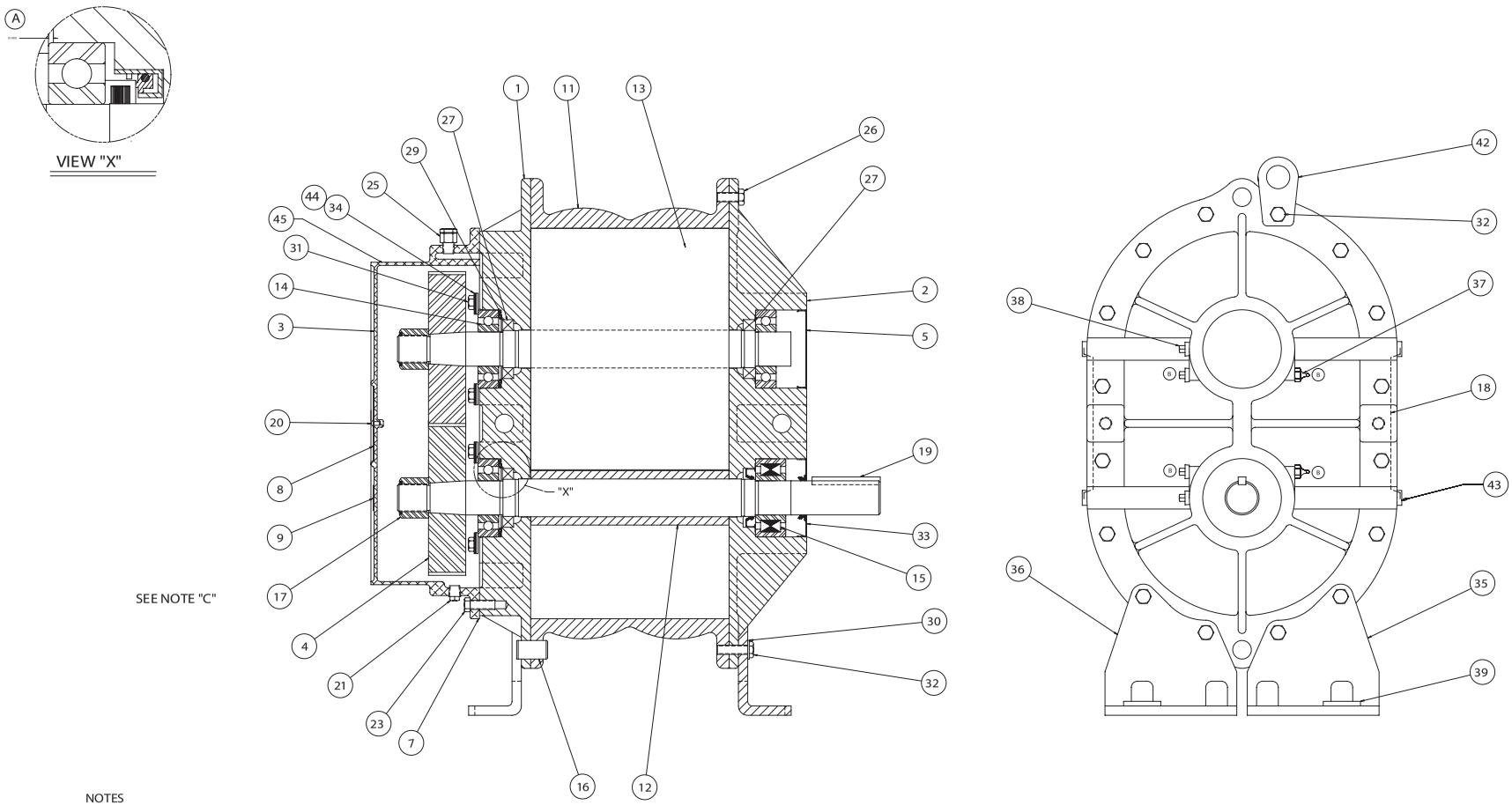
REV F



# ASSEMBLY OF UNIVERSAL RAI® BLOWERS, 6" AND 7" DIAMETER




## ASSEMBLY OF UNIVERSAL RAI™-G SERIES GAS BLOWERS, 3-1/2"THRU 5" GEAR DIAMETER




NOTES

A USE LOCKTITE #2 (30515) BETWEEN HEADPLATE AND CYLINDER JOINTS.

B SEE OPERATING MANUAL IRB-180 FOR LUBRICATION INSTRUCTION

C NUT TO BE TORQUED TO: 6"---400 LB. FT.

| PART NAME | PATT No. / PART No. | MATL. |
|---|---|---|
| | | |

| REVISIONS | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| C | ADD ITEMS # 8 & 20 (WAVEPLATE & SCREW) | RK | 11/16/12 | T129 | RK | | | |
| B | PICTURE CHANGE | VC | 07/25/11 | PROTO | RK | | | |
| A | ADDED DIMENSION .066 | VC | 06/28/11 | PROTO | RK | | | |

MFG REF. REF. 64792023

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DR. VC 07/12/11
CHKD.
APP.
DRV.
SCALE NTS

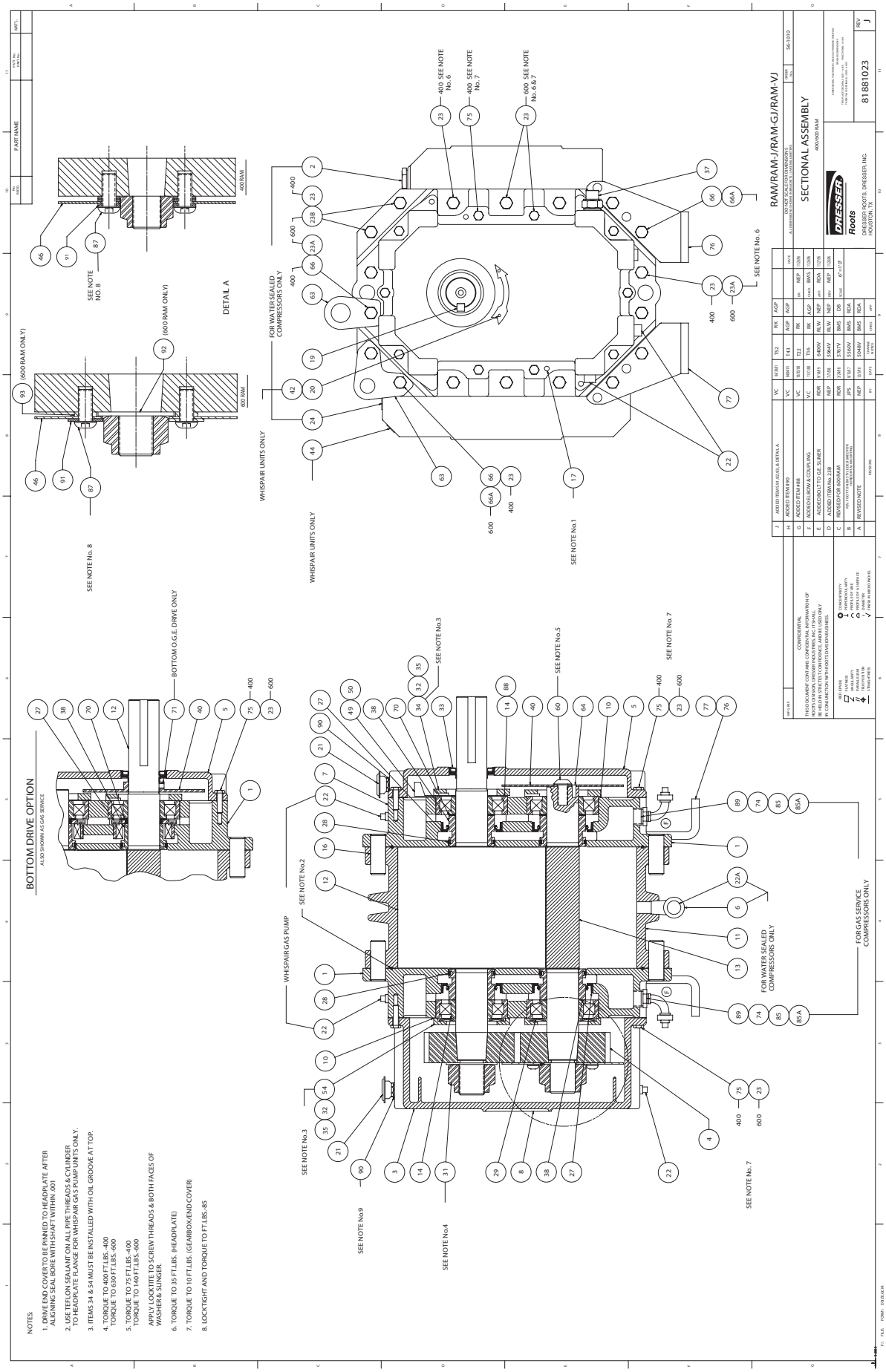
DO NOT SCALE FOR DIMENSIONS
ALL DIMENSIONS SHOWN IN PARENTHESIS ( ) ARE IN MILLIMETERS

SECTIONAL ASSEMBLY
FOR 6" U-RAI GAS BLOWERS

DRESSER Roots
DRESSER ROOTS, DRESSER, INC.
HOUSTON, TX

T30110023 REV B

# ASSEMBLY OF UNIVERSAL RAI® SERIES GAS BLOWERS, 6" GEAR DIAMETER




# ASSEMBLY OF RAM™ SERIES AIR & GAS BLOWERS

## UNIVERSAL RAI® SERIES BLOWERS PARTS LIST

| Item No. | Part Name | Qty. |
|---|---|---|
| 1 | Headplate Gear End | 1 |
| 2 | Headplate Drive End | 1 |
| 3 | Gearbox | 1 |
| 4 | Gears | 1 |
| 5 | Cover-Blind (Plug Opening) | 1 |
| 7 | Gasket | 1 |
| 9 | Nameplate Lube | 1 |
| 14 | Bearing G.E., - Driven | 3 |
| 15 | Bearing Drive D.E., - Drive | 1 |
| 16 | Pin, Dowel | 4 |
| 17 | Gear Nut | 2 |
| 19 | Key | 1 |
| 20 | Screw, Self Tap | 1 |
| 21 | Plug, Pipe | 3 |
| 23 | Screw Hex | 6 |
| 25 | Breather (Plug Vent) | 1 |
| 26 | Screw, Hex | 14 |
| 27 | Seal | 4 |
| 29 | Washer - wavy Spring | 2 |
| 30 | Washer | 8 |
| 31 | Screw, Hex | 4 |
| 32 | Screw, Hex | 4 |
| 33 | Seal Lip-Drive | 1 |
| 34 | Clamp Plate | 2 |
| 35 | Foot | 2 |
| 36 | Foot | 2 |
| 37 | Fitting, Grease | 2 |
| 38 | Fitting, Relief | 2 |
| 39 | Washer Flat | 4 |
| 40 | Screw Socket | 2 |
| 40* | Screw, Button Hd. | 4 |
| 42 | Screw Hex | 2 |
| 43 | Plug | 8 |
| 44* | Washer | 4 |

*For 32 and 42 URAI-G only.

# RAM™ SERIES PARTS LIST

| Item No. | Part Name | Qty. |
|---|---|---|
| 01 | Headplate | 2 |
| 03 | Gearbox | 1 |
| 04 | Gear, Assembly | 1 |
| 05 | End Cover | 1 |
| 07 | Gasket – Gearbox/Cover | 2 |
| 09 | Installation Tag | 2 |
| 10 | Shims-(.010) | Lot |
| 14 | Bearing Roller | 4 |
| 16 | Pin, Dowel (Pull Out) | 4 |
| 17 | Pin, Dowel | 2 |
| 19 | Key Square | 1 |
| 20 | Screw, Drive - Rd. Hd. | 4 |
| 21 | Breather | 2 |
| 22 | Plug, Pipe | 12 |
| 23 | Screw, Cap Hex Hd. | 24 |
| 27 | Seal, (Viton) | 4 |
| 28 | Piston, Ring-Seal | 4 |
| 29 | Washer, Wavy Spring | 2 |
| 31 | Nut, Hex ESNA | 2 |
| 32 | Scr, Cap Hex Hd. | 16 |
| 33 | Seal, Lip | 1 |
| 34 | Brg. Clamp Plate - D. E. | 2 |
| 35 | Lock Washer - Spring | 16 |
| 37 | Sight Plug - Oil Level | 2 |
| 38 | Sleeve - GE & DE | 4 |
| 38 | Sleeve - Piston Ring | 4 |
| 40 | Slinger - D.E. (Top Drive) | 1 |
| 40 | Slinger - D. E. (Bottom Drive) | 1 |
| 42 | Rotation Arrow | 1 |
| 44 | Label | 1 |
| 46 | Slinger - G.E. | 1 |
| 49 | Oil Leader L/S | 1 |
| 50 | Oil, Leader-R/S | 1 |
| 54 | Brg Clamp Plate - G. E. | 2 |
| 60 | Screw, Cap Butt. HD. | 1 |
| 63 | Lifting Lug | 2 |
| 64 | Pin, Spring | 1 |
| 66 | Screw, Cap Hex HD. | 12 |
| 66.1 | Whispair, Spring Lock 3/8M | 12 |
| 70 | Shims D.E. Brg. | 1 |
| 75 | Screw, Cap - Hex HD. | 20 |
| 76 | Blower Foot - RH | 2 |
| 77 | Blower Foot - LH | 2 |
| 85 | Elb, Pipe-Black | 2 |
| 85.1 | Plug, Pipe | 2 |
| 87 | Scr, Cap BH | 2 |
| 88 | Ball Spherical | 4 |
| 90 | BSHG-RDCG | 2 |
| 91 | Washer, Plain Flat | 2 |
| 92 | Washer, Plain Flat | 2 |
| 93 | Washer | 2 |

## NOTES

# CONTACT LIST

## CUSTOMER SERVICE

**Dresser ROOTS**
2135 Hwy 6 South
Houston, TX 77077
Toll Free Hot Line: 1-877-363-ROOT(S) (7668)
Toll Free Fax: 1-877-357-7238
Local Fax: 281-966-4309

**ROOTS Factory Service & Repair Center**
11611B Tanner RD
Houston, TX 77041
Toll Free: 1-800-866-6182
Local Phone: 713-896-4810
Local Fax: 713-896-4927

**Service & Warranty**
Toll Free: 1-800-866-6182
Local Phone: 832-467-4614
Local Fax: 713-896-4927

**Dresser, Inc.**

DRESSER®
*Roots*

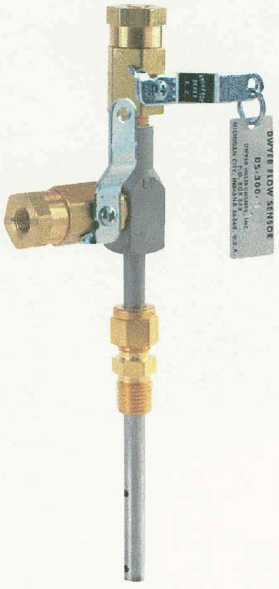
| | | |
|---|---|---|
| Dresser ROOTS<br>2135 Hwy 6 South<br>Houston, TX 77077<br>PH: 281-966-4700<br>FX: 281-966-4309<br>Toll Free: 1-877-363-ROOT(S) | Dresser ROOTS - Connersville<br>900 West Mount Street<br>Connersville, IN 47331<br>PH: 765-827-9200<br>FX: 765-827-9266 | Dresser ROOTS - Holmes Operation<br>PO Box B7<br>Off St. Andrews Rd<br>Turnbridge, Huddersfield<br>England HD1 6RB<br>PH: +44-1484-422222<br>FX: +44-1484-422668 |

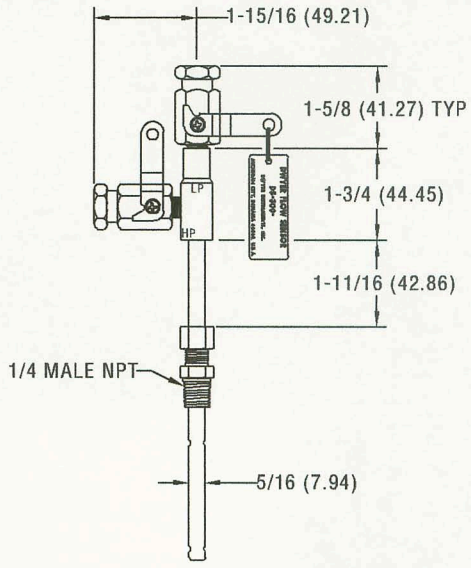
IRB-180-102
Rev. 12.02

**website: www.rootsblower.com • email: ROOTS@dresser.com**

# Series DS-300 Flow Sensors

## Installation and Operating Instructions Flow Calculations






**Series DS-300 Flow Sensors** are averaging pitot tubes that provide accurate, convenient flow rate sensing. When purchased with a Dwyer Capsuhelic® for liquid flow or Magnehelic® for air flow, differential pressure gage of appropriate range, the result is a flow-indicating system delivered off the shelf at an economical price. Series DS-300 Flow Sensors are designed to be inserted in the pipeline through a compression fitting and are furnished with instrument shut-off valves on both pressure connections. Valves are fitted with 1/8″ female NPT connections. Accessories include adapters with 1/4″ SAE 45° flared ends compatible with hoses supplied with the Model A-471 Portable Capsuhelic® kit. Standard valves are rated at 200°F (93.3°C). Where valves are not required, they can be omitted at reduced cost. Series DS-300 Flow Sensors are available for pipe sizes from 1″ to 10″.

### INSPECTION

Inspect sensor upon receipt of shipment to be certain it is as ordered and not damaged. If damaged, contact carrier.

### INSTALLATION

**General -** The sensing ports of the flow sensor must be correctly positioned for measurement accuracy. The instrument connections on the sensor indicate correct positioning. The side connection is for total or high pressure and should be pointed upstream. The top connection is for static or low pressure.

**Location -** The sensor should be installed in the flowing line with as much straight run of pipe upstream as possible. A rule of thumb is to allow 10 - 15 pipe diameters upstream and 5 downstream. The table below lists recommended up and down piping.

### PRESSURE AND TEMPERATURE

Maximum: 200 psig (13.78 bar) at 200°F (93.3°C).

**Upstream and Downstream Dimensions in Terms of Internal Diameter of Pipe***

| Upstream Condition | Minimum Diameter of Straight Pipe | | |
|---|---|---|---|
| | Upstream | | Downstream |
| | In-Plane | Out of Plane | |
| One Elbow or Tee | 7 | 9 | 5 |
| Two 90° Bends in Same Plane | 8 | 12 | 5 |
| Two 90° Bends in Different Plane | 18 | 24 | 5 |
| Reducers or Expanders | 8 | 8 | 5 |
| All Valves** | 24 | 24 | 5 |

* Values shown are recommended spacing, in terms of internal diameter for normal industrial metering requirements. For laboratory or high accuracy work, add 25% to values.

** Includes gate, globe, plug and other throttling valves that are only partially opened. If valve is to be fully open, use values for pipe size change. **CONTROL VALVES SHOULD BE LOCATED AFTER THE FLOW SENSOR.**

**DWYER INSTRUMENTS, INC.**
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Phone: 219/879-8000 www.dwyer-inst.com
Fax: 219/872-9057 e-mail: info@dwyer-inst.com

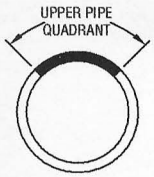
## POSITION

Be certain there is sufficient clearance between the mounting position and other pipes, walls, structures, etc, so that the sensor can be inserted through the mounting unit once the mounting unit has been installed onto the pipe.

Flow sensors should be positioned to keep air out of the instrument connecting lines on liquid flows and condensate out of the lines on gas flows. The easiest way to assure this is to install the sensor into the pipe so that air will bleed into, or condensate will drain back to, the pipe.

**For Air or Gas Flow**

Install in upper quadrant of pipe




Condensate drains back to pipe

**For Liquid or Steam Flow**

Install in lower quadrant of pipe


Air bleeds back to pipe

## INSTALLATION

1. When using an A-160 thred-o-let, weld it to the pipe wall. If replacing a DS-200 unit, an A-161 bushing (1/4˝ x 3/8˝) will be needed.

2. Drill through center of the thred-o-let into the pipe with a drill that is slightly larger than the flow sensor diameter.

3. Install the packing gland using proper pipe sealant. If the packing gland is disassembled, note that the tapered end of the ferrule goes into the fitting body.

4. Insert sensor until it bottoms against opposite wall of the pipe, then withdraw 1/16˝ to allow for thermal expansion.

5. Tighten packing gland nut finger tight. Then tighten nut with a wrench an additional 1-1/4 turns. Be sure to hold the sensor body with a second wrench to prevent the sensor from turning.

## INSTRUMENT CONNECTION

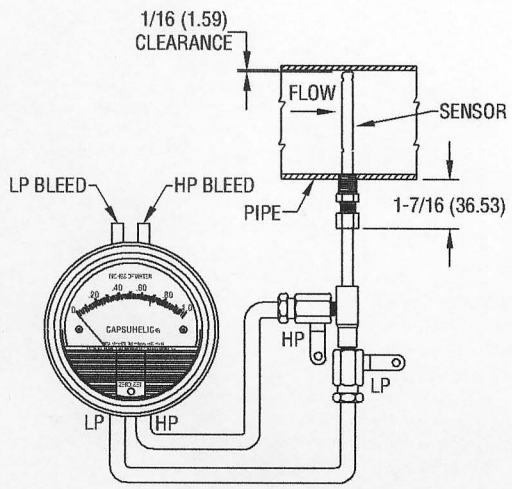
Connect the slide pressure tap to the high pressure port of the Magnehelic® (air only) or Capsuhelic® gage or transmitting instrument and the top connection to the low pressure port.

See the connection schematics below.

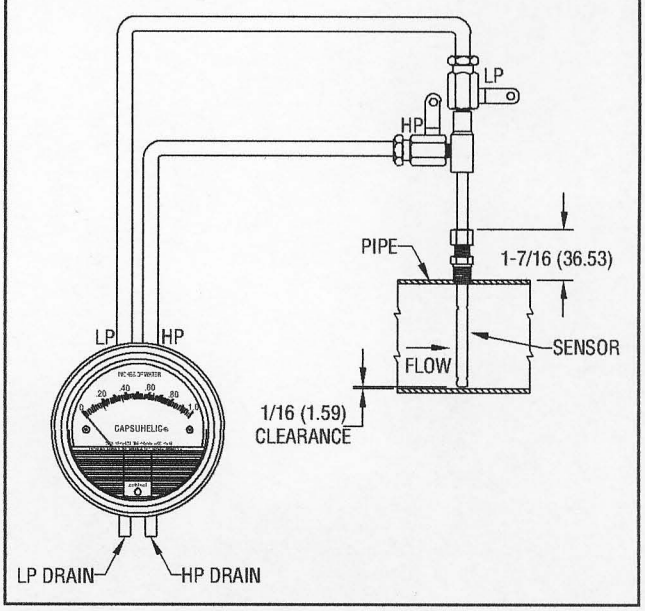
Bleed air from instrument piping on liquid flows. Drain any condensate from the instrument piping on air and gas flows.

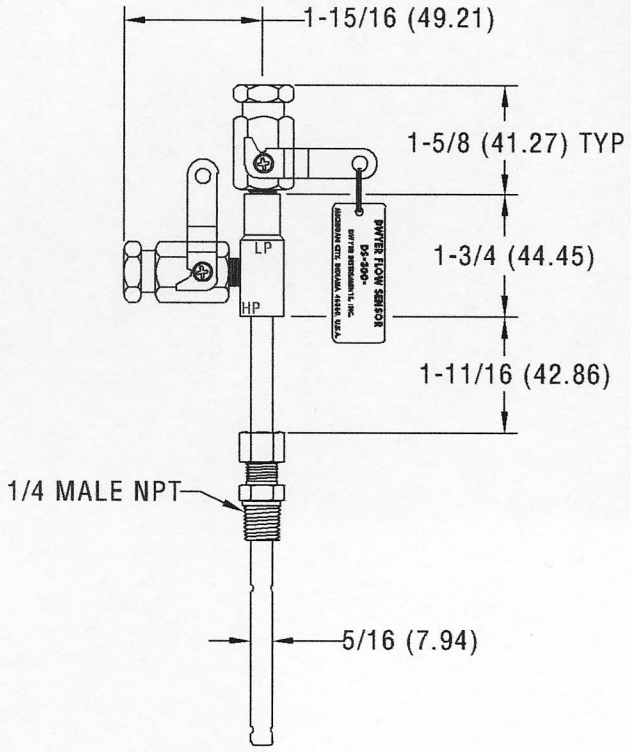
Open valves to instrument to place flow meter into service. For permanent installations, a 3-valve manifold is recommended to allow the gage to be zero checked without interrupting the flow. The Dwyer A-471 Portable Test Kit includes such a device.

**Water Flow**




**Air or Gas Flow**






**Flow Calculations and Charts**

The following information contains tables and equations for determining the differential pressure developed by the DS-300 Flow Sensor for various flow rates of water, steam, air or other gases in different pipe sizes.

This information can be used to prepare conversion charts to translate the differential pressure readings being sensed into the equivalent flow rate. When direct readout of flow is required, use this information to calculate the full flow differential pressure in order to specify the exact range of Dwyer Magnehelic® or Capsuhelic® gage required. Special ranges and calculations are available for these gages at minimal extra cost. See bulletins A-30 and F-41 for additional information on Magnehelic® and Capsuhelic® gages and DS-300 flow sensors.

For additional useful information on making flow calculations, the following service is recommended: Crane Valve Co. Technical Paper No. 410 "Flow of Fluids Through Valves, Fittings and Pipe." It is available from Crane Valve Company, www.cranevalve.com.

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Using the appropriate differential pressure equation from Page 4 of this bulletin,calculate the differential pressure generated by the sensor under normal operating conditions of the system. Check the chart below to determine if this value is within the recommended operating range for the sensor. Note that the data in this chart is limited to standard conditions of air at 60°F (15.6°C) and 14.7 psia static line pressure or water at 70°F (21.1°C). To determine recommended operating ranges of other gases, liquids an/or operating conditions, consult factory.

**Note:** the column on the right side of the chart which defines velocity ranges to avoid. Continuous operation within these ranges can result in damage to the flow sensor caused by excess vibration.

| Pipe Size (Schedule 40) | Flow Coefficient "K" | Operating Ranges Air @ 60°F & 14.7 psia (D/P in. W.C.) | Operating Ranges Air @ 60°F & 14.7 psia (D/P in. W.C.) | Velocity Ranges Not Recommended (Feet per Second) |
|---|---|---|---|---|
| 1 | 0.52 | 1.10 to 186 | 4.00 to 675 | 146 to 220 |
| 1-1/4 | 0.58 | 1.15 to 157 | 4.18 to 568 | 113 to 170 |
| 1-1/2 | 0.58 | 0.38 to 115 | 1.36 to 417 | 96 to 144 |
| 2 | 0.64 | 0.75 to 75 | 2.72 to 271 | 71 to 108 |
| 2-1/2 | 0.62 | 1.72 to 53 | 6.22 to 193 | 56 to 85 |
| 3 | 0.67 | 0.39 to 35 | 1.43 to 127 | 42 to 64 |
| 4 | 0.67 | 0.28 to 34 | 1.02 to 123 | 28 to 43 |
| 6 | 0.71 | 0.64 to 11 | 2.31 to 40 | 15 to 23 |
| 8 | 0.67 | 0.10 to 10 | 0.37 to 37 | 9.5 to 15 |
| 10 | 0.70 | 0.17 to 22 | 0.60 to 79 | 6.4 to 10 |

## FLOW EQUATIONS

1. Any Liquid

$$Q\ (GPM) = 5.668 \times K \times D^2 \times \sqrt{\Delta P / S_f}$$

2. Steam or Any Gas

$$Q\ (lb/Hr) = 359.1 \times K \times D^2 \times \sqrt{p \times \Delta P}$$

3. Any Gas

$$Q\ (SCFM) = 128.8 \times K \times D^2 \times \sqrt{\frac{P \times \Delta P}{(T + 460) \times S_s}}$$

## DIFFERENTIAL PRESSURE EQUATIONS

1. Any Liquid

$$\Delta P\ (in.\ WC) = \frac{Q^2 \times S_f}{K^2 \times D^4 \times 32.14}$$

2. Steam or Any Gas

$$\Delta P\ (in.\ WC) = \frac{Q^2}{K^2 \times D^4 \times p \times 128{,}900}$$

3. Any Gas

$$\Delta P\ (in.\ WC) = \frac{Q^2 \times S_s \times (T + 460)}{K^2 \times D^4 \times P \times 16{,}590}$$

## Technical Notations

The following notations apply:

$\Delta P$ = Differential pressure expressed in inches of water column
Q = Flow expressed in GPM, SCFM, or PPH as shown in equation
K = Flow coefficient— See values tabulated on Pg. 3.
D = Inside diameter of line size expressed in inches.

For square or rectangular ducts, use: $D = \sqrt{\frac{4 \times \text{Height} \times \text{Width}}{\pi}}$

P = Static Line pressure (psia)
T = Temperature in degrees Fahrenheit (plus 460 = °Rankine)
p = Density of medium in pounds per square foot
$S_f$ = Sp Gr at flowing conditions
$S_s$ = Sp Gr at 60°F (15.6°C)

## SCFM TO ACFM EQUATION

$$SCFM = ACFM \times \left(\frac{14.7 + PSIG}{14.7}\right) \left(\frac{520^*}{460 + °F}\right)$$

$$ACFM = SCFM \times \left(\frac{14.7}{14.7 + PSIG}\right) \left(\frac{460 + °F}{520}\right)$$

$$\text{POUNDS PER CUBIC FOOT STD.} = \text{POUNDS PER CUBIC FOOT ACT.} \times \left(\frac{14.7}{14.7 + PSIG}\right) \left(\frac{460 + °F}{520^*}\right)$$

$$\text{POUNDS PER CUBIC FOOT ACT.} = \text{POUNDS PER CUBIC FOOT STD.} \times \left(\frac{14.7 + PSIG}{14.7}\right) \left(\frac{520^*}{460 + °F}\right)$$

1 Cubic foot of air = 0.076 pounds per cubic foot at 60° F (15.6°C) and 14.7 psia.
* (520°= 460 + 60°) Std. Temp. Rankine


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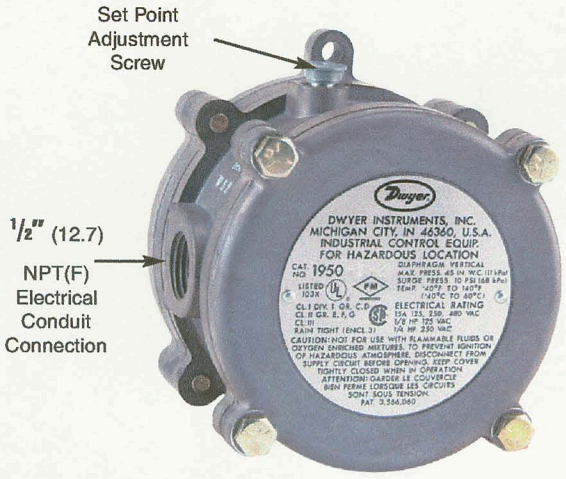
# Series 1950 – Explosion-Proof Differential Pressure Switches

## Specifications - Installation and Operating Instructions




**Series 1950 Explosion-Proof Differential Pressure Switches** combine the best features of the Dwyer Series 1900 Pressure Switch with an integral explosion-proof and weather-proof housing. Each unit is UL & CSA listed; FM approved for use in Class I, Groups C & D; Class II, Groups E, F, & G; and Class III atmospheres (NEMA 7 & 9). They are totally rain-tight for outdoor installations. Twelve models allow set-points from .03 to 20 inches w.c. and from .5 to 50 psi (3.4 to 345 kPa).

Easy access to the SPDT switch for electrical hook-up is provided by removing the top plate of the three-part aluminum housing. Adjustment to the set point of the switch can be made without disassembling the housing. The unit is very compact, about half the weight and bulk of equivalent conventional explosion-proof switches.

**CAUTION**

For use only with air or compatible gases. Use of the Model 1950 switch with explosive media connected to the Low pressure port (including differential pressure applications in such media) is not recommended. Switch contact arcing can cause an explosion inside the switch housing which, while contained, may render the switch inoperative. If switch is being used to sense a single positive pressure relative to atmosphere, run a line from the low pressure port to a non-hazardous area free of combustible gases. This may increase response time on -0 and -00 models.

**NOTE:** The last number-letter combination in the model number identifies the switch's electrical rating (number) and diaphragm material (letter). The 2F combination is standard as described in the physical data above. In case of special models, a number 1 rating is the same as 2; a number 3 or 4 rating is 10A 125, 250, 480 VAC; 1/8 H.P. 125 VAC; 1/4 H.P. 250 VAC; a number 5 or 6 rating is 1A 125 VAC. Letter B indicates a Buna-N diaphragm; N = Neoprene; S = Silicone; and V = Viton®.

**UL and CSA Listed, FM Approved For**
CL. I GR. C, D - CL. II GR. E, F, G - CL. III

**Series 1950 Switches**
Operating ranges and deadbands

| To order specify Model Number | Operating Range: Inches, W.C. | Approximate Dead Band | |
|---|---|---|---|
| | | At Min. Set Point | At Max. Set Point |
| 1950-02 | 0.03 to 0.10 | 0.025 | 0.05 |
| 1950-00 | 0.07 to 0.15 | 0.04 | 0.05 |
| 1950-0 | 0.15 to 0.5 | 0.10 | 0.15 |
| 1950-1 | 0.4 to 1.6 | 0.15 | 0.20 |
| 1950-5 | 1.4 to 5.5 | 0.3 | 0.4 |
| 1950-10 | 3.0 to 11.0 | 0.4 | 0.5 |
| 1950-20 | 4.0 to 20.0 | 0.4 | 0.6 |
| **Model Number** | **Operating Range: PSI** | **Approximate Dead Band** | |
| | | Min. Set Point | Max. Set Point |
| 1950P-2 | 0.5 to 2.0 | 0.3 PSI | 0.3 PSI |
| 1950P-8 | 1.5 to 8.0 | 1.0 PSI | 1.0 PSI |
| 1950P-15 | 3.0 to 15.0 | 0.9 PSI | 0.9 PSI |
| 1950P-25 | 4.0 to 25.0 | 0.7 PSI | 0.7 PSI |
| 1950P-50 | 15.0 to 50 | 1.0 PSI | 1.5 PSI |

## PHYSICAL DATA

**Temperature Limits:** -40° to 140°F (-40° to 60°C); 1950P-8, -15, -25, -50: 0° to 140°F (-17.8° to 60°C); 1950-02: - 30° to 130°F (-34.4° to 54.4°C).
**Rated Pressure:** 1950: 45 in. w.c. (0.1 bar); 1950P: 35 psi (2.4 bar); 1950P-50 only: 70 psi (4.8 bar).
**Maximum Surge Pressure:** 1950: 10 psi (0.7 bar); 1950P: 50 psi (3.4 bar); 1950P-50 only: 90 psi (6.2 bar).
**Pressure Connections:** 1/8" NPT(F).
**Electrical Rating:** 15A, 125, 250, 480 volts, 60 Hz. AC Resistive 1/8 H.P. @ 125 volts, 1/4 H.P. @ 250 volts, 60 Hz. AC.
**Wiring Connections:** 3-screw type; common, normally open and normally closed.
**Conduit Connections:** 1/2" NPT(F).
**Set point adjustment:** Screw type on top of housing, field adjustable.
**Housing:** Anodized cast aluminum.
**Diaphragm:** Molded fluorosilicone rubber, 02 model: silicone on Nylon.
**Calibration Spring:** Stainless Steel
**Installation:** Mount with diaphragm in vertical position.
**Weight:** 3 1/4 lbs (1.5 kg), 02 model; 4 lbs, 7 oz. (2 kg).

**RESPONSE TIME:** Because of restrictive effect of flame arrestors, switch response time may be as much as 10-25 seconds where applied pressures are near set point.

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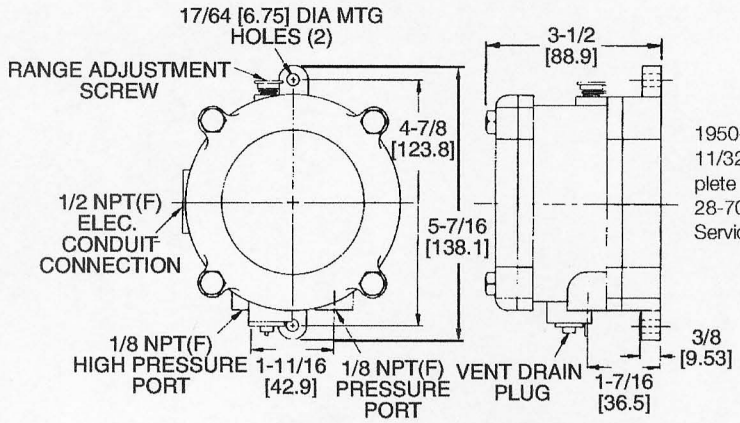
# Series 1950 – Explosion-Proof Differential Pressure Switches

## Specifications - Installation and Operating Instructions




**1950 Switch Outline Dimensions**

### INSTALLATION

1. Select a location free from excess vibration and corrosive atmospheres where temperatures will be within the limits noted under Physical Data on page 1. Switch may be installed outdoors or in areas where the hazard of explosion exists. See page 1 for specific types of hazardous service.

2. Mount standard switches with the diaphragm in a vertical plane and with switch lettering and Dwyer nameplate in an upright position. Some switches are position sensitive and may not reset properly unless they are mounted with the diaphragm vertical.

3. Connect switch to source of pressure, vacuum or differential pressure. Metal tubing with 1/4" O.D. is recommended, but any tubing which will not restrict the air flow can be used. Connect to the two 1/8" NPT(F) pressure ports as noted below:

A. Differential pressures - connect pipes or tubes from source of greater pressure to high pressure port marked HIGH PRESS, and from source of lower pressure to low pressure port marked LOW PRESS.

B. Pressure only (above atmospheric pressure) - connect tube from source of pressure to high pressure port. The low pressure port is left open to atmosphere.

C. Vacuum only (below atmospheric pressure) - connect tube from source of vacuum to low pressure port. The high pressure port is left open to atmosphere.

4. To make electrical connections, remove the three hex head screws from the cover and after loosening the fourth captive screw, swing the cover aside. Electrical connections to the standard single pole, double throw snap switch are provided by means of terminals marked "COM" (common), "NO" (norm open), "NC" (norm closed). The normally open contacts close and the normally closed contacts open when pressure increases beyond the set point. Switch loads for standard models should not exceed the maximum specified current rating of 15 amps resistive. Switch capabilities decrease with an increase in ambient temperature, load inductance, or cycling rate. Whenever an application involves one or more of these factors, the user may find it desirable to limit the switched current to 10 amps or less in the interest of prolonging switch life.

### ADJUSTMENT: To Change the Set point

1. Remove the plastic cap and turn the slotted Adjust-ment Screw at the top of the housing clockwise to raise the set point pressure and counter-clockwise to lower the set point. After calibration, replace the plastic cap and re-check the set point.

2. The recommended procedure for calibrating or checking calibration is to use a "T" assembly with three rubber tubing leads, all as short as possible and the entire assembly offering minimum flow restriction. Run one lead to the pressure switch, another to a manometer of known accuracy and appropriate range, and apply pressure through the third tube. Make final approach to the set point very slowly. Note that manometer and pressure switch will have different response times due to different internal volumes, lengths of tubing, fluid drainage, etc. Be certain the switch is checked in the position it will assume in use, i.e. with diaphragm in a vertical plane and switch lettering and Dwyer nameplate in an upright position.

3. For highly critical applications check the set point adjustment and if necessary, reset it as noted in step A.

### MAINTENANCE

The moving parts of these switches need no maintenance or lubrication. The only adjustment is that of the set point. Care should be taken to keep the switch reasonably clean. Periodically the vent drain plug should be rotated, then returned to its original position. This will dislodge deposits which could accumulate in applications where there is excessive condensation within the switch.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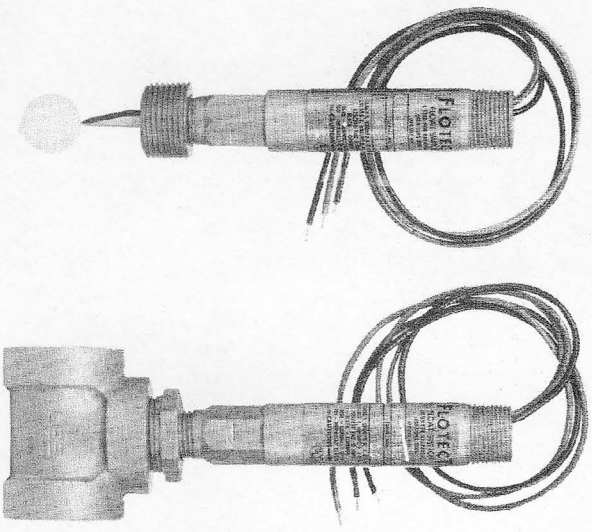
# FLOTECT™ MODEL L-6 FLOAT SWITCH

## Installation and Operating Instructions



**Explosion-Proof; U.L. and C.S.A. Listed -**
**Class I, Groups *A, B, C & D**
**Class II, Groups E, F & G**
**CENELEC: EExd IIC T6 (T amb=75°C)**
*(Group A, stainless steel body only)

### PHYSICAL DATA

**Temperature Limit:** 220°F (105°C) maximum
**Maximum Pressure:** See chart below
**Switches:** One or two SPDT snap switches
**Electrical Rating: U.L.:** 5A @ 125/250 VAC.
**C.S.A. and CENELEC:** 5A @ 125/250 VAC, 5A resistive, 3A inductive @ 30 VDC.
Optional ratings: MV option—Gold contacts for dry circuits. Rated 0.1A @ 125 VAC MT option: 400°F (205°C) 5A @ 125/250 VAC (not listed).
**Wiring Connections:** 3-18" (460mm) wire leads, 18 ga.
CENELEC models only: push-in type terminal blocks
Black = common, blue = N.O., red = N.C.
**Minimum Specific Gravity:**
Polypropylene float - 0.9
Round SS float - 0.7
Cylindrical SS float - 0.5
**Switch Body:** Brass 3/4" NPT conduit connection.
For SS switch body, change model no. to L6EPS.
**Piping/Mounting Connection:** 1" NPT
**Installation:** Horizontal, index arrow pointing down.
**Weight:** 1 lb. (.5 KG); w/external chamber 1-3/4 lb. (.8 KG)

### WETTED MATERIALS CHART

| Model | Brass | Bronze | Ceramic | Polypropylene | 301SS | 303SS | 304SS |
|---|---|---|---|---|---|---|---|
| B-S-3-A | X | | X | | X | | X |
| B-S-3-B | X | X | X | X | X | | |
| B-S-3-C | X | | X | | X | | X |
| B-S-3-H | X | X | X | | X | | X |
| B-S-3-O | X | | X | X | X | | |
| S-S-3-A | | | X | X | X | | X |
| S-S-3-C | | | X | | X | X | X |
| S-S-3-L | | | X | | X | X | X |
| S-S-3-O | | | X | X | X | X | |
| S-S-3-S | | | X | X | X | X | |

### MAXIMUM PRESSURE CHART

| Model Number | Float | Pressure Rating PSIG (KG/CM²) |
|---|---|---|
| L6EPB-B-S-3-A | Cylindrical SS | 200 (14) |
| L6EPB-B-S-3-B | Polypropylene | 250 (18) |
| L6EPB-B-S-3-C | Round SS | 350 (25) |
| L6EPB-B-S-3-H | Round SS | 250 (18) |
| L6EPB-B-S-3-O | Polypropylene | 1000 (70) |
| L6EPB-S-S-3-A | Cylindrical SS | 200 (14) |
| L6EPB-S-S-3-C | Round SS | 350 (25) |
| L6EPB-S-S-3-L | Round SS | 350 (25) |
| L6EPB-S-S-3-O | Polypropylene | 2000 (140) |
| L6EPB-S-S-3-S | Polypropylene | 2000 (140) |

### INSTALLATION:

Unpack switch and remove any packing material found inside lower housing or float chamber.

Switch must be installed with body in a horizontal plane and arrow on side pointing down.

If switch has an external float chamber (tee), connect it to vertical sections of 1" NPT pipe installed outside vessel walls at appropriate levels. If unit has no external float chamber, it must be mounted in a 1" NPT half coupling welded to the vessel wall. The coupling must extend through the wall.

Inspect and clean wetted parts at regular intervals.

### ELECTRICAL CONNECTIONS:

Connect wire leads in accordance with local electrical codes and switch action required. N.O. contacts will close and N.C. contacts will open when liquid level causes float to rise. They will return to "normal" condition on decreasing liquid level. Black = common, Blue = N.O. and Red = N.C.

For units supplied with both internal and external grounds, the ground screw inside the housing must be used to ground the control. The external ground screw is for supplementary bonding when allowed or required by local code. Some CSA listed models are furnished with a separate green ground wire. Such units must be equipped with a junction box, not supplied but available on special order.

CENELEC certified models include a junction box. Cable should enter enclosure through an approved EX cable gland, not supplied. Push stripped and tinned leads into appropriate openings in terminal block(s). To connect fine stranded leads or to remove any wire, depress spring release with small screwdriver first.

All wiring, conduit and enclosures must meet applicable codes for hazardous areas. Conduits and enclosures must be properly sealed. For outdoor or other locations where temperatures vary widely, precautions should be taken to prevent condensation inside switch or enclosure. Electrical components must be kept dry at all times. **CAUTION:** To prevent ignition of hazardous atmospheres, disconnect the device from the supply circuit before opening. Keep assembly tightly closed when in use.

*Dimensions on reverse*

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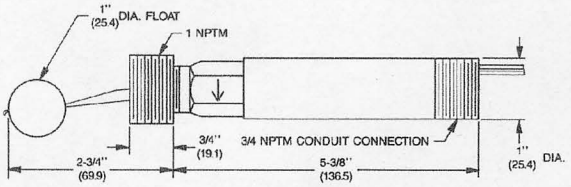
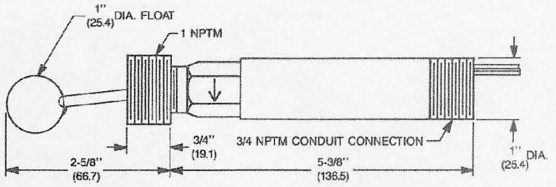
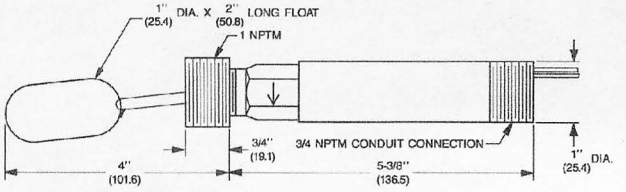
# FLOTECT MODEL L-6 FLOAT SWITCH — DIMENSION DRAWINGS



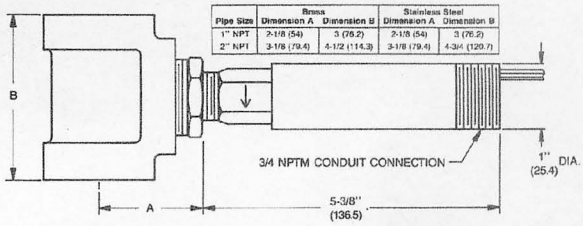

**Polypropylene Float**



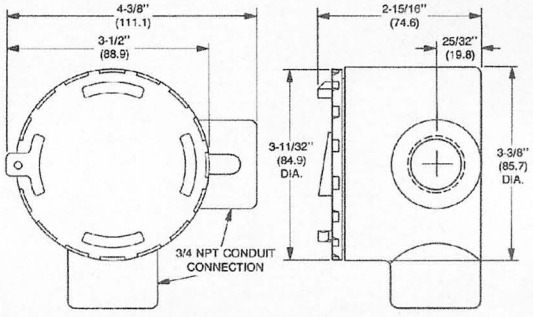

**Round Stainless Steel Float**




**Cylindrical Stainless Steel Float**




**With External Float Chamber (Tee)**




**CSA, CENELEC Conduit Enclosure**

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