HAYWARD GORDON ULC

Pumps • Mixers • Strainers

Engineered Systems and Controls

Operation and Maintenance Manual

ANSI*Max* HORIZONTAL CENTRIFUGAL PUMP

PROJECT:	
EQUIPMENT:	
MODEL:	
QUANTITY:	
SERIAL #:	
LOCAL REPRESENTATIVE:	
DATE:	

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THE HAYWARD GORDON GUARANTEE

HAYWARD GORDON ULC endeavours to supply equipment of the highest quality both in materials and workmanship. However, within one year from date of startup or eighteen (18) months from date of shipment (whichever comes first) if any part of the equipment manufactured by HAYWARD GORDON ULC is proven to have been defective in material or workmanship, HAYWARD GORDON ULC shall have the right and obligation to promptly repair or replace such part F.O.B its works. Pumps or parts to be considered for warranty repair or replacement must be returned freight prepaid to Hayward Gordon's factory at Halton Hills, ON. We reserve the right to require the return of defective parts before any claim is recognized.

Materials are certified to be of the specified composition, however, the materials are not guaranteed against chemical attack or wear.

No other warranty or condition, whether statutory or otherwise, is made, intended or to be implied and, except for its obligation to repair or replace defective parts as provided for above, HAYWARD GORDON ULC will not be responsible for any costs or damages, direct or indirect, which may result to the Purchaser from any defect in the equipment (whether of workmanship, material, design or otherwise) or from any breakage or stoppage thereof. Such costs specifically include, but are not limited to, equipment removal, re-installation, and freight. In any event, the liability of HAYWARD GORDON ULC arising through the supply of defective equipment shall not exceed the purchase price of the equipment.

For equipment included in this unit but manufactured by others, HAYWARD GORDON ULC will endeavor to assign to the purchaser, the guarantee extended by such manufacturers to HAYWARD GORDON ULC

No modifications to this guarantee may be extended without the written authorization of a signing officer of HAYWARD GORDON ULC

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I. INSTALLATION

CAUTION!
Before putting pump into service carefully study and adhere to all sections of this manual, as this is necessary for safe and satisfactory operation of your new Hayward Gordon Pump.

This pump has components with sharp edges and pinch areas that can cause cuts. Always wear protective gloves when working on or around the pump.

Always disconnect electrical power and lock out the motor starter before performing any work on the pump/motor unit. On duplex pumps with alternating relays, both starters must be locked out regardless of which pump is being worked on.

A. Unloading

Care must be taken when unloading pump. Unit must be lifted from all four lifting points in each corner of the base.

CAUTION!
An adequately sized crane or hoist must be used to lift unit.

All lifting equipment (i.e., chains, hooks and eyes) must be in accordance with local, or federal safety codes.

Failure to use approved lifting equipment may result in serious injury.

B. Inspection

Inspection should be performed immediately after unloading pump. Examine equipment for broken, cracked, bent or missing parts. Carefully check:

1. Base
2. Motor, pump feet, coupling and flanges
3. Shafts
4. Motor end bells, eyebolts, conduit box.

Report all damage or loss to the transportation company and Hayward Gordon.

C. Storage

If the pump is not to be installed and operated shortly after arrival (more than two weeks), sufficient preparation for storage should be made.

1. Inspect pump on skid or open crate if applicable and check for any signs of damage due to shipment.
2. Remove glands, packing and lantern ring from stuffing box. If pump is fitted with a mechanical seal, ensure seal faces are dry.
3. Protect exposed steel parts with a rust preventative.
4. Cover pump suction, discharge and all opening with masking tape, wood or cardboard.
5. Store pump in a dry location, protected from moisture, dirt, dust, pests and vibrations or rattles.
6. Cover pump with tarpaulin if area has no protective covering.
7. Rotate shaft every week to prevent pitting of bearing surfaces. Monthly inspections are recommended.
8. Re-grease motor bearings (if applicable) every six months and rotate the shaft by hand every week.
9. For pumps with grease lubricated bearings, re-grease at six month intervals.
10. For pumps with oil lubricated bearings, remove the vent at the top of the bearing housing and fill the chamber completely with a 20W non-detergent oil which contains rust inhibitors. Replace the vent after filling. Before starting the pump, drain the oil to the recommended level and run for two minutes. Stop the pump and drain completely of oil. Refill the bearing housing with new oil, refer to section IV Oil Lubricated Bearings for recommended oils and quantities.

D. Cleaning

Clean surfaces of suction and discharge flanges before installation. If pump was in storage, remove all grease and oil from bearings. Flush bearings with kerosene or carbon tetrachloride and re-lubricate (See MAINTENANCE).

E. Location

Allow ample space for maintenance and inspection. Provide headroom and ventilation in a dry location. **Do not** locate near dangerous or harmful elements or temperatures. Install as near to liquid source as possible. Use shortest possible direct suction pipe. Keep discharge piping direct with minimum of elbows (long radius preferred) and fittings.

F. Foundation

The foundation should be 3" to 6" wider and longer than base plate. Keep surface clean, yet rough. Do not grout until pipe connections are made and alignment established.

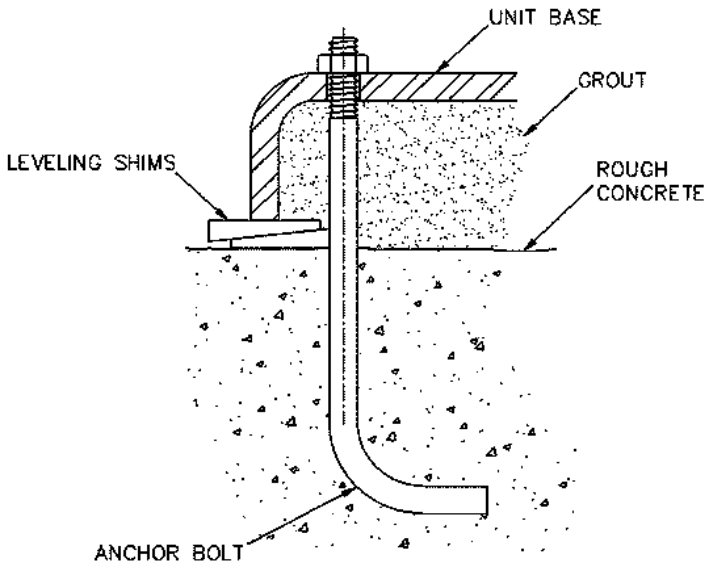


Figure I-1: Typical Anchor Bolt Detail

G. Mounting

Using Hayward Gordon plans, check pump dimensions against foundation and piping dimensions to assure fit.

1. Thoroughly clean and prepare foundation for proper bonding.
2. Lower complete assembly (pump, motor and base) into place.

CAUTION!

Attach the lifting devices to the baseplate – Do not lift the unit from the motor or pump. Use the appropriate equipment to evenly distribute the load.

3. Place wedges as close to foundation bolts as possible and raise unit to desired elevation. Align the unit to the piping.
4. Careful alignment of coupling is essential. All units are aligned at the factory but still need to be checked for any distortion or shifting caused during shipping or installation.
5. If the pump is supplied without a driver, locate the motor on the base plate by setting the shaft gap and drill the mounting holes.

H. Alignment – Direct Drive

This section must be carefully studied prior to installation or alignment of the pump/motor unit. See table below.

Table I-1: Woods Spacer Couplings

Maximum RPM and Allowable Misalignment			
Sleeve Size	**Max. RPM**	**Parallel (in.)**	**Angular (in.)**
3	9200	0.010”	0.035”
4	7600	0.010”	0.043”
5	7600	0.015”	0.056”
6	6000	0.015”	0.070”
7	5250	0.020”	0.081”
8	4500	0.020”	0.094”
9	3750	0.025”	0.109”
10	3600	0.025”	0.128”
11	3600	0.032”	0.151”
12	2800	0.032”	0.175”
13	2400	0.040”	0.195”
14	2200	0.045”	0.242”
16	1500	0.062”	0.330”

1. Pump suction and discharge piping should be installed but not connected prior to alignment. The piping should be supported independently of the pump.
2. Remove the coupling spacer from between the hubs.
3. Using a dial indicator on the pump coupling hub, check the parallel alignment to the motor coupling hub. Shim between the motor feet and base until the required parallel alignment is achieved.
4. With the same dial indicator, check the angular alignment of the motor drive coupling hub face and shim motor until the required angular alignment is achieved.
5. Repeat the same checks with the dial indicator attached to the motor drive coupling hub.
6. With the dial indicator attached to the motor coupling hub, simultaneously tighten the four motor feet without movement of the dial indicator.
7. The final alignment check and adjustment should be performed after piping is installed and the unit has reached its normal operating temperature to ensure that thermal expansion has not caused misalignment.

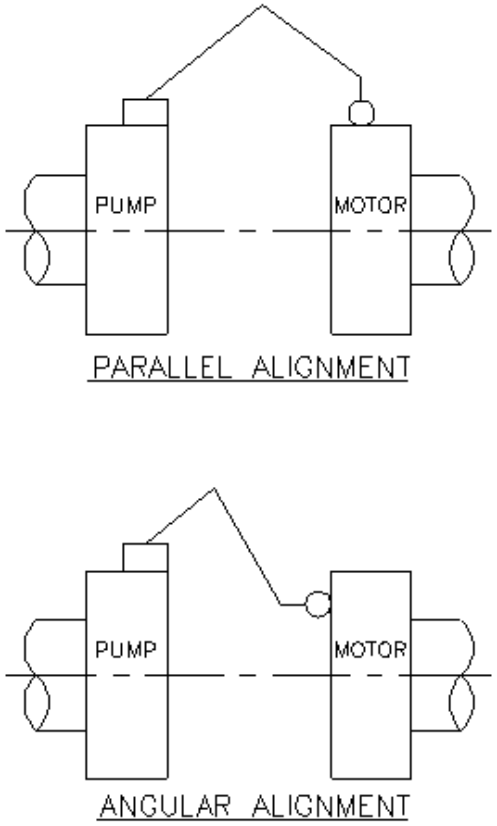


Figure I-2: Alignment

I. Grouting

1. Build form or dam around foundation.
2. Pour grout through hole or holes in base until the entire space inside base is filled. No voids should be present.
3. Allow 48 hours for grout to set. Recheck alignment and verify that no voids exist between the grout and the baseplate.
4. Tighten foundation bolts securely if alignment is correct.

J. Piping

Connecting of piping is done only after grout has set and coupling alignment verified.

1. Remove all foreign objects and debris from the piping (i.e. tools, materials, rags or slag).
2. Independent piping supports should be near the pump to eliminate loads being transferred.

CAUTION!

Do not use the pump and baseplate to support the piping and contents.

3. Wait until the grout has fully set before connecting the piping.
4. Never draw piping into place by use of force at the flanged suction or discharge connections. The suction and discharge lines should begin at the pump - ending the piping lines at the pump will cause distortion.
5. Provide expansion joints, bends or loops and hangers when handling hot liquids to prevent nozzle loads. A change in temperature of 50° F will result in a movement of 3/8" in 100 feet of line. Locate discharge side expansion joints after the first pipe anchor to prevent excessive reaction loads on the pump.

(I) Suction Piping

The suction pipe should be as short and direct as possible and one size larger than the pump suction nozzle. The size of the pipe depends on:

1. Nameplate capacity
2. Suction pipe length
3. Number and type of fittings
4. Static suction lift

Increasing sizes of the suction and discharge pipes will lower friction head loss. The piping should be as direct as possible, making long radius bends whenever possible.

Check that the NPSH available at the operating point is greater than the NPSH required by the pump before finalizing the suction pipe size. The performance curve typically shows the pump's NPSH requirements.

The highest point in the suction line should be at the pump to avoid air pockets. Lay pipe on gradual decline, avoid high points and use eccentric reducers when increasing pipe size in horizontal lines. All joints in the suction line must be airtight and either screwed or flanged.

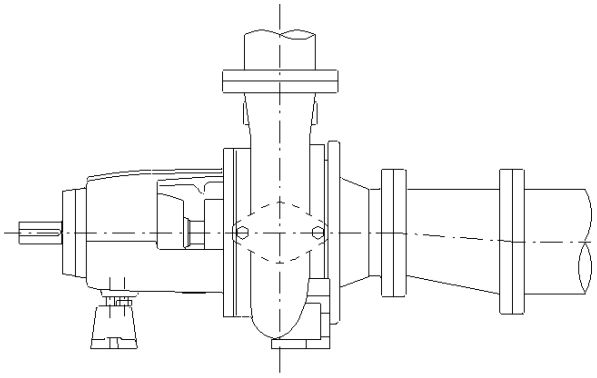


Figure I-3: Recommended Suction Piping

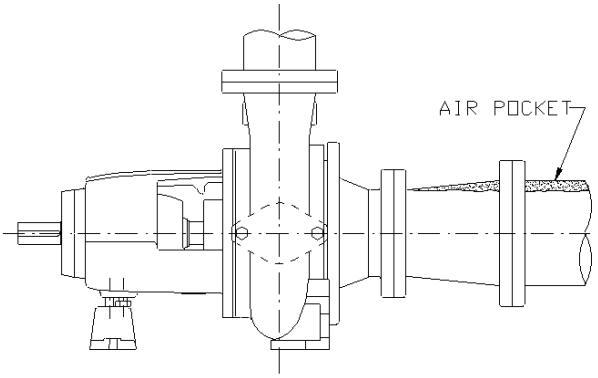


Figure I-4: Incorrect Suction Piping

Through type valves such as gate valves are preferred. If the pump is drawing a suction lift with a horizontal suction line, place the valve stem in a vertical downward position, or on the horizontal plane. Foot valves and strainers must have free openings at least three times the area of the suction pipe. Submerged valves must have four to five times the suction pipe diameter. Provide a floating board surrounding the suction pipe if submergence is limited.

There should be no turbulence near the entrance to the pump suction line.

Never throttle for capacity adjustment on suction side.

(II) Discharge Piping

Select the size of the discharge pipe so the frictional loss, plus static discharge head, plus working suction lift, does not exceed the total dynamic head on nameplate. Failure to consider the frictional losses will result in power wastage.

Start the discharge pipe at the pump, ending at the final discharge point. Avoid abrupt pipe size changes and use only concentric taper increasers.

Recheck the pump alignment after all the piping is connected.

K. Service Connections

Except where approved by Hayward Gordon, at the time of quotation, packing and mechanical seals must be flushed with clean lubricating liquid. Typical flush is below 120° F and 10-20 psi over the maximum pump discharge pressure. All service connections/ports are plugged with temporary plastic plugs at the factory – it is the installer's responsibility to install permanent plugs in the unused ports that will not have flush or drain piping connected to them. Flush liquid supplies should be installed so as to supply continuous liquid when pump is operating.

(I) Piping connection seal/packing flush:

The connection shown as Tap V in Figure I-5 must be used to supply continuous clean water (compatible with pumpage) to the lantern ring and packing. Supply pressure may be regulated with a throttling valve in the water line.

With new packing, adjust gland to allow a generous initial stuffing box leakage of 90-120 drops per minute. As the packing runs in it heats up and expands.

This cuts off the supply of lubricating and cooling liquid and this causes failure of the packing and scoring of the shaft of shaft sleeve. Gradually tighten gland nuts over a 6-hour period until leakage has reduced to 30-60 drops per minute.

If a water source is not available, a spring loaded grease cup may be used to supply grease to the lantern ring and packing through this connection.

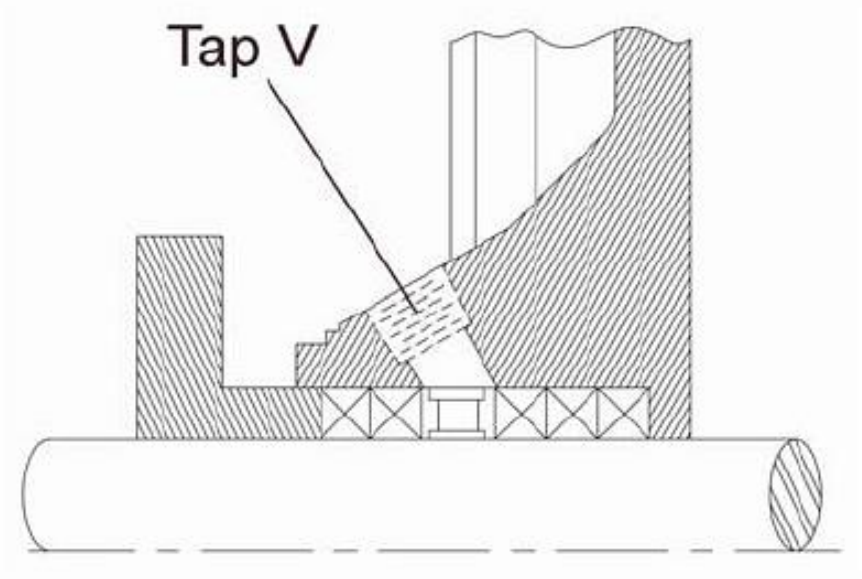


Figure I-5: Packing Flush Connection

(II) Single Mechanical Seal

A flush is often not required when using a single mechanical seals. If the application requires a clean flush (usually water) it must be supplied at a minimum pressure level of approximately 5 psi over the maximum pump discharge pressure in order to guarantee adequate flow through the chamber. A higher pressure source of supply to the seal coupled with a flow meter allows more control of the flow through the seal chamber eliminating possible pressure reversals and seal chamber contamination.

A single connection is required at the top of the seal gland to supply clean lubricating liquid to the mechanical seal faces.

(III) Double Mechanical Seal

Two seals are orientated back to back to provide a closed area in which a proper seal lubricant and coolant is circulated at a pressure of 15 psi over the discharge pressure of the pump. The liquid is cooled and lubricated from an external source and piping is so aligned that maximum circulation is incorporated in its function.

Two connections are required for the supply and return of a clean lubricating, "barrier" liquid. Always check compatibility of barrier fluid with pumped media. The service connection located at the bottom portion of the seal gland is used as the "IN" connection for the double mechanical seal. Filling from the bottom ensures a flooding action of the seal chamber. A service connections at the top of the seal chamber can be used as the return or "OUT" connection. Lubricating liquid, entering at the lower connection, should be at 15 psi over the maximum pump discharge pressure. Supply pressure should be controlled with a regulating valve installed in one seal with piping after the seal chamber.

The regulatory valve should be installed on the output side of the seal chamber.

NOTE: Flush liquid supplies should be installed so as to supply liquid when pump motor is operating. This will insure pump is not running without required fluid.

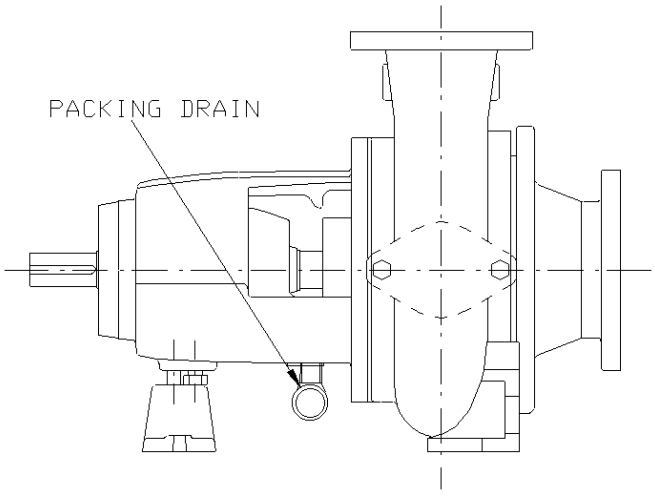


Figure I-6: Packing Drain

A packing drain can be used to divert stuffing box leakage to a standard drain.

L. Final Alignment

Verify pump alignment after all piping is connected.

II. OPERATION

A. Pre-Starting

CAUTION!

Before starting the pump, lubrication must be supplied to the packing or mechanical seal.

1. Prepare motor as specified by driver manufacturer and conform to wire and fuse sizes, types, and recommendations.
2. Be sure to disconnect coupling between the pump and motor shafts. With coupling disconnected, jog starter switch on motor to be sure wiring is properly connected, and rotation is correct. All pumps rotate clockwise if viewed from motor toward pump. Incorrect rotation of pump can unscrew impeller and cause severe damage.
3. Check connections of suction and discharge piping. Recheck pump alignment.
4. Ensure that coupling guard and all other safety devices are in place and correctly installed.
5. Mechanical seals need ample lubrication to prevent scoring of seal faces. Always install open type drain in discharge of seal cooling liquid piping so temperature and flow can be determined and controlled. Check Instructions in the MAINTENANCE section.
6. Check bearing lubrication in the maintenance section of this manual.
   Note: Bearing housings are not filled with oil prior to shipment.
7. Pump must be primed before starting. Do not operate unless pump is filled with liquid.

CAUTION!

Read "SETTING NEW PACKING" Instructions in MAINTENANCE section prior to start up for a description of run-in procedures.

B. Initial Starting

1. Start motor with suction valve fully open, suction valve should never be closed or throttled during operation. Discharge valve should be partially open during initial startup and then slowly moved to the fully open position.

CAUTION!

Never operate the pump for more than a very short interval with discharge valve closed. Never operate the pump with both suction and discharge valves closed. This could cause an explosion.

2. Be sure pump is delivering liquid and running quietly.
3. Check bearing temperature and stuffing box operation. If bearings appear to run hot on first starting, see Section IV.B – Oil Lubricated Bearings / IV.C – Grease Lubricated Bearings
4. Do not operate the pump for an extended period of time below the minimum recommended flow (see table in Appendix A) in order to conform to bearing life, shaft deflection, and vibration limits. Pumps may be operated at lower than the minimum recommended flow, although typically not below 10% of the flow at best efficiency point (BEP), but it must be recognized that the pump may not conform to one or more of these limits.

CAUTION!

Lo-Flo pumps are not covered by the minimum flow table. All pumps, including the Lo-Flo models, must not operate below the "Minimum Thermal Flow". This is defined as the minimum flow that will not cause an excessive temperature rise. Do not operate the pump below Minimum Thermal Flow, as this could cause an excessive temperature rise. Contact a Sales Engineer for determination of Minimum Thermal flow.

5. Do not exceed the maximum design pressure. See APPENDIX B – Pressure-Temperature Limits By Alloy for general pressure versus temperature ratings of common alloys.

C. Throttling

Never throttle suction line. Throttle or partially close discharge valve when operating at reduced capacity.

D. Net Positive Suction Head – available ($NPSH_A$)

NPSH available ($NPSH_A$) is the measure of the energy in a liquid above the vapour pressure expressed in feet. It is used to determine the likelihood that a fluid will vapourize in the pump. For a pump to operate properly, the $NPSH_A$ must be greater than the NPSH required ($NPSH_R$) – good practice dictates that this margin should be at least 5 ft (1.5m) or 20%, whichever is higher. The $NPSH_R$ can be found on the pump performance curve or provided by the pump manufacturer. The $NPSH_A$ is system related and can be calculated using the following formula.

$$NPSH_a = \frac{H_a - H_{vpa}}{SG} * 2.31 \pm H_s - H_f - H_v$$

H_a	Pressure on top of fluid including atmospheric (psia).
H_{vpa}	Vapour pressure of fluid (psia).
H_s	Static suction head (feet of fluid).
H_f	Friction loss (feet of fluid).
H_v	Velocity head (feet of fluid)

CAUTION!

If the NPSHA is below the suggested margin, pump performance and reliability can deteriorate. It can also result in cavitation that can severely damage the pump.

E. Necessary Checks

Pump should operate satisfactorily if Hayward Gordon instructions have been followed. Routine care of stuffing box and bearings is required. Delay and expense may also be prevented by a study of the TROUBLESHOOTING section. Initially check the following and record any deviations that could indicate wear or possible problems.

1. Check the packing on a regular basis.
2. Check the head and flow of the pump.
3. Check the amperage draw of the motor.
4. Check the temperature of the bearings.

F. Stopping the pump

1. Stop the pump.
2. Close suction and discharge valves.
3. Close external cooling water line to stuffing box.
4. In the case of an indefinite shutdown - remove seal/packing from box, flush and re-lubricate pump and motor bearings. Provide pump and motor with protective cover. Remove casing plug and drain casing and all piping if there is a possibility of freezing.

III. TROUBLESHOOTING

Hayward Gordon pumps will provide reliable service and long life, if installation, operation and maintenance procedures are followed as outlined in this manual. If operating problems occur refer to the troubleshooting table below for common problems and solutions.

Symptom	Probable Cause	Corrective Action
A. Speed too Low	1. Check motor connections and if it is receiving full voltage.	1. Properly connect motor.
	2. Check Motor.	2. See motor manual.
B. Vibration – Noise	1. Misalignment between pump and motor.	1. Re-align unit (see Alignment)
	2. Loose foundation bolts	2. Tighten bolts, take care not to distort base
	3. Worn or insufficiently lubricated bearings.	3. Check lubricant level. Ensure pump rotates freely.
	4. Defective grout.	4. Remove grout and re-grout base (see Grouting section).
	5. Bent shaft.	5. Inspect shaft, replace if bent.
	6. Binding rotating equipment.	6. Ensure pump rotates freely.
	7. Gland too tight.	7. Loosen gland to allow 30 to 60 drips per minute of stuffing box leakage.
	8. Pumps too much liquid, head lower than rated.	8. Restrict discharge by partly closing valve.
	9. Cavitation on the suction side due to insufficient NPSH available.	9. Raise suction/liquid level or lower pump.
	10. Closed suction or discharge valve	10. Open suction or discharge valve.
	11. Blockage in suction or discharge piping.	11. Remove blockage from piping.
	12. Vibration in piping or at the pump assembly. Insufficient piping support.	12. Add additional pipe supports starting at pump discharge to eliminate vibration.
C. Overheating Bearings	1. Misalignment between pump and driver.	1. Realign unit (see Alignment)
	2. Bent shaft.	2. Inspect shaft, replace if bent.
	3. Binding rotating equipment.	3. Ensure pump rotates freely.
	4. Excessive lubricant.	4. See Maintenance
	5. Defective or contaminated bearings	5. Clean bearing and lubricate, replace if worn.

Symptom	Probable Cause	Corrective Action
D. Overheating Stuffing Box	1. Loss of sealing liquid to box.	1. Ensure liquid is reaching stuffing box
	2. Excessive gland pressure	2. Loosen gland to allow 30 to 60 drips per minute of stuffing box leakage.
	3. Inferior grade of packing	3. Check/change packing.
E. No Discharge Flow	1. Pump not primed.	1. Prime pump.
	2. Speed too low.	2. Check voltage and frequency.
	3. Required discharge head too high.	3. Reduce head or increase speed. Take care not to overload motor.
	4. Suction lift higher than pump rating.	4. Raise suction/liquid level or lower pump.
	5. Impeller or volute is blocked.	5. Ensure pump rotates freely.
	6. Suction port or filter is blocked.	6. Clear blockage/clean filter.
	7. Wrong rotation direction.	7. Reverse any 2 leads on 3-phase motor.
F. Not Enough Discharge Flow	1. Excessive air leaks in suction pipe or stuffing box.	1. Tighten all flange bolts. Supply stuffing box with liquid.
	2. Speed too low.	2. Increase pumps speed.
	3. Required discharge head too high.	3. Reduce head or increase speed. Take care not to overload motor.
	4. Suction lift too high.	4. Raise suction/liquid level or lower pump.
	5. Not enough suction head for hot or volatile liquids.	5. Raise suction/liquid level or lower pump.
	6. Mechanical defects.	6. Replace defective parts.
	7. Impeller damage.	7. Replace impeller.
	8. Foot valve too small.	8. Use larger foot valve.
	9. Not enough submergence of foot valve or suction opening.	9. Raise suction/liquid level. Lower foot valve or suction opening.
	10. Wrong rotation direction.	10. Reverse any 2 leads on 3-phase motor.
	11. Insufficient NPSH available.	11. Raise suction/liquid level or lower pump.
	12. Impeller diameter too small/trimmed too much.	12. Check pump curve/change impeller.

Symptom	Probable Cause	Corrective Action
G. Not Enough Pressure	1. Speed too low	1. Provide proper voltage and frequency to motor. Increase pump speed; take care not to overload motor.
	2. Too much air or gas in liquid.	2. Vent casing.
	3. Damaged impeller.	3. Replace impeller.
	4. Wrong rotation direction.	4. Reverse any 2 leads on 3-phase motor.
H. Loss of Prime	1. Leak in suction line.	1. Tighten suction line flange bolts.
	2. Loss of sealing liquid to stuffing box.	2. Ensure sealing liquid reaches stuffing box.
	3. Suction lift too high.	3. Raise suction/liquid level or lower pump.
	4. Too much air or gas in liquid.	4. Vent case.
	5. Defective casing gasket.	5. Replace gasket.
	6. Insufficient NPSH available.	6. Raise suction level or lower pump.
I. High Power Consumption	1. Speed too high.	1. Lower pump speed.
	2. Pumps too much liquid, head lower than rating	2. Restrict discharge by partly closing valve.
	3. Specific gravity or viscosity of liquid pumped too high.	3. Reduce pump speed. Reduce liquid specific gravity or viscosity.
	4. Bent shaft.	4. Inspect shaft, replace if bent.
	5. Binding rotating element.	5. Ensure pump rotates freely.
	6. Seal/packing gland too tight.	6. Loosen gland nuts.
	7. Coupling misalignment.	7. Recheck alignment.
	8. Impeller trim is not enough	8. Trim and balance impeller.
J. Too Much Stuffing Box Leakage	1. Not enough gland pressure.	1. Tighten gland nuts.
	2. Not enough packing in box.	2. Add additional ring of packing.
	3. Grooved shaft sleeve.	3. Replace shaft sleeve.

Symptom	Probable Cause	Corrective Action
K. Oil Seal Failure	1. Clogged air vent.	1. Clear air vent.
	2. Overfilling of powerframe.	2. Check oil level and adjust.
	3. 'Trico' adjustment sleeve high.	3. Readjust sleeve.
	4. Lip seal material too hard.	4. Change lip seals.
	5. Incorrect clearance between shaft and oil seal.	5. Recheck clearance.
	6. Burr on shaft.	6. Smooth shaft.
	7. Oil seal running dry on shaft.	7. Lubricate oil seals.
	8. Oil slinger in wrong position.	8. Recheck position.
	9. Improper grade of oil.	9. Change oil.
	10. Excessive shaft vibrations.	10. See "Vibration Noise" section.
L. Too Much Stuffing Box Leakage: Packed Pump	1. Packing not properly installed.	1. Install packing per manual.
	2. Packing not suitable for pressure and temperature.	2. Change packing to a suitable grade.
	3. Packing subject to attack by liquid pumped.	3. Change packing to a suitable grade.
	4. Inner rings not seated properly, outer rings carrying entire load.	4. Change packing.
	5. Dirt or dust in stuffing box causing rapid scoring of shaft sleeve.	5. Change packing. Check sleeve. Ensure flush is on.
	6. Not enough gland pressure leakage.	6. Tighten gland nuts.
	7. Not enough packing in box.	7. Add additional ring of packing.
	8. Grooved shaft sleeve needs replacing.	8. Replace shaft sleeve.

Symptom	Probable Cause	Corrective Action
M. Mechanical Seal Failure: Sealed Pump	1. Scored or worn seal faces.	1. Replace seal.
	2. Gland bolted up unevenly.	2. Check straightness.
	3. Stationary insert face not perpendicular to shaft axis.	3. Check and re-align.
	4. Wobbling rotating seal ring.	4. Check set screws and align.
	5. Cracked or broken stationary insert.	5. Replace insert.
	6. Shaft run out through stuffing box.	6. Check shaft and replace if necessary.
	7. Foreign matter between seal faces.	7. Ensure flush is operating properly. Replace seal if necessary.
	8. Loose or released set screws.	8. Retighten set screws.
	9. Spring compression lost.	9. Check seal setting & spring.
	10. Mechanical seal improperly applied or installed.	10. Recheck installation with seal O&M.
	11. Improper materials of construction for the environment and/or temperature.	11. Contact Hayward Gordon or seal manufacturer to confirm proper seal to use.
	12. Differential or system pressure too high for seal.	12. Contact Hayward Gordon or seal manufacturer to confirm proper seal to use.

IV. MAINTENANCE

A. Field Testing and Inspection

1. Check the differential head by measuring the suction and discharge pressures.
2. Check general operation of the pump with respect to noise and vibration.
3. Check speed and amperage draw of the motor.
4. If necessary, shut the discharge valve completely with the pump running and measure the shut-off pressure.
5. Check pump for unstable operation or excessive loading.

B. Oil Lubricated Bearings

CAUTION!

Oil lubricated powerframes are shipped without oil and must be filled before starting the pump.

1. Check nameplate for pump model and powerframe number and refer to table for oil volume.

Table IV-1: Powerframe Oil Quantities

Pump Group	Metric	US
Group 1	148 ml	5 oz
Group 2	560 ml	19 oz
Group 3	1419 ml	48 oz

2. Remove vent plug at the top and add oil into bearing frame. Oil level must be maintained to the center of the sight glass.
3. Install plug back into the frame.

The pump should sit level within 3/8" per foot in longitudinal direction to ensure equal lubrication of both bearings.

Use a contact type thermometer mounted on the powerframe or bearing housing to measure the bearing temperature. Do not "test" by hand as 120° F and higher may feel hot but bearing temperature up to 180° F are normal, depending on ambient conditions. Oil lubricated bearings may be safely operated up to at least 210° F.

A sudden temperature increase indicates the possibility of damage that requires checking.

Some recommended lubricants are:

Table IV-2: Recommended Lubricants

Mineral Oil	Quality mineral oil with rust and oxidation inhibitors. Mobil DTE heavy/Medium ISO VG68 or equivalent
Synthetic	Royal Purple SynFilm 68, Conoco SYNCON 68 or equivalent. Some synthetic lubricants require Viton O-rings.
Grease	Royal Purple NLGI#2, Chevron SRI#2 (or compatible)

Table IV-3: Oil Viscosity Grades

Maximum Oil Temperature	ISO Viscosity Grade	Minimum Viscosity Index
Up to 160^{0}F (71^{0}C)	46	95
160-175^{0}F (71-80^{0}C)	68	95
175-200^{0}F (80-94^{0}C)	100	95

Oil should contain rust inhibitor, antifoam and anti-oxidation additive. In normal continuous duty, change oil every 1500 hours to eliminate sludge accumulation. Increase the frequency of oil changes in hot, damp or corrosive atmospheres.

C. Grease Lubricated Bearings

All grease lubricated ball bearings are filled with grease at the factory and do not require filling before starting.

Use a Lithium base NLG1 Grade 2 grease to replenish the bearings every 2400 hours of continuous operation. Avoid over greasing the bearings.

Use a contact type thermometer mounted on the powerframe or bearing housing to measure the bearing temperature. Do not "test" by hand as 120^{o}F and higher may feel hot but bearing temperatures up to 140^{o}F are normal, depending on ambient conditions. Grease lubricated bearings may be safely operated up to at least 170^{o}F.

A sudden temperature increase indicates the possibility of damage that requires checking.

D. Driver and Coupling Lubrication

See manufacturer’s special instructions for driver bearing lubrication.

E. Stuffing Box with Packing

Standard die-moulded packing is furnished in pump at time of shipment from factory. Use die-moulded rings only.

(I) REPACKING STUFFING BOXES

1. Remove nuts and gland.
2. Remove all packing rings and lantern ring with packing hook. Be sure to replace packing rings located on both sides of lantern ring.
3. Clean box, shaft and sleeve.
4. Install packing; see PACKING PROCEDURE (below).

Replace base ring with every second packing change. Frequent need to repack indicates deeply grooved shaft sleeve that should be replaced.

(II) PACKING PROCEDURE

1. Spin shaft by hand to see there is no binding.
2. Rub thin film of oil on shaft and in stuffing box.
3. Twist rings sideways to install die-moulded packing. DO NOT pull rings straight out over shaft.
4. Insert needed number of rings, below lantern ring, staggering joints 90^{o} and seating each ring individually.
5. Insert lantern ring, (should line up with tapped hole from seal connection).
6. Insert remaining packing rings, staggering joints 90^{o}, and insert split gland.

(III) SETTING NEW PACKING

1. Using wrench, tighten gland nuts snug, back off, and re-tighten finger tight.
2. Start pump (See Section II.B Initial Starting).
3. Check Stuffing box for overheating. Shut down to cool, if necessary.
4. Gradually pull up gland by turning gland nuts alternately, one-quarter turn at a time, as packing wears from operation. Never tighten gland excessively.
5. An additional ring of packing may be added to box after gland has been taken up full travel. Repack stuffing box when packing gland has again been taken up full travel.

CAUTION!
With new packing, generous and steady initial leakage must be maintained. Over a period of four to six hours, the gland may be gradually tightened to achieve a stuffing box leakage rate of 30 to 60 drops a minute. Monitoring is recommended during this start up period to ensure that the lubrication is not cut off as the packing warms up and expands. If this occurs, the gland must be loosened to restore the leakage.

Turn sealing liquid on before pump is primed and leave it on as long as liquid is in pump. Use sealing fluid to prevent air leakage, if a prime is to be held when pump is stopped. Do not try to prevent air leakage by tightening gland unless definite measures are taken to be sure of re-adjustment before starting.

CAUTION!
The packing must not be allowed to run dry – even for short periods. Scoring of the shaft sleeve may result that will cause premature failure of the packing and will prevent proper sealing until a new sleeve is installed.

(IV) CAUSES OF PACKING FAILURE & EXCESSIVE LEAKAGE

1. Packing not properly installed.
2. Packing not suitable for pressure and temperature.
3. Packing subject to attack by liquid pumped.
4. Inner rings not seated properly, outer rings carrying entire load.
5. Foreign matter (dirt) in stuffing box causing rapid scoring of shaft sleeve.

Keep sets of proper packing on hand.

F. Sealing Fluid

Although a sealing fluid is not normally required, it is necessary to protect against air intake and leakage of costly, hazardous or corrosive pumpage. The sealing liquid, which must be compatible to the pumpage, should be provided to the lantern ring from an independent source using a continuous, external pressure.

G. Mechanical Seal

See Manufacturer's drawing and instructions for maintenance and lubrication requirements.

Causes of failures and leakage between seal faces:

1. Scored or worn seal faces.
2. Gland bolted up unevenly.
3. Stationary insert face not perpendicular to shaft axis.
4. Binding seal ring.
5. Wobbling rotating seal ring.
6. Cracked or broken stationary insert.
7. Shaft run out through stuffing box.
8. Foreign matter between seal faces.
9. Loose or released set screws.
10. Spring compression lost.
11. Mechanical seal improperly applied or installed.
12. Improper materials of construction for the environment and/or temperature.
13. Differential or system pressure too high for seal.

Keep a spare seal on hand if stand-by equipment is not available.

H. Drive

See Manufacturer’s Instructions.

I. Motor

See Manufacturer’s Instructions.

V. SERVICE & REPAIR

CAUTION!
Always disconnect electrical power and lock out the motor starter before performing any work on the pump/motor unit. On duplex pumps with alternating relays, both starters must be locked out regardless of which pump is being worked on.

A. Removal of Powerframe

Refer to General Assembly drawings during dismantling.

1. Unhook wires, close valves, drain lines, disconnect suction and discharge flanges.
2. If necessary, flush the pump to remove any hazardous pumpage.

WARNING!!
Never attach lifting devices to the motor or pump eyebolts. Lift the assembled unit from the baseplate.

3. Remove coupling guard and coupling.
4. Remove fasteners holding the bearing frame to the base plate.
5. Remove volute fasteners (115A) connecting volute to powerframe or seal housing and remove powerframe/seal housing assembly from volute.
6. Remove gasket (#107).
7. Using the shaft key (#130) and with the wrench handle pointing to the left when viewed from the impeller end, grasp the impeller (#103) firmly with both hands. By turning the impeller in the clockwise direction, move the wrench handle to the 11:00 o'clock position and then spin the impeller quickly in a counterclockwise direction so that the wrench makes a sudden impact with a hard surface such as a workbench. After several sharp raps, the impeller should be free. Unscrew the impeller and remove from shaft. Remove impeller gasket (#104). Refer to Appendix E for instructions on removing the seal, sleeve, and rear cover plate if pump is equipped with an FMI seal chamber. This is the seal chamber that does not have a separate gland. The gland is integral to the seal chamber.
8. Remove the seal or packing gland nuts (#111 A).
9. Remove the two cap screws (#140) which attach the rear cover plate to the adapter. Carefully remove the rear cover plate (#106).

B. Disassembly of Packed Pumps

1. If packing (#113) is used, remove it and the lantern ring (#112).
2. Remove gland (#110) and sleeve (#177).

C. Disassembly of Pumps with Mechanical Seals

1. If a cartridge type mechanical seal (#153) is used, loosen the set screws which lock the unit to the shaft and remove the complete seal assembly. If the seal is to be reused, the spacing clips or tabs should be reinstalled prior to loosening the set screws. This will ensure that the proper seal compression is maintained.
2. If a component type inside mechanical seal (#153) is used, loosen the set screws on the rotating unit and remove it from the shaft. Then pull the gland (#190) and stationary seat off the shaft. Remove the stationary seat from the gland.
3. If a component type outside mechanical seal is used, remove the gland and the stationary seat. Remove the stationary seat from the gland. Loosen the set screws in the rotating unit and remove it.

D. Disassembly of Powerframe

1. If the pump has a hook type sleeve (#177) it can now be removed.
2. If the power end is oil lubricated, remove the drain plug (#134) and drain the oil from the bearing housing (#119).
3. If the pump has lip seals, a deflector (#114) will be present. Remove it.
4. Loosen the three set screws (#201A) on the bearing carrier (#201). The bearing carrier must be completely unscrewed from the bearing housing. Note: Do not pry against the shaft. The face of the bearing carrier has three square lugs that protrude from the surface. The bearing carrier is turned by using an open end wrench on one of the square lugs.
5. Because the O-rings (#201 B) will cause some resistance in removing the bearing carrier assembly from the housing, hold the bearing carrier flange firmly and with slight rotation, pull it out of the bearing housing. The bearing carrier assembly with the shaft and bearings should come free. Further disassembly is not required unless the bearings are to be replaced.
6. Remove the snap ring (#201 C) on Group 1 and 2 pumps, or the bearing retainer (#201D) on Group 3 pumps. Note: Group 1 and 2 pumps equipped with duplex angular contact bearings use a bearing retainer (#2010) instead of the snap ring. Remove the carrier from the bearing.
7. The bearing locknut (#124) and lock washer (#125) may now be removed from the shaft (#105).
8. An arbor or hydraulic press may be used to remove the bearings (#120 and #121) from the shaft. It is extremely important to apply even pressure to the inner bearing race only. Never apply pressure to the outer race as this exerts excess load on the balls and causes damage.
9. The ANSIMax design has an optional oil slinger (#122) located between the bearings. If present, inspect it for damage or looseness.
10. On Group 2 and 3 pumps, the bearing housing (#119) must be separated from the bearing housing adapter (#108). This is accomplished by removing the cap screws (#139) which thread into the bearing housing.
11. If lip seals (#118) and (#129) are used, they should be removed from the bearing housing and adapter and discarded. If bearing isolators are used, refer to manufacturer's instructions.
12. Remove sight glass (#200) from the bearing housing.

E. Parts Inspection

1. Inspect ball bearings for damage and replace if necessary. If dirty, clean with kerosene or carbon tetrachloride, wipe dry, coat with oil and protect until ready to use.
2. Replace impeller if there is sufficient wear from corrosion or abrasion to affect performance.
3. Replace pump volute if there is sufficient scoring or other wear which could inhibit performance.
4. Replace oil seals if worn or damaged. The lip seals are held by a press fit in the bearing housing and frame.
5. Examine seal faces, gaskets, O-rings and shaft sealing elements. Replace if there is any evidence of wear or damage.
6. Replace packing if worn or damaged.
7. Check for bent shaft or damage to bearing and oil seal seats and replace if necessary. Seats must be in perfect condition for smooth operation.
8. Check sleeve surface for grooves or scoring and replace if necessary. Shaft sleeve is slip fitted to the shaft for easy removal.

All parts must be clean before reassembly. This is especially important at retaining ring grooves, threads, gasket surfaces and bearing lubrication areas. Remove burrs with fine emery cloth especially on shaft surface.

F. Reassembly of Powerframe

All bolts used on dynamically loaded components i.e. pump impellers MUST be tightened to the torque values shown below. Over tightening may cause premature fatigue failure. Figures are based on dry (non-lubricated) bolts. Hayward Gordon recommends paste-type thread sealants instead of PTFE tape.

Table V-1: Recommended Bolt Torque Values

Recommended Tightening Torque All Values in ft./lbs.		
Bolt Diameter (in.)	**Std. bolts grades 0-3 Stainless Steel Alloy 20 & Hastelloy B & C**	**Grades 5-8 All socket head capscrews**
3/8”	25	36
1/2”	55	85
5/8”	95	165
3/4”	165	275
7/8”	190	470
1”	260	700
1 ¼”	525	1200

1. The ANSIMax design has an optional oil slinger. If the slinger was removed during disassembly, install a new slinger (#122).

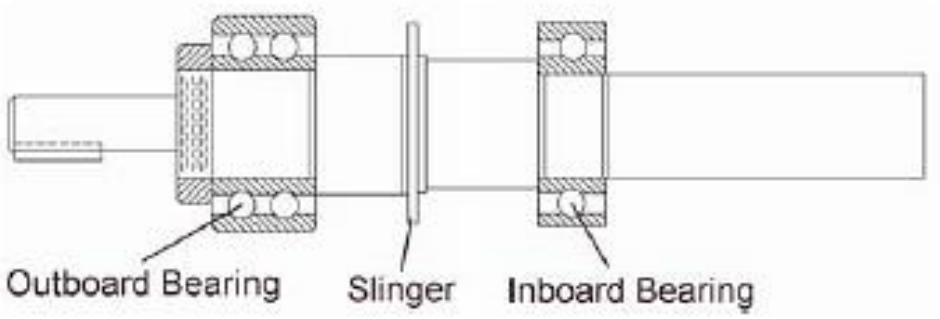


Figure V-1: Typical Shaft Arrangement

CAUTION!
Both bearings have a slight interference fit which requires that they be pressed on the shaft with an arbor or hydraulic press. Even force should be applied to the inner race only. Never press on the outer race, as the force will damage the balls and races. An alternate method of installing bearings is to heat the bearings to 200°F (93°C) in an oven or induction heater. Then place them quickly in position on the shaft. Never heat the bearings above 230°F (110°C). To do so will likely cause the bearing tits to permanently change, leading to early failure.

2. Mounting of bearings on shafts must be done in a clean environment. Bearing and power end life can be drastically reduced if even very small foreign particles work their way into the bearings. Install the inboard bearing (#120) on the shaft (#105). The inboard bearing must be positioned against the shaft shoulder. If the power end is equipped with single shield re-greaseable bearings, the shields should be oriented as shown in Figure V-2.

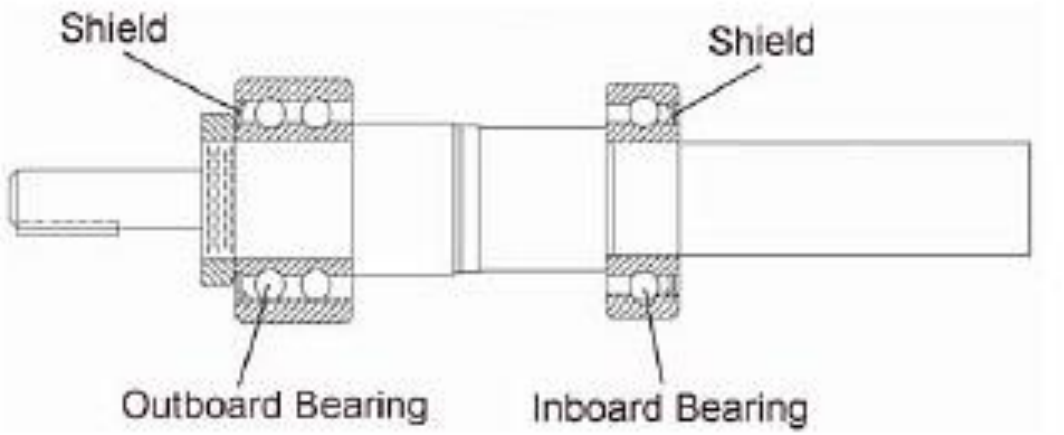


Figure V-2: Shielded Bearing Arrangement

3. Place the snap ring (#201 C) or the bearing retainer (#201 D) onto the outboard end of the shaft and slide down to the inboard bearing. Note the proper orientation of the bearing retainer or snap ring must be assured in this step. The flat side of the snap ring and the small side of the retainer must face away from the inboard bearing.
4. Using clean gloves, install the outboard bearing (#121) firmly against the shaft shoulder. If hot bearing mounting techniques are used, steps must be taken to ensure the outboard bearing is firmly positioned against the shaft shoulder. The outboard bearing, while still hot is to be positioned against the shaft shoulder. After the bearing has cooled below 100°F (38°C) the bearing should be pressed against the shaft shoulder. The locknut (#124) and lockwasher (#125) should be installed. At this point the lockwasher tang must be bent into the locknut.
5. Duplex angular contact bearings must be mounted back to back with the wider thrust sides of the outer races in contact with each other as shown in Figure V-3.

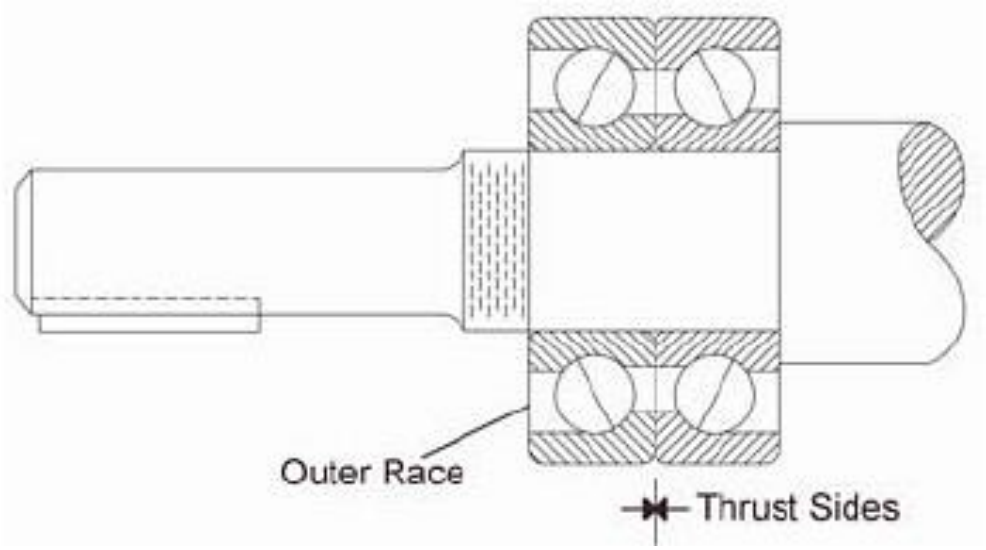


Figure V-3: Duplex Angular Contact Bearings

6. If lip seals were used, install new lip seals in the bearing carrier (#201) and the housing (#119) (Group 1) or the adapter (#108) (Group 2 and 3). The lip seals (#118 and #129) are double lip style, the cavity between the lips should be 1/2 to 2/3 filled with grease.
7. If labyrinth or magnetic type seals were used, refer to seal manufacturer's installation instructions.
8. Install new O-rings (#201 B) onto the bearing carrier. Be sure to use the correct size O-rings. Slide the bearing carrier (#201) over the outboard bearing (#121).
9. On Group 1 and 2 pumps, if standard outboard bearings are used, slide the snap ring (#201C) in place with its flat side against the outboard bearing and snap it into its groove in the bearing carrier.
10. On Group 1 and 2 pumps, if duplex angular contact bearings are used, slide the bearing retainer (#201 D) in place, install, and tighten the socket head cap screws (#201E).
11. On Group 3 pumps slide the bearing retainer (#201D) against the outboard bearing and install and tighten the socket head cap screws (#201 E).

12. The shaft, bearings, and bearing carrier assembly can now be installed into the bearing housing (#119). The bearing carrier (#201) should be lubricated with oil on the o-rings and threads before installing the assembly into the bearing housing. Thread the bearing carrier into the bearing housing by turning it clockwise to engage the threads. Thread the carrier into the housing until the carrier flange is approximately 1/8 in (3 mm) from the housing. Install the set screws (#201A) loosely.
13. Install a sight gage (#200) into the bearing housing.
14. If one was present, install a Trico oiler (#133) into the bearing housing. If not used, install a plug into the hole. When using a Trico oiler it is very important that a vent/breather be installed in the tapped hole on top of the bearing housing.
15. Install a drain plug (#134) into the bearing housing. Be sure to install the optional magnetic drain plug (#134M), if appropriate.
16. On Group 2 and 3 pumps, assemble the bearing housing adapter (#108) to the bearing housing (#119). Be sure to install a new O-ring (#131). Thread the cap screws (#139) through the adapter and into the tapped holes in the bearing housing.
17. If the pump has lip seals, install the deflector (#114).
18. If the pump is equipped with a hook type sleeve (#177), slip it into place over the impeller end of the shaft (#105).

G. Reassembly of Packed Pump

1. Install the packing rings (#113) and lantern ring halves (#112) into the stuffing box as shown in Figure I-5. Always stagger the end gaps 90° to ensure a better seal.
2. Install the gland assembly (#110) around the shaft using studs (#111) and nuts (#111A). Lightly snug up the gland. Final adjustments must be made after the pump has begun operation (refer to section IV-E).

H. Reassembly of Pump with Mechanical Seal

Cartridge Mechanical Seals

1. Slide the cartridge seal (#153) onto the shaft using a seal guide until it lightly touches the bearing housing (#119) or adapter (#108).
2. Install the rear cover plate (#106) to the bearing housing (Group 1) or tile bearing housing adapter (Group 2 and 3) by using the cap screws (#140). Now install the cartridge seal gland to the rear cover plate (#106) using studs (#111) and nuts (#111A).
3. Install the impeller (#103) as instructed in Appendix C, if reverse vane, or Appendix D, if a front vane open style impeller. Care should be taken in the handling of high chrome iron impellers.
4. Tighten set screws on tile seal to lock the rotating unit to the shaft. Finally, remove centering clips from the seal.

Component Type Mechanical Seals

1. In order to properly set a component seal it is necessary to first locate the shaft in its final axial position. This is accomplished in the following manner. Install the rear cover plate (#106) to the bearing housing (Group 1) or the bearing housing adapter (Group 2 and 3) by using the cap screws (#140). Install the impeller (#103) as instructed in Appendix C, if reverse vane, or Appendix D, if a front vane open style impeller. Put blueing on the shaft in the area near the face of the seal chamber (rear cover #106). Scribe a mark on the shaft at the face of the seal chamber. Now the location of the seal can be determined by referring to the seal drawing supplied by the seal manufacturer.
2. Remove the impeller and rear cover following disassembly instructions given in the section V.
3. Install the gland (#190) and stationary seal components following the seal manufacturer's instructions. Slide the gland and stationary seal components onto the shaft until it lightly touches the bearing housing or adapter. Install the gland gasket (#190G) into the gland.
4. Install the rotating unit onto the shaft (or sleeve) using a seal guide following the seal manufacturer's instructions.
5. Install the rear cover plate (#106) to the bearing housing (Group 1) or the bearing housing adapter (Group 2 and 3) by using the cap screws (#140). Now, install the gland (#190) to the rear cover plate (#106) using studs (#111) and nuts (#111 A).
6. Install the impeller (#103) as instructed in Appendix C, if reverse vane, or Appendix D, if a front vane open style impeller. Remember that the impeller clearance is already set. It cannot be changed at this point without resetting the seal.

I. Parts Inventory Guide

For parts inventory refer to General Assembly drawing and parts lists. The recommended spare parts are:

Table V-2: Recommended Spare Parts

Item	Description
177	Shaft sleeve
103	Impeller
104	Impeller Gasket
120	Inboard Bearing
121	Outboard Bearing
118	Inboard Lip Seal
129	Outboard Lip Seal
201B	O Ring – Bearing Carrier
124	Bearing Locknut
125	Bearing Lockwasher
107	Rear Cover Gasket
190G	Gasket – Seal Gland (*M)
153	Mechanical Seal Parts – from Manufacturer (*M)
113	Packing Set (*P)

(*M) = Mechanical Sealed Pumps
(*P) = Packed Pump

J. Parts Ordering

The following information should be available for prompt processing of parts orders:

1. The serial number of the pump (on nameplate)
2. The part name (on sectional drawing)
3. The part number (on sectional drawing)
4. The quantity of parts needed

Hayward Gordon may supply an interchangeable part that is not identical in appearance or symbol. This is done only if the part has been improved. Examine parts carefully upon their receipt.

If an impeller is ordered, specify diameter across blade tips to be sure there has been no further trim on diameter than shown on Hayward Gordon records.

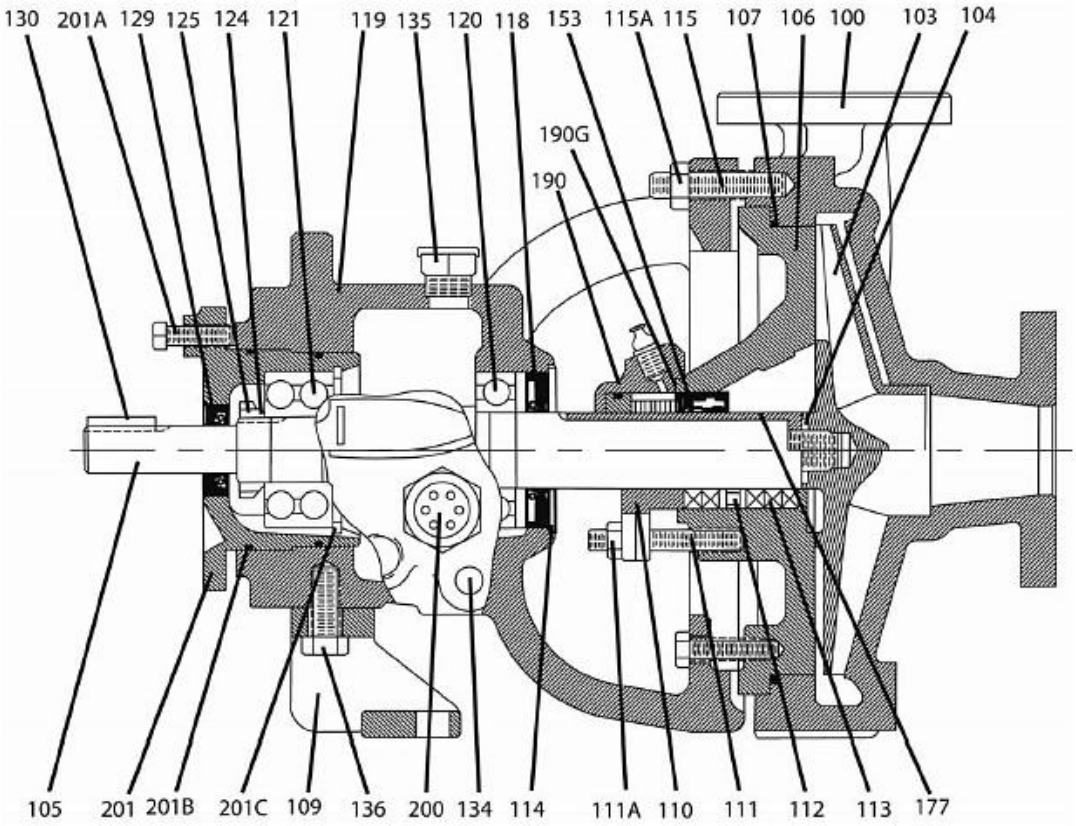
If you do have to trim an impeller, be sure to re-balance after machining.

If a motor or motor parts are ordered, specify name of drive manufacturer and all other data on driver nameplate.

VI. SECTIONAL DRAWINGS

See following pages for general assembly drawings and parts lists.

Figure VI-1: Group 1 Sectional Drawing

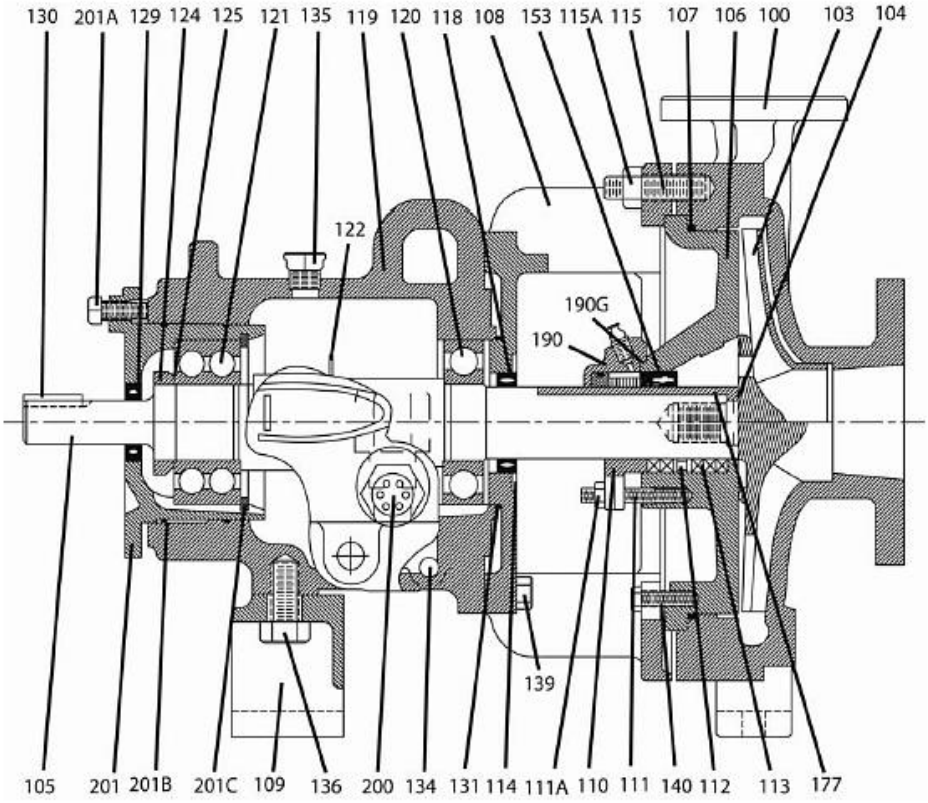


Item Number	Item Description
100	Casing
103	**Impeller**
104	Impeller Gasket
105	Shaft
106	Rear Cover Plate
107	**Rear Cover Gasket**
108	Bearing Housing Adapter
109	Bearing Housing Foot
109A	Shim
110	Gland – Packing
111	Stud – Gland
111A	Hex Nut – Gland
112	Lantern Ring Halves
113	Packing
114	Inboard Deflector
115	Stud- Casing
115A	Hex Nut- Casing
118	**Inboard Oil Lip Seal**
119	Bearing Housing
120	**Inboard Bearing**
121	**Outboard Bearing**
122	Oil Slinger

Item Number	Item Description
124	Bearing Locknut
125	Bearing Lockwasher
129	**Outboard Oil Lip Seal**
131	Adapter O-Ring
133	Trico Oiler
134	Bearing Housing Drain Plug
135	Bearing Housing Vent Plug
136	Capscrew – Foot
139	Capscrew – Bearing Housing
140	Capscrew – Cover/Adapter
153	**Mechanical Seal**
177	Hook Sleeve
190	Gland – Mechanical Seal
190G	Gland – Gasket
200	Oil Sight Gage
201	Bearing Carrier
201A	Set Screw – Bearing Carrier
201B	O-Ring – Bearing Carrier
201C	Bearing Carrier Retainer
201D	Clap Ring Bearing Housing
201E	Socket Head Capscrew Clamp

Recommended spare parts are in BOLD

Figure VI-2: Group 2 Sectional Drawing

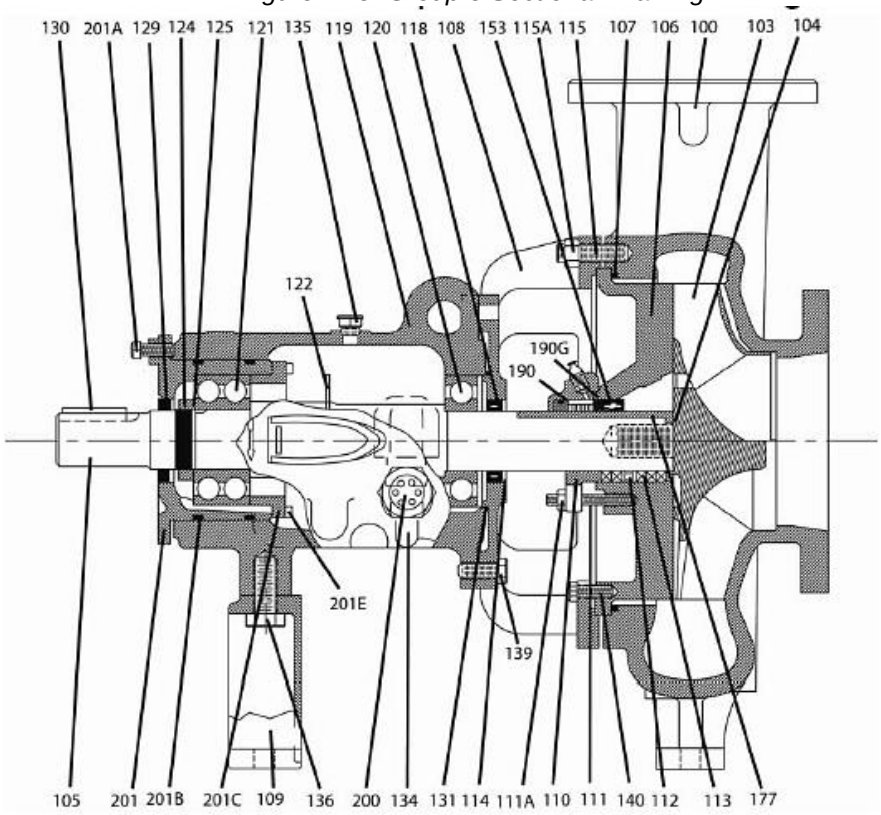


Item Number	Item Description
100	Casing
103	**Impeller**
104	Impeller Gasket
105	Shaft
106	Rear Cover Plate
107	**Rear Cover Gasket**
108	Bearing Housing Adapter
109	Bearing Housing Foot
109A	Shim
110	Gland – Packing
111	Stud – Gland
111A	Hex Nut – Gland
112	Lantern Ring Halves
113	Packing
114	Inboard Deflector
115	Stud- Casing
115A	Hex Nut- Casing
118	**Inboard Oil Lip Seal**
119	Bearing Housing
120	**Inboard Bearing**
121	**Outboard Bearing**
122	Oil Slinger

Item Number	Item Description
124	Bearing Locknut
125	Bearing Lockwasher
129	**Outboard Oil Lip Seal**
131	Adapter O-Ring
133	Trico Oiler
134	Bearing Housing Drain Plug
135	Bearing Housing Vent Plug
136	Capscrew – Foot
139	Capscrew – Bearing Housing
140	Capscrew – Cover/Adapter
153	**Mechanical Seal**
177	Hook Sleeve
190	Gland – Mechanical Seal
190G	Gland – Gasket
200	Oil Sight Gage
201	Bearing Carrier
201A	Set Screw – Bearing Carrier
201B	O-Ring – Bearing Carrier
201C	Bearing Carrier Retainer
201D	Clap Ring Bearing Housing
201E	Socket Head Capscrew Clamp

Recommended spare parts are in BOLD

Figure VI-3: Group 3 Sectional Drawing



Item Number	Item Description
100	Casing
103	**Impeller**
104	Impeller Gasket
105	Shaft
106	Rear Cover Plate
107	**Rear Cover Gasket**
108	Bearing Housing Adapter
109	Bearing Housing Foot
109A	Shim
110	Gland – Packing
111	Stud – Gland
111A	Hex Nut – Gland
112	Lantern Ring Halves
113	Packing
114	Inboard Deflector
115	Stud- Casing
115A	Hex Nut- Casing
118	**Inboard Oil Lip Seal**
119	Bearing Housing
120	**Inboard Bearing**
121	**Outboard Bearing**
122	Oil Slinger

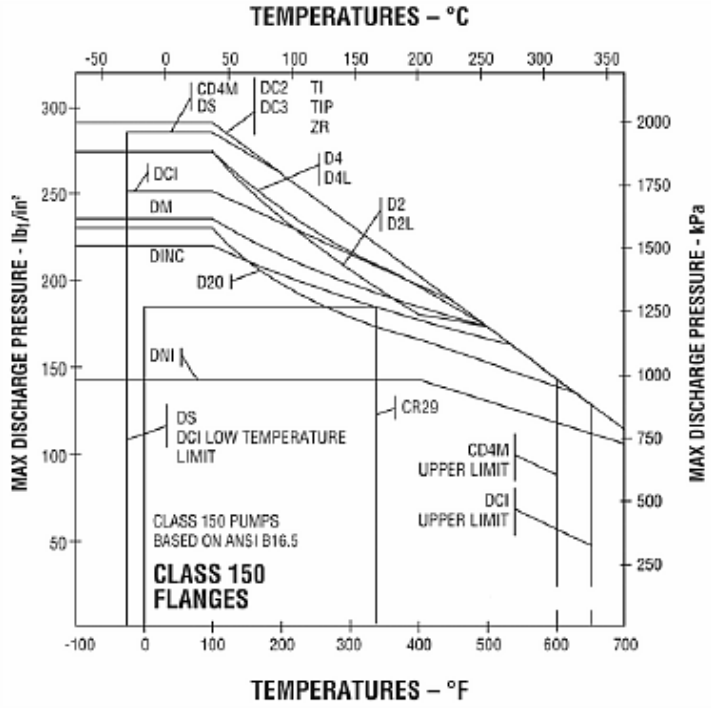
Item Number	Item Description
124	Bearing Locknut
125	Bearing Lockwasher
129	**Outboard Oil Lip Seal**
131	Adapter O-Ring
133	Trico Oiler
134	Bearing Housing Drain Plug
135	Bearing Housing Vent Plug
136	Capscrew – Foot
139	Capscrew – Bearing Housing
140	Capscrew – Cover/Adapter
153	**Mechanical Seal**
177	Hook Sleeve
190	Gland – Mechanical Seal
190G	Gland – Gasket
200	Oil Sight Gage
201	Bearing Carrier
201A	Set Screw – Bearing Carrier
201B	O-Ring – Bearing Carrier
201C	Bearing Carrier Retainer
201D	Clap Ring Bearing Housing
201E	Socket Head Capscrew Clamp

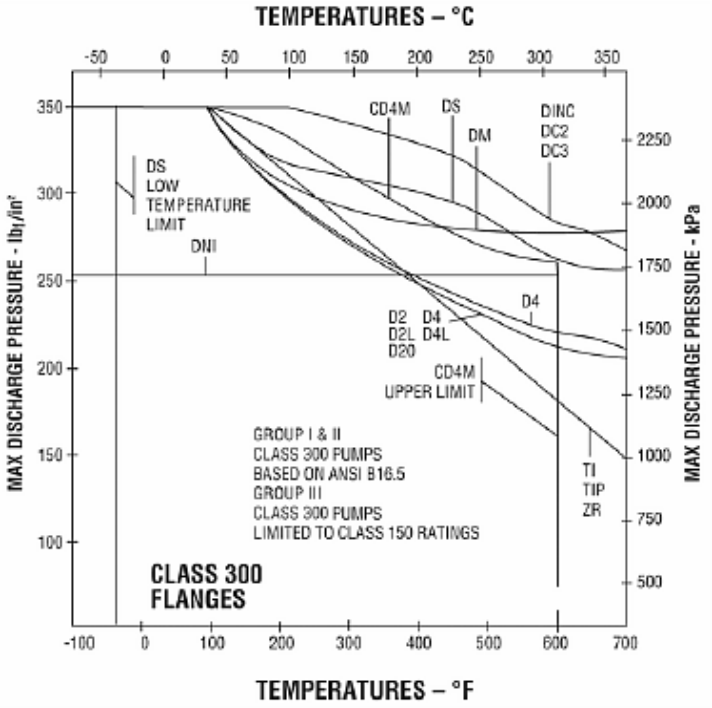
Recommended spare parts are in BOLD

A. APPENDIX A – Minimum Recommended Flow

Pump Size	60 Hz		50 Hz	
	RPM	Minimum Flow (% of BEP)	RPM	Minimum Flow (% of BEP)
1L 2x3-6	3500	25%	2900	21%
2L 2x3-8	3500	25%	2900	21%
2L 3x4-8	3500	25%	2900	21%
2L 2x4-10	3500	33%	2900	28%
2L 4x6-10	3500	50%	2900	42%
2L 2x3-13	3500	50%	2900	42%
2L 3x4-13	3500	50%	2900	42%
2L 4x6-13	1750	50%	1450	42%
All Group III	1750	50%	1450	42%
All other sizes	ANY	10%	ANY	10%

B. APPENDIX B – Pressure-Temperature Limits By Alloy





C. APPENDIX C – Installation/Clearance Setting for Reverse Vane Impeller

WARNING! *The impeller could have sharp edges which could cause an injury. It is very important to wear heavy gloves.*

Install the impeller (#103) by screwing it onto the shaft (taking care not to damage the threads) until it firmly seats against the shaft shoulder. Do not attempt to tighten the impeller on the shaft by hitting the impeller with a hammer or any other object or by inserting a pry bar between the impeller vanes. Serious damage to the impeller may result from such actions.

Set the impeller clearance by loosening the set screws (#201A) and rotating the bearing carrier (#201) to obtain the proper clearance. Turn the bearing carrier counterclockwise until the impeller comes into light rubbing contact with the rear cover. Rotating the shaft at the same time will accurately determine this zero setting. Rotate the bearing carrier clockwise to get the proper clearance. Refer to Figure C-2 for the proper impeller clearance. Rotating the bearing carrier the width of one of the indicator patterns cast into the bearing carrier moves the impeller axially 0.004 in (0.1 mm).

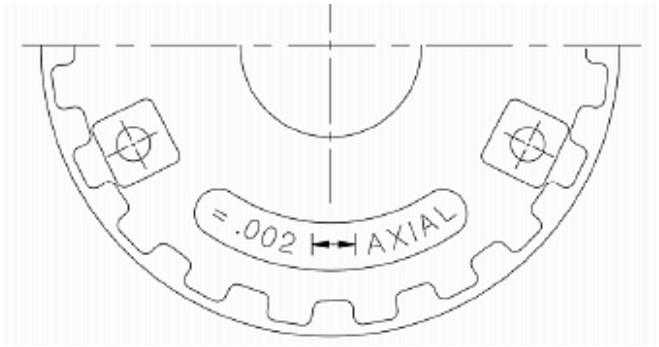


Figure C-1: Micro-millimeter adjustment

Determine how far to rotate the bearing carrier by dividing the desired impeller clearance by 0.004 (one indicator pattern). Tightening the set screws (#201A) will cause the impeller to move 0.002 in (0.05 mm) closer to the rear cover because of the internal looseness in the bearing carrier threads. This must be considered when setting the impeller clearance. Rotate the bearing carrier clockwise the required amount to get the desired clearance to the cover. Lastly, tighten the set screws (#201A) to lock the bearing carrier in place.

Temperature		Clearance to cover	
(°F)	(°C)	(inch)	(mm)
<200	93	0.018 ± 0.003	0.46 ± 0.08
200 to 250	90 to 121	0.021	0.53
251 to 300	122 to 149	0.024	0.61
301 to 350	150 to 176	0.027	0.69
351 to 400	177 to 204	0.030	0.76
401 to 450	205 to 232	0.033	0.84
>450	232	0.036	0.91

Figure C-2: Impeller Clearance Settings

Notes:

1. For 3 x 1.5 -13 and 3 x 2 -13 at 3500 rpm add 0.003 in (0.08 mm).
2. Rotation of bearing carrier from center of one lug to center of next results in axial shaft movement of 0.004 in (0.1 mm).
3. Reverse vane impeller is set to cover, open impeller is set to casing.

D. APPENDIX D – Installation/Clearance Setting for Front Vane Semi-Open Impeller

WARNING! *The impeller could have sharp edges which could cause an injury. It is very important to wear heavy gloves.*

Install the impeller (#103) by screwing it onto the shaft (taking care not to damage the threads) until it firmly seats against the shaft shoulder. Do not attempt to tighten the impeller on the shaft by hitting the impeller with a hammer or any other object or by inserting a pry bar between the impeller vanes. Serious damage to the impeller may result from such actions.

The semi-open impeller clearance must be set off the casing. The casing must be present to accurately set the impeller clearance (this illustrates an advantage of reverse vane impellers, which do not require the presence of the casing to be properly set).

Attach the power end/rear cover plate assembly to the casing. Now set the impeller clearance by loosening the set screws (#201 A) and rotating the bearing carrier (#201) to obtain the proper clearance. Turn the bearing carrier clockwise until the impeller comes into light rubbing contact with the casing. Rotating the shaft al the same time will accurately determine this zero setting. Rotate the bearing carrier counterclockwise to get the proper clearance. Refer to Figure D-2 for the proper impeller clearance. Rotating the bearing carrier the width of one of the indicator patterns cast into the bearing carrier moves the impeller axially 0.004 in (0.1 mm).

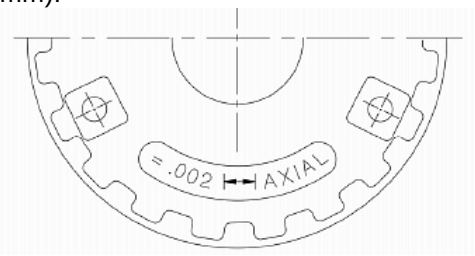


Figure D-1: Micro-millimeter adjustment

Determine how far to rotate the bearing carrier by dividing the desired impeller clearance by 0.004 in (0.1 mm) (one indicator pattern). Tightening the set screws (#201A) will cause the impeller to move 0.002 in (0.05 mm) away from the casing because of the internal looseness in the bearing carrier threads. This must be considered when setting the impeller clearance. Rotate the bearing carrier counterclockwise the required amount to get the desired clearance to the casing. Lastly, tighten the set screws (#201A) to lock the bearing carrier in place.

Temperature		**Clearance to cover**	
(°F)	**(°C)**	**(inch)**	**(mm)**
<200	93	0.018 ± 0.003	0.46 ± 0.08
200 to 250	90 to 121	0.021	0.53
251 to 300	122 to 149	0.024	0.61
301 to 350	150 to 176	0.027	0.69
351 to 400	177 to 204	0.030	0.76
401 to 450	205 to 232	0.033	0.84
>450	232	0.036	0.91

Figure D-2: Impeller Clearance Settings

Notes:

1. For 3 x 1.5 -13 and 3 x 2 -13 at 3500 rpm add 0.003 in (0.08 mm).
2. Rotation of bearing carrier from center of one lug to center of next results in axial shaft movement of 0.004 in (0.1 mm).
3. Reverse vane impeller is set to cover, open impeller is set to casing.

E. APPENDIX E – Removal/Installation of Seals with FMI Seal Chamber

Removal

After removing the impeller, slide the hook sleeve off the shaft. Remove the rotating unit from the sleeve. Remove cover. Remove the stationary seat from the seal chamber counter bore.

Installation

1. Set the impeller as instructed in Appendix C or D.
2. Remove the impeller.
3. Install stationary seat into seal chamber counterbore.
4. Refer to Figure E-1. Measure distance TL from the seal face on the stationary seat to the end of the hook sleeve.
5. The seal working length, WL, is determined from the seal drawing provided by the seal manufacturer. Subtract the seal working length WL from TL.
6. The distance remaining, RL, is the distance from the end of the hook sleeve to the rotating unit. Install the rotating unit at this location.
7. Install the hook sleeve onto the shaft.
8. Install the impeller to the shaft, locking the hook sleeve into position.

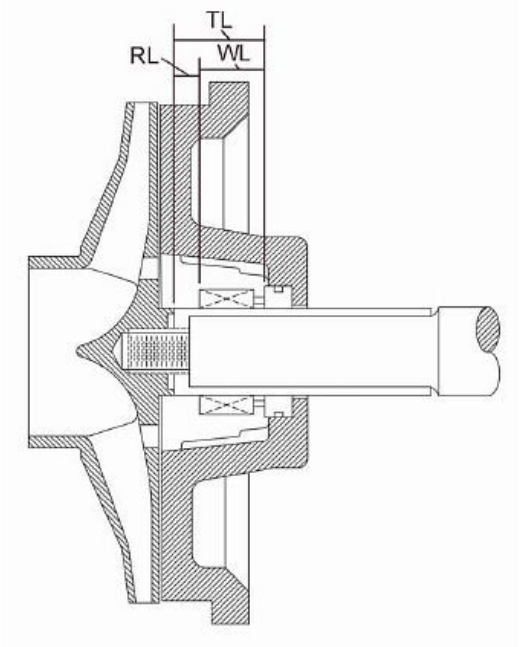


Figure E-1: FMI Seal Chamber