



STANDARD OPERATING PROCEDURE

SOP 2.1 Water Supply Pump Stations



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9. User Instructions / Submersible Water Well Pumps / Installation Operation Maintenance / Byron Jackson H2O+ Submersible Pumps and Motors
10. Operation and Maintenance Manual Vertical High Thrust Motor Vertical Industrial Turbine Pumps

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1. DEFINITIONS/ACRONYMS

1.1. Definitions

- Cavitation: A serious operational problem in centrifugal pumps caused by the formation and collapse of vapor bubbles in the liquid, which can cause serious damage to the impeller. If left uncorrected, cavitation can seriously damage the pump.
- Development tunnel: A tunnel designed to collect ground water to a central sump for pumping.
- Safety Data Sheet (SDS): An Occupational Safety and Health Administration (OSHA) standardized hazard communication document detailing a chemical's properties and hazards (physical, health, and environmental); protective measures; and safety precautions for handling, storing, and transporting the chemical.
- Vertical turbine pump: A pump with a motor located above the sump and an impeller located near the invert of the sump, connected by a shaft encased in a discharge pipe.
- Water hammer: The sudden stop or change in direction of water flow within the water system causing a pressure surge.

1.2. Acronyms and Abbreviations

- DSO Water Distribution System Operator
- ft feet
- gpm gallons per minute
- hp horsepower
- JBPHH Joint Base Pearl Harbor Hickam
- NAVFAC Naval Facilities Engineering Systems Command
- OIT Operator(s)-in-Training
- OSHA Occupational Safety and Health Administration
- PPE Personal Protective Equipment
- PRP32A Potable Water Branch
- SDS Safety Data Sheet
- SOP Standard Operating Procedure
- WHHP6A Production Work Center

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2. OVERVIEW

2.1. Scope and Purpose

This Standard Operating Procedure (SOP) covers the water supply pump stations including development tunnels, wet wells, vertical turbine pumps, station control and general maintenance. The Joint Base Pearl Harbor-Hickam (JBPHH) water system contains three distinct water supply pump stations:

- Waiawa Shaft
- Aiea-Halawa Shaft (offline) - currently used for flushing as required
- Red Hill Shaft (offline) - currently used for flushing as required

2.2. Operating Summary

2.2.1. Pumps

The water supply pump stations are controlled manually based on tank levels in S1/S2, with a target range of 10.0 ft (ft) to 10.0 ft. Under normal circumstances, a minimum of one pump is running continuously, with additional pumps being turned on and off as required to cycle tanks S1/S2.

The Aiea-Halawa Shaft is known to produce elevated saline levels if operated too frequently or for too long and is currently offline out of an abundance of caution following the November 2021 fuel release. It is currently used for flushing as required.

The Red Hill Shaft is currently being operated for non-potable water use due to the November 2021 fuel release.

2.2.2. Pump Control Valves

The Waiawa pump station is equipped with an automatically actuated butterfly valve paired with a recirculation valve. When the pump first turns on, the automatically actuated butterfly valve is in the closed position and the water is forced through the recirculation valve, which holds a preset backpressure on the pump. Once the pump is up to speed, the automatically actuated butterfly valve opens, allowing flow to enter the system. As the pressure drops, the recirculation valve automatically closes. The automatically actuated butterfly valve is set to open 10.0 seconds after the pump is turned on.

The Red Hill and Aiea-Halawa pump stations are equipped with a single pump control valve that slowly opens to reduce the risk of cavitation or excessive pump speed during start up. Red Hill accomplishes this with a singular automatically actuated butterfly valve. Aiea-Halawa utilizes a roll seal pump control valve.

2.3. Equipment List at Each Shaft

All three water supply pump stations have chlorine feed systems (*SOP 4.1*), fluoride feed systems (*SOP 4.2*), backup power supply (*SOP 7.1*), and monitoring (*SOP 8.1* and *SOP 8.2*). *Table 2-1* lists water supply pump station equipment.

The Red Hill Shaft is currently out of service and is anticipated to have a major overhaul associated with the November 2021 fuel release. The equipment listed below is generic equipment that was included in the original design, much of which has been removed for the temporary operation.

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Process flow diagrams for each shaft are provided in *Attachment 5*. The equipment list shall be updated with permanent equipment when the facility is returned to normal service.

- (b) (3) (B) Vertical Turbine Pumps
 - Automatic Check Valves
 - Gate Valves
 - Air Release Valves
 - Cable Car System
 - Chlorine Feed System
 - Fluoride Feed System
 - Generator and Electrical Equipment
 - Sump Pump System

Table 2-1 Water Supply Pump Station Equipment Specifications

Component	Waiawa Shaft	Aiea-Halawa Shaft
Vertical Turbine Pumps	(b) (3) (B)	
Valves (See SOP 5.2 - Valves for details)	• Valmatic (b) (3) (B) Valves: (b) (3) (B) • Recirculation Valve: Bermad (b) (3) (B) and Bailey (b) (3) (B) • Butterfly Valves: Valmatic (b) (3) (B) • Actuated Butterfly Valves: Fisher Controls (b) (3) (B) and Rotork (b) (3) (B) • Surge relief valve: Bailey (b) (3) (B) • Air release valves	• Pump control valves: Cla-Val (b) (3) (B) Pump discharge valve • Gate valves • Air release valves
Miscellaneous Equipment	• Cable car system • Sump pump system	• Cable car system • Sump pump system

Note: All vertical turbine pumps in this system are water-lubricated as required by the Hawaii Department of Health (DOH). The manufacturer manuals are provided for general reference. Operators must disregard any procedures referring to oil-lubricated shafts or petroleum-based lubricants

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3. RESPONSIBILITIES AND QUALIFICATIONS

3.1. Responsibilities

The JBPHH Public Works Department owns and operates the JBPHH drinking water system. Operation and maintenance of the system is the responsibility of the Utilities Maintenance Potable Water Branch (PRP32A). The water supply pump station operation and maintenance within JBPHH is performed by the Production Work Center (WHHP6A). Refer to *Figure 3-1* for details.

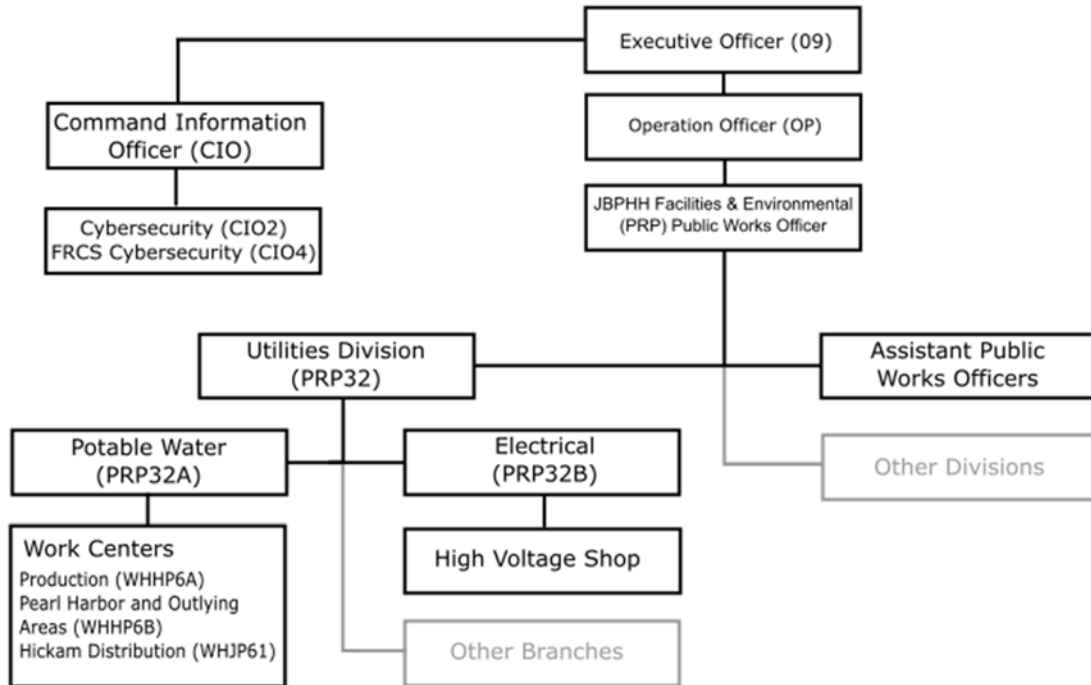


Figure 3-1 Public Works Department Organization

Lead operators and supervisors in PRP32A must ensure that the operators are trained and qualified prior to using this SOP. To support this process, a copy of this SOP should be made readily available to all users. Senior operators are required to update the SOP to reflect any changes in equipment, procedures, or regulations, and train the subordinate operators and maintenance crew(s) accordingly. It is important for senior operators to approve, coordinate, and maintain records of any major repairs on the equipment highlighted in this SOP. Training shall consist of in-depth, hands-on training for all new employees or employees new to this SOP and annual refresher meetings facilitated by the lead operator. All training should be documented using *Attachment 1 SOP Acknowledgement and Training Form*.

3.2. Qualifications

All personnel involved in operations and maintenance activities for the water supply pump station must be trained and qualified to perform their assigned tasks:

- If required, personnel are responsible for obtaining and maintaining a Water Distribution System Operator (DSO) certification, Grade 1 or higher from the State of Hawaii, Department of Health, Safe Drinking Water Branch.

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- Unlicensed or uncertified operators and Operators-in-Training (OIT) shall not make process control or system integrity decisions about water quality or quantity that affect public health.
- Follow Navy and base-specific safety regulations and directives and obtain appropriate safety training (see *Section 4*).
- Be familiar with the following:
 - Emergency protocols and communications
 - Operation of tools and equipment
 - Procedures outlined in this SOP

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4. HEALTH AND SAFETY

4.1. General Guidelines

With respect to health and safety, operators shall implement the following:

- Comply with the JBPHH Safety Manual.
- Use engineering, operational, or administrative controls or other means of performing work to eliminate or minimize health and safety hazard risk. Eliminating or minimizing health and safety hazard risk is preferred over the use of personal protective equipment (PPE). Use PPE to reduce hazard exposure when the hazard cannot be eliminated.
- Follow all OSHA requirements for work in confined spaces, trenching, roadways, etc.
- Pay specific attention to the hazards outlined in *Section 4.2*.
- Be familiar with all applicable SDSs. Ensure SDSs are up to date. Ensure the SDSs displayed / available match the chemical being used (i.e., do not use an SDS for the same chemical from another manufacturer).

4.2. Anticipated Hazards

- Confined space
- Moving parts
- Heavy equipment
- Work environment (hot weather, humid environment, wet slippery grounds, noise, elevated platform, uneven/unstable ground, etc.)
- Traffic

4.3. Personal Protective Equipment

Utilize the following PPE based on anticipated activities:

- Safety steel toe shoes with anti-slip soles
- Work gloves
- Eye protection
- Hearing protection
- Hardhat/helmet
- Class 2 safety vest (class 3 vest is required when visibility conditions are limited)

4.4. First Aid

Stocked first aid kits shall be kept in two primary locations: service trucks and water supply pump stations. Promptly remove any expired stock from first aid kits and replace. Operators shall follow detailed instructions in the JBPHH Safety Manual and EM-385-1-1, *Section 3* regarding first aid kit requirements, documentation, and follow up procedures.

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5. EQUIPMENT AND MATERIALS

The section details the equipment and materials that are relevant to perform this SOP. For detailed information regarding location and quantity of each item, please refer to the JBPHH inventory provided as an attachment to *SOP 1.1 Introduction and Overview*.

Parts:

- Seals
- Bearings
- Motor couplings
- Pressure Gauges

Equipment:

- General hand tools
- Grease gun
- Flashlight
- Straight edge
- Dial indicator
- Infrared thermometer
- Pressure gauges and various adaptors

Consumables:

- Grease
- Oil
- Packing material

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6. SCHEDULE AND PROCEDURES

6.1. Schedule

Refer to *Table 6-1* for a routine water supply pump station operation and maintenance schedule. Detailed procedures are discussed in subsequent sections.

Table 6-1 Water Supply Pump Station Schedule

Frequency	Task	Section
Daily	Observations, inspections, and record keeping	6.2
Weekly	Pump packing inspection; oil and grease inspection; miscellaneous inspection and housekeeping	6.3
Monthly	Coupling alignment inspection; sump pump field test; monthly bubbler compressor maintenance; housekeeping	6.4
Quarterly	Inspections	6.5
Annual	Replace oil and grease; full pump operating check; bubbler compressor maintenance	6.6
	Perform refresher training on this SOP	6.7

6.2. Daily Tasks

- Observe pumps specifically for abnormal noise, vibration, leaks, or visible malfunctions.
- Observe pump start up and pump control valve operation ensuring pump obtains operating speed prior to valve fully opening.
- Observe motors specifically for abnormal noise, excessive temperature, excessive sparking at commutator, hot commutator, blackened commutator, sparking brushes, fine dust under couplings with rubber buffs or pins, smoke, charred insulation, solder whiskers extending from armature, excessive hum, regular clicking, rapid knocking, chattering brush, or vibration.
- If available, use the pump run hour meters and cycle counters on the control panel to record the running times and number of cycle starts.
- Record the pump discharge pressure and flow rate from available pressure gauges and flow meters. To the greatest degree practical, take these readings at the same time every day.
- Record values in the daily log and compare them to historical values to provide insight into potential pump problems.
- Compare individual pump run-time hours to ensure that the lead/lag controls are operating properly.
- Inspect cycle starts for an excessive number of starts per hour (greater than 6 starts per hour for a single pump).
- Notify lead operator of any potential issues regarding variations from historical records, uneven run time, or excessive starts per hour. Investigate root cause and adjust controls as required.
- Note any faults or warnings in the control system.
- Inspect piping for any leaks.

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- Record all values and notes in *Attachment 2*.

6.3. Weekly Tasks

Perform the following tasks on a weekly basis.

6.3.1. Pump Packing Inspection

- Inspect the packing for proper leakage rate, consult equipment operation manual for recommended rate.
 - If the leakage rate is too low, loosen the gland.
 - If the leakage rate is too high, tighten the gland.
- Inspect the packing gland temperature with an infrared thermometer; if the temperature is excessive (confirm acceptable temperature range with installed packing material) or appears to be rising during operation, loosen the gland.
- All adjustments to packing glands must be small adjustments. After any adjustments, recheck both leakage rate and temperature.
- If the leakage rate or temperature cannot be adjusted to within the acceptable limits, replace all packing per manufacturer's recommendations.
- Record all notes in *Attachment 2*.

6.3.2. Oil and Grease Inspection

- Check Oil and Grease
 - Excess oil can create oil splashes that require cleaning to prevent contamination of water supply, avoid overfilling oil.
 - Insufficient oil can result in increased wear and temperature of moving components. Check temperature utilizing infrared thermometer to ensure sufficient oil level.
- Adding oil
 - Confirm oil fill point, acceptable levels, and type with manufacturer's literature.
 - Add oil to proper level.
- Adding grease
 - Confirm grease injection point, acceptable levels, and type with manufacturer's literature.
 - Add grease to proper level.
- Inspect oil for excessive temperature (less than 120° F) with an infrared thermometer.
- Record all notes in *Attachment 2*.

6.3.3. Miscellaneous Weekly Inspections and Housekeeping

- Inspect operation of miscellaneous equipment including sump pump systems, heating, ventilation, and air conditioning systems, lighting systems, etc.
- Inspect the bearing for excessive heat (less than 200° F) with an infrared thermometer.
- Measure vibration with handheld vibration meter; vibration should be less than (b) (3) (B) (see SOP 8.2 *Spot Monitoring* for details).
- Visually inspect the sump pump system for signs of improper operation, broken components, etc.
- Wipe equipment clean. Keep motors free from dirt or moisture.
- Perform general housekeeping including dusting, sweeping, and trash disposal.

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- Check structure inside and outside for any openings, holes, gaps, or missing/broken screens whereby animals, including insects, could gain access; report all findings to work leader or supervisor for creating of separate work order.
- Check the remaining run time versus run time-based maintenance including:
 - Bearing grease/oil life
 - Bearing life

6.4. Monthly Tasks

Perform the following monthly tasks in addition to the daily and weekly tasks provided above.

6.4.1. Coupling Alignment Inspection

- Coupling alignment should be checked as applicable and per the manufacturer's recommendations.
- Motor and pump shaft should be parallel and in line with manufacturer's recommendations.
- Adjust alignment as per manufacturer's recommendations when required.
- If significant effort or specialized tools are required, contact the manufacturer or manufacturer's representative for assistance.
- Record all notes in *Attachment 2*.

6.4.2. Sump Pump Field Test

- Manually fill the sump to above the "pump on" level with water from a hose or bucket.
- Record time required to drain sump to "pump off" level.
- Observe sump pump operation noting any abnormalities including excessive noise, excessive vibration, leaks, or other operational issues.
- Record all notes in *Attachment 3*.

6.4.3. Bubbler Compressor Maintenance

- Check compressor oil level. Fill as needed to the proper level with the proper type and grade of fresh oil.
- Clean compressor, intercooler, and aftercooler cooling fins.
- Check the condition of the air filter. Clean or replace as required.
- Verify proper operation of all safety valves and unloaders.
- Check compressor and air system piping for leaks.

6.4.4. Housekeeping

- Clean all windows.
- Clean all walls.
- Clean all ceilings.
- Remove all cobwebs.
- Hose down floor.
- Inspect and clean all name plates. Open work order to replace or provide protective coating as required.

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6.5. Quarterly Tasks

- Inspect pump base and anchor bolts.
- Check spare part inventory versus manufacturer's recommendations, scheduled maintenance, and potential failure items.
- Clean and inspect control panels. If necessary, repair according to manufacturer's instructions.
- Check and record running amps on all pumps. Record values in operator's logbook.
- Inspect all well vents and attached screens
- Inspect air release valves to ensure fine mesh screens are attached (if applicable).

6.6. Annual Task

Perform the following tasks annually following the procedures provided below.

6.6.1. Replace Oil and Grease

- Replacement of oil
 - Remove old oil as per manufacturer's recommendations.
 - Confirm oil fill points, acceptable levels, and type with manufacturer's literature.
 - Add oil to proper level.
 - Allow the pump to operate and reinspect oil levels until levels are consistent.
- Replacement of grease
 - Remove old grease as per manufacturer's recommendations.
 - Confirm grease injection point, acceptable levels, and type with manufacturer's literature.
 - Add grease to the proper level.
 - Allow the pump to operate and reinspect grease levels until levels are consistent.

6.6.2. Full Pump Operating Check

- The pumps should be operated at as many operational points regarding speed and additional pump status (on/off) as practical. If the pump station has multiple pumps, the pumps should be operated in an isolated condition as well as any anticipated concurrent operating states (i.e., two pumps on or three pumps on).
- Full pump operating check consists of operating the pump at the conditions described above until the hydraulics (flow rate and pressure) reach a steady state (i.e., fluctuations are minimal; note that in some cases, the system will not achieve a perfect steady state, and the operator must utilize their best judgement to determine if the system is adequately steady).
- During the full pump operating check, observe and notate the following in *Attachment 4*:
 - Number, tag, and description of pumps operating and target conditions
 - Flow rate
 - Discharge pressure
 - Well level
 - Running speed for each pump
 - Running amps for each pump (checking amps on pumps can be complicated and dangerous and should only be performed by a qualified and licensed electrician.)
 - Any excessive noise or vibration
 - Bearing temperature
- After completing the series of full pump operating checks, it is imperative to graph the observed design points on the pump curves (see *Attachment 6* and *Attachment 8*).
 - Adjust flow rates based upon the number of pumps operating.

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- Mark the head and flow conditions of each operating point on the pump curve.
- Note and retest any operating points that do not appear to fall on the pump curve.
- If retested operating points do not fall on the pump curve, consult with manufacturer, manufacturer's representative, or engineering consultant to investigate the cause of the discrepancy.
- If running amps, temperatures, noise, or vibration are increasing from previous tests, investigate root cause.

6.6.3. Bubbler Compressor Maintenance

- Check compressor oil level. Fill, as needed, to the proper level with the proper type and grade of fresh oil.
- Clean compressor, intercooler, and aftercooler cooling fins.
- Replace intake air filter.
- Verify proper operation of all safety valves and unloaders.
- Change compressor oil and filter according to Original Equipment Manufacturer recommendations. Record oil type and volume used. Dispose of used oil according to facility procedure.
- Tighten all fasteners to the specified torque.
- Disassemble compressor, inspect internal components for wear or damage.
- For belt-driven units - check the drive belts for wear, damage, proper alignment, and correct tension adjustment. Replace belts only if needed.
- Check compressor and air system piping for leaks.
- Take and record vibration readings from the drive and compressor bearing housings. Compare current readings with previous readings.
- Check drive and the compressor bearing temperatures with infrared thermometer. Record the temperature. Compare current readings with previous readings.
- If equipped with liquid cooling system, check for proper quantity and condition of liquid coolant and signs of coolant leaks.
- Check the condition of the exhaust silencer.

6.6.4. Miscellaneous Annual Tasks

- Inspect pump station building including inspecting paint and concrete for signs of deterioration; repair as required.
- Inspect plumbing for proper operation; repair as required.

6.7. Annual SOP Refresher Training

- Schedule Training
 - Review operator schedules to identify a convenient time and date for most or all operators to attend the training session.
 - Schedule Refresher Training.
- Review key aspects of this SOP
 - General pump station operation observances
 - Maintenance takeaways
 - Visual instructions regarding all maintenance, specifically showing where maintenance items are located and how to safely access them
 - Operators' questions or concerns

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- Potential areas to improve the SOP
- Documentation
 - Record the date, time, and attendees of the training sessions in *Attachment 1*.
 - Note any updates or revisions made to the SOP.

6.8. **Unscheduled**

Perform the following maintenance as required.

6.8.1. **Noise Check**

- If abnormal noise is noted, identify the source of the noise (e.g., fan, pipe, motor, pump, etc.).
- Remove the pump from service as required until the issue is remediated.
- Verify the pressure levels upstream and downstream of the pump. If the pressure gauges do not match the Supervisory Control and Data Acquisition readings, double check with manual devices.
- Check the pressure control valve.
- Check blockage at nearby control valve or elbow or other pipe connection.

6.8.2. **Equipment Failure**

- Investigate any failure of a system component, including components that have surpassed their useful life, to identify the initial cause of failure. This includes items such as pumps, motors, valves (e.g., flow and pressure control, air, vacuum, blowoff, manual, solenoid or motor-operated valves, etc.), water or chemical conveyance pipes (leak, break, or blockage), and electrical and electronic components (e.g., wiring, power generators, sensors, computers, communication equipment, etc.).
- Inspect and evaluate the site for safety.
- Take necessary safety precautions (PPE, equipment needed to access the failure point, etc.).
- Bypass the failed component (disconnect the power, bypass the flow, reroute equipment signals, etc.).
- Put the backup/redundant equipment in-service.
- Remediate the situation and resume service.

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7. TROUBLESHOOTING

This section offers an approach to troubleshooting common issues encountered while following this SOP. Refer to *Table 7-1* for general troubleshooting guidelines.

Table 7-1 General Troubleshooting Guide

Issue	Potential Related Issue or Cause	Remedy
Pump does not start.	The electrical circuit is open or not complete.	Check the circuit and make any necessary corrections.
	The impellers are binding against the bowls.	Reset the impeller adjustment. See manufacturer installation directions for details.
	The electric driver is not receiving enough voltage.	Make sure that the driver is wired correctly and receiving full voltage.
	The motor is defective.	Consult manufacturer or manufacturer's representative.
The pump does not deliver liquid.	The suction strainer is clogged.	Remove the clog.
	There is an obstruction in the liquid passage.	Pull the pump and inspect the impeller and bowl. Remove the obstructions or foreign objects in pump bowls.
	The discharge-head is not properly vented.	Open the vent.
	The discharge valves are closed.	Open the valves.
The pump is not producing the rated flow/head.	The impellers are not rotating fast enough.	Make sure that the driver is wired correctly and receiving full voltage.
	The liquid passages are partially obstructed.	Inspect the impellers and bowls and remove any obstructions.
	There is cavitation.	Insufficient NPSH. Check for and remove any obstructions in pump suction inlet.
	Impellers need lateral adjustment.	Adjust per pump manufacturer's instructions.
	Overload; low voltage; low frequency	Investigate cause of low motor speed and correct.
	The impellers are too high.	Reset the impeller adjustment. See manufacturer installation directions for details.

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Table 7-1 General Troubleshooting Guide (Continued)

Issue	Potential Related Issue or Cause	Remedy
There is not enough pressure.	The impellers are not rotating fast enough.	Make sure that the motor is running at the proper speed.
	The liquid passage is obstructed.	Inspect the impellers and bowls and remove any obstructions.
	The impellers are rotating in the wrong direction.	Make sure the impellers are spinning in the correct direction. Check the engagement of the motor coupling.
	The impellers are too high (semi-open construction only).	Reset the impeller adjustment. See manufacturer installation directions for details.
The pump starts and then stops pumping.	Critical parts have experienced mechanical failure.	Check the bearings, wear rings, and impellers for damage. Any irregularities in these parts will cause a drag on the shaft. Replace any damaged parts, as necessary.
	The impellers are rotating too fast.	Check the frequency on the motor.
	The pump and driver are misaligned.	Realign the pump and drive.
	The discharge head is not properly vented.	Open the vent.
The pump requires excessive power.	The impellers are damaged.	Inspect the impellers for damage and replace them if necessary.
	A foreign object is lodged between the impeller and the bowl.	Remove the object.
	The bearings are defective.	Replace the bearings and check the shaft or shaft sleeve for scoring.
	The stuffing-box packing is too tight.	Release the gland pressure and retighten. Keep the leaking fluid flowing. If there are no leaks, then check the packing, sleeve, or shaft. See manufacturer maintenance directions for details.
The pump is noisy.	The pump is cavitating.	Investigate hydraulic conditions creating cavitation.
	The shaft is bent.	Straighten, as necessary
	Rotating parts are binding, loose, or broken.	Replace parts, as necessary.
	The bearings are worn.	Replace the bearings.
	The discharge-head is not properly vented.	Open the vent.

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Table 7-1 General Troubleshooting Guide (Continued)

Issue	Potential Related Issue or Cause	Remedy
The pump is vibrating excessively.	One of these conditions might exist: • The coupling is misaligned. • The shaft is bent. • The impellers are not balanced. • The bearings are worn. • There is cavitation. • There is strain on the discharge piping. • There is resonance.	Determine the cause by using a vibration frequency analyzer or by disassembling the pump. A complex problem might require the assistance of the manufacturer or manufacturer's representative.
	The driver shaft is not adjusted properly.	Readjust the driver. See manufacturer installation directions for details.
There is excessive leakage from the stuffing box.	The packing is defective.	Replace any packing that is worn or damaged.
	The wrong kind of packing was used.	Consult manufacturer or manufacturer's representative.

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8. REFERENCES

- Unified Facilities Criteria 3-230-02 Operation and Maintenance: Water Supply Systems. 1 November 2023.
- JBPHH Safety Manual
- EM-385-1-1 Safety and Occupational Health (SOH) Requirements Manual. 15 March 2024.
- OPNAV M-5100.23: Navy Safety and Occupational Health Manual. 5 June 2020.

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9. ATTACHMENTS

- Attachment 1: SOP Acknowledgement and Training Form
- Attachment 2: Pump Inspection Log Sheet
- Attachment 3: Sump Pump Field Test Record Sheet
- Attachment 4: Full Pump Operating Check Record Sheet
- Attachment 5: Process Flow Diagrams
- Attachment 6: Pump Curve (b) (3) (B)
- Attachment 7: Goulds Pumps, Installation, Operation, and Maintenance Manual Model (b) (3) (B)
- Attachment 8: Pump Curve Byron Jackson (b) (3) (B)
- Attachment 9: User Instructions / Submersible Water Well Pumps / Installation Operation Maintenance / Byron Jackson H2O+ Submersible Pumps and Motors
- Attachment 10: Operation and Maintenance Manual Vertical High Thrust Motor Vertical Industrial Turbine Pumps

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Attachment 1:
SOP Acknowledgement and Training Form

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SOP ACKNOWLEDGEMENT AND TRAINING FORM

This SOP must be read and signed each time training is provided, or modifications are made to the SOP. This form should accompany the current SOP version.

Document Title:	Water Supply Pump Station
Document Revision Number:	
Document Revision Date:	

Please sign below in accordance with the following statement: "I have read and understood the above referenced document. I agree to perform the procedures described in this SOP in accordance with the document until such time that it is superseded by a more recent, approved revision."

Print Name	Signature	Date

Notes: _____

SOP Acknowledgement and Training Form (continued)

Trainee:

Sign below to acknowledge that training on this SOP was received, understood, and all questions/concerns were addressed by the trainer.

Trainer:

Sign below to acknowledge that training on this SOP was completed for the individual listed and that the trainee is competent to perform the procedures described within.

Date of Training [mm/dd/yyyy]	Trainee Print Name	Trainee Signature	Trainer Print Name	Trainer Signature

Notes: _____

Attachment 2:
Pump Inspection Log Sheet

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Attachment 3:
Sump Pump Field Test Record Sheet

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Sump Pump Operating Check Record Sheet												Note: Page can be folded in half along thick black line to allow for easier field note taking.									
Station:																					
Date:																					
Time:																					
Operator 1:																					
Operator 2:																					
Additional Staff:																					
Test Information					Test Results			Pump Readings				Pump Readings Continued						Does Sump Empty As Fast As Previous Test?	Pump Tag	Test No.	
Test No.	Test Description	No. of Pumps Online	Test Start Time	Test End Time	Time to Empty Sump	Estimated Volume Pumped	Test Notes	Pump Tag	Pump Running Amps			Vibration Reading	Noise Observation	Bearing Temperature							
									Phase 1 Amps	Phase 2 Amps	Phase 3 Amps			Bearing Location	Bearing Temp	Bearing Location	Bearing Temp				Bearing Location
1																			1		
2																		2			
3																		3			
4																		4			

Test Information					Test Results			Pump Readings			Pump Readings Continued								Does Sump Empty As Fast As Previous Test?	Pump Tag	Test No.	
Test No.	Test Description	No. of Pumps Online	Test Start Time	Test End Time	Time to Empty Sump	Estimated Volume Pumped	Test Notes	Pump Tag	Pump Running Amps			Vibration Reading	Noise Observation	Bearing Temperature								
									Phase 1 Amps	Phase 2 Amps	Phase 3 Amps			Bearing Location		Bearing Temp	Bearing Location					Bearing Temp

Attachment 4:
Full Pump Operating Check Record Sheet

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Full Pump Operating Check Record Sheet															
Station:															
Date:															
Time:															
Operator 1:															
Operator 2:															
Additional Staff:															
Test Information					Pump Readings										
Test No.	Operating Point Description	No. of Pumps Online	Test Start Time	Total Flow Rate	Flow Rate Per Pump	Discharge Pressure	Well Level	Pump Tag	Pump Speeds	Pump Running Amps			Vibration Reading	Noise Observation	
										Phase 1 Amps	Phase 2 Amps	Phase 3 Amps			
1															
2															
3															
See Page 2															

Note: Page can be folded in half along thick black line to allow for easier field note taking.

Pump Readings Continued						Is Pump Operating Point on Pump Curve?	Is Pump Operating Similar to Previous Years?	Pump Tag	Test No.
Bearing Temperature									
Bearing Location	Bearing Temp	Bearing Location	Bearing Temp	Bearing Location	Bearing Temp				
									1
									2
									3
See Page 2									

Test Information					Pump Readings										Pump Readings Continued						Is Pump Operating Point on Pump Curve?	Is Pump Operating Similar to Previous Years?	Pump Tag	Test No.
Test No.	Operating Point Description	No. of Pumps Online	Test Start Time	Total Flow Rate	Flow Rate Per Pump	Discharge Pressure	Well Level	Pump Tag	Pump Speeds	Pump Running Amps			Vibration Reading	Noise Observation	Bearing Temperature									
										Phase 1 Amps	Phase 2 Amps	Phase 3 Amps			Bearing Location	Bearing Temp	Bearing Location	Bearing Temp	Bearing Location	Bearing Temp				
4																					4			
5																					5			
6																					6			
7																					7			

Attachment 5: Process Flow Diagrams

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(b) (3) (B)

LEGEND	
	BALL VALVE
	GATE VALVE
	GATE VALVE (NORMALLY CLOSED)
	CHECK VALVE
	MOTORIZED BUTTERFLY VALVE
	AIR RELEASE VALVE
	DIAPHRAGM VALVE
	BOOSTER PUMP
	VERTICAL TURBINE PUMP
	METER
	POTABLE WATER LINE

CHECKED BY:

DRAWN BY:

SCALE: NTS

DATE: 05/2025

SHEET 1 OF 1

PROCESS FLOW DIAGRAM

RED HILL SHAFT



ENGINEERING
CONSULTANTS

AH Engineering Consultants

11837 Rock Landing Drive, Suite 300

Newport News, Virginia 23606

(757) 873-4959

www.ahenv.com

REVISIONS	
DESCRIPTION	DATE

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Attachment 6:
Pump Curve Goulds (b) (3) (B)

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Quote Number: (b) (4)

Model: (b) (3) (B)

Size: (b) (3) (B)

(b) (3) (B)

US gpm

(b) (3) (B)

DO NOT USE FOR CONSTRUCTION UNLESS CERTIFIED

Certified by	
Date of certification	
Pump serial number	
Project Name	WAIAWA (b) (3) (B) STATION
Tag 4	

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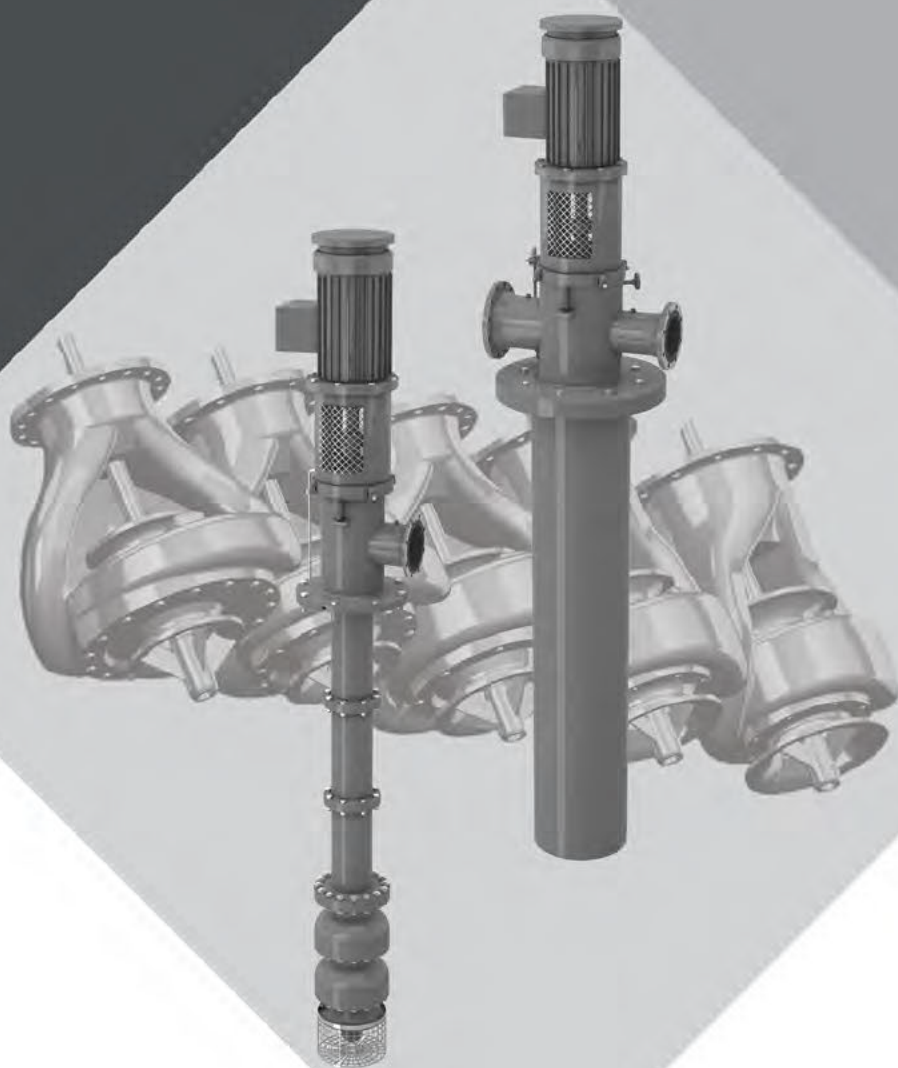
Attachment 7:
Goulds Pumps, Installation, Operation, and
Maintenance Manual Model (b) (3) (B)

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Installation, Operation, and Maintenance Manual

Model (b) (3) (B)



ITT

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1 Introduction and Safety

1.1 Introduction

Purpose of this manual

The purpose of this manual is to provide necessary information for:

- Installation
- Operation
- Maintenance



CAUTION:

Failure to observe the instructions contained in this manual could result in personal injury and/or property damage, and may void the warranty. Read this manual carefully before installing and using the product.

NOTICE:

Save this manual for future reference and keep it readily available.

1.1.1 Requesting other information

Special versions can be supplied with supplementary instruction leaflets. See the sales contract for any modifications or special version characteristics. For instructions, situations, or events that are not considered in this manual or in the sales documents, please contact the nearest ITT representative.

Always specify the exact product type and serial number when requesting technical information or spare parts.

Specifications such as weights, dimensions or centers of gravity of the pump, pump unit or subassemblies are described in the supplier's applicable documentation.

1.2 Safety



WARNING:

- Risk of serious personal injury. Applying heat to impellers, propellers, or their retaining devices can cause trapped liquid to rapidly expand and result in a violent explosion. This manual clearly identifies accepted methods for disassembling units. These methods must be adhered to. Never apply heat to aid in their removal unless explicitly stated in this manual.
- Pumps are provided specifically for an application. User should contact the OEM to use the pump for a different application.
- The operator must be aware of the pumpage and take appropriate safety precautions to prevent physical injury.
- Risk of serious injury or death. If any pressure-containing device is over-pressurized, it can explode, rupture, or discharge its contents. It is critical to take all necessary measures to avoid over-pressurization.
- Risk of death, serious personal injury, and property damage. Installing, operating, or maintaining the unit using any method not prescribed in this manual is prohibited. Prohibited methods include any modification to the equipment or use of parts not provided by

ITT. If there is any uncertainty regarding the appropriate use of the equipment, please contact an ITT representative before proceeding.

- If the pump or motor is damaged or leaking, electric shock, fire, explosion, liberation of toxic fumes, physical harm, or environmental damage may result. Do not operate the unit until the problem has been corrected or repaired.
- Risk of serious personal injury or property damage. Dry running may cause rotating parts within the pump to seize to non-moving parts. Do not run dry.
- Risk of death, serious personal injury, and property damage. Heat and pressure buildup can cause explosion, rupture, and discharge of pumpage. Never operate the pump with suction and/or discharge valves closed.
- Running a pump without safety devices exposes operators to risk of serious personal injury or death. Never operate a unit unless appropriate safety devices (guards, etc.) are properly installed. See specific information about safety devices in other sections of this manual.
- Before proceeding, after alignment is complete, make sure that the coupling guard provided by the manufacturer is properly reinstalled. Guards must not be removed while the pump is operational. Always follow lock out - tag out procedures.
- Never operate the pump if a strainer is clogged.



CAUTION:

- Risk of injury and/or property damage. Operating a pump in an inappropriate application can cause over pressurization, overheating, and/or unstable operation. Do not change the service application without the approval of an authorized ITT representative.
- When the pump is handling hazardous liquids, care must be taken to avoid exposure to the liquid by following proper safety precautions, limiting personnel access, and by operator training. If the liquid is flammable and/or explosive, strict safety procedures must be applied.
- Gland packing must not be used when wetted with hazardous liquids.

1.2.1 Safety terminology and symbols

About safety messages

It is extremely important that you read, understand, and follow the safety messages and regulations carefully before handling the product. They are published to help prevent these hazards:

- Personal accidents and health problems
- Damage to the product
- Product malfunction

Hazard levels

Hazard level	Indication
 DANGER:	A hazardous situation which, if not avoided, will result in death or serious injury
 WARNING:	A hazardous situation which, if not avoided, could result in death or serious injury

Hazard level	Indication
 CAUTION:	A hazardous situation which, if not avoided, could result in minor or moderate injury
NOTICE:	• A potential situation which, if not avoided, could result in undesirable conditions • A practice not related to personal injury

Hazard categories

Hazard categories can either fall under hazard levels or let specific symbols replace the ordinary hazard level symbols.

Electrical hazards are indicated by the following specific symbol:



ELECTRICAL HAZARD:

These are examples of other categories that can occur. They fall under the ordinary hazard levels and may use complementing symbols:

- Crush hazard
- Cutting hazard
- Arc flash hazard

1.2.1.1 The Ex symbol

The Ex symbol indicates safety regulations for Ex-approved products when used in atmospheres that are potentially explosive or flammable.



1.2.2 Environmental safety

The work area

Always keep the station clean to avoid and/or discover emissions.



WARNING:

Move equipment to a safe/non Ex environment for repairs/adjustments or use spark resistant tools and work methods.

Waste and emissions regulations

Observe these safety regulations regarding waste and emissions:

- Appropriately dispose of all waste.
- Handle and dispose of the processed liquid in compliance with applicable environmental regulations.
- Clean up all spills in accordance with safety and environmental procedures.
- Report all environmental emissions to the appropriate authorities.

**WARNING:**

If the product has been contaminated in any way, such as from toxic chemicals or nuclear radiation, do NOT send the product to ITT until it has been properly decontaminated and advise ITT of these conditions before returning.

Electrical installation

For electrical installation recycling requirements, consult your local electric utility.

1.2.2.1 Recycling guidelines

Always follow local laws and regulations regarding recycling.

1.2.3 User safety**General safety rules**

These safety rules apply:

- Always keep the work area clean.
- Pay attention to the risks presented by gas and vapors in the work area.
- Avoid all electrical dangers. Pay attention to the risks of electric shock or arc flash hazards.
- Always bear in mind the risk of drowning, electrical accidents, and burn injuries.

Safety equipment

Use safety equipment according to the company regulations. Use this safety equipment within the work area:

- Hardhat
- Safety goggles, preferably with side shields
- Protective shoes
- Protective gloves
- Gas mask
- Hearing protection
- First-aid kit
- Safety devices

Electrical connections

Electrical connections must be made by certified electricians in compliance with all international, national, state, and local regulations. For more information about requirements, see sections dealing specifically with electrical connections.

Noise**WARNING:**

Sound pressure levels may exceed 80 dbA in operating process plants. Clear visual warnings or other indicators should be available to those entering an area with unsafe noise levels. Personnel should wear appropriate hearing protection when working on or around any equipment, including pumps. Consider limiting personnel's exposure time to noise or, where possible, enclosing equipment to reduce noise. Local law may provide specific guidance regarding exposure of personnel to noise and when noise exposure reduction is required.

Temperature



WARNING:

Equipment and piping surfaces may exceed 130°F (54°C) in operating process plants. Clear visual warnings or other indicators should alert personnel to surfaces that may reach a potentially unsafe temperature. Do not touch hot surfaces. Allow pumps operating at a high temperature to cool sufficiently before performing maintenance. If touching a hot surface cannot be avoided, personnel should wear appropriate gloves, clothing, and other protective gear as necessary. Local law may provide specific guidance regarding exposure of personnel to unsafe temperatures.

1.2.3.1 Precautions before work

Observe these safety precautions before you work with the product or are in connection with the product:



- Electrostatic charging: Never earth (ground) an electric welding machine on pump equipment or base.
- Provide a suitable barrier around the work area, for example, a guard rail.
- Make sure that all safety guards are in place and secure.
- Make sure that you have a clear path of retreat.
- Make sure that the product cannot roll or fall over and injure people or damage property.
- Make sure that the lifting equipment is in good condition.
- Use a lifting harness, a safety line, and a breathing device as required.
- Allow all system and pump components to cool before you handle them.
- Make sure that the product has been thoroughly cleaned.
- Disconnect and lock out power before you service the pump.
- Check the explosion risk before you weld or use electric hand tools.

1.2.3.2 Precautions during work

Observe these safety precautions when you work with the product or are in connection with the product:



CAUTION:

Failure to observe the instructions contained in this manual could result in personal injury and/or property damage, and may void the warranty. Read this manual carefully before installing and using the product.

- Never work alone.
- Always wear protective clothing and hand protection.
- Stay clear of suspended loads.
- Always lift the product by its lifting device.
- Beware of the risk of a sudden start if the product is used with an automatic level control.
- Beware of the starting jerk, which can be powerful.
- Rinse the components in water after you disassemble the pump.
- Do not exceed the maximum working pressure of the pump.

- Do not open any vent or drain valve or remove any plugs while the system is pressurized. Make sure that the pump is isolated from the system and that pressure is relieved before you disassemble the pump, remove plugs, or disconnect piping.
- Never operate a pump without a properly installed coupling guard.

1.2.3.3 Hazardous liquids

The product is designed for use in liquids that can be hazardous to your health. Observe these rules when you work with the product:

- Make sure that all personnel who work with biologically hazardous liquids are vaccinated against diseases to which they may be exposed.
- Observe strict personal cleanliness.
- A small amount of liquid will be present in certain areas like the seal chamber.

1.2.3.4 Wash the skin and eyes

1. Follow these procedures for chemicals or hazardous fluids that have come into contact with your eyes or your skin:

Condition	Action
Chemicals or hazardous fluids in eyes	1. Hold your eyelids apart forcibly with your fingers. 2. Rinse the eyes with eyewash or running water for at least 15 minutes. 3. Seek medical attention.
Chemicals or hazardous fluids on skin	1. Remove contaminated clothing. 2. Wash the skin with soap and water for at least 1 minute. 3. Seek medical attention, if necessary.

1.2.4 Ex-approved products

Follow these special handling instructions if you have an Ex-approved unit.

Personnel requirements

These are the personnel requirements for Ex-approved products in potentially explosive atmospheres:

- All work on the product must be carried out by certified electricians and ITT-authorized mechanics. Special rules apply to installations in explosive atmospheres.
- All users must know about the risks of electric current and the chemical and physical characteristics of the gas, the vapor, or both present in hazardous areas.
- Any maintenance for Ex-approved products must conform to international and national standards.

ITT disclaims all responsibility for work done by untrained and unauthorized personnel.



Product and product handling requirements

These are the product and product handling requirements for Ex-approved products in potentially explosive atmospheres:

- Only use the product in accordance with the approved motor data.

- The Ex-approved product must never run dry during normal operation. Dry running during service and inspection is only permitted outside the classified area.
- Before you start work on the product, make sure that the product and the control panel are isolated from the power supply and the control circuit, so they cannot be energized.
- Do not open the product while it is energized or in an explosive gas atmosphere.
- Make sure that thermal contacts are connected to a protection circuit according to the approval classification of the product, and that they are in use.
- Intrinsically safe circuits are normally required for the automatic level-control system by the level regulator if mounted in zone 0.
- Do not modify the equipment without approval from an authorized ITT representative.
- Only use parts that are provided by an authorized ITT representative.
- Do not operate the pump in processes that can cause shock waves or adiabatic compression (e.g. high pressure gases or oxidizing gases).

1.3 Noise level data

Personnel exposed to noise levels exceeding 80 dBA (or less if specified by local regulations) shall wear hearing protection.

1.4 Product warranty

Coverage

ITT undertakes to remedy faults in products from ITT under these conditions:

- The faults are due to defects in design, materials, or workmanship.
- The faults are reported to an ITT representative within the warranty period.
- The product is used only under the conditions described in this manual.
- The monitoring equipment incorporated in the product is correctly connected and in use.
- All service and repair work is done by ITT-authorized personnel.
- Genuine ITT parts are used.
- Only Ex-approved spare parts and accessories authorized by ITT are used in Ex-approved products.

Limitations

The warranty does not cover faults caused by these situations:

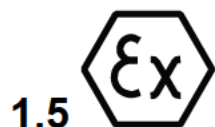
- Deficient maintenance
- Improper installation
- Modifications or changes to the product and installation made without consulting ITT
- Incorrectly executed repair work
- Normal wear and tear

ITT assumes no liability for these situations:

- Bodily injuries
- Material damages
- Economic losses

Warranty claim

ITT products are high-quality products with expected reliable operation and long life. However, should the need arise for a warranty claim, then contact your ITT representative.



Special care must be taken in potentially explosive environments to ensure that the equipment is properly operated and maintained. Compliance with the essential safety and health requirements has been assured by compliance with the following standards, method of protection Constructional Safety (C): ISO 80079-36 ISO 80079-37

Description of Ex-Directives

The Ex-directives are a specification enforced in Europe and the United Kingdom for electrical and non-electrical equipment installed in those locations. Ex-directives deal with the control of potentially explosive atmospheres and the standards of equipment and protective systems used within these atmospheres. The relevance of the Ex-requirements is not limited to Europe or the UK. You can apply these guidelines to equipment installed in any potentially explosive atmosphere.

Guidelines for compliance

Compliance is fulfilled only when you operate the unit within its intended use. Do not change the conditions of the service without the approval of an ITT representative. When you install or maintain explosion proof products, always comply with the directive and applicable standards (for example, IEC/EN 60079-14).

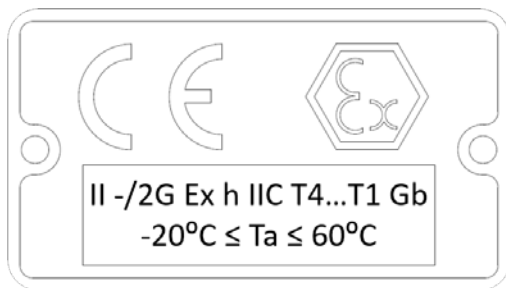
1. Monitoring the thrust bearing and liquid end temperature.
2. Maintaining proper bearing lubrication.
3. Ensuring that the pump is operated in the intended hydraulic range.

The Ex conformance is only applicable when the pump unit is operated within its intended use. Operating, installing or maintaining the pump unit in any way that is not covered in the Instruction, Operation, and Maintenance manual (IOM) can cause serious personal injury or damage to the equipment. This includes any modification to the equipment or use of parts not provided by ITT Goulds Pumps. If there is any question regarding the intended use of the equipment, please contact an ITT Goulds representative before proceeding.

Current IOMs are available at <https://www.gouldspumps.com/en-US/Tools-and-Resources/Literature/IOMs/> or from your local ITT Goulds Pumps Sales representative.

All pumping unit (pump, seal, elastic coupling, motor and pump accessories) certified for use in an Ex classified environment, are identified by an Ex tag secured to the pump or the sub base on which it is mounted. A typical tag would look like this:

If applicable, your pump may have either a CE Ex (ATEX) tag or UKCA Ex tag affixed to the pump. See the Safety section for a description of the symbols and codes. Typical nameplate only shown below, the actual area classification may be different.

**Figure 1: Typical Ex nameplate****Figure 2: Typical UKCA Ex nameplate**

The code classification marked on the equipment must be in accordance with the specified area where the equipment will be installed. If it is not, do not operate the equipment and contact your ITT Goulds Pumps sales representative before proceeding.

Equipment for monitoring

For additional safety, use condition-monitoring devices. Condition-monitoring devices include but are not limited to these devices:

- Pressure gauges
- Flow meters
- Level indicators
- Motor load readings
- Temperature detectors
- Bearing monitors
- Leak detectors
- PumpSmart control system

2 Transportation and Storage

2.1 Receive the unit

1. Inspect the package for damaged or missing items upon delivery.
2. Note any damaged or missing items on the receipt and freight bill.
3. File a claim with the shipping company if anything is out of order.

NOTICE:

Mechanical seals and related parts are shipped loose in a proper box.

2.2 Unpack the unit

1. Remove packing materials from the unit.
Dispose of all packing materials in accordance with local regulations.
2. Inspect the unit to determine if any parts have been damaged or are missing.
3. Contact your ITT representative if anything is out of order.

2.3 Pump or bowl assembly handling, rigging and lifting



WARNING:

Dropping, rolling or tipping units, or applying other shock loads, can cause property damage and/or personal injury. Ensure that the unit is properly supported and secure during lifting and handling.



CAUTION:

Risk of injury or equipment damage from use of inadequate lifting devices. Ensure lifting devices (such as chains, straps, forklifts, cranes, etc.) are rated to sufficient capacity.

2.3.1 Lifting methods



WARNING:

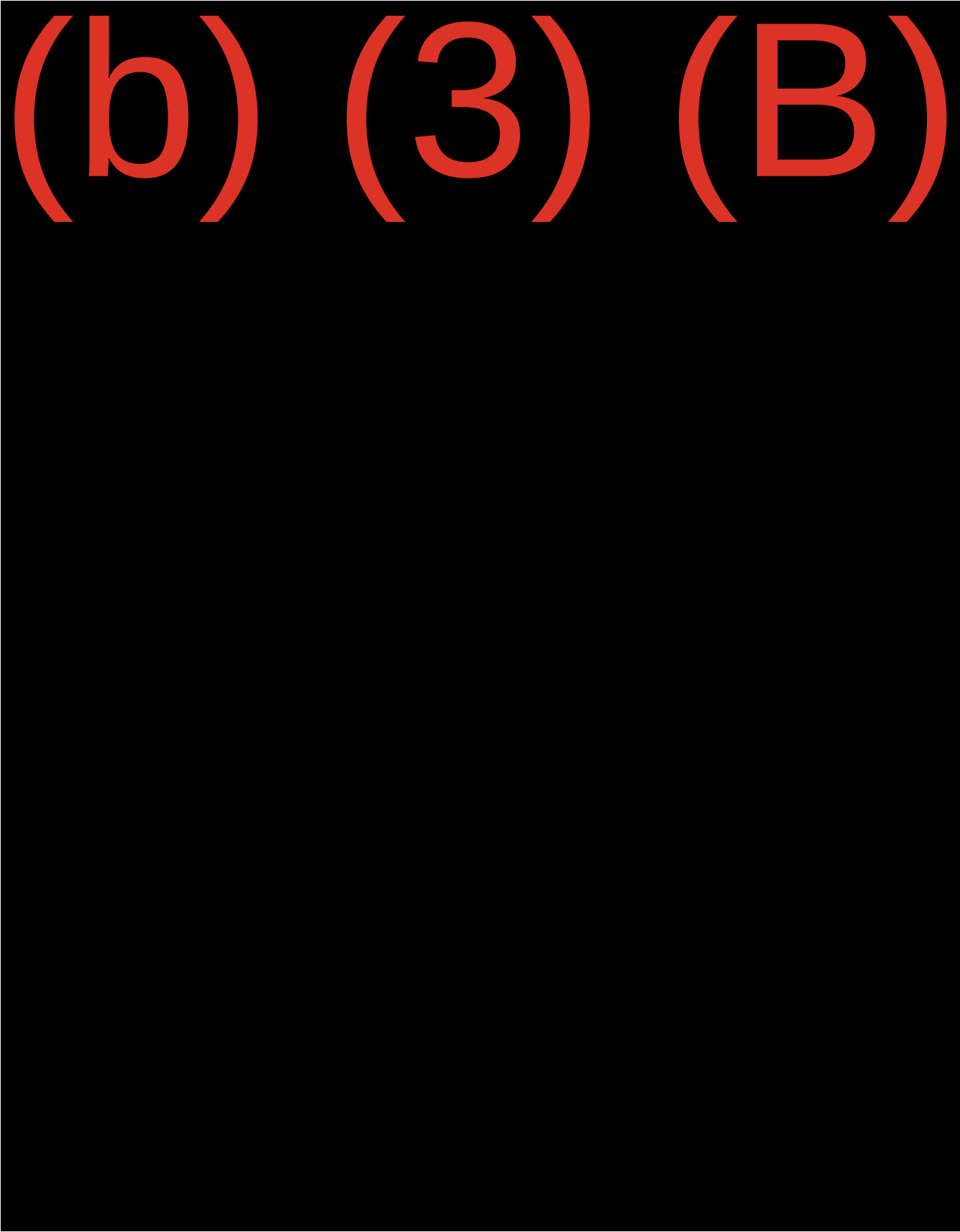
- Risk of serious personal injury or equipment damage. Proper lifting practices are critical to safe transport of heavy equipment. Ensure that practices used are in compliance with all applicable regulations and standards.
 - Safe lifting points are specifically identified in the general arrangement drawing. It is critical to lift the equipment only at these points. Integral lifting eyes or swivel hoist rings on pump and motor components are intended for use in lifting the individual components only.
 - Lifting and handling heavy equipment poses a crush hazard. Use caution during lifting and handling and wear appropriate Personal Protective Equipment (PPE, such as steel-toed shoes, gloves, etc.) at all times. Seek assistance if necessary.
-

Table 1: Methods

Pump type	Lifting method
A fully-assembled pump	Use suitable lifting devices attached to the lifting lugs on the discharge head or suitable swivel hoist rings through the barrel flange or the discharge head base flange.
A partially-assembled pump	Use suitable lifting devices attached to the component or sub-assembly lifting lugs or suitable swivel hoist rings through the component flanges.
A disassembled pump	Use suitable lifting devices attached to the component lifting lugs or suitable swivel hoist rings through the component flanges.
Bowl assembly (partly completed machinery)	Use suitable swivel hoist rings attached to the component flanges.

(b) (3) (B)

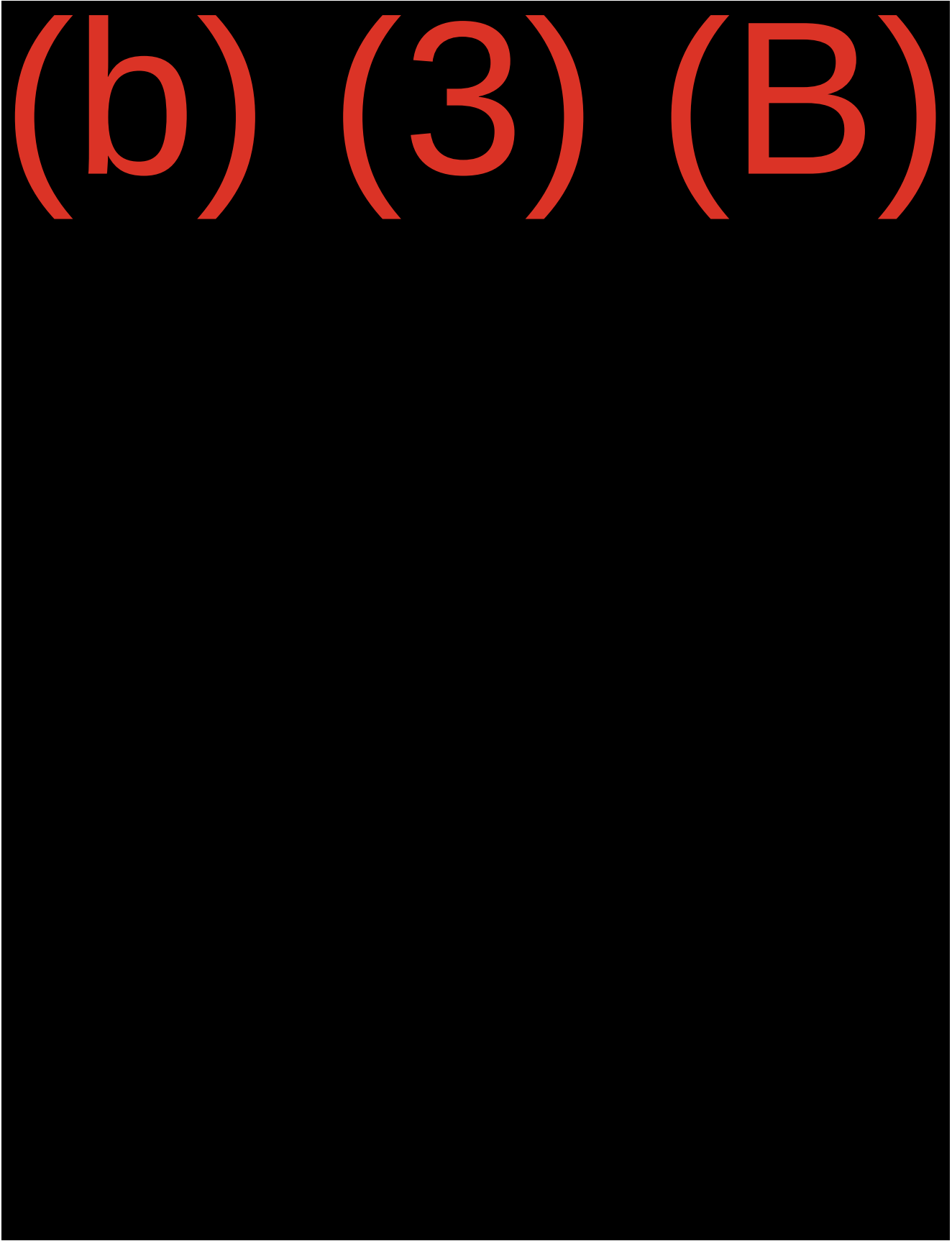
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(b) (3) (B)

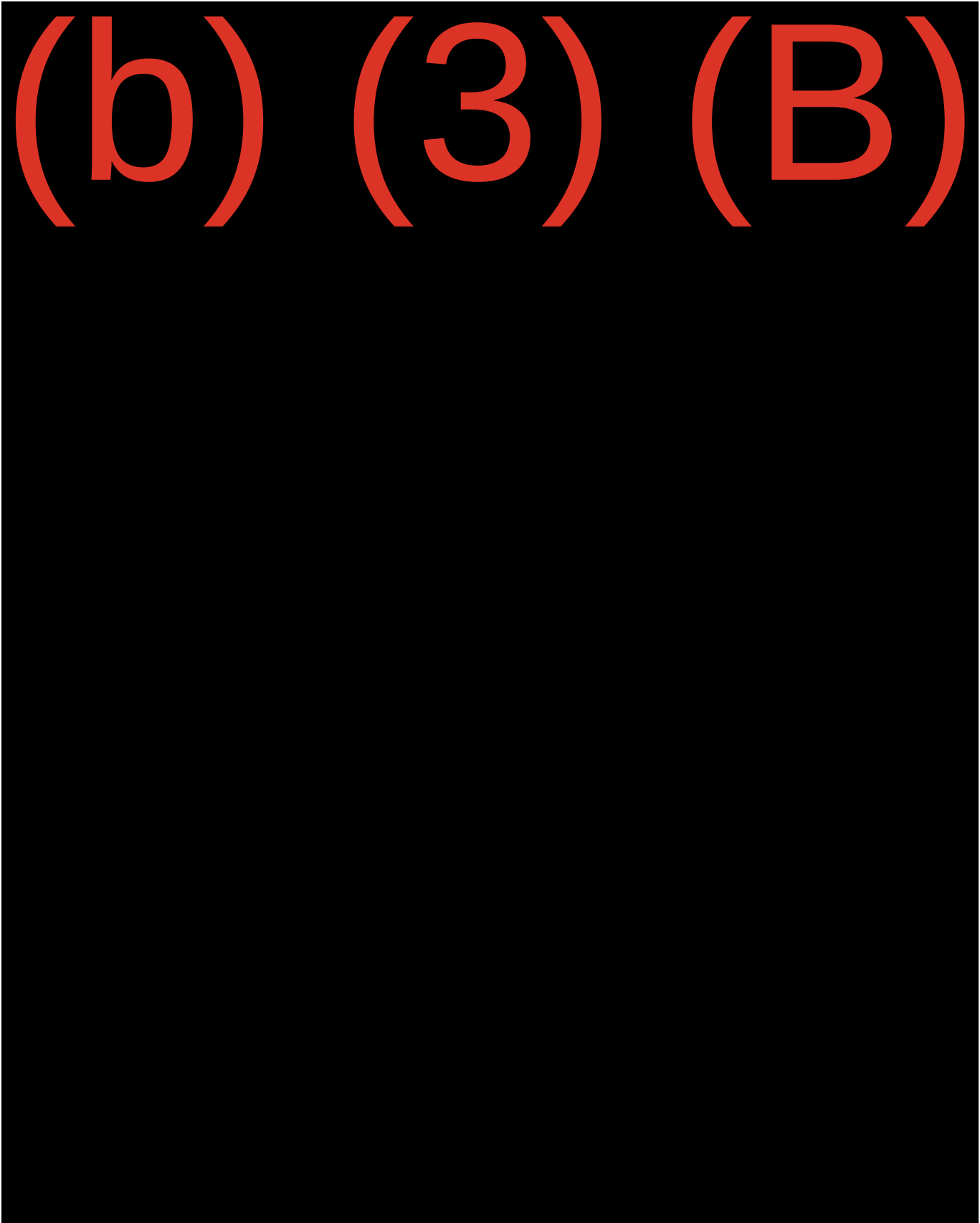


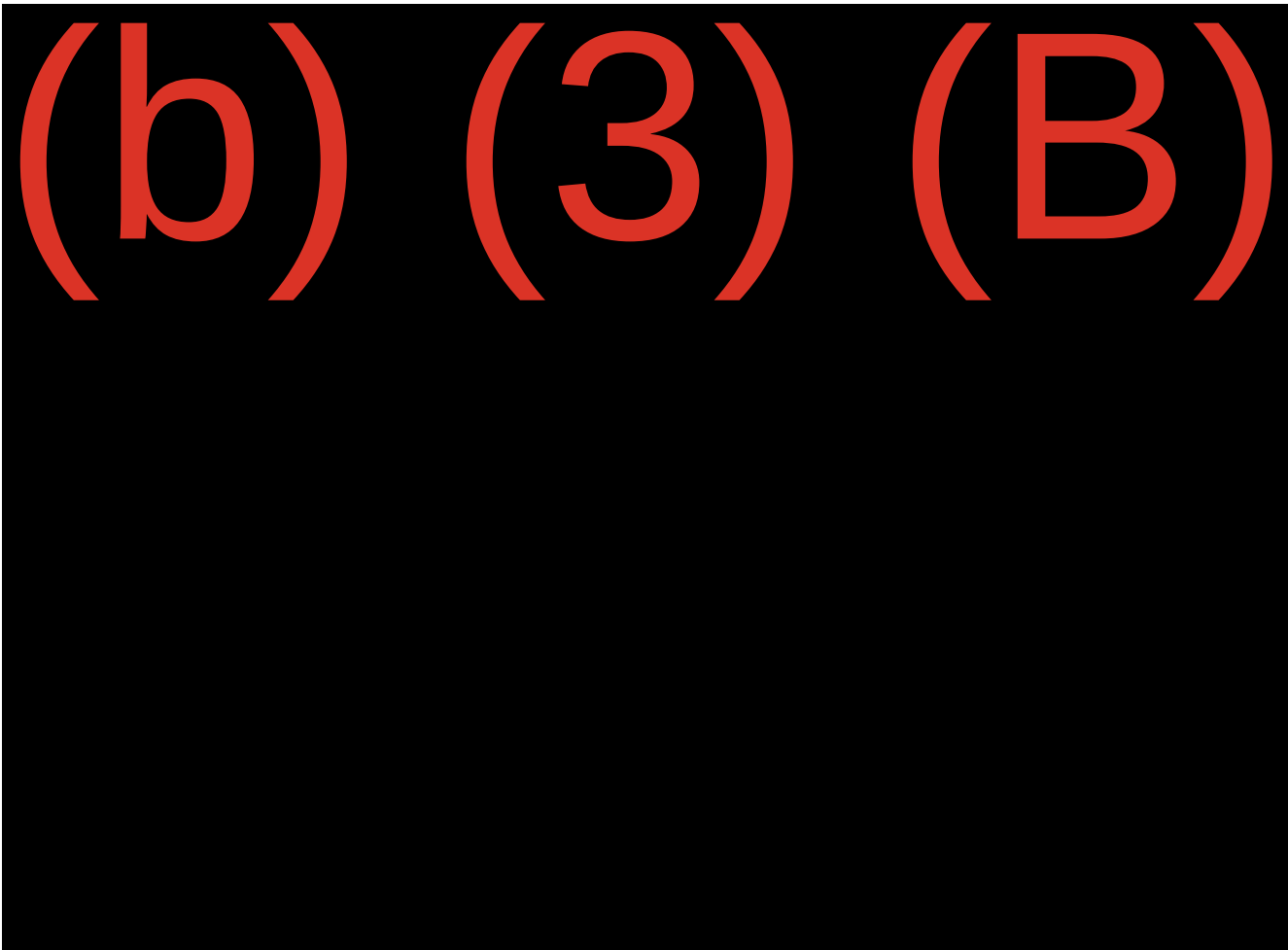
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(b) (3) (B)







2.4 Pump and bowl assembly storage requirements

Requirements

Vertical units require proper preparation for storage and regular maintenance during storage. The unit is considered in storage when it has been delivered to the job site and is awaiting installation.

For specific requirements for storing motors, gearboxes, engines, panels, sealing plans and other auxiliaries, contact the equipment manufacturer.

Storage preparation

Condition	Proper preparation
Indoor storage area (preferred)	• Pave the area. • Clean the area. • Drain the area and keep it free from flooding.
Outdoor storage area (when indoor storage is not available)	• Observe all indoor storage requirements. • Use weather-proof coverings such as flame-resistant sheeting or tarpaulins. • Place coverings in a manner that maximizes drainage and air circulation. • Tie coverings down in order to protect the pump from wind damage.

Condition	Proper preparation
Placement of units and component parts	- Place the unit on skids, pallets, or shoring higher than 15 cm 6 in. from the ground for good air circulation. - Sort the parts in order to permit easy access for inspection and/or maintenance without excessive handling.
Stacking of units or component parts	- Make sure that racks, containers, or crates bear the full weight of units or parts in order to prevent distortion. - Keep identification markings readily visible. - Immediately replace any cover you remove for internal access.
Rotation of the pump and bowl assembly shaft NOTICE: This activity is fundamental and requires a special boxing that should be ordered.	- Rotate the shaft and bowl assembly shaft counterclockwise at least 3 turns once a month, at a minimum. - Never leave the shaft in a previous position or in the extreme raised or lowered lateral position. - Make sure that the shaft rotates freely.
Controlled storage facilities	- Maintain an even temperature of 6°C 10°F or higher above the dew point. - Keep the relative humidity to less than 50%. - Make sure that there is little or no dust.
Uncontrolled storage facilities that have uneven temperatures, higher humidity, and/or dusty conditions)	- Inspect the unit periodically to make sure that all preservatives are intact. - Seal all pipe threads and flanged pipe covers with tape.

When pump is not in regular operation

If a pump has been installed, but is not in regular operation for an extended period of time, such as during a seasonal shutdown, then operate it for at least 15 minutes every two weeks.

2.4.1 Prepare the unit for long-term storage

For storage periods over six months, you must follow the [2.4 Pump and bowl assembly storage requirements on page 20](#) above this procedure:

1. Inspect the lube-oil and seal-flush piping and either fill the piping with rust-preventative oil, or recoat the piping periodically in order to prevent corrosion.
2. Place 4.5 kg | 10 lbs of moisture-absorbing desiccant or 2.3 kg | 5.0 lbs of vapor-phase inhibitor crystals near the center of the pump.
3. If the unit is assembled, place an additional 0.5 kg | 1 lb in the discharge nozzle and securely fasten the nozzle to the discharge elbow.
4. Install a moisture indicator near the perimeter of the unit.
5. Cover the unit with black polyethylene with a minimum thickness of 0.15 mm | 6.0 mil, and seal it with tape.
6. Provide a small ventilation hole approximately 12.0 mm | 0.5 in. diameter.
7. Provide a roof or shed shelter in order to protect the unit from direct exposure to the elements.
8. For units with Thrust Pot see the instructions [5.8 Lubricate the thrust pot during a shutdown period on page 69](#).

(b) (3) (B)

(b) (3) (B)

(b) (3) (B)

4 Installation

4.1 Installation of a partly completed machinery

A partly completed machinery is a bowl assembly, refer to [4.4.1 Installing the bowl assembly on page 32](#) and subsequent items.

4.2 Pre-installation

Precautions



WARNING:

- When installing in a potentially explosive environment, ensure that the motor is properly certified.
- All equipment being installed must be properly grounded to prevent unexpected discharge. Discharge can cause equipment damage, electric shock, and result in serious injury. Test the ground lead to verify it is connected correctly.
- When pumping fluids with conductivity less than 1000 ps/m follow IEC TS 60079 32-1 guidelines.
- Stray electrical currents may ignite explosive atmospheres. Ensure drives are certified for variable frequency drive operation by the manufacturer.
- In plants or pumps with cathodic corrosion protection, a small current constantly flows through the construction. This is not permissible on the complete pump or partially-assembled machinery without further precautions being taken. ITT should be consulted in this context.

NOTICE:

- Electrical connections must be made by certified electricians in compliance with all international, national, state and local regulations.
- Supervision by an authorized ITT representative is recommended to ensure proper installation. Improper installation may result in equipment damage or decreased performance.

4.2.1 Location



Do not apply additional paint or coatings to the pump when in an Ex environment. Static electric discharge can be initiated when contacting or rubbing surfaces with excessive coating thickness.



Potential electrostatic charging hazard. Do not rub, clean, or blast equipment with dry cloth or dry media.

For pumps that require assembly on site, a clean dry area should be provided next to the point of installation, of adequate size for placing the pump components and driver in the sequence in which they will be installed. Protective covers should be left on all pump openings until the time of actual installation to prevent dirt and foreign objects from entering the pump. Protective coatings should likewise be left on

machined surfaces to prevent rusting. Pump accessories such as controls instrumentation or intermediate junction boxes must be protected from damage and moisture. For outdoor installations, the components should be covered with rainproof tarps during the period of installation for protection against the elements. This is particularly important during freezing conditions to prevent water from collecting in the pump cavities and perhaps causing freezing damage.

All pumps require regular maintenance. It is therefore important to locate pump outlet piping (and inlet piping when applicable) as well as auxiliary equipment and control and starting panels in such a manner the adequate access is provided for maintenance. Adequate floor space and working room should also be provided for repair, including parts placement.

To minimize frictional head loss, locate the pump so that it can be installed with a short and direct inlet piping and with the least number of elbows and fittings.

4.2.2 Inspect the sub-base

1. If an optional sub-base is furnished, remove it from the pump discharge head or barrel when it is shipped assembled.
2. Completely clean the underside of the sub-base.
You might need to coat the underside of the sub-base with an epoxy primer which you can purchase as an option.
3. Remove the rust-preventative solution from the machined topside of the barrel flange with an appropriate solution.

4.2.3 Concrete foundation requirements

Requirements

Make sure that you meet these requirements when you prepare the pump foundation:

- The foundation must be able to absorb any vibration.
- The foundation must be able to form a permanent and rigid support for the pumping unit.
- The foundation must be of adequate strength in order to support the complete weight of the pump and driver, plus the weight of the liquid that passes through it.

Typical installation

A typical installation has these characteristics:

- Bolts with a pipe sleeve that is two and a half times the size of the bolt diameter embedded in the concrete
- Properly sized
- Located in accordance with the dimensions given in the example drawing
- Enough space inside the pipe sleeves to allow the final position of the foundation bolts to align with the holes in the sub-base flange

(b) (3) (B)

4.2.3.1 Installing the barrel or sub-base on a concrete foundation



User shall observe necessity of using a safety device, such as a flame arrestor, to prevent flame entering or leaving the pump sump, tank, or barrel when applicable.

1. Remove water and debris from the anchor bolt holes and sleeves before you start the grout.
2. For sleeve-type bolts, fill the sleeves with packing or rags in order to prevent grout from entering the sleeves.
3. Carefully lower the barrel or sub-base onto the foundation bolts and hand-tighten the bolt nuts.
4. Use a machinist's level in order to level the barrel flange or sub-base or the machine surface of the discharge head using leveling wedges or leveling screws.

In order to ensure an accurate reading, check that the surface being leveled is free from all contaminants, such as dust.

5. Level the barrel or sub-base in two directions at 90° on the machined surface to achieve levelness condition indicated in this table.

Table 3: Levelness tolerances

(b) (3) (B)

(b) (3) (B)

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(b) (3) (B)

4.4.12 Flush water system setup

Please refer to General Arrangement Drawing to get the flush water parameters.

4.4.13 Installation and startup checklist

Use this checklist in conjunction with the standard instruction manual furnished with the equipment. Initial each completed item or write N/A if the item is not applicable. After you complete this checklist, forward a copy to the VPD field service for entry into the quality assurance records. Use a separate checklist for each individual pump.

Part 1: System and installation inspections

Check	Checked
Check that the pump foundation is level according to Table 3: Levelness tolerances on page 27 .	
Check that the foundation can handle the weight and loading of the pump.	
Check that the foundation is properly grouted using a high quality non-shrink grout.	
Check that all the anchor bolts are tight.	
Check that the suction and discharge piping is properly supported and that there is no excess nozzle loading on the discharge flange.	
On units with flexible or expansion joints attached to the pump suction or discharge, check that tie rods are in place and properly installed.	
Check that the suction valve is fully open.	
Check these items for all valves: • Operate freely • Properly installed for the direction of flow • Have the proper pressure	
Check where the pumped fluid is going and that the system is properly lined up for the test.	
Check that the pumped fluid supply will be continuously available for the duration of the test.	
It is very important that the initial run is at least ten minutes in duration in order to completely flush the pump.	
If possible, check the cleanliness of the pumped fluid and piping. If you are present during the installation, check that the sump, barrel, and piping are clean.	
Check that electrical conduit and boxes aren't obstructing of the windows of the discharge head.	
Check that electrical conduit and boxes are sized to manufacturers' recommendations along with all appropriate standards and local statutes.	
Check that all control and alarm systems, which may be electrical, hydraulic, or pneumatic, are corrected installed and functioning in accordance with the manufacturer's instructions. All alarm point settings should be verified.	

Part 2: Pump assembly pre-start inspections

Check	Checked
Verify that the drivers are properly lubricated before start-up. On drives with grease-lubricated motor bearings, insist that the motor vendor grease them on-site. Lubrication information is located on special motor tags or in the motor manuals.	
For other drivers than electric motors, verify the specific assembly and installation instructions concerning to exhaust gas collection, noise, temperature protection and others.	
Determine the allowable number of cold/hot starts with the motor vendor.	
The general rule of thumb is two cold or one hot start per hour. Exceeding the recommended starts breaks down the motor insulation and can cause failure. Megger the motor if possible.	
Before you couple the driver to the pump, verify the proper rotation of the driver by bumping it. The proper rotation for vertical pumps is counterclockwise when viewed from above.	

Check	Checked
Run the pump uncoupled in order to check that the driver runs smooth and sounds normal. • (b) (3) (B) If a customer refuses to allow you to check the rotation, have the customer sign and date this check-list before you proceed.	
After you verify the proper rotation of the driver, you can couple the pump to the driver. • (b) (3) (B) See either the pump nameplate or the outline drawing for the specific impeller lift required for an individual pump.	
Check the alignment on pumps that are equipped with jacking bolts since they require that the motor be physically aligned to the pump. Special alignment of the pump to the motor is not usually required since all components are equipped with register fits.	
Use a dial indicator in order to check that the shaft runout above the sealing element is not excessive: • (b) (3) (B)	
On units with seals, check these items: • Check that the seal rotates freely. • Check that the seal spacers are removed. • Check that the seal piping is properly installed and leak-free.	
On water-lubricated, enclosed lineshaft units, check these items: • Check the water PSI and flow rate. • Check the solenoid valve and its connection for proper operation.	
On oil-lubricated, enclosed lineshaft units, check these items: • Check that the oil tank is completely full and allow the oil to drip overnight prior to start-up. • Check the solenoid valve and its connection for proper operation. • Check the oil tank and refill.	

Part 3: Unit startup

Check	Checked
After you complete all of the checks in Parts 1 and 2, conduct a start-up meeting with customer in order to discuss the actual procedures they might require during start-up and commissioning. Also, verify with the customer that their system is ready for pumped fluid.	
When the system is ready, push the start button and adjust the discharge valve in order to meet the design point, if required.	
Watch for signs of trouble. The unit must run at least ten minutes in order to flush out the pump and system.	
Verify that the unit runs smoothly with no unusual noise, vibration, or over heating.	
Run the unit for one hour in order to test the system.	

Measurements

Reading	Value
Impeller lift	
Driver shaft runout	
Pump head shaft runout	
Seal housing face runout	
Seal housing bore runout	
Megger	
Vibration	

5 Commissioning, Startup, Operation, and Shutdown

5.1 Preparation for startup



WARNING:

- Risk of serious physical injury or death. Exceeding any of the pump operating limits (e.g. - pressure, temperature, power, etc.) could result in equipment failure, such as explosion, seizure, or breach of containment. Assure that the system operating conditions are within the capabilities of the pump.
 - Risk of death or serious injury. Leaking fluid can cause fire and/or burns. Ensure all openings are sealed prior to filling the pump.
 - Breach of containment can cause fire, burns, and other serious injury. Failure to follow these precautions before starting the unit may lead to dangerous operating conditions, equipment failure, and breach of containment.
 - Risk of explosion and serious physical injury. Do not operate pump with blocked system piping or with suction or discharge valves closed. This can result in rapid heating and vaporization of pumpage.
 - Risk of breach of containment and equipment damage. Ensure the pump operates only between minimum and maximum rated flows. Operation outside of these limits can cause high vibration, mechanical seal and/or shaft failure, and/or loss of prime.
-



WARNING:

- Failure to use or incorrect use of auxiliary connections provided (e.g. barrier fluid, flushing liquid, etc.) may result in injury from escaping fluid, burns, and malfunction of the pump. Refer to the general arrangement drawing, piping layout, mechanical seal drawing and seal system drawing for the quantity, dimensions and locations of auxiliary connections.
 - Risk of death, serious personal injury, and property damage. Heat and pressure buildup can cause explosion, rupture, and discharge of pumpage. Never operate the pump with suction and/or discharge valves closed.
 - Running a pump without safety devices exposes operators to risk of serious personal injury or death. Never operate a unit unless appropriate safety devices (guards, etc.) are properly installed.
 - Prior to startup, make sure that all areas, such as threaded openings, vent and drain valves, and flanged openings, that could leak pumped fluid to the work environment are closed.
 - Failure to disconnect and lock out driver power may result in serious physical injury or death. Always disconnect and lock out power to the driver before performing any installation or maintenance tasks.
 - Electrical connections must be made by certified electricians in compliance with all international, national, state, and local rules.
 - Refer to driver/coupling/gear manufacturer's installation and operation manuals (IOM) for specific instructions and recommendations.
-



WARNING:

The mechanical seal used in an Ex-classified environment must be properly certified.



CAUTION:

Packed stuffing boxes are not allowed in an Ex-classified environment.

NOTICE:

Avoid mechanical seal failure or pump seizure by:

- never running the pump at a speed below (b) (3) (B) of full speed unless operating range for this pump has specifically been approved by the manufacturer at a lower speed.
 - never running the pump at a speed lower than the speed required to overcome the static lift.
-

Precautions



WARNING:

The mechanical seal used in an Ex-classified environment must be properly certified.



CAUTION:

When a cartridge mechanical seal is used, ensure that the set screws in the seal locking ring are tightened and that the centering clips have been removed prior to startup. This prevents seal or shaft sleeve damage by ensuring that the seal is properly installed and centered on the sleeve.



CAUTION:

Packed stuffing boxes are not allowed in an Ex-classified environment.

NOTICE:

- Avoid running a pump at critical speeds.
 - Verify the driver settings before you start any pump. Refer to the applicable drive equipment IOMs and operating procedures.
 - Excessive warm-up rates can cause equipment damage. Ensure the warm-up rate does not exceed 1.4°C | 2.5°F per minute.
-

NOTICE:

You must follow these precautions before you start the pump:

- Flush and clean the system thoroughly to remove dirt or debris in the pipe system in order to prevent premature failure at initial startup.
 - Bring variable-speed drivers to the rated speed as quickly as possible.
 - Run a new or rebuilt pump at a speed that provides enough flow to flush and cool the close-running surfaces of the stuffing-box or seal-housing bearing.
-

- If temperatures of the pumped fluid will exceed 93°C | 200°F, then warm up the pump prior to operation. Circulate a small amount of fluid through the pump until the casing temperature is within 38°C | 100°F of the fluid temperature. Accomplish this by flowing fluid from pump inlet to discharge drain (optionally, the casing vent can be included in warm-up circuit but not required). Soak for (2) hours at process fluid temperature.
- Rubber bearings must be wet prior to startup if the non-submerged (dry column) length is greater than 15 m | 50 ft. You can only use clean water or clean sea water.

At initial startup, do not adjust the variable-speed drivers or check for speed governor or over-speed trip settings while the variable-speed driver is coupled to the pump. If the settings have not been verified, then uncouple the unit and refer to instructions supplied by the driver manufacturer.

5.1.1 Prepare for startup



WARNING:

- For the VSS motor, do not check the motor rotation unless the motor is bolted to the pump and the driver hub is disconnected from the pump hub.
- For a VHS motor, do not check the motor rotation unless the motor is bolted to the pump and the drive coupling is removed.
- Do not test the motor for direction of rotation when it is coupled to the pump. If the pump is driven in the wrong direction, serious damage to the pump, motor, and personnel could result.

(b) (3) (B)

5.2 Pump priming



CAUTION:

The pump must be properly vented through the discharge head connections. This is important for liquids with suction pressures close to their vapor pressures. Vent piping must continuously rise back to the suction source so that liquid cannot collect in the vent line.

NOTICE:

Net positive suction head available (NPSH_A) must always exceed NPSH required (NPSH_R) as shown on the published performance curve of the pump.

Requirements

- The minimum submergence must always be as indicated on the Certified Pump Outline Drawing.
- Never run the pump dry as this can cause the rotating parts within the pump to gall and seize to the stationary parts.
- The parts are lubricated by the liquid being pumped unless the enclosed lineshaft option is purchased to lubricate the lineshaft bearings with a clean fluid.

5.3 Start the pump



WARNING:

- Risk of equipment damage, seal failure and breach of containment. Ensure all flush and cooling systems are operating correctly prior to starting pump.
 -
-

NOTICE:

- Risk of equipment damage due to dry operation. Immediately observe the pressure gauges. If discharge pressure is not quickly attained, stop the driver immediately, reprime, and attempt to restart the pump.
-

Before you start the pump, you must perform these tasks:

- Open the suction valve.
 - Open any recirculation or cooling lines.
1. Fully close or partially open the discharge valve, depending on system conditions.
 2. Start the driver.
 3. Slowly open the discharge valve until the pump reaches the desired flow.
 4. Immediately check the pressure gauge to ensure that the pump quickly reaches the correct discharge pressure.
 5. If the pump fails to reach the correct pressure, perform these steps:
 - a) Stop the driver.
 - b) Confirm the minimum submergence.
 - c) Restart the driver.
 6. Monitor the pump while it is operating:
 - a) Check the pump for bearing temperature, excessive vibration, and noise.

- b) If the pump exceeds normal levels, then shut down the pump immediately and correct the problem.

A pump can exceed normal levels for several reasons. See Troubleshooting for information about possible solutions to this problem.

7. Repeat steps 5 and 6 until the pump runs properly.

5.4 Pump operation precautions

General considerations

NOTICE:

- Vary the capacity with the regulating valve in the discharge line. Never throttle the flow from the suction side. This action can result in decreased performance, unexpected heat generation, and equipment damage.
- Risk of equipment damage from unexpected heat generation. Do not overload the driver. Ensure that the pump operating conditions are suitable for the driver. The driver can overload in these circumstances:
 - The specific gravity or viscosity of the fluid is greater than expected
 - The pumped fluid exceeds the rated flow rate.
- Make sure to operate the pump at or near the rated conditions. Failure to do so can result in pump damage from cavitation or recirculation.

Operation at reduced capacity



WARNING:

- Risk of breach of containment and equipment damage. Excessive vibration levels can cause damage to bearings, stuffing box, seal chamber, and/or mechanical seal. Observe pump for vibration levels, bearing temperature, and excessive noise. If normal levels are exceeded, shut down and resolve.
- Risk of equipment damage and serious physical injury. Heat build-up can cause rotating parts to score or seize. Observe pump for excessive heat build-up. If normal levels are exceeded, shut down and resolve.



CAUTION:

- Avoid increased radial load. Failure to do so can cause stress on the shaft and bearings.
- Avoid heat build-up. Failure to do so can cause rotating parts to score or seize.
- Excessive vibration levels can cause damage to bearings, stuffing box, seal chamber, and/or mechanical seal. Observe pump for vibration levels, bearing temperature, and excessive noise. If normal levels are exceeded, shut down and resolve.

NOTICE:

- Cavitation can cause damage to the internal surfaces of the pump. Ensure net positive suction head available (NPSH_A) always exceeds NPSH required (NPSH_R) as shown on the published performance curve of the pump.
-

Operation under freezing conditions

NOTICE:

Do not expose an idle pump to freezing conditions. Drain all liquid that will freeze that is inside the pump and any auxiliary equipment. Failure to do so can cause liquid to freeze and damage the pump. Note that different liquids freeze at different temperatures. Some pump designs do not drain completely and may require flushing with a liquid that doesn't freeze.

5.5 Mechanical seal leaks

Occasional leaks

If the seal leaks slightly at start-up, allow a reasonable amount of time for the seal to adjust itself. Fluids with good lubricating qualities normally take longer to adjust than fluids with lesser lubricating qualities. When a seal starts out with a slight leak and the leak decreases while running, it indicates leaks across the seal faces. Run the pump continuously in order to eliminate this issue.

Continuous leaks

When immediate leaks occur and remain constant, even during operation, it usually indicates either secondary seal damage, or seal faces that are warped or cracked. See Troubleshooting for probable causes.

5.6 Stuffing box leaks

Normal leaks

With the pump in operation, there should be some leaking at the stuffing box packing. The correct leak rate is a rate which keeps the shaft and stuffing box cool. This rate is approximately one drop per second. Check the temperature of the leaked fluid as well as the discharge head.

Decreased leaks

If the pump runs hot and the leaks begin to decrease, stop the pump and allow it to cool down. Loosen the packing gland in order to allow the packing to resume leaking. After the pump has cooled, restart the pump and run it for 15 minutes. Then check the leaks. If the leaks exceed two drops per second, adjust the packing.

5.7 Shut down the pump



WARNING:

Precautions must be taken to prevent physical injury. The pump may handle hazardous and/or toxic fluids. Proper personal protective equipment should be worn. Pumpage must be handled and disposed of in conformance with applicable environmental regulations.

1. Slowly close the discharge valve.
2. Shut down and lock out the driver to prevent accidental rotation.
3. If the driver is not equipped with a non-reverse ratchet (NRR), be certain that the unit is completely stopped before you restart the pump.
4. On pump sets with double mechanical seal, apply the required pressure specified in the mechanical seal documentation to the mechanical seal chamber also during standstill.

5. Ensure quench liquid supply is on during pump standstill.

5.8 Lubricate the thrust pot during a shutdown period

1. Completely immerse the bearings in oil.
This helps to avoid oxidation of the anti-friction bearings during shutdown periods lasting longer than one week.
2. Fill the oil reservoir until the oil runs over the oil retainer tube and down the shaft.

Before startup, drain the oil to its required level.

6 Maintenance

6.1 Maintenance schedule

Maintenance inspections

A maintenance schedule includes these types of inspections:

- Routine inspections
- Three-month inspections
- Annual inspections

Shorten the inspection intervals appropriately if the pumped fluid is abrasive or corrosive or if the environment is classified as potentially explosive.

Routine inspections

Perform these tasks whenever you check the pump during routine inspections:



WARNING:

Move equipment to a safe/non Ex environment for repairs/adjustments or use spark resistant tools and work methods.

- Check for unusual noise vibration, and bearings temperatures of thrust pot or electric motor.



- Do not insulate or allow the bearing housings to accumulate a dust layer as this can result in excess heat generation, sparks and premature failure.
- Check the pump and piping for leaks.
- Analyze the vibration.*

NOTICE:

*If equipped, temperature and vibration levels can be retrieved by using your i-ALERT® monitoring sensor and app.

Three-month inspections

Perform these tasks every three months:

- Check that the foundation and the hold-down bolts are tight.

Annual inspections

Perform these inspections one time each year:

- Check the pump capacity.
- Check the pump pressure.
- Check the pump power.

If the pump performance does not satisfy your process requirements, and the process requirements have not changed, then perform these steps:

1. Disassemble the pump.

2. Inspect it.
3. Replace worn parts.

6.2 Adjust and replace the packing

NOTICE:

Never over-tighten packing to the point where less than one drop per second is observed. Over-tightening can cause excessive wear and power consumption during operation.



WARNING:

Packed stuffing boxes are not allowed in an Ex-classified environment.

Adjust the packing when one of the following conditions occurs:

- The leakage rate exceeds two drops per second.
- There is overheating or no leakage.

If you cannot tighten the packing to obtain less than the specified leakage rate, then replace the packing.

6.2.1 Adjust the packing when leaking is excessive

Perform this procedure if leaks exceed two drops per second.

1. With the pump in operation, tighten the gland nuts one-quarter turn.
2. Before you make any more adjustments, check to see if the packing has equalized against the increased pressure by making sure the leaks have decreased to a steady state.

If the leaks decrease to two drops per second, then you are finished. If the leaks continue to exceed two drops per second, continue to the next step.

3. Shut down the pump.
4. Allow the packing to compress enough so that the gland is about to contact the upper face of the stuffing box.
5. Remove the split gland, add one extra packing ring, and readjust.
6. If this fails to reduce the leak to two drops per second, then remove all packing rings and replace them with new rings:
 - a) Remove the packing with the aid of a packing hook.
 - b) If a lantern ring is provided, remove it by inserting a wire hook in the slots of the ring and pull it from the stuffing box.
 - c) Thoroughly clean the stuffing box of all foreign matter.
7. If the replacement packing is in the form of a continuous coil or rope, cut it into rings before installing:
 - a) Tightly wrap one end of the packing material around the top shaft like one coil spring.
 - b) Cut through the coil with a sharp knife.

See Installation for details about how to properly reinstall the stuffing box.

6.2.2 Adjust the packing when there is overheating or no leaks



CAUTION:

If there are no leaks or the stuffing box overheats, do not back off the gland nuts while the pump is running. This causes the entire set of packing rings to move away from the bottom of the box without relieving pressure of the packing on the shaft.

A small amount of leaking is required in order to prevent overheating.

1. Stop the pump and allow the packing to cool.
2. Restart the pump.
3. Repeat these steps until two drops of liquid per second comes through.
4. If this fails to fix the problem, then you must replace the packing.

6.3 Thrust pot lubrication guidelines

Flushing the oil reservoir

Flush the oil reservoir in order to remove all grit particles in the oil reservoir sump. Use the same type of oil to flush the reservoir as specified for lubrication.

NOTICE:

- Pumps are shipped without oil. Oil-lubricated bearings must be lubricated at the job site.
- Refer to Thrust Pot IOM for lubrication requirements.

Oil levels

Pump status	Oil level
Not operating	At (b) (3) (B) from the top of the oil sight gauge. Never operate the pump when the oil in the sight gauge is not at the required level.
Operating	Lower than the required level as indicated on the oil sight gauge.

Changing the oil

Observe the instructions in the Thrust Pot IOM.

6.4 Disassembly

6.4.1 Disassembly precautions



WARNING:

- Failure to disconnect and lock out driver power may result in serious physical injury or death. Always disconnect and lock out power to the driver before performing any installation or maintenance tasks.
 - Electrical connections must be made by certified electricians in compliance with all international, national, state, and local rules.
 - Refer to driver/coupling/gear manufacturer's installation and operation manuals (IOM) for specific instructions and recommendations.
- Risk of serious personal injury. Applying heat to impellers, propellers, or their retaining devices can cause trapped liquid to rapidly expand and result in a violent explosion. This

manual clearly identifies accepted methods for disassembling units. These methods must be adhered to. Never apply heat to aid in their removal unless explicitly stated in this manual.

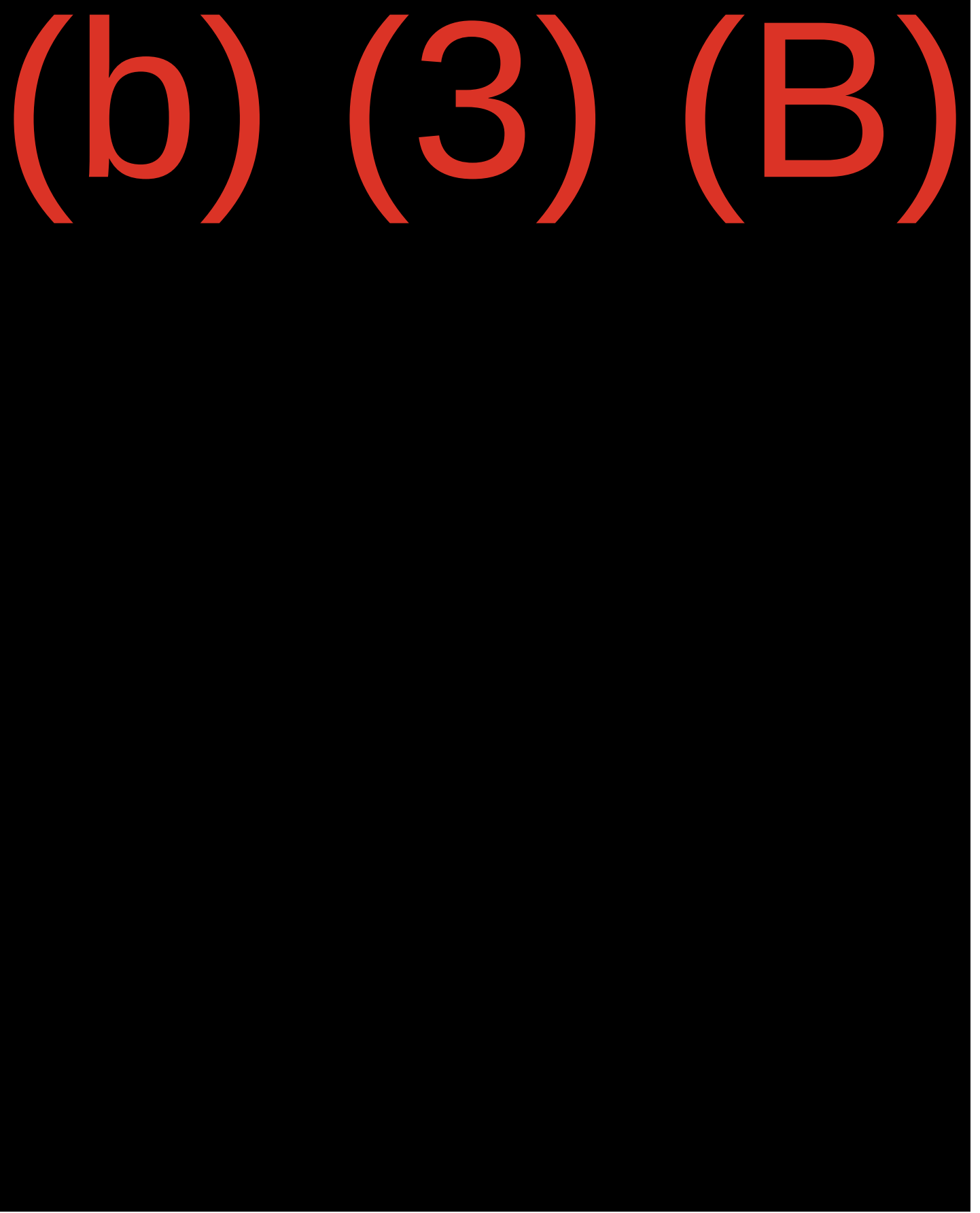
- Handling heavy equipment poses a crush hazard. Use caution during handling and wear appropriate Personal Protective Equipment (PPE, such as steel-toed shoes, gloves, etc.) at all times.
- Precautions must be taken to prevent physical injury. The pump may handle hazardous and/or toxic fluids. Proper personal protective equipment should be worn. Pumpage must be handled and disposed of in conformance with applicable environmental regulations.
- Risk of serious physical injury or death from rapid depressurization. Ensure pump is isolated from system and pressure is relieved before disassembling pump, removing plugs, opening vent or drain valves, or disconnecting piping.
- Risk of serious personal injury from exposure to hazardous or toxic liquids. A small amount of liquid will be present in certain areas like the seal chamber upon disassembly.
- The pump can handle hazardous and toxic fluids. Identify the contents of the pump and observe proper decontamination procedures in order to eliminate the possible exposure to any hazardous or toxic fluids, which may cause injury and/or illness. Wear the proper personal protective equipment. Potential hazards include, but are not limited to, high temperature, flammable, acidic, caustic, explosive, and other risks. You must handle and dispose of pumped fluid in compliance with the applicable environmental regulations. The pump must also be decontaminated if it will return to ITT. Refer to the ITT return goods policy.

**CAUTION:**

- Avoid injury. Worn pump components can have sharp edges. Wear appropriate gloves while handling these parts.

(b) (3) (B)

(b) (3) (B)





6.5.1 Replacement guidelines

Casing check and replacement



WARNING:
Risk of death or serious injury. Leaking fluid can cause fire and/or burns. Inspect and ensure gasket sealing surfaces are not damaged and repair or replace as necessary.

Inspect the casing for cracks and excessive wear or pitting. Thoroughly clean gasket surfaces and alignment fits in order to remove rust and debris.

Impeller replacement

This table shows the criteria for replacing the impeller:

Impeller parts	When to replace
Impeller vanes	(b) (3) (B)
Vane edges	When you see cracks, pitting, or corrosion damage
Keyway and bores	When you see damage

Gaskets, O-rings, and seats replacement



WARNING:
Risk of death or serious injury. Leaking fluid can cause fire and/or burns. Replace all gaskets and O-rings at each overhaul or disassembly.

- Replace all gaskets and O-rings at each overhaul and disassembly.
- Inspect the seats. They must be smooth and free of physical defects. In order to repair worn seats, skin cut them in a lathe while you maintain dimensional relationships with other surfaces.
- Replace parts if the seats are defective.

**WARNING:**

Risk of serious personal injury or property damage. Fasteners such as bolts and nuts are critical to the safe and reliable operation of the product. Ensure appropriate use of fasteners during installation or reassembly of the unit.

- Use fasteners of the proper size and material only.
- Replace all corroded fasteners.
- Ensure that all fasteners are properly tightened and that there are no missing fasteners.

Bearing retainer check

Check the bearing retainer for deformation and wear.

Shaft check

- Check the shafts for straightness and excessive wear on the bearing surfaces.
- Check the deflection of shafts. The average total runout should not exceed (b) (3) (B)
- Inspect shaft straightness using precision V-block or roller and dial indicator. Replace shafts with total indicated runout greater than (b) (3) (B)

Mechanical seal checks

On pumps equipped with a mechanical seal, check that the shaft or sleeve is free of pits, burrs, or sharp edges in order to prevent cutting or improper sealing of the seal O-rings. Remove any burrs and sharp edges by polishing with a fine emery cloth.

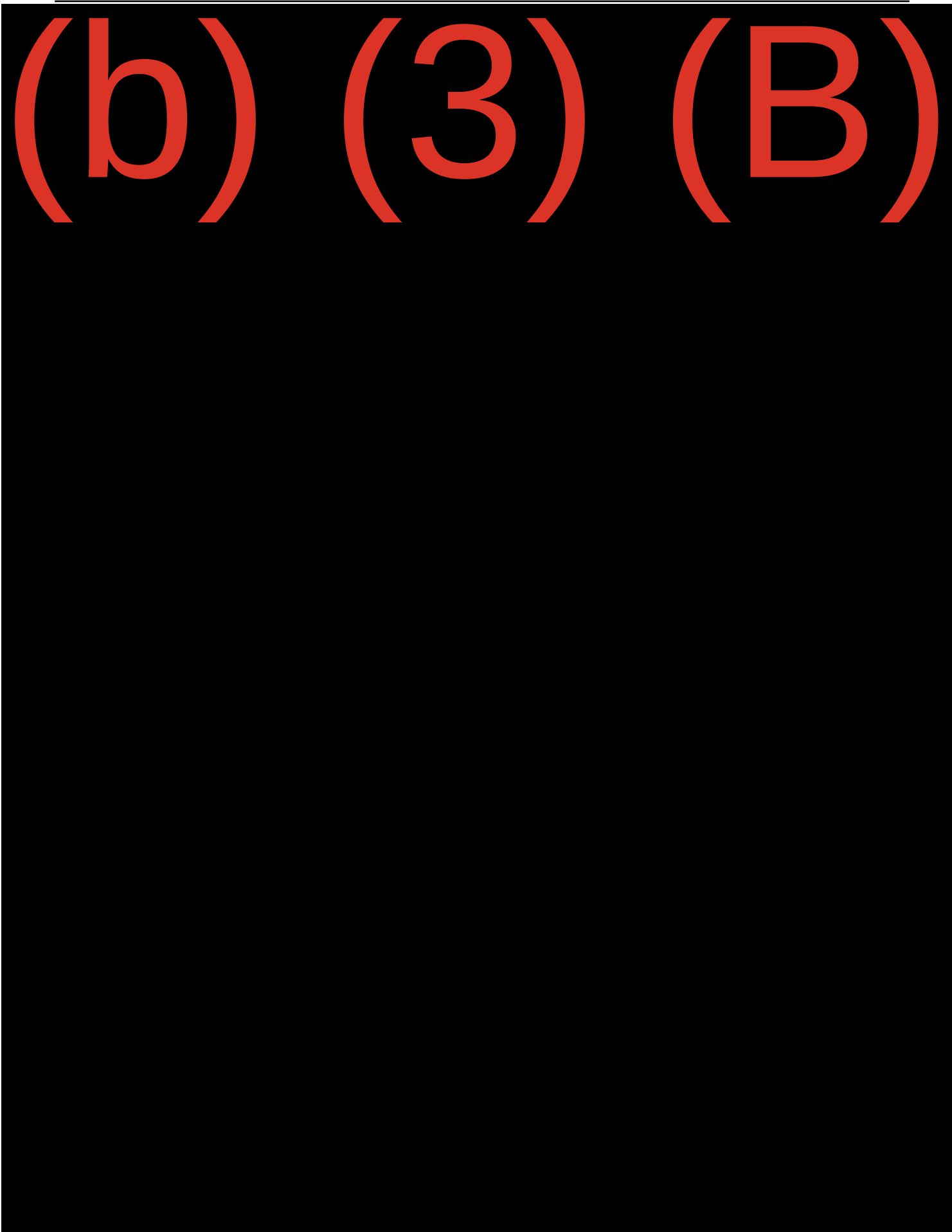
Impeller and bowl checks

Visually check impellers and bowls for cracks and pitting. Check all bowl bearings for excessive wear and corrosion.

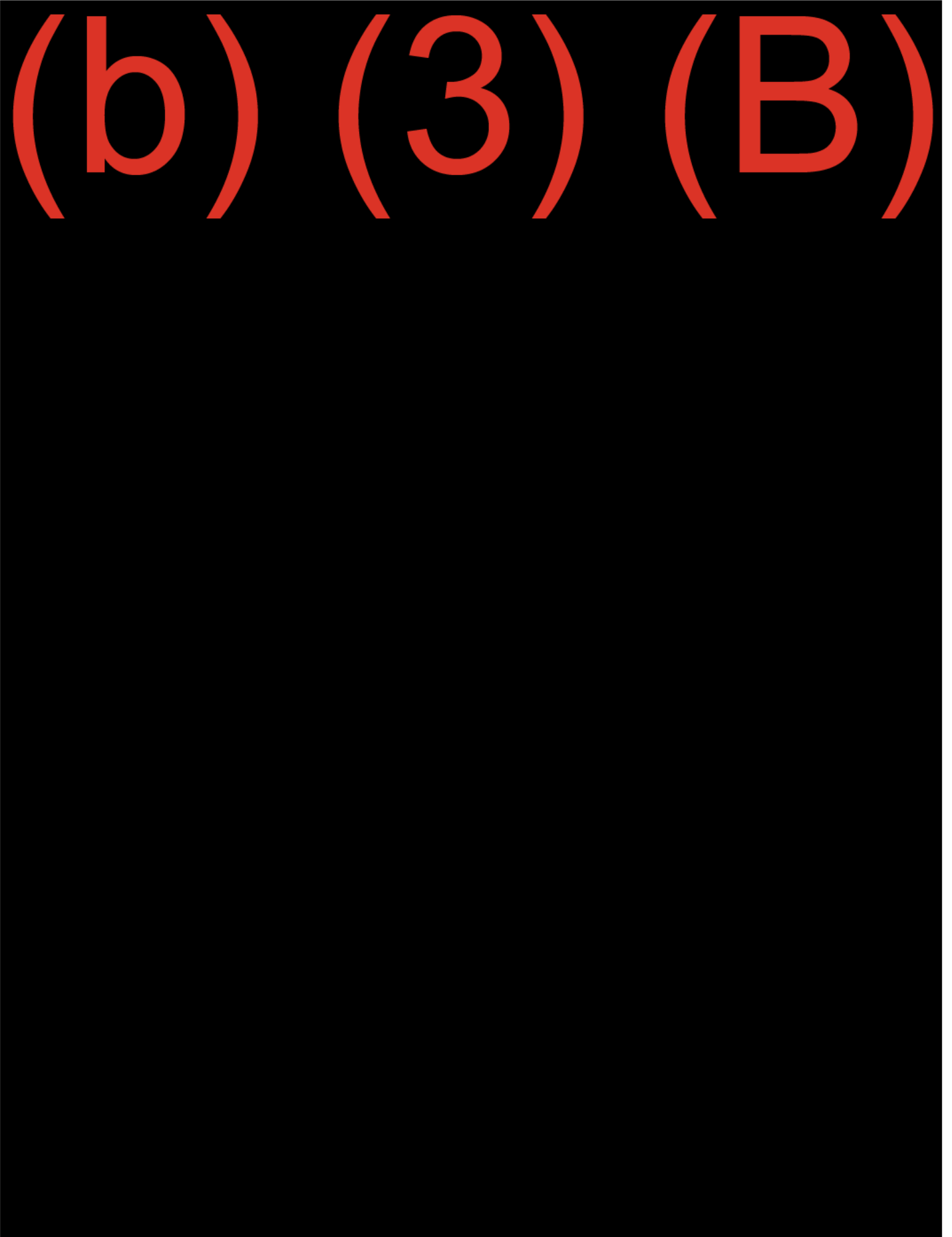
6.6 Reassembly

(b) (3) (B)

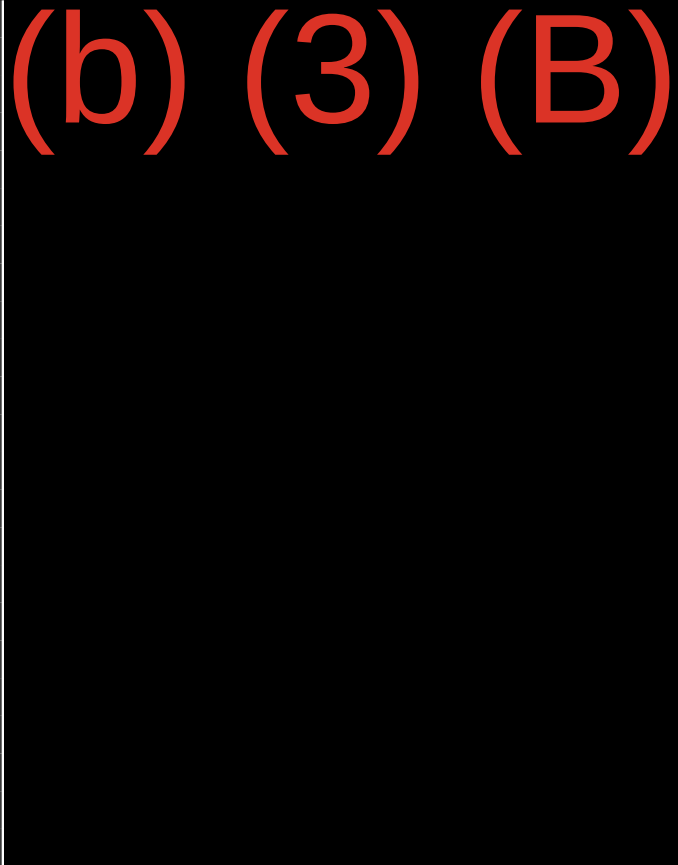
(b) (3) (B)



(b) (3) (B)



Pump size	X dimension (inches)	X dimension (millimeters)
(b)	(3)	(B)



6.6.6 Tightening torques

Refer to Tightening torque table for tie-rods for bowl assembly and [10.1 Tightening torque tables for studs, capscrews and nuts on page 101](#).

7 Troubleshooting

7.1 Operation troubleshooting

Symptom	Cause	Remedy
Pump does not start.	The electrical circuit is open or not complete.	Check the circuit and make any necessary corrections.
	Rotor resists turning due to freezing.	Drain pump and dry internal surfaces with dry air.
	The impellers are binding against the bowls.	Reset the impeller adjustment. See Installation for details.
	The electric driver is not receiving enough voltage.	Make sure that the driver is wired correctly and receiving full voltage.
	The motor is defective.	Consult an ITT representative.
The pump is not delivering liquid.	The bowl assembly is not submerged enough.	Adjust the liquid level in the sump as necessary.
	The suction strainer is clogged.	Remove the obstructions.
	There is an obstruction in the liquid passage.	Pull the pump and inspect the impeller and bowl.
	The discharge head is not properly vented.	Open the vent.
	The suction or discharge valves are closed.	Open the valves. For more information, see 5 Commissioning, Startup, Operation, and Shutdown on page 63
The pump is not producing the rated flow or head.	The impellers are not rotating fast enough.	Make sure that the driver is wired correctly and receiving full voltage.
	The impellers are rotating the wrong direction.	Make sure the impellers are spinning counterclockwise when viewed from above. Check the engagement of the motor coupling.
	The total pump head is too high.	Check the pipe friction losses. Use larger discharge piping.
	The liquid passages are partially obstructed.	Inspect the impellers and bowls and remove any obstructions.
	There is cavitation.	Insufficient NPSH. Check for and remove any obstructions in pump suction inlet.
	The impellers are too high	Reset the impeller adjustment. See Installation for details.
There is not enough pressure.	The impellers are not rotating fast enough.	Make sure that the driver is running at the proper speed. Make sure that the turbine is receiving full steam pressure.
	The liquid passage is obstructed.	Inspect the impellers and bowls and remove any obstructions.
	The impellers are rotating in the wrong direction.	Make sure the impellers are spinning counterclockwise when viewed from above. Check the engagement of the motor coupling.
	The impellers are too high (semi-open construction only).	Reset the impeller adjustment. See Installation for details.

Symptom	Cause	Remedy
The pump starts and then stops pumping.	Excessive power is required.	Use a larger driver. Consult an ITT representative.
	The pump is pumping a higher viscosity or different specific gravity liquid than it was designed to handle.	Test the liquid for viscosity and specific gravity. Consult an ITT representative.
	Critical parts have experienced mechanical failure.	Check the bearings, wear rings, and impellers for damage. Any irregularities in these parts will cause a drag on the shaft. Replace any damaged parts as necessary.
	The impellers are rotating too fast.	Check the frequency on the motor.
	The pump and driver are misaligned.	Realign the pump and driver.
	The discharge head is not properly vented.	Open the vent.
The pump requires excessive power.	The impellers are damaged.	Inspect the impellers for damage and replace them if necessary.
	A foreign object is lodged between the impeller and the bowl.	Remove the object.
	The liquid is heavier than expected.	Check the specific gravity and viscosity.
	The liquid viscosity is too high or the pumped fluid is partially freezing.	Check for both conditions. They can cause drag on the impeller. Consult an ITT representative.
	The bearings are defective.	Replace the bearings and check the shaft or shaft sleeve for scoring.
	The stuffing-box packing is too tight.	Release the gland pressure and retighten. Keep the leaking fluid flowing. If there are no leaks, then check the packing, sleeve, or shaft. See Maintenance for details.
The pump is noisy.	The pump is cavitating.	Increase the liquid level in the sump.
	The shaft is bent.	Straighten as necessary.
	Rotating parts are binding, loose, or broken.	Replace parts as necessary.
	The bearings are worn.	Replace the bearings.
	The discharge head is not properly vented.	Open the vent.
The pump is vibrating excessively.	One of these conditions might exist: (b) (3) (B)	Determine the cause by using a vibration frequency analyzer or by disassembling the pump. A complex problem might require the assistance of an ITT representative.
	The driver shaft is not adjusted properly.	Readjust the driver. See Installation for details.
There is excessive leakage from the stuffing box.	The packing is defective.	Replace any packing that is worn or damaged.
	The wrong kind of packing was used.	Consult an ITT representative.

Symptom	Cause	Remedy
The stuffing box is overheating.	The packing is too tight.	Release the gland pressure and retighten. Keep the leakage flowing. If there is no leakage, then check the packing, sleeve, or shaft. See Maintenance for details.
	The packing is not lubricated.	Release the gland pressure and replace any packing that is burned or damaged. Regrease the packing as necessary.
	The wrong grade of packing was used.	Consult an ITT representative.
	The stuffing box was improperly packed.	Repack the stuffing box.
The packing wears out too fast.	The shaft or shaft sleeve is worn or scored.	Remachine or replace any parts as necessary.
	There is insufficient leakage across the packing.	Repack the stuffing box and make sure that the packing is loose enough to allow some leakage.
	The stuffing box was improperly packed.	Repack the stuffing box properly, making sure that all old packing is removed and the stuffing box is clean.
	The wrong grade of packing was used.	Consult an ITT representative.
The mechanical seal leaks.	The seal faces are not flat because the gland bolts are too tight. This causes the gland and insert to warp.	Remove the gland bolts and then reinstall them properly.
	The gasket has been chipped during installation.	Replace the gasket.
	One of these conditions exists: - The carbon insert is cracked. - The insert face or seal ring was chipped during installation.	Remove the mechanical seal, inspect, and replace as necessary.
	The seal faces are scored from foreign particles between the faces.	Install a strainer, and then filter or cyclone the separator as required in order to filter out any foreign particles.
The seal squeals during operation.	There is an inadequate amount of liquid at the seal faces.	A bypass flush line is necessary. If a bypass line is already in use, then enlarge it in order to produce more flow.
Carbon dust is accumulating on the outside of the gland ring.	There is an inadequate amount of liquid at the seal faces.	Bypass the flush line. If a bypass line is already in use, then enlarge it to produce more flow.
	Liquid film is flashing and evaporating between the seal faces and leaving residue, which is grinding away the carbon.	Consult an ITT representative.
The seal leaks but nothing appears to be wrong.	The seal faces are not flat.	Relap or replace the seal faces.
The seal is wearing out too quickly.	This product is abrasive. This causes excessive seal face wear.	Determine the source of the abrasives and install a bypass flushing in order to prevent abrasives from accumulating in the seal area. Install a cyclone separator as necessary.
	Abrasives are forming due to the process liquid cooling and crystallizing or partially solidifying in the seal area.	Install a bypass flush line in order to hold the liquid temperature around the seal above the crystallization point.

Symptom	Cause	Remedy
	The seal is running too hot.	Check for possible rubbing of the seal components. Recirculation or a bypass line may be necessary.
	The wrong kind of seal was used.	Consult an ITT representative.

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11 CE Declaration of Conformity

11.1 CE Declaration of Conformity

EC DIRECTIVES – HEALTH & SAFETY (MACHINERY)



ITT

CE DECLARATION OF CONFORMITY

We,

Manufacturer
ITT Goulds Pumps

Person Authorized To Compile Technical File

Maik Spannuth – Quality Manager
ITT Bornemann GmbH
Industriestrasse 2
31683 Obernkirchen, Germany
Tel: +49 5724 390 190
Email: Maik.Spannuth@itt.com

Declare under our sole responsibility that the product

Model/Type _____

Serial Number(s):

Pump Size:

comply with all applicable Directives and Regulations set out by the directives and standards listed below as well as with all the essential health and safety requirements applying to it.

Machinery Directive 2006/42/EC - (Subordinates to EN 809)
ISO 12100
EN 809:1998+A1:2009

.....
Place & Date of Issue

.....
Authorized Name (Print)

.....
Function (Print)

.....
Authorized Name (Signature)

EC DIRECTIVES – HEALTH & SAFETY (MACHINERY)



ITT

**CE DECLARATION OF INCORPORATION of PARTLY
COMPLETED MACHINERY**

We,

Manufacturer
ITT Goulds Pumps

Person Authorized To Compile Technical File
Maik Spannuth – Quality Manager
ITT Bornemann GmbH
Industriestrasse 2
31683 Obernkirchen, Germany
Tel: +49 5724 390 190
Email: Maik.Spannuth@itt.com

Declare under our sole responsibility that the following partly completed machinery

Bowl Assembly _____

Serial Number(s):

comply with all applicable Directives and Regulations set out by the directives and standards listed below as well as with all the essential health and safety requirements applying to it.

Machinery Directive 2006/42/EC - (Subordinates to EN 809)
ISO 12100
EN 809:1998+A1:2009

.....
Place & Date of Issue

.....
Authorized Name (Print)

.....
Function (Print)

.....
Authorized Name (Signature)

12 Local ITT Contacts

12.1 Regional offices

Region	Address	Telephone	Fax
North America (Headquarters)	ITT - Goulds Pumps 240 Fall Street Seneca Falls, NY 13148 USA	+1 315-568-2811	+1 315-568-2418
Houston office	12510 Sugar Ridge Boulevard Stafford, TX 77477 USA	+1 281-504-6300	+1 281-504-6399
Los Angeles	ITT - Goulds Pumps 880 W. Crowther Ave Placentia, CA 92870 USA	+1 562-908-4125	+1 562-695-8523
Asia Pacific	ITT Fluid Technology Asia Pte Ltd 1 Jalan Kilang Timor #04-06 Singapore 159303	+65 627-63693	+65 627-63685
Asia Pacific	ITT Goulds Pumps Ltd 35, Oksansandan-ro Oksan-myeon, Heungdeok-gu, Cheongju-si, Chungcheongbuk-do 28101, Rep. of KOREA	+82 234444202	
Europe	ITT Bornemann GmbH Industriestrasse 2, 31683 Obern- kirchen, Germany	+49 5724 390 2340	+49 5724 390 290
Latin America	ITT - Goulds Pumps Camino La Colina # 1448 Condominio Industrial El Rosal Huechuraba Santiago 8580000 Chile	+562 544-7000	+562 544-7001
Middle East and Africa	ITT - Goulds Pumps Achileos Kyrou 4 Neo Psychiko 115 25 Athens Greece	+30 210-677-0770	+30 210-677-5642

**Visit our website for the latest version of
this document and more information:**
<http://www.gouldspumps.com>



ITT Goulds Pumps, Inc.
240 Fall Street
Seneca Falls, NY 13148
USA

Form IOM.VIT.VIC.VIDS.en-US.2023-11

Attachment 8:
Pump Curve Byron Jackson (b) (3) (B)

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%EFFICIENCY

HORSEPOWER

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ITEM NO.	DATE BY								
FACTORY NO.	DRAWN BY	10 MAR 87							
861-S-2147	(b) (6)	CUSTOMER'S ORDER NO.	(b) (3) (B)						

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Attachment 9:
User Instructions / Submersible Water
Well Pumps / Installation Operation
Maintenance / Byron Jackson H2O+
Submersible Pumps and Motors

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Annex A: Example Declaration of Conformity for CE Marked Pumps



EU Declaration of Conformity



- Original -

The manufacturer:

Flowserve Pumps, Flowserve GB Ltd.
Hawton Lane, Newark, Notts NG24 3BU, United Kingdom

declares herewith that the product

Pumpset consisting of:

Pump: Byron Jackson H2O+

Motor: ...

Serial number: ...

fulfils all relevant provisions of the **Directive Machinery 2006/42/EC Annex IIA** (Applicable also to electrical with voltage input >1000 VAC).

Furthermore the aforementioned product complies with the provisions of the EC Directives:

Low Voltage Directive 2014/35/EU (Applicable to electrical with voltage input 50-1000 VAC)

Harmonised standards used:

BS EN 809
BS EN ISO 12100
BS EN 60204-1
BS EN 60034-1

Other technical standards and specifications used:

Person authorised to compile the technical file:

...
...

Place, date:

.....

Person empowered to draw up this declaration:

Product Line Manager

Operation Manager

...

...



Annex B: Example Declaration of Conformity for UKCA Marked Pumps



UKCA Declaration of Conformity



- Original -

The manufacturer:

Flowserve Pumps, Flowserve GB Ltd.
Hawton Lane, Newark, Notts NG24 3BU, United Kingdom

declares herewith that the product

Pumpset consisting of:

Pump: Byron Jackson H2O+

Motor: ...

Serial number: ...

fulfils all relevant provisions of the **Directive Machinery 2006/42/EC Annex IIA** (Applicable also to electrical with voltage input >1000 VAC), and UK legislation "**The Supply of Machinery (Safety) Regulations 2008**"

Furthermore the aforementioned product complies with the provisions of the EC Directives:

Low Voltage Directive 2014/35/EU (Applicable to electrical with voltage input 50-1000 VAC) and UK legislation "**The Electrical Equipment (Safety) Regulations 2016**"

Harmonised standards used:

BS EN 809
BS EN ISO 12100
BS EN 60204-1
BS EN 60034-1

Other technical standards and specifications used:

Person authorised to compile the technical file:

...
...

Place, date:

... ..

Person empowered to draw up this declaration:

Product Line Manager

...

Operation Manager

...



10 Appendix



Flowserve factory contacts:

Flowserve Hastings
1341 W 2nd St,
Hastings,
NE 68901, USA
Telephone +1 (402) 463 1306

Flowserve Castlemaine
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Castlemaine
Victoria 3450, Australia
Telephone +61 3 5479 1200

Flowserve Taneytown:
5310 Taneytown Pike
Taneytown, MD 21787
Telephone: +1 (410) 756-2602

Flowserve Pumps
Lowfield Works, Balderton
Newark, Notts NG24 3BU
United Kingdom
Telephone (24 hours) +44 1636 494 600
Sales & Admin Fax +44 1636 705 991
Repair & Service Fax +44 1636 494 833

Flowserve Auckland:
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Manuewa, Auckland 2102
New Zealand

Local Flowserve representative:

To find your local Flowserve representative use the Sales Support Locator System found at www.flowserve.com

FLOWSERVE REGIONAL SALES OFFICES:

USA and Canada
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Suite 2300
Irving, Texas 75039-5421, USA
Telephone +1 972 443 6500
Fax +1 972 443 6800

Europe, Middle East, Africa
Flowserve Worthington S.r.l.
Via Rossini 90/92
20033 Desio (Milan), Italy
Telephone +39 0362 6121
Fax +39 0362 303 396

Latin America and Caribbean
Flowserve Corporation
6840 Wynnwood Lane
Houston, Texas 77008, USA
Telephone +1 713 803 4434
Fax +1 713 803 4497)

Asia Pacific
Flowserve Pte. Ltd
10 Tuas Loop
Singapore 637345
Telephone +65 6771 0600
Fax +65 6862 2329

Flowserve Corporation has established industry leadership in the design and manufacture of its products. When properly selected, this Flowserve product is designed to perform its intended function safely during its useful life. However, the purchaser or user of Flowserve products should be aware that Flowserve product might be used in numerous application under a wide variety of industrial service conditions. Although Flowserve can (and often does) provide general guidelines, it cannot provide specific data and warnings for all possible applications. The purchaser/user should read and understand the User Instructions: Installation Operation Maintenance included with the product, and train its employees and contractors in the safe use of Flowserve products in connection with its application

While the information and specifications contained in this literature are believed to be accurate, they are supplied for informative purpose only and should not be considered certified or as a guaranteed of satisfactory results by reliance thereon. Nothing contained herein is to be construed as a warranty or guarantee, express or implied, regarding any matter with respect to the product. Because Flowserve is continually improving and upgrading its product design, the specifications, dimensions and information contained herein are subject to change without notice. Should any question arise concerning these provisions, the purchaser/user should contact Flowserve Corporation at any one of its worldwide operations or offices.

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Attachment 10:
Operation and Maintenance Manual
Vertical High Thrust Motor Vertical
Industrial Turbine Pumps

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OPERATIONS AND MAINTENANCE MANUAL

Vertical High Thrust Motor

Vertical Industrial Turbine Pumps

Waiawa Pump Station Improvements
Waiawa, Oahu, Hawaii

Prepared for



Prepared by:



CONTRACT N62478-11-D-4045 T.O. 0024
WORK ORDER NO. 1159038

Vertical High Thrust Motors



INSTALLATION, OPERATION AND MAINTENANCE MANUAL

Save this instruction manual for future reference.





WARNING: Read this manual in its entirety before operating or performing maintenance on the equipment in this manual.



WARNING: Use caution when working on, with or around the equipment in the manual.



WARNING: Failure to follow instructions for proper electrical wiring, storage, setup and maintenance may cause serious injury, damage equipment or void warranty



INSTALLATION AND MAINTENANCE

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I. SHIPMENT

Prior to shipment, all motors undergo extensive mechanical and electrical testing, and are thoroughly inspected. Upon receipt of the motor, carefully inspect the unit for any signs of damage that may have occurred during shipment. Should such damage be evident, unpack the motor at once in the presence of a claims adjuster and immediately report all damage and breakage to the transportation company.

When contacting Nidec Motor Corporation (NMC) concerning the motor, be sure to include the complete motor identification number, frame, and type which appear on the nameplate.

II. HANDLING

The equipment needed to handle the motor includes a hoist and spreader bar arrangement (see Figure 1) of sufficient strength to lift the motor safely. The spreader bar should have the lifting rings or hooks positioned to equal the span of the lifting lugs or eyebolts. The lifting lugs or eyebolts are intended to lift the motor weight only.

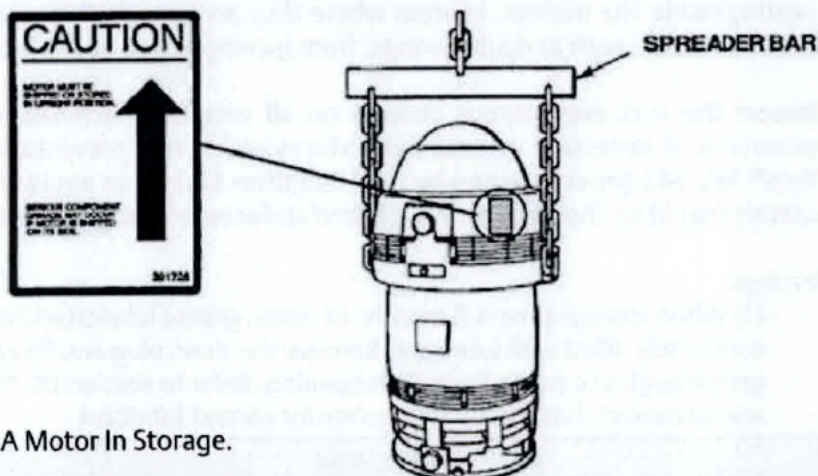
⚠ WARNING

Lifting the motor by other means may result in damage to the motor or injury to personnel.

⚠ CAUTION

Do not move motor with oil sumps filled. Sloshing action of oil in sumps can result in oil leaks and motor damage.

FIGURE 1



III. STORAGE

1. When To Put A Motor In Storage.

If a motor is not put into immediate service (one month or less), or if it is taken out of service for a prolonged period, special storage precautions should be taken to prevent damage. The following schedule is recommended as a guide to determine storage needs.





- A. Out of service or in storage less than one month - no special precautions except that space heaters, if supplied, must be energized at any time the motor is not running.
- B. Out of service or in storage for more than one month but less than six months - store per items 2A, B, C, D, E, F(2), and G, items 3A, B, and C, and item 4.
- C. Out of service or in storage for six months or more - all recommendations.

2. Storage Preparation.

- A. Where possible, motors should be stored indoors in a clean, dry area.
- B. When indoor storage is not possible, the motors must be covered with a tarpaulin. This cover should extend to the ground; however, it should not tightly wrap the motor. This will allow the captive air space to breathe, minimizing formation of condensation. Care must also be taken to protect the motor from flooding or from harmful chemical vapors.

NOTICE

Immediately remove any shrink wrap used during shipping. Never wrap any motor in plastic for storage. This can turn the motor into a moisture trap causing severe damage not cover by Nidec Motor Corporation's limited warranty.

- C. Whether indoors or out, the area of storage should be free from excessive ambient vibration which can cause bearing damage.
- D. Precautions should be taken to prevent rodents, snakes, birds, or other small animals from nesting inside the motors. In areas where they are prevalent, precautions must be taken to prevent insects, such as dauber wasps, from gaining access to the interior of the motor.
- E. Inspect the rust preventative coating on all external machined surfaces, including shaft extensions. If necessary, re-coat the surfaces with a rust preventative material, such as Rust Veto[®] No. 342 (manufactured by E.F. Houghton Co.) or an equivalent. The condition of the coating should be checked periodically and surfaces re-coated as needed.
- F. Bearings:
 - (1) When storage time is 6 months or more, grease lubricated cavities must be completely filled with lubricant. Remove the drain plug and fill cavity with grease until grease begins to purge from drain opening. Refer to section IX. "LUBRICATION" and/or review motor's lubrication nameplate for correct lubricant.

CAUTION

Do not re-grease bearings with drain closed or with unit running.

- (2) Oil lubricated motors are shipped without oil. When storage time exceeds one (1) month, the oil sumps must be filled to the maximum capacity as indicated on the oil chamber sight gauge window. Refer to motor lubrication nameplate or Section IX "Lubrication" for proper oil.





NOTE: Motor must not be moved with oil in reservoir. Drain oil before moving to prevent sloshing and possible damage. With a clean cloth, wipe any excess oil from the threads of the drain plug and the inside of the drain hole. Apply Gasoil[®] P/N SS08 or equivalent thread sealant to the threads of the drain plug and replace the plug in the oil drain hole. Refill oil when motor has been moved to the new location.

- G. To prevent moisture accumulation, some form of heating must be utilized. This heating should maintain the winding temperature at a minimum of 5° above ambient. If space heaters are supplied, they should be energized. If none are available, single phase or "trickle" heating may be utilized by energizing one phase of the motor's winding with a low voltage. Request the required voltage and transformer capacity from Nidec Motor Corporation. A third option is to use an auxiliary heat source and keep the winding warm by either convection or blowing filtered warm air into the motor.

3. Periodic Maintenance.

- A. Oil should be inspected monthly for evidence of moisture or oxidation. The oil must be replaced whenever contamination is noted or every twelve months, whichever occurs first. It is important to wipe excess oil from the threads of the drain plug and the drain hole and to coat the plug threads with Gasoil[®] P/N SS08 or equivalent thread sealant before replacing the drain plug.
- B. Grease lubricated bearings must be inspected once a month for moisture and oxidation by purging a small quantity of grease through the drain. If any contamination is present, the grease must be completely removed and replaced.
- C. All motors must have the shaft rotated once a month to maintain a lubricant film on the bearing races and journals.

D. Insulation Testing:

Two tests are used to evaluate the condition of the winding insulation. The first of these is the one minute insulation resistance test (IR_1) and the second is the polarization index test (PI), which can also be referred to as a dielectric absorption test. The results of either of these tests can be skewed by factors such as the winding temperature and its relation to the dew point temperature at the time the test was conducted. The PI test is less sensitive to these factors than the IR_1 test, but its results can still be affected significantly. Due to these factors, the most reliable method for evaluating the condition of the winding insulation is to maintain a record of periodic measurements, accumulated over months or years of service, for one or both of these tests. It is important that these tests be conducted under similar conditions of winding temperature, dew point temperature, voltage magnitude and duration, and relative humidity. If a downward trend develops in the historical data for either test, or if the readings from both tests drop below a minimum acceptable value, have an authorized electrical apparatus service shop thoroughly clean and dry the winding, and retreat, if necessary.





1. The recommended procedure for the IR_1 test is as follows:

- (1) Disconnect all external accessories or equipment that have leads connected to the winding and connect them to a common ground. Connect all other accessories that are in contact with the winding to a common ground.

⚠ WARNING

Failure to have accessories grounded during this test can lead to the accumulation of a hazardous charge on the accessories.

- (2) Using a megohmmeter, apply DC voltage at the level noted below for 1 minute and take a reading of the insulation resistance between the motor leads and ground.

Rated Motor Voltage

UP to 1000 (inclusive)
1001 to 2500 (inclusive)
2501 to 5000 (inclusive)
5001 and up

Recommended DC Test Voltage

500 VDC
500 to 1000 VDC
500 to 2500 VDC
500 to 5000 VDC

⚠ WARNING

Follow appropriate safety procedures during and after high voltage testing. Refer to the instruction manual for the test equipment. Make sure the winding insulation is discharged before beginning the test. The winding insulation will retain a potentially dangerous charge after the DC voltage source is removed, so use proper procedures to discharge the winding insulation at the end of the test. Refer to IEEE 43 Standard for additional safety information.

- (3) The reading should be corrected to a 40°C base temperature by utilizing the formula:

$$R_{40C} = K_T R_T$$

Where:

R_{40C} = insulation resistance (in megohms) corrected to 40°C

K_T = insulation resistance temperature coefficient at temperature T°C

R_T = measured insulation resistance (in megohms) at temperature T°C

The value of K_T can be approximated by using the formula:

$$K_T = (0.5)^{(40-T)/10}$$

Where:

T = the winding temperature in °C that the insulation resistance was measured at





The recommended procedure for the PI test is as follows:

- (1) Perform steps 1 and 2 from the IR₁ test procedure. Heed the safety warnings given in the IR₁ test procedure.
- (2) With DC voltage still being applied by the megohmmeter, taken an additional reading of insulation resistance between the motor leads and ground 10 minutes after the DC voltage was initially applied. To minimize measurement errors, the variation in winding temperature between the 1 minute and 10 minute readings should be kept to a minimum.
- (3) Obtain the polarization index by taking the ratio of the 10 minute resistance reading to the 1 minute resistance reading.

If historical data from previous IR₁ and / or PI tests is available, then a comparison of the present test result to previous tests can be used to evaluate the condition of the insulation. To minimize error, all readings that are compared should be taken at test voltages, winding temperatures, dew point temperatures, and relative humidities that are similar as possible. If a downward trend in the readings develops over time, have an authorized electrical apparatus service shop thoroughly clean and dry the winding and, if necessary, retreat the winding. Then, repeat the test and re-check results before returning the motor service.

If historical data from previous IR₁ or PI tests is not available, then compare readings from the present test to the recommended minimum values listed below. If the readings from both tests fall below the minimum, have an authorized electrical apparatus service shop thoroughly clean and dry the winding and, if necessary, retreat the winding. Then, repeat the tests and re-check results before returning the motor to service.

The recommended minimum value for the 1 minute insulation resistance reading corrected to 40°C is:

Rated Motor Voltage	Minimum Insulation Resistance
Up to 999 (inclusive)	5 Megohms
1000 and up	100 Megohms

The recommended minimum value for the polarization index is 2.0. if the 1 minute insulation resistance reading corrected to 40° C is above 5000 megohms, however, the polarization index may not be meaningful. In such cases, the polarization index may be disregarded as a measure of insulation condition.

Refer any question to the Nidec Motor Corporation Product Service Department.

For more information, refer to the IEEE [®] 43 Standard.





4. Start-up Preparations After Storage.

- A. Motor should be thoroughly inspected and cleaned to restore to an "As Shipped" condition.
- B. Motor which has been subjected to vibration must be disassembled and each bearing inspected for damage.
- C. When storage time has been six (6) months or more, oil and/or grease must be completely changed using lubricants and methods recommended on the motor's lubrication plate, or in **Section IX - "Lubrication."**
- D. The winding must be tested to obtain insulation resistance and dielectric absorption ratio as described in **Section III., item 3.**
- E. Contact Nidec Motor Corporation Product Service Department prior to start-up if storage time has exceeded one year.

IV. INSTALLATION LOCATION

When selecting a location for the motor and driven unit, keep the following items in mind:

- 1. The location should be clean, dry, well ventilated, properly drained, and provide accessibility for inspection, lubrication, and maintenance. Ambient vibration should be kept to a minimum. Outdoor installations on open driproof motors require protection from the elements.
- 2. The location should provide adequate space for motor removal without shifting the driven unit.
- 3. Temperature rise of a standard motor is based upon operation at an altitude not exceeding 3300 feet (1000 meters) above sea level, and a maximum ambient temperature of 40°C unless specified otherwise on nameplate. See NEMA® MG-1 20.28 for usual service conditions.
- 4. To avoid condensation inside the motor, it should not be stored or operated in areas subject to rapid temperature changes unless it is energized or protected by space heaters.
- 5. The motor should not be installed in close proximity to any combustible material or where flammable gases may be present, unless it is specifically built for that environment and is U.L. labeled accordingly.





6. Oil lubricated motors must be mounted within one degree of true vertical. Failure to do so will result in oil leakage and possibly bearing failure.

7. Recommended Minimum Installation Clearances

This is a general guide and cannot cover all circumstances. Unusual arrangements should have inquiries to Nidec Motor Corporation Product Service Department. Unusual arrangements might include high ambient, limited ventilation, or a large number of motors in a coned space. The distance to the wall is at the side or end of the motor. The distance to another motor is considered as surface to surface and for side-by-side arrangements. This recommendation considers all motors to be mounted in the same orientation (e.g. all main conduit boxes facing east).

Speed	Distance to Wall	Distance to Another Motor
3600 RPM	2 x Motor Width	2 x Motor Width
1800 RPM or Less	1 x Motor Width	

V. INITIAL INSTALLATION

1. General

Reliable, trouble free operation of a motor and driven unit depends on a properly designed foundation and base plus good alignment. If the motor and driven unit are not installed properly, the following may result:

- * Noisy operation
- * Excessive vibration
- * Bearing damage or failure
- * Motor failure

2. Shaft Alignment

On HOLLOSHAFT® motors, the pump shaft and motor coupling must be aligned within .003" TIR. On solid shaft motors, the motor and pump shafts must be aligned within .002" TIR.

3. Pump Shaft Adjustment (HOLLOSHAFT® motors only)

To facilitate axial pump shaft adjustment, a locking feature is provided to lock the motor shaft against rotation. The two types of locking features are as follows:

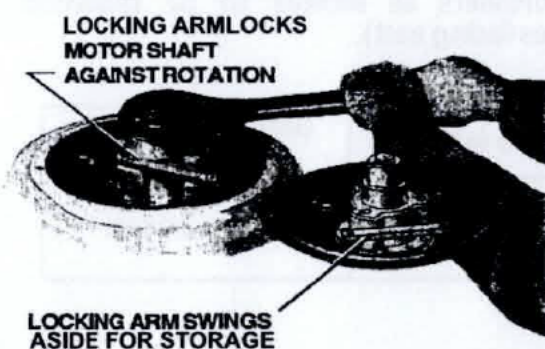




A. Locking arm (Figure 2) -The locking arm is bolted to a stationary part and is pinned (for best results use arm in tension) or interferes with a rotating part (when locking arm is not in use it should be moved out of the way and bolted in place). A non-reverse ratchet functions as a locking device. Motors supplied with a non-reverse ratchet are not equipped with a locking arm.

B. Pinning through mating holes-Holes are provided in both a stationary and rotating part which line up allowing insertion of a pin.

FIGURE 2



⚠ WARNING

Locking device must be disengaged prior to starting motor or motor damage and/or injury to personnel may result.

⚠ CAUTION

Care should be exercised when lowering the motor over the pump shaft so that the oil retaining tube in the lower bracket is not damaged (applies only to motors with oil lubricated lower bearing).

4. Drive Coupling (HOLLOSHAFT® units only).

The drive coupling may be utilized in one of two ways:

A. Bolted type (Figure 3) - Hold down bolts are installed (some motors require removal of driving pins to allow installation of hold down bolts) in the drive coupling to prevent upward movement of the pump shaft. This will allow momentary upthrust from the pump to be taken by the motor's guide bearing.

⚠ WARNING

Failure to tighten coupling and non-reverse ratchet bolts to required torque values may cause bolts to break, resulting in equipment damage or injury to personnel.

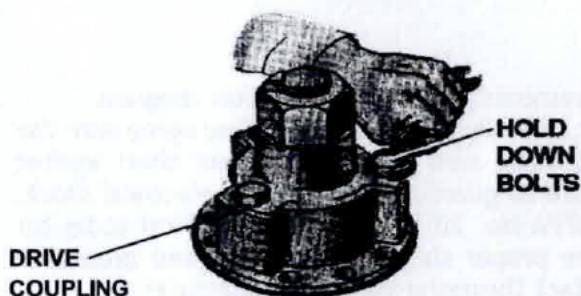




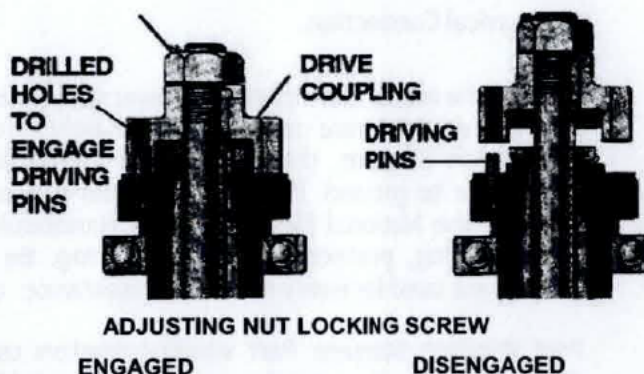
⚠ WARNING

Failure to tighten coupling and non-reverse ratchet bolts to required torque values may cause bolts to break, resulting in equipment damage or injury to personnel.

**BOLTED COUPLING
FIGURE 3**



**SELF RELEASE COUPLING
FIGURE 4**



B. Self-release type (Figure 4) - Driving pins are used to engage the drive coupling with the rotor. A power reversal may unscrew the joints of the pump shafting, causing the shafting to lengthen and buckle or break if the shafting is restrained. The self-release coupling will lift out of engagement with partial unscrewing of the shafting, thus stopping further rotation of the pump. The following items must be followed for proper functioning of the self-release coupling:

- The pump shaft adjusting nut must be properly secured to the drive coupling with a locking screw.
- The drive coupling should not bind on the driving pins.
- The drive coupling must not be bolted down.
- The pump shaft must be concentric to the motor shaft to prevent rubbing of the pump shaft inside the motor shaft.
- There must be no potential for upthrust in the application.
- Do not use the self-release feature in conjunction with a lower steady bushing, as friction between the parts can damage the line shafting and/or bushing.
- Due to the possibility of sparking as the parts separate, the self-release feature must not be used in an environment where explosive gases or dust may be present.

⚠ WARNING

Should a motor supplied with a self-release coupling become uncoupled, the motor and pump must be stationary and all power locked out before manually re-coupling.





5. Water Cooling For Bearing Oil Reservoir.

If the motor is equipped with cooling coils in the oil reservoir, a minimum water supply of 4 GPM must be maintained at a maximum of 125 PSI with a 32°C (90°F) maximum inlet temperature. External water connections must be self draining to prevent cooling coil rupture at freezing temperatures. Use clean, noncorrosive water only. If corrosive conditions exist and are specified at time of motor order, special corrosion resistant fittings can be supplied.

6. Electrical Connection.

Refer to the motor nameplate for power supply requirements and to the connection diagram on the motor. Be sure connections are tight. Check carefully and assure that they agree with the connection diagram, then insulate all connections to be sure that they will not short against each other to ground. Be sure the motor is grounded to guard against possible electrical shock. Refer to the National Electrical Code Handbook (NFPA No. 70) and to local electrical codes for proper wiring, protection, and wire sizing. Be sure proper starting equipment and protective devices are used for every motor. For assistance, contact the motor starter manufacturer.

Part Winding Starters: Part winding starters used with part winding start motors should have the timer set at a minimum time consistent with the power company requirements. The recommended maximum time on part winding is two seconds. Setting the timer for longer periods can cause permanent damage to the motor and may void the warranty. Note that motor may or may not start on part winding start connection.

7. Direction Of Rotation.

As a standard, motors that are equipped with a non-reverse ratchet are designed to operate in a counterclockwise direction as viewed from the top of the motor. Also, some high speed motors have unidirectional ventilating fans. When the motor has a unidirectional ventilating fan, the direction of rotation is indicated by an arrow mounted on the motor and by a warning plate mounted near the main nameplate.

CAUTION

Apply power momentarily to observe the direction of rotation for which the leads are connected. Motor damage may occur if power is applied for more than ten seconds while rotation is locked against the non-reverse ratchet. The motor should be uncoupled from the driven equipment during this procedure to assure driven equipment is not damaged by reverse rotation. Couplings (if installed) should be properly secured.

For a 3 phase motor, to reverse the direction of rotation (if the motor is not operating in the correct direction), interchange any two of the three power leads on the motor. For a 1 phase motor, if the motor is not operating in the correct direction, follow the instructions on the connection plate attached to the motor in order to reverse the direction of rotation. For both 1 and 3 phase motors, be sure that the power is off and steps are taken to prevent accidental starting of the motor before attempting to change electrical connection.





8. Spring-Preloaded Thrust Bearings.

Motors built with spherical roller thrust bearings (bearing number 29xxx) at any speed or tandem angular contact thrust bearings (bearing number 7xxx) on large 3600 or 3000 RPM (2-pole) motors have preload springs which maintain a minimum thrust load at all times to prevent bearing skidding. These motors require a minimum external thrust load sufficient to compress the springs to properly seat the thrust bearing and to relieve the lower guide bearing of axial spring thrust. Refer to motor's minimum thrust nameplate for required thrust.

CAUTION

Do not run a motor which has bearing preload springs without thrust load for more than fifteen (15) minutes as bearing damage may result.

9. Initial Start.

After installation is completed, but before motor is put into regular service, make an initial start as follows:

- A. Ensure that motor and control device connections agree with wiring diagrams.
- B. Ensure that voltage, phase, and frequency of line circuit (power supply) agree with motor nameplate.
- C. Check insulation resistance according to **Section III "STORAGE" item 3.**
- D. Check all foundation, base, non-reverse ratchet (if applicable), and coupling bolts (if applicable) to ensure they are tight.
- E. If motor has been in storage, either before or after installation, refer to **Section III "STORAGE" item 4** for preparations.
- F. Motors are tested with oil at our manufacturing facility then drained prior to shipment. Note: A small amount of residual oil and rust inhibitor will remain in the oil sump. This residual oil and rust inhibitor is compatible with Turbine Type Mineral Oils and Synthetic, PAO (Poly Alpha Olefin) based oils listed in this manual. It is not necessary to drain this residual oil when adding new oil for operation. Check oil lubricated units to be certain that bearing housings have been filled to between the "MAX" and "MIN" levels on the sight gauge windows with the correct lubricant. Refer to **Section IX "LUBRICATION"** for proper oils.
- G. Check for proper or desired rotation. See item 7 of this section for details.
- H. Ensure that all protective devices are connected and operating properly, and that all outlet accessory, and access covers have been returned to their original intended position.
- I. Start motor at lowest possible load and monitor to be sure that no unusual condition develops.

WARNING

All loosened or removed parts must be reassembled and tightened to original specifications. Keep all tools, chains, equipment, etc. clear of unit before energizing motor.

- J. When checks are satisfactory to this point, increase load slowly up to rated load and monitor unit for satisfactory operation.





VI. NORMAL OPERATION

Start the motor in accordance with standard instructions for the starting equipment used.

1. General Maintenance.

Regular, routine maintenance is the best assurance of trouble-free, long-life motor operation. It prevents costly shutdown and repairs. Major elements of a controlled maintenance program are:

- A. Trained personnel who have a working knowledge of rotational equipment and have read this manual.
- B. Systematic records which contain at least the following:
 - 1. Complete nameplate data.
 - 2. Prints (wiring diagrams, certified outline dimensions).
 - 3. Alignment data.
 - 4. Results of regular inspection, including vibration and bearing temperature data, as applicable.
 - 5. Documentation of any repairs.
 - 6. Lubrication data:
 - Method of application
 - Types of lubricants for wet, dry, hot, or adverse locations
 - Maintenance cycle by location (some require more frequent lubrication)

2. Inspection and Cleaning

Stop the motor before cleaning. **CAUTION: Assure against accidental starting of the motor.** Clean the motor inside and out regularly. The frequency of cleaning depends upon actual conditions existing around the motor. Use the following procedures as they apply:

- A. Wipe off dirt, dust, oil, water, or other liquids from external surfaces of motor. These materials can work into or be carried into the motor windings and may cause overheating or insulation breakdown.
- B. Remove dirt, dust, or debris from ventilating air inlets. Never allow dirt to accumulate near air inlets. Never operate motor with air passages blocked.
- C. Clean motors internally by blowing with clean, dry, compressed air at 40 to 60 PSI. If conditions warrant, use a vacuum cleaner.

CAUTION

When using compressed air, always use proper eye protection to prevent accidental eye injury.

D. When dirt and dust are solidly packed, or windings are coated with oil or greasy grime, disassemble the motor and clean with solvent. Use only high-flash naphtha, mineral spirits, or Stoddard solvent. Wipe with solvent dampened cloth, or use suitable soft bristled brush. **DO NOT SOAK.** Oven dry (150 - 175°F) solvent cleaned windings thoroughly before reassembly.

- E. After cleaning and drying the windings, check the insulation resistance per **Section III, Item 3.**





VII. NON-REVERSE RATCHET

Units featuring non-reverse ratchets are refine-balanced by attaching weights to the rotating ratchet. If the ratchet is removed it should be marked and reassembled in the same position to retain proper balance.

VIII. ENDPLAY ADJUSTMENT

The term endplay is defined as the total axial float of the rotor. Should the motor be disassembled for any reason, the rotor endplay must be adjusted. Care must be taken to ensure that end play is within the proper range. Use one of the following procedures, depending upon the type of thrust bearing to set end play:

⚠ CAUTION

Excessive endplay can allow the thrust bearing to separate when units are run with zero thrust or momentary up thrust, resulting in thrust bearing failure. Insufficient endplay may cause the bearings to load against each other, resulting in extreme heat and rapid failure of both the guide and thrust bearings.

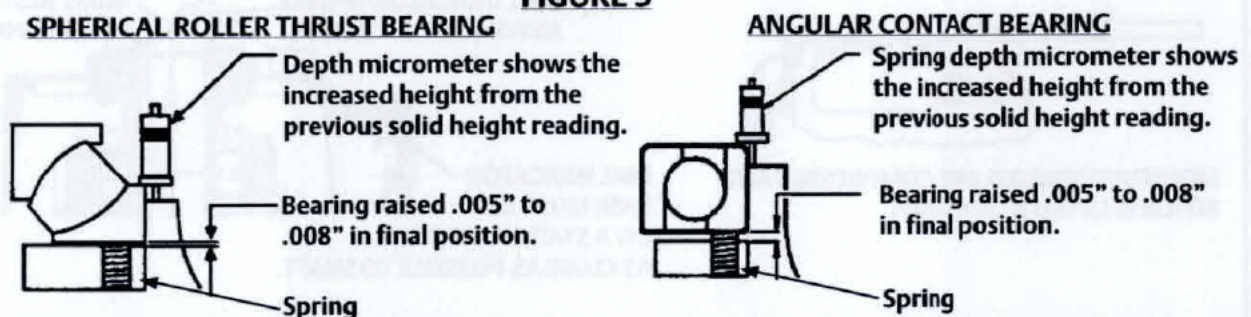
1. Spherical Roller Thrust Bearings and Angular Contact Bearings (With Springs).

Setting the correct end play on units with spring-preloaded spherical roller or angular contact thrust bearings requires a controlled assembly method, due to various deflections internal to the motor and friction of locknut threads from spring force. An end play setting of .005 to .008 inches is required to allow the lower guide bearing to return to an unloaded position when external thrust is applied to the motor (see Figure 5). End play can be properly adjusted by the following recommended procedure:

- Place spring retainer (without springs) and lower thrust washer of bearing into upper bearing bore.
- Using a depth micrometer, measure the distance between the top of the lower thrust washer and the faced surface on top of the bearing housing (see Figure 5). Record dimension to three decimals.
- Add .005 to .008 inches to the recorded dimension to obtain the correct endplay range for the unit.
- Reassemble bearing with springs. Motor is now ready to set end play. Several acceptable methods for setting endplay are following.

NOTE: Certain motor builds require removal of the fabricated steel or cast aluminum oil baffle to provide access for depth micrometer measurements.

FIGURE 5





2. Angular Contact Ball Bearings (Without Springs)

- A. No preliminary measurements are required to set end play. End play may be set by any of the following methods described in this section.
- B. To correctly adjust the endplay setting, a dial indicator should be positioned to read the shaft axial movement. (See figure 7 for location of dial indicator). The rotor adjusting lock nut should be turned until no further upward movement of the shaft is indicated. The locknut is then loosened until .005 to .008" endplay is obtained. Lock the locknut with lock washer.

⚠ CAUTION

Care should be taken to ensure that the locknut is not over-tightened, as this can lead to an erroneous end play setting (due to deflection of parts) and bearing damage may result.

- C. Motors that have two opposed angular contact bearings that are locked for up and downthrust do not require endplay adjustment. The shaft, however, must be set to the original 'AH' (shaft extension length) to prevent the guide bearing from taking thrust.

ENDPLAY ADJUSTMENT METHODS

1. Method 1 (refer to Figures 6 & 7)

This method requires the user to install a bolted chain from the bearing mount back to a lifting lug. Rotate the locknut with a spanner wrench (and bar extension) until dial indicator shows no movement on end of shaft. The locknut should then be loosened until proper endplay is obtained, lock the locknut with lock washer. (See figure 7 for location of dial indicator.)

NOTE: This is the lowest cost of the three methods and requires the least amount of equipment. This method, however, may be less desirable than Method 2 as considerable locknut torque may be encountered on units with bearing preload springs.

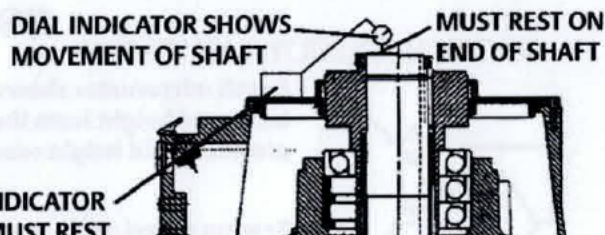
- Special equipment required:
- Locking bolts
 - 3/4" chain
 - Spanner wrench with extension
 - Dial indicator
 - Depth micrometer

FIGURE 6 (METHOD 1)



MOUNTING SPRINGS ARE COMPRESSED AND ROTOR IS LIFTED BY LOCKNUT

FIGURE 7 (METHOD 1 & 3)



DIAL INDICATOR SHOWS MOVEMENT OF SHAFT
DIAL INDICATOR BASE MUST REST ON A STATIONARY PART AS CLOSE AS POSSIBLE TO SHAFT.
MUST REST ON END OF SHAFT





2. Method 2 (refer to Figure 8 - Utilized on Spring Loaded Bearings Only)

This method utilizes a spreader bar and chains to wrap around lifting lugs, a hydraulic jack (five ton), and crane to lift the spreader bar. The hydraulic jack is supported by two steel blocks of equal thickness on top of the bearing mounting with the jack pushing against the spreader bar. On large motors, the rotor can be lifted by placing a second jack below the motor shaft to allow the locknut to be turned easily.

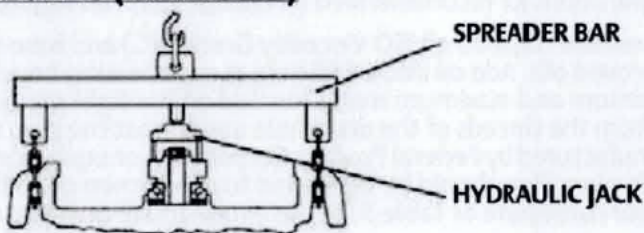
NOTE: This method utilizes typical shop equipment and tools. Endplay settings can be checked quickly on larger vertical motor products. The locknut lifts rotor weight only.

Equipment required:

- Large spreader bar with chains and locking bolts
- Overhead crane
- Metal blocks
- Depth micrometer
- 5-ton hydraulic jack
- Spanner wrench
- Dial indicator

FIGURE 8 (METHOD 2)

MOUNTING SPRINGS ARE COMPRESSED – ONLY THE ROTOR IS LIFTED BY THE LOCKNUT.



3. Method 3 (refer to Figure 9)

This method uses a one inch thick steel disc with a center hole for the shaft end bolt and two threaded hydraulic jacks connected to a single pump. Apply load to hydraulic jacks until dial indicator shows no movement on end of shaft. (See figure 7 for location of dial indicator). The shaft locknut should be positioned and the pressure from hydraulic jack relieved until proper endplay is obtained.

CAUTION

Use of excessive hydraulic pressure can damage bearings.

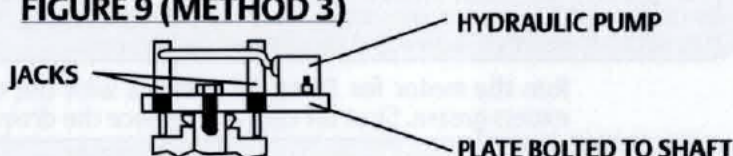
NOTE: This method is directly usable on solid shaft motors and can be used on most HOLLOSHAFT® motors with the use of a long threaded rod and plate. It is easy to apply and settings can be checked quickly, especially in field service. The locknut does not see any force and can be turned easily.

Equipment required:

- Fixture with hydraulic jacks
- Dial indicator
- Spanner wrench

MOUNTING SPRINGS ARE COMPRESSED AND ROTOR IS LIFTED BY THE FIXTURE. THE LOCKNUT IS TURNED FOR ADJUSTMENT.

FIGURE 9 (METHOD 3)



CAUTION

After setting endplay, run unit for three to five minutes, then stop and verify the endplay setting. Readjust as necessary. All loosened or removed parts must be reassembled and tightened to original specifications. Keep all tools, chains, equipment, etc. clear of unit before energizing motor.





IX. LUBRICATION

Motor must be at rest and electrical controls should be locked open to prevent energizing while being serviced. If motor is being taken out of storage refer to **Section III "STORAGE", item 4** for instructions.

1. Oil Lubricated Bearings.

Motors are tested with oil at our manufacturing facility then drained prior to shipment. A small amount of residual oil and rust inhibitor will remain in the oil sump. This residual oil and rust inhibitor is compatible with Turbine Type Mineral Oils and Synthetic, PAO (Poly Alpha Olefin) based oils listed in this manual. It is not necessary to drain this residual oil when adding new oil for operation.

Change oil once per year with normal service conditions. Frequent starting and stopping, damp or dusty environment, extreme temperature, or any other severe service conditions will warrant more frequent oil changes. If there is any question, consult Emerson Motor Co. Product Service Department for recommended oil change intervals regarding your particular situation.

Determine required oil ISO Viscosity Grade (VG) and base oil type from Table 3, then see Table 4 for approved oils. Add oil into oil fill hole at each bearing housing until the oil level reaches between minimum and maximum marks located on the sight gauge window. It is important to wipe excess oil from the threads of the drain hole and to coat the plug threads with Gasoil[®] P/N SS08, manufactured by Federal Process Corporation or equivalent thread sealant before replacing the drain plug. Plug should be tightened to a minimum of 20 lb.-ft. using a torque wrench. See the motor nameplate or Table 5 for the approximate quantity of oil required.

2. Grease Lubricated Bearings.

A. Relubrication of Units in Service

Grease lubricated bearings are pre-lubricated at the factory and normally do not require initial lubrication. Relubricating interval depends upon speed, type of bearing and service. Refer to Table 1 or suggested regreasing intervals and quantities. Note that operating environment and application may dictate more frequent lubrication. To relubricate bearings, remove the drain plug. Inspect grease drain and remove any blockage (caked grease or foreign particles) with a mechanical probe, taking care not to damage bearing.

⚠ WARNING

Under NO circumstances should a mechanical probe be used while the motor is in operation.

Add new grease at the grease inlet. New grease must be compatible with the grease already in the motor (refer to table 2 for compatible greases).

⚠ CAUTION

Greases of different bases (lithium, polyurea, clay, etc.) may not be compatible when mixed. Mixing such greases can result in reduced lubricant life and premature bearing failure. Prevent such intermixing by disassembling motor, removing all old grease and repacking with new grease per item B of this section. Refer to Table 2 for recommended greases.

Run the motor for 15 to 30 minutes with the drain plug removed to allow purging of any excess grease. Shut off unit and replace the drain plug. Return motor to service.

⚠ CAUTION

Overgreasing can cause excessive bearing temperatures, premature lubricant breakdown and bearing failure. Care should be exercised against overgreasing.





B. Change of Lubricant

Motor must be disassembled as necessary to gain full access to bearing housing(s).

Remove all old grease from bearings and housings (including all grease fill and drain holes). Inspect and replace damaged bearings. Fill bearing housings both inboard and outboard of bearing approximately 30 percent full of new grease. Grease fill ports must be completely charged with new grease. Inject new grease into bearing between rolling elements to fill bearing. Remove excess grease extending beyond the edges of the bearing races and retainers.

Table 1
Recommended Grease Replenishment Quantities & Lubrication Intervals

Bearing Number		Grease Replenishment Quantity (Fl.Oz.)	Lubrication Interval		
62xx, 72xx	63xx, 73xx		1801 thru 3600 RPM	1201 thru 1800 RPM	1200 RPM and slower
03 thru 07	03 thru 06	0.2	1 Year	2 Years	2 Years
08 thru 12	07 thru 09	0.4	6 Months	1 Year	1 Year
13 thru 15	10 thru 11	0.6	6 Months	1 Year	1 Year
16 thru 20	12 thru 15	1.0	3 Months	6 Months	6 Months
21 thru 28	16 thru 20	1.8	3 Months	6 Months	6 Months

Refer to motor nameplate for bearings provided on a specific motor. For bearings not listed in Table 1, the amount of grease required may be calculated by the formula:

$$G = 0.11 \times D \times B$$

Where: G = Quantity of grease in fluid ounces.
D = Outside diameter of bearing in inches.
B = Width of bearing in inches.

Table 2
Recommended Greases

Motor Frame Size	Motor Enclosure	Grease Manufacturer	Grease (NLGI Grade 2)
All Thru 447	All	Exxon Mobil	Polyrex-EM
449 and Up	Open Dripproof		
449 and Up	TEFC and Explosionproof	Exxon Mobil	Mobilith SHC-100

The above greases are interchangeable with the grease provided in units supplied from the factory (unless stated otherwise on motor lubrication nameplate).





INSTALLATION AND MAINTENANCE

Lubrication

Table 3
Nidec Motor Corporation Recommended Oil Viscosities

Angular Contact Thrust Bearing (7XXX Series) (ABMA BT-Series)					
Motor Enclosure	Frame Size	Speed (RPM)	Ambient Temperature	ISO VG	Base Oil Type
Open Dripproof or Weather Protected	324 and Larger	All	-15C thru 40C (5-104F)	32	Mineral or Synthetic
			41C thru 50C (105-122F)	68	Synthetic Only
Totally Enclosed or Explosion proof	404 thru 447		-15C thru 40C (5-104F)	32	Mineral or Synthetic
			41C thru 50C (105-122F)	68	Synthetic Only
	449 thru 5811	1801 - 3600	-15C thru 40C (104F)	32	Synthetic Only
		1800 & Below		68	Synthetic Only
All		41C thru 50C (105-122F)	Refer to Office		
Spherical Roller Thrust Bearing (29XXX Series) (ABMA TS-Series)					
Motor Enclosure	Frame Size	Speed (RPM)	Ambient Temperature	ISO VG	Base Oil Type
Open Dripproof or Weather Protected	444 and Larger	1800 and Below	-15C thru 25C (5-77F)	68	Mineral or Synthetic
			6C thru 40C (42-104F)	150	
			41C thru 50C (105-122F)		
Totally Enclosed or Explosion proof	449 and Larger		-15C thru 25C (5-77F)	68	Mineral or Synthetic
			6C thru 40C (42-104F)	150	Synthetic Only
			41C thru 50C (105-122F)	Refer to Office	

Notes:

1. If lower guide bearing is oil lubricated, it should use the same oil as the thrust bearing.
2. If lower guide bearing is grease-lubricated, refer to TABLE 2 for recommended greases.
3. Refer to Nidec Motor Corporation for ambient temperatures other than those listed.

Table 4
Nidec Motor Corporation Approved Oil Specifications For Use With Anti-Friction Bearings

Oil Manufacturer	ISO VG 32		ISO VG 68		ISO VG 150	
	Viscosity: 130-165 SSU @ 100F		Viscosity: 284-347 SSU @ 100F		Viscosity: 620-765 SSU @ 100F	
	Mineral Base Oil	Synthetic Base Oil	Mineral Base Oil	Synthetic Base Oil	Mineral Base Oil	Synthetic Base Oil
Chevron USA, Inc	GST Turbine Oil 32	Tegra 32	GST Turbine Oil 68	Tegra 68	R & O Machine Oil 150	Tegra 150
Conoco Oil Co.	Hydroclear Turbine Oil 32	Syncon 32	Hydroclear Turbine Oil 68	Syncon 68	Hydroclear AW Hyd. Fluid 150	N/A
ExxonMobil	Teresstic 32	Synnestic 32	Teresstic 68	Synnestic 68	Teresstic 150	Synnestic 150
ExxonMobil	DTE Oil Light	SHC 624	DTE Oil Heavy Medium	SHC 626	DTE Oil Extra Heavy	SHC 629
Pennzoil Co., Inc	Pennzbell TO 32	Pennzbell SHD 32	Pennzbell TO 68	Pennzbell SHD 68	Pennzbell TO 150	Pennzbell SHD 150
Phillips Petroleum Co.	Magnus 32	Syndustrial "E" 32	Magnus 68	Syndustrial "E" 68	Magnus 150	N/A
Shell Oil Co.	Tellus 32	Tellus HD Oil AW SHF 32	Tellus 68	Tellus HD Oil AW SHF 68	Tellus 150	N/A
Texaco Lubricants Co.	Regal 32	Cetus PAO 32	Regal 68	Cetus PAO 68	Regal 150	N/A





Table 5
Approximate Oil Sump Capacities

Frame Size	Motor Type Designation (See Motor Nameplate)	Oil Capacity (Quarts)	
		Upper Bearing	Lower Bearing
180 - 280	AU, AV-4	Grease	Grease
180 - 280	AV		
320 - 440	RV		
320 - 360	RV-4, RU	3	
400	RV-4, RU	5	
440	RV-4 (2 pole)	17	
	RV-4, RU (4 pole & slower)	6	
180 - 440	TV-9, TV, LV-9, LV	Grease	
180 - 360	TV-4, TU, LV-4, LU		
400	TV-4, TU, LV-4, LU	6	
440	TV-4, TU, LV-4, LU	5	
449	JU, JV-4	22	
	HU, HV-4	12	
	JV-3, JV, HV	Grease	
5000	HV, EV, JV, RV	Grease	
	RU, RV-4	30	
	HU, HV-4 (4 pole & slower)	12	
	HV-4 (2 pole only)	20	
	EU, JU, EV-4, JV-4	22	
5800	RU, RV-4	48	5
	HU, HV-4	24	4
	EU, JU, EV-4, JV-4	37	3
6800	HU, HV-4	70	4
	HV (Bow Thruster)	Grease	Grease
	HV (Other Than Bow Thruster)	70	3
8000	RU, RV-4	70	6
	RV	Grease	Grease
9600	RU, RV-4	95	13
	RV	Grease	Grease





INSTALLATION AND MAINTENANCE

Troubleshooting

X. FUNDAMENTAL TROUBLESHOOTING - PROBLEM ANALYSIS

This chart can reduce work and time spent on motor analysis. Always check the chart first before starting motor disassembly, as what appears to be a motor problem may often be located elsewhere. For additional information, consult our website at www.usmotors.com.

SYMPTOM	POSSIBLE CAUSE	ANALYSIS
Motor fails to start	Defective power supply	Check voltage across all phases above disconnection switch.
	Blown or defective primary fuses	
	Blown or defective secondary fuses	Check voltage below fuses (all phases) with disconnect closed.
	Open control circuit	Push reset button
	Overload trips are open	
	Defective holding coil in magnetic switch	Push start button and allow sufficient time for operation of time delay, if used, the check voltage across magnetic holding coil. If correct voltage is measured, coil is defective. If no voltage is measured, control circuit is open
	Loose or poor connections in control circuits	Make visual inspection of all connections in control switch.
	Magnetic switch closes	Open manual disconnect switch, close magnetic by hand, and examine contractors and springs
	Poor switch closes	
	Opens circuit in control panel	Check voltage at T1, T2, & T3
	Open circuit leads to motor	Check voltage at leads in outlet box
	Leads improperly connected	Check lead numbers and connections
Motor fails to come up to speed	Low or incorrect voltage	Check voltage at T1, T2, & T3 in control panel and at motor leads in outlet box.
	Incorrect connection at motor	Check for proper lead connections at motor and compare with connection diagram on motor.
	Overload - mechanical	Check impeller setting. Check for a tight or locked shaft.
	Overload - hydraulic	Check impeller setting. Check GPM against pump capacity and head.
Motor Vibrates	Headshaft misaligned	Remove top drive coupling and check alignment of motor to pump.
	Worn line shaft bearings or bent line shaft	Disconnect motor from pump and run motor only to determine source of vibration.
	Hydraulic disturbance in discharge piping	Check isolation joint in discharge piping near pump head.
	Ambient Vibration	Check base vibration level with motor stopped.
	System Natural Frequency (Resonance)	Revise rigidity of support structure.
Motor noisy	Worn thrust bearing	Remove dust cover, rotate rotor by hand, and make visual examination of balls and races. Bearing noise is commonly accompanied by a high frequency vibration and /or increased temp.
	Electrical noise	Most motors are electrically noisy during the starting period. This noise should diminish as motor reaches full speed.





INSTALLATION AND MAINTENANCE

Troubleshooting

SYMPTOM	POSSIBLE CAUSE	ANALYSIS
Motor overheating (Check with thermo- couple or by resistance methods. Do not depend on hand.)	Overload	Measure load and compare to nameplate rating. Check for excessive friction in motor or in complete drive. Reduce load or replace motor with greater capacity motor. Refer to Appendix C.
	Motor intake or exhaust blocked or clogged.	Clean motor intake and exhaust areas. Clean filters or screens if motor is so equipped.
	Unbalanced voltage	Check voltage to all phases. Refer to Appendix A.
	Open stator windings	Disconnect motor from load. Check idle amps for balance in all three phases. Check stator resistance in all three phases.
	Over / Under Voltage	Check voltage and compare to nameplate voltage.
	Ground	Locate with test lamp or insulation tester and repair.
	Improper Connections	Recheck connections.
Bearing Overheating Generally, bearing temperatures (as mea- sured by a tipsensitive RTD or thermocouple touching the bearing outer race) should not exceed 90°C when using mineral-based lubricants or 120°C when using synthetic-based lubricants.	Misalignment	Check alignment.
	Incorrect oil, or oil level too high or too low.	Refill with proper oil. Verify oil level is correct.
	Excessive thrust.	Reduce thrust from driven machine.
	Bearing over-greased.	Relieve bearing cavity of grease to level specified in lubrication section.
	Motor overloaded	Measure load and compare to nameplate rating. Check for excessive friction in motor or in complete drive. Reduce load or replace motor with greater capacity motor. Refer to Appendix C.
	Motor intake or exhaust blocked or clogged	Clean motor intake and exhaust areas. Clean filters or screens if motor is so equipped.
Bearing oil leaking around the drain plug.	Insufficient sealant applied to drain plug threads.	Remove drain plug and drain existing oil from sump. With a clean cloth, wipe excess oil from the plug threads and the threads in the drain hole. Apply Gasolia Thread Sealant P/N SS08 to the threads of the plug and replace. Fill sump with new oil to the proper level.





XI. SPARE PARTS

A parts list is available for your unit and will be furnished upon request. Parts may be obtained from local Nidec Motor Corporation distributors and authorized service shops, or through Nidec Motor Corporation distribution center.

Nidec Motor Corporation
710 Venture Drive
Suite 100
Southaven, MS 38672
Phone (662) 342-6910
Fax (662) 342-7350

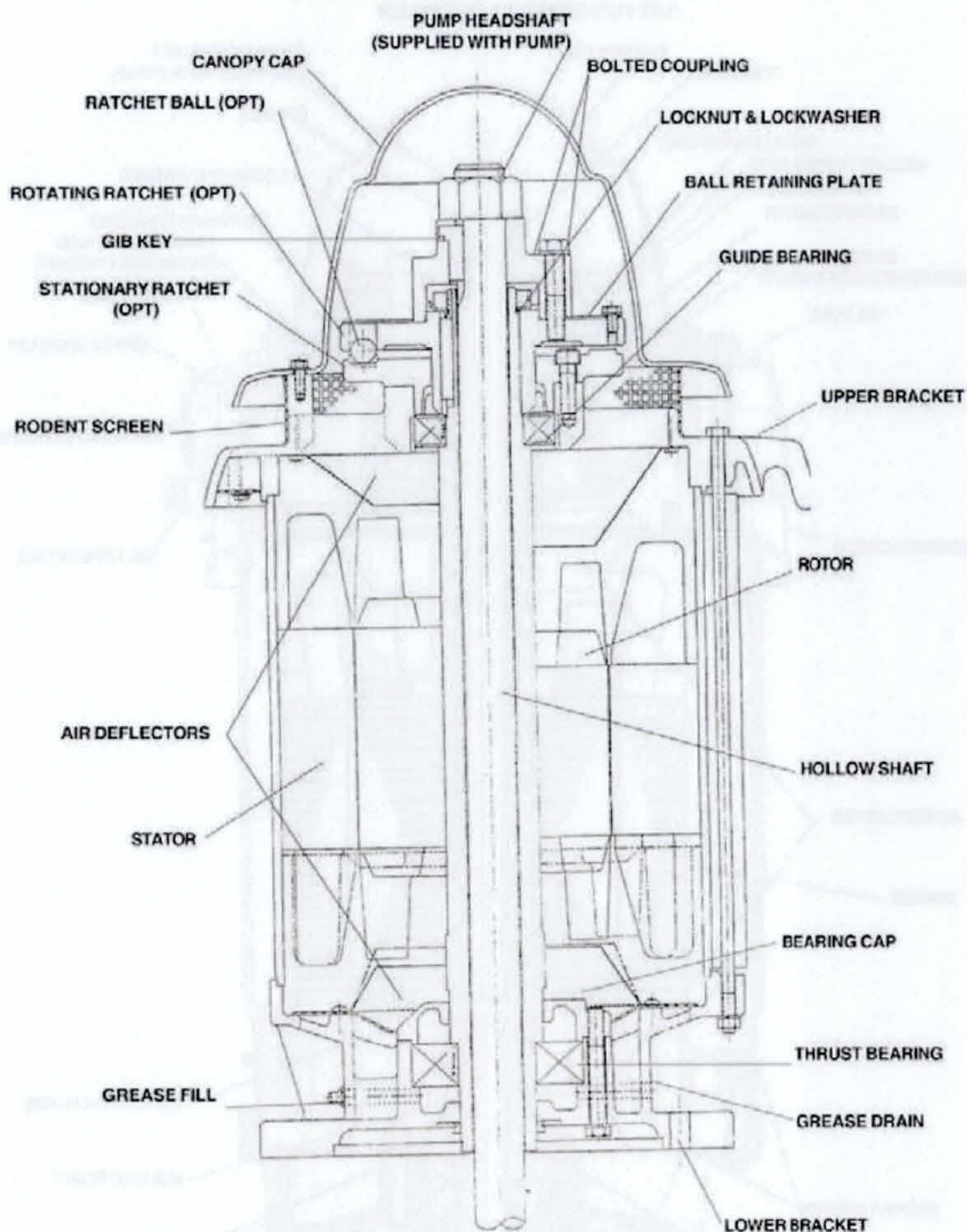
Drawings for many standard designs are supplied on the following pages. Most of the parts should be easy to identify. If however, there is some deviation from your machine, consult the factory for assistance.





INSTALLATION AND MAINTENANCE

Spare Parts 250 and 280 Frames Type AU HIGH THRUST

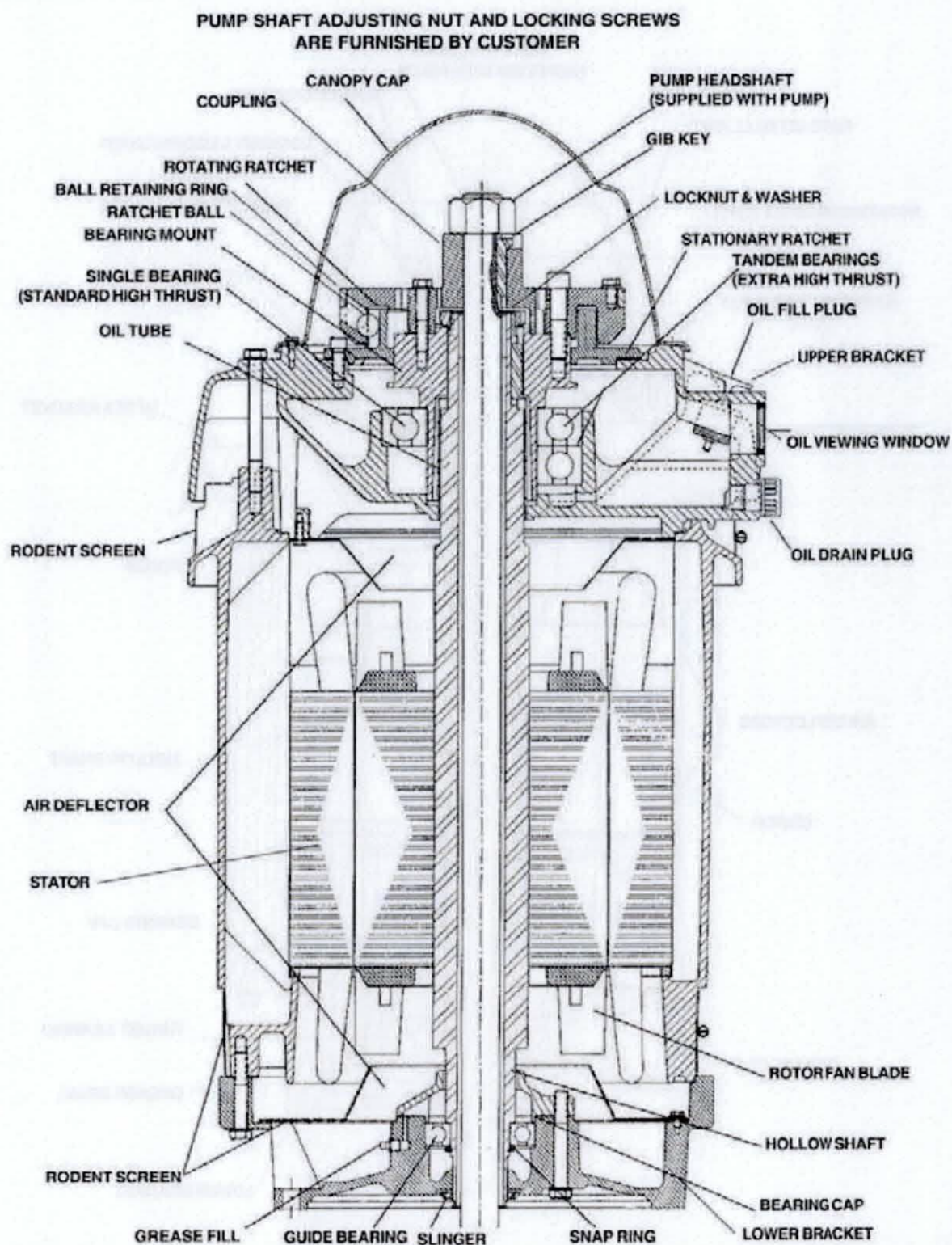




INSTALLATION AND MAINTENANCE

Spare Parts

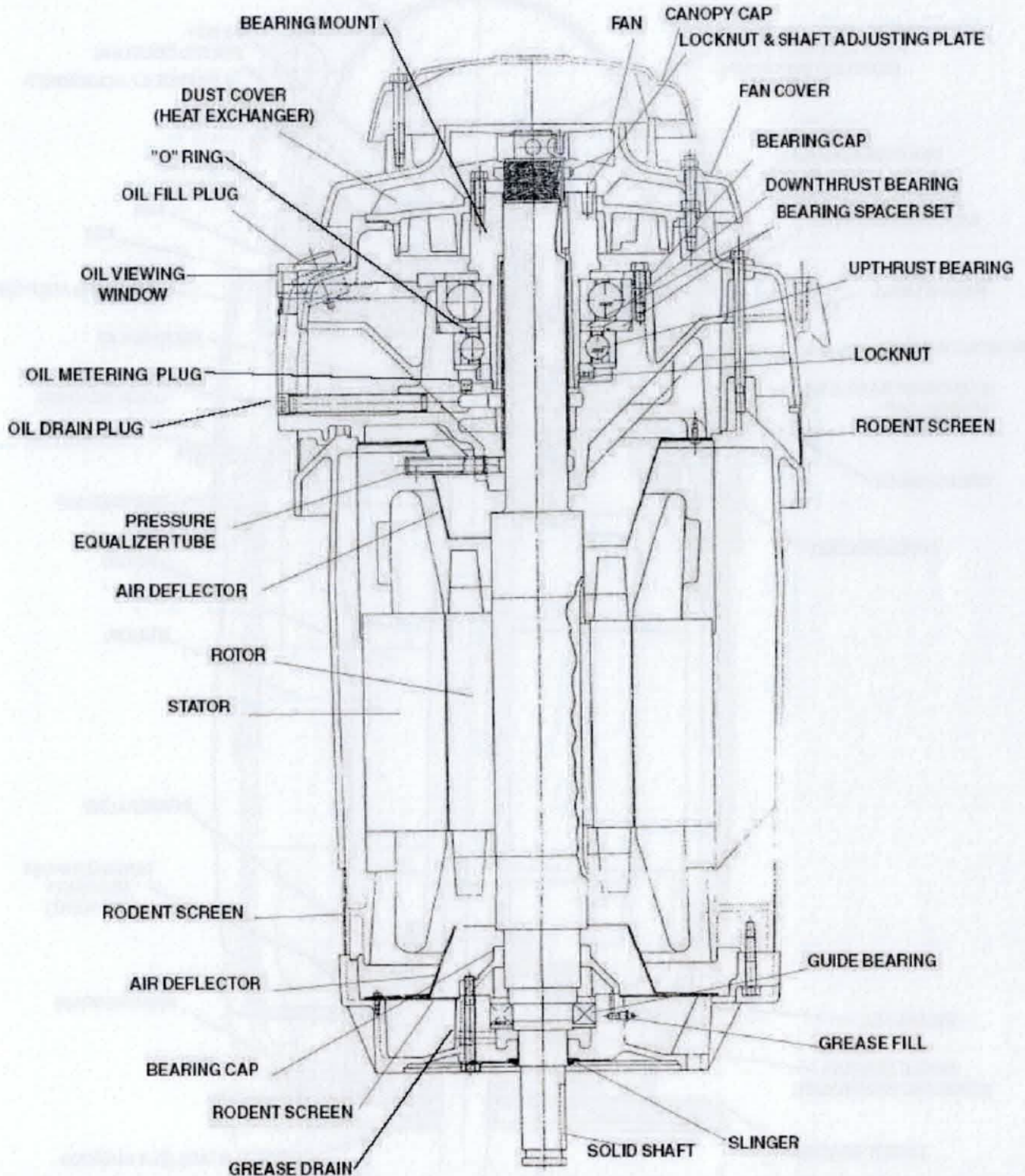
320 Thru 440 Frames
Type RU - HIGH THRUST





INSTALLATION AND MAINTENANCE

Spare Parts 440 Frame, Type RV-4 (2 Pole)

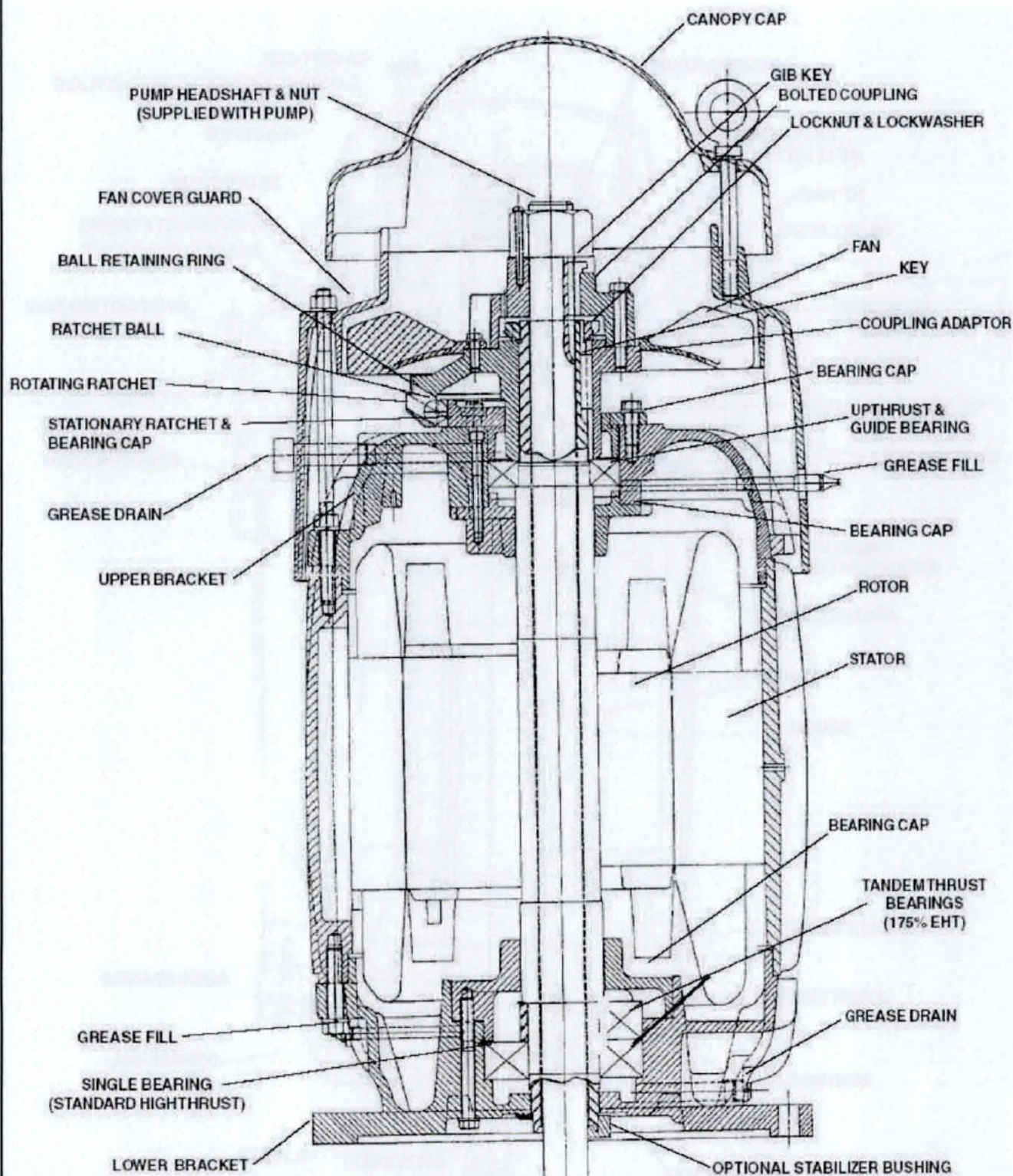




INSTALLATION AND MAINTENANCE

Spare Parts

280, 320, 360 Frames, Type LU
320, 360 Frames, Type TU

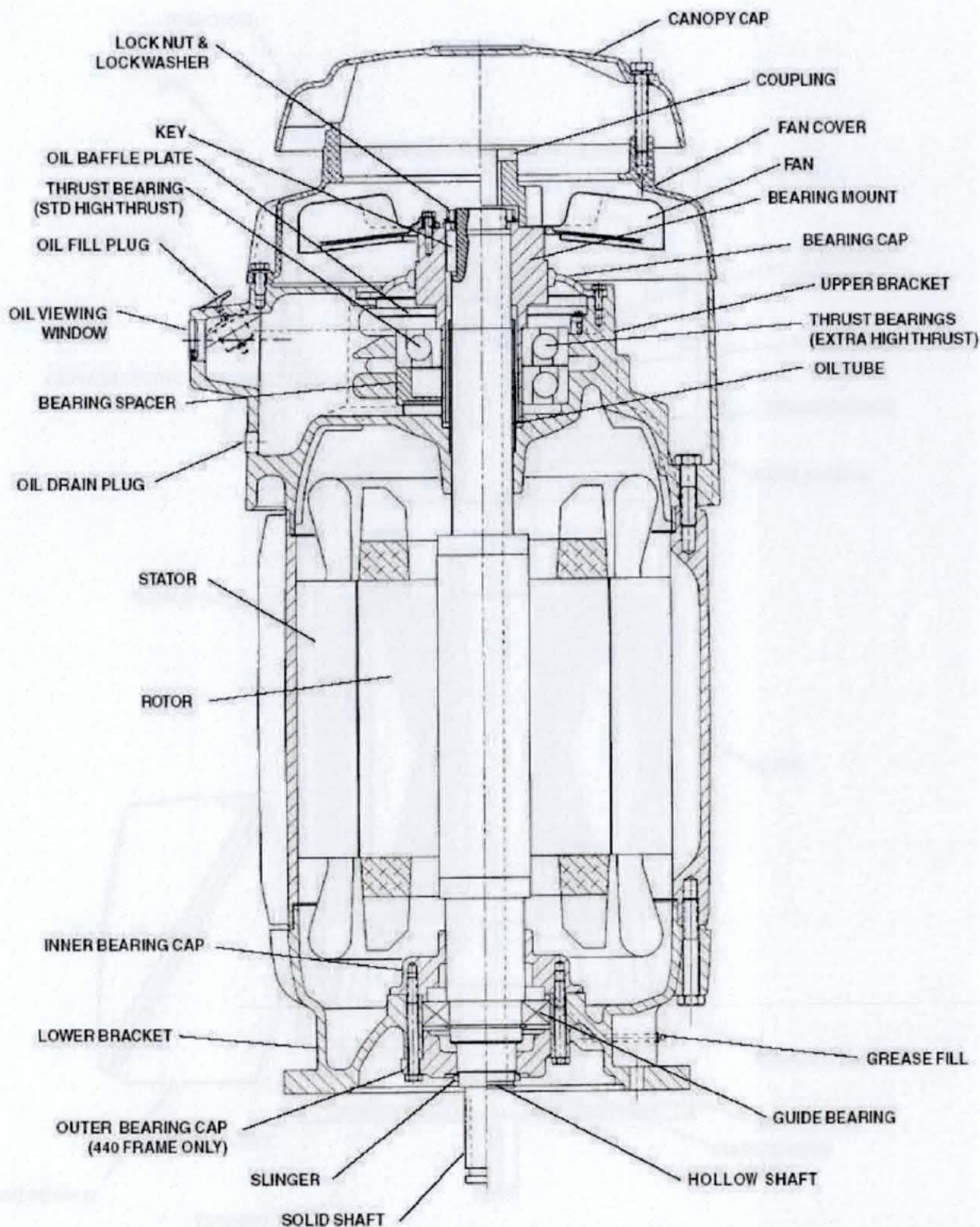




INSTALLATION AND MAINTENANCE

Spare Parts

400 Thru 440 Frame
Types TU, LU, TV-4 and LV-4
High Thrust

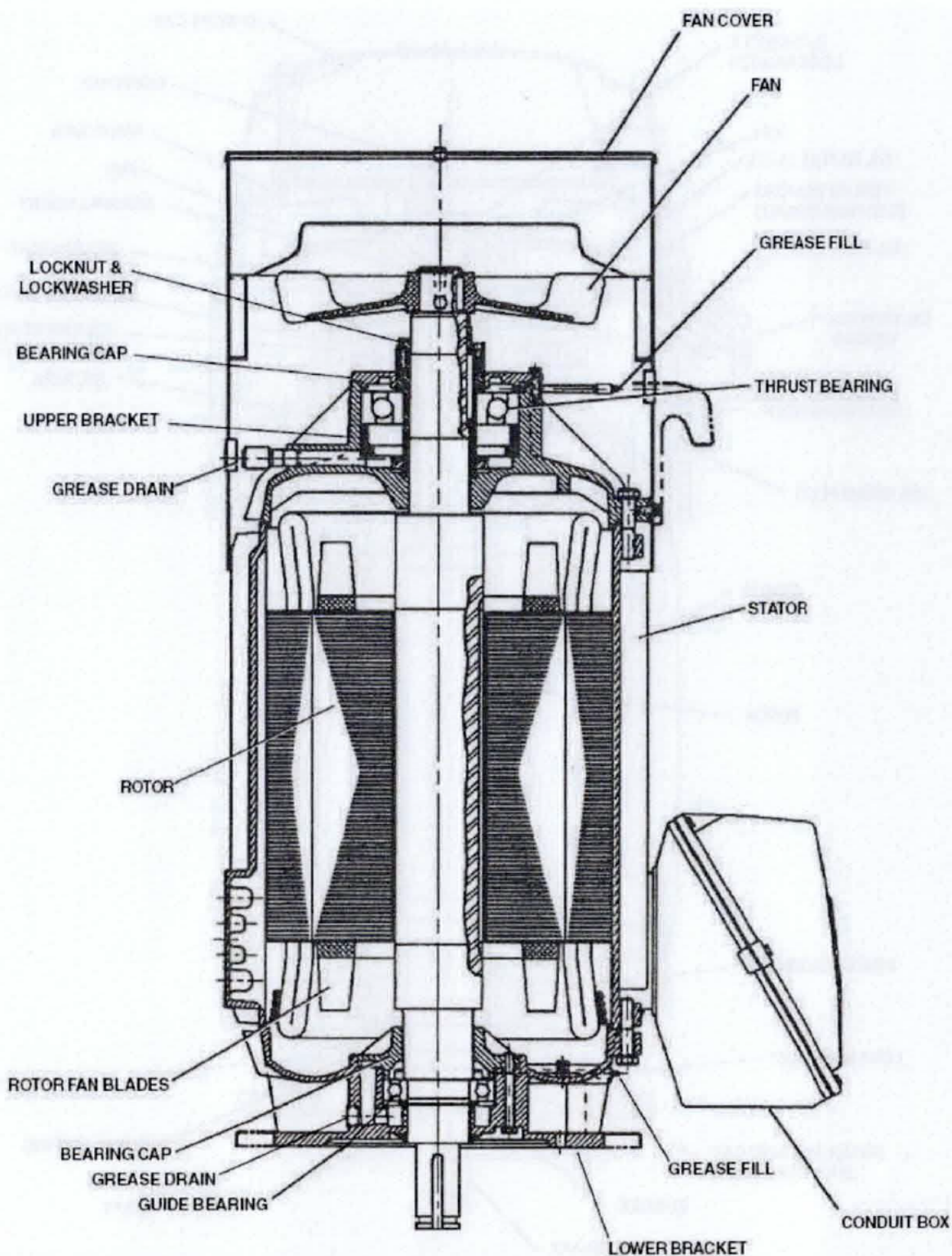




INSTALLATION AND MAINTENANCE

Spare Parts

449 Frame
Type JV & JV-3

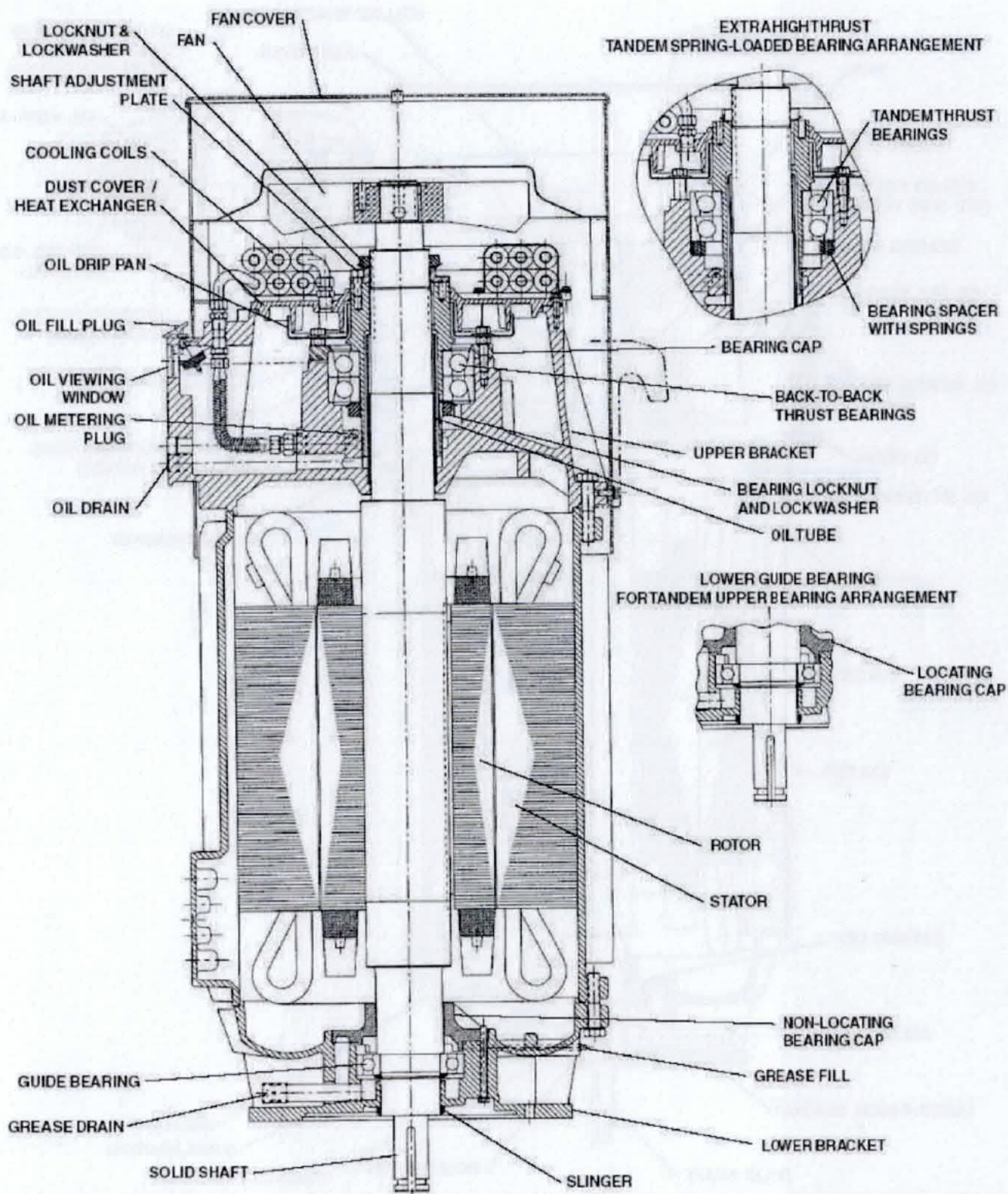




INSTALLATION AND MAINTENANCE

Spare Parts

449 Frame
Type JV-4 (2 Pole)

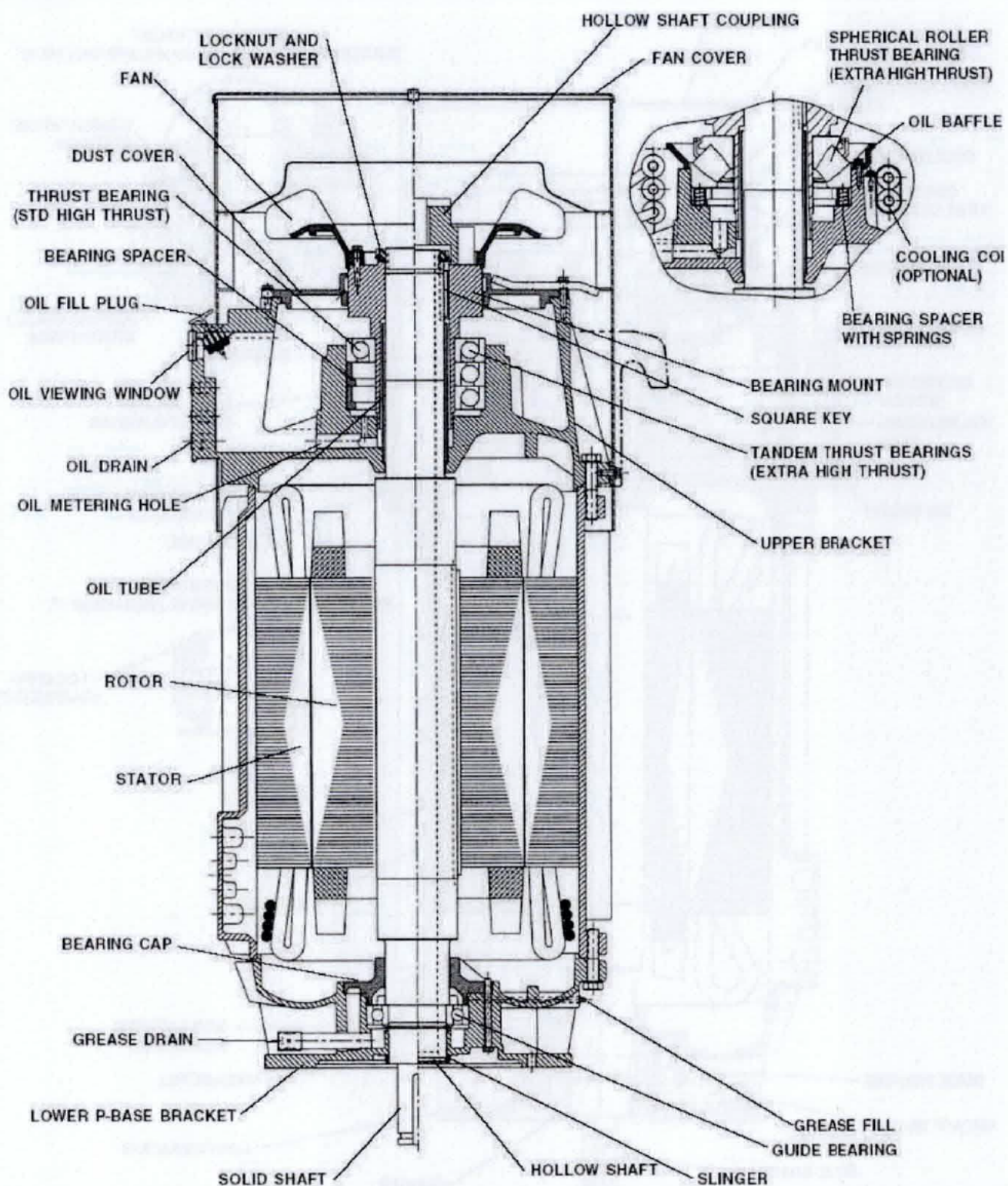




INSTALLATION AND MAINTENANCE

Spare Parts

449 Frame
Type JU and JV-4
(4 Pole & Slower)

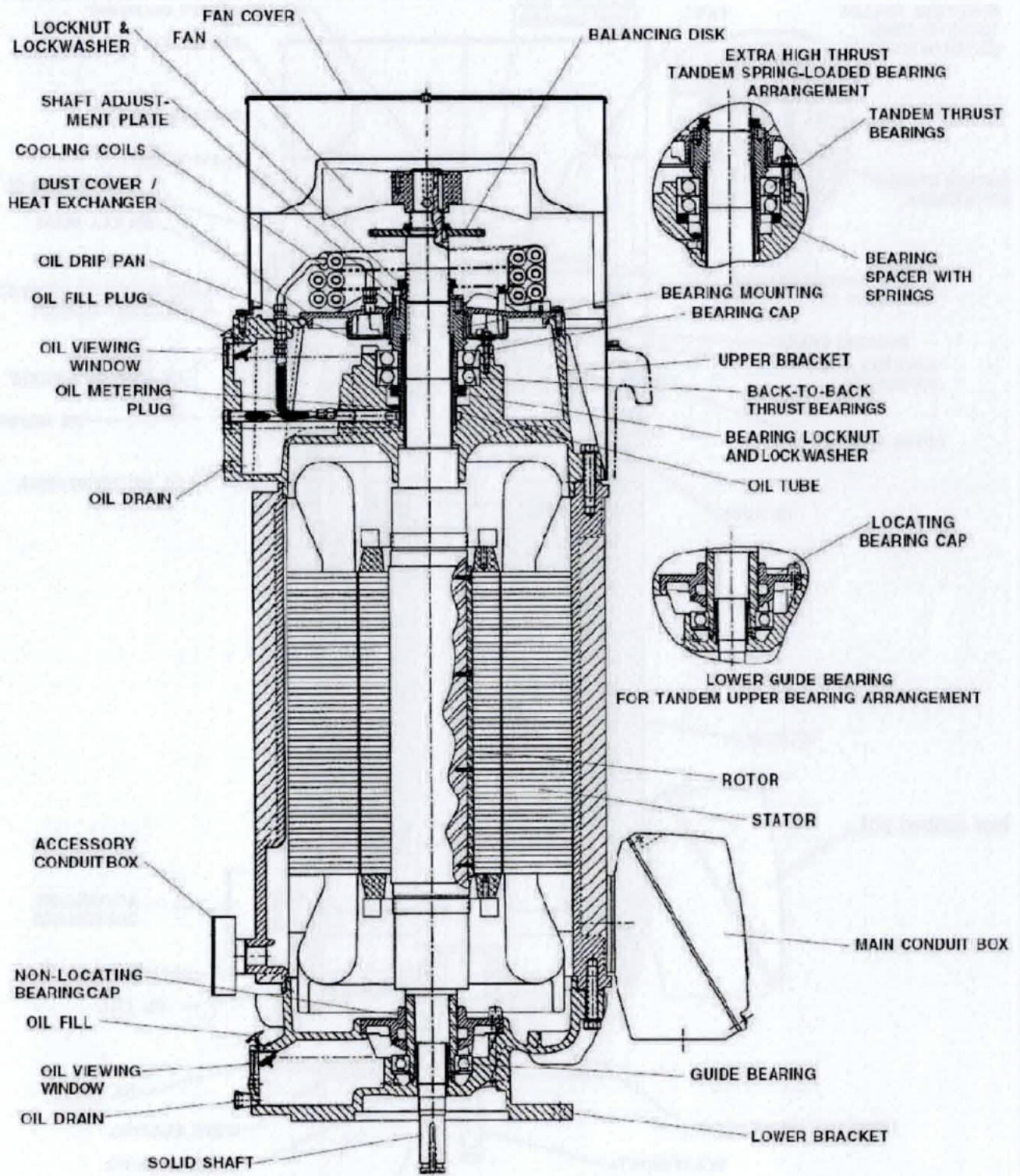




INSTALLATION AND MAINTENANCE

Spare Parts

5800 Frame
JV-4 & EV-4 (2 Pole)

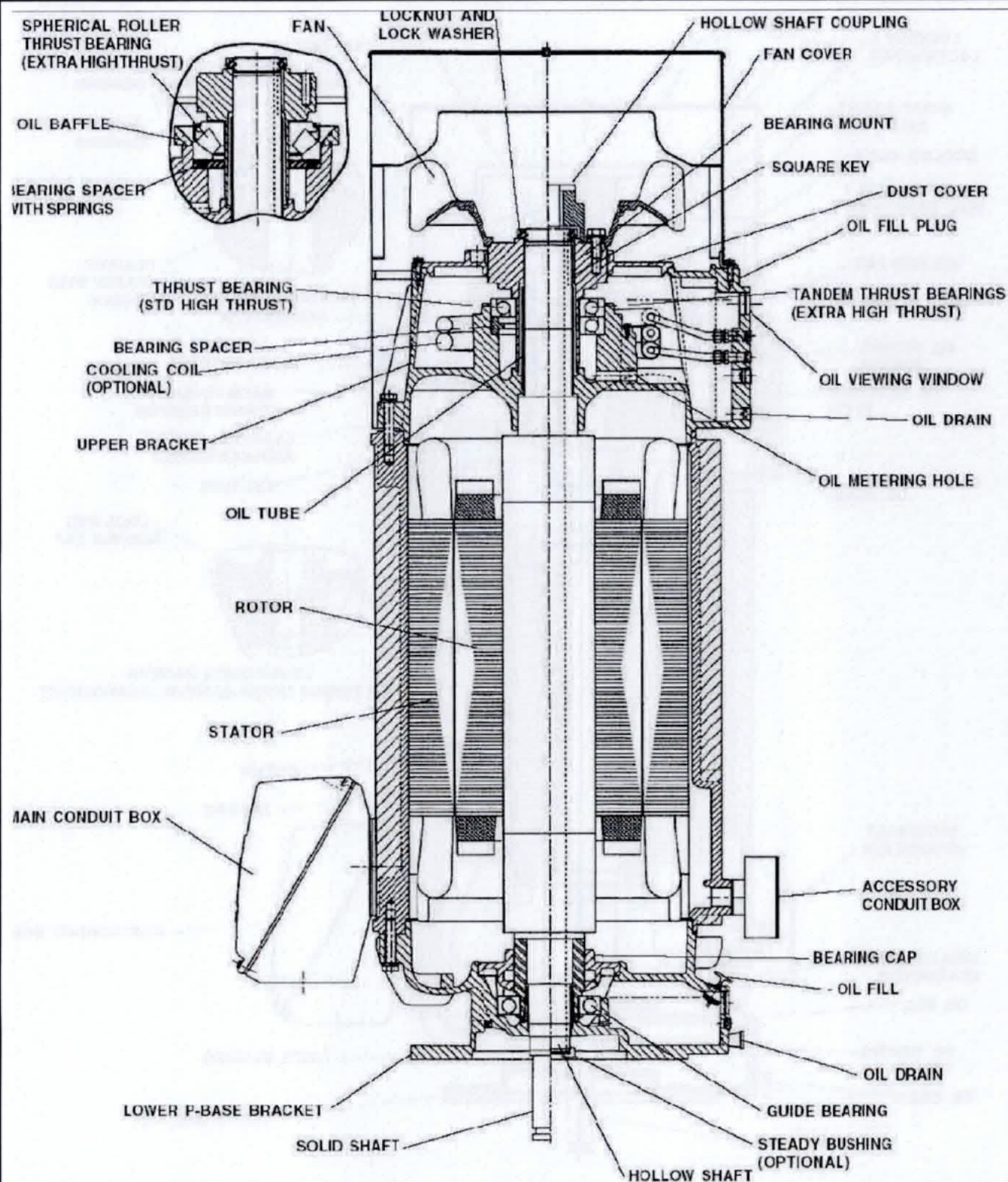




INSTALLATION AND MAINTENANCE

Spare Parts

5800 Frame
Type JU, and JV-4, EU, EV-4
(4 Pole & Slower)



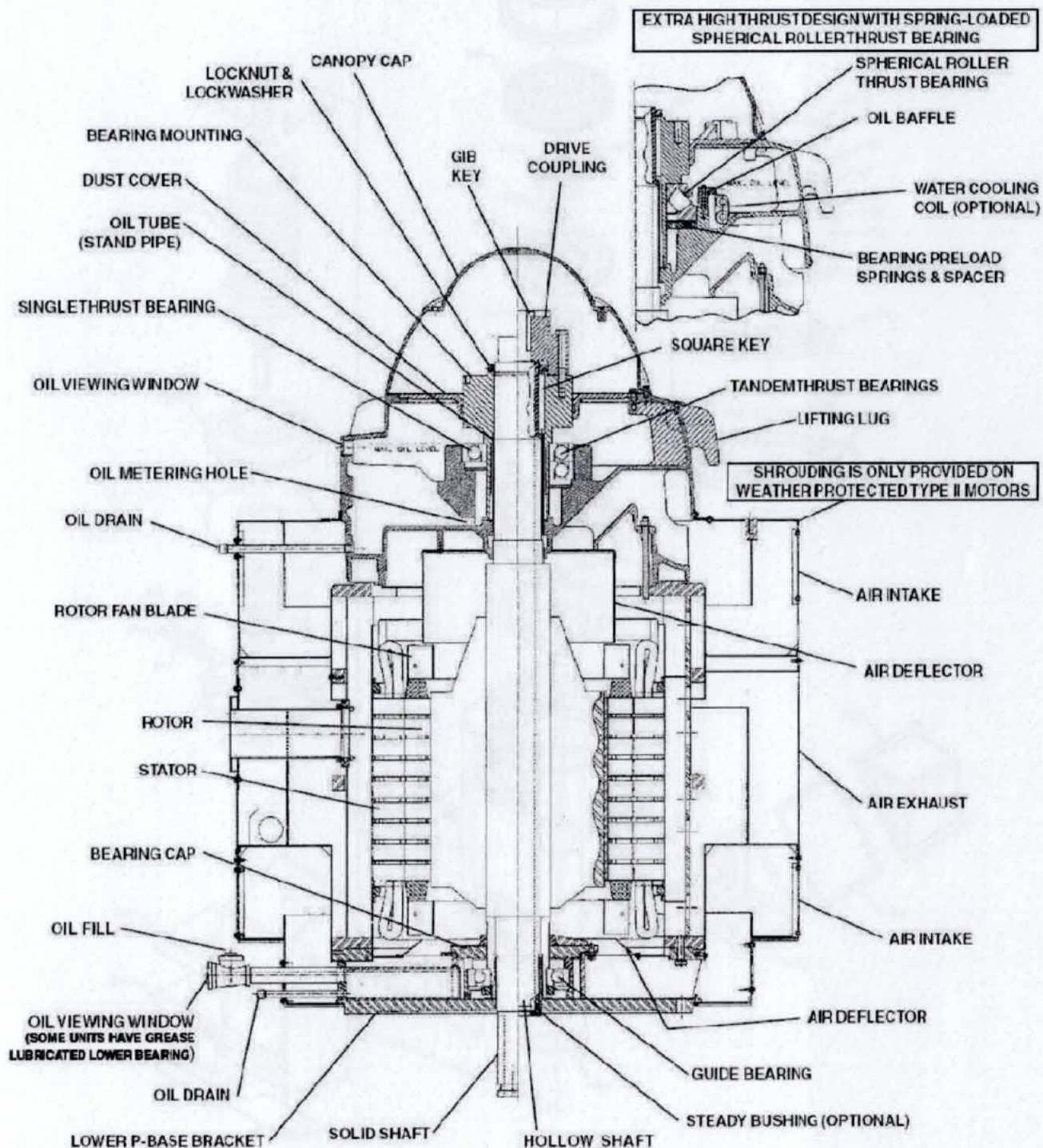


INSTALLATION AND MAINTENANCE

Spare Parts

5000-6800 Frame, Type HU & HV4
8000 Frame, Type RU & RV
(4-Pole and Slower)

PUMP SHAFT, ADJUSTING NUT, AND LOCKING SCREWS
ARE FURNISHED BY CUSTOMER

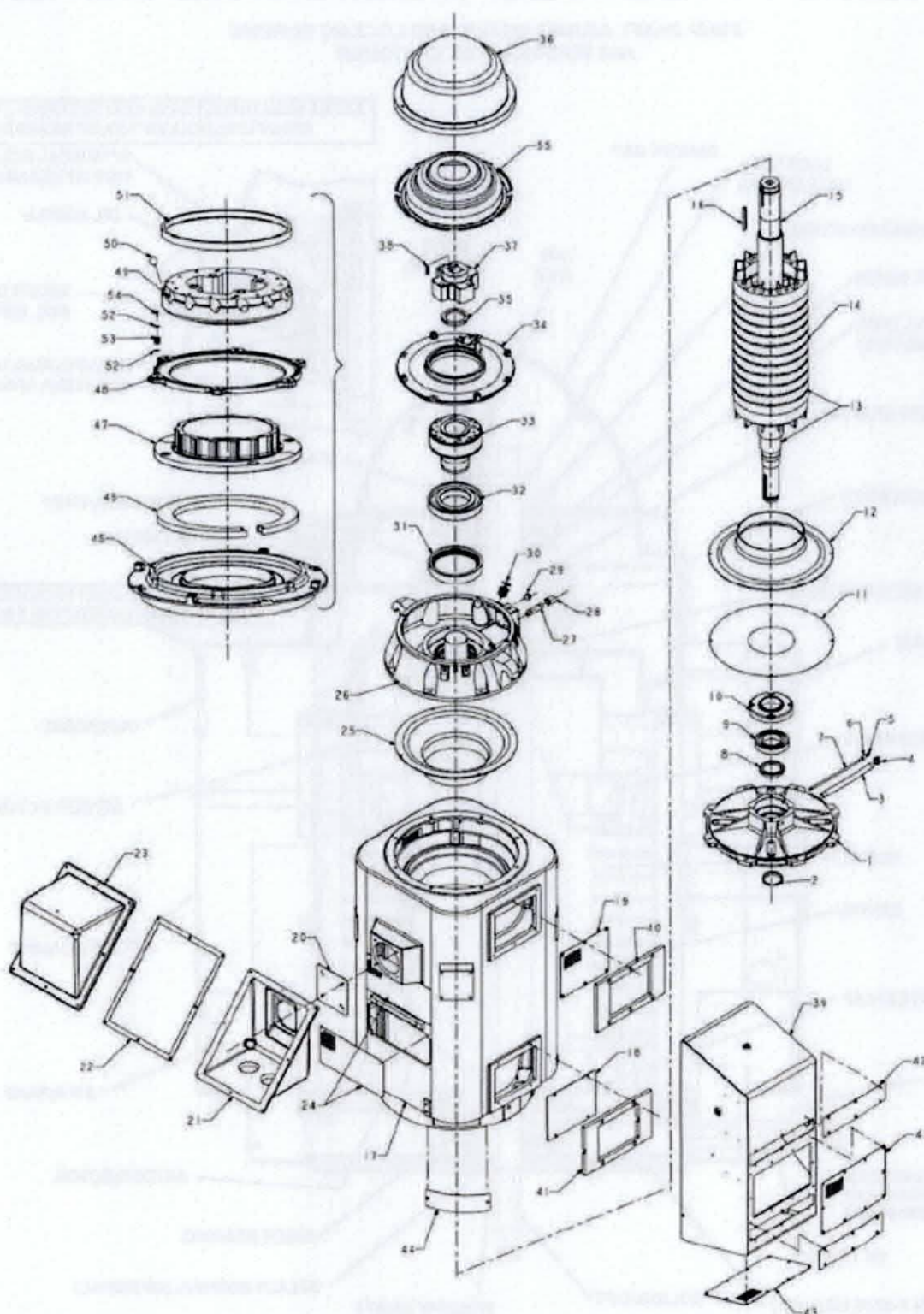




INSTALLATION AND MAINTENANCE

Spare Parts

5000 and 5800 Frame
Type RU and RV-4





INSTALLATION AND MAINTENANCE

Spare Parts

5000 and 5800 Frame
Types RU and RV-4

ITEM NO.	QTY	NAME OF PART
1	1	Lower Bracket
2	1	Shaft Water Slinger
3	1	Pipe Nipple (Lower Grease Drain)
4	1	Pipe Cap (Lower Grease Drain)
5	1	Grease Zerk Fitting
6	1	Pipe Coupling (Lower Grease Fill)
7	1	Pipe Nipple (Lower Grease Fill)
8	1	Locknut and Lockwasher (Lower Bearing)
9	1	Lower Bearing
10	1	Lower Bearing Cap
11	1	Lower Intake Screen (Only on WP-1)
12	1	Lower Air Deflector
13	1	Rotor Assembly
14	1	Rotor Core
15	1	Rotor Shaft
16	1	Square Key (Bearing Mounting to Shaft)
17	1	Stator Assembly
18	2	Lower Air Intake Cover (Only on WP-1)
19	2	Upper Air Intake Screen (Only on WP-1)
20	1	Gasket (Outlet Box Base to Stator)
21	1	Outlet Box Base
22	1	Gasket (Outlet Box Cover to Base)
23	1	Outlet Box Cover
24	2-(5008) 4-(5012) 4-(5813)	Exhaust Screen
25	1	Upper Air Deflector
26	1	Upper Bracket
27	1	Pipe Nipple (Oil Drain)
28	1	Pipe Cap (Oil Drain)
29	1	Oil Sight Gauge Window

ITEM NO.	QTY	NAME OF PART
30	1	Oil Fill Plug (Expanding)
31	1	Bearing Spacer (or Tandem Thrust Bearing)
32	1	Upper Thrust Bearing
33	1	Bearing Mounting
34	1	Dust Cover (Only on Units Without Ratchet)
35	1	Locknut and Lockwasher (Brg Mtg to Shaft)
36	1	Canopy Cap
37	1	Thrust Coupling (Only on Hollowshaft)
38	1	Gib Key (Only on Hollowshaft)
39	2	WP2 Intake Box (Only on WP-2)
40	2	Upper Adapter Flange (Only on WP-2)
41	2	Lower Adapter Flange (Only on WP-2)
42	4	Filter Access Cover (Only on WP-2)
43	4	Intake Screen (Only on WP-2)
44	4	Cover (Flange Access) (Only on WP-2)
45	1	Ratchet Adaptor (Only on Units With Ratchet)
46	1	Connection Spring (Only on Units With Ratchet)
47	1	Stationary Ratchet (Only on Units With Ratchet)
48	1	Pressure Plate (Only on Units With Ratchet)
49	1	Rotating Ratchet (Only on Units With Ratchet)
50	12-(5008) 14-(5012) 16-(5813)	Ratchet Ball (Only on Units with Ratchet)
51	1	Ball Retaining Ring (Only on Units With Ratchet)
52	4-(5008) 12-(5012) 8-(5813)	Plain Washer (Only on Units With Ratchet)
53	4-(5008) 6-(5012) 8-(5813)	Die Spring (Only on Units With Ratchet)
54	4-(5008) 6-(5012) 8-(5813)	Screw (Only on Units With Ratchet)
55	1	Pressurization Baffle (5000 Frame Only)

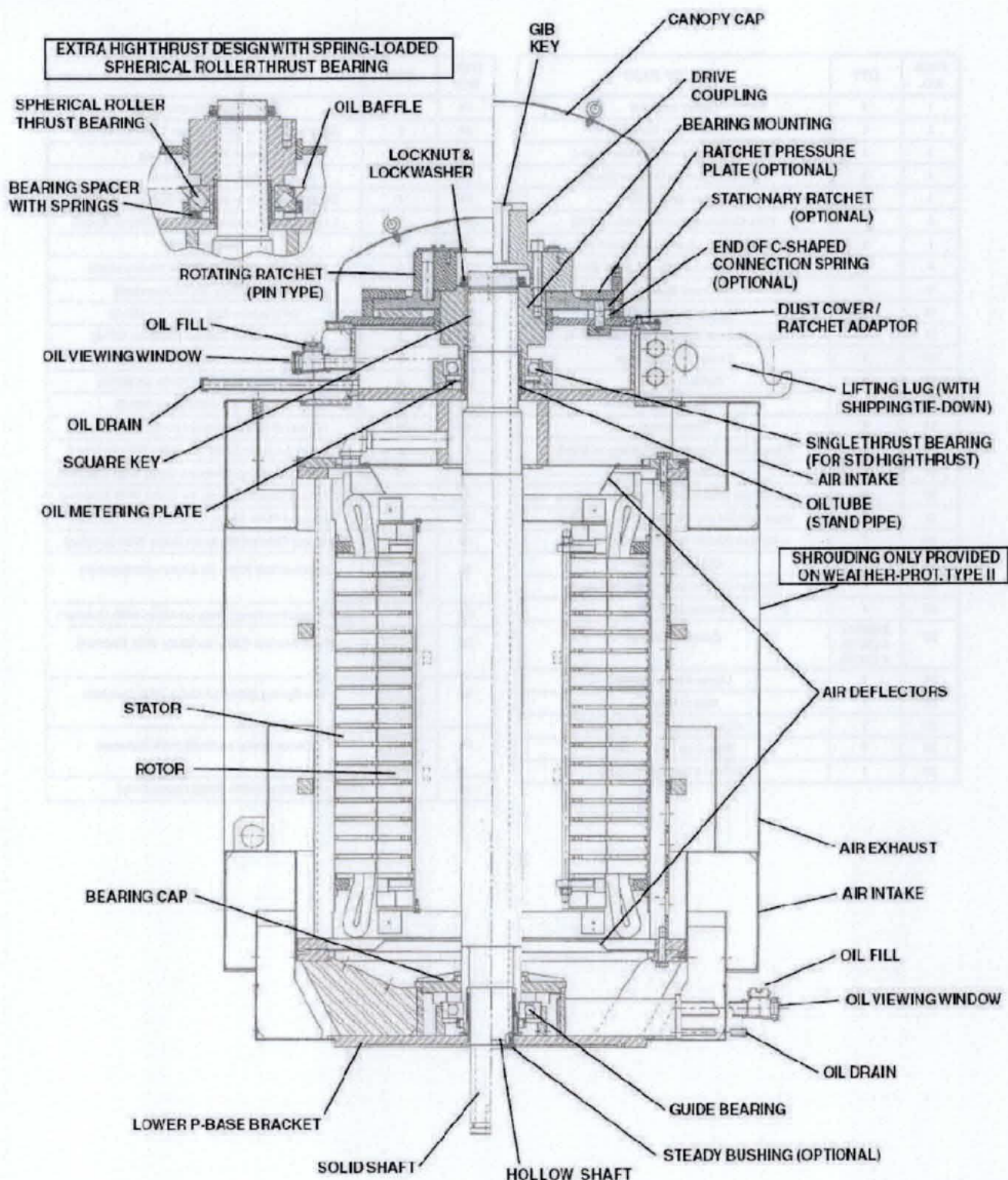




INSTALLATION AND MAINTENANCE

Spare Parts

9600 Frame
Types RU and RV-4





INSTALLATION AND MAINTENANCE

Installation Record

NAMEPLATE AND INSTALLATION INFORMATION

SERIAL NUMBER OR MODEL NUMBER..... _____
HORSEPOWER _____
MOTOR RPM..... _____
PHASE _____
FREQUENCY _____
AMPS _____ AT _____ VOLTS
DESIGN _____
FRAME _____
DATE PURCHASED _____ P.C. NUMBER
DATE INSTALLED _____
LOCATION OF JOB SITE _____
MACHINE OR INSTALLATION NUMBER _____
PURCHASED FROM _____
MOTOR RESISTANCE LINE TO LINE AT TIME OF INSTALLATION _____

INSULATION TO GROUND READING AT TIME OF INSTALLATION

RECORD OF MAINTENANCE

GRADE AND TYPE OF LUBRICANT USED

DATE OF LAST RELUBRICATION	INSULATION RESISTANCE		OVERHAUL OR REPAIR	
	DATE	MEGOHMS	DATE	ACTION





INSTALLATION AND MAINTENANCE

Installation Record

Table 6
Threaded Fastener Torque Requirements

All threaded fasteners used for rigid joints (cast iron and low carbon steel) in products of Nidec Motor Corporation, are to be tightened to the torque values listed in the following tabulation. Values are based upon dry assembly.

Diameter of Fastener	Number of Threads Per Inch	Grade 5 Fasteners	Grade 2 Fasteners
#6	32	16 lb.-in.	10 lb.-in.
	40	18	12
#8	32	30	19
	36	31	20
#10	24	43	27
	32	49	31
#12	24	66	37
	28	72	40
1/4"	20	96	66
	28	120	76
5/16"	18	16 lb.-ft.	11 lb.-ft.
	24	18	12
3/8"	16	29	20
	24	34	23
7/16"	14	46	30
	20	52	35
1/2"	13	70	50
	20	71	55
9/16"	12	102	
	18	117	
5/8"	11	140	
	18	165	
3/4"	10	249	
	16	284	
7/8"	9	401	
	14	446	
1"	8	601	
	14	666	
1-1/8"	7	742	
	12	860	
1-1/4"	7	1046	
	12	1196	
1-3/8"	6	1371	
	12	1611	
1-1/2"	6	1820	
	12	2110	

The above torque limits are not to be used when a drawing or specification lists a specific torque.



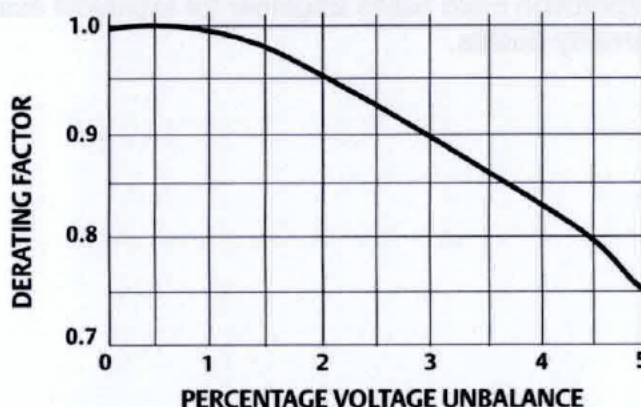


Effects of Unbalanced Line Voltage.

A potential cause of premature motor failure is unbalanced line (supply) voltage. Three phase motors produce useful work when they efficiently convert electrical energy into mechanical energy. This is accomplished when each phase of the supply voltage is of equal strength and works in harmony to produce a rotating magnetic field within the motor.

When the value of supply voltage leg to leg is not equal (e.g. 460-460-460), the risk of unbalanced line voltage is present. If this voltage unbalance exceeds about 1%, excessive temperature rise will result. Unless the motor HP capacity is derated to compensate, the motor will run hot resulting in degradation of the insulation system and bearing lubricant.

From NEMA MG-1, 14.36: Derating factors due to unbalanced line voltage



Example: Field ratings of Phase A - 480 v, Phase B = 460 v, Phase C = 450 v

As a rule of thumb, the percentage increase in temperature rise will be about two times the square of the percentage voltage unbalance. In this case the average voltage (480 + 460 + 450) is equal to 463 volts. The maximum deviation between legs is 17 volts (480 - 463 volts).

The Percentage voltage unbalance is determined as follows: $17 / 463 \times 100 = 3.7\%$. The temperature rise will then increase $(3.7)^2 \times 2 = 27\%$. This condition will reduce the typical life of your motor to less than 25% of its design life. Should this condition be present, call your electric utility and resolve your unbalanced supply condition.

Other areas of motor performance will also be affected - e.g., loss of torque capacity, change in full load RPM, greatly unbalanced current draw at normal operating speed. Refer to NEMA MG-1 section 14.36 for details.

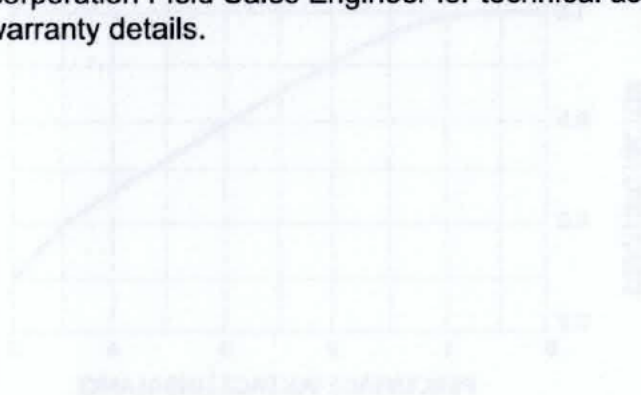




Appendix B

Electric motors can be detrimentally affected when applied with variable frequency drives (VFD's). The non-sinusoidal waveforms of VFD's have harmonic content which causes additional motor heating; and high voltage peaks and short rise times, which result in increased insulation stress, especially when long power cable lengths are used. Standard motors utilized with VFD's must be limited to those application considerations defined in **NEMA MG-1 Part 30**.

NEMA MG-1 Part 31 defines performance and application considerations for Definite-Purpose Inverter Fed motors. To insure satisfactory performance and reliability, Nidec Motor Corporation offers and recommends nameplated inverter duty motor products which meet the requirements of NEMA MG-1 Part 1. The use of non-inverter duty motors may result in unsatisfactory performance or premature failure, which may not be warrantable under the Terms and Conditions of Sale. Contact your Nidec Motor corporation Field Sales Engineer for technical assistance in motor selection, application and warranty details.





ELECTRIC MOTOR LOAD TEST USING THE WATT HOUR METER

In the analysis of electric motors it is sometimes desirable to conduct an accurate load check on a particular installation to determine whether the motor is operating within the rating and horsepower for which it was designed. Since most pumps installations have their own watt hour power meters, accurate readings will permit a load check via the following formula:

K = Disc constant (watts per revolution of disc per hour). This is typically found on the meter face.

R = Revolutions of disc in watt meter within the time of the test.

T = Time of test, in seconds.

Transformer ratio = Stated on meter face. Must be included where current transformers are used with watt meters.

To obtain input kilowatts:

$$\text{Input KW} = \frac{K \times R \times 3.6}{T}$$

To obtain input horsepower:

$$\text{Input HP} = \frac{K \times R \times 4.83 \times \text{Transformer Ratio}}{T}$$

The watt hour meter measures power consumed over a period of time. It is necessary to establish the rate at which power is being consumed by the work being done. We establish this rate by counting the revolutions of the disc in a given time. Here is a typical example of a load check:

GIVEN

- Pump motor to be load checked is rated 100 HP, 1800 RPM, 3-phase, 60 Hz, 1.15 service factor, 91.0 Percent Efficiency.
- Disc constant (K) found on face of meter = 40.
- Transformer ratio found on face of meter = 3.

DATA FOUND FROM TESTS

With stop watch, disc was observed to revolve 10 times in exactly 49 seconds. Therefore, R = 10; T = 49.

THUS

$$\text{Input HP} = \frac{40 \times 10 \times 4.83 \times 3}{49} = 118.29$$

$$\begin{aligned} \text{Output HP} &= \text{Input HP} \times \text{Motor Efficiency} \\ \text{Output HP} &= 118.29 \times 91\% = 107.54 \end{aligned}$$

CONCLUSION

The output HP (107.54) is greater than output HP shown on nameplate (100 HP) but is well within the 1.15 service factor which applies to this motor.





SAFETY FIRST

High voltage and rotating parts can cause serious injury or loss of life. Installation, operation, and maintenance must be performed by qualified personnel. Familiarization with and adherence to NEMA MG2[®], the National Electrical Code, and local codes is recommended. It is important to observe safety precautions to protect personnel from possible injury. Personnel should be instructed to:

1. Disconnect all power to motor and accessories prior to initiating any installation, maintenance, or repairs. Also ensure that driven equipment connected to the motor shaft will not cause the motor to rotate (windmilling of fans, water flowing back through pump, etc.).
2. Avoid contact with rotating parts.
3. Act with care in accordance with this manual's prescribed procedures in handling and installing this equipment.
4. Be sure unit and accessories are electrically grounded and proper electrical installation wiring and controls are used in accordance with local and national electrical codes. Refer to "National Electrical Code Handbook" - NFPA No. 70. Employ qualified electricians.
5. Be sure equipment is properly enclosed to prevent access by children or other unauthorized personnel in order to prevent possible accidents.
6. Be sure shaft key is fully captive before unit is energized.
7. Provide proper safeguards for personnel against rotating parts and applications involving high inertia loads which can cause overspeed.
8. Avoid extended exposure to equipment with high noise levels.
9. Observe good safety habits at all times and use care to avoid injury to yourself or damage to equipment.
10. Be familiar with the equipment and read all instructions thoroughly before installing or working on equipment.
11. Observe all special instructions attached to the equipment. Remove shipping fixtures if so equipped before energizing unit.
12. Check motor and driven equipment for proper rotation and phase sequence prior to coupling. Also check if a unidirectional motor is supplied and note proper rotation.
13. Electric motors can retain a lethal charge even after being shut off. Certain accessories (space heaters, etc.) are normally energized when the motor is turned off. Other accessories such as power factor correction capacitors, surge capacitors, etc. can retain an electrical charge after being shut off and disconnected.
14. Do not apply power correction capacitors to motors rated for operation with variable frequency drives. Serious damage to the drive will result if capacitors are placed between the motor and drive. Consult drive supplier for further information.

[†]All non Nidec Motor Corporation marks shown within this document are properties of their other respective owners.



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(b) (3) (B)

INSTRUCTION MANUAL

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VERTICAL INDUSTRIAL TURBINE PUMPS

INSTALLATION, OPERATION AND MAINTENANCE INSTRUCTIONS

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1. Warning
2. O&M for Vertical High Thrust Motors
3. O&M for Vertical Industrial Turbine Pumps
5. Warranty Information
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Foreword

This manual provides instructions for the Installation, Operation, and Maintenance of the Goulds Water Technology Vertical Industrial Turbine Pumps. This manual covers a standard product. For special options, supplemental instructions are available. **This manual must be read and understood before installation and start-up.**

This instruction manual covers several different pump models. Most assembly, disassembly, and inspection procedures are the same for all the pumps. However, where there are differences, these differences will be noted within the manual. The design, materials and workmanship incorporated in the construction of the Goulds Water Technology VIT Pumps makes them capable of giving long, trouble-free service. The life and satisfactory service of any mechanical unit, however, is enhanced and extended by correct application, proper installation, periodic inspection, condition monitoring and careful maintenance. This instruction manual was prepared to assist operators in understanding the construction and the correct methods of installing, operating, and maintaining these pumps.

The information contained in this book is intended to assist operating personnel by providing information on the characteristics of the purchased equipment. It does not relieve the user of their responsibility of using accepted safe engineering practices in the installation, operation and maintenance of this equipment.

Goulds Water Technology shall not be liable for physical injury, death, damage, or delays caused by a failure to observe the instructions for installation, operation and maintenance contained in this manual.

Warranty is valid only when genuine Goulds Water Technology parts are used.

Use of the equipment on a service other than stated in the order will nullify the warranty, unless written approval is obtained in advance from Goulds Water Technology.

For information or questions not covered in this manual, contact Goulds Water Technology at (806) 763-7867.

THIS MANUAL EXPLAINS :

- Proper Installation
- Start-up Procedures
- Operation Procedures
- Routine Maintenance
- Pump Overhaul
- Trouble Shooting
- Ordering Spare or Repair Parts

Owner's Information

Pump Model Number: _____

Pump Serial Number: _____

Motor Model Number: _____

Motor Serial Number: _____

Dealer: _____

Dealer Telephone: _____

Purchase Date: _____

Installation Date: _____

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Safety Instructions – SECTION 1

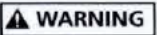
TO AVOID SERIOUS OR FATAL PERSONAL INJURY OR MAJOR PROPERTY DAMAGE, READ AND FOLLOW ALL SAFETY INSTRUCTIONS IN THE MANUAL AND ON THE PUMP.



This is a **SAFETY ALERT SYMBOL**. When you see this symbol on the pump or in the manual, look for one of the following signal words and be alert to the potential for personal injury or property damage.



DANGER Warns of hazards that **WILL** cause serious personal injury, death or major property damage.



WARNING Warns of hazards that **CAN** cause serious personal injury, death or major property damage.



CAUTION Warns of hazards that **CAN** cause personal injury or property damage.

NOTICE: INDICATES SPECIAL INSTRUCTIONS WHICH ARE VERY IMPORTANT AND MUST BE FOLLOWED.

THIS MANUAL IS INTENDED TO ASSIST IN THE INSTALLATION AND OPERATION OF THIS UNIT. THOROUGHLY REVIEW ALL INSTRUCTIONS AND WARNINGS PRIOR TO PERFORMING ANY WORK ON THIS PUMP.

MAINTAIN ALL SAFETY DECALS.



Install, ground and wire according to local and National Electrical Code Requirements.



Install an all leg disconnect switch near the pump.



Disconnect and lockout electrical power before installing or servicing the pump.



Electrical supply must match motor's nameplate specifications. Incorrect voltage can cause fire, damage motor and void the warranty.



Single phase pump motors are equipped with an automatic thermal protector, which opens the motor's electrical circuit when an overload condition exists. This can cause the pump to start unexpectedly.

General Precautions



WARNING *Personal injuries will result if procedures outlined in this manual are not followed*



CAUTION *Electric supply **MUST** match pump's nameplate specifications. Incorrect voltage can cause fire, damage to motor and voids warranty.*

Safety Apparel:

- Insulated work gloves when handling hot sand collar.
- Heavy work gloves when handling parts with sharp edges, especially impellers.
- Safety glasses (with side shields) for eye protection.
- Steel-toed shoes for foot protection when handling parts, heavy tools, etc.

- Other personal protective equipment to protect against hazardous/toxic fluid.

Maintenance Safety:

- Always lock out power.
- Ensure pump is isolated from system and the pressure is relieved before disassembling the pump, removing plugs, or disconnecting the piping.
- Use proper lifting and supporting equipment to prevent serious injury or death.
- Observe all decontamination procedures.

General Information – SECTION 2

INTRODUCTION

NOTE: The information in this manual intends to be used as a guide only. If you are in doubt, consult your Goulds Water Technology representative for specific information about your pump.

The design, material, and workmanship incorporated in the construction of Goulds Water Technology VIT Pumps makes them capable of giving long, trouble free service. The life and satisfactory service of any mechanical unit, however, is enhanced and extended by correct application, proper installation, periodic inspection and careful maintenance. This instruction manual was prepared to assist operators in understanding the construction and the correct methods of installing, operating and maintaining these pumps.



WARNING *Rotating components of the pump assembly must be covered with a suitable rigid guard to prevent injury to personnel.*

Study thoroughly Sections 1 through 6 and carefully follow the instructions for installing and operating. Section 5 contains answers to troubleshooting and maintenance questions. Keep this instruction manual handy for reference.



CAUTION *Goulds Water Technology will not be liable for any damages or delay caused by failure to comply with the provisions of this instruction manual.*

RECEIVING AND CHECKING

The pump should be carefully supported prior to unloading from the carrier. Handle all components carefully. Inspection for damage of the shipping crate should be made prior to unpacking the pump. After unpacking, visually inspect the pump and check the following:

1. Contents of the pump assembly against the packing list.
2. All components against damage.
3. All shafting for damage, should the crate be broken or show careless handling. All shafting must be checked for straightness.

Any shortages or damages should be immediately called to the attention of the local freight agent of the carrier by which the shipment arrived and proper notation made on the bill. This will prevent any controversy when a claim is made and facilitate prompt and satisfactory adjustment.

EQUIPMENT REQUIRED

The material and equipment necessary for installation of the pump will vary with the size of the pump and the type of installation.

The following list of standard tools and supplies is offered only as a guide.

BULK MATERIAL

- Anti-Galling lubricant (such as Dow Corning "MOLYKOTE")
- Thread Compound
- Lubrication Oil
- Turbine Oil
- Grease

RIGGING EQUIPMENT

- Mobile power hoist, traveling crane or derrick.
- Drag line and blocks.
- Lifting Bail for Threaded Column.
- Elevator clamps, if unit is unassembled.
- Clevises – for use with eyebolts.
- Timbers – size, length and quantity to support long pump parts on the floor.
- I-Beams or timbers to support pump over installation.

HAND TOOLS

- Pipe wrenches
- Feeler gauges
- Machinist Level
- Set of mechanics tools including: files, wire brush, pliers, wire cutters and pocket knife.
- Clean rags
- Dial indicator to assist in motor and pump alignment

OPTIONAL TOOLS TO FACILITATE PUMP ASSEMBLY AND DISASSEMBLY

- Taperlock driver to assist in bowl assembly and disassembly for pumps with taper lock impellers only.

STORAGE

Goulds Water Technology carefully preserves and protects its products for shipment. However, the effective life of the preservatives applied at the factory can vary from 3 to 18 months depending on the severity of the environment in which the equipment is stored. This section provides procedures for preparation prior to storage and maintenance during storage of Goulds Water Technology VIT Pumps. These procedures are necessary to protect the precision parts of the pumps. Specific procedures for storing motors, gear drivers, and engines, should be obtained from the equipment manufacturer. This section is intended to be of general assistance to users of Goulds Water Technology VIT Pumps. It shall not modify, amend and/or otherwise alter the scope of Goulds Water Technology VIT Pumps warranty responsibilities to the purchaser in any way whatsoever.

Storage Preparation

Goulds Water Technology VIT Pumps require proper preparation for storage and regular maintenance during storage. The pump shall be considered in storage when it has been delivered to the job site and is awaiting installation.

Preferably, the storage area shall be paved, well drained and free from flooding, and be indoors whenever possible.

Weatherproof coverings used for outdoor storage shall be flame resistant type sheeting or tarpaulins. They shall be placed so as to provide good drainage and air circulation and shall be tied down to protect from wind damage.

Storage area shall be maintained in a clean condition at all times.

Pumps and/or component parts shall be placed on skids, pallets, or shoring to permit good air circulation.

Pumps and/or component parts shall be sorted so as to permit ready access for inspection and/or maintenance without excessive handling.

Pumps and/or component parts stacked during storage shall be arranged so that the racks, containers, or crates bear full weight without distortion of pumps or parts. Identification markings must be readily visible. Any cover removed for internal access shall be replaced immediately.

Pump and bowl assembly shafting shall be rotated counter clockwise, as a minimum, once a month. Shaft shall not be left in the same previous position, nor in the extreme raised or lowered lateral position. Shaft should rotate freely.

NOTE: For further information on these procedures contact your Goulds Water Technology representative.

Recommended Storage Procedures

Controlled storage facilities should be maintained at an even temperature 10° F (6° C) or more above the dew point with relative humidity less than 50% and little or no dust. (If these requirements can not be met the pump is to be considered in uncontrolled storage.)

For uncontrolled storage periods of 6 months or less, the pump is to be inspected periodically to insure that all preservatives are intact.

All pipe threads and flanged pipe covers are to be sealed with tape.

The pump must not be stored closer than six inches (15 cm) from the ground.

Uncontrolled Long Term Storage Preparations

When applicable to the pump, storage periods over six months require the preceding storage procedure and storage preparation plus the following:

Inspect the lube oil and seal flush piping and either fill the piping with rust preventative oil, or re-coat the piping periodically to prevent corrosion.

Place 10 pounds (4.5 kg) of moisture absorbing desiccant or 5 pounds (2.3 kg) of vapor phase inhibitor crystals near the center of the pump. If the pump is assembled, place an additional one pound (0.5 kg) in the discharge nozzle securely fastened to the discharge elbow.

Install a moisture indicator near the perimeter of the pump. Cover the pump with 6 mil (0.15 mm) minimum thickness black polyethylene or equal and seal it with tape. Provide a small ventilation hole approximately ½ inch (12 mm) diameter.

Provide a roof or shed shelter to protect from direct exposure to the elements.

GENERAL DESCRIPTION

The model VIT pump is a vertical turbine lineshaft pump, which is designed to meet wide ranges of service with maximum dependability. See Figure 1 or Figure 2 for open lineshaft pump and Figure 3 and Figure 4 for enclosed lineshaft pump.

Drivers

Hollow shaft motors or right angle gear drives, are often used with a separate head shaft through the driver and connected to the pump by a threaded coupling.

Discharge Head

The discharge head is either a cast iron head or a fabricated head. Ports are provided for connecting the pressure gauge, stuffing box bypass return and lubricator connections. The driver support portion of the discharge head is designed with large windows for easy stuffing box or tension plate adjustment. The windows are covered with guards for safe operation.

Column

Threaded or flanged column construction provides positive shaft and bearing alignment. Bearings are spaced to provide vibration free operation away from the shaft critical speed in order to insure long bearing life and reduced shaft wear. For open lineshaft, the shaft is supported within the column by using bearing retainers in the column assembly. For enclosed lineshaft, the bearings are also the tube couplings of the shaft-enclosing tube. The shaft-enclosing tube is stabilized in the column pipe by tube stabilizer.

Bowl Assembly

The bowls are generally of flanged construction for accurate alignment and ease of assembly and disassembly. Impellers may be either open or enclosed depending on the design requirements. They are fastened to the pump shaft by taperlocks. For temperatures over 140° F (60° C) and in the larger size bowls (over 18"), impellers are keyed to the shaft. A special first stage low NPSH impeller may be provided on some pump for certain special application.

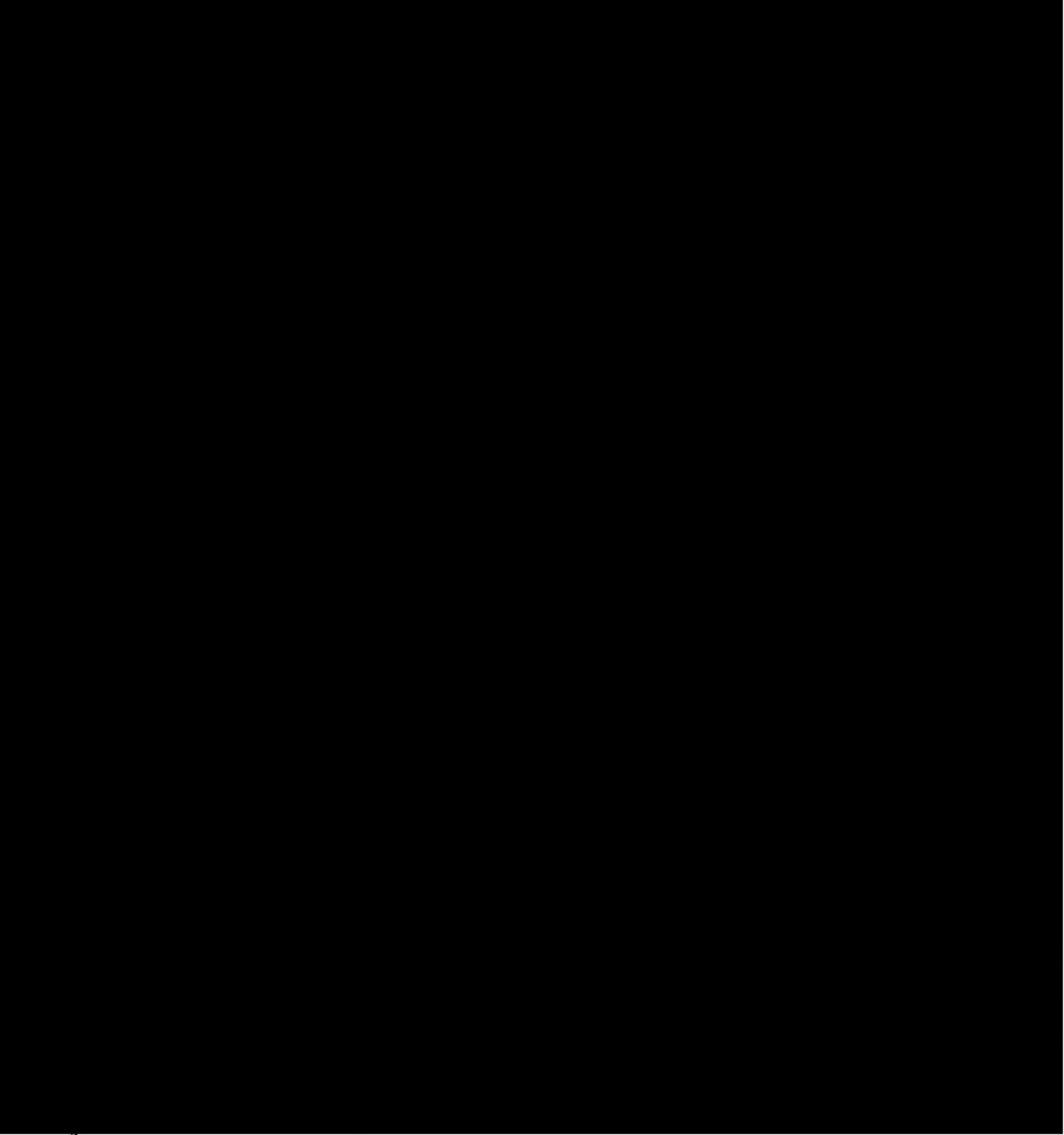
Thrust Pot

A thrust pot is utilized when the driver is not designed to carry the pump thrust.

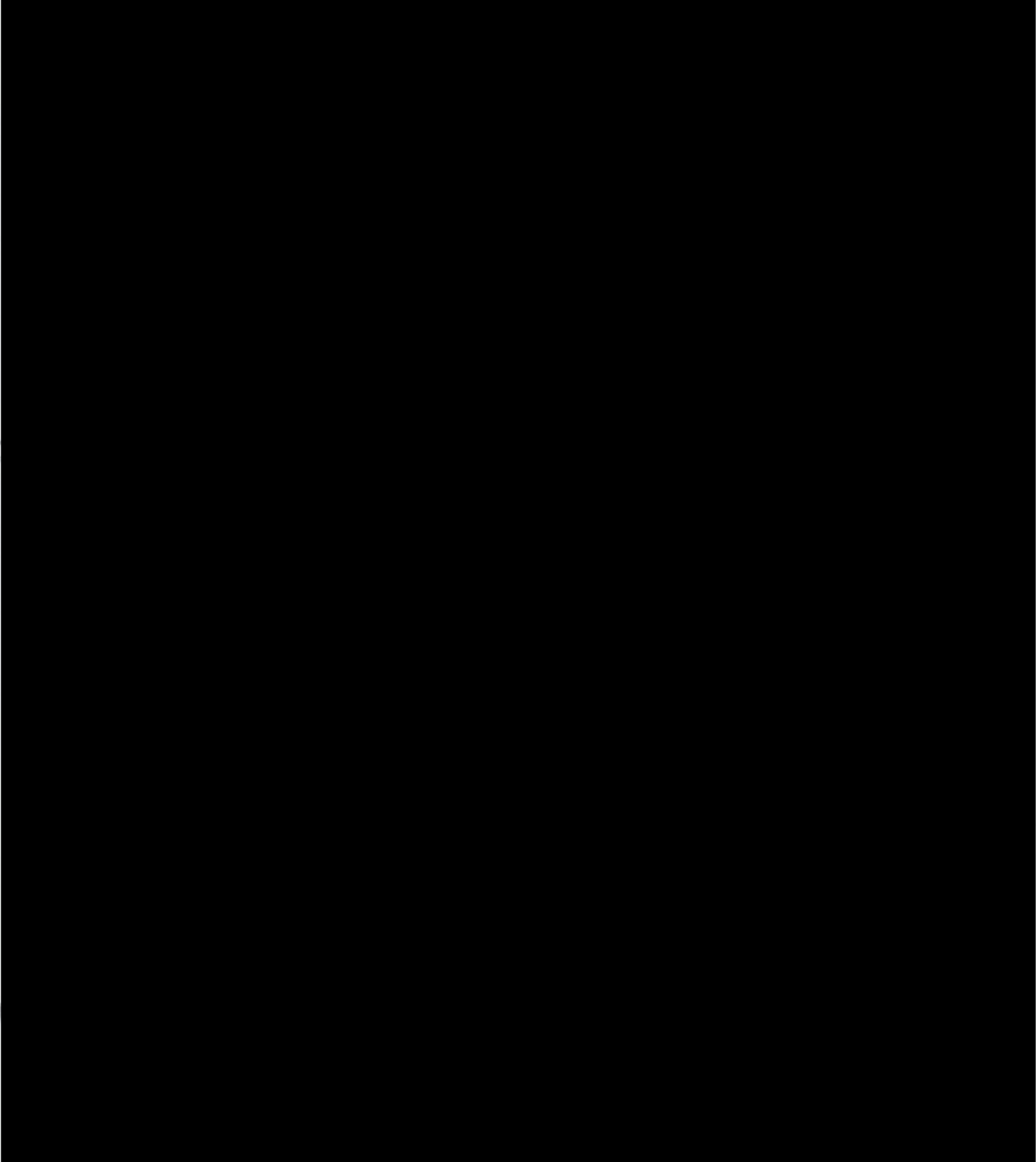
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Installation – SECTION 3

FOUNDATION AND PIPING

SUB BASE (SOLE PLATE) INSPECTION

Sub base and sole plate are terms in common use to describe a general class of solid steel plates mounted in grout (or bolted to steel structures) at the pump-foundation interface.

1. Remove the sub base from the pump discharge head, when shipped assembled.
2. Completely clean the underside of the sub base. It is sometimes necessary to coat the underside of the sub base with an epoxy primer. (This is available as an option.)
3. Remove the rust preventative solution from the machined topside with an appropriate solution.

SITE WITH CONCRETE FOUNDATION

1. A pump should have adequate space for operation, maintenance and inspection.
2. Sub base mounted pumps are normally grouted on a concrete foundation, which has been poured on a solid footing. The foundation must be able to absorb any vibration and to form a permanent, rigid support for the pumping unit.
3. The foundation must be of adequate strength to support the complete weight of the pump, plus the weight of the liquid passing through it. A typical installation will have bolts with a pipe sleeve $2\frac{1}{2}$ times the bolt diameter embedded in the concrete.

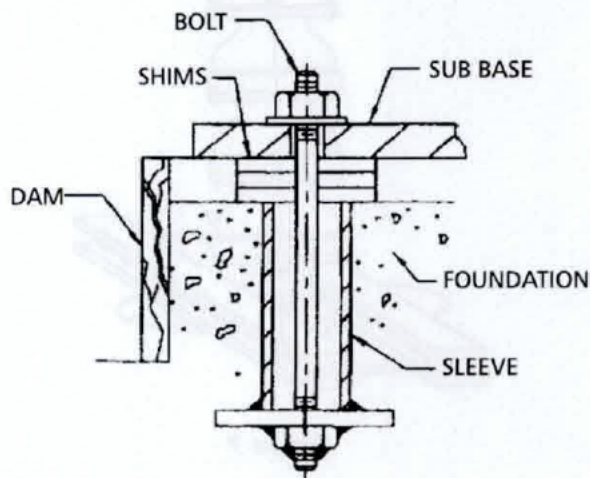


Figure 5

Bolts should be sized and located in accordance with the dimensions given on the Certified Pump Outline Drawing, if provided. The pipe sleeve allows movement for the final positioning of the foundation bolts to conform to the holes in the sub base flange. See Figure 5.

4. Remove water and/or debris from anchor bolt holes/sleeves prior to grouting. If the sleeve type bolts are being used, fill the sleeves with packing or rags to prevent grout from entering.

5. Carefully lower the sub base onto the foundation bolts. Hand tighten the nuts.
6. Leveling the sub base may be done by several methods. Two common methods are:
 - A. Using leveling wedges. This is shown in Figure 6.
 - B. Leveling nuts on the anchor bolts.

Regardless of the method, a machinist level must be used for leveling.

NOTE: When using a machinist level, it is important that the surface being leveled is free of all contaminants, such as dust, to ensure an accurate reading.

7. Level the sub base in two directions at 90 degrees on the machined surface. The levelness tolerance is 0.005 inches per foot for commercial, and 0.001 inches per foot for API.

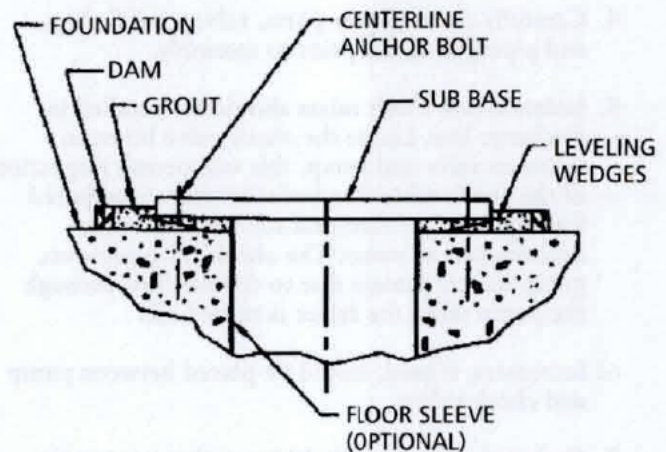


Figure 6

SUB BASE GROUTING

1. Inspect foundation for dust, dirt, oil, chips, water, etc. and remove any contaminants. Do not use oil-based cleaners as grout will not bond to them. Refer to grout manufacturer's instructions.
2. Build dam around foundation (See Figure 6). Thoroughly wet foundation. Refer to grout manufacturer's instructions.
3. Pour grout between sub base and concrete foundation, up to level of dam. Remove air bubbles from grout as it is poured by puddling, using a vibrator, or pumping the grout into place. Non-shrink grout is recommended. Refer to grout manufacturer's instructions.
4. Allow grout to set at least 48 hours.
5. Tighten foundation bolts.

PIPING

Guidelines for piping are given in the "Hydraulic Institute Standards", available from: Hydraulic Institute,

9 Sylvan Way, Parsippany, NJ 07054-3802 and must be reviewed prior to pump installation.

⚠ WARNING *Never draw piping into place by forcing the flange connections of the pump. Pipe strain will adversely effect the operation of the pump resulting in damage to the equipment and possible physical injury.*

1. All piping must be supported independently of, and line up naturally with the pump flange so that undue pipe strain is not imposed on the pump.
2. **DO NOT** connect piping to pump until grout has hardened and pump hold-down bolts have been tightened.
3. It is suggested that expansion loops or joints, if used, be properly installed in the discharge line. When handling liquids at elevated temperatures expansion joints are used, so linear expansion of piping will not draw pumps out of alignment.
4. Carefully clean all pipe parts, valves and fittings, and piping branches prior to assembly.
5. Isolation and check valves should be installed in discharge line. Locate the check valve between isolation valve and pump, this will permit inspection of the check valve. The isolation valve is required for regulation of flow, and for inspection and maintenance of pump. The check valve prevents pump or seal damage due to reverse flow through the pump when the driver is turned off.
6. Increasesers, if used, should be placed between pump and check valves.
7. Cushioning devices should be used to protect the pump from surges and water hammer if quick-closing valves are installed in the system.

PUMP INSTALLATION

Pumps of 20 feet (6 meters) or less in length are usually shipped assembled, with the exception of the driver, mechanical seal with tubing and coupling assembly, spacer or non spacer type. When provided, refer to the Certified Pump Outline for the applicable base plate plan for the location of anchor bolt holes.

INSTALLING AN ASSEMBLED PUMP

1. If a base plate was supplied, install as described in Foundation/Piping Section (page 11).
2. Clean the mounting surface of the plate and clean bottom surface of discharge head mounting flange.
3. Sling through discharge head holes or thread two eyebolts through bolt holes in the mounting flange and hoist unit into position over foundation.
NOTE: Eyebolts or sling should be rated to handle in excess of the pump weight (See Outline Drawing).
4. Lower the unit and carefully guide it so that unit does not strike the side of the base plate. Continue

to lower unit until the discharge head flange engages and rests firmly on the plate, then secure with capscrews provided.

5. When a lineshaft is shipped separately check shaft for straightness; average total run out should not exceed 0.005" TIR (0.127mm) for 10 feet (3m). Shaft must be within tolerance prior to installation.
6. Refer to remainder of this manual for complete assembly, startup, maintenance, disassembly and recommended lubricants for the pump.

INSTALLING A PARTIALLY ASSEMBLED PUMP

⚠ WARNING *Do not work under a heavy suspended object unless there is positive support and safe guards, which will protect personnel, should a hoist or sling fail.*

⚠ CAUTION *Do not attempt to lift bowl assembly by the pump shaft. This can result in damaging the pump shaft.*

1. Prior to installing the bowl assembly, check that all capscrews are tight. Turn the pump shaft by hand and make sure it turns freely. Remove all accumulated dust, oil or other foreign material from the external surfaces.
2. Place two I-beam supports across the base plate opening, strong enough to safely support the weight of the entire pump assembly. These I-beams should be connected by threaded rods and nuts so as to clamp them firmly together to support the pump. (See Figure 7).

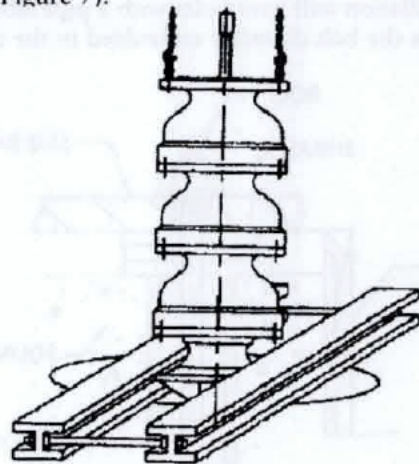


Figure 7

3. Place a suitable hoist or derrick over base plate opening with the hook in the center.
4. If a suction strainer is provided, assemble it to the suction bell (or suction bowl).
5. Place the elevator clamps just below the discharge bowl. For flanged column install two threaded eyebolts through the discharge bowl bolt holes 180° apart for flanged column. For threaded discharge utilize a lifting bail sized to handle the weight of the bowl assembly and suction apparatus.

6. Attach a sling to the elevator clamps, eyebolts, or lifting bail and hoist it into position over the foundation opening. (See Figure 7).
7. Carefully lower bowl assembly, guiding the unit so it does not strike the sides of the opening. Continue to lower bowl assembly until the elevator clamps or discharge bowl flange rests firmly on the I-beam supports.
8. Place a cover over the discharge bowl opening to prevent entrance of dirt or other foreign matter until ready for installation of the column assembly.

CAUTION Do not drop any foreign object into the bowl assembly. Such an object can cause serious damage to the pump and any downstream components. Any foreign object dropped into the bowl assembly must be retrieved prior to continuing assembly.

COLUMN

OPEN LINESHAFT

Lineshafts are coupled with threaded or keyed couplings. Column pipe may be threaded or flanged. When provided, see the Certified Pump Outline Drawing for the number of column and shaft sections required. The top and bottom sections may be special lengths:

1. Check the lineshaft (646) for straightness. Average total runout should be less than 0.0005" TIR per foot, not to exceed 0.005" T.I.R. for every 10 feet of shafting.

CAUTION Bottom section of column pipe should not be longer than 5 feet.

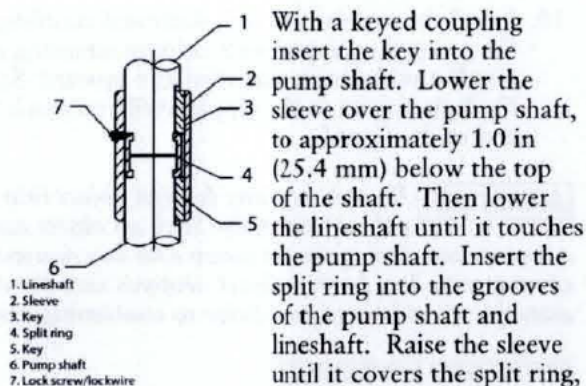
2. Hoist the first piece of lineshaft over the bowl assembly. Lower the lineshaft until the bottom end is properly aligned with the coupling of the pump shaft. Apply a thin film of oil to the threads on the lineshaft (646) and the coupling (649) (for non-galling material, or Molykote if galling material).

CAUTION Use "MOLYKOTE" Dow Corning or equal for all galling material such as 316 stainless steel.

- 3a. With lineshaft in the proper position on the coupling, screw lineshaft into the coupling manually until resistance is felt. A fine wire inserted in the hole at the center of the coupling can be used as a gage to determine when the coupling is correctly positioned on the shaft. Remove the wire after installing the shaft. Completely tighten the joint by using a pair of pipe wrenches. Use care not to damage any bearing journal areas on the shaft.
NOTE: Shaft threads are left-handed.

CAUTION Make up threaded joints manually to verify that the threads are properly engaged prior to applying a wrench. If cross-threading occurs, break the joint and repair the threads. If the threads are beyond repair, replace the damaged part.

3b.



With a keyed coupling insert the key into the pump shaft. Lower the sleeve over the pump shaft, to approximately 1.0 in (25.4 mm) below the top of the shaft. Then lower the lineshaft until it touches the pump shaft. Insert the split ring into the grooves of the pump shaft and lineshaft. Raise the sleeve until it covers the split ring, then insert the key into the lineshaft. Raise the sleeve to the top of the key and secure the sleeve to the split ring with a lock screw and lock wire.

4. For threaded column, secure a friction clamp immediately below the column coupling. Hoist column section over bowl assembly. Lower column over lineshaft until column pipe engages the discharge bowl. Manually screw the column into discharge bowl. Complete joint by tightening column with chain tongs until the end of the column butts firmly against discharge bowl.
5. For flanged column, install two eyebolts diametrically opposite the upper flange of the bottom column. Attach a sling to the eyebolts and to the hoist hook. Lower column section until the flange engages the flanged top bowl register. Insert as many bolts through both flanges as possible. Lift column assembly high enough to allow rotation of the supports. Install and tighten remaining capscrews gradually in diametrically opposite pairs until all are uniformly tightened.
6. Lift the assembly and remove the elevator clamp or supports and slowly lower the bowl and the column assembly. Place supports on the base plate and continue to lower the assembly until the column elevator clamps or column flange comes to rest on the supports. Place an elevator clamp under the column pipe and allow it to butt firmly against the column pipe coupling.
7. Place the bearing retainer over the shaft and locate it in the column coupling recess. Make sure the end faces of the column pipe are clean. For flanged columns, fit the retainer in the female register of the flange. Make sure the contact faces in the flanges are clean.
8. Check that the shaft is approximately centered in the bearing. Move the shaft around slightly so as to center it in its bearing. Only a slight amount of force should be required. If an excessive amount of force is required, the pipe or shaft may not be butted properly or the shaft may be bent. In any case, the problem must be corrected prior to proceeding further.
9. Repeat the preceding procedures until all column sections required have been installed.

10. Install the top shaft or stub shaft and coupling. If the pump is equipped with column adjusting nipple, install it with longer threaded end upward. Screw the lock ring on to the nipple until you reach the end of the thread.

CAUTION Do not drop any foreign object into the column assembly. Such an object can cause serious damage to the pump and any downstream components. Any foreign object dropped into the column assembly must be retrieved prior to continuing assembly.

ENCLOSED LINESHAFT

1. Insert tube (654) and shaft (646) sections into column section.
2. Place an elevator clamp near top of column just below and butt firmly against column pipe coupling (645). For flanged columns, place the elevator clamp just below the flange.
3. Attach a sling to hoist hook. Attach bottom of shaft (646) to column (644), by tying a tail rope to deep-throated clamp attached to bottom of column. (See Figure 8). Tie a clove hitch or double half hitch around the enclosing tube and then around the shaft in threaded area. Figure 8 also shows the alternate method (dotted lines).

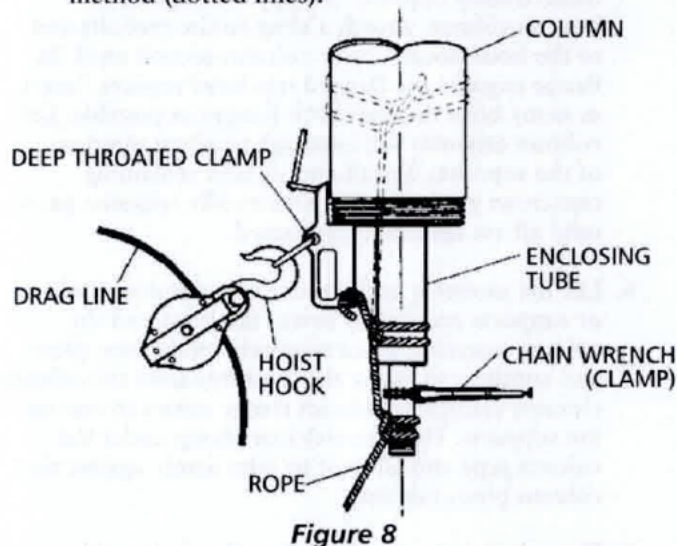


Figure 8

4. Utilize the remaining tail rope to keep tension on the knots during hoisting. Lower end of column section shall be guided by a drag line which is pulled by the hoist. A traveling block for the drag-line shall be attached to a deep-throated clamp, which is secured to bottom of the column threads.
5. Hoist column section over pump, keeping tension on tail rope. With column in a vertical position, remove drag-line and traveling block, lower column until bottom line shaft is properly aligned with pump shaft coupling.
6. Apply a thin film of oil to the threads on the lineshaft (646) and the coupling (649) (for non-galling material or Molykote if galling material).

CAUTION Use "MOLYKOTE" Dow Corning or equal for all galling material such as 316 stainless steel.

7. With lineshaft in proper position on the coupling, remove tail rope and screw lineshaft into coupling until resistance is felt. A fine wire inserted in the hole at the center of the coupling can be used as a gage to determine when the coupling is correctly positioned on the shaft. **Remove the wire after installing the shaft.** Completely tighten the joint by using a pair of pipe wrenches. Use care not to damage any bearing journal areas of the shaft. **NOTE: Shaft threads are left-handed.**

CAUTION Make up threaded joints manually to verify that the threads are properly engaged prior to applying a wrench. If cross-threading occurs, break the joint and repair the threads. If the threads are beyond repair, replace the damaged part.

8. Carefully lower column section until lower end of the tube section rests on the adapter bearing (668). The end faces of the tube should be clean and free of nicks. Remove tail rope, clean outside of the adapter bearing and lubricate with thread compound. Screw tube section onto adapter bushing manually, until resistance is felt. Complete tube joint by utilizing a pair of pipe wrenches or chain tongs, butting the end of tube against the upper end of the tube adapter bearing.
9. Clean column threads and lubricate with thread compound.
10. Lower column until column pipe engages in the discharge bowl. Manually thread the column into discharge bowl. Complete joint by tightening column, utilizing chain tongs until the end of the column butts firmly against discharge bowl.
11. Lift the pump assembly and remove elevator clamp secured to discharge bowl. Slowly lower assembly into well or sump until elevator clamp gently comes to rest on timbers or I-beam supports and remove the sling.
12. Remove the exposed lineshaft bearing, pour oil into the tubing and reinstall the bearing. The amount of oil to be poured is given in the following table:

Tube Size	Amount of oil per section	
	10 ft. Sections	20 ft. Sections
1 1/4, 1 1/2, 2	1/2 Cup	1 Cup
2 1/2, 3, 3 1/2	1 Cup	1/2 Qt.
4 and larger	1/2 Qt.	1 Qt.

See page 27 for recommended oil.

13. Repeat the preceding procedures. Throughout the column assembly, install tube stabilizer (658) over the enclosing tube (654) every 40 feet. The last one should be less than 20 feet below the bottom of the discharge head. Use soapy water as lubricant when sliding the stabilizer over the tube.
14. Continue the procedure until all column sections for the proper setting have been installed, excluding the column adjusting nipple (631) and tube nipple (629), if provided.

15. Install the top shaft or stub shaft and coupling.

CAUTION Do not drop any foreign object into the bowl assembly. Such an object can cause serious damage to the pump and any downstream components. Any foreign object dropped into the bowl assembly must be retrieved prior to continuing assembly.

INSTALLING THE DISCHARGE HEAD

VIT Pumps are provided with either a cast iron or fabricated steel type head. For pump with below ground discharge, a motor stand is provided instead the discharge head. Install the discharge head as follows:

1. If the stuffing box (See Fig. 9) or tension nut (See Fig. 10) is assembled to the head, remove it and all the attached piping.
2. For threaded column, check to be sure that the column flange (637) is securely attached to the bottom of the discharge head. Check and tighten the capscrews (or socket head screw) gradually in diametrically opposite pairs.
3. Remove coupling guard if provided. Attach a sling to the lifting lugs on the side of the discharge head through windows and hoist discharge head over the protruding top shaft (or stub shaft).

CAUTION Do not bump or scrape the shaft protruding above the column. This could result in bending or damaging the shaft.

4. Orient the discharge head in the required position and lower the head. Center the vertical hole with the top shaft protruding above the column. For threaded column, continue to lower the discharge head until the large threaded hole in the bottom of the discharge head rests squarely on top of column. Clean the threads at upper end of column assembly and lubricate with thread compound. Rotate discharge head, screw it onto the column, for short set-pump, (without the column adjusting nipple) butting the top of column tightly against the discharge head.
5. For flanged column, continue to lower the discharge head until the discharge head engages the column flange. Install capscrews and secure discharge head to the column flange. Tighten capscrews gradually in diametrically opposite pairs. Lift the pump assembly high enough to allow rotation of the supports. Realign and lower assembly. Install and tighten remaining capscrews. Repeat the rotating and the tightening procedure until all capscrews are uniformly tight.
6. Hoist the discharge head by lifting lug and remove the elevator clamp attached to column.
7. Remove the support timbers or I-beams and clean the top of foundation or base plate. Orient the discharge head in the required position.

NOTE: Sling should be rated to handle in excess of the pump weight.

8. Lower bowl, column and head assembly, until discharge head mounting flange engages base plate. Secure discharge head to the foundation or base plate. Check the levelness of the discharge head in all directions, utilizing a machinist level across the driver's mounting surface of the discharge head.
9. Check whether the top shaft (or stub shaft) is in the center of the stuffing box bore. If not, the shaft must

be centered by shimming the head base and the sub base (or the foundation).

10. Rotate the shaft approximately 90°. Check again whether the shaft is at the center of the stuffing box bore or not. If not, either the top shaft is bent or the first shaft below it did not butt properly. Correction must be made before the installation procedures can proceed.

INSTALLING THE STUFFING BOX

Assemble stuffing box as shown in Figure 9.

1. Clean the surface of the discharge head where the stuffing box will be mounted and remove any nicks or burrs with a fine flat file. Position gasket on surface. Slide stuffing box (616) down over headshaft and into position on the gasket. Secure stuffing box with capscrews. Make sure the capscrews are torqued equally to prevent misalignment.
2. Grease the packing ring (620) for easier installation.
3. Twist the packing ring sideways to get it around the shaft easily. Start the first ring into the stuffing box. When the entire ring is worked in using the fingers, tamp it down using a split wood bushing (or equal) and push the packing ring down firmly. It must seal on the shaft and bore of the stuffing box. Install all three (3) rings in this manner. Stagger ring joints 90° apart. The split gland may be used as a tamper for the top ring.
4. Insert lantern ring (622) into stuffing box. Be sure it is properly positioned so that it aligns with the lubrication passage in the stuffing box.
5. Insert three (3) additional rings of packing. Stagger ring joint 90° apart.
6. Install the split gland and screw nuts on the split gland studs. Tighten nuts then relieve the nuts and tighten finger tight.

CAUTION Check that the split gland is square in the stuffing box. Cocking can cause uneven compression of packing and damage to the shaft or sleeve and heat up the shaft and stuffing box.

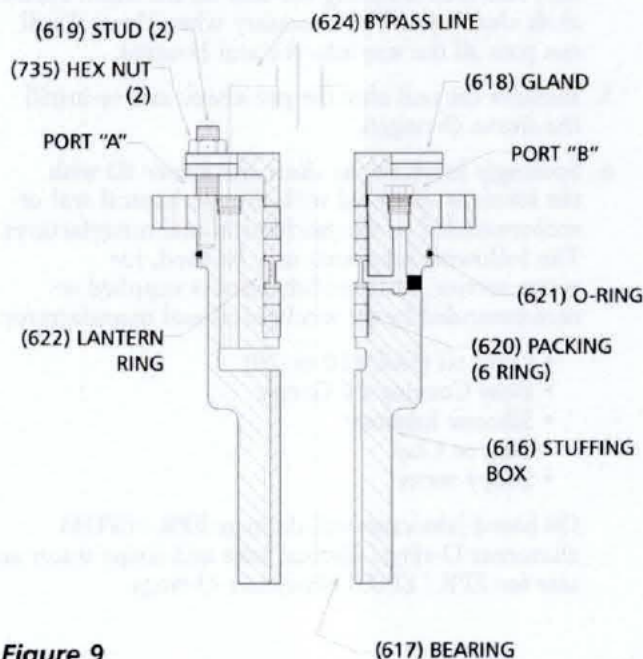


Figure 9

7. The stuffing box is shipped with both ports plugged. If the discharge pressure is over 100 psi, remove the plug on Port "A" and attach a bypass (relief) line. If the discharge pressure is over 200 psi, remove the plug on Port "B" and attach another bypass line.
8. Final adjustment of the stuffing box must be made at pump start up. A properly packed stuffing box should be loose enough to allow the shaft to be turned manually. Also, packing must allow leak. See page 24, Pump Start Up #5.

▲ CAUTION *Do not over tighten packing or excessive wear can occur on the shaft or sleeve.*

INSTALLING THE MECHANICAL SEAL

Vertical turbine pumps are usually supplied with cartridge type mechanical seals, shipped assembled - ready for installation, when mechanical seals are supplied. Instructions for installing mechanical seals are provided by the seal manufacturer. Consult the seal manufacturer's instructions (furnished with the seal) for information on the type of seal used. Additionally, refer to factory furnished outline drawing and seal piping schematic on complex seal piping arrangements.

GENERAL REQUIREMENTS FOR INSTALL SEALS

1. Check surfaces at the face of the seal housing and at the bottom of the seal housing to insure that they are clean, flat and free of burrs. The face surface must be smooth to form a good sealing surface for a gasket or O-ring.
2. Check that shaft is smooth, and free of burrs, nicks and sharp corners that could nick or cut the O-ring or shaft packing. When further clean up is required, protect by covering the inside of the pump seal housing. Remove burrs, nicks and sharp corners by using a strip of emery cloth over the shaft threads. File threads around the keyway with a smooth mill file or emery cloth. Sharp edges must be rounded.
3. Remove all chips and dust from the shaft area.
4. Check that all rotary unit parts of the seal fit over the shaft. A pre-check may be made by removing the O-ring(s) from the cartridge sleeve Inside Diameter (ID) and then installing the seal on the shaft. Further shaft clean up will be necessary when the seal will not pass all the way into the seal housing.
5. Remove the seal after the pre-check and re-install the sleeve O-ring(s).
6. Sparingly lubricate the shaft and sleeve ID with the lubricant included with the mechanical seal or recommended by the mechanical seal manufacturer. The following lubricants may be used, for water service, when no lubricant is supplied or recommended by the mechanical seal manufacturer.

- Light oil (SAE #10 or 20)
- Dow Corning #4 Grease
- Silicone lubricant
- Wax or Clay
- Soapy water

Oil based lubricants will damage EPR / EPDM elastomer O-rings. Silicone lube and soapy water are safe for EPR / EPDM elastomer O-rings.

7. Install the O-ring or gasket, between the seal housing and seal. Install the seal over the shaft and ease it into position against the face of the seal box. Take care when passing the sleeve and O-ring over keyways or threads to avoid damaging the O-ring.

▲ CAUTION *Do not bump carbon members against The shaft as they may chip, crack or break.*

8. Position seal gland on discharge head seal housing and secure with capscrews (or nuts for studs) provided. Tighten capscrews gradually and uniformly in a criss-cross pattern, taking 2 or 3 passes.

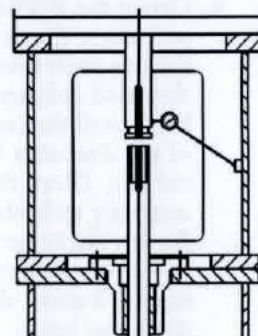
▲ CAUTION *Do not over tighten capscrews on gland. This can distort seal seat and cause seal failure.*

9. Install all seal piping as required. Prior to making final connections of sealing liquid pressurizing lines, make sure the seal housing and all sealing liquid lines are flushed free of dirt, scale and other particles that would be abrasive to the sealing faces.
10. The Driver and Coupling must now be installed per instruction. (See page 24 - INSTALLING THE HOLLOW SHAFT DRIVER or page 26 - INSTALLING THE SOLID SHAFT DRIVER).

MECHANICAL SEAL ALIGNMENT

CONCENTRICITY OF MOTOR SHAFT

1. Install the dial indicator as shown, with the base attached to the motor support.
2. Rotate the motor shaft by hand while you read the dial.
3. Make sure that the runout does not exceed NEMA standards, 0.002 in (0.05 mm) maximum TIR.
4. If the indicator reads higher than 0.002 in (0.05 mm)TIR, loosen the four motor hold-down bolts and relocate the motor on the motor base register.
5. Obtain the desired position.
6. Tighten the hold-down bolts and repeat the indicator reading.

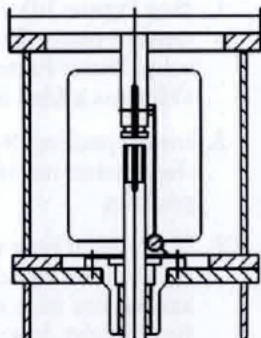


Note: Adding or removing shims between the motor and the discharge head helps alignment in the vertical direction. The motor may also have to be adjusted in the horizontal direction for alignment.

FLATNESS OF THE SEAL HOUSING

For this measurement, remove the mechanical seal if the dial indicator stylus cannot rotate 360° on the top surface of the seal gland.

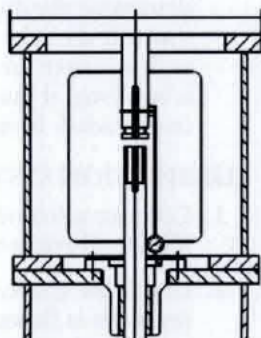
1. Install the dial indicator as shown, with the base 1) Remove the lower coupling components and attach the base of the dial indicator to the motor shaft.
2. Place the stylus at the top surface of the seal gland, or at the top surface of the seal housing.
3. Slowly rotate the motor shaft 360°.
4. Check that the face of the seal housing is square with the shaft to within 0.002 in (0.05 mm) TIR.



CONCENTRICITY OF THE SEAL HOUSING

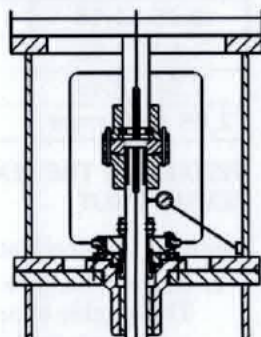
This measurement requires that you remove the mechanical seal.

1. Install the dial indicator as shown.
2. Rotate the motor shaft by hand and run the indicator in the inside-machined surface of the seal housing in order to determine the concentricity.
3. If the indicator reads higher than 0.004 in (0.10 mm) TIR, loosen the four motor hold-down bolts and relocate the motor on the motor base register.
4. Obtain the desired position.
5. Tighten the hold-down bolts and repeat the indicator reading.



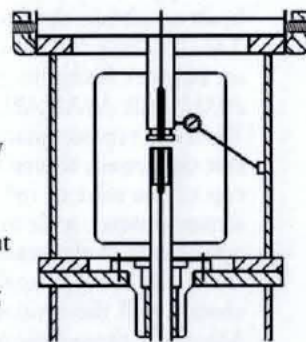
CONCENTRICITY OF THE HEADSHAFT

1. Reinstall the mechanical seal if it was removed for the flatness or concentricity measurement.
2. Install the coupling assembly and adjust the impeller.
3. Attach the base of the dial indicator on the discharge head or motor support.
4. Place the stylus on the shaft between the top of the seal and the bottom of the pump coupling.
5. Slowly rotate the motor shaft 360°.
6. Check that the shaft runout is within 0.004 in (0.10 mm) TIR, or as required by specification.
7. Drill and dowel the pin in three places in order to secure the motor to the motor base after you obtain the required runouts.



CONCENTRICITY OF MOTOR SHAFT USING JACKSCREWS

1. Install the dial indicator as shown, with the base attached to the motor support.
2. Rotate the motor shaft by hand while you read the dial.
3. Make sure that the runout does not exceed NEMA standards, 0.002 in (0.05 mm) maximum TIR.
4. If the indicator reads higher than 0.002 in (0.05 mm) TIR, using the jackscrews relocate the motor on the motor base (sometimes no register).
5. Obtain the desired position.
6. Tighten the hold-down bolts (not the jackscrews) and repeat the indicator reading.



Note: Adding or removing shims between the motor and the discharge head helps alignment in the vertical direction. The jackscrews are provided to adjust the motor in the horizontal direction for alignment.

INSTALLING THE TENSION PLATE WITH CAST IRON TENSION NUT

INSTALLING THE TUBE TENSION PLATE

1. (See Figure 10). Lubricate tube threads and underside of tension plate flange with thread compound. Thread the tension plate (625) onto the enclosing tube nipple (629) manually until its shoulder rests on the discharge head.

TENSIONING THE ENCLOSING TUBE

The enclosing tube sags from its own weight as it is installed and must be pulled tight (tensioned) to make it straight. This section describes two methods of tensioning the tube. The direct pull method is more precise and is preferred. The second method--the wrenching method--is given as an alternate.

NOTE: The correct tension is equal to the weight of the enclosing tube plus 10%.

Weights per unit length for each tube size are given in the Table 1. Multiply by total length of the tube to determine the total weight.

TABLE 1 – Weight-per-foot of Enclosing Tubing

TUBE SIZE (INCH)	WEIGHT PER FOOT (LB.)
1¼	2.99
1½	3.63
2	5.02
2½	7.66
3	10.25
3½	12.50
4	14.98
5	20.78
6	28.57

DIRECT PULL METHOD

1. The upper end of the tube may be pulled by the hoist to obtain the predetermined tension value. This requires the use of a dynamometer scale and an adapter fitting to grip the tube. **TUBE TENSION ADAPTER AVAILABLE THROUGH FACTORY.** With the tension plate installed manually but not tightened, thread the special fitting onto the top of the tube to full engagement. Attach the dynamometer scale to the fitting, and connect the upper end of the scale to the hoist hook. Operate the hoist hook to apply the required tension. This should pull the tension plate off the discharge head. Manually thread the tension plate to reset it. Release tension, remove dynamometer scale and special fitting.

WRENCHING METHOD

1. If a dynamometer is not available, the tube can be tensioned by wrenching the tube tension plate. Make up a spanner wrench to straddle the projecting threaded tube end and to engage the tube tension plate capscREW holes by two lugs. Torque the tension plate to take all the slack out of the shaft tubing and induce a reasonable amount of tension by turning the tension plate counterclockwise. For tubing 2½" (63.5mm) and larger, an individual's full

NOTE: Do not turn clockwise to align holes in tension plate and discharge head.

INSTALLING TENSION NUT

1. (See Figure 10). Install capscrews (760) in the tension plate. Pour one pint of oil down the oil tube. **Note: Factory assembled unit has no oil in it. Oil must added in the field.**
2. Install packing (620) in the tension plate and thread the tension nut (626), tightening it firmly against the packing.
3. If a packed type tension nut (626) is used (for water flush), install packing (620), packing gland (618) and secure with stud (734) and nut (735). Screw nut finger tight. Install line assembly (635) and connect to flush liquid supply (see Figure 10).

CAUTION Be sure that the top of the enclosing tube does not interference with the tension nut.

4. If the top of the tube interferes with the tension nut, determine the distance, if the tube is too long or too short. If the tube is too short, it must be replaced with a longer tube of the correct length. If the tube is too long, it must be cut to the correct length and re-threaded. Reinstall and re-level pump.

LUBRICATION SYSTEM

1. Connect solenoid valve (if provided), oil lines, and fill the oil reservoir with oil.
2. Check the lubricator feed and see that the oil reservoir is flowing freely. (In the case of a solenoid valve, temporary power connections are required.) Set the proper drops per minute on the regulator. Table 2 shows recommended regulator setting.

TABLE 2 – Regulator Setting

Shaft Size (in.)	Basic drops per minute	Additional drops per minute per 100 ft. setting
0.75 - 1.18	5	2
1.50 - 1.68	7	3
1.94 - 2.43	10	4
2.68 and larger	12	5

INSTALLING THE TENSION PLATE WITH BRONZE TENSION NUT

Assemble Tension Plate Assembly as shown in Figure 11.

1. Remove the lock bolt (636) and o-ring (621). Thoroughly clean the tension plate (625) include the o-ring groove. Lightly grease the o-ring and re-install it.
2. Clean the surface of the discharge head where the tension plate will be mounted and remove any nicks or burrs with a fine flat file. Clean the O.D. of the tube nipple. Carefully install the tension plate and gasket (779). Evenly tighten the mounting capscrews (759F).
3. Pour one pint of recommended oil down the tube nipple (629). (See page 27 for recommended lubricants.) **Note: Factory assembled unit has no oil in it. Oil must be added in the field.**

(b) (3) (B)

4. Clean the tension nut (623) and lightly oil its bore and the threads. Screw the tension nut into the tube nipple until the flange face of the nut contact the tension plate.
5. For setting less than 100 feet, tighten the tension nut until a slot aligns with the nearest locking position. Install the locking bolt.

INSTALLING THE DRIVER

INSTALLATION OF A HOLLOW SHAFT DRIVER

This refers to either VHS type electric motors or hollow shaft type gear drives. A small paragraph will be devoted to combination electric motor and right angle gear drives.

▲ WARNING *Do not work under a heavy suspended object unless there is a positive support and safe guards which will protect personnel should a hoist or sling fail.*

1. The driving mechanism of all hollow shaft driver is shown on Figure 12. The head shaft (608) extends up through the quill or hollow shaft of the driver and is held in place by an adjusting nut (604), which not only carries all the static and hydraulic thrust of the impellers and shaft, but also provides the adjustment for the impeller clearances. The head shaft is connected to top shaft (or stub shaft) by a threaded coupling or a rigid flange coupling.
2. When a motor stand is furnished and not installed, proceed as follows:
 - A. Hoist the motor stand, inspect the mounting surfaces, register and clean these surfaces thoroughly.
 - B. Install the motor stand on discharge head and secure with capscrews provided.
3. Attach a sling to the lifting lugs of driver and hoist the driver up. Inspect the mounting surface, register and clean these surfaces thoroughly. If any burrs are found, remove burrs with a smooth mill file, cleaning thoroughly afterward.
4. For motor, orient the motor conduit box in the required position. For the right angle gear, orient
6. After lowering and orienting the driver as explained above, remove the drive coupling and the hold down bolts (See Figure 12). **Be sure to mark the location of the coupling before removing it.**
7. Lower the head shaft through the motor quill shaft to meet the shaft coupling. Apply a thin film of oil to head shaft threads (if non-galling material) and screw into the shaft coupling (located above the stuffing box). Make sure the shaft is not damaged in any way. Tighten the joint.
8. Check that the head shaft centers inside the driver quill shaft within 0.06" (1.5 mm). If it does not, misalignment is indicated.
9. Any head shaft misalignment with driver quill shaft could be caused by a bent headshaft, burrs, or foreign matter between shaft ends or any of the mounting flanges: motor flange to discharge head top flange, discharge head base flange to base plate or the base plate itself could be out of level. If the latter, shimming between base plate and discharge head base, will correct it. Also, check concentricity of motor to motor-stand (if provided) to discharge head.
10. With the motor in place and the head shaft projecting through the motor quill shaft, make temporary electrical connection to check the motor rotation. **(Be sure to remove the ratchet pins or balls before checking motor rotation.)** Motor must rotate counter-clockwise when viewed from the top. See arrow on pump name plate. If motor does not rotate counter-clockwise, you can change the rotation by interchanging any two leads. (For three phase only. For single phase motors see motor manufacturer's instructions.)

▲ CAUTION *Never check motor rotation with the drive coupling in place. The bore clearance between the drive coupling and the pump shaft O. D. is so close that should the motor spin with this shaft stationary, galling and locking together is very likely to take place.*

11. Install motor drive coupling. (Be sure to line up the match mark made at step 6.) Inserting the ratchet pins if a non-reverse ratchet is used. Match the coupling lugs with corresponding holes in motor. Tighten hold down bolts evenly, making sure driver coupling is properly seated in the register fit.
12. Fit gib key (730) into keyway, by filing if necessary, to where there is a snug but sliding fit. This key must be able to be removed by gentle leverage with a screwdriver under it.
13. Be careful that the gib key (730) is not too high so as to hold up the adjusting nut (604) from seating on the drive coupling. If it is, cut off some length of the key.
14. Install adjusting nut (604) to hand tight.

COMBINATION ENGINE AND MOTOR DRIVES

1. On combination drivers, the motor is invariably on top with a projecting head shaft extension.
2. Follow all procedures outlined in the previous paragraph, except that the motor must be lowered over this extended head shaft and great care must be taken to center it exactly so as not to bump or misalign the shaft while the motor is being lowered into place.
3. There are several methods of running engines without electric motors and vice versa, requiring simple adjustment to the combination drive, but they are too numerous to mention here and can be obtained from the gear manufacturers instructions included with the shipment.

IMPELLER ADJUSTMENT FOR ALL HOLLOW SHAFT DRIVERS

NOTE: Shaft adjustment up or down is accomplished by turning the adjusting nut (604) Figure 13.

NOTE: There are five holes in the adjusting nut and only four in the motor coupling. See Figure 13.

1. With shafting all the way down and the impellers resting on their seats, turn the adjusting nut (604) in counter-clockwise direction, thus lifting the shaft, until the impellers just clear their seats and the shaft/motor turns free by hand. This removes all deflection from the shaft.
2. If pump setting is 200 ft. or less, make another two turns on the adjusting nut for the first 100 ft. (3 turns for 12 thread/inch shaft). Line-up one of the holes in the adjusting nut with the nearest hole in the driver coupling. Insert the capscrew in the hole and tighten it.

NOTE: 1.00" and 1.18" diameter shafts are 12 thread per inch (tpi), 1.50" through 2.44" are 10 tpi, all larger sizes are 8 tpi.

3. For pump setting over 200 ft. see IOM for DWT.

FOR OPEN IMPELLERS

1. With shafting all the way down and the impellers resting on their seats, turn the adjusting nut (604) in counter-clockwise direction, thus lifting the shaft, until the impellers just clear their seats and the shaft/motor turns free by hand. This removes all deflection from the shaft.

(b) (3) (B)

INSTALLATION OF A SOLID SHAFT DRIVER

NOTE: When pump is supplied with an oil lubricated thrust pot, do not secure driver to discharge head until after the thrust pot and flexible coupling are installed. (See page 22 for thrust pot installation instruction.)

⚠ WARNING Do not work under a heavy suspended object unless there is a positive support and safe guard which will protect personnel should a hoist or sling fail.

The coupling between the driveshaft and discharge head shaft may be a non-spacer type (see Figure 14), or a spacer type (see Figure 15). The latter is used on pumps furnished with a mechanical seal to permit servicing of the seal without removal of the driver.

1. Driver support. When a driver support is furnished and not installed, proceed as follows.
 - A. Hoist driver support, inspect the mounting surfaces, register and clean these surfaces thoroughly.
 - B. Install driver support on discharge head and secure with capscrews provided.
2. Attach a sling to the lifting lugs of driver, hoist motor, inspect the mounting surface, register, and shaft extension, and clean those surfaces thoroughly. If any burrs are found, remove burrs with a smooth mill file, cleaning thoroughly afterward.

3. Orient the motor conduit box in the required position. Align the motor mounting holes with the mating tapped holes on the discharge head. Lower the motor until the registers engage and the motor rests on the discharge head. Secure motor with capscrews provided.
4. On drivers having a non-reverse ratchet or pins, manually turn the driver shaft clockwise viewed from the top until the non-reverse ratchet or pins fully engage.
5. Lubricate motor bearings in accordance with instructions given on lubrication plate attached to the motor case.

NOTE: Please read and follow the motor manufacturer's instructions before lubricating the motor bearings. Too much lubricant can cause the bearings to overheat and prematurely fail.

⚠ WARNING *The motor must not be tested for direction of rotation when coupled to the pump. If pump should rotate in the wrong direction, serious damage to the pump and motor would result. Also serious injury to personnel could result.*

6. Make temporary electrical connections according to tagged leads or diagram attached to the motor. Motor must rotate counter-clockwise when viewed from the top. See arrow on pump name plate. If motor does not rotate counter-clockwise, you can change the rotation by interchanging any two leads (For three phase only, for single phase motors see motor manufacturer's instructions.)
7. Motor shaft end play adjustment: if required, motor shaft end play shall be checked with a dial indicator prior to connecting the pump coupling to the solid shaft motor. Consult the applicable motor manufacturer's instruction manual for detailed information on motor shaft end play.

COUPLING INSTALLATION: (SEE FIGURES 14 and 15)

1. Check all mating face with a fine flat file before installation. Remove all burrs from face.
2. Apply a thin film of oil on the pump key (730) and insert key into headshaft keyway seat.
3. Gently lower pump hub of coupling (614) onto headshaft.
4. Thread on the adjusting plate (613) onto the headshaft until flush with top of the headshaft.
5. Clean driver shaft by removing all grease and burrs. Try to fit the key on the driver hub (610) before installing it to the driver shaft.

(b) (3) (B)

Figure 15

6. Apply a thin film of oil to the driver key (730) and insert key into drive shaft keyway seat. Place the driver hub (610) onto the drive shaft and with key slide it up the drive shaft until the annular groove is exposed. Install split ring (722) in the groove and slide driver hub down over the split ring to capture it.
7. If the pump is supplied with an adjustable spacer coupling (see Figure 15), install spacer (612) between headshaft and driveshaft hubs. Secure with capscrews (759) and hex nuts (735).

IMPELLER ADJUSTMENT

Impeller adjustment is identical for all motors and right angle gear drives. Adjustment is accomplished by turning the adjusting plate (613). (See Figure 16 or 17). The correct adjustment is listed on the Outline Drawing for the specific unit. If the pump has a thrust pot, do not adjust the impeller position until the thrust pot has been installed and adjust the impeller position by using the adjust nut on the thrust pot.

NOTE: Mechanical seal, when provided, must not be secured to the shaft prior to impeller adjustment. (open or enclosed type impellers). Shaft must move up or down within the seal Assembly.

For pumps handling liquids between -50° to 200° F, impeller adjustment can be made under ambient conditions. For liquids in excess of this range, it is recommended that impeller adjustment be made after the pump surface temperature has reached an equilibrium when charged with the pumpage. In those cases, where this is not feasible due to safety consideration or impossible due to external ice build up in cryogenic applications, refer to factory for specific instructions.

OPEN IMPELLERS

1. With the impellers touching the bottom of the bowls, turn the adjusting plate (613) towards the driver hub (610) or spacer (612) to obtain 0.015 inch clearance between the adjusting plate and driver hub or spacer for the first 10 feet of column. Add 0.010" for each additional 10 feet of column. See Figures 16 and 17. **Note:** The determination of driver shaft end play can be critical and should be added to this setting. For larger pumps over 8", this amount may be too little; please refer to Outline Drawing.

Example: total pump length is 50 feet - set impellers at 0.055 inch.

2. After impeller adjustment, align adjusting plate (613) with the pump hub (614), and tightly draw coupling flanges together with capscrews (759) and nuts (735). (See Figures 14 and 15.)
3. Check shaft run out with dial indicator. For mechanical seal installation, the run out should be 0.005" or less.
4. Set seal after impeller adjustment. Securely tighten all set screws in the collar. Remove the spacer between the gland plate and collar. Retain spacer for future resetting of seal.

NOTE: When impellers are reset, the seal must also be reset.



ENCLOSED IMPELLERS

For enclosed impellers obtain the clearance between the adjusting plate and driver hub or spacer as specified on the outline drawing. See Figure 16 or 17.

INSTALLING THE GREASE LUBRICATED THRUST POT

This type of thrust pot and the motor stand are assembled on the discharge head by the factory. This thrust pot is designed to be used with NEMA Vertical C-face motors. The motor shaft and the pump shaft are to be coupled with flexible coupling.

INSTALLATION:

1. Install both coupling halves prior to mounting the motor. Refer to the coupling manufacturer's instructions.
2. Using the lifting lugs on the motor, carefully lower the motor onto the motor stand of the thrust pot (See Figure 18) and align the bolt holes.
3. Install the bolts finger tight.
4. Make temporary electrical connections according to tagged leads or diagram attached to the motor. Motor must rotate counterclockwise when viewed from the top. See arrow on pump name plate. If motor does not rotate counterclockwise, you can change the rotation by interchanging any two leads.

⚠ WARNING Before beginning any alignment procedure, make sure driver power is locked out. Failure to lock out driver power will result in serious physical injury.

ALIGNMENT OF FLEXIBLE COUPLING:

Alignment of the pump and motor is extreme importance for trouble-free mechanical operation. Straight edge alignment by an experienced installer proves adequate for most installations.

1. Check for coupling alignment by laying a straight edge across both coupling rims at four points 90° apart.
2. Move motor until straight edge rests evenly at each position. Repeat procedure until correct alignment is achieved.
3. Install flexible sleeve between the hubs per the manufacture's instructions.
4. Tighten all motor bolts.

NOTE: Be sure the relief fitting (#11 in Figure 18) is clear of paint or any other obstructive material. Otherwise it will cause premature failure of the

INSTALLING THE OIL LUBRICATED THRUST POT

If the unit is supplied with a thrust pot (see Figure 19), the thrust pot should be installed on top of the discharge head or motor stand before installing the driver. The driving mechanism of the thrust pot assembly is similar to the hollow shaft motor. (See Figure 12)

1. Attach a sling to the thrust pot assembly through the windows on the motor adapter and hoist the assembly over the top of the discharge head.
2. Clean the mounting face with a flat file to remove any burrs of the discharge head and the thrust pot. Lower the thrust pot assembly and orient it so that the bolt hole on the base of the thrust pot and the top flange of the discharge head are line up. Install all the bolts to secure the assembly to the discharge head.
3. Lower the drive shaft through the quill of the thrust pot assembly to meet the shaft coupling. Apply a thin film of oil to the head shaft thread and screw into the shaft coupling.
4. For unit with mechanical seal and flanged coupling, install the spacer flange coupling as instructed on page 20.
5. Install the gib key (#16) into the drive shaft and the hollow shaft clutch.
6. Install the adjusting nut (#17) to hand tight.
7. With shafting all the way down and the impellers resting on their seats, turn the adjusting nut (#17) in counter-clockwise direction, thus lifting the shaft, until the impellers just clear their seats and the shaft/motor turns free by hand. This removes all deflection from the shaft.
8. For enclosed impellers, if pump setting is 200 feet

(b) (3) (B)

9. Install the bottom of the flexible coupling to the top of the drive shaft.
10. Attach a sling to the lifting lugs of driver and hoist the driver up. Inspect the mounting surface, register and clean these surfaces thoroughly. If any burrs are found, remove burrs with a smooth mill file, cleaning thoroughly afterward. Temporarily attach the top half of the flexible coupling to the motor shaft.
11. Orient the motor conduit box in the required position. Align the driver mounting holes with the mating tapped holes on the discharge head. Lower the driver until the registers engage and the driver rests on the thrust pot assembly. Secure driver with capscrews provided.
12. Secure the flexible coupling assembly.
13. Install the coupling guard.
14. Fill the oil reservoir with recommended oil.

⚠ WARNING Do not check motor rotation unless motor is bolted to pump and drive coupling is removed.

Be sure to remove all the hand tools and to install the coupling guards around all exposed shafts and couplings before start up of the pump. Failure to comply may result in severe personnel injury or death.

- C. Check alignment of pump and driver.
- D. Impeller adjustment has been made.
- E. Mechanical seal lock collar is attached to shaft.

(b) (3) (B)

Pump Startup And Operation – SECTION

PRE-START PROCEDURE

Consult the applicable manufacturer's instruction for detailed information for the prime mover (electric motor, engine or steam turbine), coupling, driveshaft, gear driver. Prior to startup, check the following:

1. Confirm that the following procedures described in the "Installing the Drivers" sections have been performed:
 - A. Wiring of Driver.
 - B. Driver must rotate counterclockwise (CCW) when viewed from above.

Figure 19 – Oil Lubricated Thrust Pot

ITEM	DESCRIPTION
1	Thrust pot body
2	Tube - oil retaining
3	Thrust bearing
4	Capscrew - head to thrust pot
5	Washer - head to thrust pot
6	Hex Nut - head to thrust pot
7	Roller bearing
8	Bearing seat
9	Allen head screw
10	Capscrew - motor adapter to motor or thrust pot
11	Washer - motor adapter to motor or thrust pot
12	Gasket
13	Capscrew
14	Non-reverse pin
15	Socket head screw
16	Gib key
17	Adjusting nut
18	Coupling guard
19	Setscrew

ITEM	DESCRIPTION
20	Flexible shaft coupling
21	Gib key
22	Key (motor shaft)
23	Setscrew
24	Round head screw for coupling guard
25	Washer coupling guard
26	Motor adapter
27	Capscrew - adjusting nut
28	Washer - adjusting nut
29	Retaining ring
30	Hollow shaft clutch
31	Non-reverse plate
32	Pipe plug - oil filling
33	Retaining ring
34	Hollow shaft
35	Shaft sleeve
36	Sight gauge
37	Pipe plug - oil drain

2. For open lineshaft pump, make sure the stuffing box relief (bleed) line is connected (if applicable). For enclosed lineshaft pump, make sure the oil lubrication piping is connected and oil reservoir filled with the recommended oil. (See page 15 and 18.)
3. For pump with mechanical seal, make sure mechanical seal is properly lubricated and all piping to seal is connected. Also, check that all cooling, heating and flushing lines are operating and regulated.
4. For open lineshaft pump, when water level exceeding 30 feet, pre-lubrication is necessary. If it is equipped with prelube system supplied from a pressurized header, open the supply valve and allow the prelube water to flow for 15 seconds plus 15 seconds per 100 ft of pump setting. If it is equipped with a tank type prelube system, open the valve between the prelube tank and the pump and allow approximately half of the water in the tank to run into the pump before start the pump. The prelube valve should remain open during the start up.
5. For oil lubricated pump, clean and fill the lubricator tank with recommended oil. (See page 27.) Manually open the lubricator valve and allow oil to run into the shaft enclosing tube for at least 20 minutes for each 100 feet of setting prior to start up. On the system equipped with a solenoid operated lubricator valve that cannot be energized independently, it will be necessary to remove the valve stem to allow the oil to flow into the tube. If the start up is delayed or the pump has been shut down for over 150 hours, the lubrication procedure must be repeated just prior to actual start up.
6. Open the air release system isolation valve. Adjusting the air release system throttling device so that it is partially open. It should not be closed or fully open.

NOTE: Not exhausting the air or exhausting it too fast can damage the pump.

7. All connections to driver and starting device match wiring diagram. Voltage, phase and frequency on motor nameplate agree with line current.
8. Rotate shaft manually to ensure impellers are not binding.
9. Verify that driver bearings are properly lubricated and check oil level in housing.
10. Inspect discharge piping connection, valves and pressure gauges for proper operation.

PUMP STARTUP

1. Partially close the valve in the discharge line.
2. Start the pump. If any abnormal noises, jerking or vibration is noted, stop the pump immediately, determine the cause of the abnormalities and correct them.
3. After the pump is operating at full speed, slowly open discharge valve. If driver overheats or there is excessive vibration, stop the pump, determine the causes and correct them.
4. If the air release valve is manually operated, close it.
5. For open lineshaft pumps, with the pump in operation, there should be some leakage at the stuffing box packing. The correct leakage rate is approximately one drop per second. Check the temperature of the leakage as well as the discharge head. If the pump runs hot and the leakage begins to choke off, stop the pump and allow it to cool down. A few light taps with a hammer on the gland will upset the packing sufficiently to resume leakage. After pump has cooled, restart pump and follow preceding procedure. Run pump 15 minutes, check leakage, if it exceeds two drops per second, adjust packing as described in "Packing Adjustment and Replacement".
6. For enclosed line shaft pumps, adjust the lubricator valve for the proper flow rate of the lubrication oil. (See Page 18.)
7. For pump with mechanical seal, if seal leaks slightly at startup, allow a reasonable amount of time for seal to adjust itself. Liquids with good lubricating qualities normally take longer to wear in the seal than liquid with lesser qualities. When a seal starts out with a slight leak and gets progressively less while running, it is indicative of leakage across the seal faces. Continued running will eliminate this. Where leakage occurs immediately and remains constant, unaffected by running, it usually indicates secondary seal (Shaft packing) damage, or seal faces are warped out of flat.

Maintenance – SECTION 5

PREVENTIVE MAINTENANCE

⚠ WARNING *Before initiating maintenance procedures, disconnect all electric sources to the equipment and accessories and completely. Discharge all parts and accessories which retain electric charges. Failure to comply may result in severe personnel injury or death.*

Preventive maintenance includes periodic inspection of oil level in the oil reservoir (for pump with oil lube column) re-lubrication of electric motors, gear drives and prime mover. Systematic inspection of the pump and its components shall be made at regular intervals. The frequency required depends upon the operating conditions of the pump and its environment. See following Preventive Maintenance schedule. Consult the applicable manufacturer's instructions for detailed information on maintenance for the prime mover, driveshaft, electric motors and gear drives. Any deviation in performance or operations from what is expected can be traced to some specific cause. Variances from initial performance will indicate changing system conditions, wear, or impending breakdown of the unit.

PREVENTIVE MAINTENANCE SCHEDULE

PROCEDURE	TIME INTERVAL (in operating hours)
Clean dirt, oil and grease from driver and discharge head.	As required
Clean driver ventilation passage to prevent overheating.	As required
Change lubrication in gear drive.	2,000 or once a year
Change lubrication in thrust pot.	See page 27
Check oil level in the reservoir. It should never be less than ½ full. Refill, check drip rate.	24
Tighten all loose bolts and check for excessive vibration.	As required
If packing is grease lubricated, add as required.	100
Check that there is some leakage through stuffing box while pump is in operation. Do not tighten gland nuts unless necessary. Refer to page 24 for tightening requirement.	As required
Maintain a liquid film of lubrication between the seal rubbing faces.	As required
Re-grease the motor bearings: 1800 RPM and above Below 1800 RPM	Refer to Motor IOM Refer to Motor IOM

PACKING ADJUSTMENT AND REPLACEMENT

Pumps equipped with packing, shall be adjusted whenever the leakage rate exceeds two drops per second. If there is no leakage or the stuffing box overheats, do not back off gland nuts while the pump is running. This will allow the entire set of rings to move away from the bottom of the box, without relieving pressure of the packing on the shaft. Stop the pump and allow packing to cool then restart the pump.

It may be necessary to repeat this procedure several times before proper amount of liquid comes through to efficiently prevent overheating. If leakage is excessive, adjust the stuffing box as follows:

1. With the pump in operation, tighten the gland nuts one-quarter turn for each adjustment. Allow packing to equalize against the increased pressure and leakage to gradually decrease to a steady rate, before making another adjustment.

⚠ CAUTION *Do not over tighten the stuffing box. Excessive pressure can wear out packing prematurely and seriously damage the shaft.*

2. With the pump shut down and when packing has been compressed to the point that the gland is about to contact the upper face of stuffing box, remove the split gland, add one extra packing ring and readjust. If this fails to reduce leakage to two drops per second, remove all packing rings and replace with new rings.
3. Remove the packing with the aid of a packing hook. If a lantern ring is provided, remove it by inserting a wire hook in the slots of the ring and pull it from the packing box. Thoroughly clean the stuffing box of all foreign matter.
4. If the replacement packing is in the form of a continuous coil or rope, it must be cut into rings before installing. Tightly wrap one end of the packing material around the top shaft like one coil spring, and cut through the coil with a sharp knife. For re-packing sequence, refer to "Installing the Stuffing Box" (page 15).

⚠ WARNING *Do not over tighten the stuffing box. Excessive pressure can wear out packing prematurely and seriously damage the shaft.*

SEASONAL SHUTDOWN

⚠ WARNING *Prior to restarting the pump, manually rotate the shaft several times.*

1. For oil lubricated pumps that are shut down for an extended period of time, it is suggested that the pump be operated for at least 15 minutes every two weeks with oil feed wide open 2 hours before and during startup in order to maintain a film of oil on the shafting and shaft bearings.
2. For product (or water) lubricated pump, if the pump is to be shut down for an extended period of time, operate it for at least 15 minutes with adequate pre-lubrication every two weeks.
3. Before resuming normal operations, oil should be changed on drivers, right angle gear and lubricating oil system. After 15 minutes of operation adjust the lateral.

THRUST POT LUBRICATION AND MAINTENANCE

OIL LUBRICATED THRUST POT (SEE FIGURE 19)

⚠ WARNING *Pumps are shipped without oil. Oil-lubricated bearings must be lubricated at jobsite.*

It is a good practice to flush the oil reservoir before first time operation and at the time of oil changes to remove all grit particles in the oil reservoir sump. Use the same type of oil to flush reservoir as specified for lubrication. (See page 28 on recommended turbine oil.) Remove drain plug (Item # 39) before flushing. Flushing oil may be poured through oil fill opening (item #33) after removing oil fill plug #39. The proper oil level when the unit is not running shall be not more than $\frac{1}{8}$ " to $\frac{1}{4}$ " from the top of the oil sight gauge (Item #37). Overfilling may result in overheating of the unit. During operation the oil level in the sight gauge may be higher than the recommended range mentioned above. Under no circumstance is it allowed to rotate the unit when the oil in the sight gauge is not at the required level.

To avoid oxidation of the anti-friction bearings during shut-down periods lasting longer than one week, it is recommended to fill up the oil reservoir until the oil runs over the oil retainer tube (Item #2) and down the shaft so that the bearings remain completely immersed in the oil. Before startup, do not forget to drain the excess oil to its required level. Oil change depends on the severity of the environment. Generally speaking, when the oil in the sight gauge changes to a darkish brown color it is time for an oil change. However, for a longer bearing life, it is recommended that the oil be changes every six months. Be sure to flush the oil reservoir (see above) with each oil change.

GREASE LUBRICATED THRUST POT (SEE FIGURE 18)

Lubricating Intervals in Operating Hours

Thrust Rating	Operating Speed (RPM)			
	<1770	1770	2900	3500
2000 lbs	2000	2000	2000	1800
4000 lbs	2000	2000	1600	1400
6600 lbs	2000	2000	1400	1200

The bearing is pre-lubricated at factory. Re-grease the bearing according the following procedure and per the schedule in the above table. Following are the re-grease procedure:

1. Wipe dirt from grease fittings.
2. Check relief port 180° from fitting to make sure it is open.
3. Fill the grease cavity through the fitting until fresh grease comes out the relief hole.
4. Ensure the relief port closes.

NOTE: The bearing temperature usually rises after re-greasing due to an excess supply of grease. Temperature will return to normal after the pump has run and purged the excess from the bearings, usually two to four hours.

For most operating conditions, lithium based NLGI 2 grease is recommended. This is the grease factory used for pre-lubrication. This grease is acceptable for bearing temperatures of 5° to 230° F. Temperature extremes (either high or low) may require different type grease. Following table lists some various manufacturers' compatible grease:

Mobil	Mobilith AW2
Amoco	Amolith EP2
Ashland	Multilube EP2
Exxon	Unirex N2
Shell	Alvania EP LF2
Unocal	Unoba EP2
Chevron	Dura-Lith EP NLGI2

NOTE: If it is necessary to change the grease type or consistency, the bearing must be removed and all the old grease eliminated from the housing and bearing.

⚠ WARNING *Bearings must be lubricated properly in order to prevent excess heat generation, spark and premature failure.*

RECOMMENDED LUBRICANTS		
	Grease for Lineshafts, Suction Bowl Bearings and Shaft Packings	Turbine oils for Lineshafts, Suction Bowl Bearings and similar applications
Operating Temperature Range	20° F to 120° F	20° F to 120° F
Required properties Pour Point : Flash Point : 100° F Viscosity : ASTM Dropping Point : Nitrile Rubber Swell : Thickener Type: Thickener Percent:	20° F or lower (base oil) 300° F or higher (base oil) 450 SUS or higher (base oil) 160° F or higher Minimal (up to 3%) Calcium or Lithium 15% Minimum	20° F or lower 300° F or higher 150 SUS or higher 32 Minimal (up to 3%)

Manufacturer	Recommended Standard Industrial Lubricants	
Chevron Texaco Corp.	Chevron Ulti-Plex Grease EP2	Chevron *Hydraulic Oil AW32
	Texaco Novatex EP2	Texaco *Regal EP 32
CITGO Petroleum Corp.	Mystik Oil & Grease Mystik JT-6 Grease (5484)	Mystik Oil & Grease *Mystik Turbax Oil 32 (1812)
	Citgo Oil & Grease Premium Lithium EP2	Citgo Oil & Grease Pacemaker Oil 32
	Lyondell Lubricants Litholine HEP Grease	Lyondell Lubricants *Duro Oil 32
Exxon Mobil Corp.	Mobil Mobilux Grease EP2	Mobil DTE Oil 24
	Exxon Lodok EP 2	Exxon *Nuto H Hydraulic Oil 32
76 Lubricants Co.	76 Lubricants Multiplex EP Grease 2	76 Lubricants Hydraulic Oil AW/D 32
Shell Oil	Shell Alvania EP Grease 2	Shell *Tellus Plus Oil 32

Note: * in front of the oil grade means it is suitable for sub zero (F) temperature service.

Manufacturer	Recommended Food Machinery Lubricants	
Chevron Texaco Corp.	Chevron #FM Grease EP2	Chevron *#Lubricating Oil FM32
	Texaco #Cygnus Grease 2	Texaco #Cygnus Hydraulic Oil 32
CITGO Petroleum Corp.	Mystik Oil & Grease #Mystik FG2 Grease (5607)	Mystik Oil & Grease #Mystik FG/AW 32 Oil (1931)
	Citgo Oil & Grease #Clarion FG HTEP Grease	Citgo Oil & Grease #Clarion FG AW Oil 32
	Lyondell Lubricants Ideal FG 2 Grease	Lyondell Lubricants #Ideal FG 32 Oil
Exxon Mobil Corp.	Mobil #Mobil Grease FM102	Mobil DTE FM 32 Oil
	Exxon Foodrex FG 1	Exxon *Nuto FG Hydraulic oil 32
76 Lubricants Co.	76 Lubricants 76 Pure FM Grease	76 Lubricants 76 FM Oil 32

Note: 1. * in front of the oil grade means it is suitable for sub zero temperature (F) service.
2. Food machinery lubricants meet USDA H-1 requirements and FDA document 21 CFR 178.3570.
In addition, # in front of the product name means it is NSF 61 registered products.

TROUBLESHOOTING		
TROUBLE	PROBABLE CAUSE	REMEDY
1. Pump does not start	A. Electrical circuit open or not completed B. Improper lateral adjustment. Impeller on bottom. C. Low voltage supplied to electric driver D. Defective motor	Check circuit and correct. Reset impeller adjustment, See pages 20 or 22. Check whether driver wiring is correct and receiving full voltage. Consult factory.
2. No liquid delivered	A. Discharge valve closed B. Speed is too low C. Wrong rotation D. Obstruction in liquid passage E. Water level in the well is below 1st stage impeller F. Static lift too high G. Field head requirement greater than design head H. Damaged bowl assembly; Broken or disconnected shaft I. Driver with reduced voltage, or reduced current starting does not come up to speed	Be sure the discharge valve is in full open position. Check if driver is directly across the line and receiving full voltage. Check for CCW rotation when viewed from above. Check engagement of motor coupling. Pull pump, inspect suction strainer, impeller and bowls. Increase pump setting by adding column. Check the dynamic water level in well. Consult factory for adding stages or increase impeller diameter. Check system friction loss. Increase discharge piping size. Consult factory for adding stages or increase impeller diameter. Pull pump and repair all damaged components. Check RPM, voltage and amps.
3. Not enough liquid	A. Same as items 2-A thru 2-G B. Cavitation C. Impellers adjusted too high D. Air or gas in the water E. Excessive pump wear	Same as items 2-A thru 2-G. Insufficient NPSH available. Consider lowering the bowl assembly by adding column. See pages 20 or 22. If successive starts and stops do not remedy, lower pump if possible, or close discharge valve to maintain well pumping level at a lower GPM. Pull pump and repair as required.
4. Not enough pressure	See not enough liquid.	See not enough liquid.
5. Pump works for a while and quits	A. Excessive horsepower required. B. Pumping higher viscosity or specific gravity liquid than designed for. C. Mechanical failure of critical parts D. Suction strainer clogged E. Misalignment F. Break suction	Use larger driver. Consult factory. Test liquid for viscosity and specific gravity. Check bearings and impellers for damage. Any irregularities in these parts will cause a drag on the shaft. Pull pump and clean the strainer. Realign pump and driver. Check dynamic water level in the well. Lower bowl assembly by adding column.

TROUBLESHOOTING		
TROUBLE	PROBABLE CAUSE	REMEDY
6. Pump takes too much power	A. Damaged impeller B. Foreign object lodged between impeller and bowl C. Specific gravity higher than pump designed for D. Viscosity too high, partial freezing of pumpage E. Defective bearing F. Packing is too tight	Inspect, replace if damaged. Remove object as required. Test liquid for viscosity and specific gravity. Check for both. They can cause drag on impeller. Replace bearing, check shaft or shaft sleeve for scoring. Release gland pressure. Retighten. (See page 15.) Keep leakage flowing. If no leakage, check packing, sleeve or shaft.
7. Pump is too noisy	A. Cavitation B. Bent shaft C. Rotating parts binding, loose or broken. D. Bearings are worn out E. Resonance	Same as Item 3-B. Straighten as required. See Page 13 for runout limits. Replace as required. Replace bearings. Check piping strain, consult factory.
8. Excessive vibrations	A. Coupling misalignment, bent impeller unbalance, worn bearings, cavitation, piping strain and/or resonance B. Motor or gear driveshaft end play maladjustment C. Bent shaft D. Crooked well.	Determine cause utilizing shaft vibration frequency analyzer and/or disassemble pump. Complex problem may require factory service assistance. See Installation of Hollow Shaft Driver (VHS), Page 19. Straighten as required. See Page 13 for runout limits. Survey the well and consult factory.
9. Pump leaks excessively at stuffing box	A. Defective packing B. Wrong type of packing	Replace worn packing. Replace packing not properly installed or run-in. Replace improper packing with correct grade for liquid being pumped.
10. Stuffing box is overheating	A. Packing is too tight B. Packing is not lubricated C. Wrong grade of packing D. Stuffing box improperly packed	See item 6-F. Release gland pressure and replace all packing if burnt or damaged. Re-grease packing as required. Consult factory. Repack stuffing box.
11. Packing wears too fast	A. Shaft or shaft sleeve worn B. Insufficient or no lubrication C. Improperly packed D. Wrong grade of packing	Pull pump and remachine, or replace shaft and/or sleeve. Repack and make sure packing is loose enough to allow some leakage. Repack properly, make sure all old packing is removed and stuffing box is clean. Consult factory.

Disassembly And Reassembly – SECTION 6

DISASSEMBLY

⚠ WARNING *Before working on pump or motor, lock out driver power to prevent accidental startup and physical injury.*

NOTE: Pump components should be match-marked prior to disassembly to ensure they are reassembled in the correct location.

HEAD AND COLUMN

1. On pumps which are driven through a gear drive, remove the driveshaft between the gear and the prime mover.
2. On pumps, which are electric motor driven, remove the electrical connections at the conduit box and tag the electrical leads, so they can be reassembled the same way they were disassembled.
3. Uncouple driver (or gear box) from pump shaft and mounting flanges and lift off by the lifting lugs or eyebolts as furnished.

⚠ WARNING *Never try to lift entire pump assembly by the lifting lugs or eyebolts furnished for the driver only.*

4. Disconnect discharge head from the discharge piping. Remove all hold down bolts and external piping. Remove coupling, packing box and proceed with disassembly down to the bowls by reversing the procedures described in detail for assembling the unit.

BOWL ASSEMBLY

The bowl assembly is composed of a suction bowl/bell, intermediate bowl(s), top bowl, impellers and securing hardware, bearings, and pump shaft.

Turbine bowl impellers are secured to the shaft by either a taperlock or a key and split thrust ring. Follow only those procedures that apply to the particular construction supplied.

NOTE: Match mark bowl assembly in sequence of disassembly to aid in the reassembly procedure.

TAPERLOCK CONSTRUCTION BOWL DISASSEMBLY

1. Remove capscrews that secure top intermediate bowl (669), not shown, to intermediate bowl (670). See Figure 1 or 2.
2. Slide discharge bowl and top bowl off the pump shaft (660).

(b) (3) (B)

3. Pull shaft out as far as possible and strike the hub of the impeller by taperlock driver, or equivalent, until the impeller is off the taperlock (See Figure 20).
4. After the impeller is free, insert a screw-driver into the slot in the taperlock and spread it open. Slide the taperlock and impeller off the pump shaft.
5. Repeat the above procedures until the bowl assembly is completely disassembled.

KEYED BOWL DISASSEMBLY

1. Remove capscrews that secure top bowl (669) to intermediate bowl (670).
2. Slide top bowl off the pumpshaft (660).
3. Remove capscrews (759) and split thrust ring (725) from pump shaft.
4. Slide impeller off the pumpshaft and remove the key (730). If impeller is seized to the shaft, strike impeller with a fiber mallet and drive impeller off the pumpshaft.
5. Repeat the above procedures until the bowl assembly is completely disassembled.

TURBINE BOWL – WEAR RING REMOVAL

1. Remove set screws or grind off tack weld, when rings are furnished with those locking methods.
2. Utilizing a diamond point chisel, cut two “V” shaped grooves on the bowl wear ring approximately 180° apart. Use extreme care not to damage the wear ring seat.
3. With a chisel or drift, knock the end of one half of the ring in, and pry the ring out.
4. On special materials such as chrome steel, set up the bowl in a lathe and machine the wear ring off using extreme care not to machine or damage the ring seat.

IMPELLER WEAR RING REMOVAL

1. Utilizing a diamond point chisel, cut two "V" shaped grooves on the impeller wear ring approximately 180 degrees apart. Use extreme care not to damage the wear ring seat.
2. With a chisel or drift, knock the end of one half of the ring out, and pry the ring off.
3. On special materials such as chrome steel, set up the impeller in a lathe and machine the wear ring off using extreme care not to machine or damage the ring seat.

BOWL AND LINESHAFT BEARING REMOVAL

Utilizing an arbor press and a piece of pipe or sleeve with outside diameter slightly smaller than the outside diameter of the bearing to press the bearing out.

NOTE: Bowl bearings are press fit. Do not remove unless replacement is necessary.

INSPECTION AND REASSEMBLY

INSPECTION AND REPLACEMENT

1. Clean all pump parts thoroughly with a suitable cleaner.
2. Check bearing retainers for deformation and wear.
3. Check shafts for straightness and excessive wear on bearing surfaces. Average total runout should be less than 0.0005" TIR per foot, not to exceed 0.005" T.I.R. for every 10 feet of shafting.
4. Visually check impellers and bowls for cracks and pitting. Check all bowl bearings for excessive wear and corrosion.
5. Replace all badly worn or damaged parts with new parts. In addition, replace all gaskets and packing as required.

TURBINE BOWL WEAR RING INSTALLATION

Place chamfered face of the bowl or impeller wear ring towards the ring seat and press the ring into the seat. Use an arbor press or equal, making sure the ring is flush with the edge of the wear ring seat.

INSTALL BOWL AND LINESHAFT BEARING

(Refer to Figure 1 for components numbers)

1. Press bearing (653) into retainer (652) using an arbor press or equal.
2. Press bearing (690) into suction bowl/bell (689) by using an arbor press or equal. The top of the bearing should protrude above the suction hub equal to the depth of the counter bore in the sand collar.
3. Place the bowl (670) with the flange downward and press bearing (672) through chamfered side of bowl hub until the bearing is flush with the hub by using an arbor press or equal.

REASSEMBLY OF THE BOWL ASSEMBLY WITH TAPERLOCK CONSTRUCTION

1. For ease in reassembly apply a thin film of turbine oil to all mating and threaded parts.
2. If the sand collar is not assembled to the shaft, install the sand collar. The sand collar is attached to the shaft with a shrink fit. The larger diameter of the counterbore of the sand collar goes toward the suction bell bearing. Heat the sand collar until it slips over the shaft and quickly position it so that the bottom of the sand collar is set according to the "X" dimension, before it cools. See Figure 21. See Table 3 for the "X" dimensions. Slide the plain end of the pump shaft into the suction bowl/bell bearing until the sand collar rests against the suction bowl/bell.

⚠ WARNING *Wear protective gloves and use appropriate eye protection to prevent injury when handling hot parts.*

(b) (3) (B)

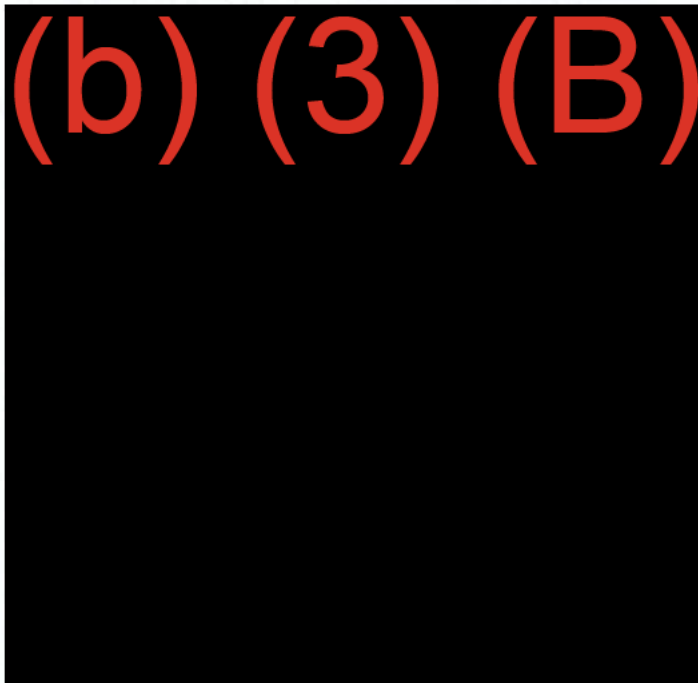
3. Hold the shaft in this position by inserting a long capscrew (or all thread rod with a hex nut) with an assembly jig into the bottom end of the suction hub and secure tight into the threaded hole at the end of the shaft. **Be sure the shaft has been cleaned and checked for straightness.**
4. Slide the first impeller over the shaft until it seats on the suction bowl/bell.

NOTE: If there are different diameter impellers, put the large diameter impeller at the lower stage.

5. Insert a screwdriver into the slot in the taperlock (677) to spread the slot and slide the taperlock over the pump shaft. Hold the impeller against bowl and slide the taperlock into the impeller hub. **Be sure the taperlocks have been cleaned and are dry.**
6. Hold impeller firmly against the suction bowl/bell and drive the taperlock into place with a taperlock driver, (See Figure 22). After the impeller is secured in position, the top end of the taperlock should be 1/8" above the impeller hub.
7. Slide intermediate bowl (670) onto shaft and secure with capscrews provided.
8. Repeat preceding procedure for number of stages required.
9. Remove long capscrew and the assembly jig at the end of suction hub and check that the shaft rotates freely without dragging or binding. Also check for adequate lateral (end play).

FINAL ASSEMBLY

After reassembling the bowl assembly, see Section 3 for installation. Refer to Section 4, for startup and operation procedures.



Repair Parts – SECTION 7

ORDERING PARTS

When ordering spare or replacement parts, the pump serial number and size and type of pump must be given. This can be found on the nameplate furnished with the unit. Give the complete name and reference number of each part as indicated on the applicable sectional drawings, Figure 1 to Figure 4, and the quantity required.

STOCKING SPARE PARTS

Spare parts to be kept in inventory will vary according to service, field maintenance, allowable down time and number of units. A Minimum inventory of one complete set of bearings and one spare of each moving part is suggested.

RETURNING PARTS

A completed Return Material Authorization (RMA) form must accompany all materials returned to the factory. The RMA forms can be obtained direct from the factory or through your local Goulds Water Technology representative. The RMA form must be filled in completely and forwarded as directed thereon. Parts being returned under warranty claim must have a complete written report submitted with the RMA form.

⚠ WARNING *Returned goods must be free of any hazardous materials, substances, or residue.*

⚠ CAUTION *Returned material must be carefully packaged to prevent transit damage - the factory cannot assume any responsibility for parts damaged in transit.*



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LIMITED WARRANTY

Company warrants title to the product(s) and, except as noted with respect to items not of Company's manufacturer, also warrants the product(s) on date of shipment to Purchaser, to be of the kind and quality described herein, and free of defects in workmanship and material. THIS WARRANTY IS EXPRESSLY IN LIEU OF ALL OTHER WARRANTIES, INCLUDING BUT NOT LIMITED TO IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS, AND CONSTITUTES THE ONLY WARRANTY OF COMPANY WITH RESPECT TO THE PRODUCT(S).

If within one year from date of initial operation, but not more than 18 months from date of shipment by Company of any item of product(s), Purchaser discovers that such item was not as warranted above and promptly notifies Company in writing thereof, Company shall remedy such nonconformance by, at Company's option, adjustment or repair or replacement of the item and any affected part of the product(s). Purchaser shall assume all responsibility and expense for removal, reinstallation, and freight in connection with the foregoing remedies. The same obligations and conditions shall extend to replacement parts furnished by Company hereunder. Company shall have the right of disposal of parts replaced by it. Purchaser agrees to notify Company, in writing, of any apparent defects in design, material or workmanship, prior to performing any corrective action back-chargeable to the Company. Purchaser shall provide a detailed estimate for approval by the Company.

ANY SEPARATE LISTED ITEM OF THE PRODUCT(S) WHICH IS NOT MANUFACTURED BY THE COMPANY IS NOT WARRANTED BY COMPANY and shall be covered only by the express warranty, if any, of the manufacturer thereof.

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