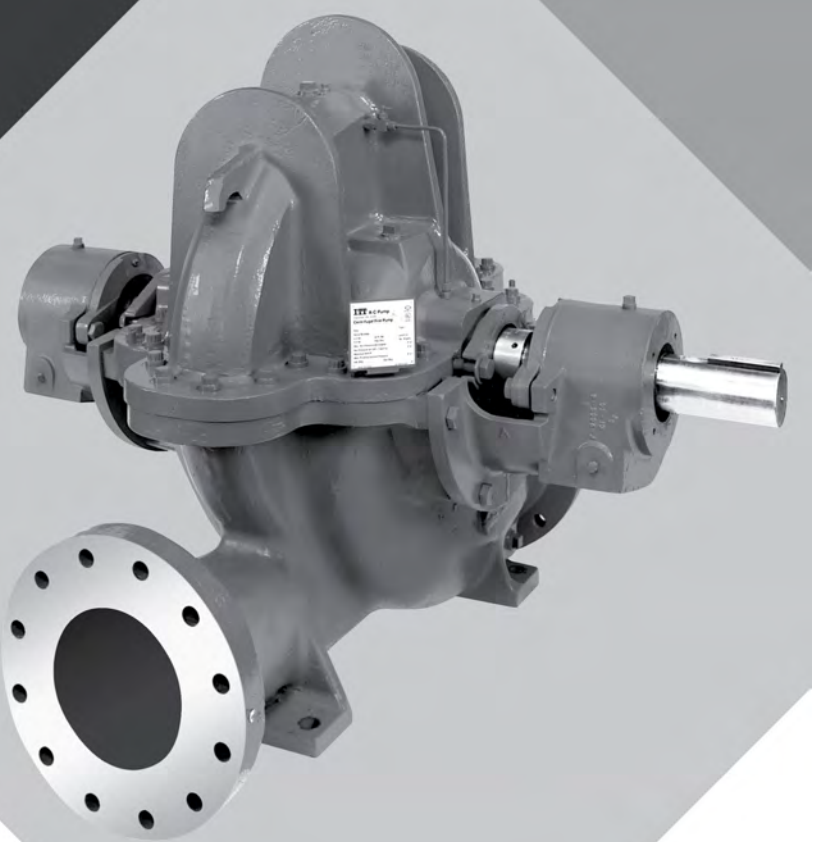
GOULDS PUMPS

Installation, Operation, and Maintenance Manual

Model 3409



ITT

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Table of Contents

Introduction and Safety

Introduction

Purpose of this manual

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

- Installation
- Operation
- Maintenance

CAUTION:
Read this manual carefully before installing and using the product. Improper use of the product can cause personal injury and damage to property, and may void the warranty.

NOTICE:
Save this manual for future reference, and keep it readily available at the location of the unit.

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 identification code when requesting technical information or spare parts.

Safety

WARNING:

- The operator must be aware of safety precautions to prevent physical injury.
- Any pressure-containing device can explode, rupture, or discharge its contents if it is over-pressurized. Take all necessary measures to avoid over-pressurization.
- Operating, installing, or maintaining the unit in any way that is not covered in this manual could cause death, serious personal injury, or damage to the equipment. This includes any modification to the equipment or use of parts not provided by ITT. If there is a question regarding the intended use of the equipment, please contact an ITT representative before proceeding.
- ⟨Ex⟩ This manual clearly identifies accepted methods for disassembling units. These methods must be adhered to. Trapped liquid can rapidly expand and result in a violent explosion and injury. Never apply heat to impellers, propellers, or their retaining devices to aid in their removal unless explicitly stated in this manual.
- Do not change the service application without the approval of an authorized ITT representative.
- Never operate the pump below the minimum rated flow, when dry, or without prime.
- Never operate the pump without safety devices installed.
- Never operate the pump with the discharge valve closed.
- Never operate the pump with the suction valve closed.
- 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. 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.

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
 **CAUTION:**	A hazardous situation which, if not avoided, could result in minor or moderate injury

Hazard level	Indication
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

The Ex symbol

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

Environmental safety

The work area

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

Recycling guidelines

Always recycle according to these guidelines:

1. If the unit or parts are accepted by an authorized recycling company, then follow local recycling laws and regulations.
2. If the unit or parts are not accepted by an authorized recycling company, then return them to the nearest ITT representative.

Waste and emissions regulations

Observe these safety regulations regarding waste and emissions:

- Dispose appropriately of all waste.
- Handle and dispose of the pumped fluid 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.

Reference for electrical installation

For electrical installation requirements, consult your local electric utility.

Recycling guidelines

Always follow local laws and regulations regarding recycling.

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:

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

NOTICE:
Never operate a unit unless safety devices are installed. Also see specific information about safety devices in other sections of this manual.

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.

Precautions before work

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

- Provide a suitable barrier around the work area, for example, a guard rail.
- Make sure that all safety guards are in place and secure.
- Allow all system and pump components to cool before you handle them.
- 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.
- Make sure that the product is thoroughly clean.
- Make sure that there are no poisonous gases within the work area.
- Make sure that you have quick access to a first-aid kit.
- Disconnect and lock out power before servicing.
- Check the explosion risk before you weld or use electric hand tools.

Precautions during work

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

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.

Safety regulations for Ex-approved products in potentially explosive atmospheres

Description of ATEX

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

Guidelines for compliance

WARNING:

This manual clearly identifies accepted methods for disassembling units. These methods must be adhered to. Trapped liquid can rapidly expand and result in a violent explosion and injury. Never apply heat to impellers, propellers, or their retaining devices to aid in their removal unless explicitly stated in this manual.

If there are any questions regarding these requirements, the intended use, or if the equipment requires modification, contact an ITT representative before you proceed.

Personnel requirements

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

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 and/or vapor present in hazardous areas.
- Any maintenance for Ex-approved products must conform to international and national standards (for example IEC/EN 60079-17).

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 stated on the nameplates.
- 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 working with 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.
- Intrinsically safe circuits are normally required for the automatic level-control system by the level regulator if mounted in zone 0.
- The yield stress of fasteners must be in accordance with the approval drawing and the product specification.
- Make sure that the equipment is properly maintained:
  - Monitor the pump components and the end temperature of the liquid.
  - Maintain proper bearing lubrication.
- Do not modify the equipment without approval from an authorized ITT representative.
- Only use parts that have been provided by an authorized ITT representative.

Equipment for monitoring

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

Monitoring equipment

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

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.

Transportation and Storage

Inspect the delivery

Inspect the package

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.
   If the product has been picked up at a distributor, make a claim directly to the distributor.

Inspect the unit

1. Remove packing materials from the product.
   Dispose of all packing materials in accordance with local regulations.
2. Inspect the product to determine if any parts have been damaged or are missing.
3. If applicable, unfasten the product by removing any screws, bolts, or straps.
   For your personal safety, be careful when you handle nails and straps.
4. Contact your sales representative if anything is out of order.

Transportation guidelines

Precautions

WARNING:

- Stay clear of suspended loads.
- Observe accident prevention regulations in force.

Lifting methods

WARNING:

- All lifting must be done in compliance with all applicable regulations/standards.
- Assembled units and their components are heavy. Failure to properly lift and support this equipment can result in serious physical injury and/or equipment damage. Lift equipment only at the specifically identified lifting points. Lifting devices such as hoist rings, shackles, slings and spreaders must be rated, selected, and used for the entire load being lifted.
- Crush hazard. The unit and the components can be heavy. Use proper lifting methods and wear steel-toed shoes at all times.
- Do not attach sling ropes to shaft ends.

The unit must be unloaded and handled by lifting equally at four or more points on the baseplate. The lugs on the upper half casing are designed for lifting the upper half of the casing only.

Pumps mounted horizontally

Pump mounting	Lifting method
A bare pump	Place a nylon sling, chain, or wire rope around both bearing housings.

Pump mounting	Lifting method
A pump mounted on a base that has lifting holes	**WARNING:** If the driver has been mounted on the baseplate at the factory, then it is safe to lift the entire assembly. **CAUTION:** Take care to size equipment for unbalanced loads that may exist if the driver is not mounted on the base at the time of lifting. The driver may or may not be mounted at the factory. Attach nylon slings, chains, or wire rope to ANSI/OSHA Standard S hooks. Then attach the hooks in the holes provided in the four corners of the base. Make sure that the points of the hooks do not touch the bottom of the pump base. Size the equipment for the load so that the lift angle is less than 45° from the vertical.
A pump mounted on a base that does not have lifting holes	Place one sling around the outboard bearing housing and place the another sling around the back-end of the driver as close to the mounting feet as possible. Make certain that the sling will not damage the housing cover or conduit boxes. Join the free ends of the slings together and place over the lifting hook.

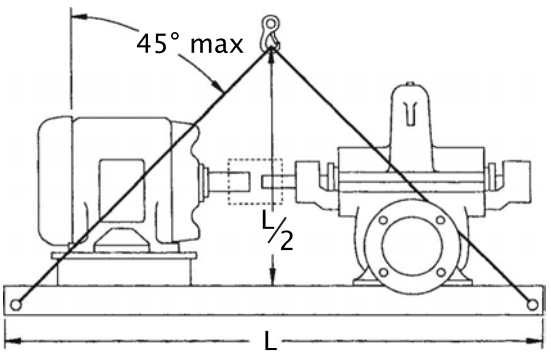


Figure 1: The proper lifting method for a horizontal pump on a base with lifting holes

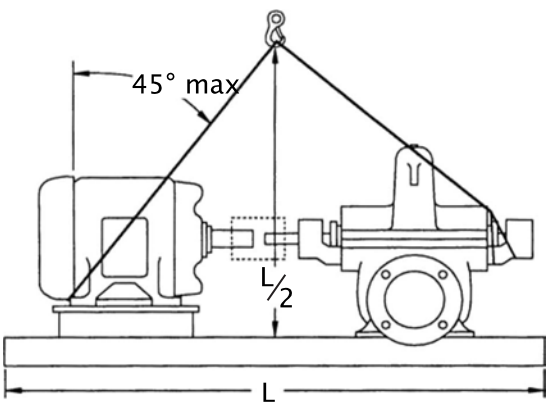
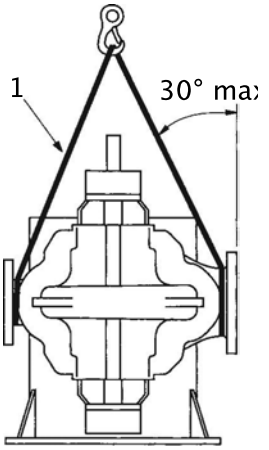


Figure 2: The proper lifting method for a horizontal pump on a base without lifting holes

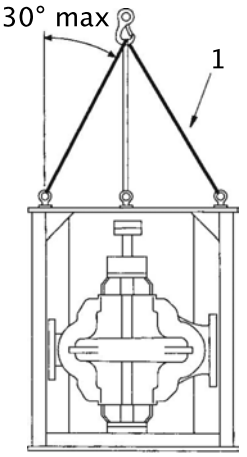
Pumps mounted vertically

Pump mounting	Lifting method
Half pedestal	Place a nylon sling chain or wire rope around both flanges. Use a latch hook or standard shackle and end loops. Be sure the lifting equipment is long enough to keep the lift angle less than 30° from the vertical.
Full pedestal	Install eyebolts in the three holes provided at the top of the support and tighten securely. Attach a chain or wire rope using a latch hook or standard shackle and end loop. You must use shoulder eyebolts that are manufactured per ANSI B18.15 and sized to fit the holes provided. Be sure the lifting equipment is long enough to keep the lift angle less than 30° from the vertical.



1. Nylon sling, chain, or wire rope

Figure 3: The proper lifting method for a vertical pump mounted on a half pedestal



1. Nylon sling, chain, or wire rope

Figure 4: The proper lifting method for a vertical pump mounted on a full pedestal

Storage guidelines

Pump storage requirements

Storage requirements depend on the amount of time that you store the unit. The normal packaging is designed only to protect the unit during shipping.

Length of time in storage	Storage requirements
Upon receipt/short-term (less than six months)	• Store in a covered and dry location. • Store the unit free from dirt and vibrations.

Length of time in storage	Storage requirements
Long-term (more than six months)	• Store in a covered and dry location. • Store the unit free from heat, dirt, and vibrations. • Rotate the shaft by hand several times at least every three months.

Treat bearing and machined surfaces so that they are well preserved. Refer to drive unit and coupling manufacturers for their long-term storage procedures.

You can purchase long-term storage treatment with the initial unit order or you can purchase it and apply it after the units are already in the field. Contact your local ITT sales representative.

Product Description

General description

Product description

Goulds Model 3409 is a double-suction, horizontally split-case pump. The product line consists of 11 sizes from size 6x10-22 through size 14x18-28.

Casing

The axially split, double-volute casing is constructed of cast iron, for working pressures up to 175 psig (some sizes have ratings of 300 psig), or ductile iron, for working pressures up to 400 psig (some sizes are limited to 300 psig). Suction and discharge flanges and mounting feet are cast integral with the lower half of the casing.

Tapped and plugged holes are provided for priming, vent, drain, and gauge connections. The upper half of the casing can be removed without disturbing suction or discharge piping. Flanges are ASA Standard 125/125#, 125/250#, or 250/250#. Suction and discharge are on a common centerline in both the horizontal and vertical planes.

Impeller

- Enclosed, double suction
- Bronze, ductile iron, or 316 stainless steel
- Statically and hydraulically balanced
- Keyed to the shaft
- Positioned axially by the shaft sleeves
- Hub with sufficient metal thickness to allow machining for installation of impeller rings

Shaft

The shaft is made of AISI 4140 steel, 316 stainless steel, or 17-4 ph stainless steel. The shaft size allows for operation under load with a minimum of deflection.

Shaft sleeves

- Bronze, 420 hardened stainless steel (packing only), 316 stainless steel, or cast iron
- Protect the shaft from wear and from contact with the pumped fluid
- An O-ring under the sleeve to prevent leaks

Stuffing box

- Non-asbestos packing
- Split-type gland to permit removal and access to packing
- Ample space for repacking the stuffing box
- Arranged for field or factory conversion to mechanical seals without machine work

Casing rings

- Made of bronze, cast iron, or Nitronic 60 stainless steel
- Installed with an anti-rotation device
- Designed to restrict leakage across the ring fit

Bearings

- Grease lubricated or oil lubricated
- Inboard, or coupling end, bearing: single row ball bearing
- Outboard bearing: double row cylindrical roller bearing, retained by a bearing locknut and lockwasher

Bearing housing

The bearing housings are bolted to the end of the lower half of the casing and assure positive alignment of the rotating element.

The housings provide a fit for the inboard bearing that allows freedom for thermal expansion. The outboard bearing is clamped in place in order to take all thrust loads and to keep the rotating element in its proper axial location. Openings for adding new grease and draining old grease are provided.

Baseplate

- Sufficiently rigid to support the pump and driver
- Steel construction
- Drip pan beneath pump end with tapped drain connection

Coupling

The coupling is all metal.

NOTICE:
The coupling used in an ATEX classified environment must be properly certified.

Coupling guard

The coupling guard is all metal.

CAUTION:
You must use a coupling guard made of a non-sparking material in an ATEX classified environment.

Rotation

The pump has a clockwise or counterclockwise rotation when viewed from the drive end.

Nameplate information

Important information for ordering

Every pump has nameplates that provide information about the pump. The nameplates are located on the casing and the bearing frame.

When you order spare parts, identify this pump information:

- Model
- Size
- Serial number
- Item numbers of the required parts

Refer to the nameplate on the pump casing for most of the information. See Parts List for item numbers.

Nameplate types

Nameplate	Description
Pump casing Pump	Provides information about the hydraulic characteristics of the pump. The formula for the pump size is: Discharge x Suction - Nominal Maximum Impeller Diameter in inches. (Example: 2x3-8)
Bearing frame	Provides information about the lubrication system used.
ATEX	If applicable, your pump unit might have an ATEX nameplate affixed to the pump, the baseplate, or the discharge head. The nameplate provides information about the ATEX specifications of this pump.

Nameplate on the pump casing

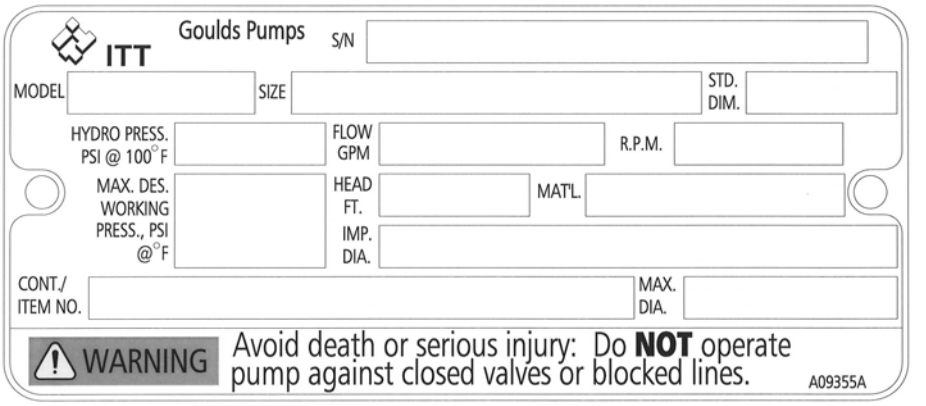


Figure 5: Nameplate on the pump casing

Nameplate field	Explanation
Size	Size of the pump
Type	Type of pump
Serial number	Serial number of the pump
GPM	Rated pump flow in gallons per minute
Head (ft)	Rated pump head, in feet
RPM	Rated pump speed, in revolutions per minute
Model number	Model number of the pump
Imp. Dia.	Impeller diameter
Max. Field Hydrotest Pressure PSI	Maximum field hydrostatic test pressure
Identification No.	A number which the end user of the pump requests to be put on the nameplate to identify the pump in his operation
Year	Year in which the pump was built

Nameplate on the bearing frame

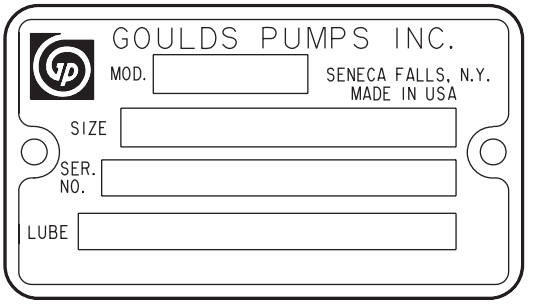


Figure 6: Nameplate on the bearing frame

Table 1: Explanation of the nameplate on the bearing frame

Nameplate field	Explanation
BRG. O. B.	Outboard bearing designation
BRG. I. B.	Inboard bearing designation
S/N	Serial number of the pump
LUBE	Lubricant, oil or grease

ATEX nameplate

Figure 7: ATEX nameplate

Nameplate field	Explanation
II	Group 2
2	Category 2
G/D	Pump can be used when gas and dust are present
T4	Temperature class

NOTICE:
Make sure that the code classifications on the pump are compatible with the specific environment in which you plan to install the equipment. If they are not compatible, do not operate the equipment and contact your ITT representative before you proceed.

Installation

Preinstallation

Precautions

WARNING:

- ⟨Ex⟩ When installing in a potentially explosive environment, make sure that the motor is properly certified.
- ⟨Ex⟩ You must earth (ground) all electrical equipment. This applies to the pump equipment, the driver, and any monitoring equipment. Test the earth (ground) lead to verify that it is connected correctly.
- Electrical connections must be made by certified electricians in compliance with all international, national, state, and local rules.

NOTICE:
Supervision by an authorized ITT representative is recommended to ensure proper installation. Failure to do so may result in equipment damage or decreased performance.

Pump location guidelines

WARNING:
Assembled units and their components are heavy. Failure to properly lift and support this equipment can result in serious physical injury and/or equipment damage. Lift equipment only at the specifically identified lifting points. Lifting devices such as hoist rings, shackles, slings and spreaders must be rated, selected, and used for the entire load being lifted.

Guideline	Explanation/comment
Keep the pump as close to the liquid source as practically possible.	This minimizes the friction loss and keeps the suction piping as short as possible.
Make sure that the space around the pump is sufficient.	This facilitates ventilation, inspection, maintenance, and service.
If you require lifting equipment such as a hoist or tackle, make sure that there is enough space above the pump.	This makes it easier to properly use the lifting equipment and safely remove and relocate the components to a safe location.
Protect the unit from weather and water damage due to rain, flooding, and freezing temperatures. If the possibility of freezing exists during a shutdown period, then drain the pump completely and use compressed air to blow out all passages and pockets where liquid might collect.	This is applicable if nothing else is specified.
Do not install and operate the equipment in closed systems unless the system is constructed with properly-sized safety devices and control devices.	Acceptable devices: • Pressure relief valves • Compression tanks • Pressure controls • Temperature controls • Flow controls If the system does not include these devices, consult the engineer or architect in charge before you operate the pump.
Take into consideration the occurrence of unwanted noise and vibration.	The best pump location for noise and vibration absorption is on a concrete floor with subsoil underneath.
If the pump location is overhead, undertake special precautions to reduce possible noise transmission.	Consider a consultation with a noise specialist.
When possible, locate the pump below the fluid level.	This facilitates priming, ensures a steady flow of liquid, and provides a positive suction head on the pump.

Guideline	Explanation/comment
Make sure there is a suitable power source available for the pump driver.	If the pump is motor-driven, then the electrical characteristics of the power source should be identical to those shown on motor data plate.

The installation must be evaluated to determine that the Net Positive Suction Head Available ($NPSH_A$) meets or exceeds the Net Positive Suction Head Required ($NPSH_R$), as stated by the pump performance curve.

Foundation requirements

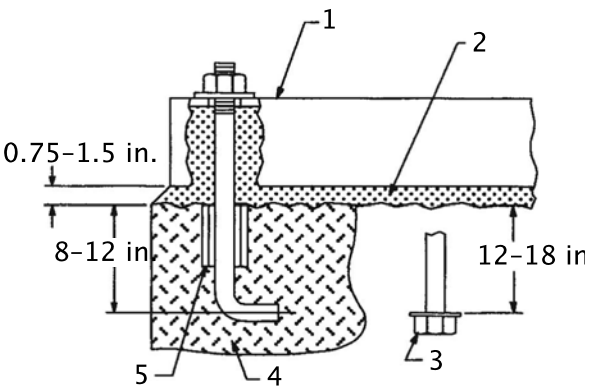
Requirements

- The foundation must be able to absorb any type of vibration and form a permanent, rigid support for the unit.
- The foundation must weigh at least five times the weight of the pump unit.
- Provide a flat, substantial concrete foundation in order to prevent strain and distortion when you tighten the foundation bolts.
- Allow the foundation to cure for several days before you proceed with the pump installation.
- The foundation must be poured to within 0.75–1.5 in. (1.905–3.81 cm) of the finished height.

Foundation bolts

- Foundation bolts must be embedded in the concrete to a depth of 8âM M 12 in. (20âM M 30 cm) and locked with either a hook around a reinforcing bar or a nut and washer at the bottom.
- Foundation bolts must have a sleeve around them at least six times the bolt diameter in length and at least two bolt sizes larger in ID.
- If a nut and washer are used for locking, then the washer must have an OD two sizes larger than the sleeve.
- Foundation bolts must be sized 0.125 in. (3.175 mm) less than the anchor bolt holes in the base.

Bolt installation diagram



1. Baseplate
2. Grout
3. Alternate bolt and washer
4. Concrete
5. Bolt sleeve

Figure 8: Bolt installation

Set the baseplate

Pumps are checked at the factory for the ability to be aligned to the required tolerances. Due to the flexibility of an ungrouted base and handling in shipment, do not assume that the unit is in alignment when it is placed on the rough foundation. If these directions are followed, then the required alignment must be readily achieved.

1. Perform the initial or rough alignment.
   Rough alignment is designated as 0.020 in. (0.051 cm) TIR for parallel alignment and 0.009 in. (0.023 cm) TIR per inch of radius for angular alignment. Use blocks at the anchor bolts and midway between to position the bottom of the base at a finished height with the foundation bolts extending through the holes in the baseplate. Instead of blocks and shims, you can also use metal wedges with a small taper.
2. If the unit has a non-flexible coupling, such as a Falk Gear coupling, then disconnect the coupling halves.
   This is usually not necessary on flexible-type couplings, such as Wood's Sure-Flex coupling.
3. Tighten all pump and motor bolts.
   This ensures that bolts have not loosened or that a soft foot has not occurred due to base distortion during shipment. A soft foot causes a change in the alignment when one bolt is loosened.
4. If the driver is being installed in the field, then make sure it is centered in its bolt holes with shims added to bring the driver into rough alignment with the pump.
   Move the pump also, if necessary.

   NOTICE:
   Risk of improper alignment. Do not use more than six shims and use the thickest shims possible. Place thin shims in between thick shims.

5. Level and plumb the pump shaft, coupling faces, and flanges by adding or removing shims between the blocks and the bottom of the base.
6. Hand-tighten the anchor bolt nuts. Then tighten the nuts with a wrench, taking care not to distort the base.
   Do not reconnect the non-flexible coupling until after you complete the alignment operation. The baseplate does not need to be level.
7. After the foundation bolts are lightly torqued, recheck the alignment requirements.
   If the alignment must be corrected, then add or remove shims or wedges under the baseplate.

Pump-to-driver alignment

Precautions

WARNING:

- Follow shaft alignment procedures in order to prevent catastrophic failure of drive components or unintended contact of rotating parts. Follow the coupling installation and operation procedures from the coupling manufacturer.
- Ⓔx Always disconnect and lock out power to the driver before you perform any installation or maintenance tasks. Failure to disconnect and lock out driver power will result in serious physical injury.
  - Electrical connections must be made by certified electricians in compliance with all international, national, state, and local rules.
  - Refer to driver/coupling/gear manufacturers installation and operation manuals (IOM) for specific instructions and recommendations.

NOTICE:
Proper alignment is the responsibility of the installer and the user of the unit. Check the alignment of frame-mounted units before you operate the unit. Failure to do so can result in equipment damage or decreased performance.

Alignment checks

When to perform alignment checks

You must perform alignment checks under these circumstances:

- The process temperature changes.
- The piping changes.
- The pump has been serviced.

Types of misalignment

Type of misalignment	Description
Angular misalignment	Shafts have an axis concentric at the intersection but not parallel.
Parallel offset misalignment	Shafts have an axis parallel but offset.

Check and correct angular misalignment before correcting parallel misalignment.

Permissible coupling misalignment

Type of misalignment	Single element coupling	Double element (spacer) coupling
Parallel misalignment	0.004 in. (0.1 mm) TIR (4 mils)	0.060 in. (1.52 mm) TIR per foot of spacer length
Angular misalignment	0.004 in. (0.1 mm) TIR per inch of radius.	0.002 in. (0.51 mm) TIR per inch of radius

Types of alignment checks

Type of check	When it is used
Initial alignment (cold alignment) check	Prior to operation when the pump and the driver are at ambient temperature.
Final alignment (hot alignment) check	After operation when the pump and the driver are at operating temperature.

To make the final alignment, move and shim the motor on its base until the coupling hubs are within the recommended tolerances measured in total runout. Take all measurements with the pump and driver bolts tightened. Make the final alignment check after the unit has attained its final operating temperature.

Initial alignment (cold alignment) checks

When	Why
Before you grout the baseplate	This ensures that alignment can be accomplished.
After you grout the baseplate	This ensures that no changes have occurred during the grouting process.
After you connect the piping	This ensures that pipe strains have not altered the alignment.

Final alignment (hot alignment) checks

When	Why
After the first run	This ensures correct alignment when both the pump and the driver are at operating temperature.
Periodically	This follows the plant operating procedures.

Cold settings for parallel vertical alignment

Introduction

This section shows the recommended preliminary (cold) settings for electric motor-driven pumps based on different temperatures of pumped fluid. Consult driver manufacturers for recommended cold settings for other types of drivers such as steam turbines and engines.

Recommended settings

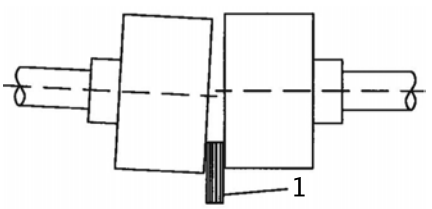
Pumped fluid temperature	Recommended setting for driver shaft
Ambient	0.05 mm | 0.002 in. to 0.102 mm | 0.004 in., low
38°C | 100°F	0.00 mm | 0.000 in. to 0.05 mm | 0.002 in, high
93°C | 200°F	0.102 mm | 0.004 in. to 0.152 mm | 0.006 in., high
149°C | 300°F	0.203 mm | 0.008 in. to 0.254 mm | 0.010 in., high
204°C | 400°F	0.305 mm | 0.012 in. to 0.356 mm | 0.014 in., high

Align the pump using a straight edge

Before you begin, you must have a straight edge and a taper gauge or set of feeler gauges.

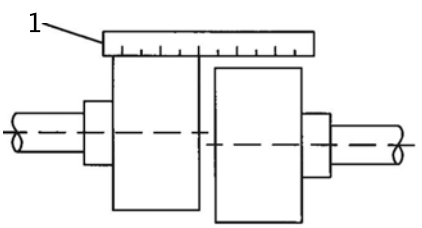
Only use this method if the face and outside diameters of the coupling halves are square and concentric with the coupling bores. If this condition does not exist or elastomeric couplings do not make this method convenient, then use the dial indicator method.

1. Check for angular alignment by inserting the taper or feeler gauges between the coupling faces at 90° intervals.
   The unit is in angular alignment when these four measurements are the same or are within recommended tolerances.
2. Check for parallel alignment by placing a straight edge across both coupling rims on all four sides.
   The unit is in parallel alignment when the straight edge rests evenly across both coupling rims in all four positions.



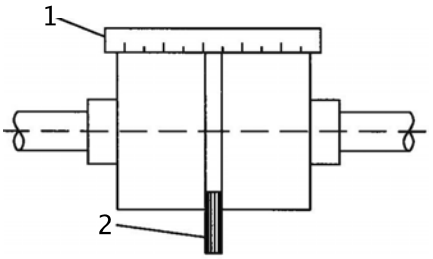
1. Feeler gauge

Figure 9: Incorrect angular alignment



1. Straight edge

Figure 10: Incorrect parallel alignment



1. Straight edge
2. Feeler gauge

Figure 11: Correct alignment

Align the pump using a dial indicator

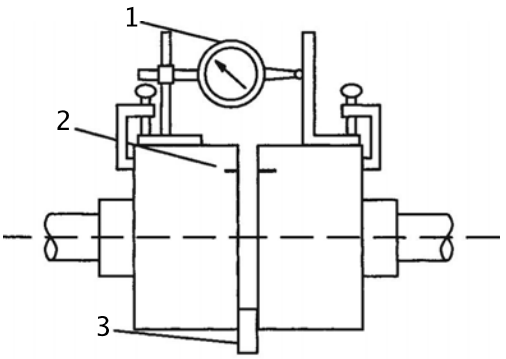
Before you begin, you must have a dial indicator with a mounting magnet and extension bars.

A dial indicator can provide more accurate alignment than a straight edge.

1. Fasten the indicator stand or magnetic base to the pump half of the coupling.
2. Adjust the assembly until the indicator button is resting on the periphery of the other coupling half.
3. Set the dial to zero and use chalk to mark the coupling half where the button rests. Then place a separator between the coupling halves so that the bearing slack does not affect the readings.
   Chalk and separators are not necessary on the elastomeric couplings that have not been disconnected.
4. Rotate both shafts by the same amount.
   All readings must be made with the button on the chalk mark.
   The dial readings will indicate whether the driver must be raised, lowered, or moved to either side. You can accurately align the shaft centers with this method even where faces or outside diameters of the coupling are not square or concentric with the bores.

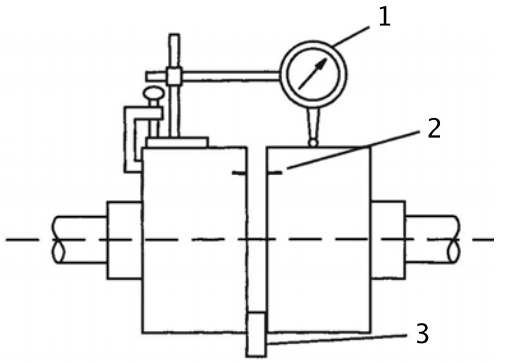
   NOTICE:
   Risk for rotation unbalance. Any gross deviation in squareness or concentricity must be corrected.

5. After each adjustment, recheck both parallel and angular alignments.



1. Dial indicator
2. Reference mark
3. Separator to take up the bearing slack

Figure 12: Angular alignment



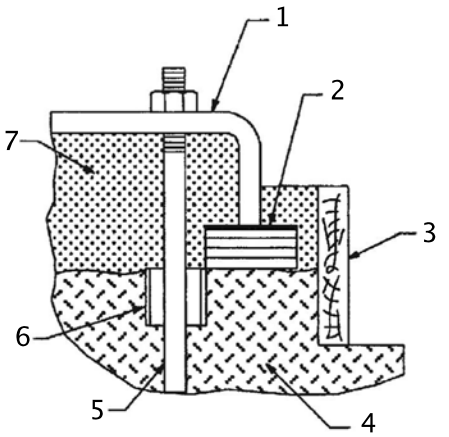
1. Dial indicator
2. Reference mark
3. Separator to take up the bearing slack

Figure 13: Parallel alignment

Grout the baseplate

CAUTION:
Do not grout until the initial alignment is made.

Grout compensates for an uneven foundation. Together with the baseplate, grout makes a very rigid interface between the pump and the foundation by distributing the weight over the length of the base and preventing shifting. Use an approved, non-shrinking grout such as Embeco 636 or 885 by Master Builders, Cleveland, Ohio, or the equivalent.



1. Baseplate
2. Shims
3. Form
4. Concrete
5. Anchor bolt
6. Bolt sleeve
7. Grout

Figure 14: Baseplate grouting

1. Build a strong form around the foundation to contain the grout.
2. Soak the top of the foundation thoroughly, then remove surface water.
3. Completely fill the baseplate with grout.

If necessary, temporarily use air relief tubing or drill vent holes in order to remove trapped air.

4. After the grout has completely hardened, tighten the foundation bolts.
   It will take approximately 24 hours for the grout to harden.
5. Check the alignment.
6. Approximately fourteen days after the grout has been poured and the grout has completely dried, apply an oil-based paint to the exposed edges of the grout in order to prevent air and moisture from coming in contact with the grout.

Piping checklists

General piping checklist

Precautions

CAUTION:

- Never draw piping into place by using force at the flanged connections of the pump. This can impose dangerous strains on the unit and cause misalignment between the pump and driver. Pipe strain adversely affects the operation of the pump, which results in physical injury and damage to the equipment.
- 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.
- Do not move the pump to the pipe. This could make final alignment impossible.

CAUTION:

Ex Flange loads from the piping system, including those from the thermal expansion of the piping, must not exceed the limits of the pump. Casing deformation can result in contact with rotating parts, which can result in excess heat generation, sparks, and premature failure.

Piping guidelines

Guidelines for piping are given in the Hydraulic Institute Standards available from the Hydraulic Institute at 9 Sylvan Way, Parsippany, NJ 07054-3802. You must review this document before you install the pump.

Checklist

Check	Explanation/comment	Checked
Check that all piping is supported independently of, and lined up naturally with, the pump flange.	This helps to prevent: • Strain on the pump • Misalignment between the pump and the drive unit • Wear on the pump bearings, seal, and shafting	
Keep the piping as straight as possible. Avoid unnecessary bends. Use 45° or long radius 90° fittings where necessary.	This helps to minimize friction losses.	
Check that only necessary fittings are used.	This helps to minimize friction losses.	
Make sure that the inside diameters match properly when you use flange joints.	—	
Do not connect the piping to the pump until: • The grout for the baseplate or sub-base becomes hard. • The hold-down bolts for the pump are tightened.	—	

Check	Explanation/comment	Checked
Make sure that all the piping joints and fittings are airtight.	This prevents air from entering the piping system or leaks that occur during operation.	
If the pump handles corrosive fluids, make sure that the piping allows you to flush out the liquid before you remove the pump.		
If the pump handles liquids at elevated temperatures, make sure that the expansion loops and joints are properly installed.	This helps to prevent misalignment due to thermal expansion of the piping.	
Make sure that all piping components, valves and fittings, and pump branches are clean prior to assembly.	—	

Suction piping checklist

The sizing and installation of the suction piping is extremely important. It must be selected and installed so that pressure losses are minimized and sufficient liquid flows into the pump when it is started and operated. Many NPSH problems can be directly attributed to improper suction piping systems.

CAUTION:

- Flange loads from the piping system, including those from the thermal expansion of the piping, must not exceed the limits of the pump. Deformation can result in contact with rotating parts, which can result in excess heat generation, sparks, and premature failure.
- Air pockets can form in the top of the reducer and the pipe when operating on suction lift. Never use a concentric reducer in a horizontal line.

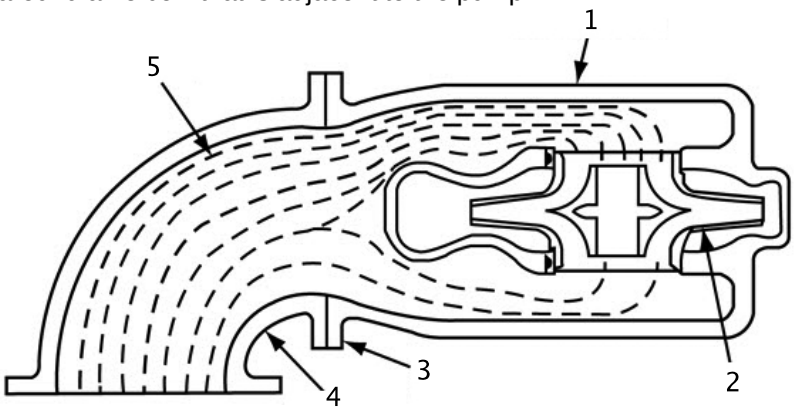
Piping checklist

Check	Explanation/comment	Checked
Check that the elbows in the suction piping for horizontal double-suction pumps are installed per the Hydraulics Institute Standards since there is always an uneven turbulent flow around an elbow.	When there is an elbow in a position other than the vertical when in relation to the pump suction nozzle, this causes more liquid to enter one side of the impeller than the other. The result is highly unequalized thrust loads that overheat the bearings and cause rapid wear, which adversely affects the hydraulic performance. See the Example of unbalanced loading figure.	
Check that pipe reducers on the inlet side have no more than one pipe diameter reduction in a single reducer.	This avoids excessive turbulence and noise.	
When operating on a suction lift, check that the suction pipe slopes upward to the pump nozzle.	A horizontal suction line must have a gradual rise to the pump. Any high point in the pipe can become filled with air and prevent proper operation of the pump.	
(Optional) You can install a short section of pipe adjacent to the suction flange such as Dutchman or a spool piece that is designed so that it can be readily dropped out of the line.	This facilitates the cleansing of the liquid passage of the pump without dismantling the pump. With this arrangement, anything that clogs the impeller is accessible with the removal of the spool piece or pipe section.	

Example of unbalanced loading

CAUTION:
Risk of excessive axial load or cavitation. Do not install an elbow directly before the suction of a double suction pump if the plane of the suction is parallel to the pump shaft. Alternatively, install an elbow with straightening vanes to help evenly distribute the flow.

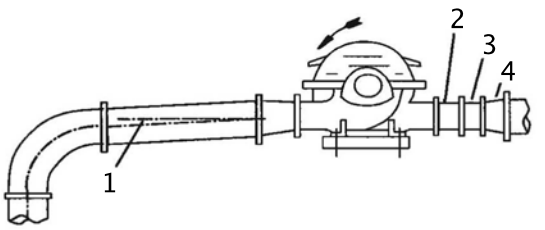
This figure shows the unbalanced loading of a double-suction impeller due to the uneven flow around an elbow that is adjacent to the pump:



1. Pump casing
2. Impeller
3. Pump suction flange
4. Suction elbow
5. Water velocity increases here and causes a greater flow to one side of the impeller.

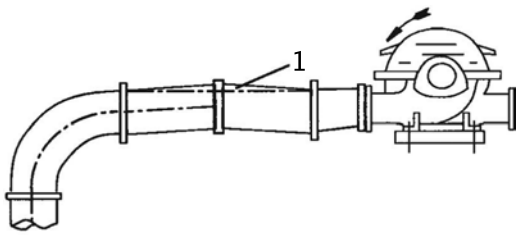
Figure 15: Unbalanced loading of double-suction impeller

Examples



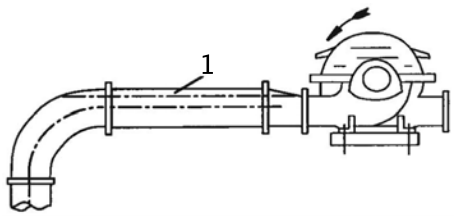
1. Level centerline of pipe
2. Check valve
3. Gate valve
4. Increaser

Figure 16: Suction pipe installed with a gradual rise to the pump – correct



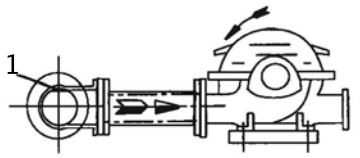
1. Air pocket

Figure 17: Suction pipe installed with a gradual rise to the pump – incorrect



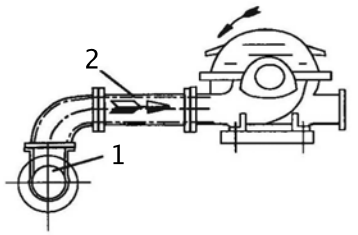
1. Air pocket

Figure 18: Suction pipe installed with a reducer – incorrect



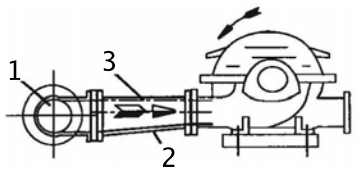
1. Air pocket

Figure 19: Incorrect



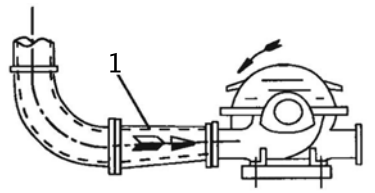
1. No air pockets
2. Gradual rise

Figure 20: Correct



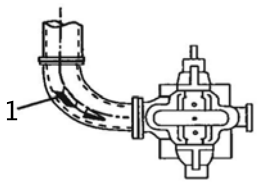
1. No air pockets
2. Eccentric reducer
3. Gradual rise

Figure 21: Gradual rise to the pump – correct



1. Distance plus eccentric reducer straightens the flow

Figure 22: Suction pipe above the pump – correct



1. Path of the water

Figure 23: Suction pipe above the pump – incorrect

Suction-piping valve considerations

Suction valves

CAUTION:
Never throttle the flow from the suction side. Only use suction valves to isolate the pump for maintenance, and install such valves in positions to avoid air pockets.

Before you install suction valves in the suction piping, review these considerations:

- Make sure that the suction piping valves are placed right before the run of recommended straight pipe.
- Never throttle the pump with the use of a valve on the suction side of the pump.
- Only use suction valves to isolate the pump for maintenance purposes.
- Always install the valve in a position that avoids the formation of air pockets.

Foot valves

If the pump operates under static suction lift conditions, you can install a foot valve in the suction line in order to avoid the necessity of priming each time you start the pump.

Before you install foot valves in the suction piping, review these considerations:

- Make sure this valve is of the flapper type, rather than the multiple spring type, and that it is sized to avoid excessive friction in the suction line.
- Size the foot valve and pipe in order to maximize $NPSH_A$ to the pump by minimizing suction line losses.
- When foot valves are used, or where there are other possibilities of water hammer, close the discharge valve slowly before you shut down the pump.

Check valves

In normal applications, check valves are placed in the discharge piping. Before you use a check valve in the suction piping, consider the added pressure drop to the pump, the potential of water hammer, and the chance of allowing the entire pump volute to be exposed to the discharge pressure.

Gate valves

Where two or more pumps are connected to the same suction line, install gate valves so that any pump can be isolated from the line.

Before you install gate valves, review these considerations:

- Always install gate valves on the suction side of the pumps with a positive pressure for maintenance purposes.
- Always install gate valves with the stems in a horizontal position to avoid air pockets.
- Globe valves should not be used, particularly where NPSH is critical.

Discharge piping considerations

Before you construct discharge piping, review these considerations:

- If the discharge piping is short, then the pipe diameter can be the same as the discharge opening.
- If the piping is long, then the pipe diameter should be one or two sizes larger than the discharge opening.
- On long horizontal runs, it is desirable to maintain the most even grade possible.
- Avoid high spots, such as loops. High spots will collect air and throttle the system or lead to erratic pumping.
- A check valve and an isolating gate valve should be installed in the discharge line.
  - The check valve is placed between the pump and the gate valve. This protects the pump from excessive backpressure and prevents liquid from running back through the pump in case of power failure.
  - The gate valve is used for priming and starting and also shutting down the pump.

Pressure gauges

Install properly sized pressure gauges in both the suction and discharge nozzles in the gauge taps provided. The gauges enable the operator to observe the operation of the pump and to determine whether the pump is operating in conformance with the performance curve. If cavitation, vapor binding, or other unstable operations occur, then widely fluctuating discharge pressure will be noted.

Pump doweling

Pump units can be doweled on diagonally opposite feet. Do not do this until the unit has run for a sufficient length of time and alignment is within the required alignment tolerance.

Commissioning, Startup, Operation, and Shutdown

Preparation for startup

WARNING:

- Ⓔx Always disconnect and lock out power to the driver before you perform any installation or maintenance tasks. Failure to disconnect and lock out driver power will result in serious physical injury.
  - Electrical connections must be made by certified electricians in compliance with all international, national, state, and local rules.
  - Refer to driver/coupling/gear manufacturers installation and operation manuals (IOM) for specific instructions and recommendations.
- Electrical connections must be made by certified electricians in compliance with all international, national, state, and local rules.
- Never operate a pump without a properly installed coupling guard. Personal injury will occur if you run the pump without a coupling guard.
- Check the rotation of the power unit and pump in relation to that of the drive as shown by the arrows on the case. Rotate the drive manually before you apply power-checking rotation. Do not operate in the reverse direction of these arrows as serious damage or injury can occur.

CAUTION:

- Serious damage to the pump may result if it is started dry. Make sure that the pump is completely filled with liquid before it is started.

System flushing

Flush new and old systems in order to eliminate all foreign matter. Heavy scale, welding splatter, and wire or other large foreign matter can clog the pump impeller. This reduces the capacity of the pump which then causes cavitation, excessive vibration, and/or damage to close clearance parts such as wear rings, seals, and sleeves.

Pre-operation inspections

NOTICE:
Foreign objects in the pumped liquid or piping system can block the flow and cause excess heat generation, sparks and premature failure. Make sure that the pump and systems are free of foreign objects before and during operation.

Perform these inspections before you start the pump:

- Check the alignment between the pump and motor.
  See Coupling alignment in the Installation chapter for alignment requirements.
- Check all connections to the motor and starting device against the wiring diagram.
  Check the voltage, phase, and frequency on the motor nameplate against the line circuit.
- Check the suction and discharge piping and the pressure gauges for proper operation.
- Check that you can turn the rotating element by hand in order to verify that it rotates freely.
- Check the stuffing box adjustment, lubrication, and piping.
- Check the driver lubrication.
  Refer to the driver Installation, Operation, and Maintenance manual.

- Check that the pump bearings are properly lubricated.
- If the pump is oil lubrication, check that the oil level is correct prior to starting pump.
- If the pump is oil mist lubrication, check that the mist is flowing properly prior to starting pump.
- Check that the coupling is properly lubricated, if required.
- Check that the pump is full of liquid and that all valves are properly set and operational, with the discharge valve closed and the suction valve fully open. Purge all air from the top of the casing.
- Check the direction of the rotation.
  Be sure that the driver operates in the direction indicated by the arrow on the pump casing. Serious damage can result if you operate the pump with the incorrect rotation. Check the rotation each time you disconnect the motor leads.

Pump priming

CAUTION:
Do not run the pump dry.

When to prime the pump

You must prime the pump before startup. When it is possible, locate the pump below the fluid level in order to facilitate priming and to ensure a steady flow of liquid. This condition provides a positive suction head on the pump. It is also possible to prime the pump by pressurizing the suction vessel.

Methods for pump priming

Pump installation	Priming method
Positive head on the suction	Open the suction valve and loosen the vent plug on top of the casing. This allows air to be purged from the casing. While you vent the air from the pump body, always rotate the pump shaft a few times by hand.
Suction lift	Priming must be done by other methods such as foot valves, ejectors, or by manually filling the casing and suction line.

Fill the system

DANGER:
All openings (e.g. pipe connections, flanges) must be sealed off with proper fitting and material prior to filling pump. Failure to plug all openings will result in personal injury.

1. Locate the vents at the highest point so that trapped gases and air can escape.
   However, if the gases are flammable, toxic, or corrosive, then vent them to an appropriate place in order to prevent harm to personnel or to other parts of the system.
2. Check the pipe hangers and anchors to make sure that they are properly set to take the additional weight of the pumped fluid.
3. Close all of the drains.
4. Fill the system slowly so that excessive velocities do not cause rotation of the pumping elements.
   Rotation of the pumping elements can cause damage to the pump or its driver.
5. Check the adequacy of the anchors and hangers:
   a) Mount a dial indicator off of any rigid structure not tied to the piping.

b) Set the indicator button on the pump flange in the axial direction of the nozzle.
If the indicator moves as the filling proceeds, then the anchors and supports are not adequate or are not set properly. Take corrective measures.

Start the pump

1. Close the drain valves.
2. Completely open all valves in the suction and discharge lines.
3. Turn on the seal water to the stuffing box.
These lines must always be left open if the pumped fluid is dirty or if there is the possibility of air leaks.
4. Prime the pump.

NOTICE:
Make sure that the pump is properly primed. If it is not, then shut down the pump and correct the condition.

5. Start the pump driver.
Turbines and engines can require a brief warm-up period. Consult the instructions provided by the engine manufacturer.
6. When the pump is operating at full speed, make sure that the check valve has opened.
The check valve must open five seconds or less after startup in order to prevent damage to the pump by operating at zero flow.
7. Adjust the liquid seal valves to produce the recommended pressure for either the mechanical seal or the packed stuffing box.

Operational checklist

Check	Explanation/comment	Checked
Driver rotation	Check the rotation each time the motor leads are disconnected.  **WARNING:** Check the rotation of the power unit and pump in relation to that of the drive as shown by the arrows on the case. Rotate the drive manually before you apply power-checking rotation. Do not operate in the reverse direction of these arrows as serious damage or injury can occur.	
Stuffing box adjustment	Make stuffing box packing gland and lubrication adjustments.	
Flow	It is difficult to accurately measure flow rate (volume/time). Any of the following methods of measuring can be used: • Venturi meters • Flow nozzles • Orifice plates • Timing the draw down in the wet well Record any reading for future reference.	

Check	Explanation/comment	Checked
Pressure	Check and record both suction and discharge pressure gauge readings for future reference. Also record the following: • Voltage • Amperage per phase • Kilowatts (if an indicating wattmeter is available) • Pump speed	
Temperature	Check and record bearing temperatures using a thermometer. The temperature should not exceed 180°F (82°C).	
Vibration and sound	The acceptable vibration level of a centrifugal pump depends on the rigidity of the pump and the supporting structure. Recommended values for vibration can vary between 0.20–0.60 ips (inches per second) velocity depending on the operating characteristics and the structure. Refer to the Centrifugal Pump section of the Hydraulic Institute Standards for a complete description and charts on various pumps. Field sound levels are difficult to measure because of background noise from piping, valves, drivers, gears, and other parts. Follow the recommendations in the Hydraulic Institute Standards.	

Shut down the pump

WARNING:
Always disconnect and lock out power before servicing to prevent unexpected startup. Failure to do so could result in death or serious injury.
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. 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.

1. Shut down the pump driver.
   Consult the manufacturer instructions for special operations.
2. Close the suction and discharge valves.
3. Close the seal liquid valves.
   However, in order to prevent contamination to the packing, leave these lines open unless the pump is completely drained.
4. Open drain valves as required.

Freeze protection

Pumps that are shut down during freezing conditions must be protected using one of the following methods:

- Drain the pump and remove all liquid from the casing.
- Keep fluid moving in the pump and insulate or heat the pump to prevent freezing.

NOTICE:
If heat is used to prevent the pump from freezing, then the temperature should not rise above 66°C | 150°F.

Maintenance

Maintenance schedule

CAUTION:
Shorten the inspection intervals if the pumped liquid is abrasive or corrosive, or if the environment is classified as potentially explosive.

NOTICE:
This timetable assumes that the unit has been constantly monitored after startup. Adjust the timetable for any extreme or unusual applications or conditions.

Monthly inspections

Check the bearing temperature with a thermometer. Do not check the temperature by hand. If the bearings are running over 180°F (82°C), then there is too much or too little lubricant.

If changing the lubricant or adjusting to the proper level does not correct the condition, then disassemble and inspect the bearings.

Three-month inspections

Perform these tasks every three months:

- Check the oil on oil-lubricated units.
- Check the grease-lubricated bearings for saponification. This condition is usually caused by the infiltration of water or other fluid. Saponification gives the grease a whitish color. If this condition occurs, then wash out the bearings with a clean industrial solvent and replace the grease with the proper type as recommended.

Six-month inspections

Perform these tasks every six months:

- Check the packing and replace if necessary. Use the grade recommended. Make sure the seal cages are centered in the stuffing box at the entrance of the stuffing box piping connection.
- Take vibration readings on the bearing housings. Compare the readings with the last set of readings to check for possible pump component failure.
- Check the shaft or shaft sleeve for scoring. Scoring accelerates packing wear.
- Check the alignment of the pump and driver. Shim the units if necessary. If misalignment reoccurs frequently, then inspect the entire piping system. Unbolt the piping at the suction and discharge flanges to see if it springs away, which indicates strain on the casing. Inspect all piping supports for soundness and effective support of load. Correct as necessary.

Annual inspections

Perform these inspections one time each year:

- Remove the upper half of the casing. Inspect the pump thoroughly for wear. Order replacement parts if necessary.
- Check the wear ring clearances. Replace the wear rings when clearances become three times their normal clearance or when you observe a significant decrease in discharge pressure for the same flow rate.
- Remove any deposit or scaling.
- Clean out the stuffing box piping.

- Measure the total dynamic suction and discharge head in order to test pump performance and pipe condition. Record the figures and compare them with the figures of the last test. This is especially important where the pumped liquid tends to form a deposit on internal surfaces.
- Inspect foot valves and check valves. A faulty foot or check valve will cause poor performance. The check valve safeguards against water hammer when the pump stops.

Flood-damaged pumps

If the pump is properly sealed at all joints and connected to both suction and discharge, then it will exclude outside liquid. Therefore, it is only necessary to service the bearings, stuffing box, and coupling after flood damage.

Perform the following service on a centrifugal pump after a flooded condition:

- Dismantle the frame, and then inspect the bearings for any rusted or badly worn surfaces. Clean as necessary. If the bearings are free from rust and wear, then reassemble and relubricate them with one of the recommended lubricants. Depending on the length of time the pump has remained in the flooded area, it is unlikely that bearing replacement is necessary. Only replace the bearings if rust or worn surfaces appear.
- Inspect the stuffing box and clean out any foreign matter that will clog the box. Replace packing that appears to be worn or no longer regulates leakage properly. Clean and thoroughly flush mechanical seals.
- Dismantle and thoroughly clean the couplings. Lubricate the couplings where required with one of the lubricants recommended by the coupling manufacturer.

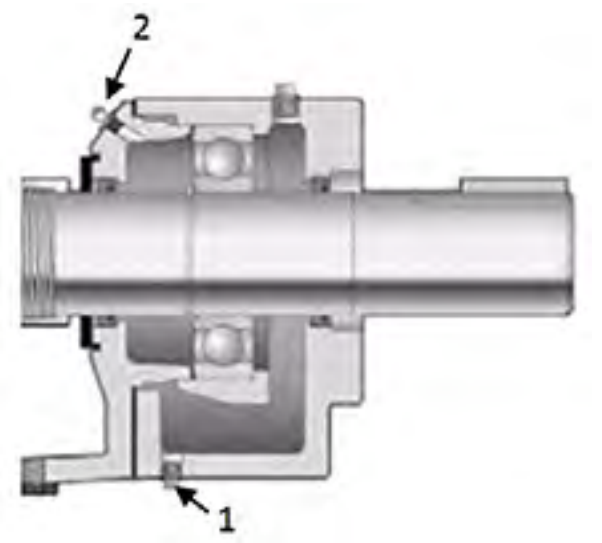
Bearing maintenance

⟨Ex⟩ These bearing lubrication sections list different temperatures of the pumped fluid. If the pump is ATEX-certified and the temperature of the pumped fluid exceeds the permitted temperature values, then consult your ITT representative.

Regrease the grease-lubricated bearings

CAUTION:
Grease-lubricated bearings are lubricated at the factory. Do not grease too frequently.

NOTICE:
Make sure that the grease container, the greasing device, and the fittings are clean. Failure to do this can result in impurities entering the bearing housing when you regrease the bearings.



1. Relief plug
2. Fitting

Figure 24: Grease lubricated bearings

1. Wipe dirt from the grease fittings.
2. Remove the two grease-relief plugs on the bearing housings.
3. Fill both of the grease cavities through the fittings with a recommended grease until the fresh grease comes out of the relief holes.
4. Run the pump for about 30 minutes or until grease no longer comes out of the housing.
5. Reinstall the grease-relief plugs.
6. Wipe off any excess grease.
7. Recheck the alignment.

The bearing temperature usually rises after you regrease due to an excess supply of grease. Temperatures return to normal in about two to four operating hours as the pump runs and purges the excess grease from the bearings.

Lubricating-grease requirements

Grease-lubricated ball bearings are standard on this model. A grease-lubricated bearing can be identified by grease fittings located on the bearing housing.

Precautions

NOTICE:

- Never mix greases of different consistencies (NLGI 1 or 3 with NLGI 2) or with different thickeners. For example, never mix a lithium-based grease with a polyurea-based grease. Doing so may result in decreased performance.
- Remove the bearings and old grease if you need to change the grease type or consistency. Failure to do so may result in equipment damage or decreased performance.

Recommended grease types

- Mobilux EP No. 2
- Texaco Multifak EP-2
- ShellAlvania EP-2

Requirements

Keep the following points in mind when lubricating with grease:

- Grease must be of sodium or lithium base with a NLGI-2 consistency. Do not use graphite.

- Greases made from animal or vegetable oils are not recommended due to the danger of deterioration and forming of acid.
- Additional or replacement lubricant must be added after 2,000 hours or at three-month intervals.
- Replace the lubricant in the housings at least once annually. This must be done when an overhaul is made.
- When greasing anti-friction bearings, do not use high-pressure equipment. High pressure can damage the bearings or seals, cause unnecessary loss of grease, create a danger of overheating due to over greasing, and produce unsightly conditions around the bearing.
- Excess grease is the most common cause of overheating. Maintain the grease level at about the capacity of the bearing and 1/3 to 1/2 of the cavity between the bearing and grease fitting. Any greater amount will be discharged by the seal or vent.

Lubricate the oil-lubricated bearings

Oil lubrication is optional. Oil-lubricated pumps are installed with Trico oilers. The oilers keep the oil level in the housings constant at the proper level.

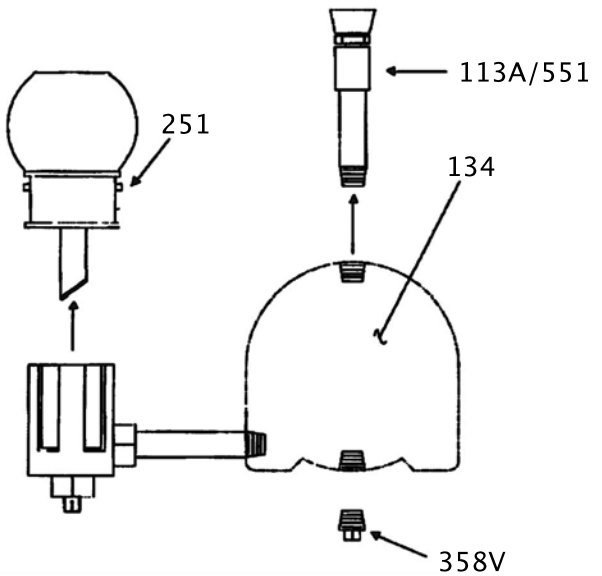


Figure 25: Oiler assembly

1. Remove the vent assembly from the top of the bearing housing.
2. Remove the pipe plug from the bottom of the bearing housing.
3. Unscrew and remove the reservoir.
4. Flush the oiler and bearing housing with a light grade of oil until all foreign particles are removed.
5. Screw the pipe plug and vent assembly back into place.
6. Fill the reservoir with a good grade of filtered mineral oil.

NOTICE:
Make sure to fill the oiler and bearing housing with oil through the oiler reservoir.

---

7. Place your thumb over the reservoir spout, invert the reservoir, and place it onto the lower casting while removing your thumb.
   Allow the reservoir to empty as it fills the bearing housing. You will need to fill the reservoir several times before the correct level is reached.
   When the correct oil level is reached, no more oil will run out of the reservoir.

A periodic filling of the reservoir is required. When the oil becomes dirty, repeat this procedure.

Lubricating-oil requirements

Oil specifications

Use oils that meet these specifications. These oils are furnished by all major oil companies. It is the responsibility of the oil vendor to supply a suitable lubricant.

Do not mix oils from different suppliers.

Specification	Requirement
Saybolt viscosity at 100°F (38°C)	215 SSU – 240 SSU
Saybolt viscosity at 210°F (99°C)	49 SSU
Viscosity index, minimum	95
API gravity	28–33
Pour point, maximum	+20°F (-6.7°C)
Flash point, minimum	400°F (204°C)
Additives	Rust and oxidation inhibitors
ISO viscosity	46

Oil quality

The oil must be a well-refined, good grade, straight cut, filtered mineral oil. It must be free from water, sediment, resin, soaps, acid, and fillers of any kind. It must also be non-foaming with a viscosity of about 215-240 SSU at 100°F (38°C) (approximately SAE-20).

Lubrication schedule

In installations with moderate temperature changes, low humidity, and a clean atmosphere, change the oil after approximately 1,000 hours of operation. Inspect the oil at this time to determine the operating period before the next oil change. Oil change periods may be increased up to 2,000–4,000 hours based on an 8,000-hour year. Check the oil frequently for moisture, dirt or signs of breakdown, especially during the first 1,000 hours.

CAUTION:
Risk of bearings overheating and failing.

- Do not over oil the bearings.
- The maximum operating temperature for ball bearings is 180°F (82°C).
- If the temperature of the bearing frame exceeds 180°F (82°C) (measured by thermometer), shut down the pump to determine the cause.
- Do not mix oils from different suppliers.

Bearing temperatures

- Bearing temperatures up to 180°F (82°C) are normal. For accurate measurement, place a contact-type thermometer against the bearing housing. Record the reading in a convenient location for reference.
- The stability of the temperature, rather than the number of degrees, is the best indication of normal operation. A sudden increase in temperature is an indication of danger and a signal to investigate. Check the unit for abnormal hydraulic operation and unnecessary loads, such as coupling misalignment. See *Troubleshooting* (page 59).
- Do not use the human hand as a thermometer. A temperature that feels hot to the hand can vary from 120°F (49°C) to 130°F (54°C) depending upon the individual. Above this temperature, the human hand can not accurately estimate temperature.

Coupling lubrication

Grid or gear-tooth couplings

Grid or gear-tooth couplings, such as Falk Grid Steelflex or Falk Crowned Tooth coupling, are initially lubricated with Falk Long Term Grease (LTG) and do not require relubrication for up to

three years. If the coupling leaks grease or is exposed to extreme temperatures or excessive moisture, then more frequent lubrication is required.

Use the grease recommendations from the coupling manufacturer for the best performance.

Flexible couplings

Flexible couplings, such as Wood's Sure-Flex or Falk Torus coupling, provide smooth transmission of power. There is no rubbing action of metal against rubber to cause wear. Couplings are not affected by abrasives, dirt, or moisture. This eliminates the need for lubrication or maintenance and provides clean and quiet performance.

If other types of couplings are used, then follow the maintenance instructions provided by the coupling manufacturer.

Shaft-seal maintenance

Packed stuffing box maintenance

Check or instruction	Explanation/comment
When starting a pump with fiber packing for the first time, make sure that the packing is slightly loose without causing an air leak. As the pump runs in, gradually tighten the gland bolts evenly.	Never draw the gland to the point where the packing is compressed too tightly and no leakage occurs. This will burn the packing, score the shaft sleeve, and prevent circulation of the liquid that cools the packing.
Turn the rotating element by hand.	The stuffing box is improperly packed or adjusted if friction in the box prevents turning the rotating element by hand. A properly operated stuffing box runs lukewarm with a slow drip of sealing liquid.
After the pump has been in operation for some time and the packing is completely run in, check that the stuffing box leaks at the rate of 40–60 drops per minute.	This indicates proper packing, shaft sleeve lubrication, and cooling. **NOTICE:** Eccentricity of the shaft or sleeve through the packing can result in excess leakage. Make sure that the parts are properly centered.
Check the packing frequently and replace as service indicates.	Six months is a reasonable expected life, depending on operating conditions. Use a packing tool in order to remove all old packing from the stuffing box. Never reuse old packing or add new rings to old packing. Clean the stuffing box thoroughly before you install new packing.
Check the condition of the shaft or sleeve for possible scoring or eccentricity and make replacements as necessary.	—
When placing new, non-asbestos packing into the stuffing box, open the molded rings sideways and push the joints into the stuffing box first. Then install the rings one at a time, making sure to seat each ring firmly. Stagger the joints at a 90° rotation from each preceding joint.	—
If coil packing is used, then cut one ring to the accurate size with either a butt or mitered joint. Fit the ring over the shaft to assure the proper length, and then remove and cut all the rings to this first sample. When you place the rings around the shaft, make sure to form a tight joint. Place the first ring in the bottom of the stuffing box. Then install each succeeding ring. Stagger the joints at a 90° rotation.	An accurately cut butt joint is superior to a poorly fitted mitered joint. Make sure that each ring is firmly seated.
If a seal cage is supplied, check that it is properly located in the stuffing box under the sealing water inlet.	The function of the seal cage is to establish a liquid seal around the shaft, to prevent leakage of air through the stuffing box, and to lubricate the packing. If it is not properly located, then it serves no purpose.

Mechanical seal maintenance

Keep in mind the following general rules regarding mechanical seal maintenance. Refer to the instructions provided by the seal manufacturer for detailed information.

- Mechanical seals are precision products that must be treated with care. Use special care when handling seals. Make sure that oil and parts are clean in order to prevent scratching the finely lapped sealing faces. Even light scratches on these faces can result in leaky seals.
- Mechanical seals typically require no adjustment or maintenance except for routine replacement of worn or broken parts.
- A used mechanical seal should not be put back into service unless the sealing faces have been replaced or relapped. Relapping is practical only for seals that are 2 in. (5.1 cm) or larger.

For optimum seal life, always follow these precautions:

- Keep the seal faces as clean as possible.
- Keep the seal as cool as possible.
- Make sure the seal always has proper lubrication.
- If the seal is lubricated with filtered fluid, then clean the filter frequently.

Disassembly

Disassembly precautions

WARNING:

- This manual clearly identifies accepted methods for disassembling units. These methods must be adhered to. Trapped liquid can rapidly expand and result in a violent explosion and injury. Never apply heat to impellers, propellers, or their retaining devices to aid in their removal unless explicitly stated in this manual.
- Always disconnect and lock out power to the driver before you perform any installation or maintenance tasks. Failure to disconnect and lock out driver power will result in serious physical injury.
  - Electrical connections must be made by certified electricians in compliance with all international, national, state, and local rules.
  - Refer to driver/coupling/gear manufacturers installation and operation manuals (IOM) for specific instructions and recommendations.
- Crush hazard. The unit and the components can be heavy. Use proper lifting methods and wear steel-toed shoes at all times.
- 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. 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.
- A small amount of liquid will be present in certain areas like the seal chamber.

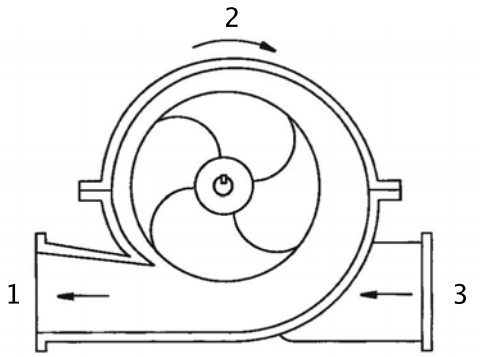
NOTICE:

- Avoid injury. Worn pump components can have sharp edges. Wear appropriate gloves while handling these parts.
- Make sure that all replacement parts are available before you disassemble the pump for overhaul.

Change the rotation

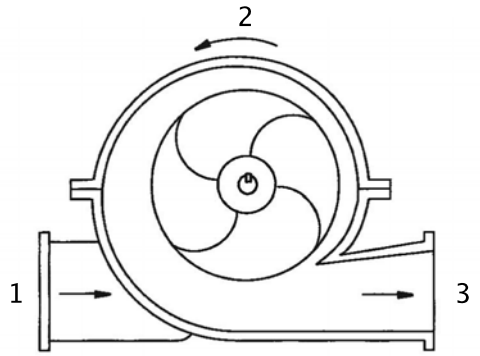
CAUTION:
Risk of motor running hot. Make sure that the motor fan is bidirectional. If it is not bidirectional, then turn it around or replace it.

These centrifugal pumps can be operated clockwise or counterclockwise when viewed from the coupling end of the pump.



1. Discharge
2. Clockwise rotation
3. Suction

Figure 26: Clockwise rotation viewed from the coupling end



1. Suction
2. Counterclockwise rotation
3. Discharge

Figure 27: Counter\clockwise rotation viewed from the coupling end

Use the following instructions to reverse the suction and discharge nozzles, which changes the rotation:

1. Remove the impeller from the shaft, turn it 180°, and replace it on the shaft.
   Make sure to use the disassembly and assembly instructions in this manual.
2. With the rotating element out of the casing, remove the casing from the baseplate and turn the casing 180°.
   Factory-supplied baseplates are drilled for both rotations.
3. Put the rotating element back in the casing and reassemble the pump.
   The impeller and casing are in the same relationship to each other as they were originally.
   The shaft and motor are also in the same relationship to each other as they were originally.
4. Reassemble the pump and realign the coupling as specified in the alignment instructions.
5. Switch the motor leads in order to reverse the motor rotation.
   If you do not reverse the motor rotation, then the impeller will not rotate in the right direction.

Remove the upper half of the casing

1. Drain the pump by opening the vent plug and removing the drain plugs on the suction and discharge nozzles.
2. Remove the coupling guard and separate the coupling in order to disconnect the pump from the driver.
3. Remove the seal lines.
   Not all pumps are supplied with seal lines.
4. For pumps with packing, remove the gland bolts, washers, and gland from each stuffing box.
5. For pumps with mechanical seals, remove the gland bolts and slide the gland away from the casing.
6. Remove all casing main joint capscrews and dowels.
7. Insert a screwdriver or pry bar into the slots between the upper and lower casing halves and separate the halves.

Remove the rotating element

1. Tap the stuffing boxes with a soft-headed hammer in order to break the seal between the stuffing box and lower half of the casing.
2. Remove the capscrews that hold the bearing housings to the casing.
3. Lift the rotating element out of the lower half of the casing.
4. Move the rotating element to a suitable working location.
   A spare rotating element can be installed at this point.
5. Pull the coupling half and key off the shaft.

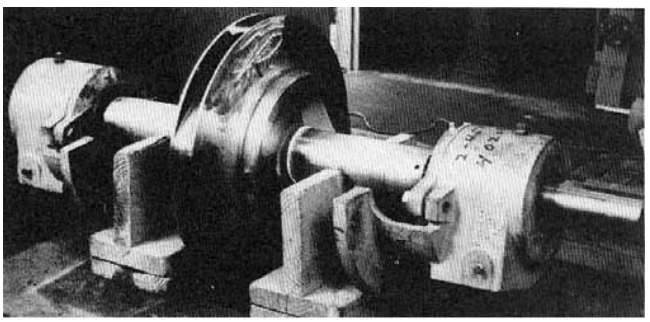


Figure 28: Rotating element

Disassemble the pump

1. Remove the capscrews (371C) from the bearing covers (109 and 119).
2. Remove the bearing housings (134), locknut (136), and lockwasher (382).
3. Mount a bearing puller and remove the bearings (168 and 410).
4. Remove the thrust washer (535) and snap rings (276).
   Inboard bearings do not use a locknut, lockwasher, or thrust washer.

NOTICE:
Save the bearings for inspection. Do not reuse the bearings. Doing so may result in decreased performance.

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5. Remove the bearing covers (109 and 119) and push the bearing isolators out of the bearing covers and the coupling-end of the bearing housing (332A and 333A).
6. For pumps with mechanical seals, do the following:
   a) Remove the glands.
   b) Loosen the setscrews and remove the head assembly of the mechanical seal.
   c) Press the mechanical seal seats from the glands.
7. Remove the casing rings (127) from the impeller (101).
8. Remove the setscrew from the shaft nuts.

9. Remove the shaft nuts, O-rings, sleeves, sleeve gaskets, and the impeller.
10. Apply heat uniformly to the shaft sleeve to loosen the sealant between the shaft and sleeve.
    Do not heat the shaft sleeve to temperatures above 275°F (135°C). To further assist in removing the sleeves, hold the shaft vertically and tap it on a block of wood. The weight of the impeller will force both the impeller and sleeve from the shaft.
11. If the pump is equipped with adjustable rings, then refer to *Replace the wear rings* (page 45) for instructions on removing the rings.
12. If the impeller has replaceable rings, then cut the rings (142) with a cold chisel in order to remove them.

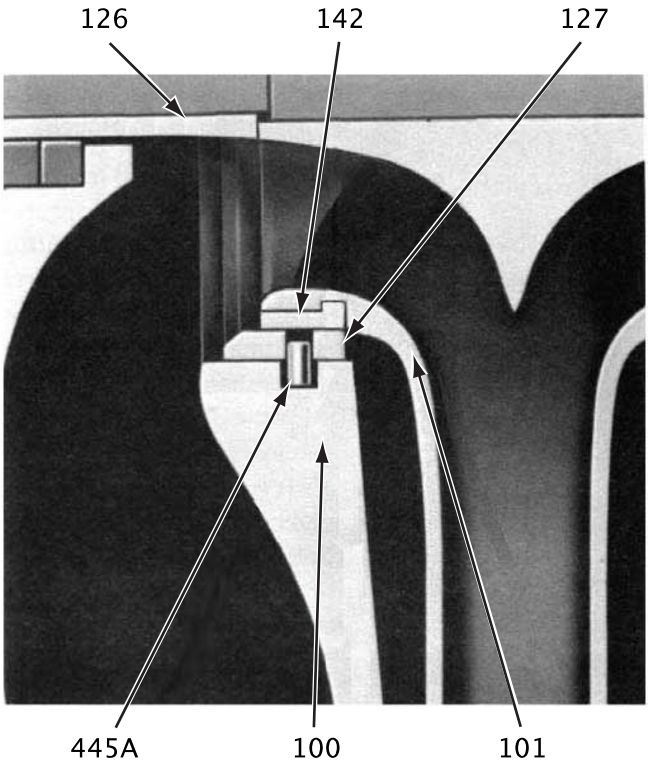

Figure 29: Pump disassembly

Preassembly

Replace wear parts

When you reassemble the pump, make sure to do the following:
Replace all bearings, O-rings, seals, gaskets, impeller rings, casing wear rings with new parts during assembly.Clean all reusable parts of foreign matter.Make the main casing joint gasket by using the upper or lower half as a template:

a) Lay the gasket material on the casing joint and mark it by pressing it against the edges of the casing.
b) Trim the gasket so that it is flush with the inside edges of the casing.

Adjustable wear rings

Adjustable rings are an assembly of two threaded rings. The outer, stationary ring is held in the casing by a flange and an anti-rotation pin in the lower half of the main joint. The inner, adjustable ring can be moved axially by rotating it in either direction. The ring is held in position by a stainless steel locking pin. All rings have clockwise threads.

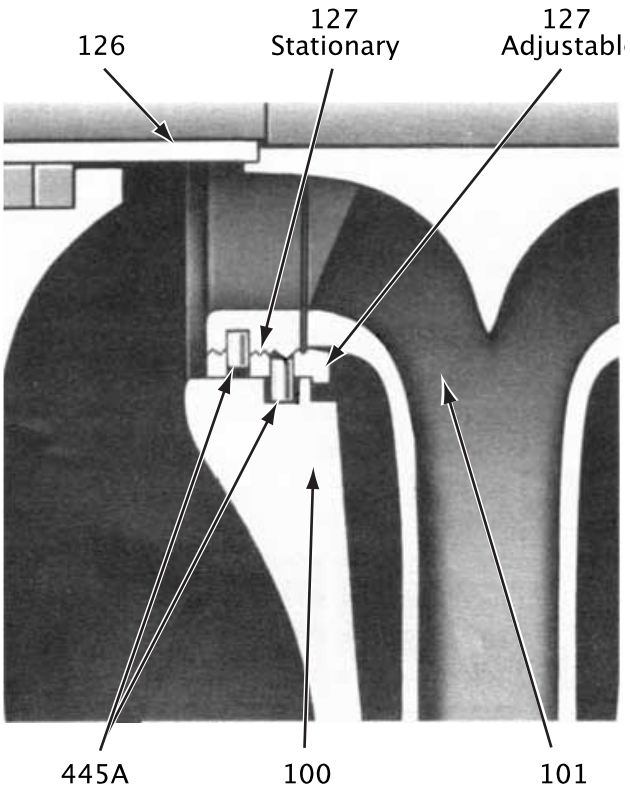

Figure 30: Adjustable wear rings

Adjust the wear rings

If the clearance between the impeller wear face and the adjustable wear ring becomes excessive, then do the following:

1. Remove the upper half of the casing and pull out the locking pin.
2. Rotate the inner rings clockwise to restore 0.005–0.008 in. (0.13–0.20 mm) of clearance greater than the shaft-end float between the ring and the impeller.
3. Drill a new hole in the inner ring for the locking pin.
   This is a blind hole. Do not drill all the way through.
4. Replace the locking pin and upper half of the casing.

Replace the wear rings

Adjustable rings are removed in the same manner as standard casing rings. They can be separated for cleaning. Adjustable rings are installed in the pump with stationary and the adjustable members that are assembled but not pinned.

1. Turn the adjustable member counterclockwise to provide maximum impeller clearance and slide over the shaft ends.
   The rings can be adjusted with the rotating element in the pump. Make sure that the stationary member has its flange flush against the lower half of the casing.
2. Move the rotating element toward the outboard end as far as the bearings permit.
3. Screw the outboard-end adjustable ring toward the impeller to obtain 0.005–0.008 in. (0.13–0.20 mm) of axial impeller clearance.
4. Drill through the stationary ring hole into the adjustable ring and insert the locking pin.
5. Move the rotating element toward the coupling and set the coupling-end ring in the same manner.

Reassembly

Assemble the pump with packing

1. Place the impeller key (178) in the shaft (122).

2. Check the impeller (101) and casing (100) to determine the correct impeller rotation, and then place the impeller on the shaft as specified in *Dimension A* (page 49).
   For the correct impeller rotation, refer to *Change the rotation* (page 42).
3. If the impeller has replaceable rings, then heat each new ring (142) to approximately 300–400°F (149–204°C), and then slide them onto the impeller. Hold the rings against the impeller shoulder until they cool.

CAUTION:
Wear insulated gloves when you handle rings. Rings will be hot and can cause physical injury.

4. Place both shaft sleeve keys (401) on the shaft (122).
5. Slide the sleeve gaskets (428) onto the shaft and against the hubs of the impeller.
6. Slide the sleeves (126) onto the shaft.
7. Place the sleeve O-ring (497) onto the shaft, into the sleeve counterbore.
8. Verify that dimension A is maintained, and then use a pin spanner wrench and a hammer to securely tighten the shaft sleeve nuts (124).
9. Drill a shallow recess in the shaft through the setscrew hole in each of the shaft sleeve nuts, and then lock each shaft sleeve nut in position with cone point setscrews (222B).
   A low-strength sealant such as Loctite 271 can be used to retain the setscrews.

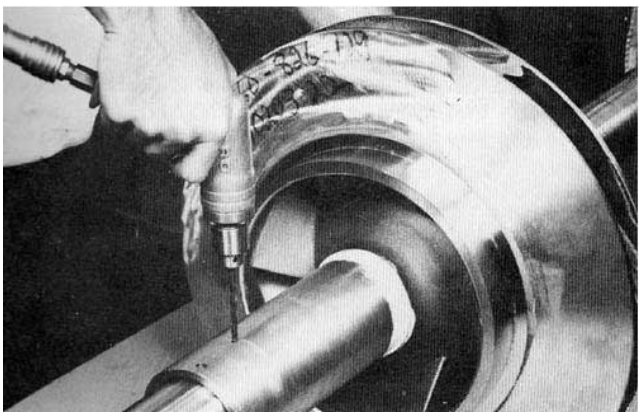

Figure 31: Shallow recess drilled through setscrew hole

10. Assemble the casing rings (127).
    Refer to *Adjust the wear rings* (page 45).

Assemble the pump with mechanical seals

1. Place the impeller key (178) in the shaft (122).
2. Check the impeller (101) and casing (100) to determine the correct impeller rotation, and then place the impeller on the shaft as specified in *Dimension A* (page 49).
   For the correct impeller rotation, refer to *Change the rotation* (page 42).
3. If the impeller has replaceable rings, then heat each new ring (142) to approximately 300–400°F (149–204°C), and then slide them onto the impeller. Hold the rings against the impeller shoulder until they cool.

CAUTION:
Wear insulated gloves when you handle rings. Rings will be hot and can cause physical injury.

4. Place both shaft sleeve keys (401) on the shaft (122).
5. Slide the sleeve gaskets (428) onto the shaft and against the hubs of the impeller.
6. Slide the sleeves (126) onto the shaft.

7. Place the sleeve O-ring (497) onto the shaft, into the sleeve counterbore.
8. Verify that dimension A is maintained, and then use a pin spanner wrench and a hammer to securely tighten the shaft sleeve nuts (124).
9. Drill a shallow recess in the shaft through the setscrew hole in each of the shaft sleeve nuts, and then lock each shaft sleeve nut in position with cone point setscrews (222B). A low-strength sealant such as Loctite 271 can be used to retain the setscrews.

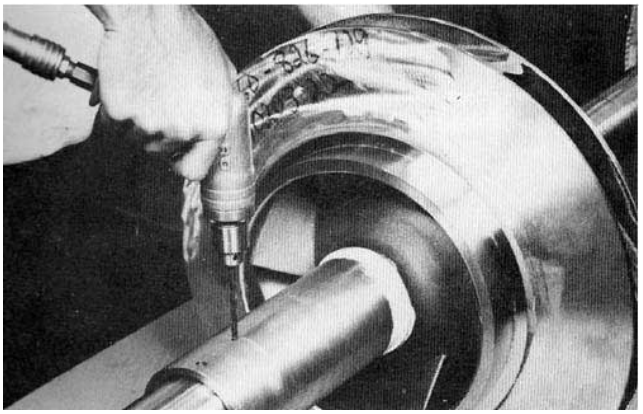

Figure 32: Shallow recess drilled through setscrew hole

10. Assemble the casing rings (127).
    Refer to *Adjust the wear rings* (page 45).
11. Install the stationary seats (383) into the glands (250) with the lapped surface facing outward.

NOTICE:
Do not scratch or damage the seal faces during assembly. The stationary seat must bottom squarely in the gland.

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12. Apply a fine coat of silicon grease or equivalent to the shaft sleeve, and then slide the seal head assembly (383) over the sleeve. If the seal is a John Crane Type 8, then set the seal to the approximate dimension shown in *Dimension A* (page 49) and tighten the setscrews.

NOTICE:
Avoid elastomer damage. Do not use petroleum-based products to install the mechanical seal head.

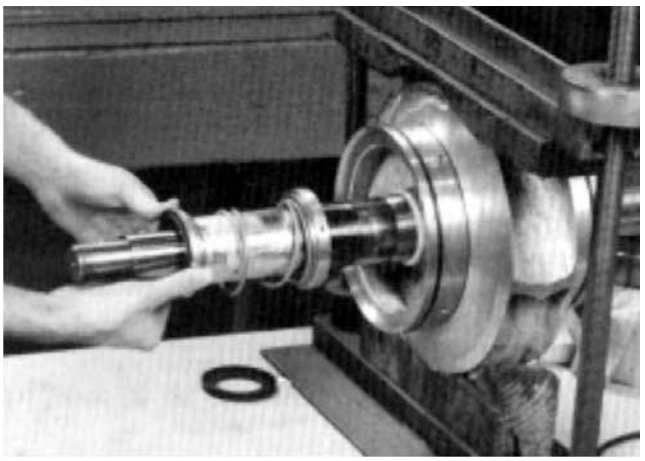


Figure 33: O-ring and gland installation

13. Install the O-rings (412G) onto the glands (250) and install the glands on the shaft.

Dimension A

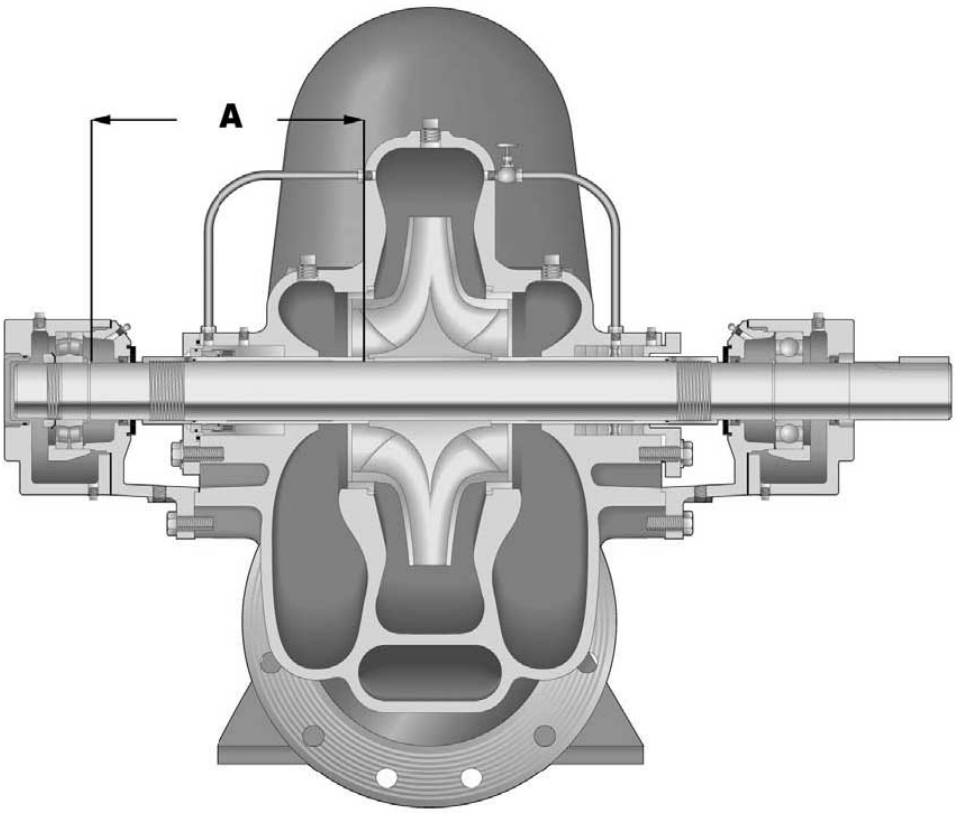


Figure 34: Seal setting

Pump size	Gland style	Quantity items 426	Quantity item 426A	Dimension A
6x10-22	all	26	--	13.5
8x10-21				
8x12-21				
8x12-27	all	44	--	16.54
10x14-20S	2 bolt gland	26	--	
10x14-20L				
12x16-23				
14x16-17		24		
10x14-20S	4 bolt gland	8	32	
10x14-20L				
12x16-23			36	
14x16-17		6	34	
10x12-22	all	24	--	15.81
14x18-23	2 bolt gland	32		
14x18-28		34		
14x18-23	4 bolt gland	8	36	
14x18-38		8	40	

Install the bearings

NOTICE:
To protect rubber parts during assembly, cover the O-ring groove, keyways, and threads with electrical tape.

There are several methods you can use to install bearings. The recommended method is to use an induction heater that heats and demagnetizes the bearings. Bearings can get hot and can cause physical injury.

1. Heat the bearings (168 and 410).
   Use either dry heat with the bearing well lubricated or an induction heater.

   NOTICE:
   Do not heat the bearings above 275°F (135°C).

2. Assemble the bearing covers:
   a) Press the inboard bearing isolators (333A) into each bearing cover.
      The inboard bearing cover (119) is approximately 1/4 in. (0.6 cm) less in width than the outboard bearing cover (109). This is the only dimensional difference.
   b) Install the gaskets (360) on each bearing cover.
   a) Slide the bearing covers (109 and 119) onto the shaft.
3. Install the snap rings (276), and then install the thrust washer (535) on the outboard end.
4. Press the heated bearings (168 and 410) onto the shaft against the snap ring or thrust washer.
5. Install the locknut (136) and lockwasher (382) on the outboard end.
6. Make sure the locknut is secured, and then bend over the tab on the lockwasher.
7. Do one of the following:

Lubrication type	Instruction
Grease	Cool the bearings to room temperature and coat them with 2–3 ounces of a recommended grease. See *Lubricating-grease requirements* (page 37).
Oil	See *Lubricate the oil-lubricated bearings* (page 38) for installation of oil-lubricated parts.

8. Press the outboard bearing isolator (332A) into the bearing housing for the coupling end.
9. Slide the bearing housings (134) onto the shaft over the bearings (168 and 410).
10. Assemble the bearing cover to the bearing housing with two capscrews (371C).

Install the rotating element

1. Replace the pump coupling half and the key (400).
2. Assemble the rotating element in the lower half of the casing (100).
   Make sure to correctly locate the casing ring pins (445A) in the casing main joint slot.
   To ease assembly, slide the inboard bearing housing toward the coupling before assembling the rotating element in the casing.
3. Bolt the outboard bearing housing in place.

   NOTICE:
   Make sure that both bearing housings are seated properly in the lower-half casing.

4. Bolt the inboard bearing housing in place.
   If the pump has a mechanical seal that is a John Crane Type 8, then set the seal to the dimension shown in the following figure and then tighten the setscrews.

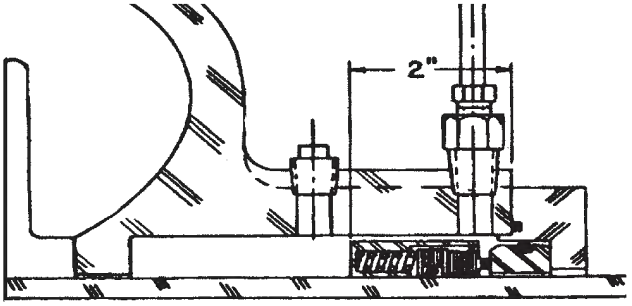


Figure 35: Mechanical seal (John Crane Type 8) setting

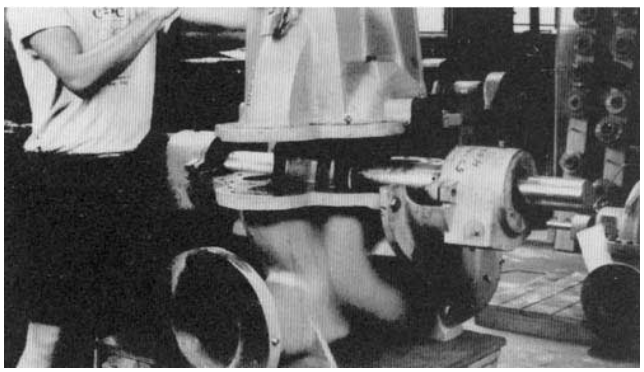
Install the gaskets

1. Clean the gasket surfaces of the casing.
2. Apply Scotch 3M-77 spray adhesive or equivalent to the lower half of the casing.
3. Within one minute of spraying, do the following:
   a) Set the gaskets (351D and 351S) in place on the lower half of the casing.
   b) Align the holes in the gaskets with the holes in the casing.
   c) Press the gaskets firmly against the face the lower half of the casing in the area coated by the adhesive.

Assemble the casing

Check the rotation of the pump before installing the upper half of the casing. For the correct rotation, see the figure in *Change the rotation* (page 42).

1. Lower the upper half of the casing (100) into place and locate with the taper dowels (469G).



Upper half casing

2. Install the casing joint bolts (426 and 426A) and tighten to the following torque values:

Screw type	Torque
0.75 in.-10 Ferry Cap Countr-bor screws (Grade 8)	300 ft-lb (Nm) minimum
1.0 in.-8 Ferry Cap Countr-bor screws (Grade 8)	400 ft-lb (Nm) minimum

The number of casing bolts varies with the size of the pump. See *Dimension A* (page 49).

NOTICE:
Avoid leakage at the main joint. Tighten bolts to the proper values in the proper sequence to obtain the proper gasket compression.

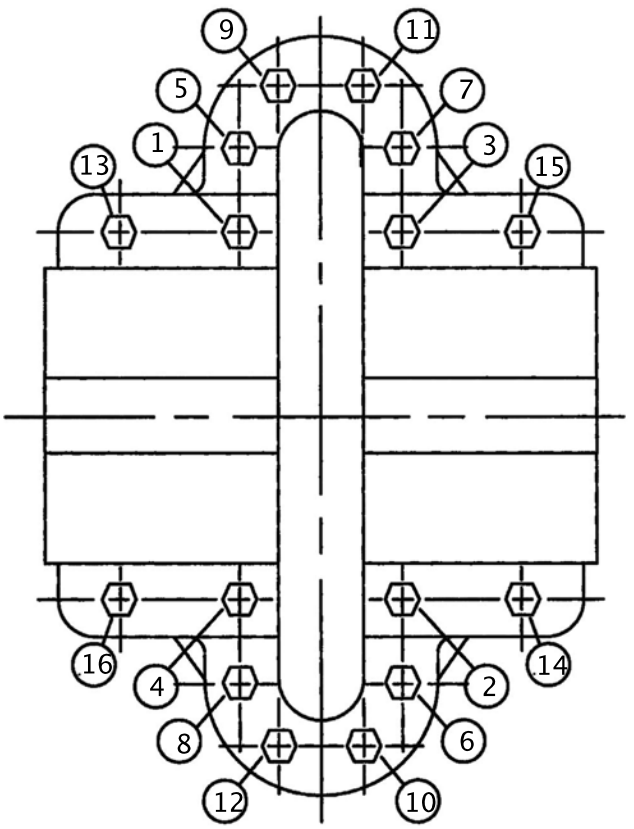


Figure 36: Casing joint bolts

Complete the assembly

1. Rotate the shaft by hand to make sure that it turns smoothly and does not rub or bind.
2. Bolt the glands (250) to the casing with gland bolts (353B).
3. Connect the seal water lines (102) to the stuffing box and casing.
   Pipe the seal water lines to the tapped holes nearest the bearings.
4. Check the coupling alignment and redowel if necessary.

Vertical units

Remove the upper half of the casing

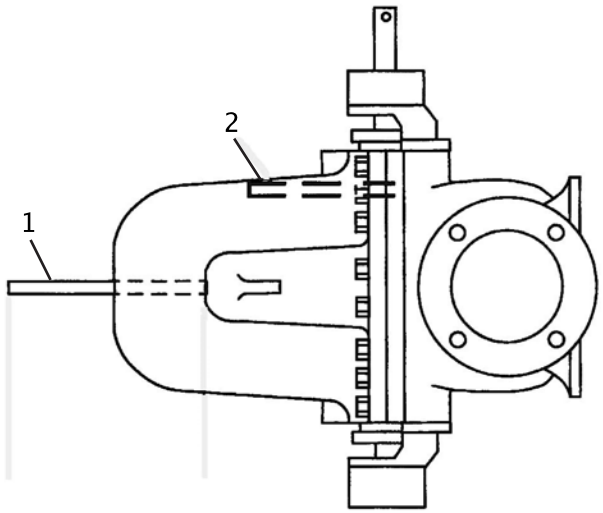
WARNING:
Crush hazard. The rotating element may fall out of the lower-half casing. Do not loosen the bolts that hold the bearing housing in the casing until you are ready to remove the rotating element from the casing.

If only the upper half of the casing will be removed in order to inspect the rotating element, then you do not need to remove the line shafting or motor.

1. Remove the larger of the two pipe plugs from the top of the upper half of the casing, and then install an 18–24 in. (46–61 cm) solid bar that is threaded at one end into the exposed tapped hole.

If a threaded bar is not available, then you can use standard pipe.

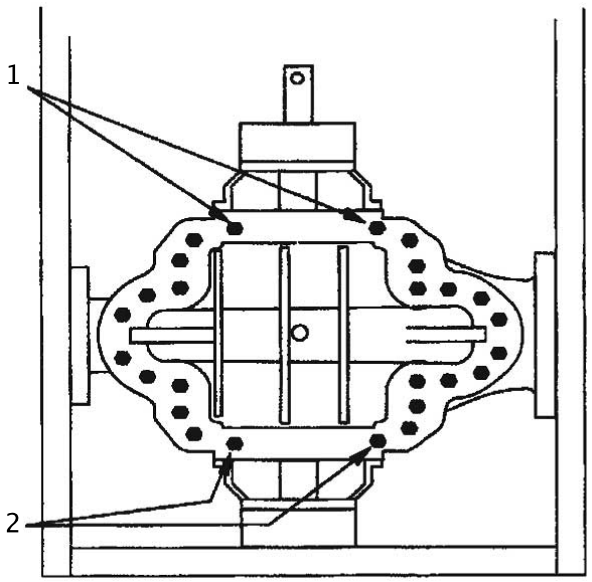
This bar will be used to stabilize the upper half during disassembly of upper half of the casing.



1. Stabilizer bar, 18–24 in. (46–61 cm)
2. Alignment rods

Figure 37: Stabilizer bar and alignment rods

2. Disconnect the seal water lines at the stuffing boxes and remove the gland bolts.
3. Remove the dowel pins and all parting line bolts except for the two upper most and two lower most.



1. Upper most bolts
2. Lower most bolts

Figure 38: Dowel pin and parting line bolts

4. Install alignment rods through the upper half and into the tapped bottom half, one on the suction side and one on the discharge side above the horizontal center line of the casing. An alignment rod is a threaded rod that screws into the bottom half of the casing and is approximately 2 in. (5 cm) longer than one half of the impeller diameter. This prevents the top half from falling onto the impeller and also helps with alignment while installing the

upper half. If alignment rods are not supplied with the pump, then they can be made from a threaded rod.

5. Place nylon slings around upper-half casing ears and pull the slings taut so that they cannot slip off.

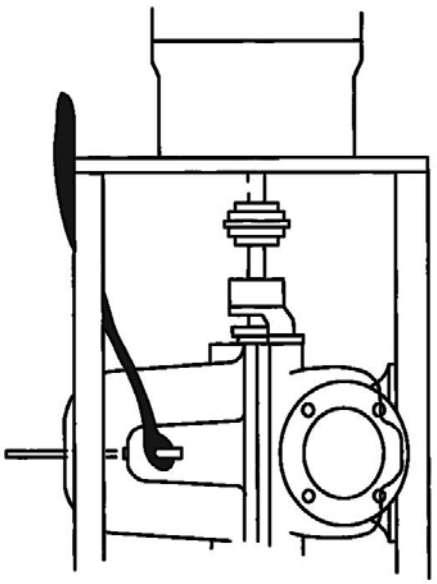


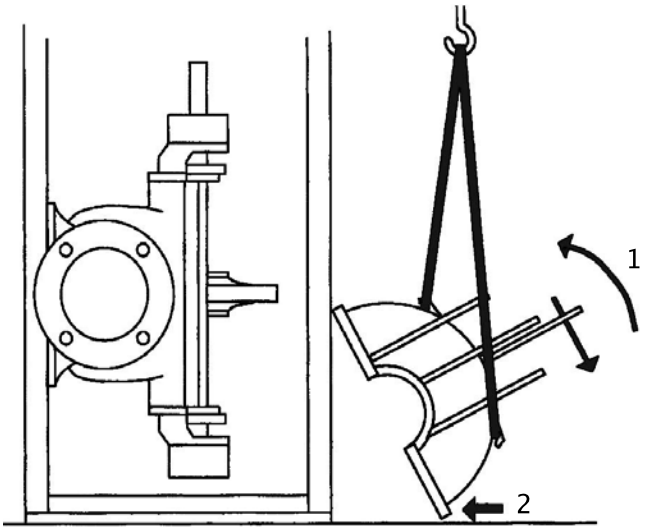
Figure 39: Nylon sling placement

6. Remove the two lower most bolts, and then remove one of the two upper most bolts. Maintain downward pressure on the stabilizing rod when removing these bolts.
7. While maintaining downward pressure on the stabilizer bar, loosen the remaining upper most bolt.

WARNING:
Crush hazard. Do not remove the last bolt completely yet.

8. Separate the upper and lower halves with a pry bar between the two halves. Alternately, you can use jacking screws if the top half is provided with tapped holes.
9. When the halves separate, slide the upper half away from the lower half, maintain downward pressure on the stabilizing rod end furthest from the pump, and slowly remove the remaining upper most bolt.
   Allow the top half to slide on the alignment rods.

10. While you balance the upper half with the stabilizing rod, lower the upper half to the ground and allow it to rotate so that the main joint flange rests on the ground.



1. Rotate
2. Main joint flange

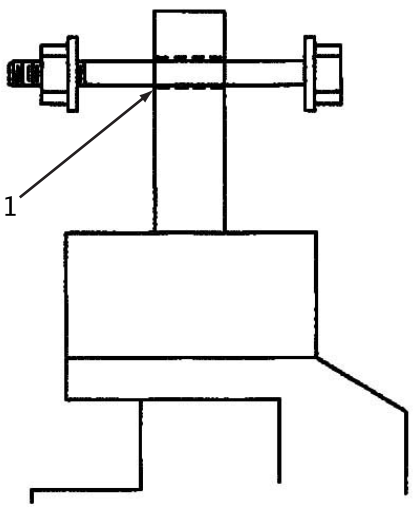
Figure 40: Rotating element

The rotating element is now ready for inspection or removal. If the element is inspected and does not need to be removed, then refer to *Assemble the casing* (page 51).

Remove the rotating element

You must remove the line shafting or motor before you can remove the pump-half of the coupling.

1. Thread a long bolt, washer, and nut through the hole at the end of the shaft.

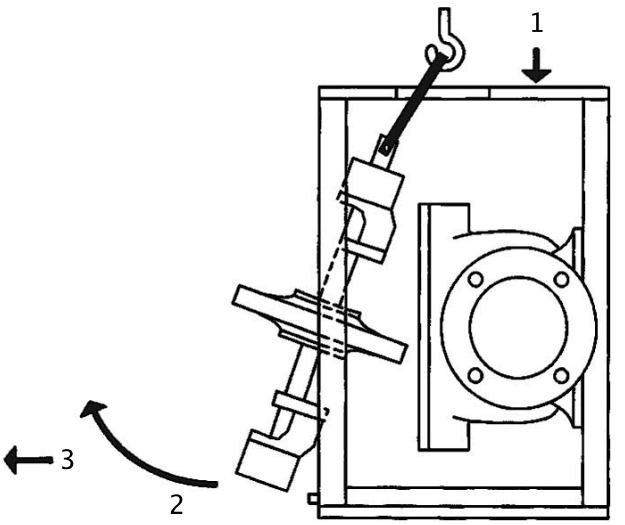


1. Coupling-end of the shaft drilled through for a long bolt with nut and washer

Figure 41: Rotating element removal

2. Place a sling around the eye bolt, putting a slight amount of tension on the sling.
3. Remove the four bolts that hold each bearing housing to the casing.
4. Lightly tap on the inboard and outboard bearing housings to spread them apart, and then slide the rotating element away from the lower half of the casing.

5. Lower the rotating element to the ground by sliding the outboard bearing housing away from the pedestal, allowing the element to rest on the floor with the shaft in a horizontal position.



1. Lower
2. Rotate
3. Slide

Figure 42: Lowering of rotating element

The rotating element can now be serviced using the procedures in the Disassembly section.

Assemble the rotating element

1. Inspect the main joint gasket and replace it if necessary.
2. Place a sling around the bolt in the end of the pump shaft.
   On full pedestals, the lifting sling must come through the hole in the top plate of the pedestal.
3. When the rotating element is off the ground and in a vertical position, align any anti-rotation pins in the casing rings and stuffing boxes for proper orientation in the slots in the lower half of the casing.
4. Assemble the rotating element in the lower half of the casing (100), placing the casing ring pins (445A) in the casing main joint.
   To ease assembly, slide the inboard bearing housing toward the coupling prior to assembling the rotating element in the casing.
5. Bolt the outboard bearing housing (134) to lower half of the casing (100) first.
   Make sure that both bearing housings are seated properly in the lower half.
6. Bolt the inboard bearing housing (134) to the lower half of the casing (100).
   Check again to make sure that bearing housings are seated properly.

Assemble the casing

1. Place a sling around the lifting ears, and then lift the upper half off the ground and rotate it so that the main joint flange is vertical.
   Make sure a stabilizing rod is installed.
2. If the impeller was removed from the shaft, then double-check the rotation of the pump.
   To determine the correct direction of rotation, refer to *Change the rotation* (page 42).
3. Move the upper half of the casing towards the lower half of the casing.
   You can use the alignment rods located in the lower half of the casing as guides.
4. Before you connect the upper half to the lower half, use the dowel pins to guide the upper half into its final exact position.
5. Reinstall all main joint bolts and tighten to the following torque values:

Screw type	Torque
0.75 in. -10 Ferry Cap Countr-bor screws (Grade 8)	300 ft-lb (407 Nm) minimum
1.0 in. -8 Ferry Cap Countr-bor screws (Grade 8)	400 ft-lb (542 Nm) minimum

The number of casing bolts varies with the size of the pump. See *Dimension A* (page 49).

NOTICE:
Avoid leakage at the main joint. Tighten bolts to the proper values in the proper sequence to obtain the proper gasket compression.

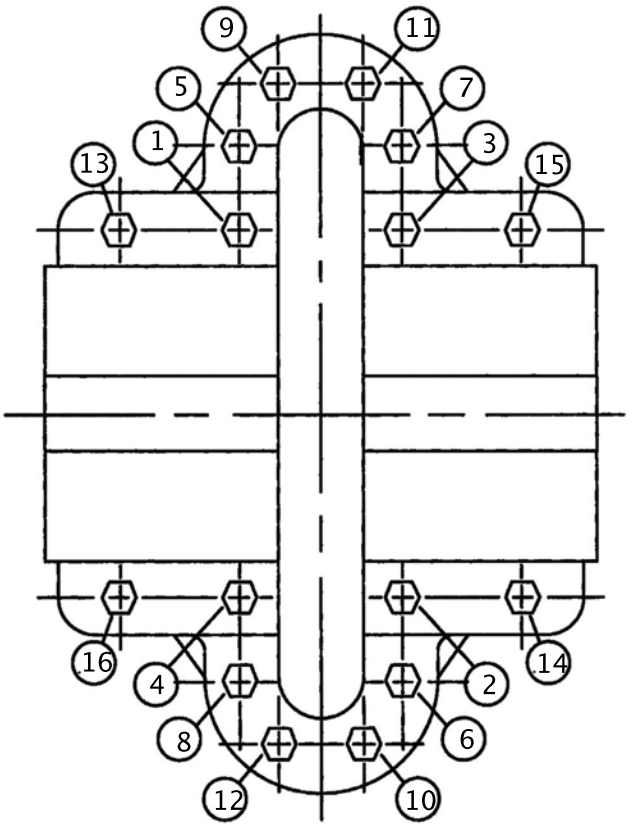


Figure 43: Casing bolts

6. Rotate the shaft and make sure it spins freely.

If the motor or line shafting was removed, then you can now reinstall it.

Remove the complete pump

If you need to remove a complete pump, then you must remove the line shafting or motor.

1. Disconnect the pedestal from its anchor bolts.
2. Disconnect and remove all suction and discharge piping.
3. Turn the entire pedestal horizontal, allowing the complete pump to be removed from a horizontal position.

Spare parts

Ordering parts

Repair orders will be handled with the minimum of delay if the following directions are followed:

- Specify the model number, pump size, and serial number. These can all be obtained from the nameplate.
- List plainly the names, part numbers, and materials of the parts required. These names and numbers must agree with those in the Parts list chapter of this manual.
- Specify the number of parts required.
- Specify definite billing and shipping instructions.

Troubleshooting

Troubleshooting

Symptom	Cause	Remedy
The pump is not delivering liquid.	The pump is not primed.	Re-prime the pump and check that the pump and suction line are full of liquid.
	The pump has lost prime.	Check for leaks in the suction pipe joints and fittings. Vent the casing to remove accumulated air. Check the mechanical seal or packing.
	The impeller is clogged.	Back-flush the pump in order to clean the impeller.
	The impeller is loose on the shaft.	Check the key, locknut, and setscrews.
	The shaft is rotating in the wrong direction.	Change the rotation. The rotation must match the arrow on the bearing housing or pump casing.
	The shaft is not rotating at all.	Check the power, coupling, line shaft, and shaft keys.
	The foot valve or suction pipe opening is not submerged enough.	Consult an ITT representative for the proper submersion depth. Use a baffle to eliminate vortices.
	The suction lift is too high.	Check for obstructions at the inlet and make sure the suction valves are open. Check for pipe friction losses. Use a vacuum or compound gauge to check the NPSH available.
	The motor speed is too low.	Make sure that the motor wiring is correct and receives full voltage or that the turbine receives full steam pressure. The motor can have an open phase.
	The system static head is too high.	Check with ITT to determine whether a larger impeller can be used. If not, then cut pipe losses, increase the speed, or both. Do not overload the driver.
	The system head or discharge head is too high.	Check for pipe friction losses and that the valves are wide open. The condition can be corrected with larger piping.

Symptom	Cause	Remedy
The pump is not delivering enough liquid or pressure.	The suction piping has air leaks.	If the pumped liquid is water or another non-explosive and no explosive gas or dust is present, then test the flanges for leaks with a flame or match. When explosive liquids such as gasoline are present, then test the suction line by shutting off or plugging the inlet and putting the line under pressure. A gauge will indicate a leak with a drop of pressure.
	The stuffing box has air leaks.	Check the packing or seal and replace if necessary. Check for the proper amount of lubrication.
	The motor speed is too low.	Make sure that the motor wiring is correct and receives full voltage or that the turbine receives full steam pressure. The motor can have an open phase.
	The discharge head is too high.	Check for pipe friction losses and that the valves are wide open. The condition can be corrected with larger piping.
	The suction lift is too high.	Check for obstructions at the inlet and make sure the suction valves are open. Check for pipe friction losses. Use a vacuum or compound gauge to check the NPSH available.
	The impeller is clogged.	Back-flush the pump in order to clean the impeller.
	The amount of available NPSH is not sufficient.	1. Increase the positive suction head by lowering the pump or increasing the suction pipe and fittings size. 2. Sub-cool the suction piping at the inlet to lower the temperature of liquid that is entering the pump. 3. Pressurize the suction vessel.
	The impeller or wear rings are worn or broken.	Inspect the impeller and wear rings and replace if any of the following conditions are present: • The impeller or wear rings are damaged. • The vane sections are severely eroded. • The wear ring clearance is three times normal.
	The foot valve is too small or partially obstructed.	Check the valve and replace with the correct size if necessary. The openings of the valve ports must be 1–1.5 times as large as the suction pipe opening. If a strainer is used, then the valve port openings must be 3–4 times as large the suction pipe opening.
	The suction inlet is not submersed deep enough.	If the inlet cannot be lowered or if the problem persists after the inlet is lowered, then chain a board to the suction pipe. The board will be drawn into the eddies and smother the vortex.
	The shaft is rotating in the wrong direction.	Change the rotation. The rotation must match the arrow on the bearing housing or pump casing.
	The system static head is too high.	Check with ITT to determine whether a larger impeller can be used. If not, then you can cut pipe losses, increase the speed, or both. Do not overload the driver.
	The mechanical seal is worn or broken.	Repair or replace the seal as necessary.
	The liquid passages are obstructed.	Make sure that the suction and discharge valves are fully open. Disassemble the pump and inspect the passages and casing. Remove the obstruction.
	Air or gases are trapped in the liquid.	Install a gas separation chamber on the suction line near the pump and periodically exhaust the accumulated gas.
The pump starts and then stops pumping.	The amount of available NPSH is not sufficient.	1. Increase the positive suction head by lowering the pump or increasing the suction pipe and fittings size. 2. Sub-cool the suction piping at the inlet to lower the temperature of liquid that is entering the pump. 3. Pressurize the suction vessel.
	The system static head is too high.	Check with ITT to determine whether a larger impeller can be used. If not, then cut pipe losses, increase the speed, or both. Make sure to not overload the driver.
	The system head or discharge head is too high.	Check for pipe friction losses and that the valves are wide open. The condition can be corrected with larger piping.
The pump leaks excessively at the stuffing box.	The shaft is bent.	Straighten the shaft or replace it if necessary.
	The pump and driver are not aligned properly.	Realign the pump and driver.
	The bearings are worn out or improperly lubricated.	Inspect the bearings and replace them if necessary.

Symptom	Cause	Remedy
The motor requires excessive power.	The discharge head has dropped below the rated point and is pumping too much liquid.	Install a throttle valve. If this does not help, then trim the impeller diameter. If this does not help, then consult an ITT representative.
	The liquid is heavier than expected.	Check the specific gravity and viscosity.
	The shaft is rotating in the wrong direction.	Change the rotation. The rotation must match the arrow on the bearing housing or pump casing.
	The impeller is damaged.	Inspect the impeller and replace it if necessary.
	Rotating parts are binding.	Check the internal wearing parts for proper clearances.
	The shaft is bent.	Check the deflection of the rotor by turning it on the bearing journals. The total indicator runout must not exceed 0.002 in. (0.05 mm) on the shaft and 0.004 in. (0.10 mm) on the impeller wearing surface.
	The motor speed is too high.	Check the motor voltage or the steam pressure received by turbines. Make sure the motor speed matches the speed on the nameplate.
	The stuffing box is improperly packed.	Check the packing and repack the stuffing box. If the packing is too tight, then try releasing the gland pressure and tightening again.
	The bearings are worn out or improperly lubricated.	Inspect the bearings and replace them if necessary.
	The running clearances between the wear rings are incorrect.	Check for the proper clearances. Replace the casing or impeller wear rings if necessary.
	There is excessive pipe strain on the pump casing.	Relieve the strain and check the alignment. Consult ITT if necessary.
	The amount of available NPSH is not sufficient.	1. Increase the positive suction head by lowering the pump or increasing the suction pipe and fittings size. 2. Sub-cool the suction piping at the inlet to lower the temperature of liquid that is entering the pump. 3. Pressurize the suction vessel.
	The pump and driver are not aligned.	Realign the pump and driver.
	The suction inlet is not submersed deep enough.	If the inlet cannot be lowered or if the problem persists after the inlet is lowered, then chain a board to the suction pipe. The board will be drawn into the eddies and smother the vortex.
	The casing is distorted due to excessive strains from the suction and discharge piping.	Check the alignment. Examine the pump for rubbing between the impeller and the casing. Replace damaged parts and redo the piping.

Parts Listings and Cross-Sectionals

Drawings

Standard grease lubrication

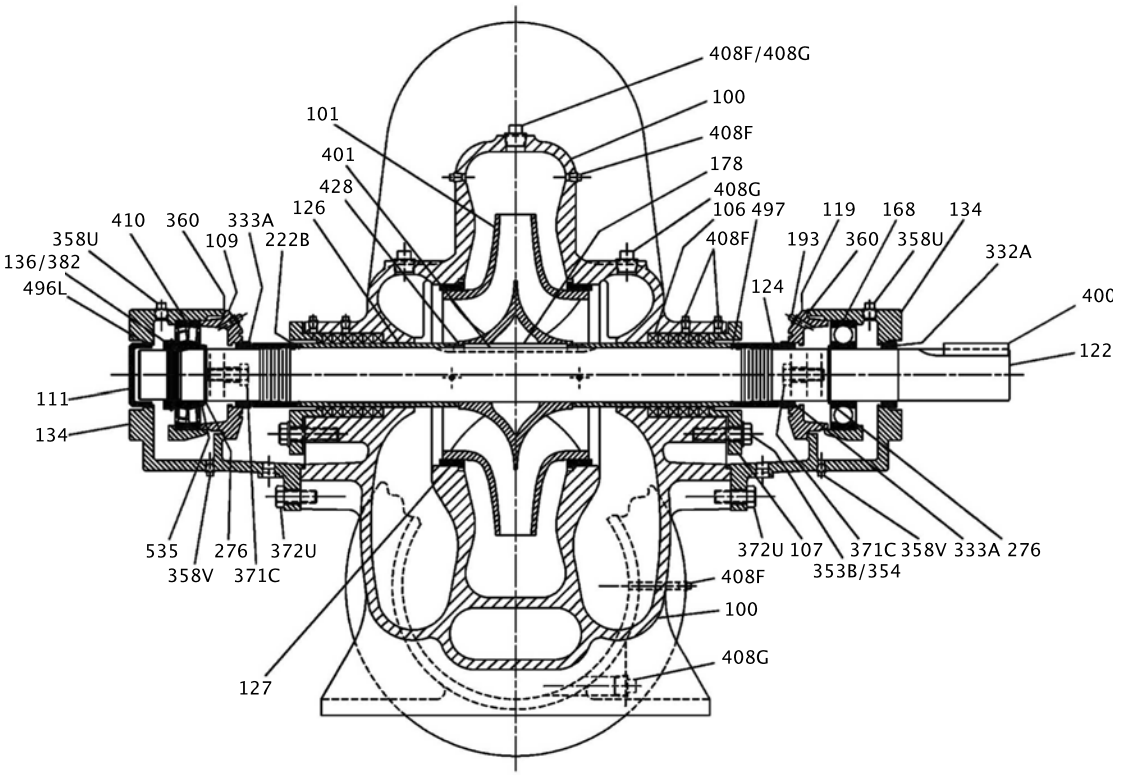


Figure 44: Standard grease lubrication

Casing ring detail

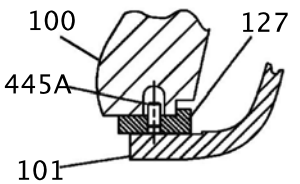


Figure 45: Casing ring detail

Main joint bolt detail

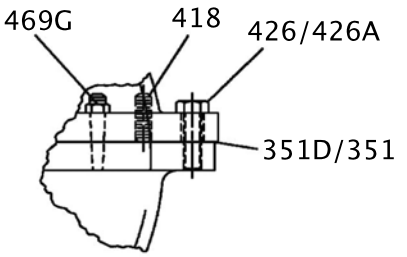


Figure 46: Main joint bolt detail

Internally-flushed stuffing box — packing

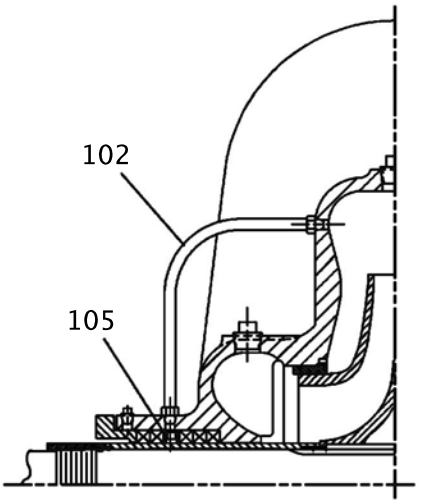


Figure 47: Internally-flushed stuffing box - packing

Internally-flushed stuffing box — mechanical seal

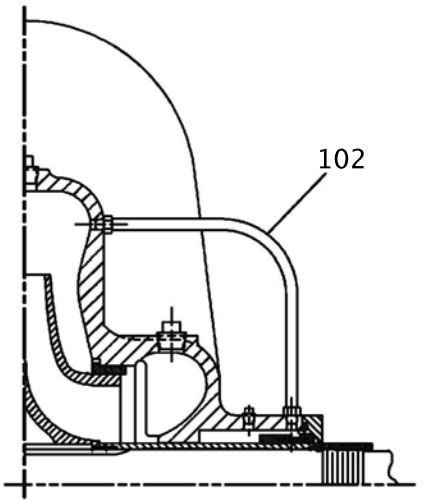


Figure 48: Internally-flushed stuffing box - mechanical seal

Ring oil lubrication option

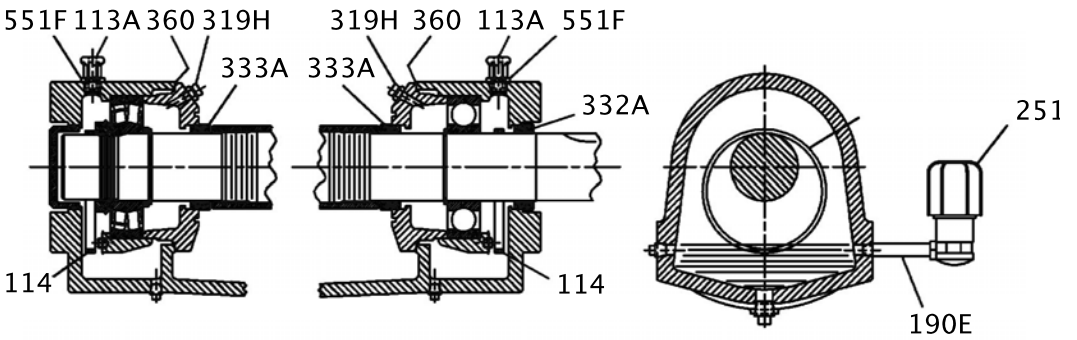


Figure 49: Ring oil lubrication option

Casing ring and optional impeller ring detail

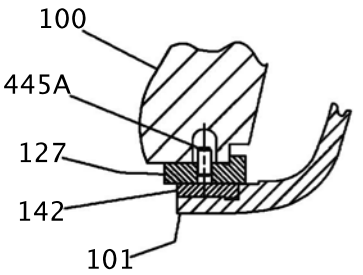


Figure 50: Casing ring and optional impeller ring detail

Mechanical seal stuffing box option

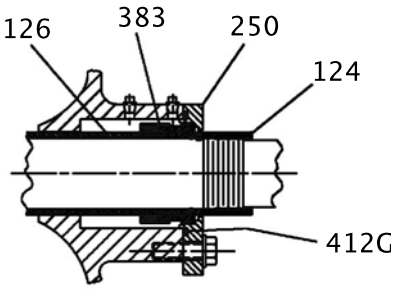


Figure 51: Mechanical seal stuffing box option

Parts list

Item number	Part name	Quantity
100	Casing, upper half	1
100	Casing, lower half	1
101	Impeller	1
102	Piping	2
105	Lantern ring	2
106*	Stuffing box packing	1 set
107	Stuffing box gland	2
109	End cover, inboard thrust bearing	1
111	End cap, bearing housing	1
113A	Breather	2
114	Oil ring	2
119	End cover, inboard coupling bearing	1
122	Shaft	1
124	Sleeve nut	2
126*	Shaft sleeve	2
127*	Casing wear ring	2
134	Bearing housing	2
136	Bearing locknut	1
142	Impeller wear ring	2
168	Radial ball bearing	1
178	Impeller key	1
190E	Oiler pipe nipple	2
193	Grease fitting, straight drive	2
222B	Setscrew, sleeve nut	2
250	Gland, mechanical seal	2
251	Oiler	2
276	Retaining ring, thrust bearing	1

Item number	Part name	Quantity
319H	Air vent	2
332A/333A	Bearing isolator	3
351D*	Parting gasket, casing discharge	1
351S*	Parting gasket, casing suction	1
353B	Hex capscrew, gland	4/8
354	Washer, gland	4/8
358U	Plug, bearing housing oil fill pipe	2
358V	Plug, bearing housing drain pipe	4
360	Gasket, end cover	2
371C	Hex screw, bearing housing to end cover	4
372U	Hex capscrew, bearing housing to casing	8
382	Bearing lockwasher	1
383*	Mechanical seal	2
400	Coupling key	1
401	Sleeve key	2
408F	Plug, casing pipe	9
408G	Plug, casing pipe	5
410	Thrust ball bearing	1
412G*	O-ring, mechanical seal	2
418	Jack bolt	2
424A	Nameplate pin	10
426	Parting hex capscrew	Size-dependent
426A	Parting hex capscrew	Size-dependent
428	Sleeve gasket	2
433	Nameplate, frame	1
433A	Nameplate, casing	1
433B	Nameplate, logo casing	2
445A	Anti-rotation pin	2
469G	Taper pin with hex nut	2
496L	O-ring, end cap	1
497*	O-ring, sleeve nut	2
535	Washer, outboard bearing	1
551F	Bushing, reducer	2

Technical Reference

Engineering data

Pump Size		[5]6x10–22	[5]8x12–21	[5]8x12–22M	[5]8x12–22L	8x12–27
Casing Data (all dimensions in inches)						
[2]125#FF ASA flanges	Max. suction pressure (PSIG)	75	75	75	75	Not available
	Max. working pressure (PSIG)	300	300	300	300	
	Max. hydrostatic test pressure (PSIG)	450	450	450	450	
	Casing material	Cast iron	Cast iron	Cast iron	Cast iron	
[1]250# FF [3] ASA Flanges	Max. suction pressure (PSIG)	200	200	200	200	200
	Max. working pressure (PSIG)	400	400	400	400	400
	Max. hydraulic test pressure (PSIG) [4]	600	600	600	600	600
	Casing material	Ductile iron	Ductile iron	Ductile iron	Ductile iron	Ductile iron
	Casing wall thickness	.625	.625	.625	.625	.625
Stuffing Box Data						
Bore		5.125	5.125	5.125	5.125	5.125
Depth		4.812	4.812	4.812	4.812	4.812
Seal cage width		.75	.75	.75	.75	.75
Packing no. rings/size sq.		6/.625	6/.625	6/.625	6/.625	6/.625
Shaft sleeve O.D.		3.875	3.875	3.875	3.875	3.875
Mechanical seal size (type 8–1)		3.875	3.875	3.875	3.875	3.875
[6]Mechanical seal size (type 8–1B)	Major dia.	4.125	4.125	4.125	4.125	4.125
	Minor dia.	3.875	3.875	3.875	3.875	3.875
Impeller Design Data						
Number of vanes		6	6	5	6	6
Inlet area (sq. inches)		59	35.7	61	80	82.4
Inlet velocity per 100 GPM (ft/sec)		.54	.90	.53	.40	.37
Maximum diameter		23.0	21.8	20.5	23.0	27.0
Minimum diameter		12.0	12.5	12.5	12.0	20.0
Maximum sphere		1.30	1.00	1.32	1.60	1.50
$WR^2$for maximum diameter (lbs-ft^2)		56	49	50	59	185
Wear ring clearance — dia. BRZ impellers		.016–.019	.016–.019	.016–.019	.016–.019	.016–.019
Wear ring clearance — dia. Ci and SS impellers		.025–.028	.025–.028	.025–.028	.025–.028	.025–.028
Shaft and Bearing Data						
At coupling		3.125	3.125	3.125	3.125	3.125
Thru impeller and sleeves		3.311	3.311	3.311	3.311	3.311
Shaft span	Bearing to bearing centerline	35.800	35.800	35.800	35.800	40.500
Ball bearing	Inboard	6316	6316	6316	6316	6316
	Outboard	21316	21316	21316	21316	21316
Frame group		S	S	S	S	M

Pump	10x14–20S	10x14–20L	12x16–23	14x16–17	14x18–23	13x18–28
Casing Data (all dimensions in inches)						

Pump		10x14–20S	10x14–20L	12x16–23	14x16–17	14x18–23	13x18–28
[2]125# FF std. [3] ASA flanges	Max. suction pressure (PSIG)	75	75	75	75	75	75
	Max. working pressure (PSIG)	175	175	175	175	175	175
	Max. hydro-static test pressure (PSIG)[4]	262	262	262	262	262	262
	Casing material	Cast iron	Cast iron	Cast iron	Cast iron	Cast iron	Cast iron
[1]250# FF [3]ASA flanges	Max. suction pressure (PSIG)	200	200	200	200	200	200
	Max. working pressure (PSIG)	300	300	300	300	300	300
	Max. hydro-static test pressure (PSIG) [4]	450	450	450	450	450	450
	Casing material	Ductile iron	Ductile iron	Ductile iron	Ductile iron	Ductile iron	Ductile iron
	Casing wall thickness	.625	.625	.625	.625	.625	.625
Stuffing Box Data (all dimensions in inches)							
Bore		5.125	5.125	5.125	5.125	5.875	5.875
Depth		4.812	4.812	4.812	4.812	4.812	4.812
Seal cage width		.75	.75	.75	.75	.75	.75
Packing no. rings/size sq.		6/.625	6/.625	6/.625	6/.625	6/.625	6/.625
Shaft sleeve O.D.		3.875	3.875	3.875	3.875	4.625	4.625
Mechanical seal size (type 8–1)		3.875	3.875	3.875	3.875	4.625	4.625
[6] Mechanical seal size (type 8–1B)	Major dia.	4.125	4.125	4.125	4.125	4.750	4.750
	Minor dia.	3.875	3.875	3.875	3.875	4.500	4.500
Impeller Design Data (all dimensions in inches)							
Number of vanes		6	6	6	6	6	6
Inlet area (sq. inches)		112	128	150	171	212	196
Inlet velocity per 100 GPM (ft/sec)		.29	.25	.21	.19	.15	.16
Maximum diameter		19.8	19.8	23.0	17.5	23.0	27.9
Minimum diameter		9.4	14.0	13.0	12.5	14.0	14.0
Maximum sphere		1.63	1.56	1.63	1.20	2.10	1.30
WR^2 for maximum diameter ($lbs\text{-}ft^2$)		47	52	109	46	120	254
Wear ring clearance — dia. BRZ impellers		.016–.019	.016–.019	.016–.019	.016–.019	.016–.019	.016–.019
Wear ring clearance — dia. Ci and SS impellers		.025–.028	.025–.028	.025–.028	.025–.028	.025–.028	.025–.028
Shaft and Bearing Data (all dimensions in inches)							
At coupling		3.125	3.125	3.125	3.125	3.125	3.125
Thru impeller and sleeves		3.311	3.311	3.311	3.311	4.061	4.061
Shaft span	Bearing to bearing centerline	40.500	40.500	40.500	40.500	41.375	41.375
Ball bearing	Inboard	6316	6316	6316	6316	6316	6316
	Outboard	21316	21316	21316	21316	21316	21316
Frame group		M	M	M	M	L	L

Footnotes

1. With 250#FF flanges refer to pump as H6x10–22
2. Flange dimensions are in accordance with ANSI A21,10,AWWA C110 and ANSI B16.1 Class 125.

3. Flange dimensions are in accordance with ANSI B16.1 Class 250 except flanges are flat faced.
4. The hydrostatic test will be in accordance with the latest edition of the hydraulic Institute Standards, test will be maintained for a minimum of 10 minutes.
5. 6x10–22, 8x12–21, and 8x12–22M/L are standard with 125#FF suction and 250#FF discharge flanges.
6. Balanced mechanical seal have a major and a minor diameter as listed.

Other Relevant Documentation or Manuals

For additional documentation

For any other relevant documentation or manuals, contact your ITT representative.

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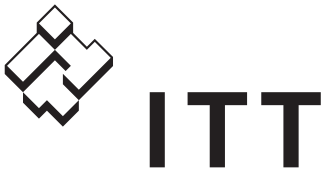

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