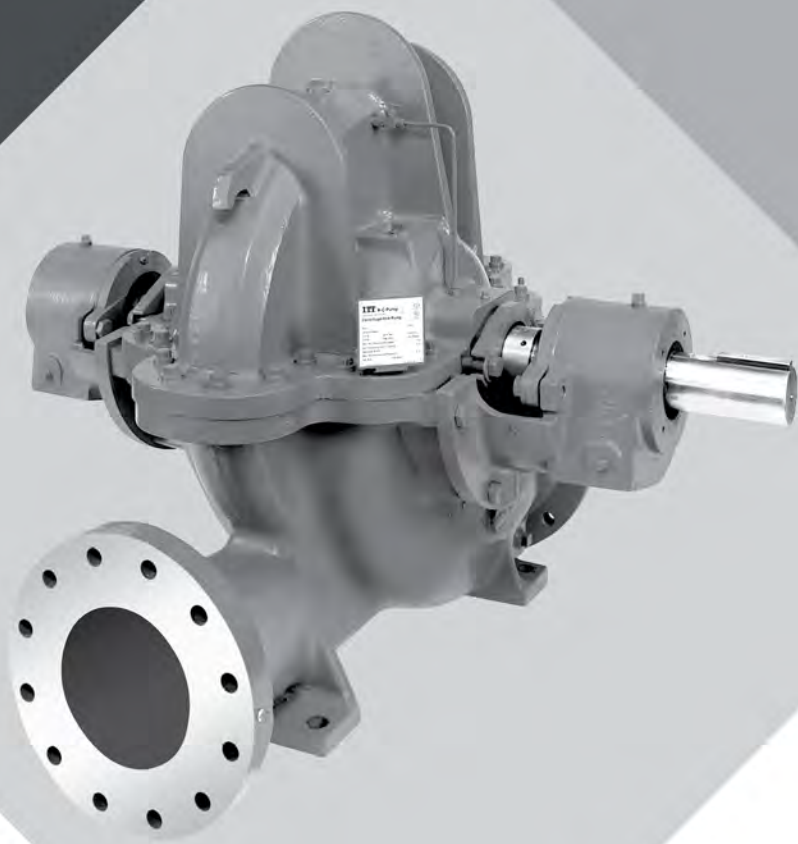
GOULDS PUMPS

Installation, Operation, and Maintenance Manual

Model 3409



ITT

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1 Introduction and Safety

1.1 Introduction

Purpose of this manual

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

- Installation
- Operation
- Maintenance

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

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

1.1.1 Requesting other information

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

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

1.2 Safety

WARNING:

- The operator must be aware of the pumpage and take appropriate safety precautions to prevent physical injury.
- Risk of serious injury or death. If any pressure-containing device is over-pressurized, it can explode, rupture, or discharge its contents. It is critical to take all necessary measures to avoid over-pressurization.
- Risk of death, serious personal injury, and property damage. Installing, operating, or maintaining the unit using any method not prescribed in this manual is prohibited. Prohibited methods include any modification to the equipment or use of parts not provided by ITT. If there is any uncertainty regarding the appropriate use of the equipment, please contact an ITT representative before proceeding.
- Risk of serious personal injury. Applying heat to impellers, propellers, or their retaining devices can cause trapped liquid to rapidly expand and result in a violent explosion. This manual clearly identifies accepted methods for disassembling units. These methods must be adhered to. Never apply heat to aid in their removal unless explicitly stated in this manual.
- Risk of serious personal injury or property damage. Dry running may cause rotating parts within the pump to seize to non-moving parts. Do not run dry.

- Running a pump without safety devices exposes operators to risk of serious personal injury or death. Never operate a unit unless appropriate safety devices (guards, etc.) are properly installed. See specific information about safety devices in other sections of this manual.
- Risk of death, serious personal injury, and property damage. Heat and pressure buildup can cause explosion, rupture, and discharge of pumpage. Never operate the pump with suction and/or discharge valves closed.
- Never operate the pump with the suction valve closed.
- Precautions must be taken to prevent physical injury. The pump may handle hazardous and/or toxic fluids. Proper personal protective equipment should be worn. Pumpage must be handled and disposed of in conformance with applicable environmental regulations.
- If the pump or motor is damaged or leaking, electric shock, fire, explosion, liberation of toxic fumes, physical harm, or environmental damage may result. Do not operate the unit until the problem has been corrected or repaired.

CAUTION:
Risk of injury and/or property damage. Operating a pump in an inappropriate application can cause over pressurization, overheating, and/or unstable operation. Do not change the service application without the approval of an authorized ITT representative.

WARNING:
This product contains Carbon Black a chemical known to the State of California to cause cancer. For more information go to www.P65Warnings.ca.gov

1.2.1 Safety terminology and symbols

About safety messages

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

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

Hazard levels

Hazard level	Indication
DANGER:	A hazardous situation which, if not avoided, will result in death or serious injury
WARNING:	A hazardous situation which, if not avoided, could result in death or serious injury
CAUTION:	A hazardous situation which, if not avoided, could result in minor or moderate injury
NOTICE:	• A potential situation which, if not avoided, could result in undesirable conditions

Hazard level	Indication
	• A practice not related to personal injury

Hazard categories

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

Electrical hazards are indicated by the following specific symbol:

ELECTRICAL HAZARD:

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

- Crush hazard
- Cutting hazard
- Arc flash hazard

1.2.1.1 The Ex symbol

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

1.2.2 Environmental safety

The work area

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

Recycling guidelines

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

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.

1.2.2.1 Recycling guidelines

Always follow local laws and regulations regarding recycling.

1.2.3 User safety

General safety rules

These safety rules apply:

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

Safety equipment

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

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

Electrical connections

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

Noise

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

Temperature

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

1.2.3.1 Precautions before work

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

- Provide a suitable barrier around the work area, for example, a guard rail.
- Make sure that all safety guards are in place and secure.
- Recognize the site emergency exits, eye wash stations, emergency showers and toilets.
- 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.

1.2.3.2 Precautions during work

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

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

- Never work alone.
- Always wear protective clothing and hand protection.
- Stay clear of suspended loads.
- Always lift the product by its lifting device.
- Beware of the risk of a sudden start if the product is used with an automatic level control.
- Beware of the starting jerk, which can be powerful.
- Rinse the components in water after you disassemble the pump.

1.2.3.3 Wash the skin and eyes

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

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

1.2.4 Safety regulations for Ex-approved products in potentially explosive atmospheres

Special care must be taken in potentially explosive environments to ensure that the equipment is properly maintained. This includes but is not limited to:

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

Personnel requirements

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

- All work on the product must be carried out by certified electricians and ITT-authorized mechanics. Special rules apply to installations in explosive atmospheres.
- All users must know about the risks of electric current and the chemical and physical characteristics of the gas, the vapor, or both present in hazardous areas.
- Any maintenance for Ex-approved products must conform to international and national standards (for example, EN 60079-17).

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

Product and product handling requirements

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

- Only use the product in accordance with the approved motor data.
- The Ex-approved product must never run dry during normal operation. Dry running during service and inspection is only permitted outside the classified area.
- Before you start work on the product, make sure that the product and the control panel are isolated from the power supply and the control circuit, so they cannot be energized.
- Do not open the product while it is energized or in an explosive gas atmosphere.
- Make sure that thermal contacts are connected to a protection circuit according to the approval classification of the product, and that they are in use.
- Intrinsically safe circuits are normally required for the automatic level-control system by the level regulator if mounted in zone 0.

- The yield stress of fasteners must be in accordance with the approval drawing and the product specification.
- Do not modify the equipment without approval from an authorized ITT representative.
- Only use parts that are provided by an authorized ITT representative.

Description of Ex-Directives

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

Guidelines for compliance

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

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

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

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

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

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

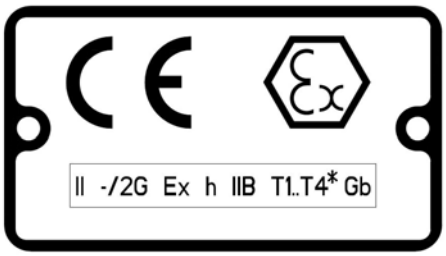


Figure 1: Typical Ex nameplate

Figure 2: Typical UKCA Ex nameplate

Table 1: Temperature class definitions

Code	Maximum permissible surface temperature in °C | °F	Maximum permissible liquid temperature in °C | °F
T1	440 | 824	372 | 700
T2	290 | 554	267 | 513
T3	195 | 383	172 | 342
T4	130 | 266	107 | 225
T5	Option not available	Option not available
T6	Option not available	Option not available

* Maximum liquid temperature may be limited by the pump model and order specific options. Table 1: Temperature class definitions on page 11 is for the purpose of determining T'x' code for Ex applications with liquid temperatures exceeding 107ºC | 225ºF.

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

Equipment for monitoring

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

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

WARNING:

- When pumping unit is installed in a potentially explosive atmosphere, the instructions after the Ex symbol must be followed. Personal injury and/or equipment damage may occur if these instructions are not followed. If there is any question regarding these requirements or if the equipment is to be modified, please contact a Goulds representative before proceeding.
- If equipment is to be installed in a potentially explosive atmosphere and these procedures are not followed, personal injury or equipment damage from an explosion may result.
- Particular care must be taken when the electrical power source to the equipment is energized.
- Improper impeller adjustment could cause contact between the rotating and stationary parts, resulting in a spark and heat generation.
- Lock out driver power to prevent electric shock, accidental start-up and physical injury.
- NEVER start pump without proper prime (all models), or proper liquid level in self-priming pumps (Model 3796 and SP3298).
- Equipment that will operate in a potentially explosive environment must be installed in accordance with the following instructions.
- All equipment being installed must be properly grounded to prevent unexpected static electric discharge. This includes ensuring that the PFA lined pumps (Model 3198), ETFE

lined pumps (Model 3298, SP3298, V3298), and the non-metallic liquid end pumps (Model NM3196) are pumping fluids that are conductive. If not, a static electric discharge may occur when the pump is drained and disassembled for maintenance purposes.

- All equipment being installed must be properly grounded to prevent unexpected static electric discharge.
- When pumping fluids with conductivity less than 1000 ps/m follow IEC TS 60079 32-1 guidelines.
- Alignment procedures must be followed to prevent unintended contact of rotating parts. Follow coupling manufacturer's installation and operation procedures.
- When installing in a potentially explosive environment, ensure that the motor and accessories are properly certified.
- The impeller clearance setting procedure must be followed. Improperly setting the clearance or not following any of the proper procedures can result in sparks, unexpected heat generation and equipment damage.
- The impeller and wear ring clearance setting procedures must be followed. Improperly setting the clearance or not following any of the proper procedures can result in sparks, unexpected heat generation and equipment damage.
- Service temperature in an Ex classified environment is limited to the area classification specified on the Ex tag affixed to the pump (reference Table 1 in the Safety section for Ex classifications).
- The coupling used in an Ex classified environment must be properly certified.
- The coupling guard used in an Ex classified environment must be constructed from a spark-resistant material.
- Bearings must be lubricated properly in order to prevent excess heat generation, sparks and premature failure.
- The mechanical seal used in an Ex classified environment must be properly certified.
- The mechanical seal must have an appropriate seal flush system. Failure to do so will result in excess heat generation and seal failure.
- Packed stuffing boxes are not allowed in an Ex classified environment.
- Dynamic seals are not allowed in an Ex classified environment.
- Pumps that are not self-priming must be fully primed at all times during operation. The only model lines that are self-priming is the 3796 and SP3298.
- Pumps must be fully primed at all times during operation.
- The preventive maintenance section must be adhered to in order to keep the applicable Ex classification of the equipment. Failure to follow these procedures will void the Ex classification for the equipment. Bearing replacement intervals are given in the specific pump model IOM.
- Inspection intervals should be shortened appropriately if the pumpage is abrasive and/or corrosive, or if the environment is classified as potentially explosive.
- Throughout this section on bearing lubrication, different pumpage temperatures are listed. If the equipment is Ex certified and the listed temperature exceeds the applicable value shown in Table 1 under SAFETY, then that temperature is not valid. Should this situation occur, please consult with your ITT/Goulds representative.
- Cooling systems, such as those for bearing lubrication, mechanical seal systems, etc., where provided, must be operating properly to prevent excess heat generation, sparks and premature failure.
- Rotate shaft by hand to ensure it rotates smoothly and there is no rubbing which could lead to excess heat generation, sparks and premature failure.

- Flange loads from the piping system, including those from 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.
- Ensure that pump and systems are free of foreign objects before operating and that objects cannot enter the pump during operation. Foreign objects in the pumpage or piping system can cause blockage of flow which can result in excess heat generation, sparks and premature failure.
- Do not insulate or allow the bearing housings to accumulate a dust layer as this can result in excess heat generation, sparks and premature failure.
- Check for magnetism on the pump shaft and demagnetize the shaft if there is any detectable magnetism. Magnetism will attract ferritic objects to the impeller, seals and bearings which can result in excess heat generation, sparks and premature failure.
- Leakage of process liquid may result in creation of an explosive atmosphere. Ensure the materials of the pump casing, impeller, shaft, sleeves, gaskets and seals are compatible with the process liquid.
- Leakage of process liquid may result in creation of an explosive atmosphere. Follow all pump and seal assembly procedures.
- A buildup of gases within the pump, sealing system and or process piping system may result in an explosive environment within the pump or process piping system. Ensure process piping system, pump and sealing system are properly vented prior to operation.
- Sealing systems that are not self purging or self venting, such as plan 23, require manual venting prior to operation. Failure to do so will result in excess heat generation and seal failure.
- Do not apply additional paint or coatings to the pump when in an Ex environment. Static electric discharge can be initiated when contacting or rubbing surfaces with excessive coating thickness.
- Potential electrostatic charging hazard. Do not rub, clean, or blast equipment with dry cloth or dry media.
- Stray electrical currents may ignite explosive atmospheres. Ensure drives are certified for variable frequency drive operation by the manufacturer.
- User shall observe necessity of using a safety device, such as a flame arrestor, to prevent flame entering or leaving the pump sump, tank, or barrel when applicable.
- For variable speed motor applications, the electric motor must be specified with shaft grounding and used with a conductive type coupling suitable for the area classification.
- In plants or pumps with cathodic corrosion protection, a small current constantly flows through the construction. This is not permissible on the complete pump or partially-assembled machinery without further precautions being taken. ITT should be consulted in this context.

1.2.5 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
- Filter

1.3 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.

2 Transportation and Storage

2.1 Inspect the delivery

2.1.1 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.

2.1.2 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.

2.2 Transportation guidelines

2.2.1 Precautions

WARNING:

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

2.2.2 Lifting methods

WARNING:

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

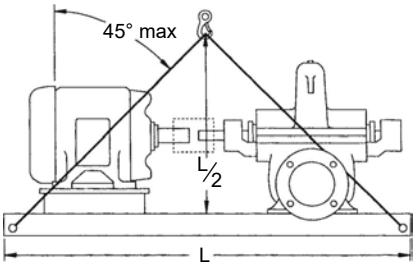


Figure 3: The proper lifting method for a horizontal pump on a base with lifting holes

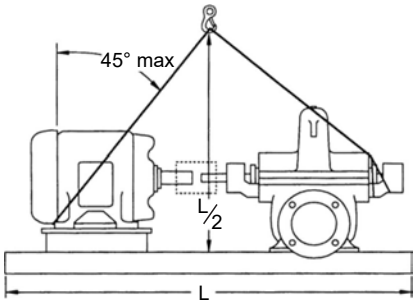
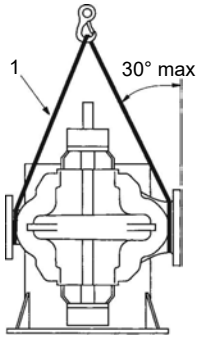


Figure 4: The proper lifting method for a horizontal pump on a base without lifting holes

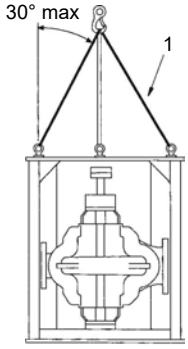
Pumps mounted vertically

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



1. Nylon sling, chain, or wire rope

Figure 6: The proper lifting method for a vertical pump mounted on a full pedestal

2.3 Storage guidelines

2.3.1 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.
Long-term (more than six months)	• Store in a covered and dry location. • Store the unit free from heat, dirt, and vibrations.

Length of time in storage	Storage requirements
	• 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.

3 Product Description

3.1 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.

WARNING:
Use of equipment unsuitable for the environment can pose risks of ignition and/or explosion. Ensure the pump driver and all other auxiliary components meet the required area classification at the site. If they are not compatible, do not operate the equipment and contact an ITT representative before proceeding.

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 lock-washer

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.

WARNING:
The coupling used in an Ex classified environment must be properly certified.

Coupling guard

The coupling guard is all metal.

WARNING:
The coupling guard used in an Ex classified environment must be properly certified and constructed from a spark resistant material.

Rotation

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

3.2 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

Item numbers can be found in the spare parts list.

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	Provides information about the hydraulic characteristics of the pump.
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.
Ex	If applicable, your pump unit might have an Ex nameplate affixed to the pump, the baseplate, or the discharge head. The nameplate provides information about the Ex specifications of this pump.

Nameplate on the pump casing

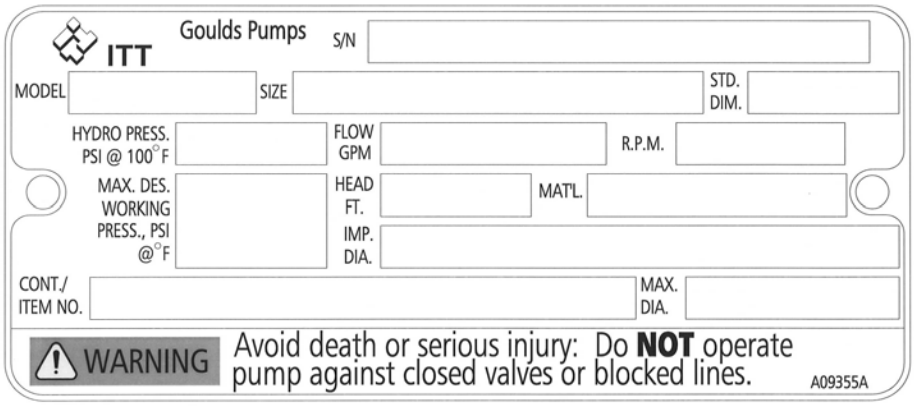


Figure 7: Nameplate on the pump casing

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

Nameplate field	Explanation
Year	Year in which the pump was built

Nameplate on the bearing frame

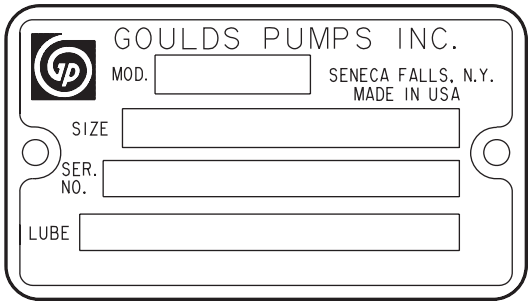


Figure 8: Nameplate on the bearing frame

Table 2: 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

Ex nameplate

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

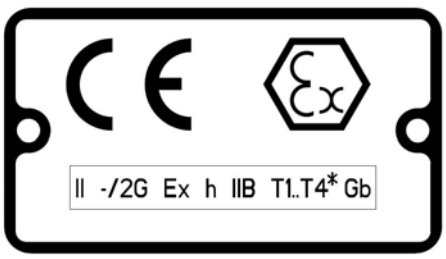


Figure 9: Typical Ex nameplate

Figure 10: Typical UKCA Ex nameplate

Refer to Table 1 for pumpage temperature restrictions.

The code classification marked on the equipment should be in accordance with the specified area where the equipment will be installed. If it is not, please contact your ITT/Goulds representative before proceeding.

WARNING:
Use of equipment unsuitable for the environment can pose risks of ignition and/or explosion. Ensure the pump driver and all other auxiliary components meet the required area classification at the site. If they are not compatible, do not operate the equipment and contact an ITT representative before proceeding.

4 Installation

4.1 Pre-installation

Precautions

WARNING:

- When installing in a potentially explosive environment, ensure that the motor is properly certified.
- All equipment being installed must be properly grounded to prevent unexpected discharge. Discharge can cause equipment damage, electric shock, and result in serious injury. Test the ground lead to verify it is connected correctly.

NOTICE:

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

4.1.1 Pump location guidelines

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.

Guideline	Explanation/comment
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.
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.

4.1.2 Foundation requirements

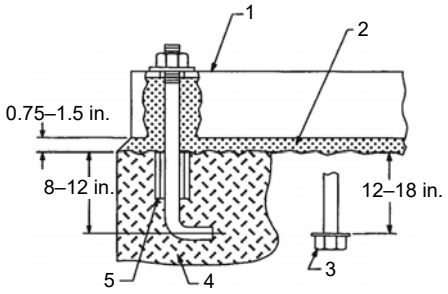
Requirements

- 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 1.905 – 3.81 cm | 0.75 – 1.5 in. of the finished height.

Foundation bolts

- Foundation bolts must be embedded in the concrete to a depth of 8â12 in. (20â30 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 3.175 mm | 0.125 in. 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 11: Bolt installation

4.2 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 0.051 cm | 0.020 in. TIR for parallel alignment and 0.023 cm | 0.009 in. 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.

4.3 Pump-to-driver alignment

Precautions

WARNING:

- Failure to disconnect and lock out driver power may result in serious physical injury or death. Always disconnect and lock out power to the driver before performing any installation or maintenance tasks.
  - Electrical connections must be made by certified electricians in compliance with all international, national, state, and local rules.
  - Refer to driver/coupling/gear manufacturer's installation and operation manuals (IOM) for specific instructions and recommendations.

4.3.1 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	0.1 mm | 0.004 in. TIR (4 mils)	1.52 mm | 0.060 in. TIR per foot of spacer length
Angular misalignment	0.1 mm | 0.004 in. TIR per inch of radius.	0.51 mm | 0.002 in. 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.

4.3.1.1 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

4.3.2 Align the pump using a straight edge

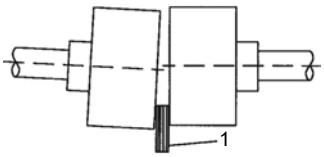
Before you begin, you must have a straight edge and a taper gauge or set of feeler gauges.

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.

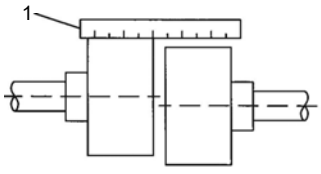
   The unit is in angular alignment when these four measurements are the same or are within recommended tolerances.
2. Check for parallel alignment by placing a straight edge across both coupling rims on all four sides.

   The unit is in parallel alignment when the straight edge rests evenly across both coupling rims in all four positions.



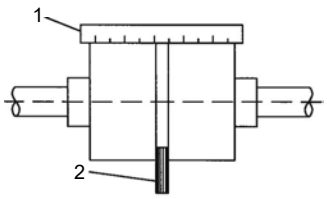
1. Feeler gauge

Figure 12: Incorrect angular alignment



1. Straight edge

Figure 13: Incorrect parallel alignment



1. Straight edge
2. Feeler gauge

Figure 14: Correct alignment

4.3.3 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.

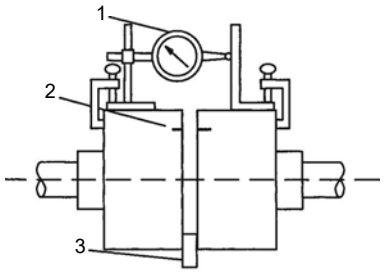
   Chalk and separators are not necessary on the elastomeric couplings that have not been disconnected.
4. Rotate both shafts by the same amount.

   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.

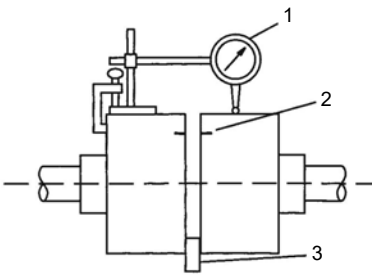
   NOTICE:

   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 15: Angular alignment



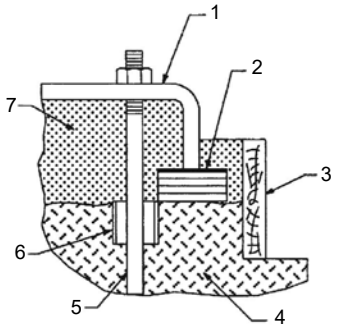
1. Dial indicator
2. Reference mark
3. Separator to take up the bearing slack

Figure 16: Parallel alignment

4.4 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 17: 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.

4.5 Piping checklists

4.5.1 General piping checklist

Precautions

WARNING:

- Risk of premature failure. Casing deformation can result in misalignment and contact with rotating parts, causing excess heat generation and sparks. Flange loads from the piping system, including those from the thermal expansion of the piping, must not exceed the limits of the pump.
- Risk of serious personal injury or property damage. Fasteners such as bolts and nuts are critical to the safe and reliable operation of the product. Ensure appropriate use of fasteners during installation or reassembly of the unit.
  - Use fasteners of the proper size and material only.
  - Replace all corroded fasteners.
  - Ensure that all fasteners are properly tightened and that there are no missing fasteners.

CAUTION:
Do not move the pump to the pipe. This could make final alignment impossible.

CAUTION:
Never draw piping into place 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.

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.

NOTICE:
Vary the capacity with the regulating valve in the discharge line. Never throttle the flow from the suction side. This action can result in decreased performance, unexpected heat generation, and equipment damage.

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 short as possible.	This helps to minimize friction losses.	
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.	—	
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.	—	
Make sure that the isolation and check valves are installed in the discharge line.	Locate the check valve between the isolation valve and the pump. This will permit inspection of the check valve. The isolation valve is required for regulation of flow, and for inspection and maintenance of the pump. The check valve prevents pump or seal damage due to reverse flow through the pump when the driver is turned off.	
Use cushioning devices.	This protects the pump from surges and water hammer if quick-closing valves are installed in the system.	
In no case should loads on the pump flanges exceed the limits stated in API Standard 610, 11th Edition (ISO 13709).	Bottom of casing should be supported by a solid foundation or casing feet should be used.	

4.5.2 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

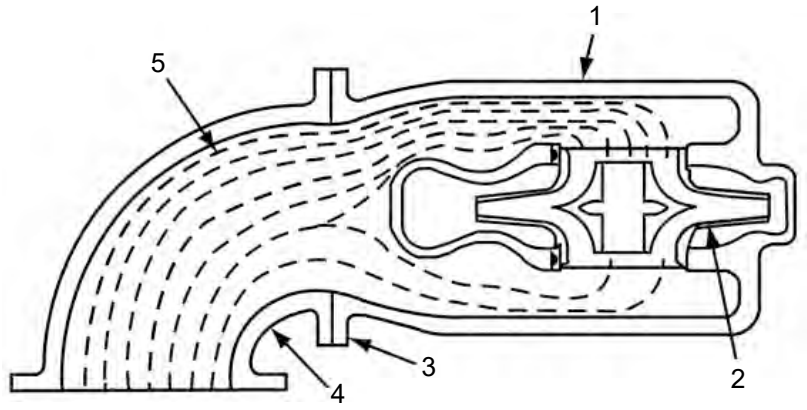
Check	Explanation/comment	Checked
Check that the elbows in the suction piping for horizontal double-suction pumps are installed per the Hydraulics Institute Standards since there is always an uneven turbulent flow around an elbow.	When there is an elbow in a position other than the vertical when in relation 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.

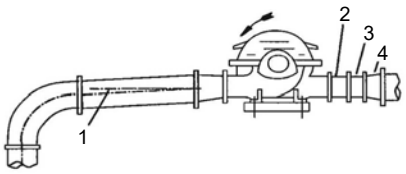
This figure shows the unbalanced loading of a double-suction impeller due to the uneven flow around an elbow that is adjacent to the pump:



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.

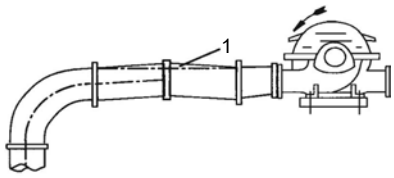
Figure 18: Unbalanced loading of double-suction impeller

Examples



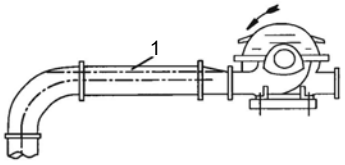
1. Level centerline of pipe
2. Check valve
3. Gate valve
4. Increaser

Figure 19: Suction pipe installed with a gradual rise to the pump – correct



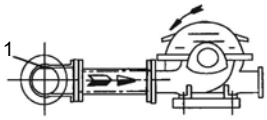
1. Air pocket

Figure 20: Suction pipe installed with a gradual rise to the pump – incorrect



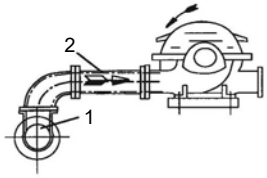
1. Air pocket

Figure 21: Suction pipe installed with a reducer – incorrect



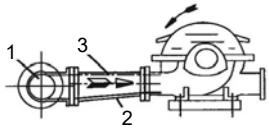
1. Air pocket

Figure 22: Incorrect



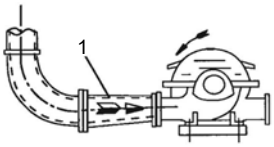
1. No air pockets
2. Gradual rise

Figure 23: Correct



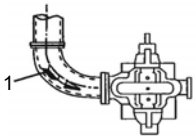
1. No air pockets
2. Eccentric reducer
3. Gradual rise

Figure 24: Gradual rise to the pump – correct



1. Distance plus eccentric reducer straightens the flow

Figure 25: Suction pipe above the pump – correct



1. Path of the water

Figure 26: Suction pipe above the pump – incorrect

4.5.3 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.

4.5.4 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.

4.5.5 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.

4.6 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.

5 Commissioning, Startup, Operation, and Shutdown

5.1 Preparation for startup

WARNING:

- Failure to disconnect and lock out driver power may result in serious physical injury or death. Always disconnect and lock out power to the driver before performing any installation or maintenance tasks.
  - Electrical connections must be made by certified electricians in compliance with all international, national, state, and local rules.
  - Refer to driver/coupling/gear manufacturer's installation and operation manuals (IOM) for specific instructions and recommendations.
- Electrical connections must be made by certified electricians in compliance with all international, national, state, and local rules.
- Running a pump without safety devices exposes operators to risk of serious personal injury or death. Never operate a unit unless appropriate safety devices (guards, etc.) are properly installed.

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.

5.2 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.

5.3 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.

5.4 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.

5.5 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.	

Check	Explanation/comment	Checked
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.	
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 watt meter is available) • Pump speed	
Temperature	Check and record bearing temperatures using a thermometer. The temperature should not exceed 82°C | 180°F.	
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.	

5.6 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.
Precautions must be taken to prevent physical injury. The pump may handle hazardous and/or toxic fluids. Proper personal protective equipment should be worn. Pumpage must be handled and disposed of in conformance with applicable environmental regulations.

1. 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.

5.7 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.

6 Maintenance

6.1 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 82°C | 180°F, 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.

6.2 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:

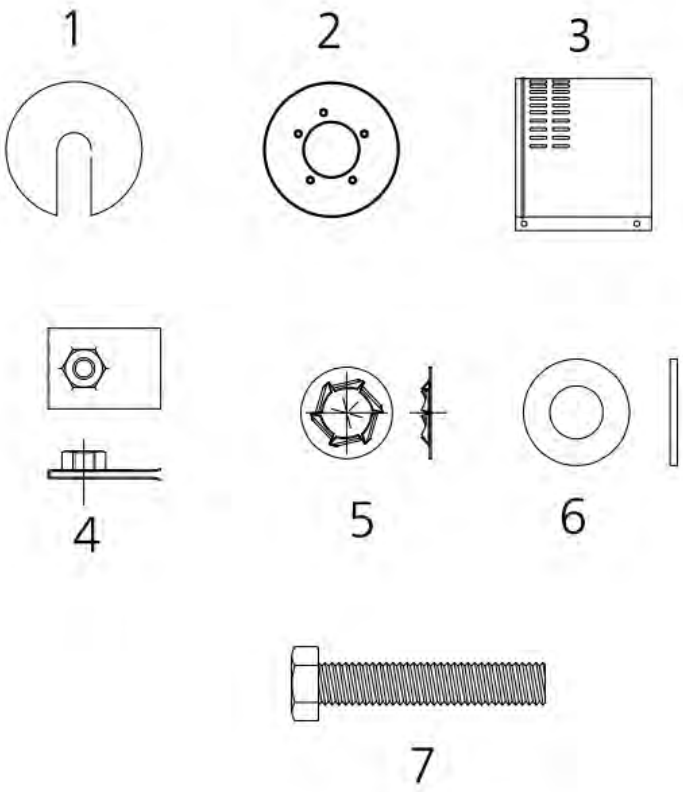
- Dismantle the frame, and then inspect the bearings for any rusted or badly worn surfaces. Clean as necessary. If the bearings are free from rust and wear, then reassemble and re-lubricate them with one of the recommended lubricants. Depending on the length of time the pump has remained in the flooded 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.

6.3 Install the coupling guard

WARNING:

- Running a pump without safety devices exposes operators to risk of serious personal injury or death. Never operate a unit unless appropriate safety devices (guards, etc.) are properly installed.
- Failure to disconnect and lock out driver power may result in serious physical injury or death. Always disconnect and lock out power to the driver before performing any installation or maintenance tasks.
    - Electrical connections must be made by certified electricians in compliance with all international, national, state, and local rules.
    - Refer to driver/coupling/gear manufacturer's installation and operation manuals (IOM) for specific instructions and recommendations.

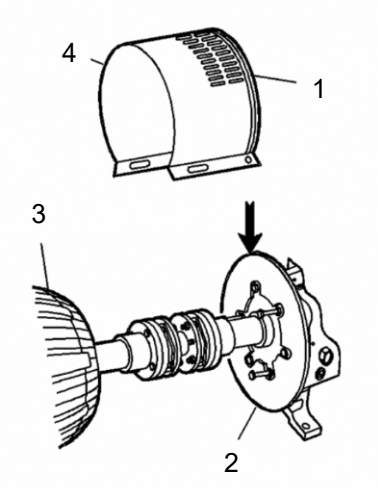
WARNING:
The coupling guard used in an Ex classified environment must be properly certified and constructed from a spark resistant material.



Part No.	Description	Part No.	Description
1	Cover driver	5	Retainer (Qty 3)
2	Cover pump	6	Washer (Qty 4)
3	Guard (Qty 2)	7	Hex head bolt (Qty 3)
4	U-nut (Qty 3)		

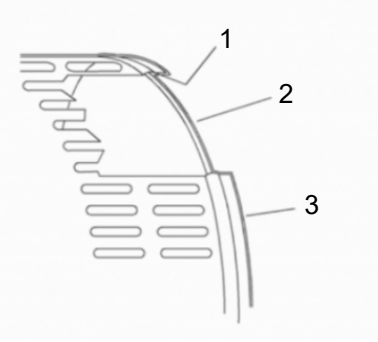
Figure 27: Required parts

1. De-energize the motor, place the motor in a locked-out position, and place a caution tag at the starter that indicates the disconnect.
2. Put the pump-side end plate in place.
   If the pump-side end plate is already in place, make any necessary coupling adjustments and then proceed to the next step.
3. Slightly spread the opening of the coupling guard half and place it over the pump end plate.
   a) The annular groove in the guard is located around the end plate.
   b) Position the opening (flange) so that it does not interfere with the piping but still allows for access when you install the bolts.



Item	Description
1.	Annular groove
2.	Pump-side end plate
3.	Driver
4.	Pump half of the coupling guard

Figure 28: Align pump end guard half with annular groove



Item	Description
1.	Annular groove
2.	End plate (pump end)
2.	Guard half

Figure 29: Annular groove in coupling guard

4. Place one washer over the bolt and insert the bolt through the round hole at the front end of the guard half.

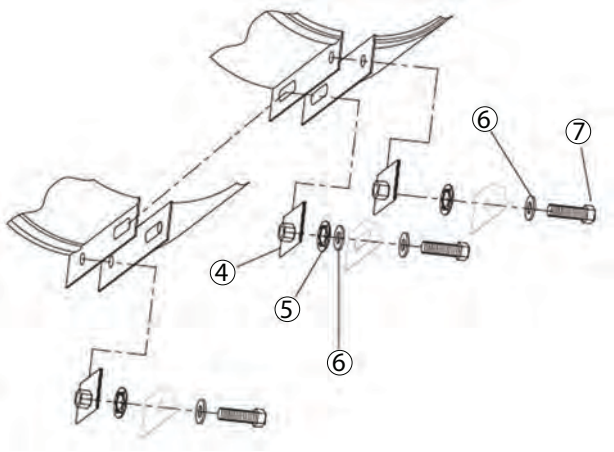


Figure 30: Captured hardware component assembly

5. Install the bolt retainer over the exposed end of the bolt, and the U-Nut into the slot in the coupling guard if it was not done from the factory.
6. Thread bolt into the U-Nut and tighten firmly.
7. Slightly spread the opening of the remaining coupling guard half and place it over the installed coupling guard half so that the annular groove in the remaining coupling guard half faces the motor.

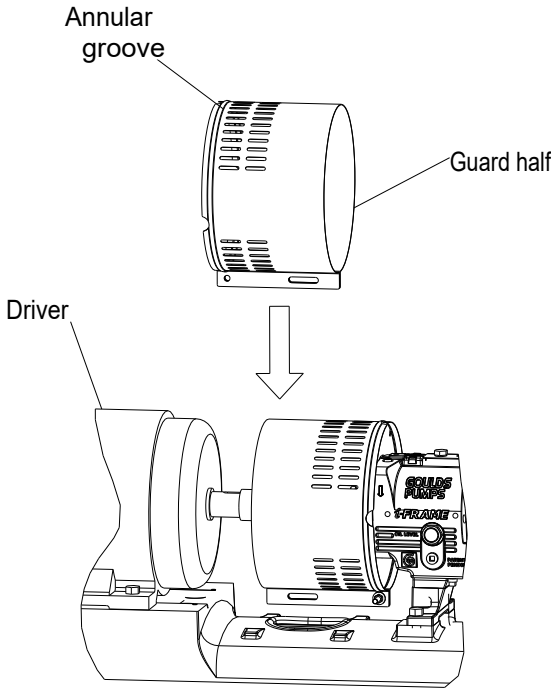


Figure 31: Placement of driver half of coupling guard

8. Place the end plate over the driver shaft and locate the end plate in the annular groove at the rear of the coupling guard half.

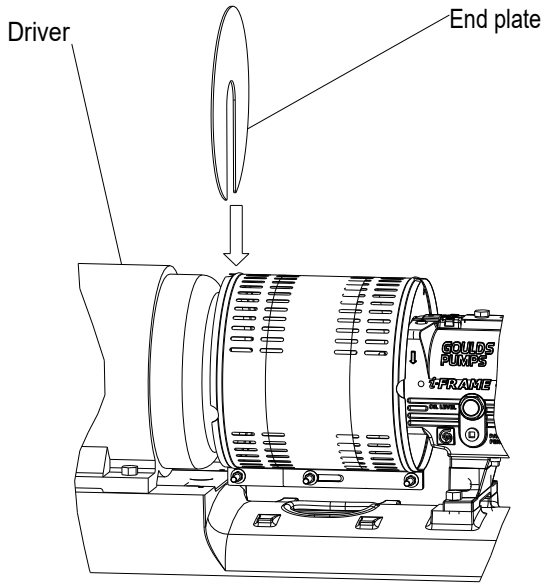


Figure 32: Placement of driver half of coupling guard

9. Hand-tighten only. Repeat Steps 4 through 6 for the rear end of the coupling guard half. The hole is located on the driver-side of the coupling guard half.
10. Slide the driver-half of the coupling guard towards the motor so that the coupling guard completely covers the shafts and coupling.

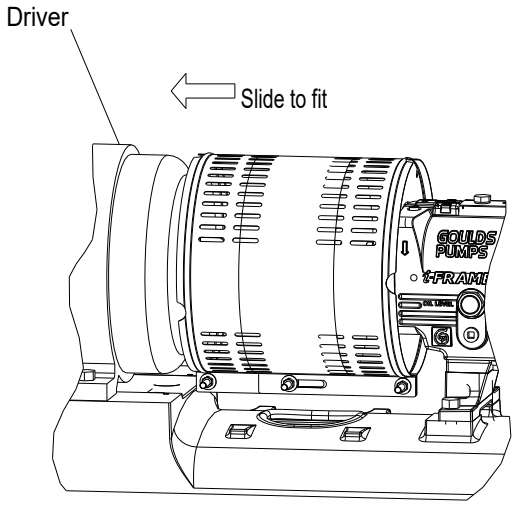


Figure 33: Slide driver-half of coupling guard towards motor

11. Repeat Steps 4 through 6 for the center slots in the coupling guard.
12. Tighten all nuts on the guard assembly.

6.4 Bearing maintenance

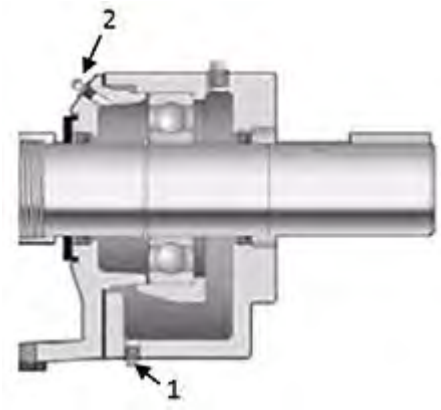
These bearing lubrication sections list different temperatures of the pumped fluid. If the pump is Ex-certified and the temperature of the pumped fluid exceeds the permitted temperature values, then consult your ITT representative.

For Ex applications bearing replacement (all) is recommended after 50K hours of operation.

6.4.1 Regrease the grease-lubricated bearings

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

NOTICE:
Risk of equipment damage. Ensure that the grease container, the greasing device, and the fittings are clean. Failure to do so can result in impurities entering the bearing housing while re-greasing the bearings.



1. Relief plug
2. Fitting

Figure 34: 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.

6.4.1.1 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:

- Avoid equipment damage or decreased performance. 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. If it is necessary to change the grease type or consistency, remove the rotor and old grease from the housing before regreasing.
- 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.

6.4.2 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.

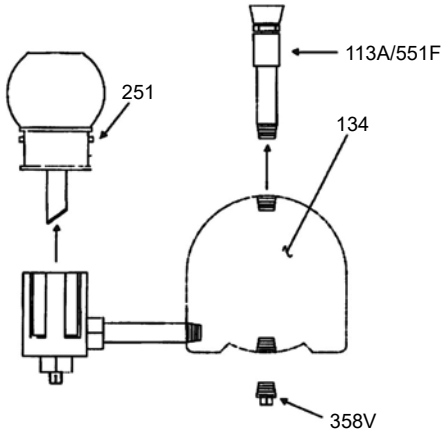


Figure 35: Oiler assembly

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.

6.4.2.1 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 38°C | 100°F	215 SSU – 240 SSU
Saybolt viscosity at 99°C | 210°F	49 SSU
Viscosity index, minimum	95
API gravity	28–33
Pour point, maximum	-6.7°C | +20°F
Flash point, minimum	204°C | 400°F
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 38°C | 100°F (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 82°C | 180°F.
- If the temperature of the bearing frame exceeds 82°C | 180°F (measured by thermometer), shut down the pump to determine the cause.
- Do not mix oils from different suppliers.

6.4.3 Bearing temperatures

- Bearing temperatures up to 82°C | 180°F 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 7.1 Troubleshooting on page 69.
- Do not use the human hand as a thermometer. A temperature that feels hot to the hand can vary from (49°C | 120°F to 54°C | 130°F depending upon the individual. Above this temperature, the human hand can not accurately estimate temperature.

6.4.4 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.

6.5 Shaft-seal maintenance

6.5.1 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.

6.5.2 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 5.1 cm | 2 in. 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.

6.6 Disassembly

6.6.1 Disassembly precautions

WARNING:

- Failure to disconnect and lock out driver power may result in serious physical injury or death. Always disconnect and lock out power to the driver before performing any installation or maintenance tasks.
  - Electrical connections must be made by certified electricians in compliance with all international, national, state, and local rules.
  - Refer to driver/coupling/gear manufacturer's installation and operation manuals (IOM) for specific instructions and recommendations.
- Risk of serious personal injury. Applying heat to impellers, propellers, or their retaining devices can cause trapped liquid to rapidly expand and result in a violent explosion. This manual clearly identifies accepted methods for disassembling units. These methods must be adhered to. Never apply heat to aid in their removal unless explicitly stated in this manual.
- Handling heavy equipment poses a crush hazard. Use caution during handling and wear appropriate Personal Protective Equipment (PPE, such as steel-toed shoes, gloves, etc.) at all times.
- Precautions must be taken to prevent physical injury. The pump may handle hazardous and/or toxic fluids. Proper personal protective equipment should be worn. Pumpage must be handled and disposed of in conformance with applicable environmental regulations.
- Risk of serious physical injury or death from rapid depressurization. Ensure pump is isolated from system and pressure is relieved before disassembling pump, removing plugs, opening vent or drain valves, or disconnecting piping.
- Risk of serious personal injury from exposure to hazardous or toxic liquids. A small amount of liquid will be present in certain areas like the seal chamber upon disassembly.

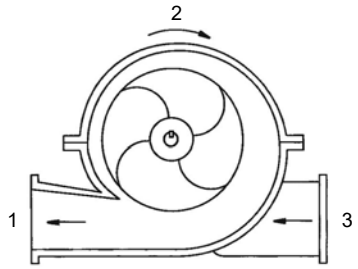
CAUTION:

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

6.6.2 Change the rotation

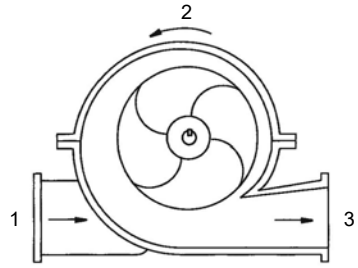
CAUTION:
Risk of motor running hot. Make sure that the motor fan is bidirectional. If it is not bidirectional, then turn it around or replace it.

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 36: Clockwise rotation viewed from the coupling end



1. Suction
2. Counterclockwise rotation
3. Discharge

Figure 37: 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.

6.6.3 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.

6.6.4 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.

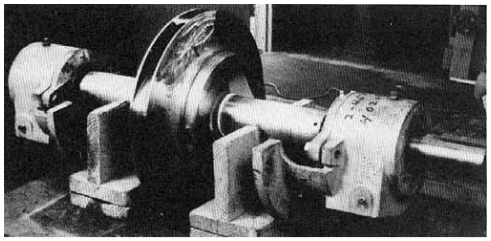


Figure 38: Rotating element

6.6.5 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:

   Do not reuse bearings if removed from shaft. Doing so may result in equipment damage. Replace the bearings before reassembly.
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 6.7.2.2 Replace the wear rings on page 57 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.

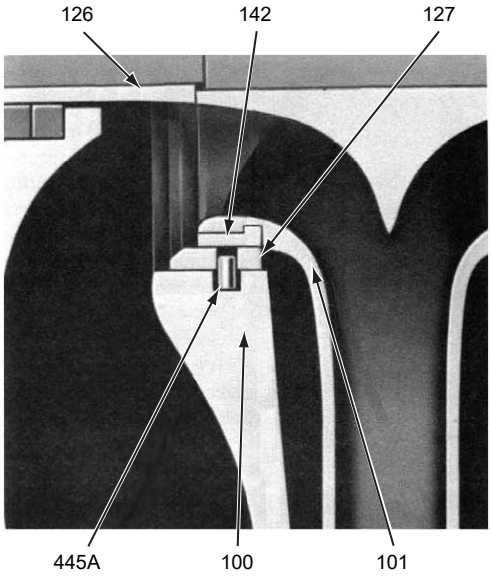


Figure 39: Pump disassembly

6.7 Preassembly

6.7.1 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:
  1. Lay the gasket material on the casing joint and mark it by pressing it against the edges of the casing.
  2. Trim the gasket so that it is flush with the inside edges of the casing.

6.7.2 Adjustable wear rings

Adjustable rings Adjustable Wear 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.

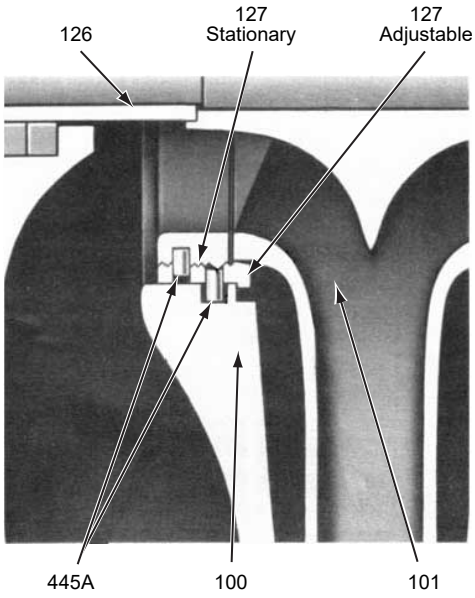


Figure 40: Adjustable wear rings

6.7.2.1 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.

6.7.2.2 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.

6.8 Reassembly

6.8.1 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 6.8.2.1 Dimension A on page 60.

   For the correct impeller rotation, refer to 6.6.2 Change the rotation on page 54.
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.

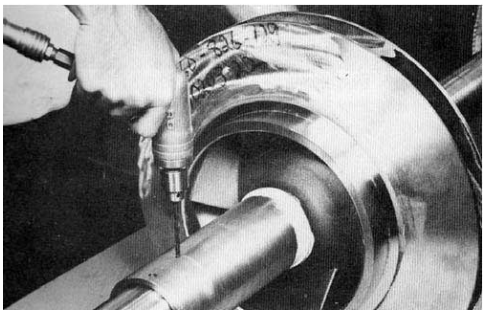


Figure 41: Shallow recess drilled through setscrew hole

10. Assemble the casing rings (127).

    Refer to 6.7.2.1 Adjust the wear rings on page 57.

6.8.2 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 6.8.2.1 Dimension A on page 60.

   For the correct impeller rotation, refer to 6.6.2 Change the rotation on page 54.
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.

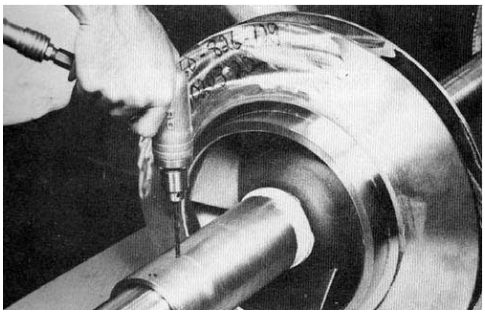


Figure 42: Shallow recess drilled through setscrew hole

10. Assemble the casing rings (127).

    Refer to 6.7.2.1 Adjust the wear rings on page 57.
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.

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 6.8.2.1 Dimension A on page 60 and tighten the setscrews.

NOTICE:

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

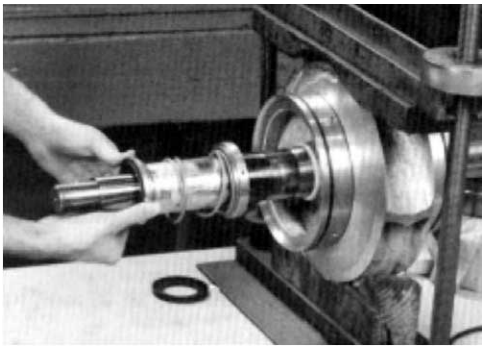


Figure 43: O-ring and gland installation

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

6.8.2.1 Dimension A

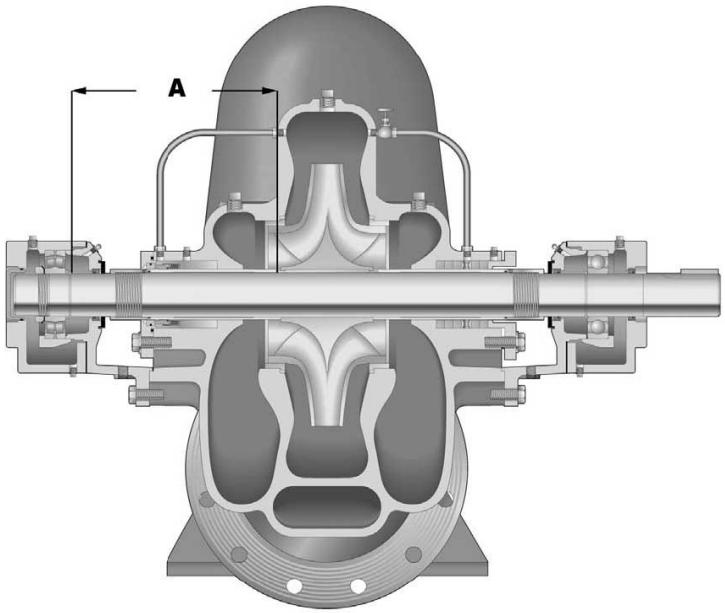


Figure 44: Seal setting

Pump size	Gland style	Quantity items 426	Quantity item 426A	Dimension A
6x10-22	all	26	--	13.5
8x10-21				
8x12-22				
8x12-27	all	44	--	15.81
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	--	
14x18-23	2 bolt gland	32		
14x18-28		34		
14x18-23	4 bolt gland	8	36	
14x18-38		8	40	

6.8.3 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 135°C | 275°F.

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 6.4.1.1 Lubricating-grease requirements on page 49.
Oil	See 6.4.2 Lubricate the oil-lubricated bearings on page 49 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).

6.8.4 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.

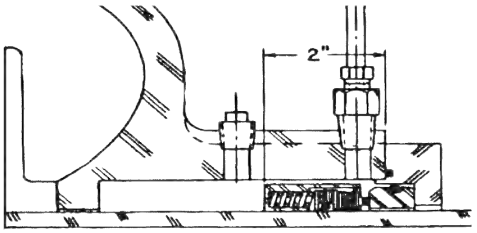


Figure 45: Mechanical seal (John Crane Type 8) setting

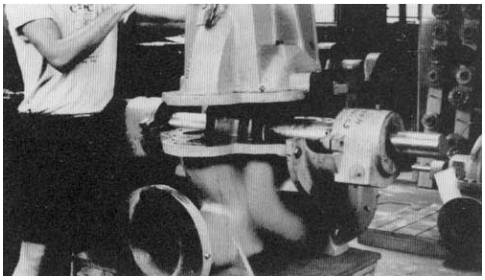
6.8.5 Install the gaskets

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.

6.8.6 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 6.6.2 Change the rotation on page 54.

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 6.8.2.1 Dimension A on page 60.

NOTICE:

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

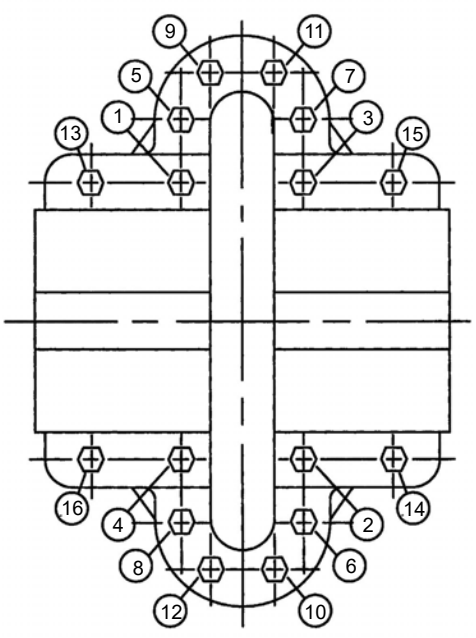


Figure 46: Casing joint bolts

6.8.7 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.

6.9 Vertical units

6.9.1 Remove the upper half of the casing

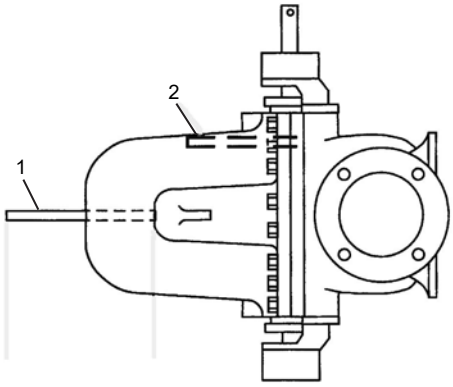
WARNING:
Crush hazard. The rotating element may fall out of the lower-half casing. Do not loosen the bolts that hold the bearing housing in the casing until you are ready to remove the rotating element from the casing.

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.

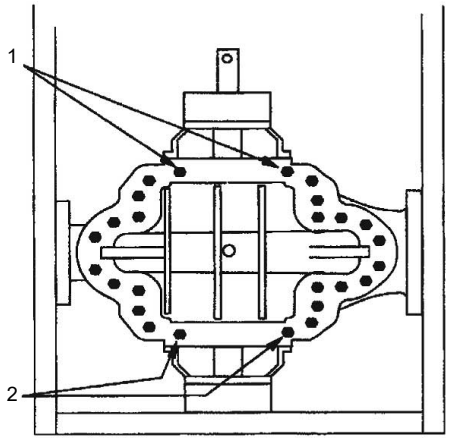
This bar will be used to stabilize the upper half during disassembly of upper half of the casing.



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

Figure 47: 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 48: 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.

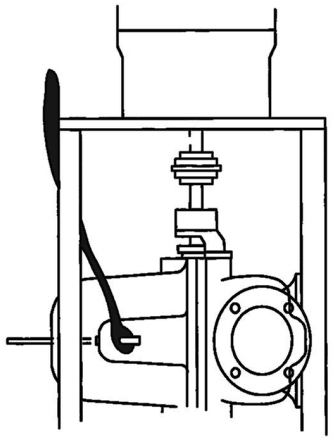


Figure 49: Nylon sling placement

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.

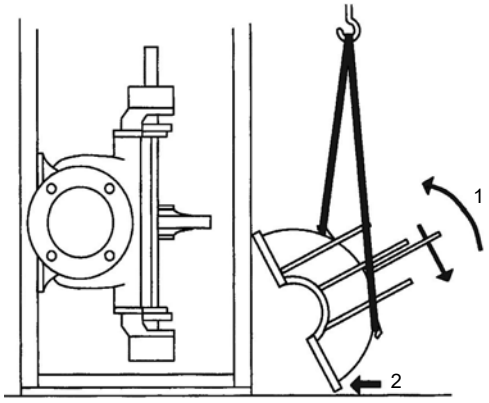
WARNING:

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

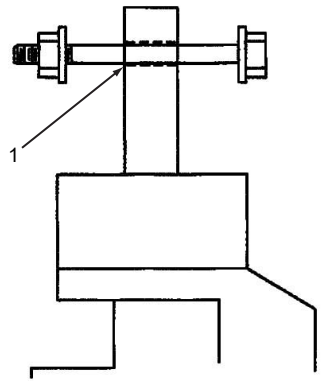
Figure 50: Rotating element

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 6.8.6 Assemble the casing on page 62.

6.9.2 Remove the rotating element

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

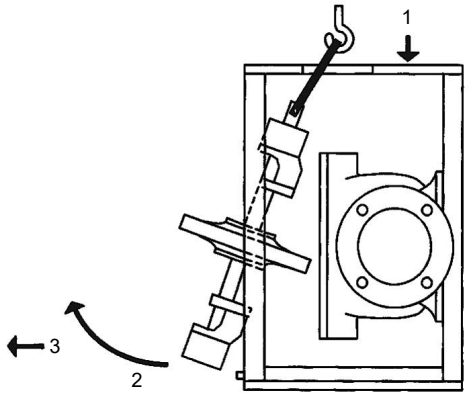
1. Thread a long bolt, washer, and nut through the hole at the end of the shaft.



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

Figure 51: 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 52: Lowering of rotating element

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

6.9.3 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.

6.9.4 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 6.6.2 Change the rotation on page 54.
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 6.8.2.1 Dimension A on page 60.

NOTICE:

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

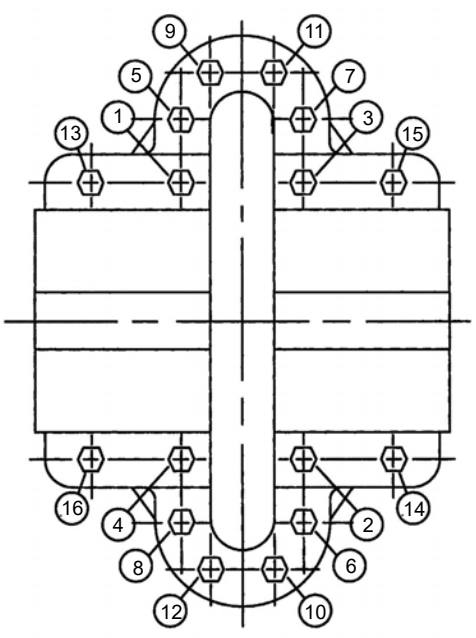


Figure 53: Casing bolts

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

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

6.9.5 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.

6.10 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.

7 Troubleshooting

7.1 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.
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

Symptom	Cause	Remedy
		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.

Symptom	Cause	Remedy
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.
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 0.05 mm | 0.002 in. on the shaft and 0.10 mm | 0.004 in. 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.

8 Parts List and Cross-Sectionals

8.1 Drawings

Standard grease lubrication

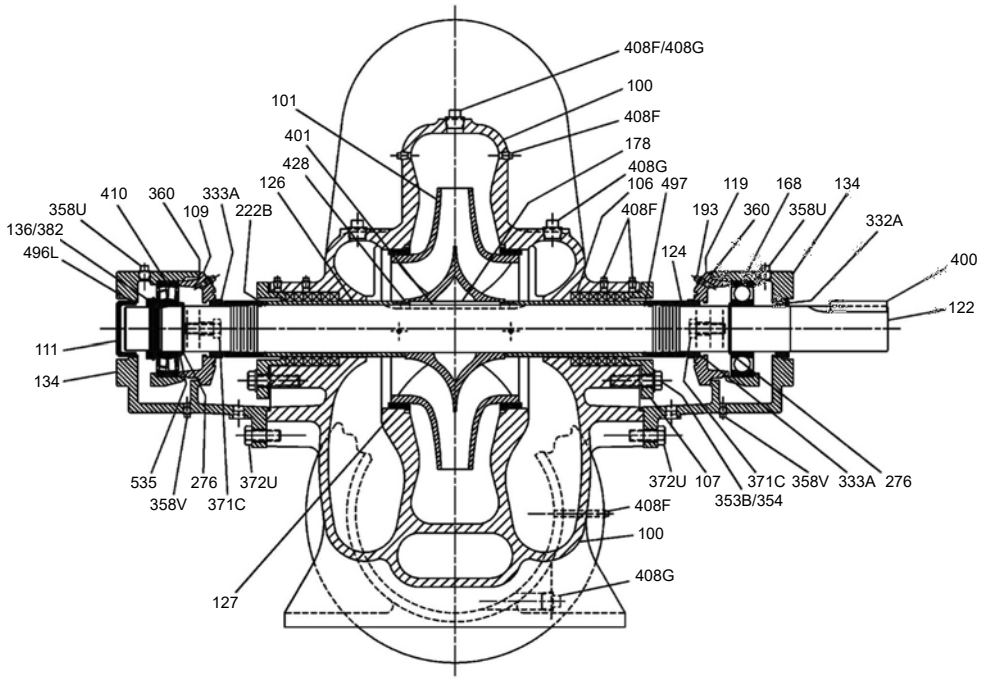


Figure 54: Standard grease lubrication

Casing ring detail

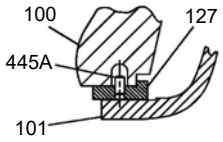


Figure 55: Casing ring detail

Main joint bolt detail

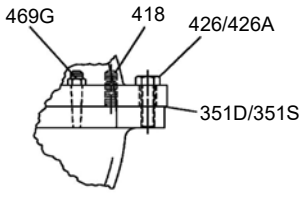


Figure 56: Main joint bolt detail

Internally-flushed stuffing box — packing

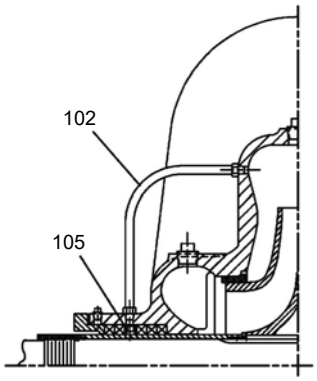


Figure 57: Internally-flushed stuffing box - packing

Internally-flushed stuffing box — mechanical seal

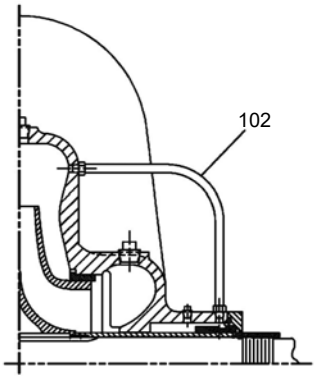


Figure 58: Internally-flushed stuffing box - mechanical seal

Ring oil lubrication option

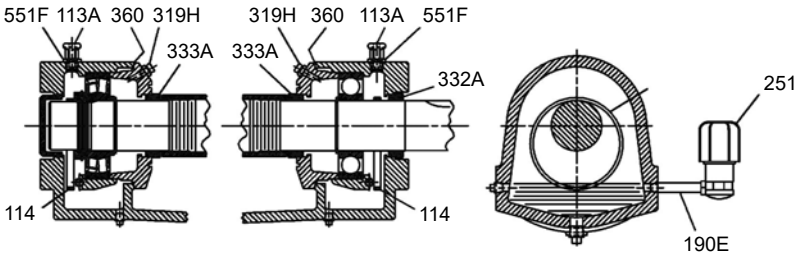


Figure 59: Ring oil lubrication option

Casing ring and optional impeller ring detail

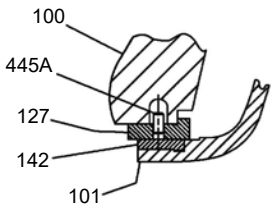


Figure 60: Casing ring and optional impeller ring detail

Mechanical seal stuffing box option

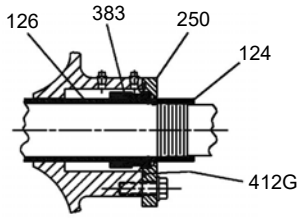


Figure 61: Mechanical seal stuffing box option

8.2 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
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

Item number	Part name	Quantity
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

9 Technical Reference

9.1 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

Pump Size		[5]6x10–22	[5]8x12–21	[5]8x12–22M	[5]8x12–22L	8x12–27
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 center-line	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)							
[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. hydrostatic 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. hydrostatic 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-ft^2)		47	52	109	46	120	254

Pump		10x14–20S	10x14–20L	12x16–23	14x16–17	14x18–23	13x18–28
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

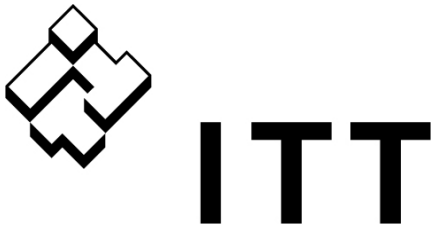
1. With 250#FF flanges refer to pump as H6x10–22
2. Flange dimensions are in accordance with ANSI A21,10,AWWA C110 and ANSI B16.1 Class 125.
3. Flange dimensions are in accordance with ANSI B16.1 Class 250 except flanges are flat faced.
4. The hydrostatic test will be in accordance with the latest edition 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.

10 Other Relevant Documentation or Manuals

10.1 For additional documentation

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

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



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