

 **GOULDS PUMPS**

Installation, Operation, and Maintenance Manual

Model 3410



ITT

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1 Introduction and Safety

1.1 Introduction

Purpose of this manual

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

- Installation
- Operation
- Maintenance



CAUTION:

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

NOTICE:

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

1.1.1 Requesting other information

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

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

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

1.2 Safety



WARNING:

- 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.
- 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.

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 ProCast 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

1.3 Safety terminology and symbols


About safety messages

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

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

Hazard levels

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

Hazard level	Indication
 <p>CAUTION:</p>	A hazardous situation which, if not avoided, could result in minor or moderate injury
<p>NOTICE:</p>	<ul style="list-style-type: none"> • A potential situation which, if not avoided, could result in undesirable conditions • A practice not related to personal injury

Hazard categories

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

Electrical hazards are indicated by the following specific symbol:



ELECTRICAL HAZARD:

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

- Crush hazard
- Cutting hazard
- Arc flash hazard

1.3.1 The Ex symbol

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



1.4 Environmental safety

The work area

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



WARNING:

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

Waste and emissions regulations

Observe these safety regulations regarding waste and emissions:

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

- Report all environmental emissions to the appropriate authorities.

**WARNING:**

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

Electrical installation

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

1.4.1 Recycling guidelines

Always follow local laws and regulations regarding recycling.

1.5 User safety

General safety rules

These safety rules apply:

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

Safety equipment

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

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

Electrical connections

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

Noise**WARNING:**

Sound pressure levels may exceed 80 dbA in operating process plants. Clear visual warnings or other indicators should be available to those entering an area with unsafe noise levels. Personnel should wear appropriate hearing protection when working on or around any equipment,

including pumps. Consider limiting personnel's exposure time to noise or, where possible, enclosing equipment to reduce noise. Local law may provide specific guidance regarding exposure of personnel to noise and when noise exposure reduction is required.

Temperature



WARNING:

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

1.5.1 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.
- Make sure that the equipment is properly insulated when it operates at extreme temperatures.
- 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.

1.5.2 Precautions during work

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



CAUTION:

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

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

- Rinse the components in water after you disassemble the pump.
- Do not exceed the maximum working pressure of the pump.
- Do not open any vent or drain valve or remove any plugs while the system is pressurized. Make sure that the pump is isolated from the system and that pressure is relieved before you disassemble the pump, remove plugs, or disconnect piping.
- Never operate a pump without a properly installed coupling guard.
- Always bear in mind the risk of drowning, electrical accidents, and burn injuries.
- Never heat the condition monitor to temperatures in excess of 300°F (149°C).
- Never expose the condition monitor to open flames.
- Do not use the condition monitor in atmospheres containing acetic acid.
- Always wear protective gloves. The pump and condition monitor can be hot.

1.5.3 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	<ol style="list-style-type: none"> 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	<ol style="list-style-type: none"> 1. Remove contaminated clothing. 2. Wash the skin with soap and water for at least 1 minute. 3. Seek medical attention, if necessary.

1.6 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 operated and maintained. Compliance with the essential safety and health requirements has been assured by compliance with the following standards, method of protection Constructional Safety (C): ISO 80079-36 ISO 80079-37



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 pump frame 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 baseplate 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.

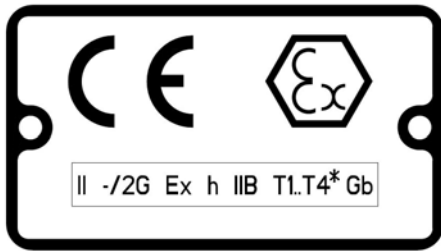


Figure 1: Typical Ex nameplate



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 107°C | 225°F.

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.

Recommended bearing replacement interval (based on L10 life) = 50,000 hours of operation.

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.
- 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, E3198, CV3198), 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 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/Goolds 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.
-

1.7 Product approval standards

Regular standards



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.

All standard products are approved according to CSA standards in Canada and UL standards in USA. The drive unit degree of protection follows IP68 See the nameplate for maximum submersion, according to standard IEC 60529.

All electrical ratings and performance of the motors comply with IEC 600341.

Explosion-proofing standards

All explosion-proof products for use in explosive atmospheres are designed in compliance with one or more of the following approvals:

- European Standards
- FM According to NEC
 - Class 1 Div 1 Groups “C”, and “D”
 - Class 2 Div 1 Groups “E”, “F”, and “G”
 - Class 3 Div 1 Hazardous Locations

ATEX

- ATEX Marking

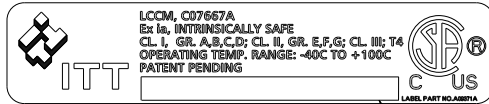


Refer to [Table 1: Temperature class definitions on page 11.](#)

CSA certification

Intrinsically safe for:

- Class I, Div. 1, Groups A, B, C, D
- Class II, Div. 1, Groups E, F, G
- Class III
- Certified to Canadian and US requirements



SERIAL NO& YEAR OF
MANUFACTURE HERE.

1.8 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 a ProCast 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 ProCast 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 Pump handling



WARNING:

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



CAUTION:

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

2.2.3 Lifting methods





WARNING:

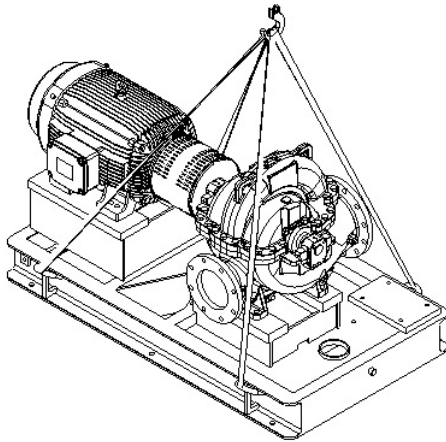
- Risk of serious personal injury or equipment damage. Proper lifting practices are critical to safe transport of heavy equipment. Ensure that practices used are in compliance with all applicable regulations and standards.
-

- 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	<div style="display: flex; align-items: flex-start;"> <div style="margin-right: 20px;">  </div> <div> <p>WARNING:</p> <p>If the driver has been mounted on the baseplate at the factory, then it is safe to lift the entire assembly.</p> </div> </div> <hr/> <div style="display: flex; align-items: flex-start;"> <div style="margin-right: 20px;">  </div> <div> <p>CAUTION:</p> <p>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.</p> </div> </div> <hr/> <p>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.</p>
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.



1. Nylon sling, chain, or wire rope
2. Do not lift the entire pump with these lugs
3. Choker hitch around the bearing frame

Figure 3: The proper lifting method for a horizontal bare pump

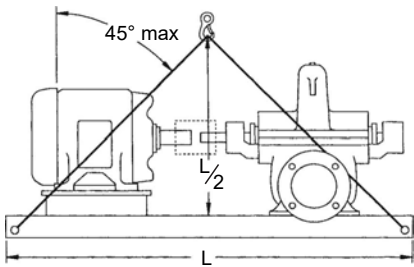


Figure 4: The proper lifting method for a horizontal pump on a base with lifting holes

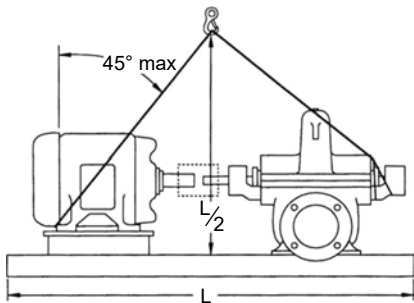
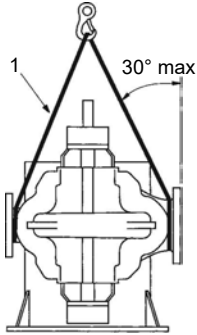


Figure 5: The proper lifting method for a horizontal pump on a base without lifting holes

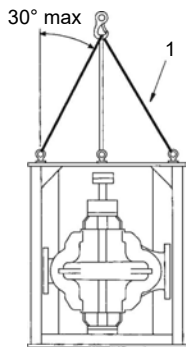
Pumps mounted vertically

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



1. Nylon sling, chain, or wire rope

Figure 7: 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)	<ul style="list-style-type: none"> • Store in a covered and dry location. • Store the unit free from dirt and vibrations.
Long-term (more than six months)	<ul style="list-style-type: none"> • Store in a covered and dry location. • Store the unit free from heat, dirt, and vibrations. • Rotate the shaft by hand several times at least every three months.

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

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

3 Product Description

3.1 General description

Product description

Goolds Model 3410 is a single-stage, double-suction pump with the following capabilities:

Measurement	Maximum tolerance
Capacity	1,817 m ³ /hr 8,000gpm
Head	530 ft (161 m)
Pressure	<ul style="list-style-type: none"> Cast iron: 1,200 kPa 175 psig Ductile iron or steel: 1,725 kPa 250 psig
Temperature	177°C 350°F

Pump sizes with an H designation are designed for a higher flow than the equivalent size standard pump. External casing dimensions are the same, but the H pumps have wider casing cutwaters and impellers.

Standard constructions are:

Table 2: Materials of Construction (ASTM Material standards)

Part Description	Cast Iron/ 316SS	All 316	Duplex	NSF Construction
Casing	Cast Iron	316SS	Duplex (1B)	Cast Iron
Impeller	316SS	316SS	Duplex (1B)	316SS
Impeller wear ring	316SS	316SS	Duplex	316SS
Casing Wear ring	Nitronic 60	Nitronic 60	Coated Duplex	Bronze
Shaft	4140*	4140*	4140**	4140*
Sleeves	316SS	316SS	Duplex	316SS
Sleeve Nut	Nitronic 60	Nitronic 60	Nitronic 60	Nitronic 60
Bearing housing	Cast Iron	Cast Iron	Cast Iron	Cast Iron

*3410 "S" shaft material is 316SS

**3410 "S" shaft material is Duplex

Right-hand rotation is standard. Left-hand rotation is available as an option. The rotation can be changed after installation without any additional parts.

Vertical application

Model 3410 is available in a vertical configuration (3410V). This arrangement is ideal for applications with limited space such as shipboard service. A rugged fabricated-steel frame supports the pump and driver, providing a machined fit for positive alignment when using standard P-base motors.

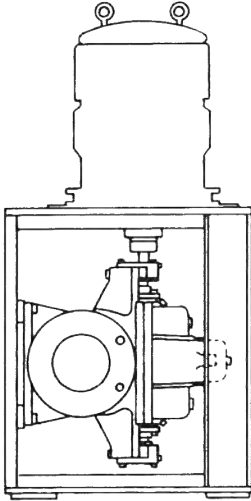


Figure 8: Vertical configuration



WARNING:

Leakage of pumped liquid can create an explosive environment. Make sure that the pumped liquid is compatible with all pump materials it comes in contact with.

Casing

The casing is split horizontally. The upper and lower halves are held together with capscrews and studs on the side of each stuffing box to aid in disassembly and reassembly. The casing is supported by integrally cast feet. Separate bearing housings are attached directly to machined fits in each end of the casing with capscrews.

Fifteen of the 27 casings are double volute as follows:

- 4x6-11
- 4x6-11H
- 6x8-11
- 8x10-21
- 8x10-12
- 8x10-14
- 8x10-17
- 8x10-17H
- 10x12-12
- 10x12-12H^{*1}
- 10x12-14
- 10x12-17
- 10x12-15
- 12x16-15
- 12x14-15^{*2}

*1 This casing uses a partial splitter.

*2 Consult factory for availability.

Flange drilling	<p>3410 S, M, L, XL and XL1 groups, flanged suction and discharge connections are located in the lower half of the casing and conform to these standards:</p> <ul style="list-style-type: none"> • Standard <ul style="list-style-type: none"> • Flat Faced • Iron ASME B16.1 Class 125 • Steel ASME B16.5 Class 150 • Options <ul style="list-style-type: none"> • Raised Face (Steel and Ductile Iron) • Iron ASME B16.1/B16.42 Class 250 • Steel ASME B16.5/B16.47 Class 300 <p>DIN flanges may also be provided on all sizes. The flanges conform to these standards:</p> <ul style="list-style-type: none"> • Standard <ul style="list-style-type: none"> • Flat Faced Standard • DIN 1092-2 PN 16 (Iron only) • Options <ul style="list-style-type: none"> • Raised Face (Steel and Ductile Iron) • DIN 1092-1 PN 25 (Steel Only)
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The casings are standard with the following parts:

- Two jackscrews (except S group)
- Two lifting lugs
- Two tapered dowel pins for alignment
- One 0.0762 cm 0.030 in. parting gasket

The upper-half casing has a vent connection, a priming connection, and two stuffing box seal ring connections. The lower half has two drain connections.

Impeller

- Enclosed, double suction
- Axial hydraulic balance
- Key driven
- Dynamically balanced, when the diameter to width ratio is less than six

Wear rings

- Casing wear rings are supplied as standard to maintain proper running clearance and to minimize leakage between the suction and discharge chambers in the casing. Each casing ring is held in place by a single anti-rotation pin located in a milled slot at the horizontal parting surface.
- Optional impeller wear rings are available on all pump sizes. The impeller wear rings are held in position by axial setscrews. Field installation of impeller rings requires a re-machining of the impeller hubs.
- The casing rings remain the same for designs with or without impeller rings.

Shaft

The 3410 model line has five shaft groups. Shafts are standard with Imperial (inch) coupling interfaces and Metric is available as an option.

The shaft is a heavy-duty design that minimizes deflection and vibration. The shaft deflection is a maximum of 0.051 mm | 0.002 in. at the stuffing box face under the worst operating conditions. The shaft on M, L, XL and XL1 group pumps is completely dry with gasket seals between the impeller hubs and shaft sleeves. The S group does not have a completely dry shaft. The S group is standard with a 316 stainless steel shaft. The M, L, XL and XL1 sizes have an ANSI 4140 steel shaft standard with an option for 316 stainless steel.

Shaft sleeves

The M, L, XL and XL1 group pumps have standard shaft sleeves. They are keyed to the shaft at the impeller and held axially in place using threaded sleeve nuts. Inch sleeve will be used for inch seals. Metric sleeves will be used for all packing and metric seals. The S group pumps are standard without shaft sleeves, but sleeves are available.

Stuffing box

Non-asbestos stuffing box packing is optional. The stuffing box contains split lantern rings and renewable stuffing box throat bushings. Tapped openings are provided for water sealing from either the pump casing or an outside source. Bypass piping is optional. Two-piece, investment cast, 316 stainless steel, non-quench glands are standard on all 3410 pumps.

Mechanical seals

- Mechanical seals are standard for Model 3410. Oversize stuffing box bores are standard on pumps with factory-installed mechanical seals. This provides greater flexibility and an improved operating environment.
- Pumps that are supplied with optional packed boxes can be converted to mechanical seals in the field. This conversion requires either re-machining of the stuffing box to accommodate the mechanical seal or re-machining of the gland to adapt to the existing stuffing box. If the stuffing box bores are re-machined, then all standard Model 3410 mechanical seals and the standard I.D. pilot glands can be used.
- Balanced seals require conversion to stepped sleeves. Most unbalanced mechanical seals will fit in the standard packed box bores, but this requires re-machining the I.D. pilot off the glands. In this case, the glands must be centered on the shaft or the sleeve using a feeler gauge.

Bearings

- The Model 3410 is standard with double-row ball thrust bearings and a single-row deep groove ball bearing at the coupling end. There are only two sizes of bearing housings and bearings used on the Model 3410 product line. The S and M groups use identical bearings, as do the L, XL and XL1 groups. The thrust bearing is held in position with a tapered snap ring and is locked in the thrust bearing housing to take any unbalanced axial thrust load. The radial bearing is free to float axially in the bearing housing taking radial loads only.

Two bearing frame assemblies are used for the complete 3410 model line.

Bearing Housing	<p>3410 S, M, L, XL, and XL1 groups, new i-Frame bearing housings with integral mounting for i-Alert and new cooling fins. Retrofittable to existing casings in field, some modifications may be required for oil lube.</p> <ul style="list-style-type: none"> • Standard with: <ul style="list-style-type: none"> • Register fit • Labyrinth seals • Grease lubrication with pressure relief • Sight glass (oil lube only) • i-Alert mounting location • 3 points for vibration
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3.2 Nameplate information

Bearing Housing	<p>Options use the same shaft, bearings, and bearing housings.</p> <ul style="list-style-type: none"> • Options <ul style="list-style-type: none"> • Oil lubrication includes 30% increased oil sump capacity • Pure Oil Mist • Purge Oil Mist • Constant level oiler with viewport • RTD's location • Bearing cooling w/oil lubrication only (required for temperatures over 121°C 250°F.
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Bedplates

Cast iron bedplates are furnished as standard. They include a drip collection chamber with a tapped drain connection and an opening suitable for grouting. Fabricated steel bedplates are available as an option.

Fabricated steel construction baseplates are standard for 3410 XL1 12X16-15, cast iron not available for this size.

Intended applications

The Goulds 3410 model line is designed for a wide range of industrial, municipal, and marine services, which includes:

- Process – Quench water, stripper bottoms, reboiler circulation, and cooling tower
- Pulp and paper – Primary and secondary cleaner, filtrate, mill water supply, and fan pump
- Primary metals – Cooling water, quench, and leaching
- Municipal – High lift, low lift, wash water, waste water, and raw water
- Utilities – Cooling tower, component cooling, and service water
- Marine – Bilge and ballast, cargo, cooling service, and fire pump

3.2 Nameplate information

Important information for ordering

Every pump has a nameplate that provides information about the pump. The nameplate is located on the pump casing.

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	<p>The formula for the pump size is: Discharge x Suction - Nominal Maximum Impeller Diameter in inches.</p> <p>(Example: 2x3-8)</p>

Nameplate	Description
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 using English units

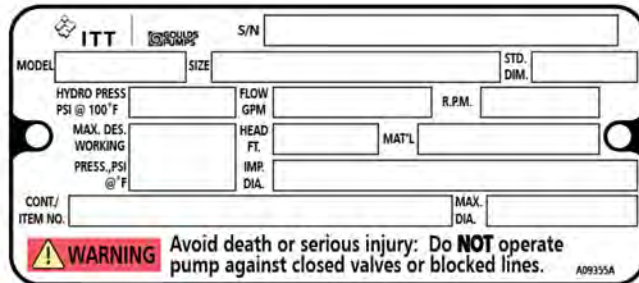


Figure 9: Nameplate on the pump casing using English units

Nameplate field	Explanation
MODEL	Pump model
SIZE	Size of the pump
FLOW	Rated pump flow, in gallons per minute
HEAD	Rated pump head, in feet
RPM	Rated pump speed, in revolutions per minute
HYDRO PRESS	Hydrostatic pressure at 100°F, in pounds per square inch
MAX. DES. WORKING PRESS	Maximum working pressure at temperature °F, in pounds per square inch
S/N	Serial number of the pump
CONT./ITEM NO.	Customer contract or item number
IMP. DIA.	Rated impeller diameter, inches
MAX. DIA.	Maximum impeller diameter, inches
STD. DIM.	Standard ANSI dimensional code
MAT'L	Material of construction

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 10: Typical Ex nameplate



Figure 11: Typical UKCA Ex nameplate

Refer to [Table 1: Temperature class definitions on page 11](#)

3.2 Nameplate information

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: <ul style="list-style-type: none"> • 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.

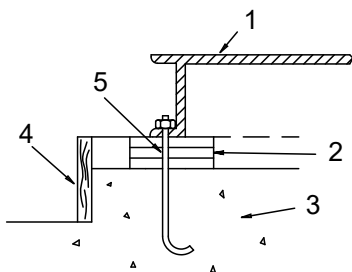
The installation must be evaluated to determine that the Net Positive Suction Head Available (NPSH_A) meets or exceeds the Net Positive Suction Head Required (NPSH_R), as stated by the pump performance curve.

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.

J-type bolts

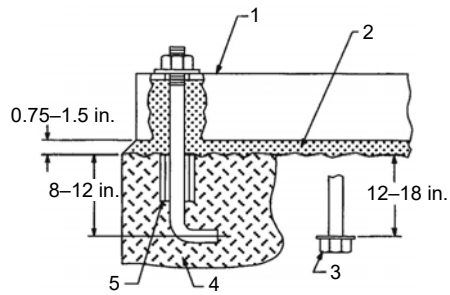


Item	Description
1.	Baseplate
2.	Shims or wedges
3.	Foundation
4.	Dam
5.	Bolt

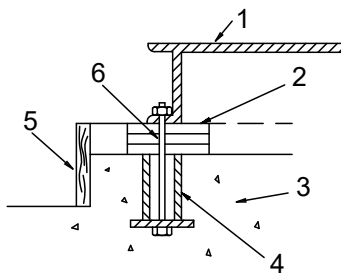
Figure 12: J-type bolts

Foundation bolts

- Foundation bolts must be embedded in the concrete to a depth of 20-30 cm | 8-12 in. 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 13: Bolt installation**Sleeve-type bolts**

Item	Description
1.	Baseplate
2.	Shims
3.	Foundation
4.	Sleeve
5.	Dam
6.	Bolt

Figure 14: Sleeve type bolts

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

Pumped fluid temperature	Recommended setting for driver shaft
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.

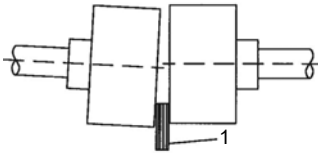
Only use this method if the face and outside diameters of the coupling halves are square and concentric with the coupling bores. If this condition does not exist or elastomeric couplings do not make this method convenient, then use the dial indicator method.

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.

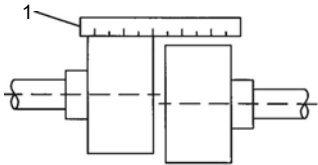
2. Check for parallel alignment by placing a straight edge across both coupling rims on all four sides.

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



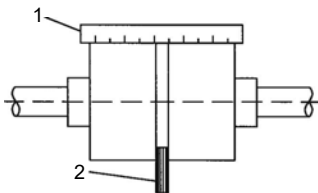
1. Feeler gauge

Figure 15: Incorrect angular alignment



1. Straight edge

Figure 16: Incorrect parallel alignment



1. Straight edge
2. Feeler gauge

Figure 17: 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.

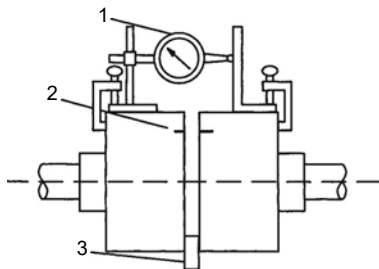
All readings must be made with the button on the chalk mark.

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:

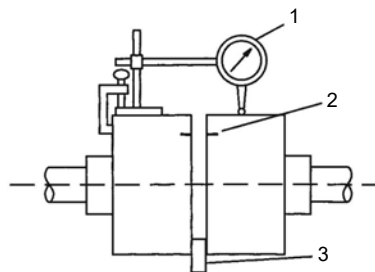
Risk for rotation unbalance. Any gross deviation in squareness or concentricity must be corrected.

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 18: Angular alignment



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

Figure 19: Parallel alignment

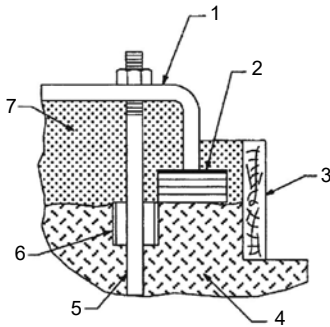
4.4 Grout the baseplate



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 20: 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.	<ul style="list-style-type: none"> • Strain on the pump • Misalignment between the pump and the drive unit 	
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: <ul style="list-style-type: none"> • The grout for the baseplate or sub-base becomes hard. 	—	

Check	Explanation/comment	Checked
<ul style="list-style-type: none"> The grout for the pit cover becomes hard. The hold-down bolts for the pump are tightened. 		
Make sure that all the piping joints and fittings are airtight.		
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 the loads on the pump flanges exceed the limits described in the Goulds Pumps Electronic Technical Manual.	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	Explanation/comment	Checked
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.	

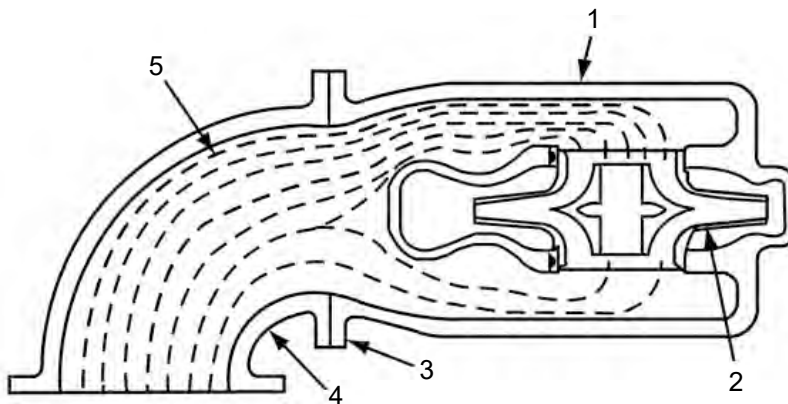
Example of unbalanced loading



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.

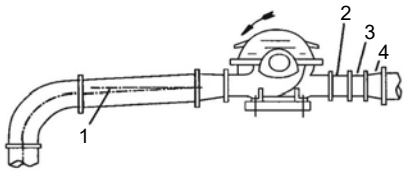
This figure shows the unbalanced loading of a double-suction impeller due to the uneven flow around an elbow that is adjacent to the pump:



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.

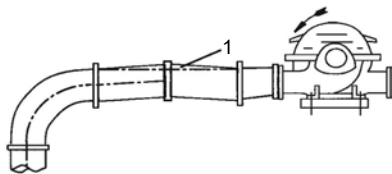
Figure 21: Unbalanced loading of double-suction impeller

Examples



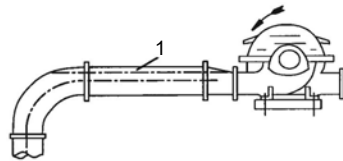
1. Level centerline of pipe
2. Check valve
3. Gate valve
4. Increaser

Figure 22: Suction pipe installed with a gradual rise to the pump – correct



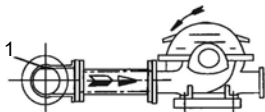
1. Air pocket

Figure 23: Suction pipe installed with a gradual rise to the pump – incorrect



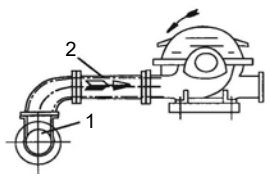
1. Air pocket

Figure 24: Suction pipe installed with a reducer – incorrect



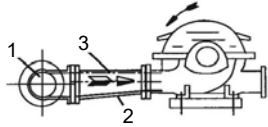
1. Air pocket

Figure 25: Incorrect



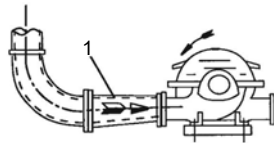
1. No air pockets
2. Gradual rise

Figure 26: Correct



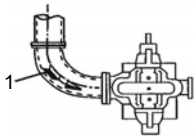
1. No air pockets
2. Eccentric reducer
3. Gradual rise

Figure 27: Gradual rise to the pump – correct



1. Distance plus eccentric reducer straightens the flow

Figure 28: Suction pipe above the pump – correct



1. Suction piping immediately adjacent to pump

Figure 29: 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 Check the rotation



WARNING:

- Starting the pump in reverse rotation can result in the contact of metal parts, heat generation, and breach of containment. Ensure correct driver settings prior to starting any pump.
 - 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.
-

1. Lock out power to the driver.
2. Make sure that the coupling hubs are fastened securely to the shafts.
3. Make sure that the coupling spacer is removed.
The pump ships with the coupling spacer removed.
4. Unlock power to the driver.
5. Make sure that everyone is clear, and then jog the driver long enough to determine that the direction of rotation corresponds to the arrow on the pump.
6. Lock out power to the driver.

5.3 Couple the pump and driver



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.
-

**CAUTION:**

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



Couplings must have proper certification to be used in an Ex classified environment. Use the instructions from the coupling manufacturer in order to lubricate and install the coupling. Refer to driver/coupling/gear manufacturers IOM for specific instructions and recommendations.

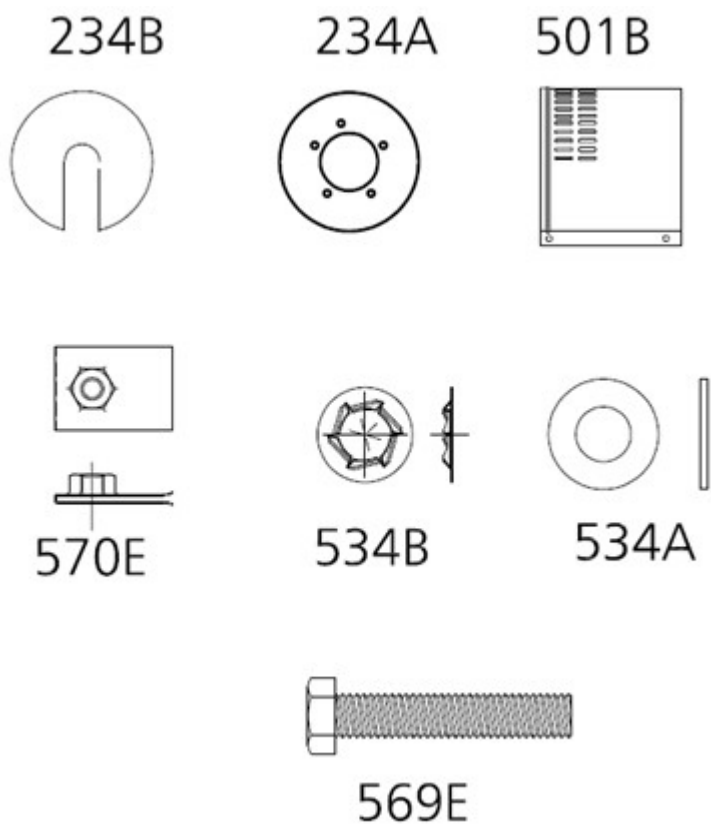
5.3.1 Install the coupling guard

**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:**

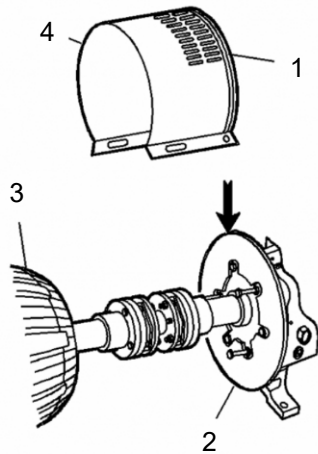
The coupling guard used in an Ex classified environment must be properly certified and constructed from a spark resistant material.



Item	Description	Item	Description
569E	Hex head bolt (Qty 3)	534A	Washer (Qty 4)
501B	Guard (Qty 2)	534B	Retainer (Qty 3)
234A	Pump-side end plate	234B	Driver-side end plate
570E	U-nut (Qty 3)		

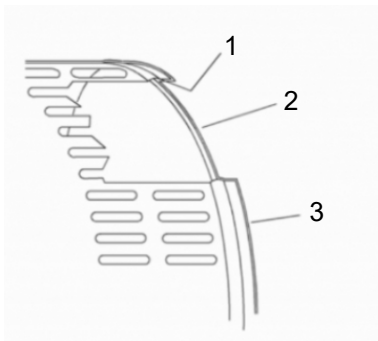
Figure 30: Required parts

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 (234A)
3.	Driver
4.	Pump half of the coupling guard (501B)

Figure 31: Align pump end guard half with annular groove



Item	Description
1.	Annular groove
2.	Pump end plate (234A)
3.	Guard half (501B)

Figure 32: 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 33: Captured hardware component assembly

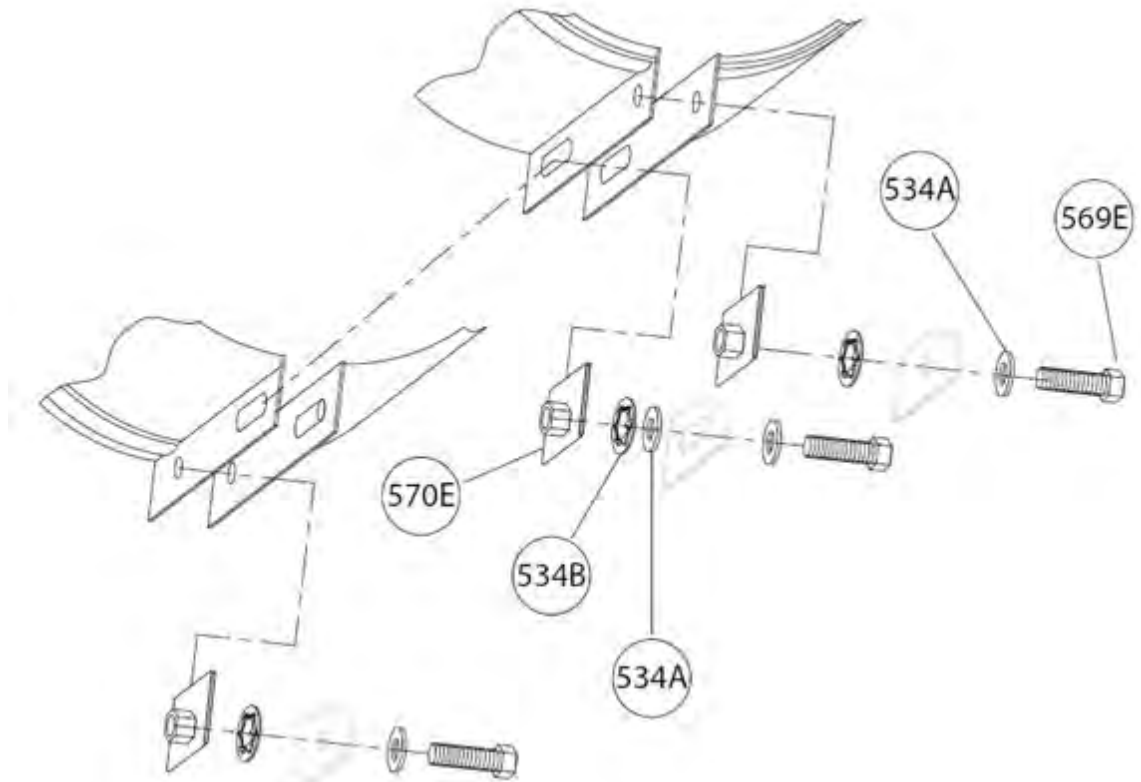


Figure 34: Captured hardware component assembly

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.

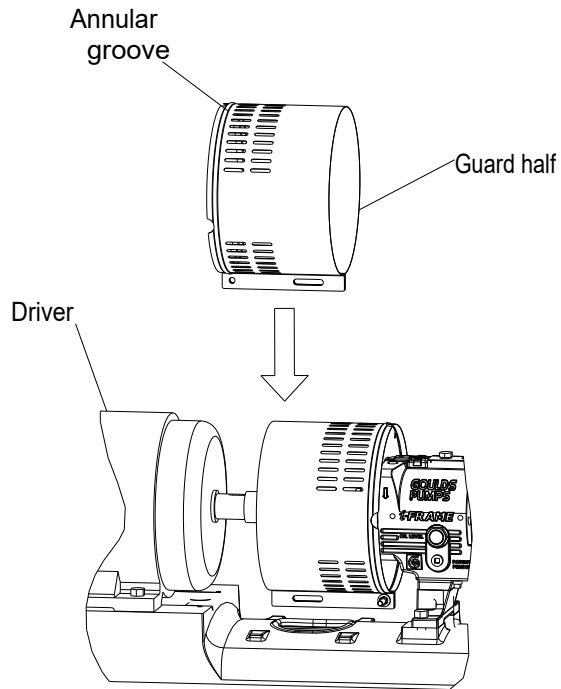


Figure 35: Placement of driver half of coupling guard

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.

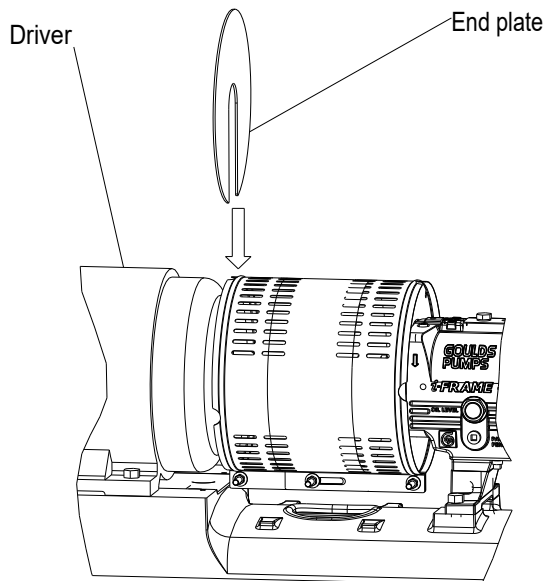


Figure 36: Placement of driver half of coupling guard

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.

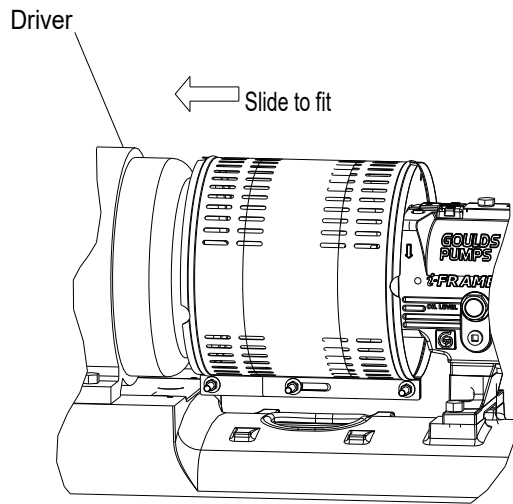


Figure 37: Slide driver-half of coupling guard towards motor

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

5.4 Install the shaft guard - if provided



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.
- Exposed rotating shaft between pump seal and bearing frame. Avoid contact and/or install proper guarding. If guarding is not provided with the pump, contact Goulds for price and availability of proper guarding.

5.5 Bearing lubrication



CAUTION:



- Risk of explosive hazard and premature failure from sparks and heat generation. Ensure bearings are properly lubricated prior to startup.
- Risk of heat generation, sparks and premature failure. Do not insulate bearing housings.

5.5.1 Lubricate the bearings with grease

Grease-lubricated pumps can be identified by grease fittings located on bearing housing. Sufficient lubricant is inserted at the factory for 2,000 hours of operation. See the Maintenance chapter for grease lubrication instructions.

5.5.2 Lubricate the bearings with oil (optional)

Oil-lubricated pumps are not lubricated at factory. Use a high quality, turbine-type oil with rust and oxidation inhibitors. See [6.3.2.1 Lubricating-oil requirements on page 63](#) for recommended lubricants and supplies.

Bearing cooling is available with the oil lubrication option only. Cooling water must be connected to the bearing housing with a waste or return line. Water cooling is required when operating temperatures exceed 121°C | 250°F.

5.6 Seal the shaft with a packed stuffing box

NOTICE:

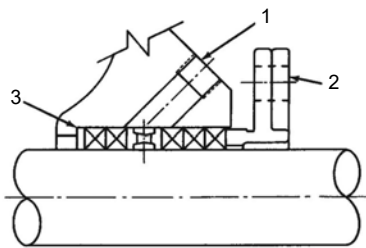


Packed stuffing boxes are not allowed in an Ex-classified environment.

1. Make sure the stuffing box is clean and contains no foreign material.
2. Install the gland studs into the casing if they are not already installed.

The stuffing box packing is furnished in the box of fittings that accompanies the pump. When you are packing the stuffing box, use the following order for the packing and lantern rings:

1. Two packing rings
2. Lantern ring
3. Last three packing rings



1. Lantern ring flush connection
 2. Two-piece, investment-cast 316 SS plain gland (non-quench)
 3. Stuffing box bushing
3. Twist the packing ring sideways just enough to get it around the shaft or sleeve.

Packing Rings

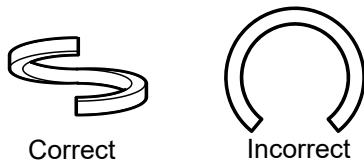


Figure 38: Packing rings

4. Twist the lantern ring halves just enough to get them around the shaft sleeve. Two pieces make one ring. The notches must face each other but do not need to be aligned.

Lantern Rings

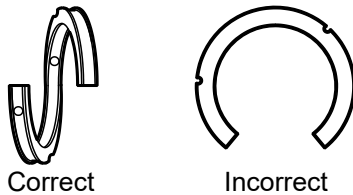
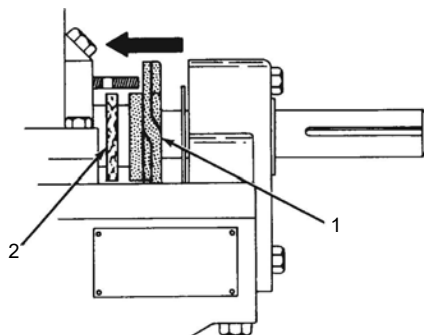


Figure 39: Lantern rings

5. Install the packing and lantern ring in the proper sequence. Each ring must be installed separately.
 - a) Firmly seat each ring.
 - b) Use the stuffing box gland to push the packing and lantern ring into the stuffing box.
 - c) Stagger the joints in each ring by 90 degrees.

Make sure the center of the lantern ring lines up with the flush tap in the stuffing box. Any extra rings are spares.



1. Gland
2. packing

6. Hand-tighten the gland nuts evenly but not tight.
7. To remove the packing from the stuffing box, do the following:
 - a) Remove the gland assembly.
 - b) Remove the packing with a packing hook.
 - c) Remove the lantern ring by inserting a wire hook into the ring on the outer edge.
 - d) Clean the stuffing box.

An alternate method of removing the packing is to remove the upper-half casing (see the Maintenance chapter). Remove the packing and lantern ring, and then inspect the sleeves or the shaft. Replace the sleeves or the shaft if either is deeply grooved.

5.7 Mechanical seal options



WARNING:

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

When mechanical seals are furnished, the description and identification are indicated on the order forms. Installation drawings from the seal manufacturer are attached to pump. Most seals are installed and adjusted at the factory. File these drawings for future use in maintenance and adjustment of the seal whenever the pump is disassembled.

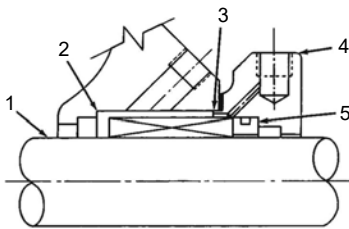
Prepare the seal for operation

To properly prepare the seal for operation, various cooling and flushing flows may have to be connected. In some cases, these flows are recirculated from pump casing. In other cases, liquid from an outside source may be used. Connect cooling and flushing flows to the seal as directed in instructions supplied by the manufacturer.

All Model 3410 mechanical seals use O-ring mounted stationary seats and a flush gland with a pilot fit in the ID of the stuffing box as standard. All S group pumps are standard without shaft sleeves; sleeves are optional. M, L, XL and XL1 groups are standard with shaft sleeves and sleeve nuts.

Single inside unbalanced or integrally balanced seals

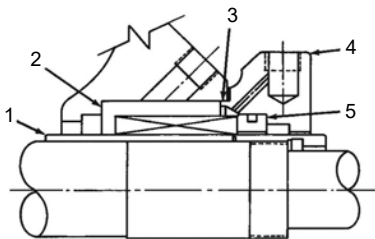
The following figure illustrates a single inside unbalanced or integrally balanced (metal bellows) seal for an S group pump. This design incorporates the standard 316SS sleeveless shaft and oversized stuffing box bore. The stuffing box bore is used to pilot the standard gland.



1. Sleeveless 316SS shaft
2. Oversize stuffing box bore
3. ID pilot fit in stuffing box
4. Standard two-bolt flush gland (cast iron or bronze)
5. O-ring mounted stationary seat

Figure 40: Single inside unbalanced or integrally balanced seal for an S group pump

The following figure illustrates the same type of seal for M group pumps. Note that the shaft is protected by sleeves and sleeve nuts as standard. All other features and details are the same.

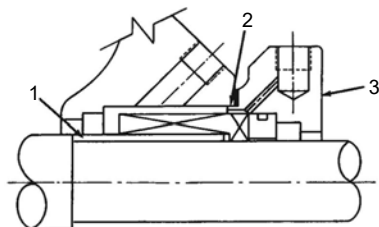


1. Standard shaft sleeve
2. Oversize stuffing box bore
3. ID pilot fit in stuffing box
4. Standard two-bolt flush gland (cast iron or bronze)
5. O-ring mounted stationary seat

Figure 41: Single inside unbalanced or integrally balanced seal for an M group pump

Conventional balanced seals

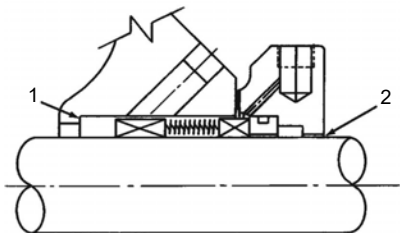
Conventional balanced seals require a stepped shaft sleeve. The following figure shows an S group pump with a stub sleeve to accomplish the seal balancing.



1. Stub sleeve
2. ID pilot fit in stuffing box
3. Standard flush gland with O-ring mounted stationary seat

Figure 42: S group pump — stub sleeve

The following figure illustrates a standard stepped sleeve used on the M group pumps to reduce the mounting diameter down to the standard sleeve nut OD.



1. Standard stuffing box bore
2. Non-piloting gland requiring feeler gauge centering on the shaft

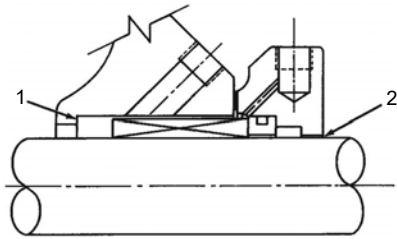
Figure 43: M group pump — stepped sleeve

Bellows-type mechanical seals are integrally balanced and do not require a step in the sleeve. They can be mounted directly on the sleeveless S group shaft or on a standard, non-balanced M group sleeve.

Packing converted to a mechanical seal

Pumps that are supplied with packing boxes can be converted to mechanical seals in the field. This conversion requires remachining the stuffing box to allow for the standard gland pilot feature or remachining the standard gland to remove the pilot lip as shown in the following figures. In this case, a shimming operation is required to center the gland on the shaft.

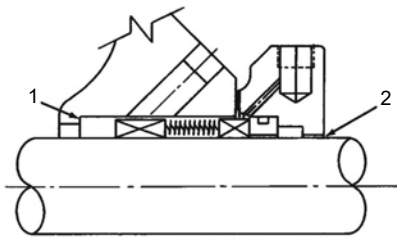
The following figure illustrates a single inside unbalanced mechanical seal mounted in the S group standard stuffing box. Note that the pilot lip has been machined off the gland since there is inadequate room in the bore for the pilot. With this arrangement, it is necessary to use a feeler gauge or shims to center the gland on the shaft.



1. Standard stuffing box bore
2. Non-piloting gland requiring feeler gauge centering on the shaft

Figure 44: S group pump – single inside unbalanced seal

The following figure illustrates a bellows-type balanced mechanical seal mounted in an S group standard stuffing box. There is inadequate room in the standard stuffing box to mount a conventional balanced seal requiring a stepped shaft sleeve. Use of these seals requires remachining of the stuffing box bores.



1. Standard stuffing box bore
2. Non-piloting gland requiring feeler gauge centering on the shaft

Figure 45: S group pump — bellows-type seal

The following mechanical seals can be installed in standard stuffing boxes by using a remachined, non-pilot gland:

- Crane type 1, 81T, 9T, and Metal Bellows (680)
- Flowserve RO

5.8 Connection of sealing liquid for a packed stuffing box

NOTICE:

Make sure to lubricate the packing. Failure to do so may result in shortening the life of the packing and the pump.

You must use an external sealing liquid under these conditions:

- The pumped fluid includes abrasive particles.
- The stuffing-box pressure is below atmospheric pressure when the pump is running with a suction lift or when the suction source is in a vacuum. Under these conditions, packing is not cooled and lubricated and air is drawn into pump.

Conditions for application of an external liquid

Condition	Action
The stuffing box pressure is above atmospheric pressure and the pumped fluid is clean.	Normal gland leaks of 40 to 60 drops per minute is usually sufficient to lubricate and cool the packing. You do not need sealing liquid.
The stuffing box pressure is below atmospheric pressure or the pumped fluid is not clean.	An outside source of clean compatible liquid is required.
An outside source of clean compatible liquid is required.	You must connect the piping to the lantern ring connection with a 40 to 60 drops-per-minute leak rate. The pressure must be 1.01 kg/cm ² 15 psi above the stuffing box pressure.

5.9 Connection of cooling water piping

Tapped openings on top of the quench gland are provided for water sealing. Bypass piping is connected from a T-shaped joint installed in the vent plug opening at the top of the upper casing to the tapped opening in the stuffing box.

5.10 Mechanical seal flushing and cooling

NOTICE:



- The mechanical seal must have an appropriate seal-flush system. Failure to do so will result in excess heat generation and seal failure.



- 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.

A liquid film is required between the seal faces for proper lubrication. If the liquid flashes to vapor, then the faces will run dry and become damaged. This requires that the liquid be cooled so that vapor pressure is well below stuffing box pressure. Consult with ITT Goulds for a recommendation if there is any uncertainty. Refer to the drawing supplied by the seal manufacturer for the location of the taps. You can use the following methods to flush and cool the seal:

Cool liquid flushing method	Description
External source	A clean, cool, compatible liquid is injected from an outside source directly into the seal gland. Flushing liquid must be at a pressure 5–15 psi (0.34–1.03 bar) greater than the pressure in the stuffing box. You must inject 1.5–2 gpm (2–8 lpm). You can install a control valve and rotometer in the inlet line for accurate regulation.
Product cooling	Pumped liquid is piped from the pump casing, is cooled in an external heat exchanger, and is injected into the seal gland. You can install a control valve and rotometer in the inlet line for accurate regulation.

Other piping plans are available.

5.11 Connection of drain piping


Tapped openings around the stuffing box for draining leakage are optional. Check the assembly dimension print for size and location. Check the rotor for free turning.



WARNING:

Explosion risk. Rubbing could lead to excess heat generation and sparks. Rotate the shaft by hand to make sure it rotates smoothly and that there is no rubbing.

5.12 Operational checklist

Check	Explanation/comment	Checked
Driver rotation	<p>Check the rotation each time the motor leads are disconnected.</p>  <p>WARNING:</p> <p>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.</p>	
Stuffing box adjustment	Make stuffing box packing gland and lubrication adjustments.	
Flow	<p>It is difficult to accurately measure flow rate (volume/time). Any of the following methods of measuring can be used:</p> <ul style="list-style-type: none"> • Venturi meters • Flow nozzles • Orifice plates • Timing the draw down in the wet well <p>Record any reading for future reference.</p>	
Pressure	<p>Check and record both suction and discharge pressure gauge readings for future reference. Also record the following:</p> <ul style="list-style-type: none"> • 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	<p>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.</p> <p>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.</p>	

5.13 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.

5.14 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.

5.15 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.

5.16 Inspect the packed box after startup

Newly installed packing requires time to run in. During this period, frequent attention and careful adjustments are necessary. Use the following instructions to adjust the stuffing box gland while the pump is running at rated speed.

1. Draw the gland nuts up evenly and only 1/6 of a turn at a time.

Allow sufficient time between adjustments for the packing to adjust itself and for you to observe the effect on leakage.

2. If any sign of heating is evident, then shut down the pump and allow the box to cool.

Several starts may be necessary before the box runs cool. Do not back off the gland nuts on a hot box because this can result in leakage between the outer edge of the packing and the stuffing box bore.

5.17 Inspect the mechanical seal after startup



CAUTION:

Running a mechanical seal dry, even for a few seconds, can cause seal failure and physical injury. Never operate the pump without liquid supplied to the mechanical seal.

The mechanical seal is adjusted at the factory. If the seal leaks slightly when the pump is first started, then allow a few hours of run-in for the seal to adjust itself.

5.18 Shut down the pump



WARNING:

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

1. Slowly close the discharge valve.
2. Shut down and lock out the driver to prevent accidental rotation.

5.19 Make the final alignment of the pump and driver



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.
 - Misalignment can cause decreased performance, equipment damage, and even catastrophic failure of frame-mounted units leading to serious injury. Proper alignment is the responsibility of the installer and the user of the unit. Check the alignment of all drive components prior to operating the unit.
 - Follow the coupling installation and operation procedures from the coupling manufacturer.
-

You must check the final alignment after the pump and driver are at operating temperature. For initial alignment instructions, see the Installation chapter.

1. Run the unit under actual operating conditions for enough time to bring the pump, driver, and associated system to operating temperature.
2. Shut down the pump and the driver.
3. Remove the coupling guard.
See Remove the coupling guard in the Maintenance chapter.
4. Check the alignment while the unit is still hot.
Refer to [4.3 Pump-to-driver alignment on page 30](#) in the Installation chapter.
5. Reinstall the coupling guard.
6. Restart the pump and driver.

5.20 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.

Refer to [6.6.2 Radial clearances on page 75](#) for standard clearances.

- 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 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.

6.3.1 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 regreasing the bearings.

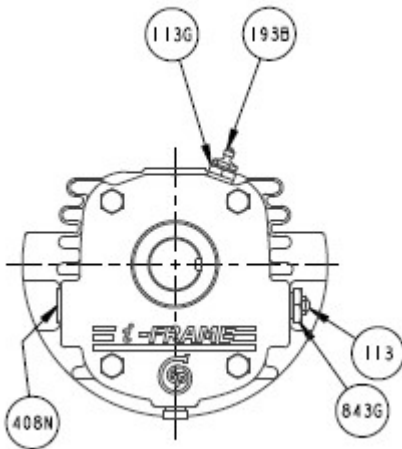


Figure 46: Grease lubricated bearings

1. Wipe dirt from the grease fittings (193B).
2. Fill both of the grease cavities through the fittings with a recommended grease until the fresh grease comes out of the relief fittings (113).
3. Run the pump for about 30 minutes or until grease no longer comes out of the housing.
4. Wipe off any excess grease.
5. 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.

6.3.1.1 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 re-greasing.
- 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.

6.3.2 Lubricate the oil-lubricated bearings

Oil-lubricated ball bearings are optional.

Oil-lubricated pumps are not lubricated at factory.

Table 3: Oil volume requirements

This table shows the required amount of oil for oil-lubricated bearings.

Frame	Milliliter	Quarts	Ounces
S, M	189.3	.2	6.4
L, XL, XL1	262.6	.28	8.88



WARNING:

Risk of explosive hazard and premature failure from sparks and heat generation. Ensure bearings are properly lubricated prior to startup.

1. After the pump has been installed, remove the fill plugs from the top of each housing (408K) and the drain plug (408B). Flush the housings to remove dirt, grit, and other impurities that have entered the bearing housing during shipment or installation.
2. Replace the drain plugs (408B).
3. Fill the bearing housings with oil through the oil fill connections. Fill the bearing housings with oil until the oil level reaches the middle of the sight glass (113E). The correct volume of oil required for each size of bearing frame can be found in the 'Oil Volume Requirements' above.

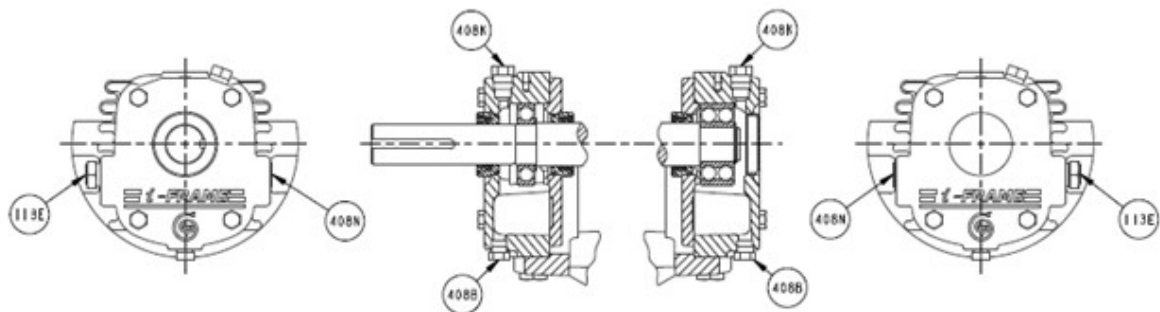


Figure 47: Oil fill connection

4. Oil level must be checked when the pump is shut down. When the pump is in running the oil level in the sight window will drop, this is normal and oil should not be added at this time.
5. Replace the fill plugs.
6. Excessive or old oil can be drained from housings by removing drain plug (408B).

6.3.2.1 Lubricating-oil requirements

Oil requirements based on temperature

For the majority of operating conditions, bearing temperatures run between 49°C | 120°F and 82°C | 180°F, and you can use an oil of ISO viscosity grade 68 at 38°C | 100°F. If temperatures exceed 82°C | 180°F, refer to the table for temperature requirements.

Temperature	Oil requirement
Bearing temperatures exceed 82°C 180°F	Use ISO viscosity grade 100. Bearing temperatures are generally about 11°C 20°F higher than bearing-housing outer surface temperatures.
Pumped-fluid temperatures are extreme	Refer to the factory or a lubrication expert.

6.3.2.2 Acceptable oil for lubricating bearings

Acceptable lubricants

Table 4: Acceptable lubricants

Brand	Lubricant type
Chevron	GST Oil 68
Exxon	Teresstic EP 68
Mobil	DTE Heavy Medium
Phillips 66	Turbine Oil VG68
Shell	-29-0°C -20-32°F: Tellus Oil 23 0-65°C 32-150°F: Tellus Oil 68 65-93°C 150-200°F: Turbo Oil 150
Royal Purple	SYNFILM ISO VG 68 Synthetic Oil
Texaco	Below 26.7°C 80°F: Regal Oil R&O-46 #10 weight Above 26.7°C 80°F (): Regal Oil R&O-46 #20 weight
Dow Corning	High Vacuum Grease, NSF 61 compliant label
MOLYKOTE from Dow Corning	111, NSF 61 compliant label
Loctite	565 thread locker, NSF 61 compliant label

6.3.2.3 Lubricate the oil lubricated bearings with constant level oilers

Oil-lubricated ball bearings are optional.

Oil-lubricated pumps are not lubricated at factory and can be supplied with oilers that maintain a constant oil level in the bearing housing.



WARNING:

Risk of explosive hazard and premature failure from sparks and heat generation. Ensure bearings are properly lubricated prior to startup.

Constant level oilers are supplied in the box of fittings that accompanies oil-lubricated pumps. Make oil adjustments before lubrication. Refer to [6.3.1.1 Lubricating-grease requirements on page 61](#) for recommended lubricants and supplies.

1. After the pump has been installed, remove the fill plugs from the top of each housing (408K) and the drain plug (408B). Flush the housings to remove dirt, grit, and other impurities that have entered the bearing housing during shipment or installation.
2. Replace the drain plugs (408B).
3. Assemble components for constant level oiler.

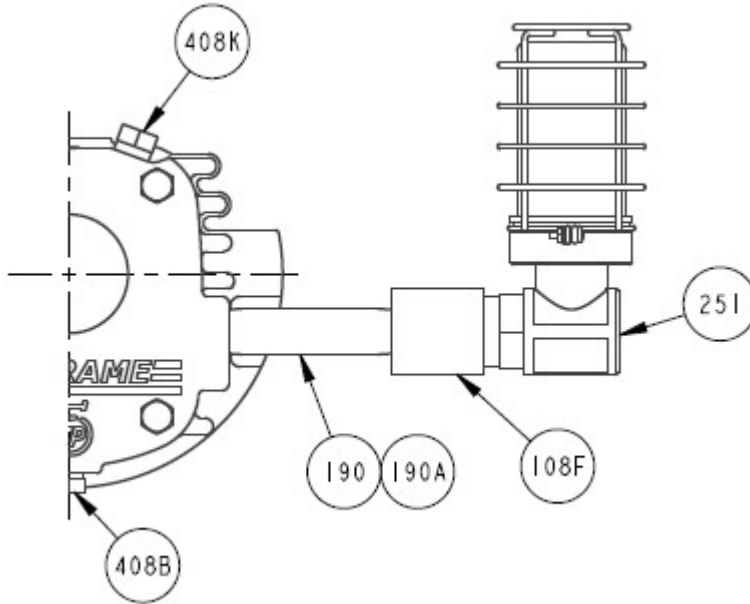


Figure 48: Oiler assembly and fill

4. Fill the bearing housings with oil through the oil fill connections. Fill the bearing housings with oil until the oil level reaches the level required on the sight glass viewport (251). Refer to [Table 3: Oil volume requirements on page 62](#) for the correct volume of oil required for each size of bearing frame.
5. Remove the Glass reservoirs and fill $\frac{3}{4}$ full and re-install.

6.3.3 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 82](#).
- 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.

6.3.3.1 Bearing cooling with oil-lubricated bearings

Bearing cooling is available with the oil lubrication option only. Cooling water must be connected to the bearing housing with a waste or return line. Water cooling is required when operating temperatures exceed 121°C | 250°F.

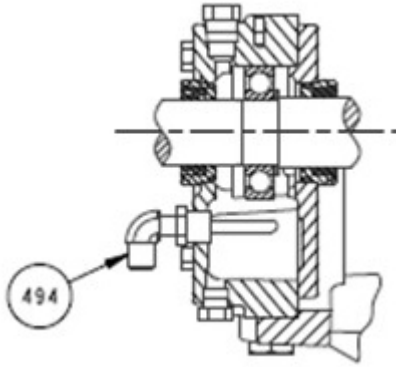


Figure 49: Bearing cooling assembly

6.3.4 Bearing conditions

The life of a bearing can be drastically reduced if contaminated with even a small amount of dust or dirt. All bearing assembly operations must be done in an environment that is as free of dust as possible. All tools and hands must be kept clean.

If...	Then...
New bearings need to be installed	They must not be unwrapped, cleaned, or washed until just before the time of installation.
Old bearings are contaminated	They must be replaced. Washing bearings does not guarantee cleanliness.
There is any question as to the condition of bearings	It is always best to replace them. This may prevent an unplanned shutdown. Check the bearing housing seals and replace as required.

6.3.4.1 Clean contaminated bearings

If new bearings are not available and immediate reassembly is necessary, then contaminated bearings can be cleaned using the following procedure.

1. Pour 1–2 quarts (0.9–1.9 liters) of clean, water-free kerosene into a clean pail.
2. Dip the bearings into the kerosene and agitate slowly.
3. Blow-dry the bearings with air that is clean, filtered, and compressed.

Hold the two races together but allow the inner race to rotate a few turns now and then to dislodge the kerosene from the retainer pockets.

4. When the bearings are dry, oil the bearings immediately with a good grade of clean machine oil to prevent corrosion or rust.

6.3.5 Emergency ball bearing replacement

If the outboard-end ball bearing needs replacement and it is not desirable to overhaul the entire pump, then the bearing can be replaced without disassembling the entire pump. See the Disassembly and Reassembly sections for details.

6.3.6 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.

6.4 Shaft-seal maintenance

6.4.1 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.	—

6.4.2 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.

6.5 Disassembly

6.5.1 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.

6.5.2 Drain the pump



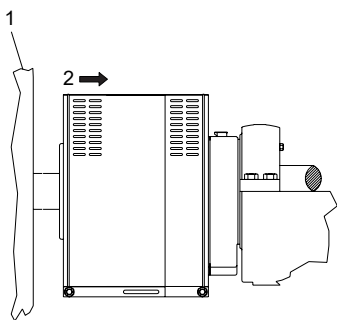
CAUTION:

- Risk of physical injury. Allow all system and pump components to cool before handling.
- If the pumped fluid is non-conductive, drain and flush the pump with a conductive fluid under conditions that will not allow for a spark to be released to the atmosphere.

1. Remove the drain plug.
Do not reinstalled the drain plug until the reassembly is complete.
2. If pump is equipped with drain valves, open the drain valves.
Do not close the drain valve until the reassembly is complete.
3. Leave the suction pipe drain valve open to drain the pump casing as much as possible.
4. Remove the coupling guard.

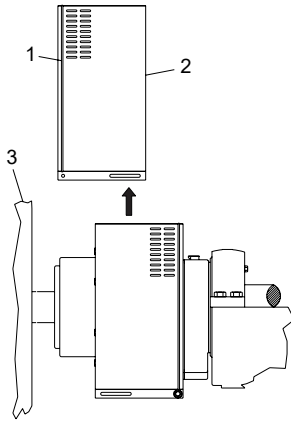
6.5.3 Remove the coupling guard

1. Remove the nut, bolt, retainer and washer from the slotted hole in the center of the coupling guard.
2. Slide the driver half of the coupling guard toward the pump.



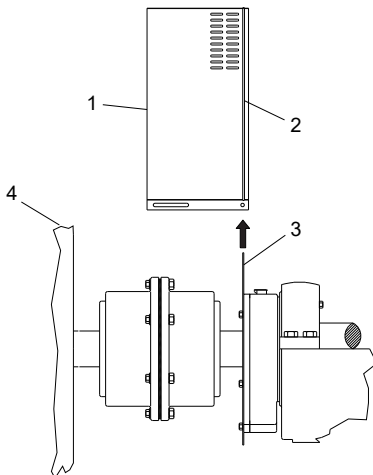
Item	Description
1.	Driver
2.	Slide to remove

3. Remove the nut, bolt, retainer and washer from the driver half of the coupling guard.
4. Remove the driver half of the coupling guard:
 - a) Slightly spread the bottom apart.
 - b) Lift upwards.



Item	Description
1.	Annular groove
2.	Coupling guard half
3.	Driver

5. Remove the remaining nut, bolt, retainer and washer from the pump half of the coupling guard. It is not necessary to remove the end plate from the pump side of the bearing housing. You can access the bearing-housing tap bolts without removing this end plate if maintenance of internal pump parts is necessary.
6. Remove the pump half of the coupling guard:
 - a) Slightly spread the bottom apart.
 - b) Lift upwards.



Item	Description
1.	Coupling guard half
2.	Annular groove
3.	Pump end plate
4.	Driver

6.5.4 Shaft guard removal (if provided)

6.5.4.1 Remove the shaft guard

1. Loosen, but do not remove, the 2 bolts (236C) on each side of upper shaft guard (501F) that mount the guard to each side of the bearing housing.
2. Slide upper shaft guard up to remove.
3. Loosen the 2 bolts (236D) on each side of lower shaft guard (501G) that mount the guard to pump casing. Once the bolts are out of the pump casing they will be held to the lower guard with the 2 bolt retainers (536R).
4. Retain each guard half for reinstallation.

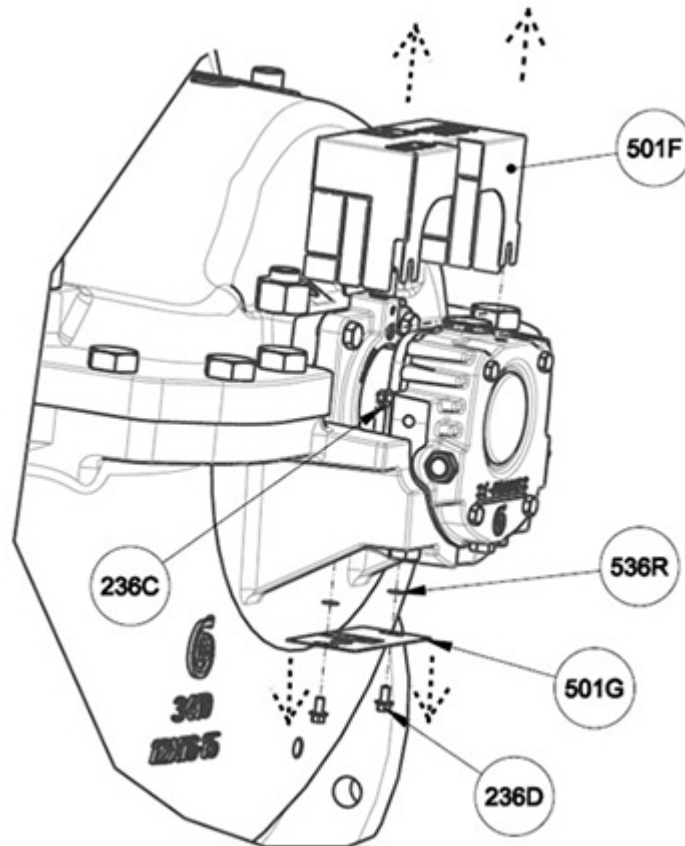


Figure 50: Shaft guard removal

6.5.5 Remove the rotating element

1. Disconnect the coupling.
 2. If the unit is oil-lubricated, then remove the reservoir bottle and oil drain plugs from the bottom of the bearing housings and drain the oil. Replace the plugs after draining.
 3. Remove the glands from the casing.
 - If the pump has packed stuffing boxes, then remove the nut from the stud, and then remove the gland halves.
 - If the pump has mechanical seals, then slide the glands toward the bearings.
- Make sure to protect the lapped stationary seal faces from damage.
4. Remove the casing screws (426) and nuts (425), and then remove the dowel pins (469G).
 5. Loosen the top half by doing one of the following:

Group	Instructions
S	Insert a prying tool into the parting slot and pry the upper-half of the casing loose. Repeat on the other side as required.
M, L, XL, XL1	Tighten the two jacking bolts (418) evenly until the seal is broken.

S group	M, L, XL, XL1 groups
 1. 469G 2. 426 3. Parting slot	 1. 426 2. 425 3. 418

- Remove the upper casing using a sling and hoist or a lift and lifting lugs.



WARNING:

Never attempt to lift the entire pump using lifting lugs.

- Remove and discard the gaskets.
- Remove the screws (372U) from the bearing saddle.
- Place the sling on the shaft (122), and then use a suitable hoist or lift to remove the rotating element and place it on padded supports.

On pumps with mechanical seals, make sure that the casing rings (103) do not slip and damage the seals.

- Mark the coupling position on the shaft (122) and remove the coupling.

Use instructions from the coupling manufacturer in order to remove the coupling.

6.5.6 Remove the bearings



CAUTION:

Never use a hammer to drive the shaft through the bearings. Doing so can cause severe shaft and bearing damage.

NOTICE:

Do not remove bearings from the shaft unless you need to replace them.

- Remove the screws (371C) and slide the housings (134) off the bearings (168 and 112) and the shaft (122).

Make sure not to damage the oil seal (332A).

- Using snap ring pliers in order to remove the retaining ring (361) from the thrust end of the shaft.
- Remove the bearings (168 and 112) with a bearing puller.

Group	Instructions
S	Use a two-jaw puller on the end cover (109). Use caution not to damage the end cover.
M, X, XL, XL1	Use a split-jaw puller on the back of the bearing (168 and 112).

Make sure not to damage the bearings. If the bearing needs to be reinstalled, then protect it from contamination by wrapping it in clean cloth or paper.

4. For L, XL and XL1 groups only, remove the radial bearing spacer (443T).
5. Remove the gaskets (360), bearing end covers (109), and deflectors (123).
6. Remove the outboard seal (332) from the coupling-end bearing housing, and remove the inboard seal (333) from each end cover (109).

You can discard the old bearings and gasket.

6.5.7 Remove the seals

1. Do one of the following:
 - If the pump has mechanical seals, then slide the glands with the stationary seat in place off the shaft. Make sure not to damage the lapped seal faces.
 - If the pump has packed stuffing boxes, then remove the nuts (355), gland (107), packing (106), lantern rings (105), and stuffing box bushings (125).
2. Slide the casing wear ring (103) off the impeller and shaft.
3. Remove the rotating portion of both seals.

6.5.8 Remove the shaft sleeve

NOTICE:

Do not remove the optional shaft sleeve on S group pumps unless you intend to replace it.

1. Remove the shaft sleeve as follows:

When you remove the sleeve (126), use a very fine emery cloth to smooth the shaft in order to prevent binding.

Group	Instructions
S	<ol style="list-style-type: none"> 1. Loosen the sleeve (126) with low heat, approximately 350–400°F 177–222°C. Use a temperature stick or other measuring device to monitor the temperature. 2. Apply torque with a strap wrench. 3. Slide the sleeve carefully off the shaft.
M, L, XL, XL1	<ol style="list-style-type: none"> 1. Loosen the setscrew (222B) on the sleeve nut (124). 2. Use a spanner or strap wrench to unscrew the sleeve nut (124). 3. Remove and discard the O-rings (497). 4. Carefully slide the sleeve (126) off the shaft. 5. Remove and discard the sleeve-to-impeller gasket (428) located on the end of the sleeve nearest the impeller.

6.5.9 Remove the impeller



CAUTION:

Do not damage the impeller hub surface that is sealed by the sleeve gasket.

1. Do one of the following:

Group	Instructions
S	<ol style="list-style-type: none"> 1. Use snap ring pliers to remove the retaining rings (361H). 2. Drive or press the impeller (101) off the shaft. 3. Remove the key (178). <p>See the Retaining ring configuration in the Parts Listings and Cross-sectional Drawings chapter for an illustration of the S group retaining ring configuration.</p>
M, L, XL, XL1	<ol style="list-style-type: none"> 1. Draw a mark on the shaft to indicate the location of the impeller hub. 2. Drive or press the impeller (101) off the shaft. 3. Remove the key (178).

6.6 Preassembly inspections



WARNING:

- Risk of death or serious injury. Leaking fluid can cause fire and/or burns. Inspect and ensure gasket sealing surfaces are not damaged and repair or replace as necessary.
- Risk of death or serious injury. Leaking fluid can cause fire and/or burns. Replace all gaskets and O-rings at each overhaul or disassembly.
 - 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.

O-rings

Inspect the O-rings (497) and replace them if damaged.

Wear rings

When hydraulic performance has substantially reduced, replace the casing wear rings.

The original radial clearance between the impeller and the casing wear rings is shown in [6.6.2 Radial clearances on page 75](#).

Impeller wear rings

If the unit has impeller wear rings (142) and it is necessary to replace the rings, then proceed as specified in [6.6.1 Replace impeller wear rings on page 75](#).

NOTICE:

If the impeller was supplied without wear rings and excessive wear has occurred, then wear rings can be fitted in the field. The impeller must then be remachined. Contact your local ITT representative for details.

Casing joint gasket

Inspect the parting gaskets (331). If they are torn or otherwise damaged, then cut a new gasket of 0.8 mm | 1/32 in. non-asbestos material using the recommendations below. Use the upper half of the casing as a template. Strike the face with a soft-face hammer. This will cut the gasket against the edge of the casing. The gasket must cover the entire surface of the parting flange, especially around the wear ring

locks and stuffing box. Otherwise, internal leakage from high to low pressure zones in the pump will occur.

The following gasket materials are recommended if pre-cut replacement gaskets are not available:

- JM - 961
- Durable - Durlon
- Garlock Blue Guard 3000
- Armstrong - N8090
- Rodgers - D7031

Shaft

Check the shaft (122) for runout to make sure that it is not bent. Straighten or replace the shaft as necessary. Bearing seats must be in perfect condition. Check keyways for burrs or foreign matter.

Impeller

Check the impeller (101). Replace the impeller if any of the following conditions exist:

- Excessive erosion, especially on inlet vanes
- Deterioration of the gasket mating surface to the point that the gasket (428) cannot seal properly
- Excessive erosion of surfaces

If the impeller diameter needs to be cut, then make sure that it is dynamically-balanced. Grind the outside of the shrouds near the periphery in order to correct imbalance.

Shaft sleeve

The sleeve (126) surface in the stuffing box area must be smooth and free of grooves. If there are grooves, replace the shaft sleeve. The O-ring groove in the end of the sleeve nut must be in good condition. The impeller end of the sleeve must be in good condition to ensure that the gasket (428) will seal properly. The original diametric clearance between the shaft sleeve and the stuffing box bushing is 0.76–0.86 mm | 0.030–0.034". If this clearance has increased to more than 1.27–1.5 mm | 0.050–0.060", then the sleeve, and possibly the stuffing box bushing, must be replaced.

Bearings

Check ball bearings (112 and 168) for visible wear. Slowly turn the races and look for pits or worn areas on the balls or raceways.

Hold the inner race and spin the outer race. If there are rasping noises or the bearing catches or binds, then replace the bearing. If any wear on the race is apparent, then replace the bearing.

Replace ball bearings that are worn, loose, rough, or noisy when rotated.

Seals

Check the seals (332 and 333) for wear, cracks, cuts, deformities, and signs of excessive leakage. Check the thrust-bearing end cover (109A) for signs of leakage and damage. Check the grease fittings (113) or oil breathers (113A) (oil option) for serviceability and replace as required.

General

NOTICE:

Protect machined surfaces while cleaning the parts. Failure to do so may result in equipment damage.

Clean all parts before reassembly. This is especially important at O-ring grooves, gasket surfaces, mating surfaces, and bearing areas. Check that threads on dowels, screws, nuts, studs, and all gasket surfaces are in good condition. Make sure the anti-rotation pins (445A) are firmly pressed into the wear rings (103).

Refer to [6.3 Bearing maintenance on page 60](#) for specific instructions on cleaning bearings.

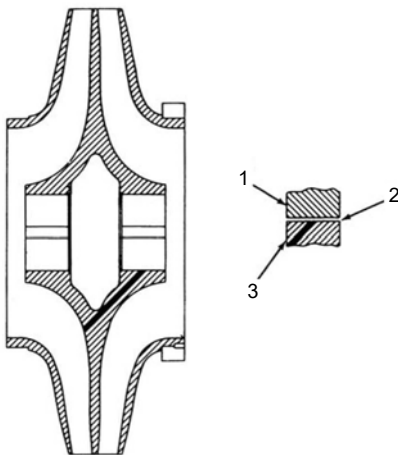
6.6.1 Replace impeller wear rings

1. Remove the old rings:
 - a) Remove the three setscrews (320).
 - b) Pull the ring (142) off the impeller hub.
2. Clean the hub and press on a new ring (142).
3. Drill and tap three holes 120° (1,600 mils) apart with a 7/32-in. drill and a 1/4-in. 20NC tap on each ring.
4. Insert the setscrews.

Make sure to use 5/16 in. x 1/4 in. cup point safety setscrews.
5. Tighten the screws and lightly upset the threads. Do not use the existing holes.

6.6.2 Radial clearances

Radial clearance between the impeller and casing wear rings



1. Casing wear ring
2. Radial clearance
3. Impeller

Table 5: Radial clearances by material

Group	Pump size	Iron and bronze	Steel
S	2 x 3-11	0.005–0.007 in. (0.013–0.018 mm)	0.009–0.011 in. (0.022–0.028 mm)
	3 x 4-10		
	4 x 6-9		
	4 x 6-11		
	4 x 6-11H		
	4 x 6-13		
	4 x 6-13H		

Group	Pump size	Iron and bronze	Steel		
M	4 x 6-15	0.005–0.007 in. (0.013–0.018 mm)	0.009–0.011 in. (0.022–0.028 mm)		
	6 x 8-11				
	6 x 8-14				
	6 x 8-14H				
	6 x 8-17				
	8 x 10-11				
	8 x 10-12				
L	8 x 10-14	0.005–0.007 in. (0.013–0.018 mm)	0.009–0.011 in. (0.022–0.028 mm)		
	6 x 8-22				
	6 x 10-17				
	8 x 10-17				
	8 x 10-17H			0.0055–0.0075 in. (0.014–0.019 mm)	0.010–0.012 in. (0.025–0.030 mm)
	8 x 10-21			0.005–0.007 in. (0.013–0.018 mm)	0.009–0.011 in. (0.022–0.028 mm)
XL	10 x 12-12	0.0055–0.0075 in. (0.014–0.019 mm)	0.010–0.012 in. (0.025–0.030 mm)		
	10 x 12-14	0.005–0.007 in. (0.013–0.018 mm)			
	10 x 12-17	0.0065–0.0085 in. (0.017–0.022 mm)	0.011–0.013 in. (0.028–0.033 mm)		
	12 x 14-15	0.0065–0.0085 in. (0.017–0.022 mm)	0.011–0.013 in. (0.028–0.033 mm)		
XL1	12 x 16-15	0.0065–0.0085 in. (0.017–0.022 mm)	0.011–0.013 in. (0.028–0.033 mm)		

6.7 Reassembly

6.7.1 Install the impeller



CAUTION:



Check for magnetism on the pump shaft and demagnetize the shaft if there is any detectable magnetism. Magnetism attracts ferritic objects to the impeller, seal, and bearings which can result in excessive heat generation, sparks, and premature failure.

NOTICE:

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.

1. Insert the key (178) into the shaft (122).
2. Determine the correct positioning of the impeller (101) on the shaft (122).
Facing the coupling-end of shaft, determine the proper rotation of the unit.
3. For S group pumps, install the retaining ring (361H) in the inboard (coupling-end) retaining groove.
4. Slide the impeller (101) on the shaft and drive the impeller flush with the retaining ring (361H).
5. If you are reinstalling the shaft and impeller, then line up the impeller hub with the mark made on the shaft during disassembly.
6. Install the shaft sleeve.

Pump group	Instructions
S	<ol style="list-style-type: none"> 1. Install the retaining ring so that the tapered side is facing the outboard end of the shaft. The inward pressure asserted by the double taper automatically centers the impeller and eliminates lateral play. The outboard (thrust-end) retaining ring groove and retaining ring (361H) are tapered. 2. If the pump does not use the optional sleeve, then you are finished. If the pump uses the optional sleeve, then continue to complete the following steps. 3. Make sure that the shaft is free of dirt, grease, and bonding compounds. 4. Apply a thin coat of Loctite 635 or equivalent to the shaft sleeve area and the inside of the sleeve. 5. Slide the sleeve on the outboard end of the shaft and seat the sleeve firmly against the shaft shoulder.
M, L, XL, XL1	<ol style="list-style-type: none"> 1. Place the sleeve-to-impeller gasket (428) on the impeller (101). Make sure that the gasket is aligned with the key (178). 2. Slide the sleeve (126) onto the shaft. 3. Slide the O-rings (497) onto the shaft by stretching them over the threaded end. 4. Using a spanner or strap wrench to tighten the sleeve nuts (124), adjusting the impeller to approximate center. Do not tighten the setscrew. You will need to adjust the impeller again when the rotating element is placed in the casing.

7. Position the casing wear rings (103) on the impeller.
Make sure that the anti-rotation pins (445A) are seated firmly.

6.7.2 Assemble the rotating element

1. Slide the stuffing box bushing (125) onto the shaft or sleeve.
Units with mechanical seals do not have a stuffing box bushing.
2. If the unit is equipped with mechanical seals, then install the seals at this time.
Refer to the instructions provided by the seal manufacturer for details.

3. Slide the deflectors (123), bearing end covers (109), and gaskets (360) onto the shaft.

6.7.3 Install the bearings

1. Apply a thin film of machine oil to the bearing seats on the shaft.
- 2.

NOTICE:

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.

Start the bearings (112 and 168) onto the shaft by tapping the inner race with a hammer or mallet.

Keep the bearing square at all times.

3. After the bearing is started on shaft, use a driving sleeve in order to press or drive the bearing until it contacts the shoulder on the inboard side of the seal.

Make sure that the sleeve contacts only one inner race.

4. For the outboard (thrust) bearing, install a tapered bearing-retaining ring (361) in the retaining ring groove on the outboard (thrust) end of the shaft (122).
5. Slide the bearing housings (134) over the bearings.
6. Tighten the screws (371C) in two stages:
 - a) Using an X pattern, tighten the screws to 8 ft-lbs (11 Nm).
 - b) Again, using an X pattern, tighten the screws to 12 ft-lbs (16.3 Nm).
 - c) Repeat these steps on the opposite side.

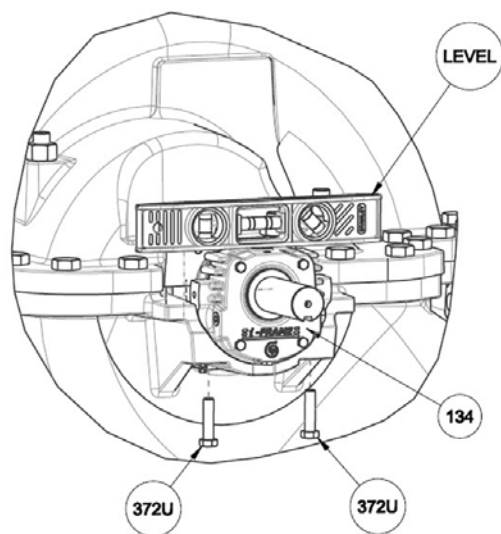
6.7.4 Install the rotating element

NOTICE:



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.

1. Install the rotating element in the lower casing with a sling, adequate hoist, or lift.
Make sure that the casing wear ring (103) and anti-rotation pins (445A) seat properly in the wear ring grooves and pin grooves.
2. Tighten or loosen the sleeve nuts with a strap wrench as required in order to center the impeller in the seated wear rings.
For M, L, XL and XL1 groups, tighten the sleeve nuts (124) to 30 ft-lbs (40.7 Nm).
3. Tighten the sleeve nut setscrews (222B).
Make sure that the stuffing box bushings (125) are aligned properly in the stuffing boxes.
4. Tighten the bearing housing to the lower casing on each side.
 - a) Install and hand tighten the screws (372U) until snug.
 - b) Ensure the bearing housing is level by laying a level on the machined surface for the i-Alert.



- c) Tighten the screws on each side to 55 Nm | 40 ft-lbs.
- d) Tighten each side to 80 Nm | 59 ft-lbs.
- e) Check the bearing housing to ensure it is still level after screws are torqued.

6.7.5 Assemble the casing

Make sure that the mating surfaces on the upper and lower halves of the casing are clean.

1. Install the gasket (351).
2. Carefully align and install the upper casing using a hoist, lift, and sling attached to lifting lugs on the upper casing.
3. Install the dowel pins (496G).
4. Install the screws (426) and parting nuts (425) on the studs (356A) and tighten as follows:
 - a) Using an X pattern working outwards towards the flanges, tighten the nuts and screws to the following torque:
 - S and M groups: 40 ft-lbs (55 Nm)
 - L, XL and XL1 groups: 60 ft-lbs (80 Nm)
 - b) Using the same pattern, increase the torque to the following:
 - S and M groups: 90 ft-lbs (122 Nm)
 - L, XL and XL1 groups: 180 ft-lbs (245 Nm)
 - c) Using the same pattern, tighten again to the following torque:
 - S and M groups: 105 ft-lbs (142 Nm)
 - L, XL and XL1 groups: 255 ft-lbs (345 Nm)
 - d) Recheck the torque on each nut and screw.

6.7.6 Complete the assembly

1. Install the stuffing box packing (106) and lantern rings (105).
See [5.6 Seal the shaft with a packed stuffing box on page 49](#).
2. Install the stuffing box gland (107) and nuts (355).
Make sure to only finger-tighten the nuts.
3. Adjust the glands.

4. Install the oiler (251) and drain plugs if they were removed.

Perform the following as required:

1. Lubricate the bearings.
2. Align the pump and driver.
3. Connect the coupling.
4. Replace the coupling guard.
5. Replace the shaft guard.

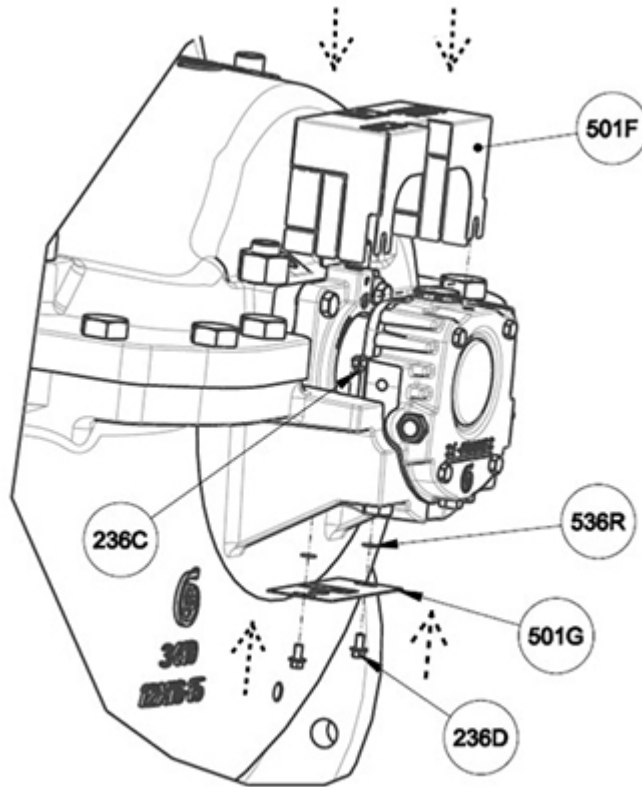


Figure 51: Shaft guard replacement

6. Replace the sealing liquid.
7. Replace the cooling water piping.
8. Reinstall the drain plugs or close the drain valves.
9. Prime the pump.
10. Inspect after starting.
11. Check the stuffing boxes.

6.7.7 Bolt Torque Values - 3410 IOM

Table 6: Bolt Torque Values - FT-lb. (N-m)

Sizes	Dry Threads	Lub. Threads	Dry Threads	Lub. Threads
	2210	2210	2239	2239
3/8"	12 (16)	6 (8)	36 (48)	18 (24)
7/16"	20 (28)	10 (14)	58 (78)	29 (39)

Sizes	Dry Threads	Lub. Threads	Dry Threads	Lub. Threads
	2210	2210	2239	2239
1/2"	30 (41)	15 (20)	90 (122)	44 (60)
9/16"	44 (60)	22 (30)	126 (170)	63 (85)
5/8"	60 (81)	30 (41)	175 (237)	87 (118)
3/4"	105 (142)	53 (72)	305 (414)	154 (209)
7/8"	170 (231)	85 (115)	495 (671)	248 (336)
1"	255 (346)	128 (174)	740 (1003)	371 (503)

6.8 Spare parts

Critical service spare parts

ITT recommends that you have spare parts available to insure against possible long and costly downtime periods, especially on critical services.

Part	Notes
Rotating element	This is a group of assembled parts including a shaft, impeller, bearings, bearing housings with seals, wear rings, stuffing box bushings, and all rotating parts except the coupling.
Stuffing box packing and lantern ring (if any)	One set for each stuffing box.
Mechanical seals (if any)	One seal for each stuffing box.

Recommended spare parts

Alternately, you can have the spare parts available that are most likely to wear and can be used as needed.

Part	Notes
Stuffing box packing (if any)	-
Mechanical seal (if any)	One seal for each stuffing box.
Shaft sleeve (if any)	-
Ball bearings	One thrust and one radial.
Wear rings	For the casing and the impeller.
Shaft	-
Impeller key	-
Stuffing box bushings (if any)	-

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 pump is not delivering enough liquid or pressure.	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 suction piping has air leaks.	Check the suction piping for air pockets and air leaks.
	The stuffing box has air leaks.	Check the packing or seal and replace if necessary. Check for the proper amount of lubrication.
	The motor speed is too low.	Make sure that the motor wiring is correct and receives full voltage or that the turbine receives full steam pressure. The motor can have an open phase.
	The discharge head is too high.	Check for pipe friction losses and that the valves are wide open. The condition can be corrected with larger piping.
	The suction lift is too high.	Check for obstructions at the inlet and make sure the suction valves are open. Check for pipe friction losses. Use a vacuum or compound gauge to check the NPSH available.
	The impeller is clogged.	Back-flush the pump in order to clean the impeller.
The amount of available NPSH is not sufficient.	1. Increase the positive suction head by lowering the pump or increasing the suction pipe and fittings size.	

Symptom	Cause	Remedy
		<ol style="list-style-type: none"> 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.	<p>Inspect the impeller and wear rings and replace if any of the following conditions are present:</p> <ul style="list-style-type: none"> • 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 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.	Consult with ITT.
The pump starts and then stops pumping.	The suction lift is too high.	Check for obstructions at the inlet and make sure the suction valves are open. Check for pipe friction losses. Use a vacuum or compound gauge to check the NPSH available.
	The impeller is clogged.	Back-flush the pump in order to clean the impeller.
	The suction piping has air leaks.	Check the suction piping for air pockets and air leaks.
	The stuffing box has air leaks.	Check the packing or seal and replace if necessary. Check for the proper amount of lubrication.
	There is not enough suction head for hot or volatile liquids.	Consult with ITT about increasing the suction head.
	The foot valve or suction pipe opening are not submerged enough.	Consult an ITT representative for the proper submersion depth. Use a baffle in order to eliminate vortices.
	Air or gases are trapped in the liquid.	Consult with ITT.
	The casing gasket is damaged.	Check the gaskets and replace if necessary.
The bearings are running hot.	The shaft is bent.	Straighten the shaft or replace it if necessary.
	The bearings are worn out or improperly lubricated.	Inspect the bearings and replace them if necessary.
	There is excessive pipe strain on the pump casing.	Relieve the strain and check the alignment. Consult ITT if necessary.
	The pump and driver are not aligned properly.	Realign the pump and driver.
	The lubrication has not been applied properly.	Check the lubricant for suitability and level.

7.1 Troubleshooting

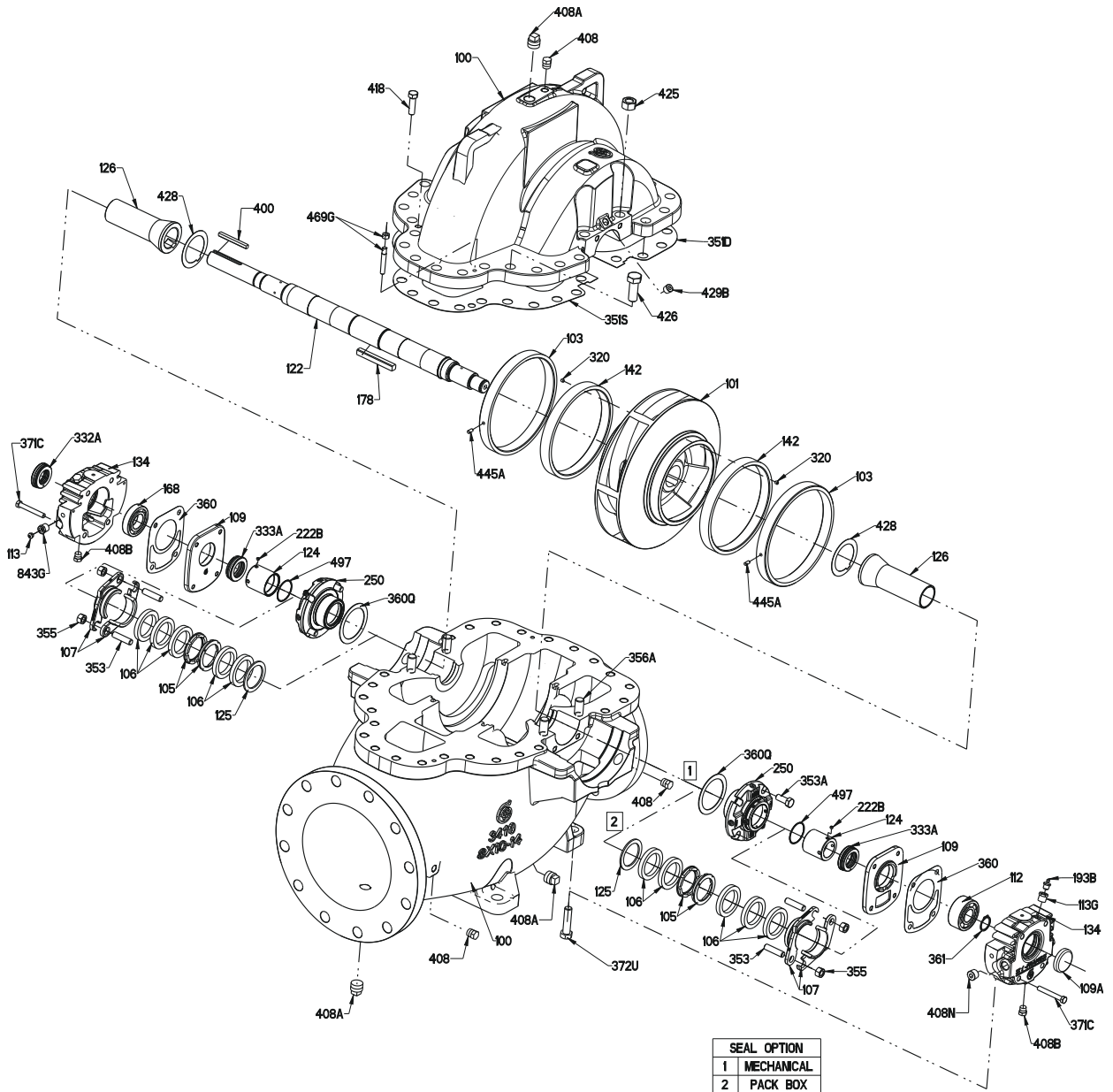
Symptom	Cause	Remedy
	The lubrication is not cooled properly.	Check the cooling system.
The pump is noisy or vibrates.	The pump and driver are not aligned properly.	Realign the pump and driver.
	The impeller is partly clogged.	Back-flush the pump to clean the impeller.
	The impeller or shaft is broken or bent.	Replace the impeller or shaft as necessary.
	The foundation is not rigid.	Tighten the hold-down bolts of the pump and motor or adjust the stilts.
	The bearings are worn.	Replace the bearings.
	Rotating parts are binding.	Check the internal wearing parts for proper clearances.
	The pump is cavitating.	Locate and correct the system problem.
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 stuffing box is overheating.	The stuffing box has air leaks.	Check the packing or seal and replace if necessary. Check for the proper amount of lubrication.
	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 incorrect packing or mechanical seal has been installed.	Consult with ITT.
	The mechanical seal is damaged.	Inspect and replace the mechanical seal as necessary. Consult with ITT.
	The shaft sleeve is scored.	Machine or replace the shaft sleeve as necessary.
	The packing is too tight or the mechanical seal is not adjusted properly.	Check and adjust the packing. Replace any parts as necessary. Adjust the mechanical seals. Consult the instructions supplied by the seal manufacturer or consult with ITT.
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.	Straighten the shaft or replace it if necessary.
	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.

Symptom	Cause	Remedy
	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.	<ol style="list-style-type: none"> 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.
The element turns hard or has a rub.	The shaft is bent.	Straighten the shaft or replace it 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.
	There is excessive runout on the shaft or impeller rings.	Inspect the rotating element and bearings. Replace worn or damaged parts as necessary.
	There is dirt in the casing ring or between the impeller and casing wear rings.	Clean and inspect the wear rings. Replace worn or damaged parts as necessary. Isolate and relieve the source of dirt.

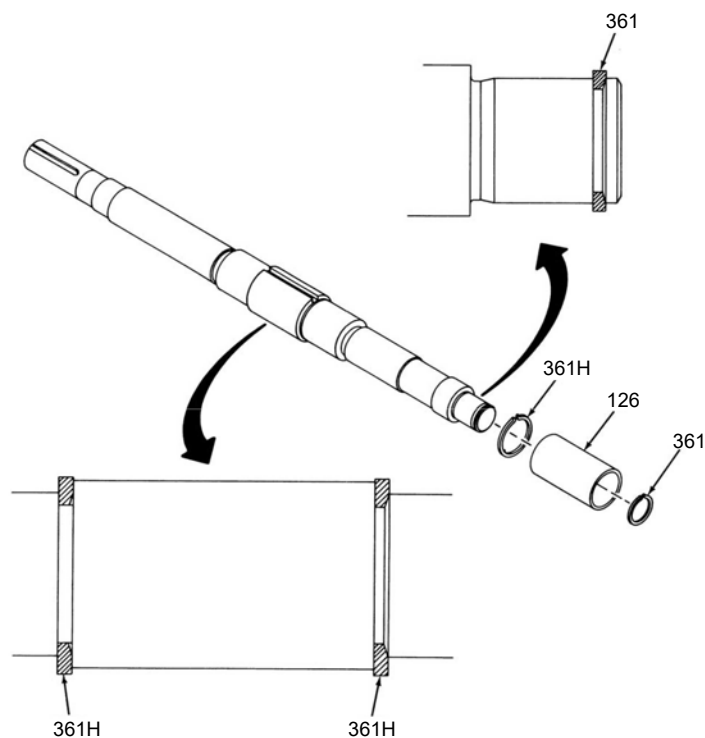
8 Parts List and Exploded View

8.1 Drawings

Exploded view



Retaining ring configuration



8.2 Parts list

Item	Name	Qty.
100	Casing	1
101	Impeller	1
103	Case wear ring	2
105	Lantern Ring	2
106	Stuffing box packing	1 set
107	Gland, Stuffing Box	2
108F	Coupling, Pipe (Oiler)	2
109	Bearing end cover	2
109A	Soft Plug, Thrust Housing	1
112	Ball bearing - thrust	1
113	Grease Relief Fitting	2
113E	Sight Glass, Oil	2
113G	Bushing, Oil/Grease Injection	2
122	Shaft	1
124	Sleeve nut (M, L, XL and XL1)	2
125	Bushing, Stuffing Box	2
126	Shaft sleeve (optional on S-Group)	2
134	Bearing housing	2
142	Impeller wear ring	2
168	Ball bearing - radial	1
178	Impeller key	1

8.2 Parts list

Item	Name	Qty.
190,190A	Pipe nipple, Oiler	2
193B	Grease fitting	2
222B	Set screws - sleeve nut	4
236C	Hex Flange screw – Upper Shaft Guard	4
236D	Hex Flange screw – Lower Shaft Guard	4
250	Gland, Mechanical Seal	2
251	Oiler, Constant Level w/viewport	2
320	Set screws – Impeller Ring	6
332A	Labyrinth seal, Outboard	1
333A	Labyrinth seal, Inboard	2
351S,D	Gasket - Casing Parting suction and discharge	2
353	Stud - Gland	4
353A	Hex cap screw – Mech Seal Gland	8
355	Hex nut - Gland	4
356A	Studs, Parting	4
358N, R	Pipe Plug, Flush, Vent and Drain Gland	6
360	Gasket, End Cover to Bearing Housing	2
360Q	Gasket, Gland to Case	2
361	Retaining Ring, Thrust	1
361H	Retaining Ring, Impeller (S-group Only)	2
371C	Hex cap screw - Bearing Housing to End cover	8
372U	Hex cap screw - Bearing Housing Casing	4
400	Key, Coupling	1
408, 408A	Pipe Plug, Casing	varies
408B	Pipe Plug, Bearing Housing Drain	2
408H	Pipe Plug, Oil Mist Injection	2
408K	Pipe Plug, Oil Fill	2
408N	Pipe Plug, Sight Glass	2 or 4
418	Jack Bolt, Parting	2
425	Hex Nuts, Parting	4
426	Hex Cap Screw, Parting	varies
428	Gasket, Sleeve to Impeller (M, L, XL and XL1)	2
429B	Plug, Flush	2
443T	Spacer, Radial Bearing (L, XL and XL1)	1
445A	Pin, Anti-Rotation, Case Ring	2
469G	Taper Pin with Hex Nut, Parting	2
492B	Pipe Plug, Lantern Ring Flush	2
494	Cooling Assembly (optional)	2
497	O-ring - sleeve nut	2
501F	Upper Shaft Guard	2
501G	Lower Shaft Guard	2
536R	Bolt Retainer - Lower Shaft Guard	4
843G	Bushing, Grease Relief Ftg.	2

9 Decommissioning

9.1 Putting pump out of operation

This chapter contains information on decommissioning the pump. Decommissioning must be performed in the following situations:

- Before maintenance and servicing work
- Before removing the pump from the plant

Emptying

1. Switch the drive system off and secure it to prevent a restart/being switched on again
2. Make sure that all interfaces for the pumping process are securely closed.
3. Relieve the pump and operator side pipelines of pressure in the safe area.

NOTICE:

Always safely collect any pumped medium that leaks out and dispose of this in accordance with applicable local regulations.

Empty the pump and operator side pipelines completely in the safe area.

Clean

The following prerequisites for cleaning must be fulfilled:

- All interfaces for the pumping process are securely closed.
- The system is completely emptied and pressure-free.
 - Clean the pump thoroughly

9.2 Disposal

This chapter contains information on proper disposal. Ensure that the pump has been decommissioned properly prior to disposal

1. Drain lubricating oil from the bearing casing and collect it safely.
2. Thoroughly clean components and disassemble these in compliance with applicable local occupational safety and environmental protection regulations.

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