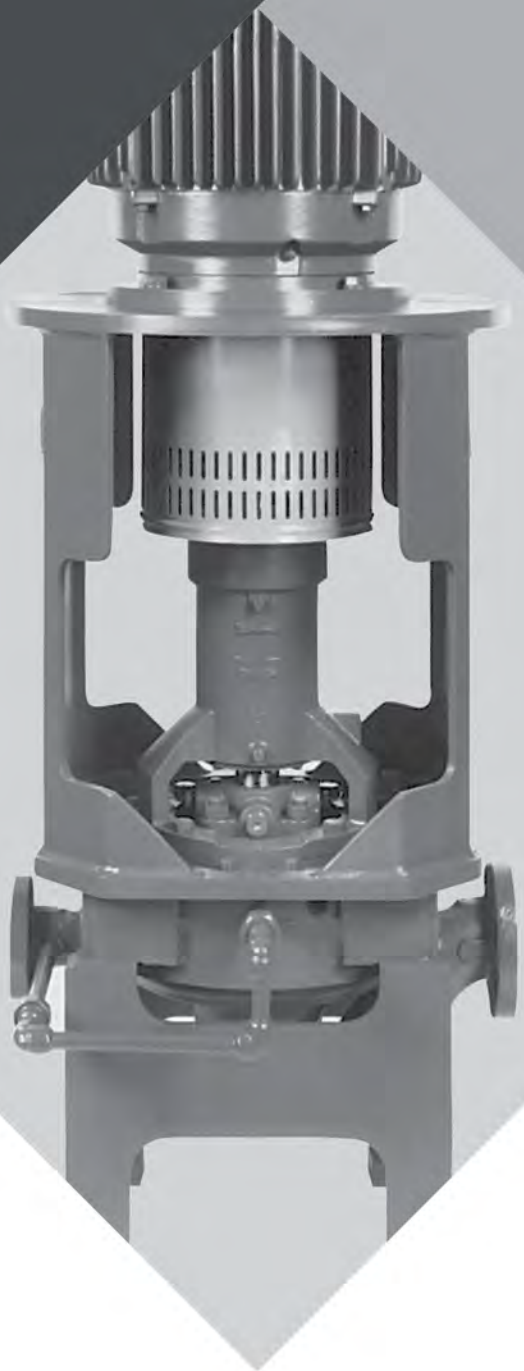
GOULDS PUMPS

Installation, Operation, and Maintenance Manual

Model 3910



ITT

Table of Contents

1 Introduction

Purpose of this manual

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

- Installation
- Operation
- Maintenance

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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.

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

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1.1.1 Requesting other information

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

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

1.2 Safety

WARNING:

- 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.
- The operator must be aware of the pumpage and take appropriate safety precautions to prevent physical injury.
- Risk of serious injury or death. If any pressure-containing device is over-pressurized, it can explode, rupture, or discharge its contents. It is critical to take all necessary measures to avoid over-pressurization.
- Risk of death, serious personal injury, and property damage. Installing, operating, or maintaining the unit using any method not prescribed in this manual is prohibited. Prohibited methods include any modification to the equipment or use of parts not provided by ITT. If there is any uncertainty regarding the appropriate use of the equipment, please contact an ITT representative before proceeding.
- If the pump or motor is damaged or leaking, electric shock, fire, explosion, liberation of toxic fumes, physical harm, or environmental damage may result. Do not operate the unit until the problem has been corrected or repaired.
- Risk of serious personal injury or property damage. Dry running may cause rotating parts within the pump to seize to non-moving parts. Do not run dry.
- Risk of death, serious personal injury, and property damage. Heat and pressure buildup can cause explosion, rupture, and discharge of pumpage. Never operate the pump with suction and/or discharge valves closed.
- Running a pump without safety devices exposes operators to risk of serious personal injury or death. Never operate a unit unless appropriate safety devices (guards, etc.) are properly installed. See specific information about safety devices in other sections of this manual.

CAUTION:

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

WARNING:

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

1.2.1 Safety terminology and symbols

About safety messages

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

- Personal accidents and health problems
- Damage to the product

- Product malfunction

Hazard levels

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

Hazard categories

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

Electrical hazards are indicated by the following specific symbol:

ELECTRICAL HAZARD:

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

- Crush hazard
- Cutting hazard
- Arc flash hazard

1.2.1.1 The Ex symbol

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

1.2.2 Environmental safety

The work area

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

Waste and emissions regulations

Observe these safety regulations regarding waste and emissions:

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

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

Electrical installation

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

1.2.2.1 Recycling guidelines

Always follow local laws and regulations regarding recycling.

1.2.3 User safety

General safety rules

These safety rules apply:

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

Safety equipment

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

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

Electrical connections

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

Noise

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

Temperature

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

1.2.3.1 Precautions before work

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

- Provide a suitable barrier around the work area, for example, a guard rail.
- Make sure that all safety guards are in place and secure.
- Recognize the site emergency exits, eye wash stations, emergency showers and toilets.
- Allow all system and pump components to cool before you handle them.
- Make sure that you have a clear path of retreat.
- Make sure that the product cannot roll or fall over and injure people or damage property.
- Make sure that the lifting equipment is in good condition.
- Use a lifting harness, a safety line, and a breathing device as required.
- Make sure that the product is thoroughly clean.
- Make sure that there are no poisonous gases within the work area.
- Make sure that you have quick access to a first-aid kit.
- Disconnect and lock out power before servicing.
- Check the explosion risk before you weld or use electric hand tools.

1.2.3.2 Wash the skin and eyes

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

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

Condition	Action
	3. Seek medical attention, if necessary.

1.2.4 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 according to standard IEC 60529.

1.3 Product warranty

Coverage

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

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

Limitations

The warranty does not cover faults caused by these situations:

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

ITT assumes no liability for these situations:

- Bodily injuries
- Material damages
- Economic losses

Warranty claim

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

1.4 Ex Considerations and Intended Use

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

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

Personnel requirements

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

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

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

Product and product handling requirements

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

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

Description of Ex-Directives

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

Guidelines for compliance

Compliance is fulfilled only when you operate the unit within its intended use. Do not change the conditions of the service without the approval of an ITT representative. When you install or maintain explosion

proof products, always comply with the directive and applicable standards (for example, IEC/EN 60079-14).

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

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

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

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

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

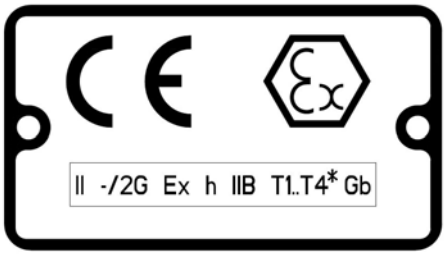


Figure 1: Typical Ex nameplate

Figure 2: Typical UKCA Ex nameplate

Table 1: Temperature class definitions

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

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

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

ISO 80079-37:2016 Section 5.7

Recommended bearing replacement interval (based on L10 life) = 25,000 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 (all models), or proper liquid level in self-priming pumps (Model 3796 and SP3298).
- Equipment that will operate in a potentially explosive environment must be installed in accordance with the following instructions.
- All equipment being installed must be properly grounded to prevent unexpected static electric discharge. This includes ensuring that the PFA lined pumps (Model 3198), ETFE lined pumps (Model 3298, SP3298, V3298), and the non-metallic liquid end pumps (Model NM3196) are pumping fluids that are conductive. If not, a static electric discharge may occur when the pump is drained and disassembled for maintenance purposes.
- All equipment being installed must be properly grounded to prevent unexpected static electric discharge.
- When pumping fluids with conductivity less than 1000 ps/m follow IEC TS 60079 32-1 guidelines.
- Alignment procedures must be followed to prevent unintended contact of rotating parts. Follow coupling manufacturer’s installation and operation procedures.
- When installing in a potentially explosive environment, ensure that the motor and accessories are properly certified.
- The impeller clearance setting procedure must be followed. Improperly setting the clearance or not following any of the proper procedures can result in sparks, unexpected heat generation and equipment damage.

- The impeller and wear ring clearance setting procedures must be followed. Improperly setting the clearance or not following any of the proper procedures can result in sparks, unexpected heat generation and equipment damage.
- Service temperature in an Ex classified environment is limited to the area classification specified on the Ex tag affixed to the pump (reference Table 1 in the Safety section for Ex classifications).
- The coupling used in an Ex classified environment must be properly certified.
- The coupling guard used in an Ex classified environment must be constructed from a spark-resistant material.
- Bearings must be lubricated properly in order to prevent excess heat generation, sparks and premature failure.
- The mechanical seal used in an Ex classified environment must be properly certified.
- The mechanical seal must have an appropriate seal flush system. Failure to do so will result in excess heat generation and seal failure.
- Packed stuffing boxes are not allowed in an Ex classified environment.
- Dynamic seals are not allowed in an Ex classified environment.
- Pumps that are not self-priming must be fully primed at all times during operation. The only model lines that are self-priming is the 3796 and SP3298.
- Pumps must be fully primed at all times during operation.
- The preventive maintenance section must be adhered to in order to keep the applicable Ex classification of the equipment. Failure to follow these procedures will void the Ex classification for the equipment. Bearing replacement intervals are given in the specific pump model IOM.
- Inspection intervals should be shortened appropriately if the pumpage is abrasive and/or corrosive, or if the environment is classified as potentially explosive.
- Throughout this section on bearing lubrication, different pumpage temperatures are listed. If the equipment is Ex certified and the listed temperature exceeds the applicable value shown in Table 1 under SAFETY, then that temperature is not valid. Should this situation occur, please consult with your ITT/Goulds representative.
- Cooling systems, such as those for bearing lubrication, mechanical seal systems, etc., where provided, must be operating properly to prevent excess heat generation, sparks and premature failure.
- Rotate shaft by hand to ensure it rotates smoothly and there is no rubbing which could lead to excess heat generation, sparks and premature failure.
- Flange loads from the piping system, including those from thermal expansion of the piping, must not exceed the limits of the pump. Casing deformation can result in contact with rotating parts which can result in excess heat generation, sparks and premature failure.
- Ensure that pump and systems are free of foreign objects before operating and that objects cannot enter the pump during operation. Foreign objects in the pumpage or piping system can cause blockage of flow which can result in excess heat generation, sparks and premature failure.
- Do not insulate or allow the bearing housings to accumulate a dust layer as this can result in excess heat generation, sparks and premature failure.
- Check for magnetism on the pump shaft and demagnetize the shaft if there is any detectable magnetism. Magnetism will attract ferritic objects to the impeller, seals and bearings which can result in excess heat generation, sparks and premature failure.
- Leakage of process liquid may result in creation of an explosive atmosphere. Ensure the materials of the pump casing, impeller, shaft, sleeves, gaskets and seals are compatible with the process liquid.

- Leakage of process liquid may result in creation of an explosive atmosphere. Follow all pump and seal assembly procedures.
- A buildup of gases within the pump, sealing system and or process piping system may result in an explosive environment within the pump or process piping system. Ensure process piping system, pump and sealing system are properly vented prior to operation.
- Sealing systems that are not self purging or self venting, such as plan 23, require manual venting prior to operation. Failure to do so will result in excess heat generation and seal failure.
- Do not apply additional paint or coatings to the pump when in an Ex environment. Static electric discharge can be initiated when contacting or rubbing surfaces with excessive coating thickness.
- Potential electrostatic charging hazard. Do not rub, clean, or blast equipment with dry cloth or dry media.
- Stray electrical currents may ignite explosive atmospheres. Ensure drives are certified for variable frequency drive operation by the manufacturer.
- User shall observe necessity of using a safety device, such as a flame arrestor, to prevent flame entering or leaving the pump sump, tank, or barrel when applicable.
- For variable speed motor applications, the electric motor must be specified with shaft grounding and used with a conductive type coupling suitable for the area classification.
- In plants or pumps with cathodic corrosion protection, a small current constantly flows through the construction. This is not permissible on the complete pump or partially-assembled machinery without further precautions being taken. ITT should be consulted in this context.
- Move equipment to a safe/non Ex environment for repairs/adjustments or use spark resistant tools and work methods.

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 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.

2.2.2 Lifting methods

WARNING:

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

- Units with drivers mounted can be top heavy. Driver weight could cause the assembled unit to overturn and could result in serious physical injury, or damage to pumps.

Table 2: Methods

Pump type	Lifting method
Bare pump without lifting handles	Use a suitable sling attached properly to solid points like the casing, the flanges, or the frames.
A bare pump with lifting handles	Lift the pump by the handles.
A base-mounted pump	Use slings under the pump casing and the drive unit, or under the base rails.

Examples

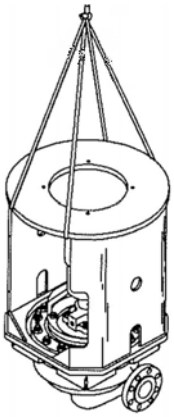


Figure 3: Example of proper lifting method for bare pump

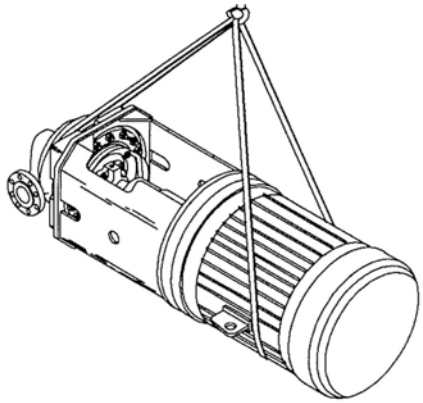


Figure 4: Example of proper lifting method for units with drivers mounted

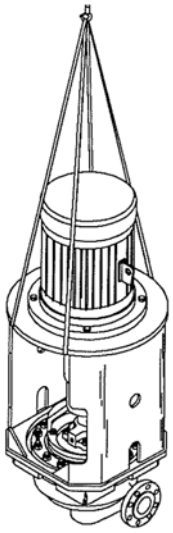


Figure 5: Example of proper lifting method for units with drivers mounted

2.3 Storage guidelines

2.3.1 Pump storage requirements

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

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

2.3.1.1 Long-term storage

If the unit is stored for more than 6 months, these requirements apply:

- 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 the drive unit and coupling manufacturers for their long-term storage procedures.

For questions about possible long-term storage treatment services, please contact your local ITT sales representative.

2.4 Frostproofing

Table 3: Situations when the pump is or is not frostproof

Situation	Condition
Operating	The pump is frostproof.
Immersed in a liquid	The pump is frostproof.
Lifted out of a liquid into a temperature below freezing	The impeller might freeze.

3 Product Description

3.1 General description 3910

Product description

The model 3910 is a vertical bearing frame in-line centrifugal pump that meets the requirements of API Standard 610 11th Edition (ISO 13709).

The model is based on 5 power ends and 27 hydraulic pump sizes.

Figure 6: 3910 pump

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

Casing

The casing is a vertical in-line mounted design. The gasket is fully confined. ANSI Class 300 raised face serrated flanges are standard; ANSI Class 300 flat face serrated and ring joint flanges are available.

Impeller

The impeller is fully enclosed and key driven by the shaft. An impeller nut with locking set screw prevents axial movement.

Table 4: Impeller

3910	3910 LF
Enclosed impeller	Semi-open impeller

Seal chamber cover

The model 3910 seal chamber cover meets API 682 3rd Edition dimensions for improved performance of mechanical seals.

Power end

The power end has the following characteristics:

- Standard regreasable bearings
- Labyrinth seals on the power end
- Optional pure oil mist lubrication (some modifications are required to convert from grease to oil mist)

Shaft

The standard shaft is machined and ground to comply with API 610 11th Edition (ISO 13709) criteria.

Bearings

Table 5: Bearings

Bearing type	Characteristics
Inboard (radial)	• Consists of a single-row deep-groove ball bearing • Carries only radial load • Freely floats axially in the frame
Outboard (thrust)	• Consists of a duplex-angular contact bearing, which uses a pair of single-row angular contact ball bearings mounted back-to-back • Shouldered and locked to the shaft • Retained in the bearing frame to enable it to carry radial and thrust loads

Motor support

The fabricated steel motor support is designed to support the driver and to provide ample access to both the seal piping and the coupling.

Direction of rotation

Counterclockwise (left hand) as viewed from the driver, looking at the pump shaft.

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	The formula for the pump size is: Discharge x Suction - Nominal Maximum Impeller Diameter in inches. (Example: 2x3-8)
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.
IECEx	If applicable, your pump unit might have the following IECEx nameplate affixed to the pump and/or baseplate. The nameplate provides information about the IECEx specifications of this pump.

Nameplate on the pump casing using English units

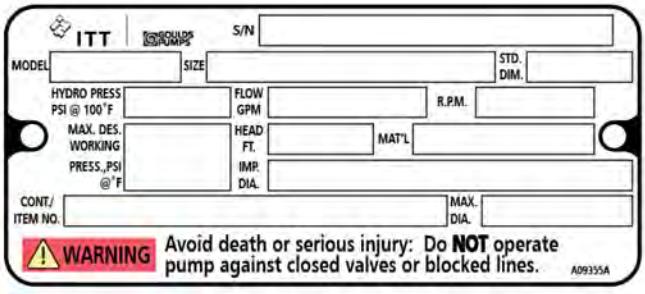


Figure 7: Nameplate on the pump casing using English units

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

Nameplate on the pump casing using metric units

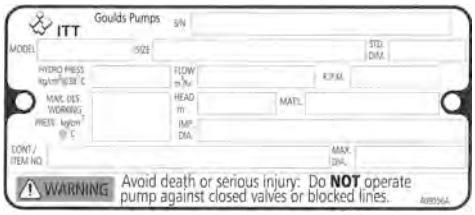


Figure 8: Metric units - nameplate on pump casing

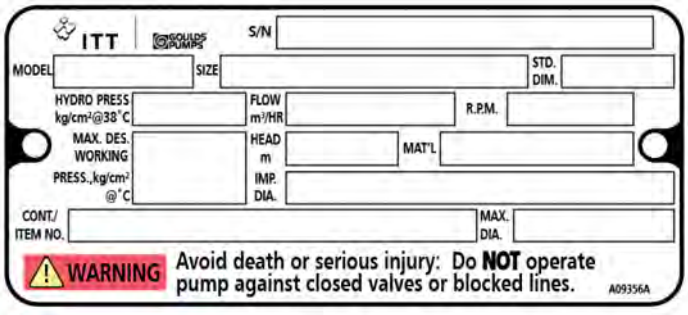


Figure 9: Nameplate on pump casing using metric units

Nameplate field	Explanation
MODEL	Pump model
SIZE	Size of the pump
FLOW	Rated pump flow, in cubic meters per hour
HEAD	Rated pump head, in meters
RPM	Rated pump speed, in revolutions per minute
HYDRO PRESS	Hydrostatic pressure at 38°C in kilopascals gauge
MAX. DES. WORKING PRESS	Maximum working pressure at temperature °C in kilopascals gauge
S/N	Serial number of the pump
CONT./ITEM NO.	Customer contract or item number
IMP. DIA.	Rated impeller diameter, millimeters
MAX. DIA.	Maximum impeller diameter, millimeters
STD. DIM.	Standard ANSI dimensional code
MAT'L	Material of construction

Nameplate on the bearing frame

Figure 10: Nameplate on the bearing frame

Table 6: Explanation of the nameplate on the bearing frame

Nameplate field	Explanation
BRG. O. B.	Outboard bearing designation

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

Ex nameplate

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

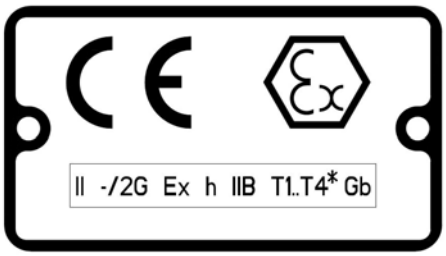


Figure 11: Typical Ex nameplate

Figure 12: Typical UKCA Ex nameplate

Recommended bearing replacement interval (based on L10 life) = 25,000 hours of operation.

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 Installation consideration

Model 3910 in-line pumps are designed to be mounted directly in the piping. The pump casing has a flat base which may be mounted on a concrete foundation which has been poured on a solid footing.

4.1.2 Pump location guidelines

Guideline	Explanation/comment
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.	This is applicable if nothing else is specified.
Do not install and operate the equipment in closed systems unless the system is constructed with properly-sized safety devices and control devices.	Acceptable devices: • Pressure relief valves • Compression tanks • Pressure controls • Temperature controls • Flow controls If the system does not include these devices, consult the engineer or architect in charge before you operate the pump.
Take into consideration the occurrence of unwanted noise and vibration.	The best pump location for noise and vibration absorption is on a concrete floor with subsoil underneath.

4.1.3 Installation consideration

Model 3910 in-line pumps are designed to be mounted directly in the piping. The pump casing has a flat base which may be mounted on a concrete foundation which has been poured on a solid footing.

4.1.4 Foundation requirements

Requirements

- The foundation must weigh not less than three times the combined weight of the pump, driver, baseplate and auxiliaries.
- Provide a flat, substantial concrete foundation in order to prevent strain and distortion when you tighten the foundation bolts.

Mounting methods

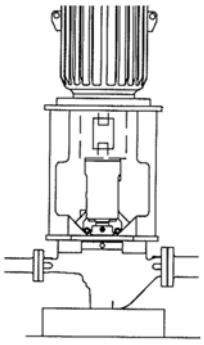
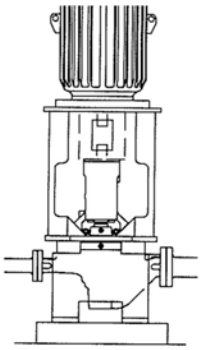


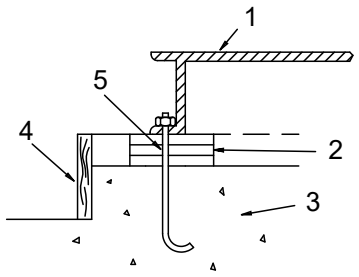
Figure 13: Recommended mounting

Figure 14: Recommended mounting with optional casing supports



NOTICE:
Do not bolt down to foundation.

J-type bolts



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

Figure 15: J-type bolts

4.2 Baseplate-mounting procedures

4.2.1 Prepare the baseplate for mounting

This procedure assumes you have a basic knowledge of baseplate and foundation design and installation methods. Follow industry-standard procedures, such as API RP 686/ PIP REIE 686, or this procedure before you grout the baseplate.

1. Make sure that all baseplate surfaces that will contact grout are free from contamination such as rust, oil, and grime.
2. Thoroughly clean all baseplate surfaces that will come in contact with grout.
   Make sure to use a cleaner that will not leave residue.

NOTICE:

You may need to sandblast the surfaces of a baseplate that come in contact with grout, and then coat those surfaces with a primer that is grout-compatible. Make sure to remove all equipment before sandblasting.

NOTICE:

Remove all dirt from the mounting pads in order to ensure that the correct leveling is achieved. Failure to do so can result in equipment damage or decreased performance.

3. Make sure that all machined surfaces are free from burrs, rust, paint, or any other type of contamination.
   If necessary, use a honing stone to remove burrs.

4.2.2 Prepare the foundation for mounting

1. Chip the top of the foundation to a minimum of 25.0 mm | 1.0 in. in order to remove porous or low-strength concrete.

If you use a pneumatic hammer, make sure that it does not contaminate the surface with oil or other moisture.

NOTICE:

Do not chip the foundation using heavy tools such as jackhammers. This can damage the structural integrity of the foundation.

2. Remove water or debris from the foundation bolt holes or sleeves.
3. If the baseplate uses sleeve-type bolts, then fill the sleeves with a non-binding, moldable material. Seal the sleeves in order to prevent the grout from entering.
4. Coat the exposed portion of the anchor bolts with a non-bonding compound such as paste wax in order to prevent the grout from adhering to the anchor bolts.
   Do not use oils or liquid wax.
5. If recommended by the grout manufacturer, coat the foundation surface with a compatible primer.

4.2.3 Install the baseplate using jackscrews

Tools required:

- Anti-seize compound
- Jackscrews
- Bar stock
- Two machinist's levels

This procedure is applicable to the feature-fabricated steel baseplate and the advantage base baseplate.

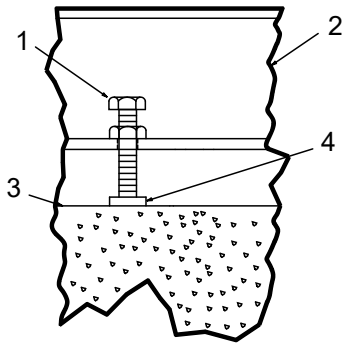
1. Apply an anti-seize compound on the jackscrews.
   The compound makes it easier to remove the screws after you grout.
2. Lower the baseplate carefully onto the foundation bolts and perform these steps:

   a) Cut the plates from the bar stock and chamfer the edges of the plates in order to reduce stress concentrations.

   b) Put the plates between the jackscrews and the foundation surface.

   c) Use the four jackscrews in the corners in order to raise the baseplate above the foundation.
   Make sure that the distance between the baseplate and the foundation surface is between 19 mm | 0.75 in. and 38 mm | 1.50 in.

   d) Make sure that the center jackscrews do not touch the foundation surface yet.



Item	Description
1.	Jackscrew
2.	Baseplate
3.	Foundation
4.	Plate

Figure 16: Jackscrews

3. Level the driver mounting pads:

NOTICE:

Remove all dirt from the mounting pads in order to ensure that the correct leveling is achieved. Failure to do so can result in equipment damage or decreased performance.

a) Put one machinist's level lengthwise on one of the two pads.

b) Put the other machinist's level across the ends of the two pads.

c) Level the pads by adjusting the four jackscrews in the corners.

Make sure that the machinist's level readings are as close to zero as possible, both lengthwise and across.

4. Turn the center jackscrews down so that they rest on their plates on the foundation surface.
5. Level the pump mounting pads:

NOTICE:

Remove all dirt from the mounting pads in order to ensure that the correct leveling is achieved. Failure to do so can result in equipment damage or decreased performance.

a) Put one machinist's level lengthwise on one of the two pads.

b) Put the other level across the center of the two pads.

c) Level the pads by adjusting the four jackscrews in the corners.

Make sure that the machinist's level readings are as close to zero as possible, both lengthwise and across.

6. Hand-tighten the nuts for the foundation bolts.
7. Check that the driver's mounting pads are level and adjust the jackscrews and the foundation bolts if necessary.

   The correct level measurement is a maximum of 0.167 mm/m | 0.002 in./ft .

   The maximum variation from one side of the baseplate to the other is 0.38 mm | 0.015 in.

4.3 Install the pump, driver, and coupling

1. Mount the driver on the motor support. Use applicable bolts and hand tighten.
2. Install the coupling.
   See the installation instructions from the coupling manufacturer.

4.4 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.

Alignment methods

Three common alignment methods are used:

- Dial indicator
- Reverse dial indicator
- Laser

Follow the instructions from the equipment manufacturer when you use the reverse dial indicator or laser methods. Detailed instructions for using the dial indicator method are contained in this chapter.

4.4.1 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 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.

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.

When	Why
After you connect the piping	This ensures that pipe strains have not altered the alignment. If changes have occurred, you must alter the piping to remove pipe strains on the pump flanges.

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.

4.4.2 Permitted indicator values for alignment checks

NOTICE:
The specified permitted reading values are valid only at operating temperature. For cold settings, other values are permitted. The correct tolerances must be used. Failure to do so can result in misalignment. Contact ITT for further information.

IMPORTANT

- For electric motors, the motor shaft initial (cold) parallel vertical alignment setting should be 0.05 to 0.10 mm | 0.002 to 0.004 in. lower than the pump shaft.
- For other drivers such as turbines and engines, follow the driver manufacturer's recommendations.
- The driver shaft initial (cold) parallel vertical alignment setting should be lower than the pump shaft. Follow the driver manufacturer's recommendations.

When dial indicators are used to check the final alignment, the pump and drive unit are correctly aligned when these conditions are true:

- The Total Indicated Reading (T.I.R.) is at 0.05 mm | 0.002 in. or less at operating temperature.
- The tolerance of the indicator is 0.0127 mm per mm | 0.0005 in. per in. of indicator separation for the reverse dial indicator or laser method when the pump and driver are at operating temperature.

4.4.3 Alignment measurement guidelines

Guideline	Explanation
Rotate the pump coupling half and the driver coupling half together so that the indicator rods have contact with the same points on the driver coupling half.	This prevents incorrect measurement.
Move or shim only the driver in order to make adjustments.	This prevents strain on the piping installations.
Make sure that the hold-down bolts for the driver are tight when you take indicator measurements.	This keeps the driver stationary since movement causes incorrect measurement.
Make sure that the hold-down bolts for the driver are loose before you make alignment corrections.	This makes it possible to move the driver when you make alignment corrections.
Check the alignment again after any mechanical adjustments.	This corrects any misalignments that an adjustment may have caused.

4.4.4 Attach the dial indicators for alignment

You must have two dial indicators in order to complete this procedure.

1. Attach two dial indicators on the pump coupling half (X):

a) Attach one indicator (P) so that the indicator rod comes into contact with the perimeter of the driver coupling half (Y).

This indicator is used to measure parallel misalignment.

b) Attach the other indicator (A) so that the indicator rod comes into contact with the inner end of the driver coupling half.

This indicator is used to measure angular misalignment.

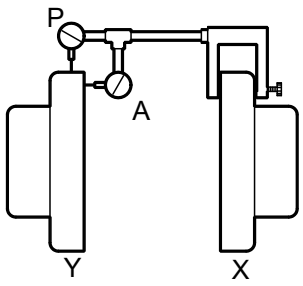


Figure 17: Dial indicator attachment

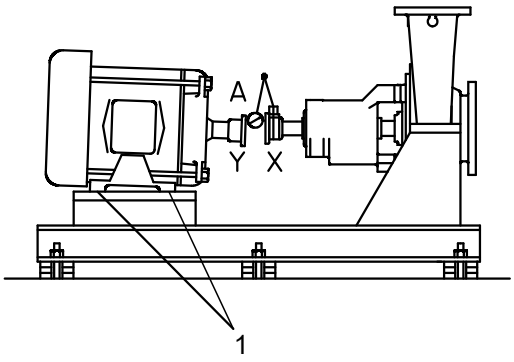
2. Rotate the pump coupling half (X) in order to check that the indicators are in contact with the driver coupling half (Y) but do not bottom out.
3. Adjust the indicators if necessary.

4.4.5 Pump-to-driver alignment instructions

4.4.5.1 Perform angular alignment for a vertical correction

1. Set the angular alignment indicator to zero at the top-center position (12 o’clock) of the driver coupling half (Y).
2. Rotate the indicator to the bottom-center position (6 o’clock).
3. Record the indicator reading.

When the reading value is...	Then...
Negative	The coupling halves are farther apart at the bottom than at the top. Perform one of these steps: • Add shims in order to raise the feet of the driver at the shaft end. • Remove shims in order to lower the feet of the driver at the other end.
Positive	The coupling halves are closer at the bottom than at the top. Perform one of these steps: • Remove shims in order to lower the feet of the driver at the shaft end. • Add shims in order to raise the feet of the driver at the other end.



Item	Description
1.	Shims

Figure 18: Example of incorrect vertical alignment (side view)

4.4.5.2 Perform angular alignment for a horizontal correction

1. Set the angular alignment indicator (A) to zero on left side of the driver coupling half (Y), 90° from the top-center position (9 o'clock).
2. Rotate the indicator through the top-center position to the right side, 180° from the start position (3 o'clock).
3. Record the indicator reading.

When the reading value is...	Then...
Negative	The coupling halves are farther apart on the right side than the left. Perform one of these steps: • Slide the shaft end of the driver to the left. • Slide the opposite end to the right.
Positive	The coupling halves are closer together on the right side than the left. Perform one of these steps: • Slide the shaft end of the driver to the right. • Slide the opposite end to the left.

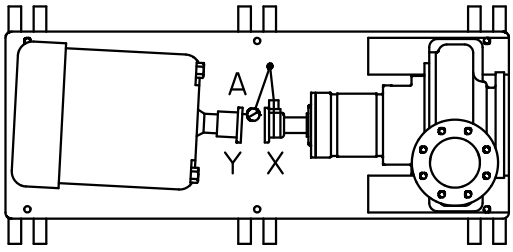


Figure 19: Example of incorrect horizontal alignment (top view)

4. Repeat the previous steps until the permitted reading value is achieved.

   Maximum permitted value for angular alignment:

4.4.5.3 Perform parallel alignment for a vertical correction

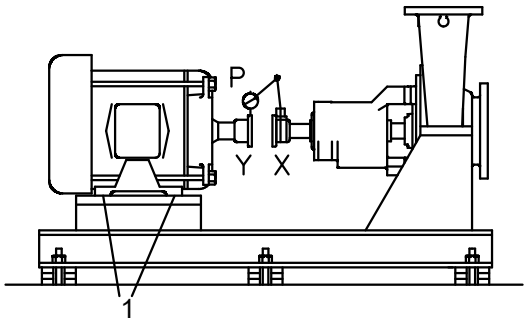
Refer to the alignment table in "Permitted indicator values for alignment checks" (see Table of Contents for location of table) for the proper cold alignment value based on the motor temperature rise and the pump operating temperature.

Before you start this procedure, make sure that the dial indicators are correctly set up.

A unit is in parallel alignment when the parallel indicator (P) does not vary by more than 0.05 mm | 0.002 in. as measured at four points 90° apart at the operating temperature.

1. Set the parallel alignment indicator (P) to zero at the top-center position (12 o'clock) of the driver coupling half (Y).
2. Rotate the indicator to the bottom-center position (6 o'clock).
3. Record the indicator reading.

When the reading value is...	Then...
Negative	The pump coupling half (X) is lower than the driver coupling half (Y). Remove shims of a thickness equal to half of the indicator reading value under each driver foot.
Positive	The pump coupling half (X) is higher than the driver coupling half (Y). Add shims of a thickness equal to half of the indicator reading value to each driver foot.



Item	Description
1.	Shims

Figure 20: Example of incorrect vertical alignment (side view)

4. Repeat the previous steps until the permitted reading value is achieved.

NOTICE:

The specified permitted reading values are valid only at operating temperature. For cold settings, other values are permitted. The correct tolerances must be used. Failure to do so can result in misalignment. Contact ITT for further information.

4.4.5.4 Perform parallel alignment for a horizontal correction

Refer to the alignment table in "Permitted indicator values for alignment checks" (see Table of Contents for location of table) for the proper cold alignment value based on the motor temperature rise and the pump operating temperature.

A unit is in parallel alignment when the parallel indicator (P) does not vary by more than 0.05 mm | 0.002 in. as measured at four points 90° apart at the operating temperature.

1. Set the parallel alignment indicator (P) to zero on the left side of the driver coupling half (Y), 90° from the top-center position (9 o'clock).
2. Rotate the indicator through the top-center position to the right side, 180° from the start position (3 o'clock).
3. Record the indicator reading.

When the reading value is...	Then...
Negative	The driver coupling half (Y) is to the left of the pump coupling half (X).
Positive	The driver coupling half (Y) is to the right of the pump coupling half (X).

4. Slide the driver carefully in the appropriate direction.

NOTICE:

Make sure to slide the driver evenly. Failure to do so can negatively affect horizontal angular correction.

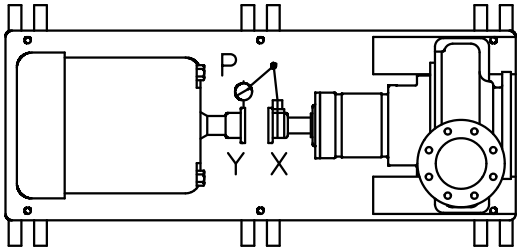


Figure 21: Example of incorrect horizontal alignment (top view)

5. Repeat the previous steps until the permitted reading value is achieved.

4.4.5.5 Perform complete alignment for a vertical correction

A unit is in complete alignment when both the angular indicator (A) and the parallel indicator (P) do not vary by more than 0.05 mm | 0.002 in. as measured at four points 90° apart.

1. Set the angular and parallel dial indicators to zero at the top-center position (12 o'clock) of the driver coupling half (Y).
2. Rotate the indicators to the bottom-center position (6 o'clock).
3. Record the indicator readings.
4. Make corrections according to the separate instructions for angular and parallel alignment until you obtain the permitted reading values.

4.4.5.6 Perform complete alignment for a horizontal correction

A unit is in complete alignment when both the angular indicator (A) and the parallel indicator (P) do not vary by more than 0.05 mm | 0.002 in. as measured at four points 90° apart.

1. Set the angular and parallel dial indicators to zero at the left side of the driver coupling half (Y), 90° from the top-center position (9 o'clock).
2. Rotate the indicators through the top-center position to the right side, 180° from the start position (3 o'clock).
3. Record the indicator readings.
4. Make corrections according to the separate instructions for angular and parallel alignment until you obtain the permitted reading values.

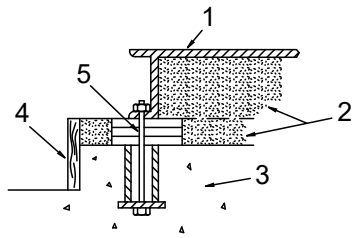
4.5 Grout the baseplate

Required equipment:

- Cleaners: Do not use an oil-based cleaner because the grout will not bond to it. See the instructions provided by the grout manufacturer.
- Grout: Non-shrink grout is recommended.

NOTICE:
It is assumed that the installer who grouts the baseplate has knowledge of acceptable methods. More detailed procedures are described in various publications, including API Standard 610, latest edition, Appendix L; API RP 686, Chapter 5; and other industry standards.

1. Clean all the areas of the baseplate that will come into contact with the grout.
2. Build a dam around the foundation.
3. Thoroughly wet the foundation that will come into contact with the grout.
4. Pour grout through the grout hole into the baseplate up to the level of the dam.
   When you pour the grout, remove air bubbles from it by using one of these methods:
   - Puddle with a vibrator.
   - Pump the grout into place.
5. Allow the grout to set.
6. Fill the remainder of the baseplate with grout, and allow the grout to set for at least 48 hours.



Item	Description
1.	Baseplate
2.	Grout
3.	Foundation
4.	Dam
5.	Bolt

Figure 22: Fill remainder of baseplate with grout

7. Remove the leveling jackscrews after the grout hardens in order to remove any stress points.
8. Tighten the foundation bolts.

4.6 Piping checklists

4.6.1 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.

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: Hydraulic Institute, 9 Sylvan Way, Parsippany, NJ 07054 and in API RP 686, and must be reviewed prior to pump installation.

Alignment criteria for pump flanges

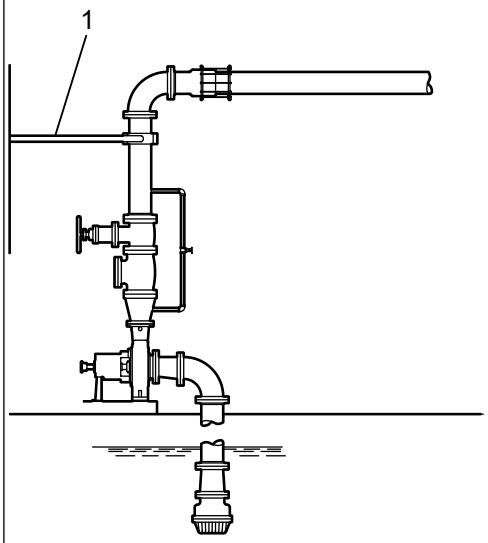
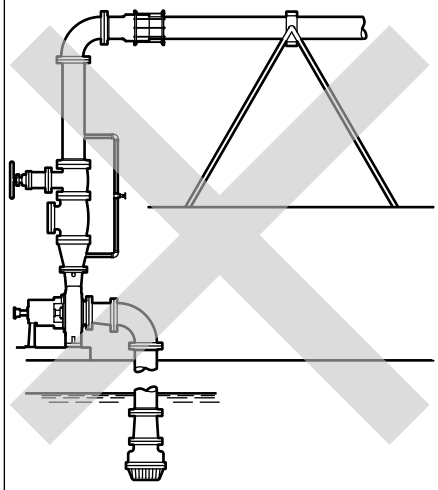
Type	Criteria
Axial	The flange gasket thickness ±0.8 mm | 0.03 in.
Parallel	Align the flange to be within 0.001 mm per mm | in. per in. of the flange diameter to 0.8mm | 0.03 in. max.
Concentric	You can easily install the flange bolts by hand.

The above criteria are based on the following references from API RP 686, 2nd Edition:

4.6.3 The machine and piping flange faces shall be parallel to less than 10 micrometers per centimeter | 0.001 in. per in. of pipe flange outer diameter up to a maximum of 750 micrometers | 0.030 in. For piping flange outer diameters smaller than 25 cm | 10 in., the flanges shall be parallel to 250 micrometers | 0.010 in. or less. For special- purpose machinery, pipe to machinery flange spacing measurements shall be recorded on the Piping alignment datasheet shown in Figure B.4. For raised face flanges, feeler gauge readings shall be taken at the raised face. For flat faced flanges, feeler gauge readings shall be taken at the flange outside diameter.

4.6.4 Flange face separation shall be within the gasket spacing ±1.5 mm | 1/16 in. Only one gasket per flanged connection shall be used.

Example: Installation for expansion

Correct	Incorrect
This illustration shows a correct installation for expansion:  1. Expansion loop/joint	This illustration shows an incorrect installation for expansion: 

4.6.2 Suction-piping checklist

Performance curve reference

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

Suction-piping checks

Check	Explanation/comment	Checked
Check that the distance between the inlet flange of the pump and the closest elbow is at least five pipe diameters.	This minimizes the risk of cavitation in the suction inlet of the pump due to turbulence. See the Example sections for illustrations.	
Check that elbows in general do not have sharp bends.	See the Example sections for illustrations. —	
Check that the suction piping is one or two sizes larger than the suction inlet of the pump. Install an eccentric reducer between the pump inlet and the suction piping.	The suction piping must never have a smaller diameter than the suction inlet of the pump. See the Example sections for illustrations.	
Check that the eccentric reducer at the suction flange of the pump has the following properties: • Sloping side down • Horizontal side at the top	See the example illustrations.	

Check	Explanation/comment	Checked
If more than one pump operates from the same liquid source, check that separate suction-piping lines are used for each pump.	This recommendation helps you to achieve a higher pump performance and prevent vapor locking especially with specific gravity of liquid less than 0.60.	
If necessary, make sure that the suction piping includes a drain valve and that it is correctly installed.	—	
Assure adequate insulation is applied for liquids with specific gravity less than 0.60.	To assure sufficient NPSHa.	

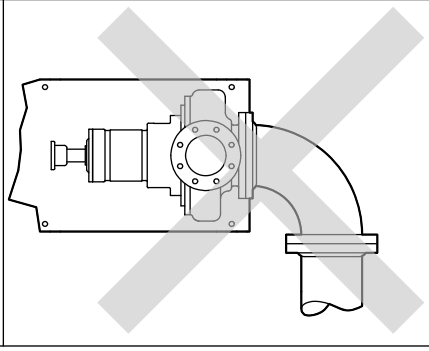
Liquid source below the pump

Check	Explanation/comment	Checked
Make sure that the suction piping is free from air pockets.	This helps to prevent the occurrence of air and cavitation in the pump inlet.	
Check that the suction piping slopes upwards from the liquid source to the pump inlet.	—	
If the pump is not self-priming, check that a device for priming the pump is installed.	Use a foot valve with a diameter that is at least equivalent to the diameter of the suction piping.	

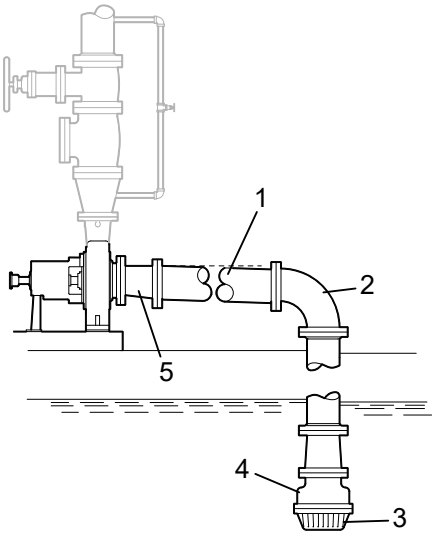
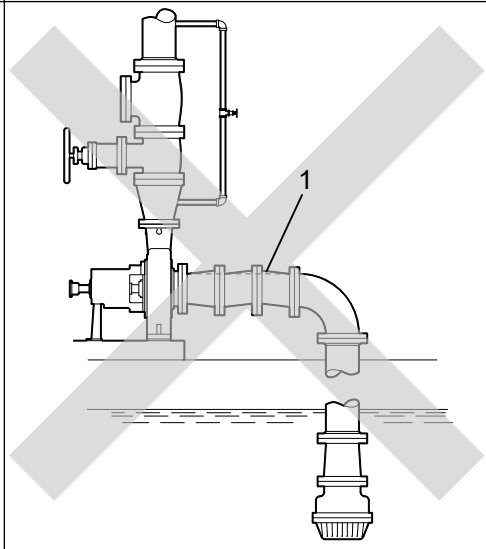
Liquid source above the pump

Check	Explanation/comment	Checked
Check that an isolation valve is installed in the suction piping at a distance of at least two times the pipe diameter from the suction inlet.	This permits you to close the line during pump inspection and maintenance. Do not use the isolation valve to throttle the pump. Throttling can cause these problems: • Loss of priming • Excessive temperatures • Damage to the pump • Voiding the warranty	
Make sure that the suction piping is free from air pockets.	This helps to prevent the occurrence of air and cavitation in the pump inlet.	
Check that the piping is level or slopes downward from the liquid source.	—	
Make sure that no part of the suction piping extends below the suction flange of the pump.	—	
Make sure that the suction piping is adequately submerged below the surface of the liquid source.	This prevents air from entering the pump through a suction vortex.	

Example: Elbow close to the pump suction inlet

Correct	Incorrect
The correct distance between the inlet flange of the pump and the closest elbow must be at least five pipe diameters. Where used, elbows should be long radius.	

Example: Suction piping equipment

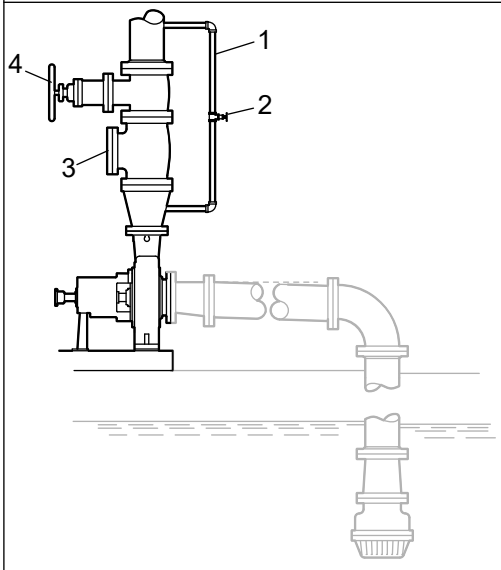
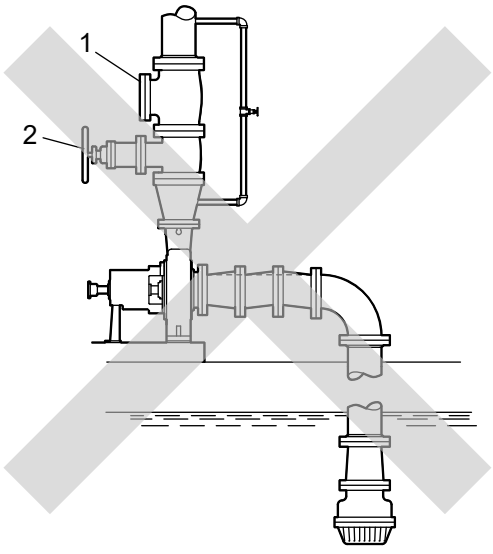
Correct	Incorrect
	
1. Suction pipe sloping upwards from liquid source 2. Long-radius elbow 3. Strainer 4. Foot valve 5. Eccentric reducer with a level top	1. Air pocket, because the eccentric reducer is not used and because the suction piping does not slope gradually upward from the liquid source

4.6.3 Discharge piping checklist

Checklist

Check	Explanation/comment	Checked
Check that an isolation valve is installed in the discharge line. For specific gravity less than 0.60, minimize distance from pump discharge.	The isolation valve is required for: • Priming • Regulation of flow • Inspection and maintenance of the pump • Reduce risk of pumpage vaporization and vapor locking at low flow rates for low specific gravity liquids. See Example: Discharge piping equipment for illustrations.	
Check that a check valve is installed in the discharge line, between the isolation valve and the pump discharge outlet.	The location between the isolation valve and the pump allows inspection of the check valve. The check valve prevents damage to the pump and seal due to the back flow through the pump, when the drive unit is shut off. It is also used to restrain the liquid flow. See Example: Discharge piping equipment for illustrations.	
If increasers are used, check that they are installed between the pump and the check valve.	See Example: Discharge piping equipment for illustrations.	
If quick-closing valves are installed in the system, check that cushioning devices are used.	This protects the pump from surges and water hammer.	

Example: Discharge piping equipment

Correct	Incorrect
 1. Bypass line 2. Shut-off valve 3. Check valve 4. Discharge isolation valve	 1. Check valve (incorrect position) 2. The isolation valve should not be positioned between the check valve and the pump.

4.6.4 Bypass-piping considerations

When to use a bypass line

Provide a bypass line for systems that require operation at reduced flows for prolonged periods. Connect a bypass line from the discharge side (before any valves) to the source of suction.

When to install a minimum-flow orifice

You can size and install a minimum-flow orifice in a bypass line in order to prevent bypassing excessive flows. Consult your ITT representative for assistance in sizing a minimum-flow orifice.

When a minimum-flow orifice is unavailable

Consider an automatic recirculation control valve or solenoid-operated valve if a constant bypass (minimum-flow orifice) is not possible.

4.6.5 Auxiliary-piping checklist

Precautions

NOTICE:

- Auxiliary cooling and flush systems must be operating properly to prevent excess heat generation, sparks, and/or premature failure. Ensure auxiliary piping is installed as specified on the pump data sheet prior to startup.

When to install

You may need to install auxiliary piping for bearing cooling, seal-chamber cover cooling, mechanical seal flush, or other special features supplied with the pump. Consult the pump data sheet for specific auxiliary piping recommendations.

Checklist

Check	Explanation/comment	Checked
Check that the minimum flow for each component is 4 lpm | 1 gpm. If the bearing and seal chamber cover cooling are provided, then the auxiliary piping must flow at 8 lpm | 2 gpm.	Make sure that these guidelines are followed.	
Check that the cooling water pressure does not exceed 7.0 kg/cm^2 | 100 psig .	Make sure that these guidelines are followed.	

4.6.6 Final piping checklist

Check	Explanation/comment	Checked
Check that the shaft rotates smoothly.	Rotate the shaft by hand. Make sure there is no rubbing that can lead to excess heat generation or sparks.	
Re-check the alignment to make sure that pipe strain has not caused any misalignment.	If pipe strain exists, then correct the piping.	

5 Commissioning, Startup, Operation, and Shutdown

5.1 Preparation for startup

WARNING:

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

WARNING:

- 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.
- Risk of death, serious personal injury, and property damage. Heat and pressure buildup can cause explosion, rupture, and discharge of pumpage. Never operate the pump with suction and/or discharge valves closed.
- Running a pump without safety devices exposes operators to risk of serious personal injury or death. Never operate a unit unless appropriate safety devices (guards, etc.) are properly installed.
- 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 seizure, breach of containment, or explosion. Ensure balance line is installed and piped back to either the pump suction or suction vessel. This prevents rapid vaporization of the pumped fluid.

Precautions

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

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

NOTICE:

- Verify the driver settings before you start any pump. Refer to the applicable drive equipment IOMs and operating procedures.
- Make sure that the temperature change does not exceed 19°C | 35°F per minute.

NOTICE:
You must follow these precautions before you start the pump:

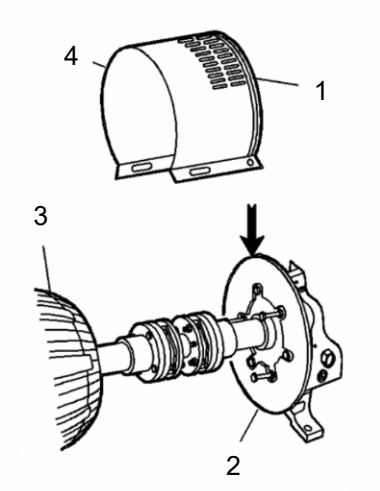
- Flush and clean the system thoroughly to remove dirt or debris in the pipe system in order to prevent premature failure at initial startup.
- Bring variable-speed drivers to the rated speed as quickly as possible.
- Run a new or rebuilt pump at a speed that provides enough flow to flush and cool the close-running surfaces of the stuffing-box bushing.
- If temperatures of the pumped fluid will exceed 93°C | 200°F, then warm up the pump prior to operation. Circulate a small amount of fluid through the pump until the casing temperature is within 38°C | 100°F of the fluid temperature. Accomplish this by flowing fluid from pump inlet to discharge drain (optionally, the casing vent can be included in warm-up circuit but not required). Soak for (2) hours at process fluid temperature.

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

5.2 Remove the coupling guard

1. Remove the nut, bolt, and washers from the slotted hole in the center of the coupling guard.
2. Slide the driver half of the coupling guard toward the pump.
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.
5. Remove the remaining nut, bolt, washer and retainer 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.	Annular groove
2.	Pump-side end plate
3.	Driver
4.	Pump half of the coupling guard

5.3 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 bearing housing or close-coupled frame.
6. Lock out power to the driver.

5.4 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.

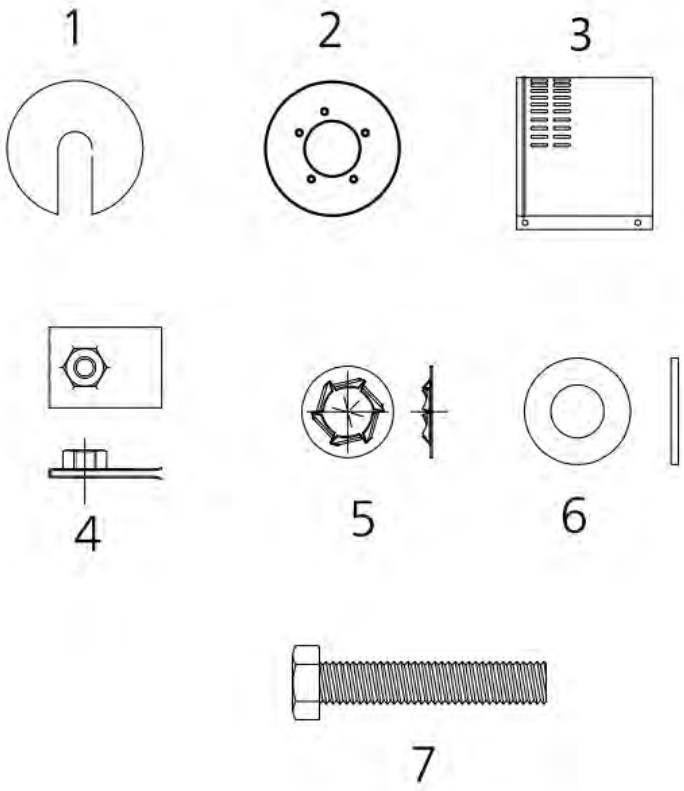
5.4.1 Coupling guard assembly

Precautions

WARNING:

- 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.
- 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.
- Avoid death or serious injury. Assure mechanical seal guard is properly installed using supplied fastening hardware.
- 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.

Required parts



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

Figure 23: Required parts

5.4.1.1 Install the coupling guard

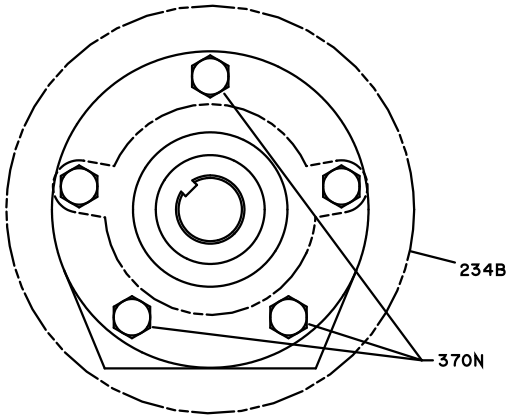
1. Is the end plate (pump end) already installed?
   - If yes: Make any necessary coupling adjustments and then proceed to Step 2.
   - If no: Complete these steps:

   a) Remove the spacer portion of the coupling.
   Refer to the instructions from the coupling manufacturer for assistance.

   b) If the coupling hub diameter is larger than the diameter of the opening in the end plate, then remove the coupling hub.

   c) Replace the four outboard end cover bolts (371D) and torque to the value shown in the 6.6.11 Assembly references on page 105.

   d) Remove the three thrust bearing end cover and bearing frame screws.



234B	End plate
370N	Bearing frame bolts

Figure 24: Thrust bearing end cover removal

e) Align the end plate to the thrust bearing end cover so that the two slots in the end plate align with the bolts remaining in the end cover, and the three holes in the end plate align with the holes in the end cover.

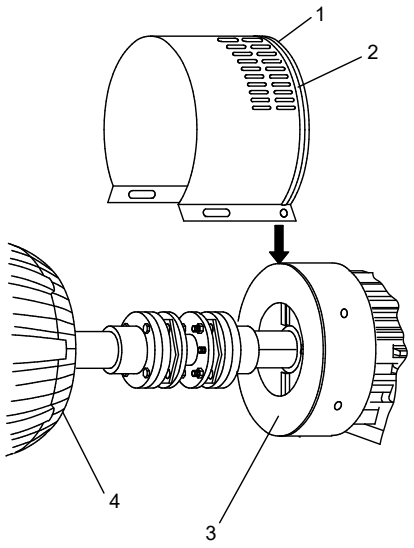
f) Replace the three thrust bearing end cover and bearing frame bolts and torque to the values shown in the Maximum torque values for 3910 fasteners table.

g) Replace the coupling hub (if removed) and the spacer portion of the coupling.

Refer to the instructions from the coupling manufacturer for assistance.

Complete any coupling adjustments before you proceed with the coupling guard assembly.

2. Slightly spread the opening of the coupling guard half and place it over the pump end plate.

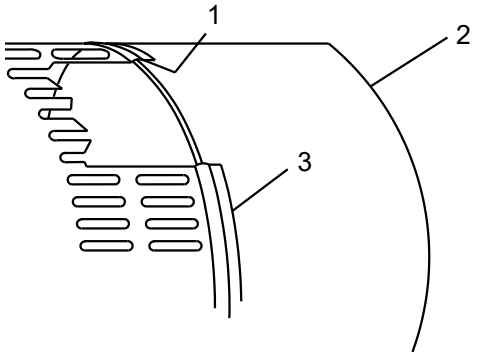


Item	Description
1.	Pump half of the coupling guard
2.	Annular groove
3.	Deflector fan guard
4.	Driver

Figure 25: Coupling guard

The annular groove in the guard is located around the end plate.

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.	Deflector fan guard
3.	Coupling guard half

Figure 26: Coupling guard

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

4. 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.

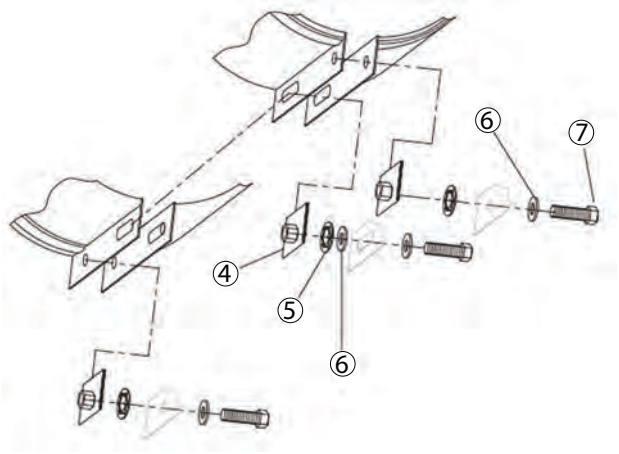
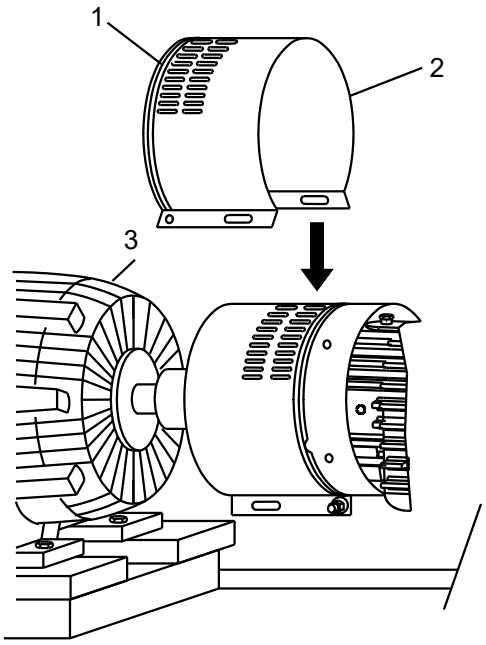


Figure 27: Captured hardware component assembly

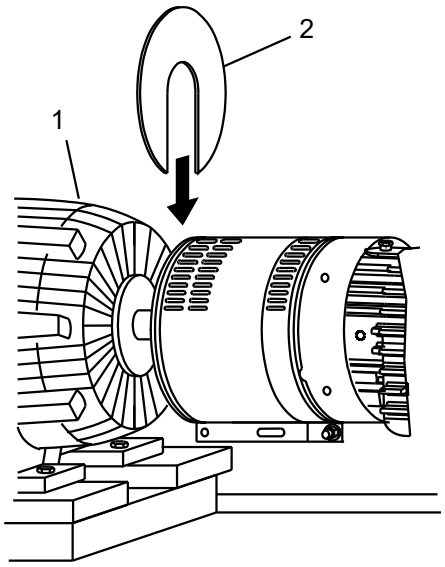
5. Thread bolt into the U-Nut and tighten firmly.
6. Slightly spread the opening of the remaining coupling guard half and place it over the installed coupling guard half so that the annular groove in the remaining coupling guard half faces the driver.



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

Figure 28: Coupling guard

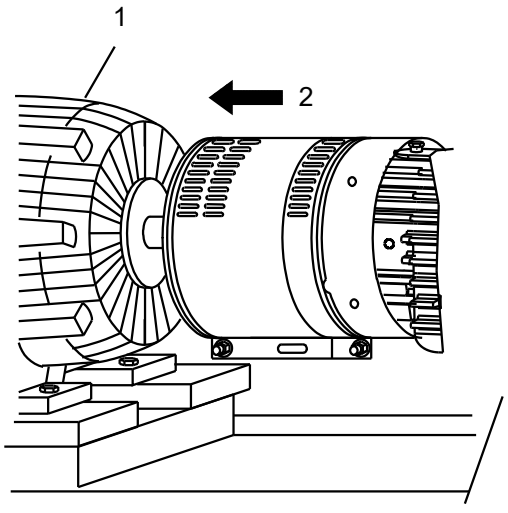
7. Place the end plate over the driver shaft and locate the end plate in the annular groove at the rear of the coupling guard half.



Item	Description
1.	Annular groove
2.	End plate

Figure 29: End plate and annular groove

8. Repeat Steps 3 through 5 for the rear end of the coupling guard half, except that you hand tighten the nut.
9. Slide the rear coupling guard half towards the motor so that it completely covers the shafts and coupling.



Item	Description
1.	Driver
2.	Slide to fit

Figure 30: Slide to fit

10. Repeat Steps 3 through 5 for the center slots in the coupling guard.
11. Firmly tighten all nuts on the guard assembly.

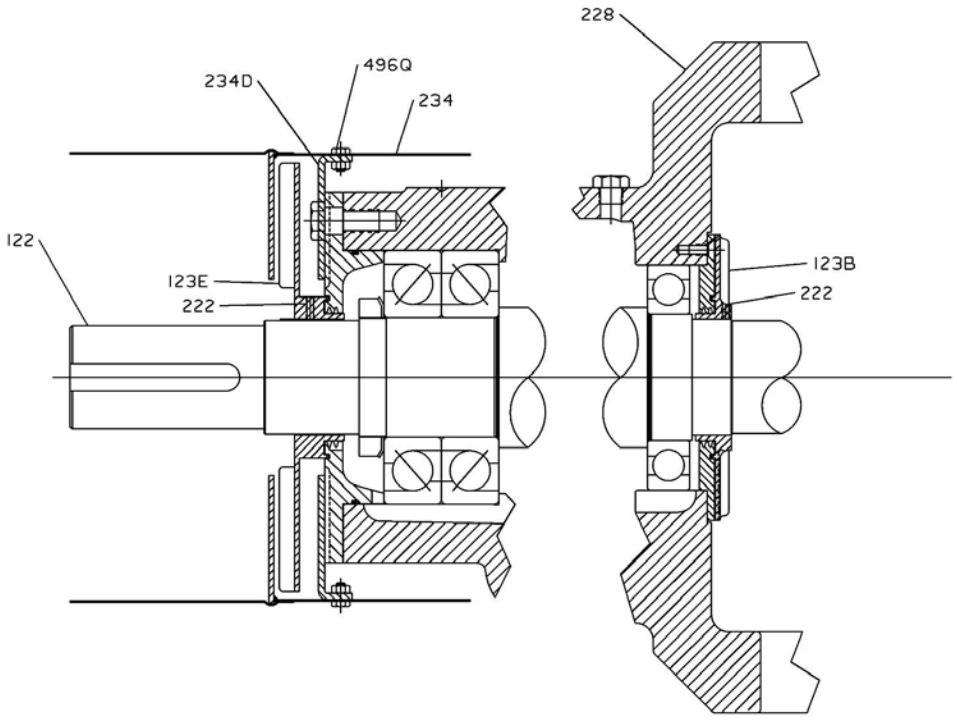
5.4.1.2 Install the coupling guard with the optional air cooling package

1. Is the deflector-fan guard support installed?
   - If yes: Make any necessary coupling adjustments and then proceed to step 2.
   - If no: Complete the following steps:

   a) Remove the spacer portion of the coupling.
   Refer to the coupling manufacturer's instructions.

   b) If the coupling hub diameter is larger than the diameter of the opening in the deflector-fan guard support, then remove the coupling hub.

   c) Loosen the thrust deflector-fan set screw.



122	Shaft
123B	Radial deflector fan
123E	Thrust deflector fan
222	Deflector set screw
228	Bearing frame
234	Thrust deflector-fan guard
234D	Thrust deflector-fan guard support
496Q	Support screws

Figure 31: Coupling guard with optional air cooling package

   d) Slide the thrust deflector fan off of the shaft.

   e) Remove the thrust bearing end cover and the bearing frame screws.

f) Align the thrust deflector-fan guard support with the thrust bearing end cover so that the support slots align with the holes in the end cover.

g) Replace the thrust bearing end cover and bearing frame screws and torque to values shown in the Maximum torque values for fasteners table.

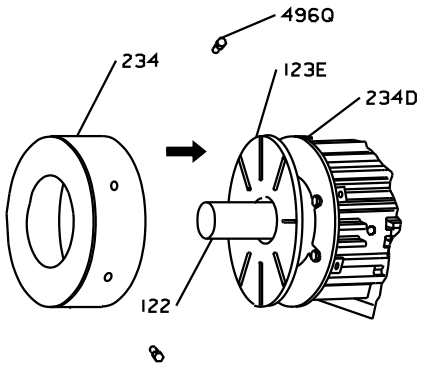
CAUTION:

Do not over-tighten the thrust bearing end cover and bearing frame screws.

h) Install the thrust deflector fan over the shaft.

i) Position the thrust deflector fan approximately 0.8 mm | 0.03 in. from the thrust bearing end cover and firmly tighten the deflector set screw.

j) Slide the thrust deflector-fan guard over the guard support and align the holes in the guard with the tapped holes in the guard support.

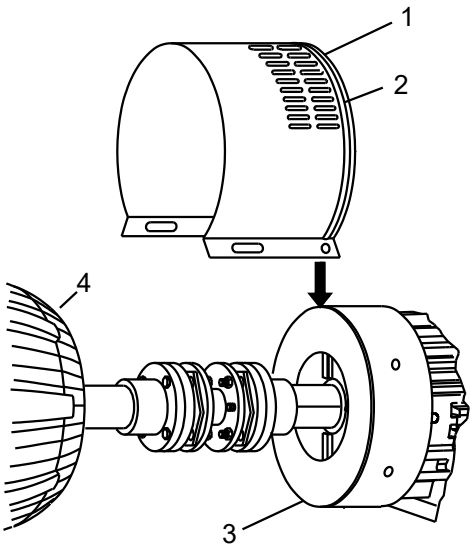


122	Shaft
123E	Thrust deflector fan
234	Thrust deflector-fan guard
234D	Thrust deflector-fan guard
496Q	Support screws

Figure 32: Thrust deflector-fan guard installation

2. Install the thrust deflector-fan guard and support screws and tighten to the torque values shown in the Maximum torque values for fasteners table.
3. Replace the coupling hub (if removed) and spacer portion of the coupling.
   Refer to the coupling manufacturer's instructions for assistance.

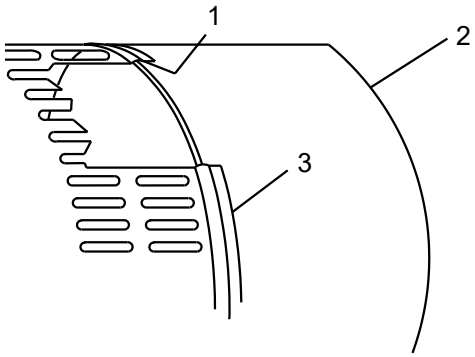
   Complete any coupling adjustments before you proceed with the coupling guard assembly.
4. Slightly spread the opening of the coupling-guard half and place it over the thrust deflector-fan guard so that the annular groove in the guard half is located around the guard support extension.



1. Rear coupling guard half
2. Annular groove
3. Deflector fan guard
4. Driver

Figure 33: Rear coupling-guard half installation

Locate the opening (flange) so that it does not interfere with the piping but does allow access for installing the bolts.



1. Annular groove
2. Deflector fan guard
3. Coupling guard half

Figure 34: Opening (flange) location

5. Place one washer over the bolt and insert the bolt through the round hole at the front end of the guard half.
6. Place a second washer 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.
7. Thread bolt into the U-Nut and tighten firmly.

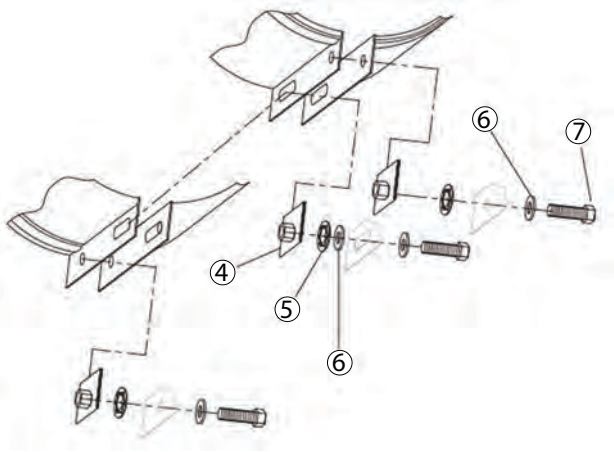
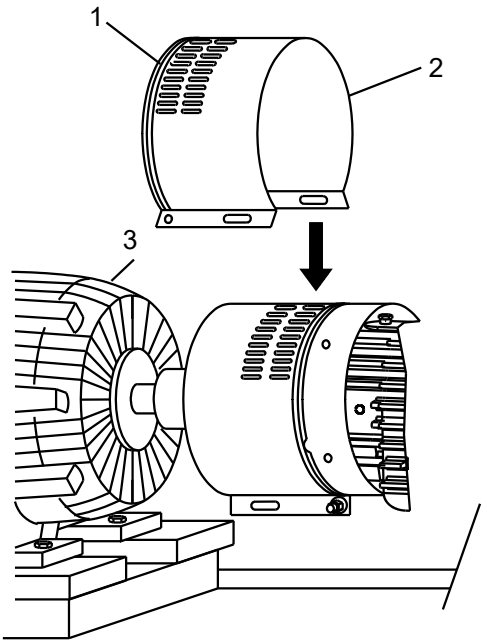


Figure 35: Captive hardware and component assembly

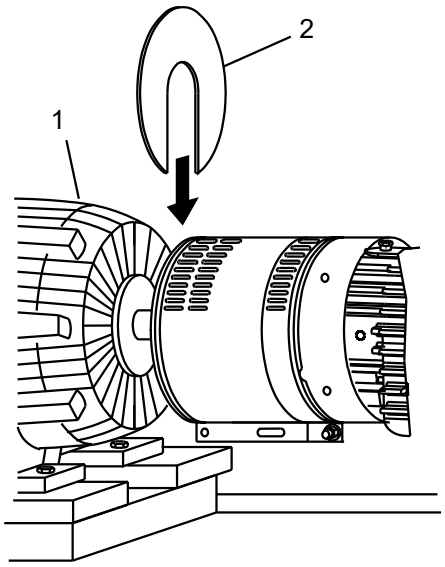
8. Slightly spread the opening of the remaining coupling guard half and place it over the installed coupling guard half so that the annular groove in the remaining coupling guard half faces the driver.



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

Figure 36: Remaining coupling guard half installation

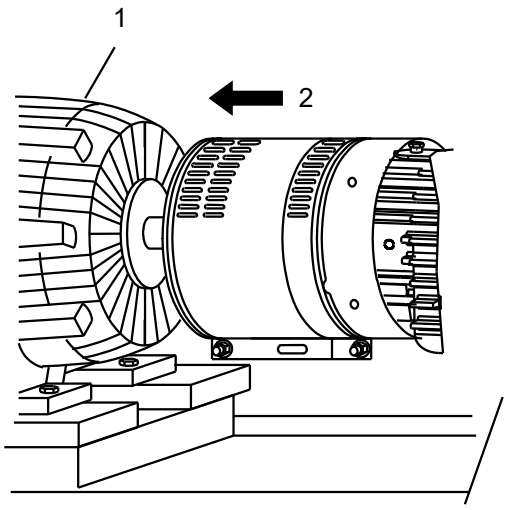
9. Place the end plate over the driver shaft and locate the end plate in the annular groove at the rear of the coupling guard half.



1. Annular groove
2. End plate

Figure 37: End plate installation

10. Repeat steps 5 through 7 for the rear end of the coupling guard half, except that you hand tighten the nut.
11. Slide the rear coupling guard half towards the motor so that it completely covers the shaft and coupling.



1. Driver
2. Slide to fit

Figure 38: Slide to fit

12. Repeat steps 5 through 7 for the center slots in the coupling guards.
13. Firmly tighten all of the nuts on the guard assembly.

5.4.2 Bearing lubrication

Precautions

WARNING:

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

5.4.2.1 Acceptable oil for lubricating bearings

Acceptable lubricants

Table 7: Acceptable lubricants

Brand	Lubricant type
Exxon	Teresstic EP 68
Mobil	DTE Heavy Medium
Sunoco	Sunvis 968
Royal Purple	SYNFILM ISO VG 68 Synthetic Oil

5.4.2.2 Lubricate the bearings with oil

WARNING:

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

1. Fill the oil reservoir in the bearing frame:
   a) Fill the bearing chamber through the main body of the Watchdog until it reaches the optimum fluid level visible in the bullseye sight.
   b) Fill the watchdog reservoir using a funnel.
   c) Verify o-ring is on the Watchdog oiler spout.
   d) Place your thumb over the reservoir spout. Invert and insert the spout into the internal threaded boss on the main body.
   e) Tighten reservoir. Do not over-tighten.
   f) Verify that proper oil level is maintained per the following diagram.

   NOTICE:

   Do not fill the oil reservoir of the bearing frame through the plug at the top.
2. Check that the oil level is correct. The correct oil level is centered in the bulls-eye sight glass, when the pump is not in operation. During operation, bulls-eye sight gives a false oil level reading. Shown is general schematic.

5.4.2.3 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.

1. Wipe dirt from the grease fittings.
2. Remove the two grease-relief plugs on the bearing housings.
3. Fill both of the grease cavities through the fittings with a recommended grease until the fresh grease comes out of the relief holes.
4. Reinstall the grease-relief plugs.
5. Wipe off any excess grease.
6. 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.

For most operating conditions a lithium complex soap based grease of NLGI consistency No. 2 is recommended. This grease is acceptable for bearing temperatures of -15°C to 110°C | 5°F to 230°F. Bearing temperatures are generally about 20°F | 11°C higher than bearing housing outer surface temperature.

The original grease from the factory is a lithium based NLGI. See Lubricating Grease Requirements Table.

5.4.2.4 Lubricating-grease requirements

Precautions

NOTICE:

- Avoid equipment damage or decreased performance. Never mix greases of different consistencies (NLGI 1 or 3 with NLGI 2) or with different thickeners. For example, never mix a lithium-based grease with a polyurea based grease. If it is necessary to change the grease type or consistency, remove the rotor and old grease from the housing before regreasing.

5.4.2.5 Lubricate the bearings after a shutdown period

1. Flush out the bearings and bearing frame with a light oil to remove contaminants.
   During flushing, make sure to rotate the shaft slowly by hand.
2. Flush the bearing housing with the proper lubricating oil to ensure oil quality after cleaning.

5.5 Shaft sealing with a mechanical seal

Precautions

NOTICE:

- Follow seal manufacturer's guidelines for proper seal installation procedures.

Shipping

Pumps may be shipped with or without a mechanical seal installed.

Cartridge-type mechanical seals

Cartridge-type mechanical seals are commonly used. Cartridge seals are preset by the seal manufacturer and require no field settings. Cartridge seals installed by the user require disengagement of the holding clips prior to operation, allowing the seal to slide into place.

If the seal has been installed in the pump by ITT, these clips have already been disengaged, however this should be verified by the customer prior to start-up.

Customers should always check to make sure the clips have been disengaged prior to starting the pump.

Other mechanical seal types

For other types of mechanical seals, refer to the instructions provided by the seal manufacturer for installation and setting.

5.6 Connection of sealing liquid for mechanical seals

Seal lubrication is required

Seal faces must have liquid film between them for proper lubrication. Locate the taps using the illustrations shipped with the seal.

Seal flushing methods

Table 8: You can use these methods in order to flush or cool the seal:

Method	Description
Product flush	Run the piping so that the pump pushes the pumped fluid from the casing and injects it into the seal gland. If necessary, an external heat exchanger cools the pumped fluid before it enters the seal gland.
External flush	Run the piping so that the pump injects a clean, cool, compatible liquid directly into the seal gland. The pressure of the flushing liquid must be 0.35 to 1.01 kg/cm^2 | 5 to 15 psi greater than the seal chamber pressure. The injection rate must be 2 to 8 lpm | 0.5 to 2 gpm.
Other	You can use other methods that employ multiple gland or seal chamber connections. Refer to the mechanical seal reference drawing and piping diagrams.

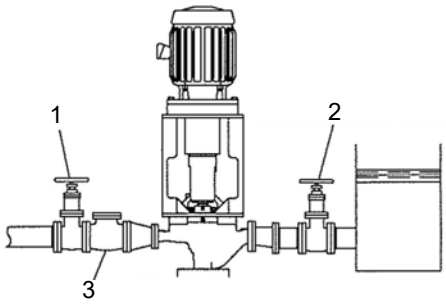
5.7 Pump priming

5.7.1 Prime the pump with the suction supply above the pump

1. Slowly open the suction isolation valve.
2. Open the air vents on the suction and discharge piping until the pumped fluid flows out.
3. Close the air vents.

Item	Description
1.	Discharge isolation valve
2.	Check valve
3.	Suction isolation valve

Figure 39: Suction supply above pump



Item	Description
1.	Discharge isolation valve
2.	Suction isolation valve
3.	Check valve

Figure 40: Pump priming with suction supply above pump

5.7.2 Prime the pump with the suction supply below the pump

Use a foot valve and an outside source of liquid in order to prime the pump. The liquid can come from one of these sources:

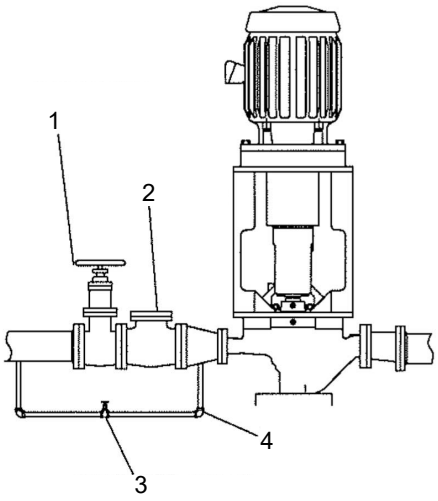
- A priming pump
- A pressurized discharge line
- Another outside supply

1. Close the discharge isolation valve.
2. Open the air vent in the casing.

WARNING:

When handling hazardous and / or toxic fluids, proper personal protective equipment should be worn. If pump is being drained, precautions must be taken to prevent physical injury. Pumpage must be handled and disposed of in conformance with applicable environment regulations.

3. Open the valve in the outside supply line until only liquid escapes from the vent valves.
4. Close the vent.
5. Close the outside supply line.



Item	Description
1.	Discharge isolation valve
2.	Check valve
3.	Shutoff valve
4.	Bypass line

Figure 41: Pump priming with suction supply below pump using bypass around check valve

5.7.3 Other methods of priming the pump

You can also use these methods in order to prime the pump:

- Prime by ejector
- Prime by automatic priming pump

5.8 Start the pump

WARNING:

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

NOTICE:

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

NOTICE:

Risk of equipment damage on pure or purge-oil mist-lubricated units. Remove the viewing port plugs to verify that oil mist is flowing properly. Reinstall the plugs after confirming.

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

- Open the suction valve.

- Open any recirculation or cooling lines.

1. Fully close or partially open the discharge valve, depending on system conditions.
2. Start the driver.
3. Slowly open the discharge valve until the pump reaches the desired flow.
4. Immediately check the pressure gauge to ensure that the pump quickly reaches the correct discharge pressure.
5. If the pump fails to reach the correct pressure, perform these steps:
   a) Stop the driver.
   b) Prime the pump again.
   c) Restart the driver.
6. Monitor the pump while it is operating:
   a) Check the pump for bearing temperature, excessive vibration, and noise.
   b) If the pump exceeds normal levels, then shut down the pump immediately and correct the problem.

   A pump can exceed normal levels for several reasons. See Troubleshooting for information about possible solutions to this problem.
7. Repeat steps 5 and 6 until the pump runs properly.

5.9 Pump operation precautions

General considerations

WARNING:

- Risk of serious personal injury or property damage. Dry running may cause rotating parts within the pump to seize to non-moving parts. Do not run dry.
- Risk of explosion and serious physical injury. Do not operate pump with blocked system piping or with suction or discharge valves closed. This can result in rapid heating and vaporization of pumpage.

NOTICE:

- Vary the capacity with the regulating valve in the discharge line. Never throttle the flow from the suction side. This action can result in decreased performance, unexpected heat generation, and equipment damage.
- Risk of equipment damage from unexpected heat generation. Do not overload the driver. Ensure that the pump operating conditions are suitable for the driver. The driver can overload in these circumstances:
  - The specific gravity or viscosity of the fluid is greater than expected
  - The pumped fluid exceeds the rated flow rate.
- On pure mist-lubricated units, remove the viewing port plugs to verify that oil mist is flowing properly. Replace the plugs.
- Check the bearing temperatures using a pyrometer or other temperature-measuring device. Monitor the bearing temperature frequently during initial operation in order to determine if a bearing problem exists, as well as to establish normal bearing operating temperature.
- For pumps with auxiliary piping, make sure that proper flows have been established and that the equipment is operating properly.

- Establish baseline vibration readings in order to determine normal running conditions. If the unit is running roughly, then consult the factory.
- Monitor all gauges to ensure that the pump is running at or near rating and that the suction screen (when used) is not clogged.

Operation at reduced capacity

WARNING:

- Risk of breach of containment and equipment damage. Excessive vibration levels can cause damage to bearings, stuffing box, seal chamber, and/or mechanical seal. Observe pump for vibration levels, bearing temperature, and excessive noise. If normal levels are exceeded, shut down and resolve.
- Risk of explosion and serious physical injury. Do not operate pump with blocked system piping or with suction or discharge valves closed. This can result in rapid heating and vaporization of pumpage.
- Risk of equipment damage and serious physical injury. Heat build-up can cause rotating parts to score or seize. Observe pump for excessive heat build-up. If normal levels are exceeded, shut down and resolve.
- Risk of explosion and serious physical injury. Do not operate the pump below the thermal minimum flow. This can cause excessive heat build-up and vaporization of the pumpage.

NOTICE:

- Cavitation can cause damage to the internal surfaces of the pump. Ensure net positive suction head available ($NPSH_A$) always exceeds NPSH required ($NPSH_3$) as shown on the published performance curve of the pump.
-

Operation under freezing conditions

NOTICE:

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

5.10 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.

5.11 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.
5. Reinstall the coupling guard.
6. Restart the pump and driver.

6 Maintenance

6.1 Maintenance schedule

Maintenance inspections

A maintenance schedule includes these types of inspections:

- Routine maintenance
- Routine inspections
- Three-month inspections
- Annual inspections

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

Routine maintenance

Perform these tasks whenever you perform routine maintenance:

- Lubricate the bearings.
- Inspect the seal.

Routine inspections

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

- Check for unusual noise vibration, and bearing temperatures.
- Check the pump and piping for leaks.
- Analyze the vibration.*
- Inspect the discharge pressure.
- Inspect the temperature.*
- Check the seal chamber and stuffing box for leaks.
    - Ensure that there are no leaks from the mechanical seal.
    - Adjust or replace the packing in the stuffing box if you notice excessive leaking.

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

Three-month inspections

Perform these tasks every three months:

- Check that the foundation and the hold-down bolts are tight.
- Check the mechanical seal if the pump has been left idle, and replace as required.
- Change the grease every three months (2000 operating hours) at minimum.
- Check the shaft alignment, and realign as required.

Annual inspections

Perform these inspections one time each year:

- Check the pump capacity.

- Check the pump pressure.
- Check the pump power.
- Inspect all plugs and seals in the power end.

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

1. Disassemble the pump.
2. Inspect it.
3. Replace worn parts.

6.2 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 25,000 hours of operation.

Bearing lubrication schedule

Type of bearing	First lubrication	Lubrication intervals
Oil-lubricated bearings	Add oil before you install and start the pump. Change the oil after 200 hours for new bearings.	After the first 200 hours, change the oil every 2000 operating hours or every three months.

6.3 Mechanical-seal maintenance

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.

Cartridge-type mechanical seals

Cartridge-type mechanical seals are commonly used. Cartridge seals are preset by the seal manufacturer and require no field settings. Cartridge seals installed by the user require disengagement of the holding clips prior to operation, allowing the seal to slide into place. If the seal has been installed in the pump by ITT, these clips have already been disengaged.

Other mechanical seal types

For other types of mechanical seals, refer to the instructions provided by the seal manufacturer for installation and setting.

Before you start the pump

Check the seal and all flush piping.

Mechanical seal life

The life of a mechanical seal depends on the cleanliness of the pumped fluid. Due to the diversity of operating conditions, it is not possible to give definite indications as to the life of a mechanical seal.

6.4 Disassembly

6.4.1 Disassembly precautions

WARNING:

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

CAUTION:

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

6.4.2 Tools required

In order to disassemble the pump, you need these tools:

- Allen wrenches
- Brass drift punch
- Cleaning agents and solvents
- Dial indicators
- Drill
- Feeler gauges

- Induction heater
- Lifting sling
- Micrometer
- Open end wrenches
- Press
- Soft face hammer
- Spanner wrench
- Spanning type puller
- Tap
- Lifting eyebolt (dependent on pump / motor size)

6.4.3 Drain the pump

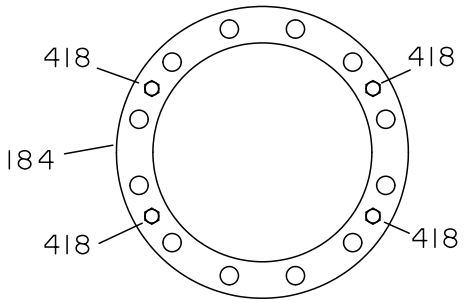
CAUTION:

- 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.

6.4.4 Remove the back pull-out assembly

WARNING:
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.

1. The back pull out assembly consists of all parts except the casing (100). The casing (100) can remain on the foundation and in the piping, if it is not the casing itself, which must be repaired. Drain the casing, by removing the casing drain plug (if equipped).
2. Tighten the jackscrews evenly, using an alternating pattern, in order to remove the back pull-out assembly.
   You can use penetrating oil if the adapter to the casing joint is corroded.



184	Seal chamber cover
418	Jackscrew

Figure 42: Jackscrew tightening

3. Remove the back pull-out assembly using a lifting sling through the bearing frame.

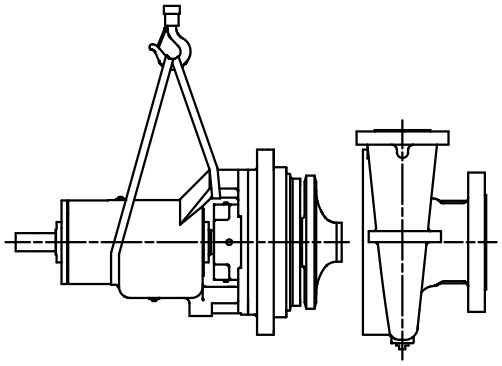


Figure 43: Lifting sling through bearing frame

4. Remove and discard the casing gasket.
   You will insert a new casing gasket during reassembly.
5. Remove the jackscrews.
6. Clean all gasket surfaces.
   Clean surfaces prevent the casing gasket from partially adhering to the casing due to binders and adhesives in the gasket material.
7. Secure the back pull-out assembly to prevent movement during transport.
8. Transport the back pull-out assembly to a clean work area for further disassembly.

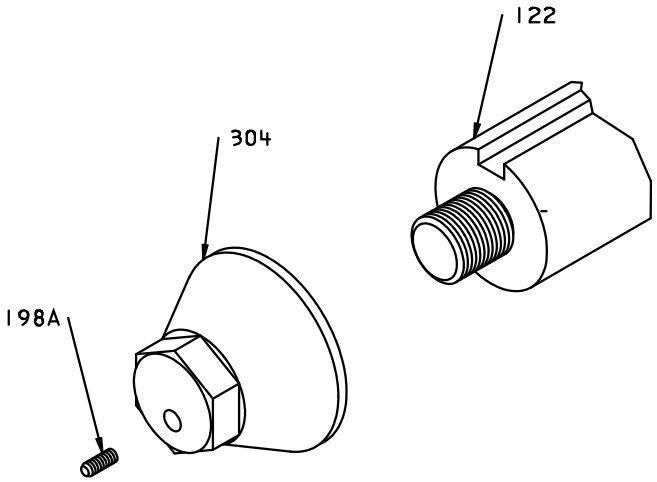
6.4.5 Remove the coupling hub

1. If the coupling hub overhangs the shaft, mark the shaft for relocating the coupling hub during reassembly.
   Coupling hubs are normally mounted flush with the end of the shaft.
2. Remove the coupling hub using a spanning-type puller or puller holes provided in the hub.
   Refer to the coupling manufacturer's instructions for assistance.

6.4.6 Remove the impeller 3910

CAUTION:
Risk of physical injury from sharp edges. Wear heavy work gloves when handling impellers.

1. Loosen the set screw at the end of the impeller nut.
2. Loosen and remove the impeller nut.
   The impeller nut has left-hand threads.



122	Shaft
198A	Set screw
304	Impeller nut

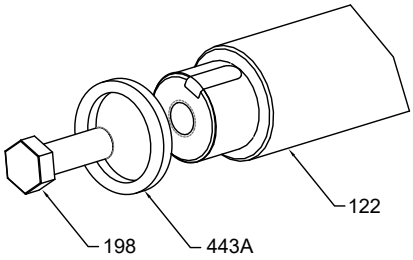
122	Shaft
198A	Set screw
304	Impeller nut

3. Pull the impeller from the shaft.
   Use a spanning-type puller if required.
4. Remove the impeller key.
   Save the key for reassembly unless it is damaged.

6.4.7 Remove the impeller (3910LF)

CAUTION:
Risk of physical injury from sharp edges. Wear heavy work gloves when handling impellers.

1. Loosen and remove the impeller capscrew.
   The impeller capscrew has left-hand threads.
2. Pull the impeller from the shaft.
   Use a spanning-type puller if required.



198	Impeller capscrew
443A	Impeller spacer
122	Shaft

Figure 44: Impeller removal

3. Remove the impeller key.
   Save the key for reassembly unless it is damaged.
4. Remove the impeller spacer.
   Save the spacer for reassembly unless it is damaged.

6.4.8 Remove the seal-chamber cover

1. Loosen and remove the gland stud nuts.
2. Slide the cartridge mechanical seal away from the seal-chamber cover.

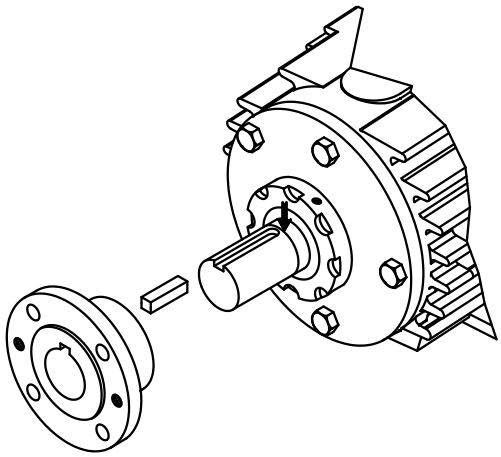
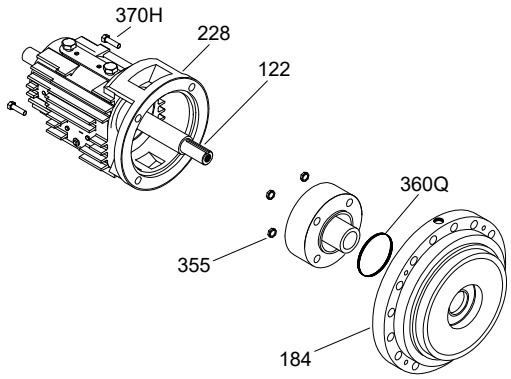


Figure 45: Cartridge mechanical seal removal

3. Install the eyebolt in the tapped hole provided in the seal-chamber cover.
4. Rig the lifting sling to the eyebolt and the overhead lifting device.
5. Loosen and remove the seal-chamber cover and the bearing frame bolts.
6. Separate the seal-chamber cover from the bearing frame by tapping on the cover flange with a hardwood block or a soft-face hammer.



122	Shaft
184	Seal-chamber cover
228	Bearing frame
355	Gland stud nuts
360Q	Gland gasket
370H	Bearing frame bolts

Figure 46: Seal-chamber cover removal

7. Guide the seal-chamber cover over the end of the shaft once the cover releases from the bearing frame.

NOTICE:

The cartridge mechanical seal may become damaged if the cover is allowed to come in contact with it.

8. Loosen the setscrews and remove the cartridge mechanical seal from the shaft.
9. Remove and discard the mechanical seal O-ring or gland gasket.
   You will replace this with a new O-ring or gasket during reassembly.

6.4.9 Remove the optional water-jacket cover

CAUTION:

- The seal-chamber cover must be adequately supported so that it cannot fall.
- You must vent all air from the water jacket. If all of the air is not vented, it can cause the water jacket cover to be propelled from its fit in the seal-chamber cover.
- Do not exceed 7.0 kg/cm^2 | 100 psig pressure in the water jacket.

1. Suspend the seal-chamber cover from the lifting sling, or firmly support the seal-chamber cover in a vertical position such that one water-jacket connection is on the top and the other is on the bottom.
2. Slowly replace all the air with water until all air is vented and only water comes out of the top connection.
3. Seal the top connection with a plug or other suitable means.
4. Slowly increase water pressure on the inlet (bottom) connection to force the water-jacket cover from its fit in the seal-chamber cover.
   Be prepared to catch the water-jacket cover.
5. Remove and discard the outer and inner water-jacket cover O-rings from the grooves in the water-jacket cover.
   You will replace these with new O-rings during reassembly.

6.4.10 Disassemble the power end

This procedure explains how to disassemble purge-oil mist-lubricated power end and includes information for the disassembly of these optional features:

- Pure oil-mist-lubricated power end
- Radial-heat-flinger end
- Air-cooling package

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

1. Does your power end have an optional air-cooling package?
    - If no: Go to step 2.
    - If yes:

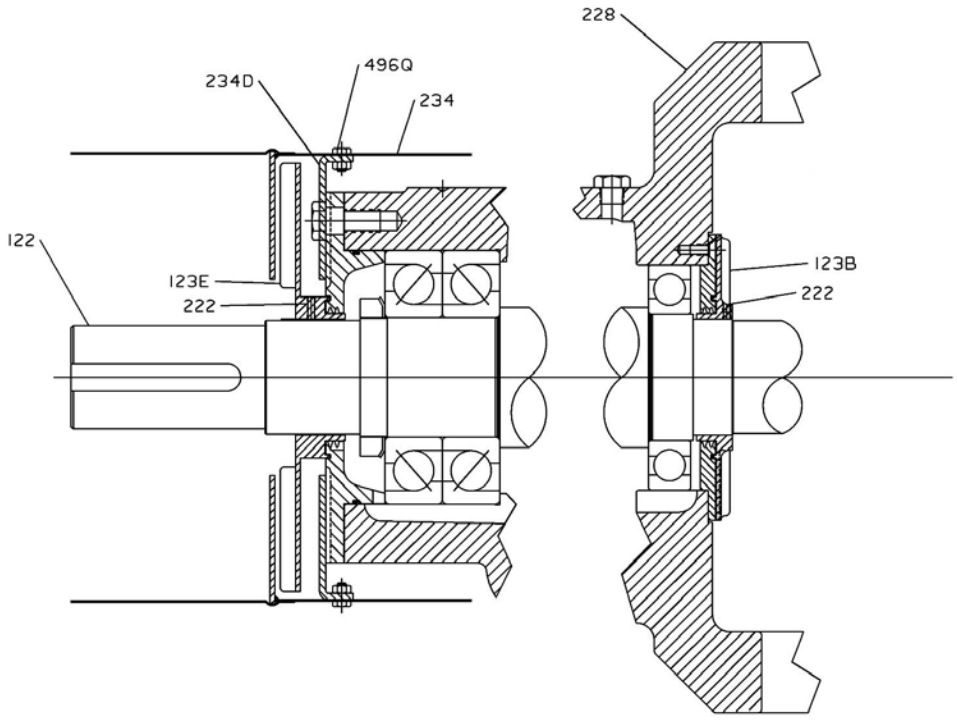
    a) Loosen the radial-heat-flinger set screw.

    b) Loosen the thrust-fan set screw.
    The thrust fan for the SA and MA pumps sits on the coupling diameter.

    c) Slide the thrust fan off the shaft.

    d) Loosen and remove the thrust-bearing end cover and bearing-frame screws.

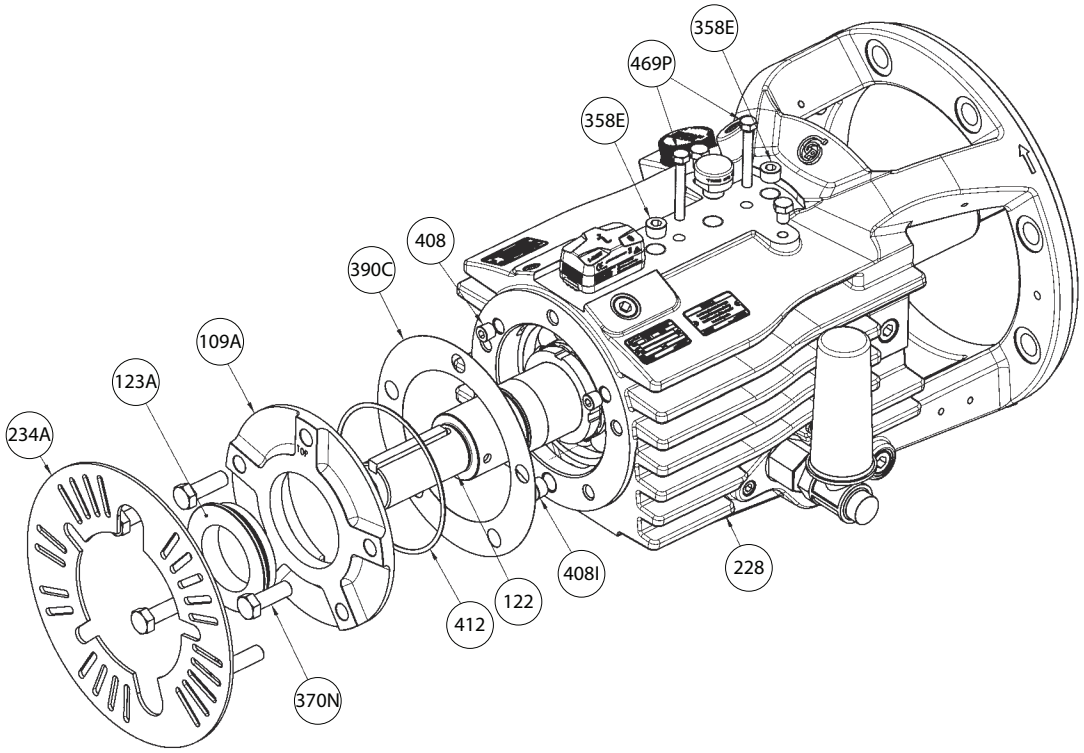
    e) Remove the thrust-fan guard support.



122	Shaft
123B	Radial deflector fan
123E	Thrust deflector fan
222	Deflector set screw
228	Bearing frame
234	Thrust deflector-fan guard
234D	Thrust deflector-fan guard support
496Q	Support screws

Figure 47: Thrust-fan guard support removal

2. Loosen and remove the thrust-bearing end cover and bearing-frame screws.
3. Pry the thrust-bearing end cover thrust deflector out of the bearing frame.
   SA and MA thrust-bearing end covers are sealed to the bearing frame with a gasket.



109A	Thrust-bearing end cover
122	Shaft
123A	Thrust deflector
228	Bearing frame
358E	Oil ring inspection plug
360A	Gasket
370N	Bearing-frame screw
390C	Thrust-bearing end-cover shim
469P	Oil ring retainer

Figure 48: Thrust bearing end cover removal

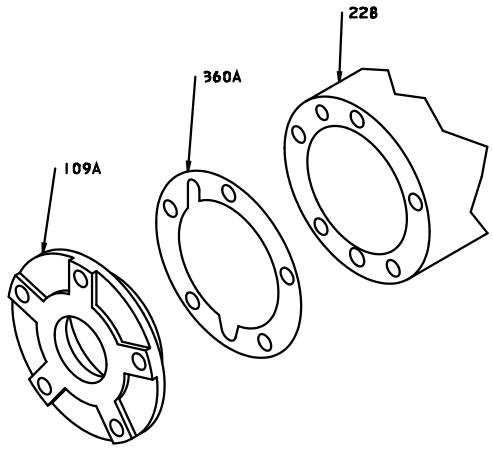
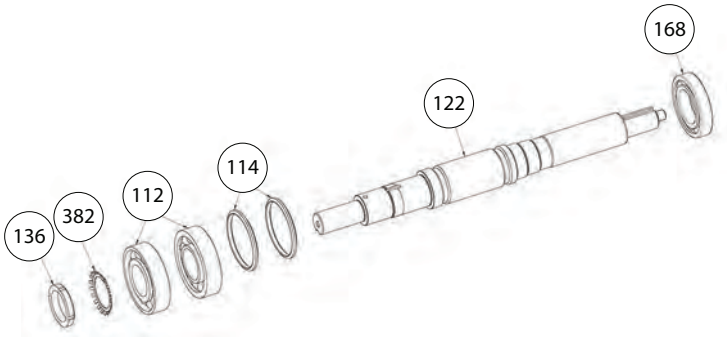


Figure 49: Thrust bearing end cover shims

4. Remove and discard the thrust-bearing end-cover shims.
   For all except SA and MA bearing frames, replace with new shims during reassembly.
5. Remove the two oil ring retainers and the oil ring inspection plugs from the top of the bearing frame. SX, MX, LA, LX, XLA, and XLX pumps have two inspection plugs. SA and MA pumps have one inspection plug.
6. Carefully withdraw the shaft and bearing assembly from the bearing frame.



112	Duplex thrust bearing
114	Oil rings
122	Shaft
136	Thrust-bearing locknut
168	Radial bearing
382	Lockwasher

Figure 50: Shaft and bearing assembly removal

7. Bend the locking tang of the thrust-bearing lockwasher away from the notch in the bearing locknut.

NOTICE:

Do not reuse bearings if removed from shaft. Doing so may result in equipment damage. Replace the bearings before reassembly.

8. Remove the radial bearing from the shaft:

a) Loosen and remove the thrust-bearing locknut and lockwasher.

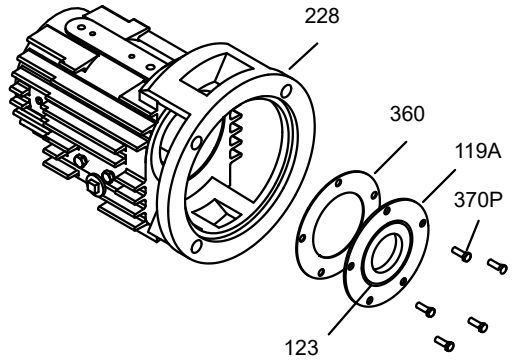
b) Press or pull the duplex thrust bearing from the shaft.

c) Press or pull the radial bearing from the shaft.

9. Perform the following based on your pump version:

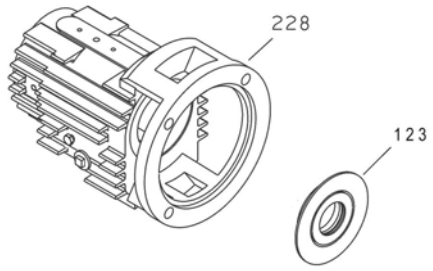
<table>
<tr><th>If your pump is...</th><th>Then...</th></tr>
<tr><td>SX, MX, LA, LX, XLA, or XLX</td><td>
1. Loosen and remove the radial-bearing end cover and bearing-frame screws.
2. Remove and discard the radial-bearing end-cover gasket. You will replace this with a new gasket during reassembly.
3. Press the radial and thrust deflector out of the radial and thrust end covers.

If you have an optional radial heat flinger, it replaces the standard radial deflector and is removed in the same manner except you loosen three set screws.



<table>
<tr><td>119A</td><td>Thrust end cover</td></tr>
<tr><td>123</td><td>Deflector</td></tr>
<tr><td>228</td><td>Bearing frame</td></tr>
<tr><td>360</td><td>Radial-bearing end-cover gasket</td></tr>
<tr><td>370P</td><td>Bearing-frame screws</td></tr>
</table>
Figure 51: Radial heat flinger
</td></tr>
<tr><td>SA and MA</td><td>Remove the radial-bearing end cover and radial deflector with gasket or radial deflector from the bearing frame by tapping it out of the frame.

If you have an optional radial heat flinger, it replaces the standard radial deflector and is removed in the same manner except you loosen three set screws.</td></tr>
</table>

If your pump is...	Then...
	 **Figure 52: Radial-bearing end cover and radial deflector with gasket (or radial deflector) removal**

10. Remove any remaining plugs and fittings.

6.5 Preassembly inspections

6.5.1 Replacement guidelines

Casing check and replacement

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

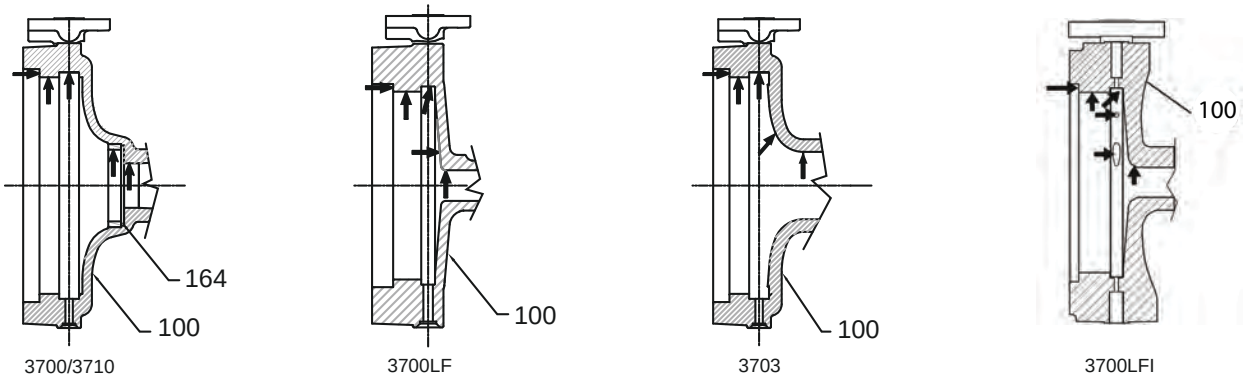
Inspect the casing for cracks and excessive wear or pitting. Thoroughly clean gasket surfaces and alignment fits in order to remove rust and debris.

Repair or replace the casing if you notice any of these conditions:

- Localized wear or grooving that is greater than 3.2 mm | 1/8 in. deep
- Pitting that is greater than 3.2 mm | 1/8 in. deep
- Irregularities in the casing-gasket seat surface

Casing areas to inspect

The arrows point to the areas to inspect for wear on the casing:



100	Casing
164	Casing wear ring

Figure 53: Areas to inspect for wear on casing

NOTICE:
3910LF does not have wear rings for case, cover and impeller.

Impeller replacement

This table shows the criteria for replacing the impeller:

Impeller parts	When to replace
Impeller vanes	• When grooved deeper than 1.6 mm | 1/16 in., or • When worn evenly more than 0.8 mm | 1/32 in.
Pumpout vanes	When worn or bent more than 0.8 mm | 1/32 in.
Vane edges	When you see cracks, pitting, or corrosion damage

Impeller checks

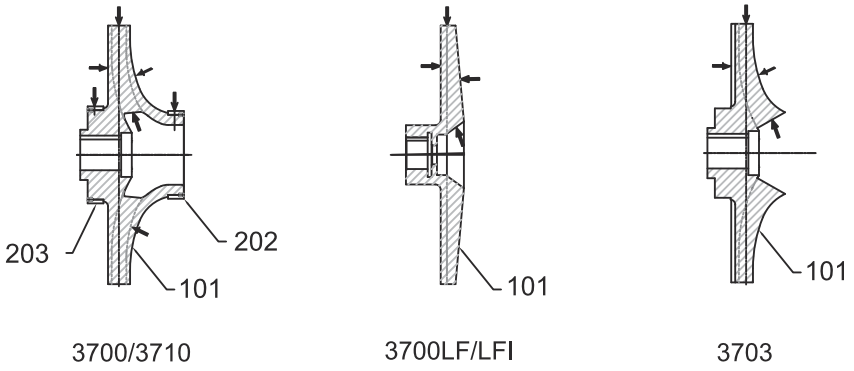
NOTICE:
Protect machined surfaces while cleaning the parts. Failure to do so may result in equipment damage.

- Check and clean the impeller bore diameter.
- Check the impeller balance. Rebalance the impeller if it exceeds the ISO 1940 G1.0 criteria.

NOTICE:

You must have extremely accurate tooling equipment to balance impellers to the ISO 1940 G1.0 criteria. Do not attempt to balance impellers to this criteria unless this type of tooling and equipment is available.

Impeller areas to inspect



101	Impeller
202 and 203	Impeller wear rings

Figure 54: Areas to inspect for wear on impeller

Cartridge mechanical seal replacement

Cartridge-type mechanical seals should be serviced by the seal manufacturer. Refer to the instructions from the mechanical seal manufacturer for assistance.

Coupling guard replacement

Repair or replace the coupling guard if you notice corrosion or other defects.

Gaskets, O-rings, and seats replacement

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

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

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

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

Additional parts

Inspect and either repair or replace all other parts, if inspection indicates continued use would be harmful to satisfactory and safe pump operation.

Inspection must include the following items:

- Bearing end covers (109A) and (119A)
- INPRO radial labyrinth bearing seal (123) and thrust radial labyrinth bearing seal (123A)
- Radial heat flinger (123B)*
- Thrust fan (123E)*
- Bearing locknut (136)
- Impeller key (178) and coupling key
- Impeller screw (198)
- Impeller washer (199)
- Impeller lockwasher (199A)
- Impeller nut (304)
- Bearing lockwasher (382)
- Impeller spacer (443A)
- Water jacket cover (490)*
- All nuts, bolts, and screws

* If supplied.

6.5.2 Fastening

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

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

6.5.3 Shaft replacement guidelines

Shaft measurement check

Check the bearing fits of the shaft. If any are outside the tolerances shown in the Bearing fits and tolerances table, then replace the shaft.

Shaft inspection

Check the shaft straightness. Use "V" blocks or balance rollers to support the shaft on the bearing fit areas. Replace the shaft if runout exceeds 0.03 mm | 0.001 in.

NOTICE:
Do not use shaft centers for the runout check as they may have been damaged during the removal of the bearings or impeller.

Shaft inspection

Check the shaft surface for damage, especially in areas indicated by the arrows in the following figure. Replace the shaft if it is damaged beyond reasonable repair.

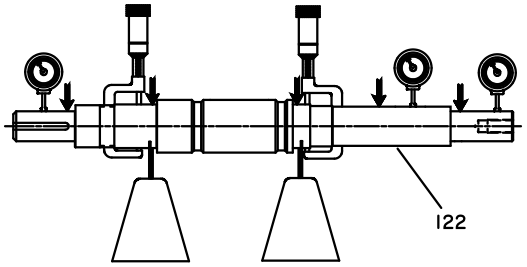


Figure 55: Shaft inspection

6.5.4 Bearings inspection

Condition of bearings

Do not reuse bearings. The condition of the bearings provides useful information on operating conditions in the bearing frame.

Checklist

Perform these checks when you inspect the bearings:

- Inspect the bearings for contamination and damage.

- Note any lubricant condition and residue.
- Inspect the ball bearings to see if they are loose, rough, or noisy when you rotate them.
- Investigate any bearing damage to determine the cause. If the cause is not normal wear, correct the issue before you return the pump to service.

Replacement bearings

Table 9: 3700 bearings based on SKF / MRC designations

Replacement bearings must be the same as, or equivalent to, those listed in this table.

Group	Radial (inboard)	Thrust (outboard)
SA	6210 C3	7310 BEGAM
MA	6211 C3	7311 BEGAM
SX	6212 C3	7312 BEGAM
MX, LA	6213 C3	7312 BEGAM
LX, XLA	6215 C3	7313 BEGAM
XLX	6218 C3	7317 BEGAM
XXL	6215 C3	7318 BEGAM

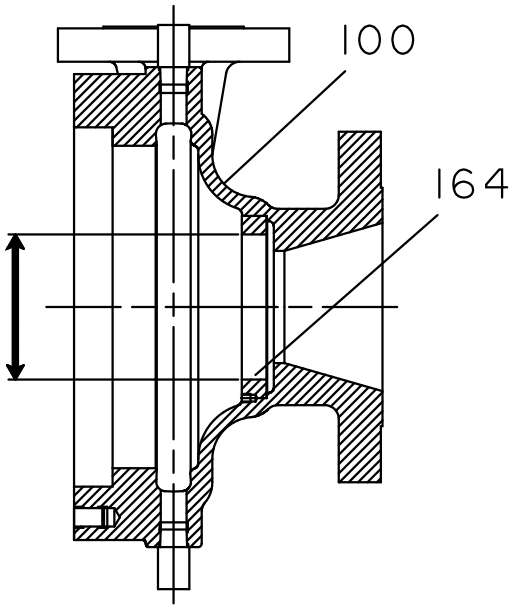
6.5.5 Wear rings inspection and replacement 3910LF

Wear ring types

All units are equipped with casing, impeller, and seal-chamber cover wear rings. When clearances between the rings become excessive, hydraulic performance decreases substantially.

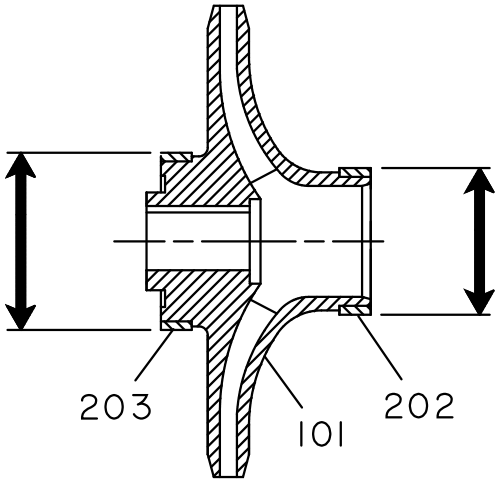
Wear ring diameter check

Measure all wear ring diameters and then calculate the diametrical wear ring clearances. Refer to Table 10: Minimum running clearances on page 83 for more information.



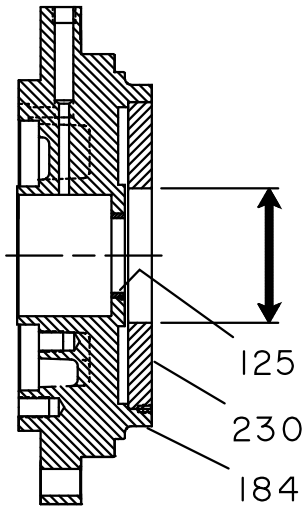
100	Casing
164	Casing wear ring

Figure 56: Casing wear ring



101	Impeller
202	Impeller wear ring
203	Impeller wear ring (No Requirement for 3910LF)

Figure 57: Impeller wear ring



125	Seal-chamber throat bushing
184	Seal-chamber cover
230	Seal-chamber cover wear ring

Figure 58: Seal chamber cover wear ring

When to replace wear rings

Replace wear rings when the diametrical clearance exceeds two times the minimum clearance as shown in this table or when the hydraulic performance has decreased to unacceptable levels.

NOTICE:
For operating temperatures above 260°C | 500°F and for material with greater galling tendencies (e.g. stainless steel), increase diametral clearance dimensions by 0.13 mm | 0.005 in.

Table 10: Minimum running clearances

Diameter of impeller wear ring		Minimum diametrical clearance	
mm	**in.**	**mm**	**in.**
<50	<2.000	0.25	0.010
To to 64.99	2.000 to 2.4999	0.28	0.011
65 to 79.99	2.500 to 2.999	0.30	0.012
80 to 89.99	3.000 to 3.499	0.33	0.013
90 to 99.99	3.500 to 3.999	0.35	0.014
100 to 114.99	4.000 to 4.499	0.38	0.015
115 to 124.99	4.500 to 4.999	0.40	0.016
125 to 149.99	5.000 to 5.999	0.43	0.017
150 to 174.99	6.000 to 6.999	0.45	0.018
175 to 199.99	7.000 to 7.999	0.48	0.019
200 to 224.99	8.000 to 8.999	0.50	0.020
225 to 249.99	9.000 to 9.999	0.53	0.021
250 to 274.99	10.000 to 10.999	0.55	0.022
275 to 299.99	10.000 to 11.999	0.58	0.023
300 to 324.99	12.000 to 12.999	0.60	0.024

6.5.5.1 Replace the wear rings

WARNING:
Dry ice and other chilling substances can cause physical injury. Contact the supplier for information and advice for proper handling precautions and procedures.
(Not applicable for 3910LF)

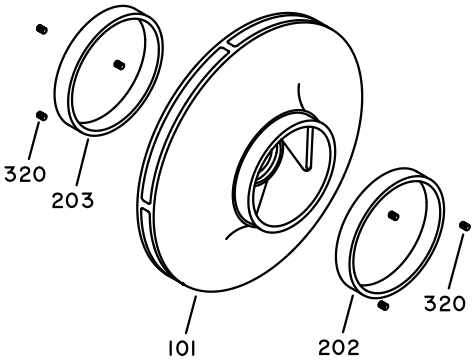
CAUTION:

- Excessive machining can damage ring fits and render parts unusable.
- Wear insulated gloves when you handle rings. Rings will be hot and can cause physical injury.
- For runout checks, firmly support the bearing-frame assembly in the horizontal position.
- Risk of physical injury from sharp edges. Wear heavy work gloves when handling impellers.

Casing, impeller, and seal chamber cover wear rings are held in place by a press fit and three set screws.

1. Remove the wear rings:
   a) Remove the set screws.
   b) Remove the wear rings from the casing, impeller, and seal-chamber cover using a pry or puller to force the rings from the fits.
2. Clean the wear-ring seats thoroughly, and make sure that they are smooth and free of scratches.

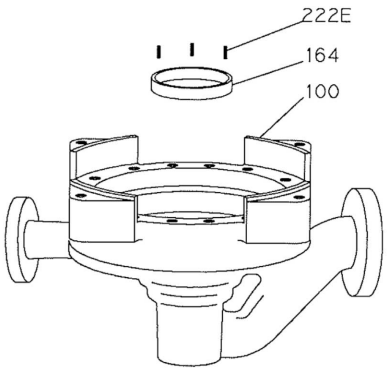
3. Heat the new impeller wear rings to 82° to 93°C | 180° to 200°F using a uniform method for heating, such as an oven, and place them on the impeller wear-ring seats.



Item	Description
101	Impeller
202	Impeller wear ring
203	Impeller wear ring
320	Set screw

Figure 59: Impeller wear ring

4. Chill the new casing wear ring using dry ice or another suitable chilling substance and install the ring into the casing fit.
Be prepared to tap the ring in place with a wood block or soft-faced hammer.



Item	Description
100	Casing
164	Casing wear ring
222E	Set screw

Figure 60: Casing wear ring

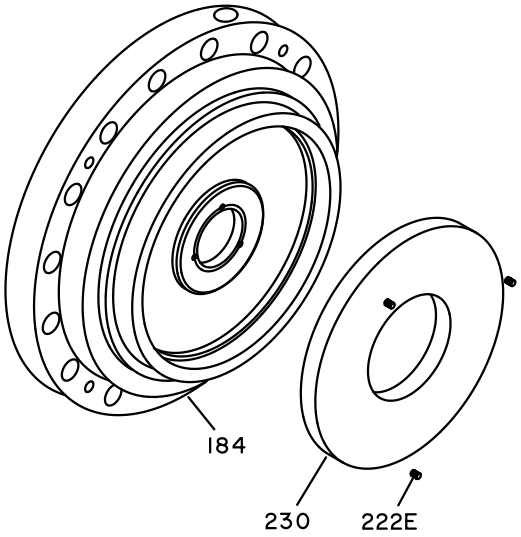
5. Insert a new seal-chamber-cover wear ring:

   a) Chill a new seal-chamber-cover wear ring, using dry ice or another suitable chilling substance, and install the ring into the cover fit.

Be prepared to tap the ring in place with a hardwood block or soft faced hammer.

   b) Locate, drill, and tap three new equally-spaced set screw holes between the original holes in each new ring and ring-seat area.

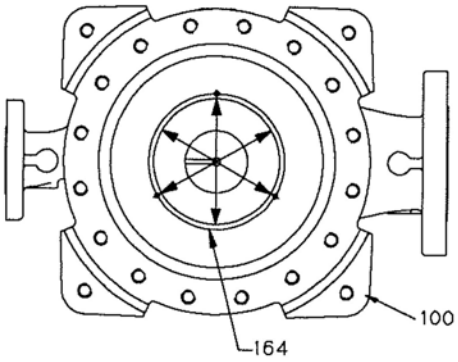
   c) Install the set screws and upset threads.



184	Cover
222E	Set screw
230	Seal-chamber-cover wear ring

Figure 61: Seal chamber cover wear ring

6. Check the casing wear ring runout and distortion:
   a) Measure the bore at each set screw location with inside micrometers or vernier calipers.
   b) Correct any distortion in excess of 0.08 mm | 0.003 in. by machining before you trim the new impeller wear rings.



100	Casing
164	Casing wear ring

Figure 62: Casing wear ring

7. Measure the bore of the casing wear ring to establish the required impeller wear-ring diameter you use to provide the recommended running clearances.
8. Repeat steps 6 and 7 for the seal-chamber wear ring.
9. Turn the impeller wear rings to size after you mount them on the impeller:

NOTICE:

- All replacement impeller wear rings, except those that are hard-faced, are supplied 0.51 mm to 0.75 mm | 0.020 in. to 0.030 in. oversize.

- Do not machine all wear rings. Spare hard-faced impeller wear rings are supplied to pre-established clearances when both impeller and casing wear rings are renewed.

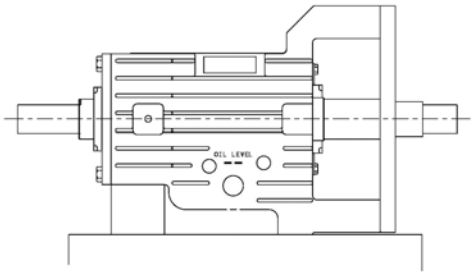
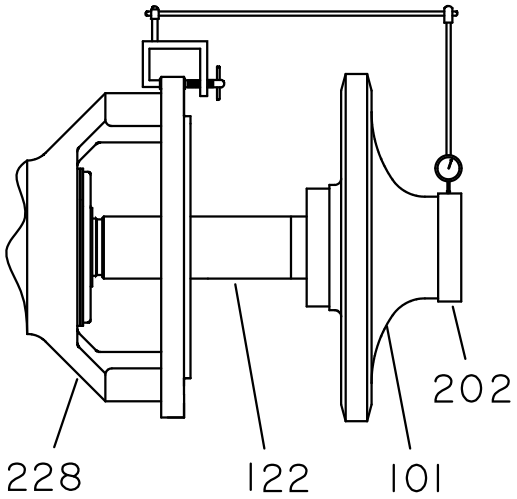


Figure 63: Impeller

10. Install the impeller:
    a) Install the impeller key on the shaft of the assembled bearing frame from which the seal-chamber cover has been removed, and on which the runouts are within the established specifications. The key should be at the top (12 o'clock) position for the impeller installation.
    b) Install the impeller on the shaft.
    c) Install the impeller washer.
    d) Secure the impeller firmly with an impeller screw or impeller nut.

    The impeller screw has left-hand threads.
11. Check the impeller wear-ring runout:
    a) Mount the dial indicator.
    b) Rotate the shaft so that the indicator rides along the casing-side impeller wear-ring surface for 360°.
    c) Repeat steps a and b for the wear ring on the seal-chamber cover side.



101	Impeller
122	Shaft
202	Casing-side impeller wear-ring
228	Seal-chamber cover side wear ring

Figure 64: Impeller wear-ring runout

If the impeller wear ring runout is in excess of 0.13 mm | 0.005 in.:

1. Check for distortion at the set screw areas.
2. Check the shaft runout and all mating surfaces of the shaft and impeller hub for perpendicularity.
3. True up all damaged surfaces.
4. Recheck the impeller wear-ring runout.

6.5.6 Seal-chamber cover inspection and replacement

Two seal-chamber cover versions

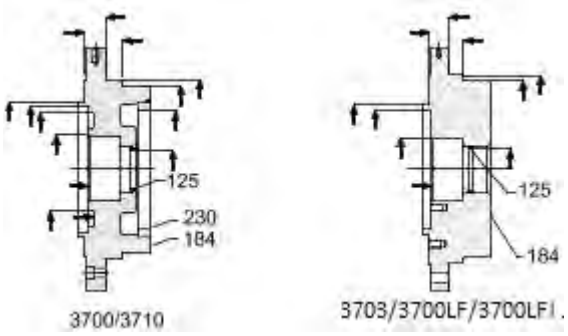
The seal-chamber cover is available in two versions:

- Standard
- Optional

The optional version has a cooling chamber and water jacket cover and is used when elevated pumped-fluid temperatures are present.

Seal-chamber cover areas to inspect

- Ensure all gasket/O-ring sealing surfaces are clean and have no damage that would prevent sealing.
- Ensure that all cooling (where applicable), flush, and drain passages are clear.



125	Seal-chamber throat bushing
184	Seal-chamber cover

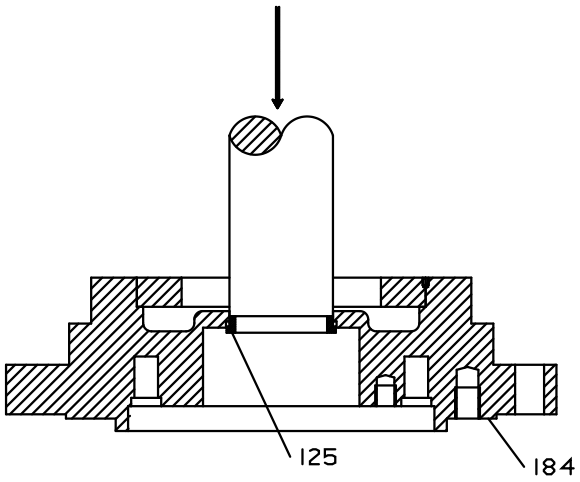
Seal-chamber cover replacement

Seal-chamber cover part	When to replace
Seal-chamber cover surfaces	When worn, damaged, or corroded more than 3.2 mm | 0.126 in. deep
Inside diameter of seal-chamber cover bushing	When the diametral clearance between the bushing and the impeller hub exceeds 1.20 mm | 0.047 in.

6.5.6.1 Replace the seal-chamber cover bushing

The seal-chamber cover bushing is held in place by a press fit and locked by three set screws.

1. Remove the bushing:
   a) Remove the set screws.
   b) Press the bushing out of the fit towards the bearing-frame side of the seal-chamber cover bore.



125	Bushing
184	Seal-chamber cover

Figure 65: Seal-chamber cover bushing replacement

2. Install the new seal-chamber cover bushing:
   a) Thoroughly clean the bushing fit in the seal-chamber cover.

b) Chill the new bushing using dry ice or another suitable chilling substance, and install the bushing into the cover fit.

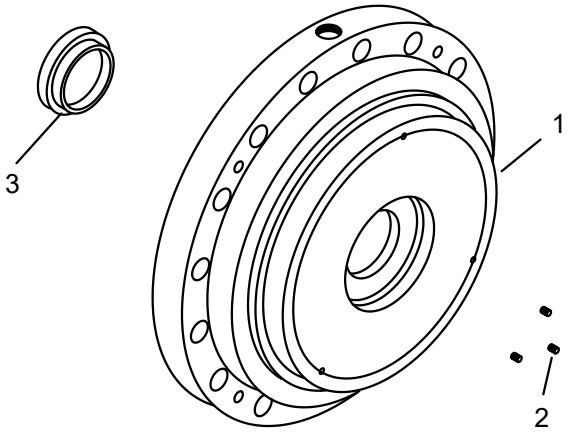
Tap the bushing in place with a wood block or soft-faced hammer.

WARNING:

Dry ice and other chilling substances can cause physical injury. Contact the supplier for information and advice for proper handling precautions and procedures.

c) Locate, drill, and tap three new equally-spaced set screw holes on the impeller side of the cover between the original set screw holes.

d) Install the set screws and upset threads.



1. Seal-chamber cover
2. Set screws
3. Bushing

Figure 66: Set screw installation

6.5.7 Bearing-frame inspection

Checklist

Check the bearing frame for these conditions:

- Visually inspect the bearing frame and frame foot for cracks.
- Check the inside surfaces of the frame for rust, scale, or debris. Remove all loose and foreign material.
- Make sure that all lubrication passages are clear.
- Inspect the inboard bearing bores.

  If any bores are outside the measurements in the Bearing fits and tolerances table, replace the bearing frame.

Surface inspection locations

This figure shows the areas to inspect for wear on the bearing frame surface.

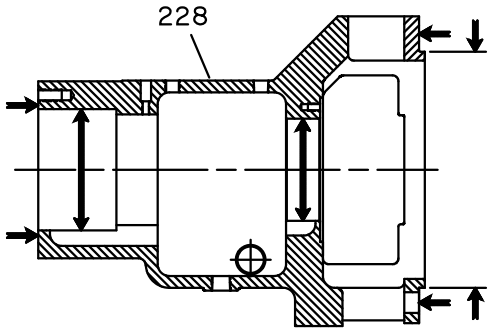


Figure 67: Surface inspection locations

6.5.8 Bearing fits and tolerances

Table 11: Bearing fits and tolerances table (SI units)

This table references the bearing fits and tolerances according to ISO 286 (ANSI/ABMA Standard 7) in millimeters | inches.

Location	Description	Tolerance	SA		SX		MA		MX, LA		LX, XLA		XLX		XXL	
			inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm
Radial (Inboard)	Shaft OD	Max	1.9690	50.013	2.3629	60.018	2.1659	55.014	2.5598	65.019	2.9534	75.016	3.5440	90.018	3.9377	100.018
		Min	1.9686	50.002	2.3623	60.002	2.1654	55.001	2.5592	65.004	2.9529	75.004	3.5434	90.002	3.9371	100.002
	Bearing ID	Max	1.9685	50.000	2.3622	60.000	2.1653	54.999	2.5591	65.001	2.9528	75.001	3.5433	90.000	3.9370	100.000
		Min	1.968	49.987	2.3616	59.985	2.1647	54.983	2.5585	64.986	2.9522	74.986	3.5425	89.980	3.9362	99.979
	Interference	Max	0.0010	0.0254	0.0013	0.0330	0.0012	0.0305	0.0013	0.0330	0.0012	0.0305	0.0015	0.0381	0.0015	0.0381
		Min	0.0001	0.0025	0.0001	0.0025	0.0001	0.0025	0.0001	0.0025	0.0001	0.0025	0.0001	0.0025	0.0001	0.0025
	Bearing OD	Max	3.5433	90.000	4.3307	110.000	3.9370	100.000	4.7244	120.000	5.1181	130.000	6.2992	160.000	7.0866	180.000
		Min	3.5427	89.985	4.3301	109.985	3.9363	99.982	4.7238	119.985	5.1174	129.982	6.2982	159.974	7.0856	179.974
	Frame ID	Max	3.5446	90.033	4.3320	110.033	3.9383	100.033	4.7257	120.033	5.1196	130.038	6.3007	160.038	7.0881	180.038
		Min	3.5438	90.013	4.3312	110.012	3.9375	100.013	4.7249	120.012	5.1187	130.015	6.2998	160.015	7.0872	180.015
	Clearance	Max	0.0019	0.0483	0.0019	0.0483	0.0020	0.0508	0.0019	0.0483	0.0022	0.0559	0.0025	0.0635	0.0025	0.0635
		Min	0.0005	0.0127	0.0005	0.0127	0.0005	0.0127	0.0005	0.0127	0.0006	0.0152	0.0006	0.0152	0.0006	0.0152
Thrust (Outboard)	Shaft OD	Max	1.969	50.013	2.3629	60.018	2.1659	55.014	2.3629	60.018	2.5598	65.019	3.3472	85.019	3.5440	90.018
		Min	1.9686	50.002	2.3623	60.002	2.1654	55.001	2.3623	60.002	2.5592	65.004	3.3466	85.004	3.5434	90.002
	Bearing ID	Max	1.9685	50.000	2.3622	60.000	2.1653	54.999	2.3622	60.000	2.5591	65.001	3.3465	85.001	3.5433	90.000
		Min	1.9680	49.987	2.3616	59.985	2.1647	54.983	2.3616	59.985	2.5585	64.986	3.3457	84.981	3.5425	89.980
	Interference	Max	0.0010	0.0254	0.0013	0.0330	0.0012	0.0305	0.0013	0.0330	0.0013	0.0330	0.0015	0.0381	0.0015	0.0381
		Min	0.0001	0.0025	0.0001	0.0025	0.0001	0.0025	0.0001	0.0025	0.0001	0.0025	0.0001	0.0025	0.0001	0.0025
	Bearing OD	Max	4.3307	110.000	5.1181	130.000	4.7244	120.000	5.1181	130.000	5.5118	140.000	7.0866	180.000	7.4802	189.997
		Min	4.3301	109.985	5.1174	129.982	4.7238	119.985	5.1174	129.982	5.5111	139.982	7.0856	179.974	7.4793	189.974
	Frame ID	Max	4.332	110.033	5.1196	130.038	4.7257	120.033	5.1196	130.038	5.5133	140.038	7.0881	180.038	7.4820	190.043
		Min	4.3312	110.012	5.1187	130.015	4.7249	120.012	5.1187	130.015	5.5124	140.015	7.0872	180.015	7.4809	190.015
	Clearance	Max	0.0019	0.0483	0.0022	0.0559	0.0019	0.0483	0.0022	0.0559	0.0022	0.0559	0.0025	0.0635	0.0027	0.0686
		Min	0.0005	0.0127	0.0006	0.0152	0.0005	0.0127	0.0006	0.0152	0.0006	0.0152	0.0006	0.0152	0.0007	0.0178

6.6 Reassembly

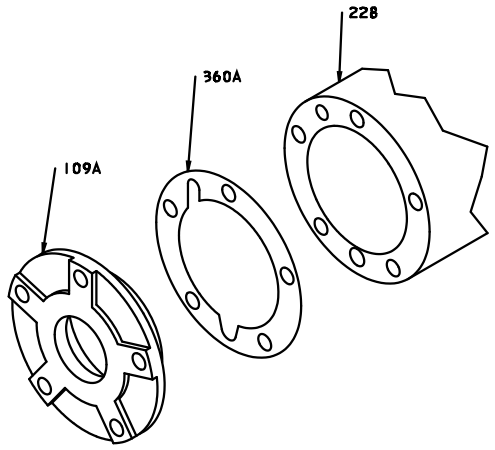
6.6.1 Assemble the frame

CAUTION:

- Failure to align the gasket with oil grooves will result in bearing failure from a lack of lubrication.
- Do not over-tighten the thrust-bearing end-cover and bearing-frame screws.
- Do not allow the dial indicator to contact the keyway when turning the shaft. Readings will be incorrect and damage to dial indicator could result.
- For runout checks, firmly support the bearing-frame assembly in the horizontal position.

1. Perform the following based on your pump:

If your pump is...	Then...
SX, MX, LA, LX, XLA, XLX, or XXL	1. Install three thrust-bearing end-cover shims on the thrust-bearing end cover. 2. Align the holes.
SA or MA	1. Install three thrust-bearing end-cover gaskets on the bearing-end cover. 2. Align the gaskets to the end cover so that the openings in the gaskets align with the oil grooves on the end cover.



109A	Thrust-bearing end cover
228	Bearing frame
360A	Thrust-bearing end-cover gaskets

Figure 68: Bearing frame assembly

2. Install the thrust-bearing end cover over the shaft and onto the bearing frame.
3. Install and tighten the thrust-bearing end cover and bearing-frame screws evenly to the torque values in the Maximum torque values for 3910 fasteners table.

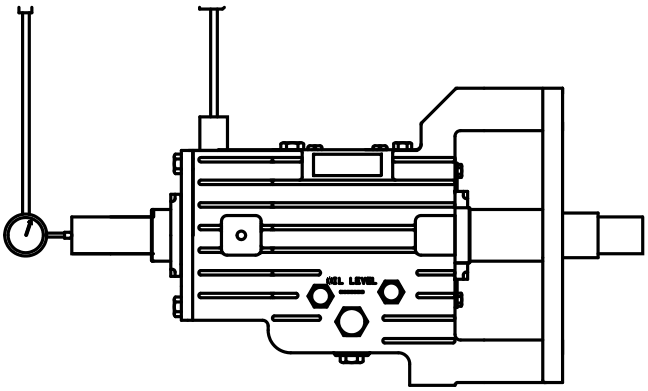


Figure 69: Axial end play determination

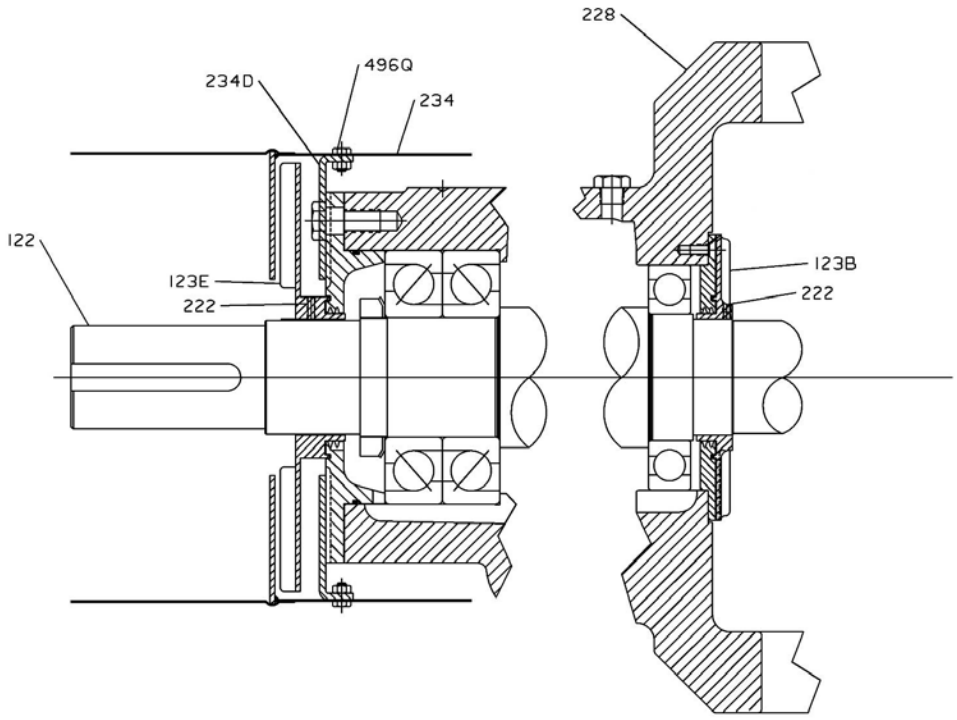
4. Determine the axial end play as follows:
   a) Mount the dial indicator.
   b) Use a lever to apply axial force to the impeller end of the shaft and firmly seat the thrust bearing against the shoulder in the bearing frame.
   c) Apply axial force in the opposite direction and firmly seat the thrust bearing against the thrust-bearing end cover.
   d) Repeat steps b and c several times and record the total travel (end play) of the rotating element.

   Total travel (end play) must fall in the range of 0.025 to 0.125 mm | 0.001 to 0.005 in. Achieve the correct axial end play by adding or removing end-cover gaskets (for SA and MA pumps) or end-cover shims (for SX, MX, LA, LX, XLA, XLX, and XXL pumps) between the thrust-bearing end cover and the bearing frame. Add gaskets and shims if no axial end play is present.
5. Repeat steps 1 through 4.
   If the measured total travel falls outside the accepted range in step 4, remove or add the appropriate quantity of individual shims or gaskets to obtain the proper total travel.
6. Perform the following based on your pump:

If your pump is...	Then...
SX, MX, LA, LX, XLA, XLX, or XXL	1. Remove the thrust-bearing end cover. 2. Press the INPRO seal into the thrust-bearing end cover and ensure that the expulsion part is at the 6 o'clock position and is properly seated. 3. Install the O-ring into the groove of the thrust-bearing end cover. 4. Lubricate the O-ring with a suitable lubricant.
SA or MA	1. Remove the thrust-bearing end cover. 2. Press the INPRO seal into the thrust-bearing end cover and ensure that the expulsion part is at the 6 o'clock position and is properly seated.

7. Install the thrust-bearing end cover with O-ring over the shaft and into the bearing-frame bore. Ensure that the O-ring is not damaged while it enters the bearing-frame bore.
8. Perform the following based on whether or not your power end has the optional air-cooling package:

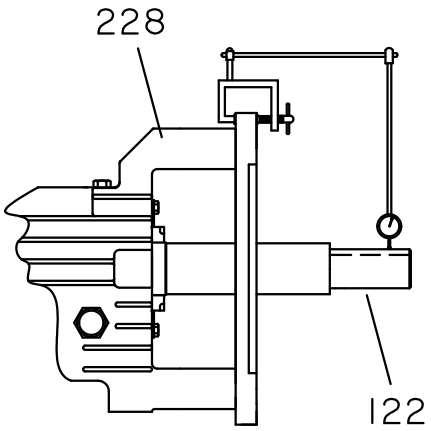
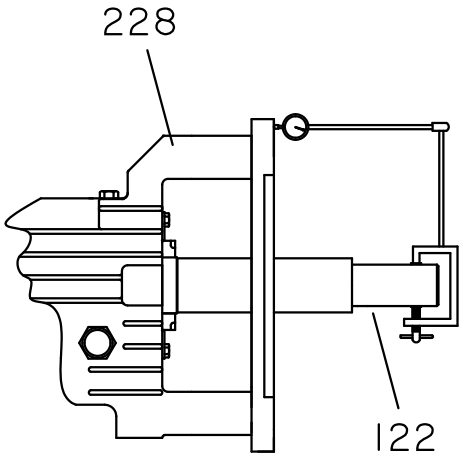
If your power end...	Then...
Has the optional air-cooling package	1. Position the thrust-fan guard support on the thrust-bearing end cover. 2. Install and tighten the thrust-bearing end cover and bearing-frame screws evenly to torque values shown in the Maximum torque values for 3910 fasteners table. 3. Install the thrust fan over the shaft. 4. Position the thrust-deflector fan approximately 0.8 mm | 0.030 in. from the thrust IN-PRO seal on SA and MA pumps. Place the fan against the coupling-diameter shoulder and tighten the deflector-fan set screw firmly. 5. Tighten the heat-flinger set screws firmly.
Does not have the optional air-cooling package	1. Install and tighten the thrust-bearing end cover and bearing-frame screws evenly to the torque values in the Maximum torque values for 3910 fasteners table. 2. Verify that the shaft turns freely. If you detect rubbing or excessive drag, then determine the cause and correct it.

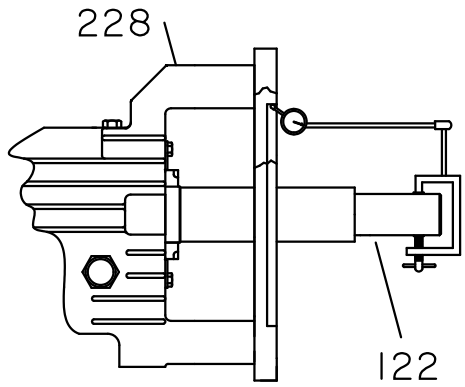


122	Shaft
123B	Radial deflector fan
123E	Thrust deflector fan
222	Deflector set screw
228	Bearing frame
234	Thrust deflector-fan guard
234D	Thrust deflector-fan guard support
496Q	Support screws

Figure 70: Power end assembly

9. Check the following runouts:

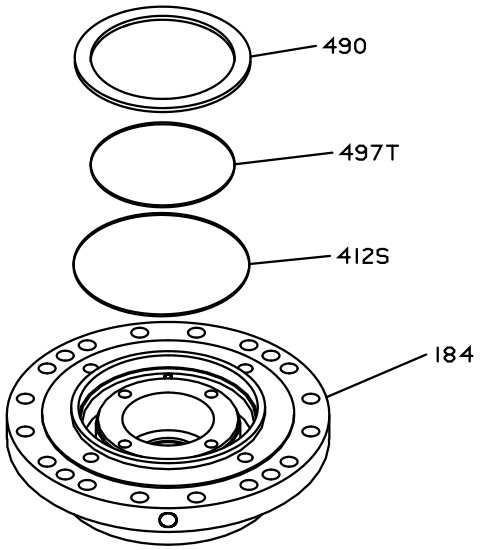
Check	Procedure
Shaft impeller fit	1. Mount the dial indicator on the bearing frame. 2. Rotate the shaft through a maximum arc from one side of the keyway to the other. If the total indicator reading is greater than 0.050 mm | 0.002 in., determine the cause and correct it. 
Shaft seal fit	1. Mount the dial indicator. 2. Rotate the shaft so that the indicator rides along the shaft surface for 360°. If the total indicator reading is greater than 0.050 mm | 0.002 in., then determine the cause and correct it.
Bearing-frame face	1. Mount the dial indicator on the shaft. 2. Rotate the shaft so that the indicator rides along the bearing-frame face for 360°. If the total indicator reading is greater than 0.10 mm | 0.004 in., then disassemble and determine the cause and correct it. 
Bearing-frame lock	1. Mount the dial indicator on the shaft. 2. Rotate the shaft so that the indicator rides along the bearing-frame lock for 360°. If the total indicator reading is greater than 0.10 mm | 0.004 in., then disassemble and determine the cause and correct it.

Check	Procedure
	

10. Install and tighten any plugs and fittings removed during disassembly, including the oil-drain plug, and the sight glass.
11. If your power end has the optional water cooling package, install the finned-tube cooling assembly into the bearing frame.

6.6.2 Install the optional water-jacket cover

1. Install the outer and inner water-jacket-cover O-rings into the grooves in the water jacket cover.



184	Seal-chamber cover
412S	Outer water-jacket-cover O-ring
490	Water jacket cover
497T	Outer and inner water-jacket-cover O-ring

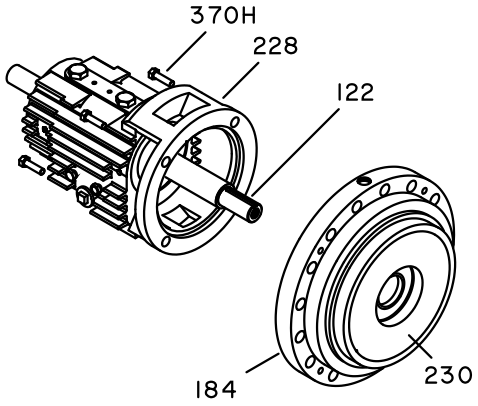
Figure 71: Optional water jacket cover

2. Lubricate the sealing surfaces in the seal-chamber cover and O-rings with a suitable lubricant.
3. Insert the water jacket cover with O-rings into the fit in the seal-chamber cover.
   Make sure that the water jacket cover enters uniformly and that the O-rings are not damaged.

6.6.3 Install the seal-chamber cover

WARNING:
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.

1. Install the eyebolt in the tapped hole provided in the seal-chamber cover.



122	Shaft
184	Seal-chamber cover
228	Bearing frame
230	Seal-chamber cover wear-ring
370H	Bearing-frame bolts

Figure 72: Seal chamber cover

2. Set up a sling from the eyebolt to the overhead lifting device.
3. Lift the seal-chamber cover and position it so that it aligns with the shaft.
4. Install the seal-chamber cover on the bearing-frame assembly:

   a) Guide the cover carefully over the shaft and into the bearing-frame lock.

   b) Install the seal-chamber cover and bearing-frame bolts.

   c) Tighten the bolts evenly using an alternating pattern.

   Torque the bolts to values shown in the Maximum torque values for 3910 fasteners table.
5. Check the seal-chamber cover face runout:

   a) Mount the dial indicator on the shaft.

   b) Rotate the shaft so that the indicator rides along the seal-chamber cover face for 360°.

   If the total indicator reading is greater than 0.13 mm | 0.005 in., determine the cause and correct it.

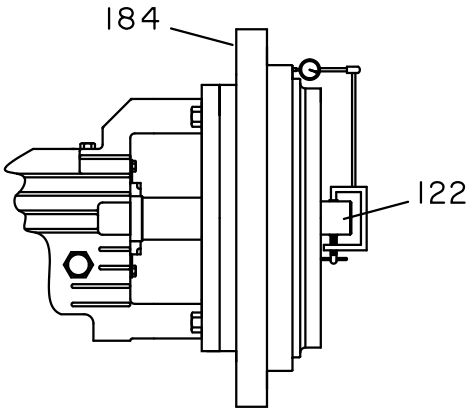


Figure 73: Seal-chamber cover face runout

6. Check the seal-chamber cover lock runout:

   a) Mount the dial indicator on the shaft.

   b) Rotate the shaft so that the indicator rides along the seal-chamber cover lock for 360°.

   If the total indicator reading is greater than 0.13 mm | 0.005 in., determine the cause and correct it.

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.

Figure 74: Seal-chamber cover face runout

7. Check the seal-chamber cover wear-ring runout:

   a) Mount the dial indicator on the shaft.

   b) Rotate the shaft so that the indicator rides on the seal-chamber cover wear-ring surface for 360°.

   If the total indicator reading exceeds 0.15 mm | 0.006 in., determine the cause and correct it.

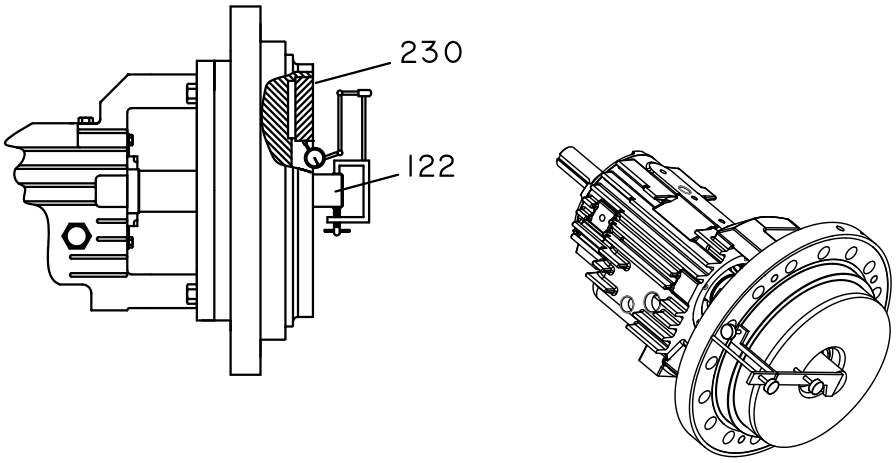


Figure 75: Seal-chamber cover wear-ring runout

8. Check the seal-chamber face runout:

   a) Mount a dial indicator on the shaft.

   b) Rotate the shaft so that the indicator rides along the seal-chamber face for 360°.

   If the total indicator reading is greater than the values shown in this table, determine the cause and correct it.

Table 12: Maximum Allowable Seal Chamber Face Runout

Group	Maximum Allowable Total Indicator Reading
SA	0.045 mm | 0.0018 in.
SX, MA	0.05 mm | 0.002 in.
MX, LA	0.06 mm | 0.0024 in.
LX, XLA	0.065 mm | 0.0026 in.
XLX	0.07 mm | 0.0028 in.
XXL	0.08 mm | 0.0031 in.

Table 13: Maximum Allowable Seal Chamber Face Runout

Group	Maximum Allowable Total Indicator Reading
13i, 14i, 24i, 25i, 35i	0.05 mm | 0.002 in.
36i	0.065 mm | 0.0026 in.
47i	0.07 mm | 0.0028 in.
58i	0.08 mm | 0.0031 in.

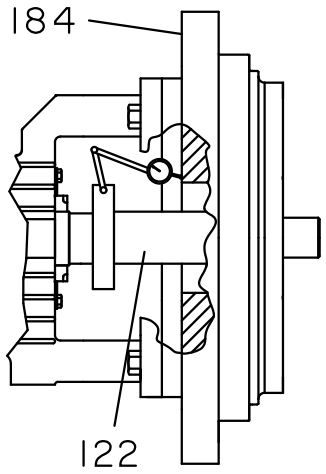


Figure 76: Seal-chamber face runout

9. Check the seal-chamber lock (register) runout:

   a) Mount a dial indicator on the shaft or shaft sleeve.

   b) Rotate the shaft so that the indicator rides along the seal-chamber lock (register) for 360°.

   If the total indicator reading is greater than 0.125 mm | 0.005 in., determine the cause and correct it.

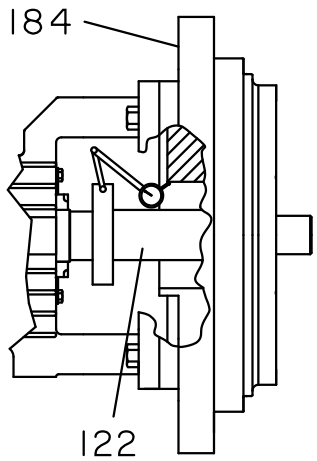


Figure 77: Seal-chamber lock (register) runout

6.6.4 Install the cartridge-type mechanical seal and seal-chamber cover

NOTICE:
Refer to the mechanical seal manufacturer’s drawings and instructions for assistance during the installation of the mechanical seal.

1. Remove the impeller.

   a) Loosen and remove the impeller nut.

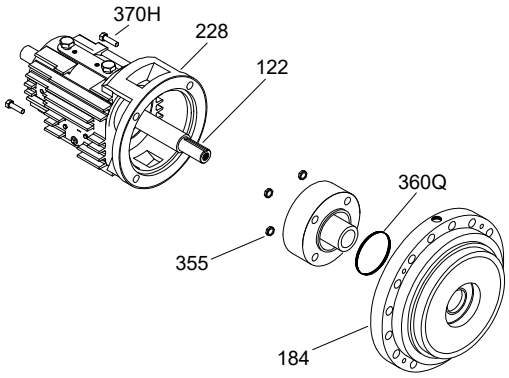
The impeller nut has left-hand threads.

b) Remove the impeller, impeller key, and seal-chamber cover as described in the Disassembly section.

2. Lubricate all O-rings with suitable lubricant, unless the seal manufacturer's instructions indicate otherwise.
3. Slide the cartridge seal assembly (rotary, stationary gland, gland gasket, and sleeve) onto the shaft.

NOTICE:

Ensure that the mechanical-seal gland-piping connections are properly oriented.



122	Shaft
184	Seal-chamber cover
228	Bearing frame
355	Gland stud nut
370H	Bearing-frame bolts

Figure 78: Cartridge-type mechanical seal and seal-chamber cover

4. Install the seal-chamber cover.
   a) Set up a sling to the eyebolt and to the overhead lifting device.
   b) Lift the seal-chamber cover and position it so that it aligns with the shaft.
   c) Install the seal-chamber cover on the power end by guiding the cover carefully over the cartridge-seal rotary.

   Ensure that the gland studs smoothly enter the holes in the cartridge-seal gland and that the cover fits into the bearing frame lock.

   d) Install the seal-chamber cover and bearing-frame bolts and tighten them using an alternating pattern.

   Torque the bolts to the values shown in the Maximum torque values for 3910 fasteners table.

   e) Install the gland stud nuts and tighten evenly to the torque values shown in the Maximum torque values for 3910 fasteners table.
5. Tighten the setscrews in the locking collar.
6. Disengage the spacer ring or clips.
7. Verify that the shaft turns freely.
   If you detect rubbing or excessive drag, then determine the cause and correct it.

6.6.5 Determining impeller spacer thickness (applicable for 3910LF)

Applicable only to a new spare impeller spacer

With an assembled power end:

1. Attach the seal chamber cover to the bearing frame.
2. Install impeller spacer as supplied between shaft and impeller.
3. Secure impeller to shaft with impeller cap screw or nut.
4. Place indicator on the coupling end of the shaft and zero it out (magnetic base attached to bearing frame).
5. Remove (or loosen to provide 3/8” travel) the thrust bearing end cover screws.
6. Install back pull-out assembly into the case and tighten down 3 or 4 nuts (equally spaced around the case).
7. Record the travel measured by the indicator.
8. Add .030" to the amount of travel measured and then machine this off the face of the impeller spacer.

6.6.6 Install the impeller 3910

CAUTION:
Risk of physical injury from sharp edges. Wear heavy work gloves when handling impellers.

It is recommended that you repeat the runout checks on the seal-chamber cover face, lock, and wear-ring surfaces as described in 6.6.3 Install the seal-chamber cover on page 97.

1. Install the impeller key in the keyway of the shaft.
   The key should be at the top (12 o’clock) position for the impeller installation.
2. Install the impeller on the shaft.
   Apply anti-galling compound to the impeller bore to aid in assembly and disassembly.
3. Install the impeller nut and tighten to the torque values shown in the Maximum torque values for 3910 fasteners table.
   The impeller nut has left-hand threads.
4. Tighten the set screw in the end of the impeller nut.
5. Verify that the shaft turns freely.
   If you notice any rubbing or excessive drag, then determine the cause and correct it.

It is recommended that you repeat the runout checks on the impeller wear-ring surface as described in Replace the wear rings.

6.6.7 Install the impeller (3910LF)

CAUTION:
Risk of physical injury from sharp edges. Wear heavy work gloves when handling impellers.

It is recommended that you repeat the runout checks on the seal-chamber cover face and lock surfaces as described in 6.6.3 Install the seal-chamber cover on page 97.

1. Install the impeller spacer on the shaft.
2. Install the impeller key in the keyway of the shaft.
   The key should be at the top (12 o’clock) position for the impeller installation.
3. Install the impeller on the shaft.
   Apply anti-galling compound to the impeller bore to aid in assembly and disassembly.
4. Install the impeller capscrew and tighten to the torque values shown in the Maximum torque values for 3910 fasteners table.
   The impeller capscrew has left-hand threads.
5. Verify that the shaft turns freely.
   If you notice any rubbing or excessive drag, then determine the cause and correct it.

6.6.8 Install the coupling hub

CAUTION:
Wear insulated gloves to handle the coupling hub. The coupling hub will get hot and can cause physical injury.

NOTICE:
If it is necessary to heat the coupling hub due to an interference fit, do not use a torch. Use a heating device such as an oven which uniformly heats the coupling hub.

1. Install the key and pump-half coupling hub on the shaft.
2. Make sure that the hub is flush with the end of the shaft or to the mark scribed during disassembly. Refer to coupling manufacturer's instructions for assistance.

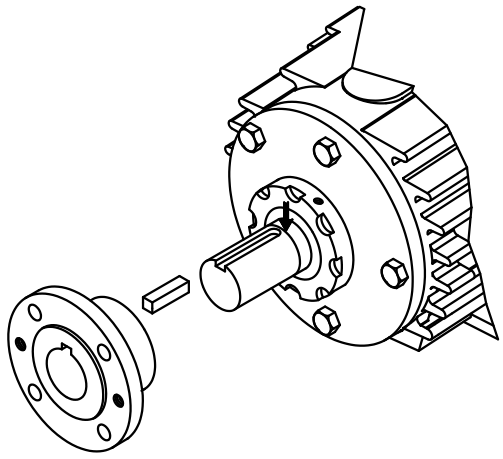


Figure 79: Coupling hub installation

6.6.9 Install the back pull-out assembly in the casing

1. Install a new casing gasket on the gasket surface of the casing.
   You can apply anti-galling compound to the casing fits to aid in assembly and disassembly.
2. Replace the back pull-out assembly in the casing using a lifting sling through the bearing frame or other suitable means.

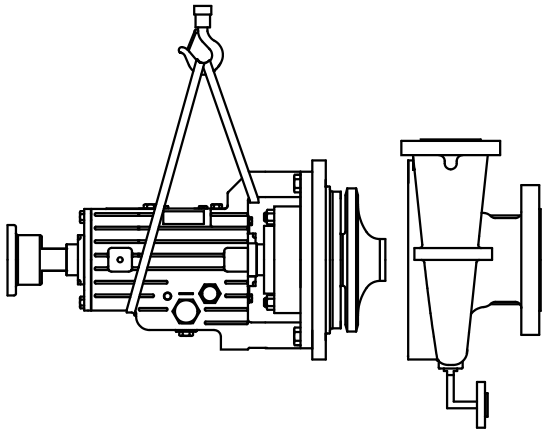


Figure 80: Back pull-out assembly

3. Slide the back pull-out assembly into the proper position in the casing by loosening the jacking bolts evenly.
   Make sure that the casing gasket is not damaged.
4. Install the casing stud nuts.
5. Inspect the gap between the seal-chamber cover and casing and adjust the casing stud nuts as necessary to make the gap uniform.
6. Tighten the casing stud nuts uniformly, using an alternating pattern, until the seal-chamber cover is in metal-to-metal contact with the casing. Tighten each nut to the torque values shown in the Maximum torque values for 3910 fasteners table.
7. Verify that the shaft turns freely.
   If you detect any rubbing or excessive drag, then determine the cause and correct it.
8. Reinstall the coupling spacer, coupling guard, auxiliary piping, tubing, and equipment that was removed during preparation for disassembly.
9. Lubricate the bearings.

6.6.10 Post-assembly checks

Perform these checks after you assemble the pump, then continue with pump startup:

- Rotate the shaft by hand in order to make sure that it rotates easily and smoothly and that there is no rubbing.
- Open the isolation valves and check the pump for leaks.

6.6.11 Assembly references

6.6.11.1 Maximum torque values for fasteners

About this table

The torque values specified in this table are for dry threads. These values should be reduced for lubricated threads only when lubricants of high stress ability, such as Molycote, are used. Materials listed in this table are equal to the respective API 610, 10th Edition material classes. In some cases, superior materials are substituted.

Construction - API designation

The following API designations apply to this table:

- S-1
- S-3
- S-4
- S-5
- S-6
- S-8
- S-8N
- S-9
- C-6
- A-8
- A-8N
- D-1
- Modified A-8 (non-API material)

6.6.11.2 Maximum torque values

Table 14: Maximum torque values 3910/3910LF

Item Number	Description	Group / Size	Fastener Size	Torque Value
304	Impeller Nut	SA, SX	5/8" - 18 UNF	80 Nm | 59 ft-lbs
		MX	3/4" - 16 UNF	138 Nm | 102 ft-lbs
		LA,LX, XLX	1" - 12 UNF	331 Nm | 244 ft-lbs
353 and 355	Gland Studs and Nuts	SA	1/2" - 13 UNC	88 Nm | 65 ft-lbs
		All others	5/8" - 11 UNC	176 Nm | 130 ft-lbs
356A and 425	Casing Studs & Nuts	SA, SX	3/4" - 10 UNC	312 Nm | 230 ft-lbs
		MX (11")	3/4" - 10 UNC	312 Nm | 230 ft-lbs
		MX (13")	7/8" - 9 UNC	503 Nm | 371 ft-lbs
		LA (16")	1" - 8 UNC	755 Nm | 557 ft-lbs
		XLX (21")	1 1/8" - 7 UNC	1070 Nm 789 ft-lbs
370H	Screw - Bearing Frame / Seal Chamber Cover	SA	1/2" - 13 UNC	30 Nm | 22 ft-lbs
		SX	5/8" - 11 UNC	60 Nm | 44 ft-lbs
		MX, LA	3/4" - 10 UNC	107 Nm | 79 ft-lbs
		LX	7/8" - 9 UNC	168 Nm | 124 ft-lbs
		XLX	1" - 8 UNC	259 Nm | 191 ft-lbs
370N	Screw - Thrust Bearing End Cover to Frame	SA, SX, MA, LA	1/2" - 13 UNC	30 Nm | 22 ft-lbs
		LX, XLX	5/8" - 11 UNC	60 Nm | 44 ft-lbs
370P and 370W Optional	Screw - Radial Bearing End Cover to Frame	SX MX, LA XLX	5/16" - 18 UNC	7 Nm | 5 ft-lbs
469Q Optional	Screw - Thrust Deflector Fan Guard Support	ALL	5/16" - 18 UNC	7 Nm | 5 ft-lbs

NOTICE:

- The torque values specified in the above table are for lubricated threads. Multiply lubricated value by 4/3 for unlubricated values.
- Thread lubricant is required for pressure boundary hardware (Items 353, 355, 356A, & 425). Use nickel-based or molybdenum-based anti-seize compound.
- Materials listed in the above table are equal to the respective API 610 material classes. In some cases, superior materials are substituted.

6.6.11.3 Spare parts

Critical services spare parts

For critical services, the following parts should be stocked, where applicable:

- Impeller (101) with impeller rings (202 and 203) (Applicable for 3700/3710)
- Impeller (101)
- Thrust bearing end-cover (109A)
- Radial bearing end cover (119A)
- Shaft (122)
- Radial INPRO seal (123)
- Thrust bearing isolator (123A)
- Thrust INPRO (123A)
- Radial heat flinger (123B)
- Thrust fan (123E)
- Impeller key (178)

An alternative approach is to stock a complete back pull-out assembly. This is a group of assembled parts which includes all but the casing and coupling.

Recommended spare parts

When ordering spare parts, always state the serial number, and indicate the part name and item number from the relevant sectional drawing. It is imperative for service reliability to have a sufficient stock of readily available spare parts.

It is suggested that the following spare parts be stocked, where applicable:

- Bearing locknut (136)
- Bearing lockwasher (382)
- Cartridge mechanical seal (383)
- Casing gasket (351)
- Casing wear ring (164) (Applicable for 3700/3710)
- Finned-tube cooling assembly (494)
- Impeller nut (304) (Applicable for 3700/3710/3703)
- Impeller cap screw (198) (Applicable for 3700LF/3700LFI)
- Impeller wear ring - casing side (202) (Applicable for 3700/3710)
- Impeller wear ring - cover side (203) (Applicable for 3700/3710)
- Oil rings (114)
- Radial bearing (168)
- Radial bearing end-cover gasket (360)

- Seal-chamber cover wear ring (230)
- Set screws (222E and 320)
- Throat bushing - seal-chamber cover (125)
- Thrust bearing (duplex pair) (112)
- Thrust bearing end-cover gaskets (360A)
- Thrust bearing end-cover O-ring (412)
- Thrust bearing end-cover shim pack (390C)
- Water jacket cover O-rings (412S and 497T)
- Impeller spacer (443A) (Applicable for 3703/3700LF/3700LFI)

7 Troubleshooting

7.1 Operation 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 suction line is clogged.	Remove the obstructions.
	The impeller is clogged.	Back-flush the pump in order to clean the impeller.
	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 foot valve or suction pipe opening is not submerged enough.	Consult an ITT representative for the proper submersion depth. Use a baffle in order to eliminate vortices.
	The suction lift is too high.	Shorten the suction pipe.
The pump is not producing the rated flow or head.	The gasket or O-ring has an air leak.	Replace the gasket or O-ring.
	The stuffing box has an air leak.	Replace or readjust the mechanical seal.
	The impeller is partly clogged.	Back-flush the pump in order to clean the impeller.
	The clearance between the impeller and the pump casing is excessive.	Adjust the impeller clearance.
	The suction head is not sufficient.	Make sure that the suction-line shutoff valve is fully open and that the line is unobstructed.
	The impeller is worn or broken.	Inspect and replace the impeller if necessary.
The pump starts and then stops pumping.	The pump is not primed.	Re-prime the pump and check that the pump and suction line are full of liquid.
	The suction line has air or vapor pockets.	Rearrange the piping in order to eliminate air pockets.
	The suction line has an air leak.	Repair the leak.
The bearings are running hot.	The pump and driver are not aligned properly.	Realign the pump and driver.
	There is not sufficient lubrication.	Check the lubricant for suitability and level.
	The lubrication was 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 in order 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. Make sure the baseplate is properly grouted without voids or air pockets.
	The bearings are worn.	Replace the bearings.
	The suction or discharge piping is not anchored or properly supported.	Anchor the suction or discharge piping as necessary according to recommendations in the Hydraulic Institute Standards Manual.
	The pump is cavitating.	Locate and correct the system problem.
The mechanical seal is leaking excessively.	The packing gland is not adjusted properly.	

Symptom	Cause	Remedy
	The stuffing box is not packed properly.	
	The mechanical seal parts are worn.	Replace the worn parts.
	The mechanical seal is overheating.	Check the lubrication and cooling lines.
	The shaft or shaft sleeve is scored.	
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 contact your ITT representative.
	The liquid is heavier than expected.	Check the specific gravity and viscosity.
	The stuffing-box packing is too tight.	Readjust the packing. If the packing is worn, then replace the packing.
	Rotating parts are rubbing against each other.	Check the parts that are wearing for proper clearances.
	The impeller clearance is too tight.	Adjust the impeller clearance.

7.2 Alignment troubleshooting

Symptom	Cause	Remedy
Horizontal (side-to-side) alignment cannot be obtained (angular or parallel).	The driver feet are bolt-bound.	Loosen the pump's hold-down bolts, and slide the pump and driver until you achieve horizontal alignment.
	The baseplate is not leveled properly and is probably twisted.	1. Determine which corners of the baseplate are high or low. 2. Remove or add shims at the appropriate corners. 3. Realign the pump and driver.

7.3 Assembly troubleshooting

Table 15: Troubleshooting procedure

Symptom	Cause	Remedy
There is excessive shaft end play.	The internal clearance of the bearings is excessive.	Replace the bearings with a bearing of the correct type.
	The thrust-bearing end cover is loose.	Tighten the screws.
	There are too many shims under the thrust bearing end cover.	Remove the individual shims to obtain the proper thickness.
The runout for the shaft is excessive.	The shaft is bent.	Replace the shaft.
The runout for the bearing-frame flange is excessive.	The shaft is bent.	Replace the shaft.
	The flange of the bearing frame is distorted.	Replace the bearing-frame flange.
The runout for the seal-chamber cover is excessive.	The seal-chamber cover is improperly seated on the frame.	Replace or re-machine the seal-chamber cover.
	There is corrosion or wear on the seal-chamber cover.	Replace the seal-chamber cover.
The runout for the impeller wear ring is excessive.	The shaft is bent.	Replace the shaft.
	The wear ring was machined improperly.	Replace or re-machine the impeller.

8 Parts List and Cross-Sectionals

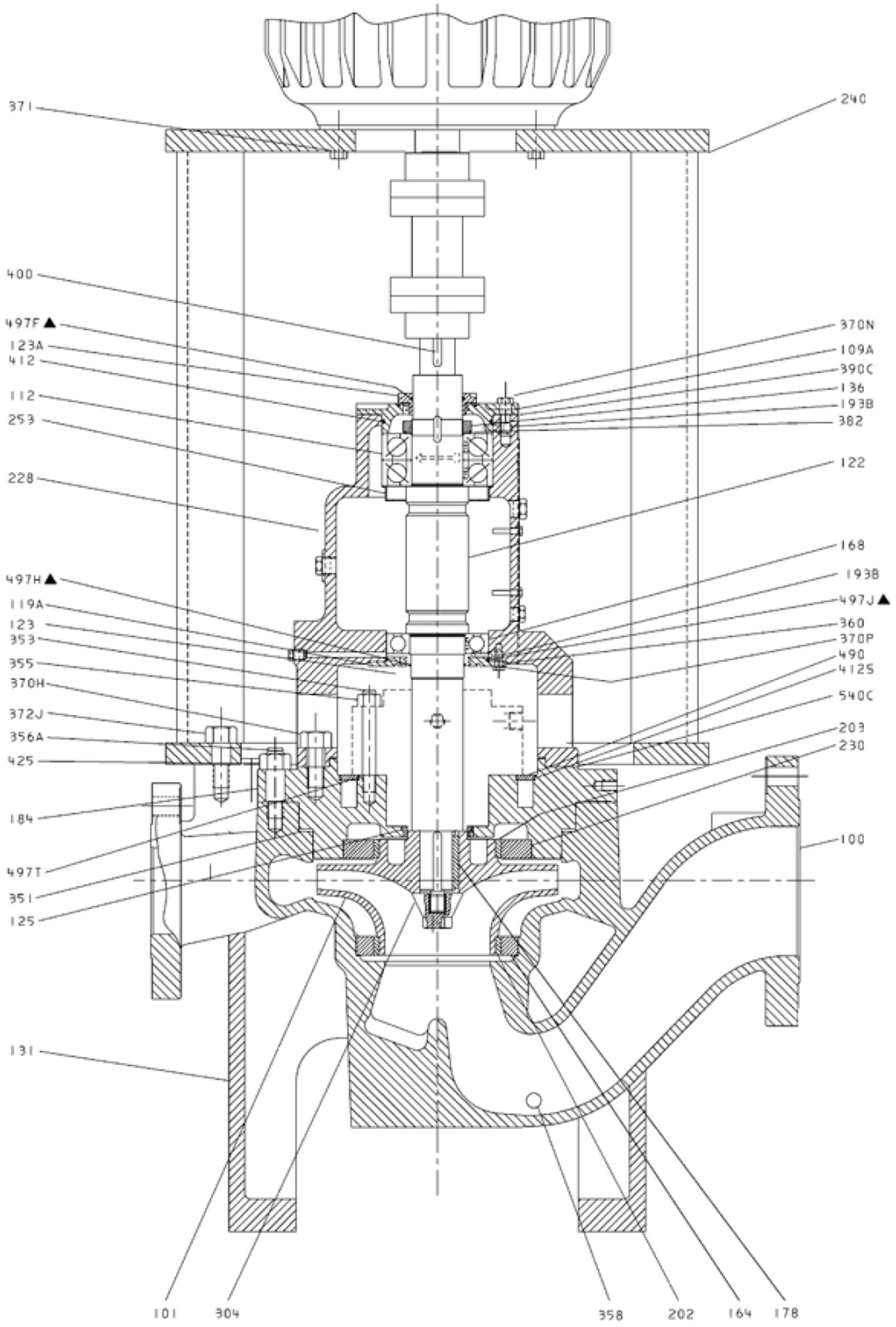
8.1 Parts list

3910 Parts list and cross sectional

Spares		Item	Qty	Component	Construction S-5	ASTM No.
Start-up	1-2 yr					
-	-	100	1	Casing	Carbon Steel	A216 GR WCB
-	X	101	1	Impeller	Carbon Steel	A216 GR WCB
-	-	109A	1	Thrust Bearing End Cover	Carbon Steel	A216 GR WCB
X	X	112	1 Pair	Bearing-Thrust	Steel	–-
-	-	119A	1	Radial Bearing End Cover	Carbon Steel	A216 GR WCB
-	X	122	1	Shaft	4140	A434 GR 4140 CL BC
-	-	123	1	Deflector-Radial	Bronze	B584 C87500
-	-	123A	1	Deflector-Thrust	Bronze	B584 C87500
-	-	123B (OPT)	1	Deflector Fan-Radial	Aluminum	SAE 319
-	-	123E (OPT)	1	Deflector Fan-Thrust	Aluminum	SAE 319
X	X	125	1	Throat Bushing-S.C. Cover	410 SS	A276 Type 410
-	-	131 (OPT)	2	Foot Case	Ductile Iron	A586 GR 60-42-10
X	X	136	1	Bearing Locknut	Steel	–-
X	X	164	1	Wear Ring-Casing	12% Chrome	A743 GR CA-15
X	X	168	1	Bearing-Radial	Steel	–-
-	-	178	1	Impeller Key	316L SS	A240 Type 316L
-	-	184	1	Seal Chamber Cover	Carbon Steel	A216 GR WCB
-	-	193B	2	Grease Fitting	Steel	–-
X	X	202	1	Wear Ring-Impeller-Casing Side	12% Chrome	A743 GR CA-15
X	X	203	1	Wear Ring-Impeller-S.C. Cover Side	12% Chrome	A743 GR CA-15
-	-	228	1	Bearing Frame	Carbon Steel	A216 GR WCB
X	X	230	1	Wear Ring-Seal Chamber	12% Chrome	A743 GR CA-15
-	-	234 (OPT)	1	Deflector Fan Guard-Thrust	Steel	A283 GR D
-	-	234D (OPT)	1	Deflector Fan Grd. Support-Thrust	Steel	A283 GR D
-	-	240	1	Support Motor	Steel	A283 GR D

Spares		Item	Qty	Component	Construction S-5	ASTM No.
Start-up	1-2 yr					
-	-	253	1	Deflector-Grease	Steel	A283 GR D
-	X	304	1	Impeller Nut	316L SS	A276 Type 316L
X	X	351	1	Gasket-Casing to SC	Spiral Wound 316SS	–-
-	-	353	4	Stud-Gland	4140	A193 GR B7
-	-	355	4	Nut-Gland Stud	4140	A194 GR 2H
-	-	356A	Note 1	Stud-Casing	4140	A193 GR B7
-	-	358	1	Plug Casing Drain	Steel	A108 GR 1211
X	X	360	1	Gasket-End CVR-Radial	Vellumoid	D-1170
-	-	370E (OPT)	4	Screw-Cap Foot to Case (not shown)	Carbon Steel	A307 GR B
-	-	370H	4	Screw-Frame to SC	Carbon Steel	A307 GR B
-	-	370N	5	Screw-End Cover-Thrust	Carbon Steel	A307 GR B
-	-	370P	5	Screw End Cover-Radial	Carbon Steel	A307 GR B
-	-	370W (OPT)	5	Screw End Cover-Radial	Carbon Steel	A307 GR B
-	-	371	4	Screw Cap Support to Motor	Carbon Steel	A307 GR B
-	-	372J	4	Screw-Cap Support to Case	Carbon Steel	A307 GR B
X	X	382	1	Bearing Lockwasher	Steel	–-
X	X	390C	1-3	Shim Pack-End Cover-Thrust	304SS	–-
-	-	400	1	Key Coupling	Steel	A108 GR 1018
X	X	412	1	O-Ring-Thrust Bearing End Cover	Buna N	–-
X	X	412S (OPT)	1	O-Ring-Water Jacket Cover-Outer	Viton	–-
-	-	425	Note 1	Hex Nut Casing SC	4140	A194 GR 2H
-	-	469Q (OPT)	5	Screw-Guard to Support	Carbon Steel	A307 GR B
-	-	490 (OPT)	1	Water Jacket Cover	Steel	A283 GR D
X	X	▲ 497F	1	O-Ring Deflector-Thrust	Buna B	–-
X	X	▲ 497H	1	O-Ring Deflector- Radial	Buna B	–-
X	X	▲ 497J	1	O-Ring Radial End Cover	Buna B	–-

Spares		Item	Qty	Component	Construction S-5	ASTM No.
Start-up	1-2 yr					
X	X	497T (OPT)	1	O-Ring-Water Jacket Cover-Inner	Viton	–-
-	-	540C (OPT)	1	Gasket-Frame to Cover	Aramid Fiber	–-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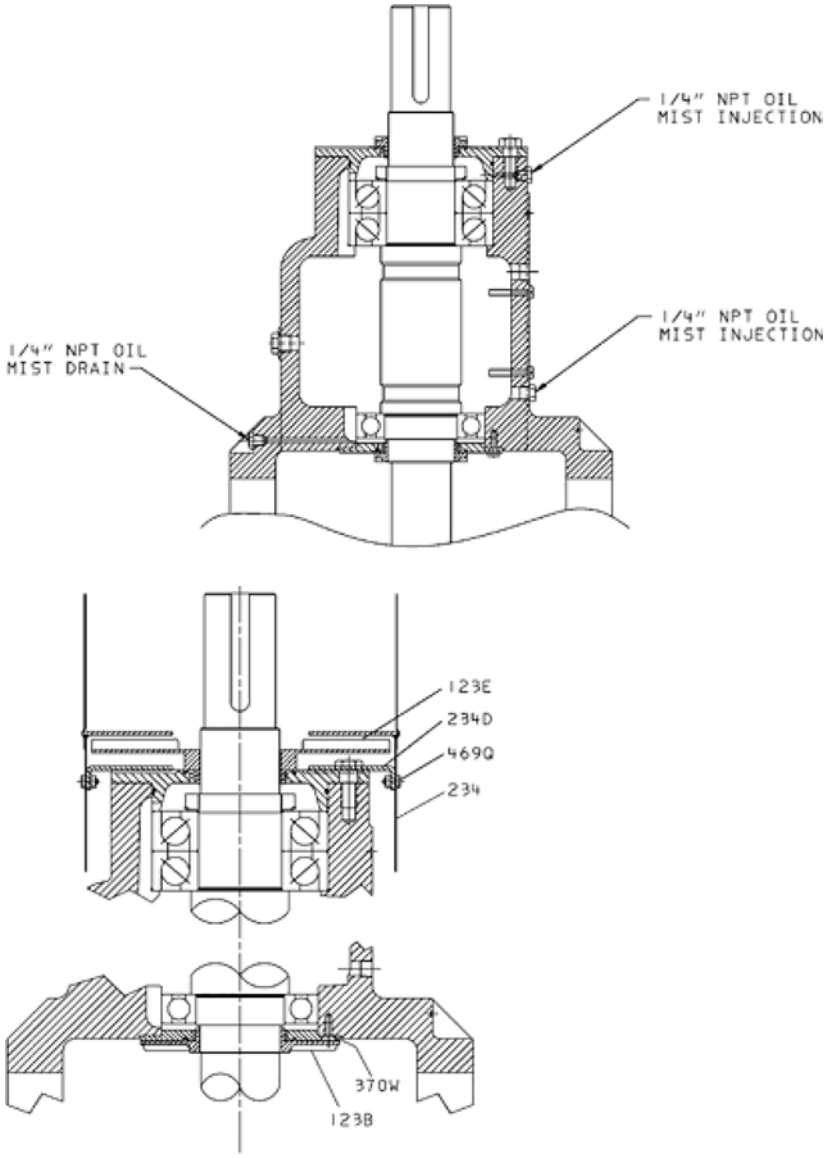
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370W
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9 Local ITT Contacts

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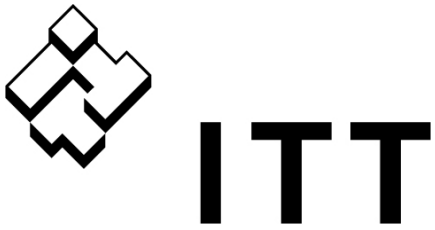

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