GOULDS PUMPS

# Installation, Operation, and Maintenance Manual

Model 3700i API610 / Type OH2

ITT

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# 1 Introduction and Safety

## 1.1 Introduction

**Purpose of this manual**

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

- Installation
- Operation
- Maintenance

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

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

### 1.1.1 Requesting other information

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

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

## 1.2 Safety

**WARNING:**

- 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<br>• 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.
- Make sure that the equipment is properly insulated when it operates at extreme temperatures.
- Recognize the site emergency exits, eye wash stations, emergency showers and toilets.
- Allow all system and pump components to cool before you handle them.
- Make sure that you have a clear path of retreat.
- Make sure that the product cannot roll or fall over and injure people or damage property.
- Make sure that the lifting equipment is in good condition.
- Use a lifting harness, a safety line, and a breathing device as required.
- Make sure that the product is thoroughly clean.
- Make sure that there are no poisonous gases within the work area.
- Make sure that you have quick access to a first-aid kit.
- Disconnect and lock out power before servicing.
- Check the explosion risk before you weld or use electric hand tools.

## 1.2.3.2 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.<br>2. Rinse the eyes with eyewash or running water for at least 15 minutes.<br>3. Seek medical attention. |
| Chemicals or hazardous fluids on skin | 1. Remove contaminated clothing.<br>2. Wash the skin with soap and water for at least 1 minute.<br>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 See the nameplate for maximum submersion, according to standard IEC 60529.

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

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

### Description of Ex-Directives

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

### Guidelines for compliance

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

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

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

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

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

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

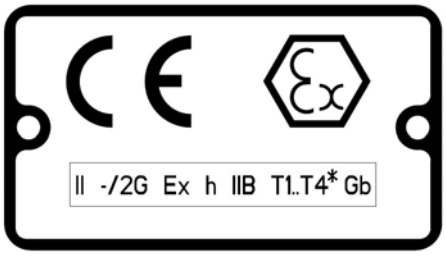



**Figure 1: Typical Ex nameplate**


**Figure 2: Typical UKCA Ex nameplate**

**Table 1: Temperature class definitions**

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

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

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

**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:

**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.

**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**

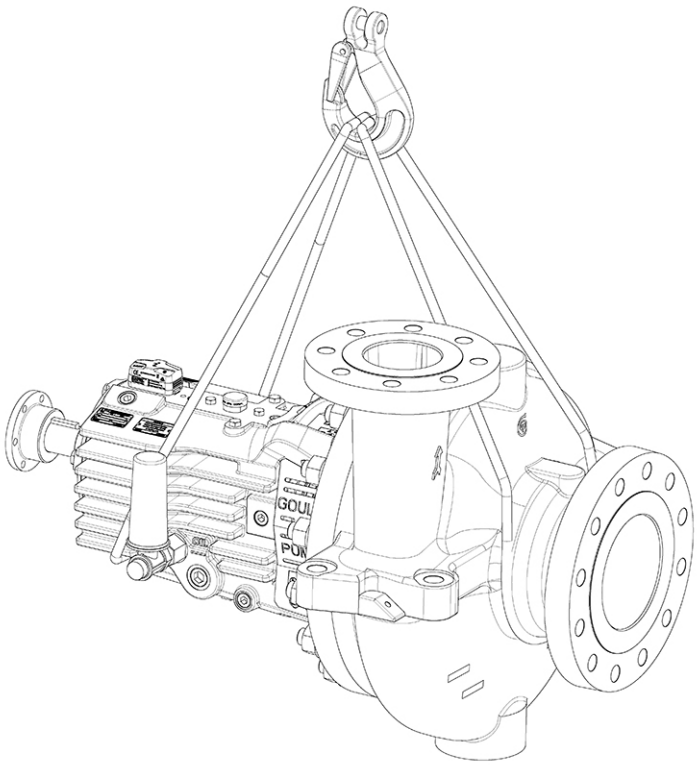


**Figure 3: Example of a proper lifting method of pump with driver**

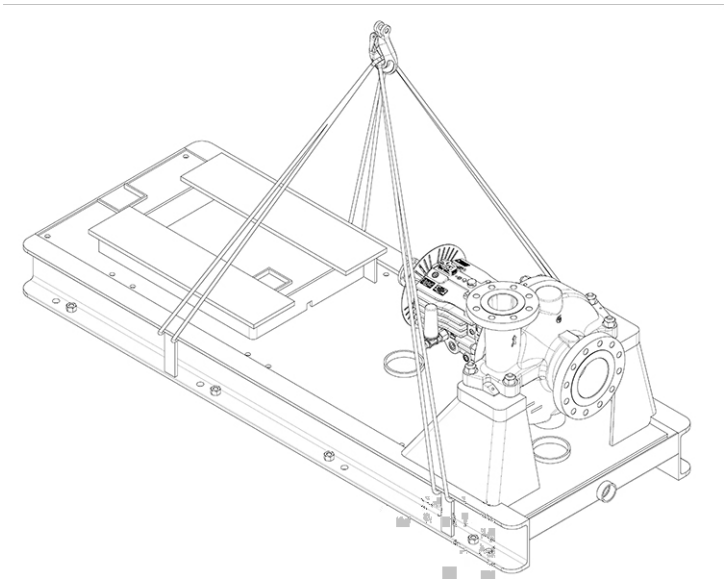


**Figure 4: Example of a proper lifting method of pump and driver on base plate**

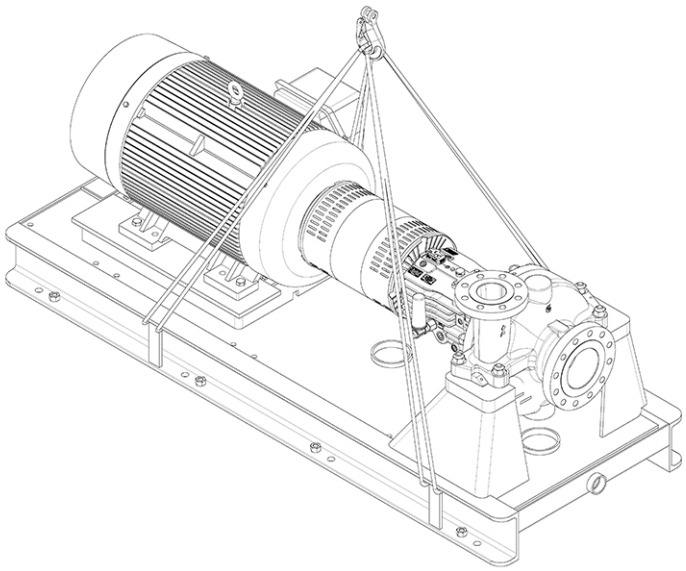


**Figure 5: Example of a proper lifting method of pump on base plate with driver and motor**

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

| Length of time in storage | Storage requirements |
|---|---|
| | • Rotate the shaft by hand several times at least every three months. |

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

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

### 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 3700i

**Product description**

The Model 3700i is a high-pressure, high-temperature centrifugal pump that meets the requirements of API Standard 610.

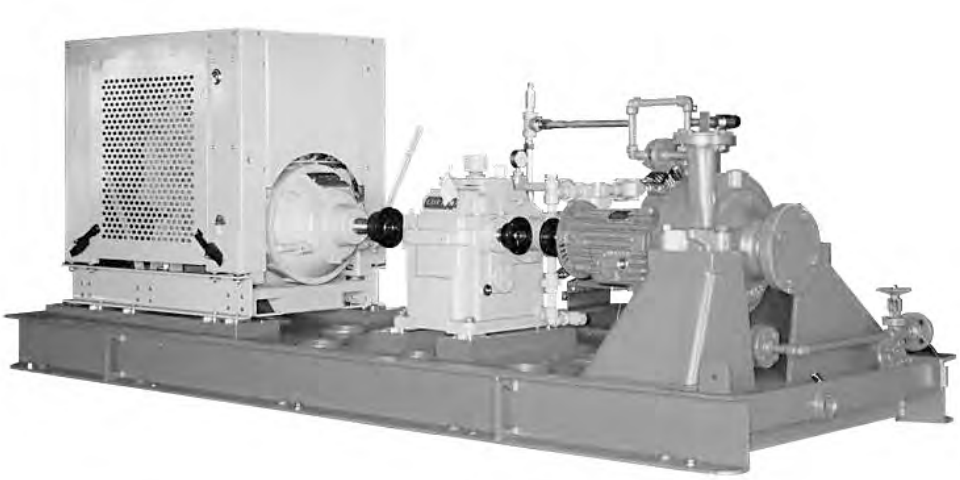


**Figure 6: 3700i pump**

**Casing**

The casing is a centerline-mounted design. The gasket is fully confined.

The standard flanges are ASME B16.5 Class 300 raised-face. The following flanges are also available:

- Class 600 raised-face
- Class 300 ring joint
- Class 600 ring joint

**Flange orientation**

- End Suction
- Top Discharge

**Impeller**

The impeller is fully enclosed and key driven by the shaft. Impeller nut with a locking screw prevents axial movement:

**Seal-chamber cover**

The seal-chamber geometry meets API 610 12th edition standard dimensions.

### Power end

The power end has the following characteristics:

- Ring oil-lubricated bearings
- Bearing isolators
- TRICO watchdog oiler
- Instrumentation provisions
- Oil filter assembly
- Shaft guard
- Optional pure oil mist lubrication (Oil mist plugs are required to convert from ring oil lubrication to pure oil mist)
- Optional forced convection cooling
- Optional oil sump liquid cooling

### Shaft

The standard shaft is machined and ground to comply with API 610.

### Bearings

| Bearing type | Characteristics |
|---|---|
| Inboard (radial) | • Consists of a single-row deep-groove ball bearing<br>• Carries only radial load<br>• 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<br>• Shouldered and locked to the shaft<br>• Retained in the bearing frame to enable it to carry radial and thrust loads |

All fits are precision-machined to industry standards.

### Baseplate

The fabricated steel baseplate supports the pump, driver, and accessories in accordance with API-610 requirements.

### Direction of rotation

The shaft rotates counterclockwise when viewed from the drive end.

## 3.2 General description i-ALERT® Equipment Health Monitor

### Description

The i-ALERT® Equipment Health Monitor is a compact, battery-operated monitoring device that continuously measures the vibration and temperature of the pump power end. The i-ALERT® sensor uses blinking LED and wireless notification to alert the pump operator when the pump exceeds vibration and temperature limits. This allows the pump operator to make changes to the process or the pump before a catastrophic failure occurs. The i-ALERT® monitor allows customers to identify potential problems before they become costly failures. It tracks vibration, temperature, change in electromagnetic field and run-time hours and wirelessly syncs the data with the i-ALERT Gateway or with a smart phone or tablet using i-ALERT® mobile app.

More information available on https://www.i-alert.com/products/

Current IOMs are available at http://www.gouldspumps.com/en-us/tools-and-resources/literature/ - and - resources/literature/ IOMs, https://www.i-alert.com/ or your local ITT Goulds Pumps Sales Rep.

### Alarm mode

The condition monitor enters alarm mode when either vibration or temperature limits are exceeded over two consecutive readings within a user defined period. Alarm mode is indicated with red flashing LED.

**Table 4: Temperature and vibration limits**

| Variable | Limit |
|---|---|
| Temperature | 100°C \| 195°F Surface Temperature |
| Vibration | 100% increase over the baseline level |

### Battery life

The i-ALERT® Condition Monitor battery is replaceable.

The battery life is not covered as part of the standard pump warranty.

This table shows the average condition monitor battery life under normal and alarm-mode operating conditions.

| Condition monitor operational state | Battery life |
|---|---|
| Normal operating and environmental conditions | Three to five years |
| Alarm mode | One year |

## 3.3 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.<br>(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

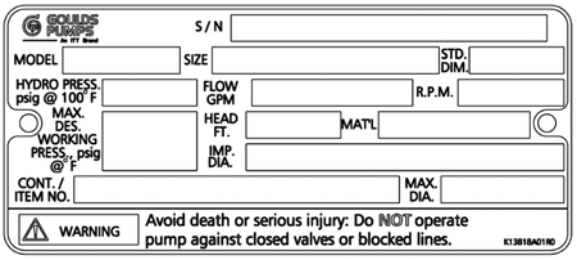



**Figure 7: Nameplate on the pump casing using English units**

| 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

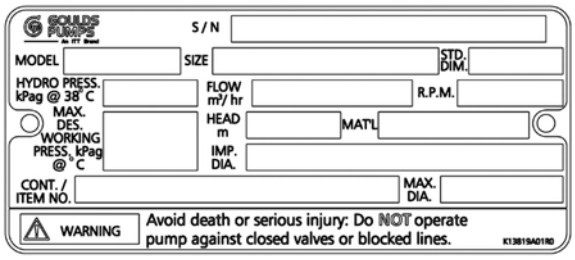



**Figure 8: Metric units - nameplate on pump casing**

| 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 |

| Nameplate field | Explanation |
|---|---|
| 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

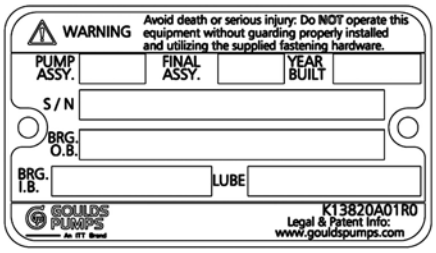



**Figure 9: Nameplate on the bearing frame**

**Table 5: Explanation of the nameplate on the bearing frame**

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

### Ex nameplate

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

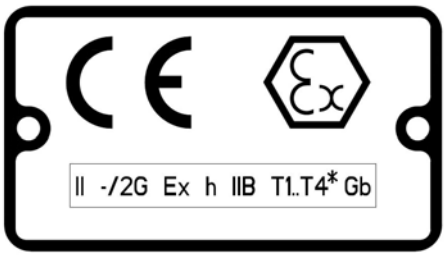



**Figure 10: Typical Ex nameplate**


**Figure 11: Typical UKCA Ex nameplate**

**ISO 80079-37:2016 Section 5.7**

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 Pump location guidelines

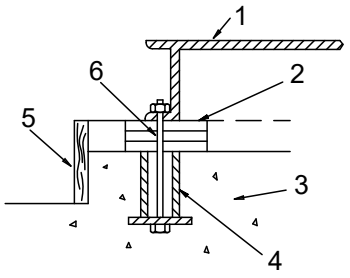
| Guideline | Explanation/comment |
|---|---|
| Keep the pump as close to the liquid source as practically possible. | This minimizes the friction loss and keeps the suction piping as short as possible. |
| Make sure that the space around the pump is sufficient. | This facilitates ventilation, inspection, maintenance, and service. |
| If you require lifting equipment such as a hoist or tackle, make sure that there is enough space above the pump. | This makes it easier to properly use the lifting equipment and safely remove and relocate the components to a safe location. |
| Protect the unit from weather and water damage due to rain, flooding, and freezing temperatures. | 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:<br>• Pressure relief valves<br>• Compression tanks<br>• Pressure controls<br>• Temperature controls<br>• Flow controls<br>If the system does not include these devices, consult the engineer or architect in charge before you operate the pump. |
| Take into consideration the occurrence of unwanted noise and vibration. | The best pump location for noise and vibration absorption is on a concrete floor with subsoil underneath. |
| If the pump location is overhead, undertake special precautions to reduce possible noise transmission. | Consider a consultation with a noise specialist. |

## 4.1.2 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.

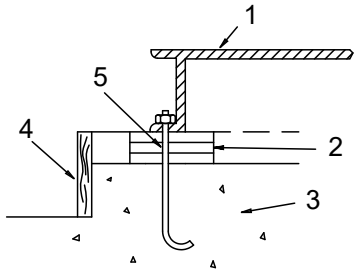
**Sleeve-type bolts**




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

**Figure 12: Sleeve type bolts**

**J-type bolts**




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

**Figure 13: 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.

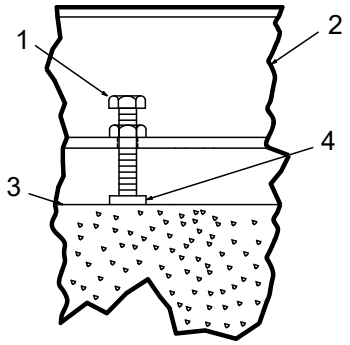
1. Apply an anti-seize compound on the jackscrews.
   The compound makes it easier to remove the screws after you grout.
2. Lower the baseplate carefully onto the foundation bolts and perform these steps:

   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 14: 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 and fasten the pump on the baseplate. Use applicable bolts.
2. Mount the driver on the baseplate. Use applicable bolts and hand tighten.
3. 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. |
| After you connect the piping | This ensures that pipe strains have not altered the alignment.<br>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.

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. |

| Guideline | Explanation |
|---|---|
| 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.

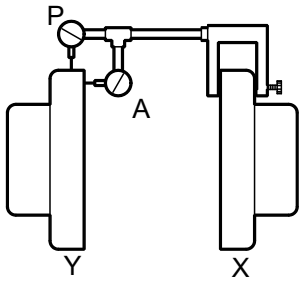



**Figure 15: Dial indicator attachment**

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.

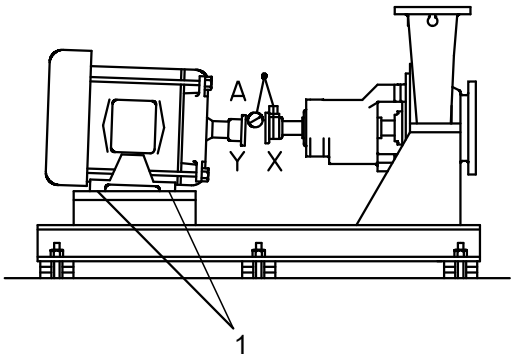
## 4.4.5 Pump-to-driver alignment instructions

## 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:<br>• Add shims in order to raise the feet of the driver at the shaft end.<br>• Remove shims in order to lower the feet of the driver at the other end. |

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




| Item | Description |
|---|---|
| 1. | Shims |

**Figure 16: Example of incorrect vertical alignment (side view)**

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

## 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:<br>• Slide the shaft end of the driver to the left.<br>• 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:<br>• Slide the shaft end of the driver to the right.<br>• Slide the opposite end to the left. |

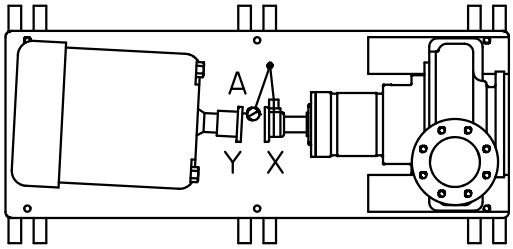



**Figure 17: Example of incorrect horizontal alignment (top view)**

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

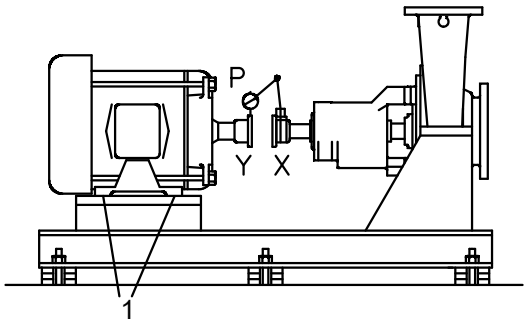
Refer to the alignment table in "Permitted indicator values for alignment checks" (see Table of Contents for location of table) for the proper cold alignment value based on the motor temperature rise and the pump operating temperature.

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 18: 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.

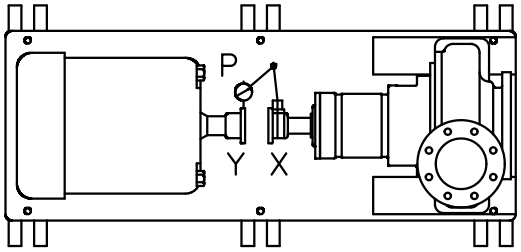



**Figure 19: Example of incorrect horizontal alignment (top view)**

5. 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.

## 4.4.5.5 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.

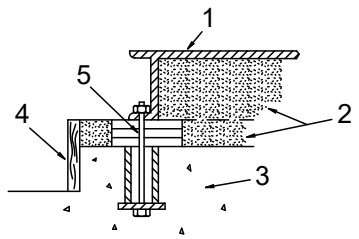
## 4.5 Grout the baseplate

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 20: 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 the Hydraulic Institute at 9 Sylvan Way, Parsippany, NJ 07054-3802. You must review this document before you install the pump.

### Alignment criteria for pump flanges

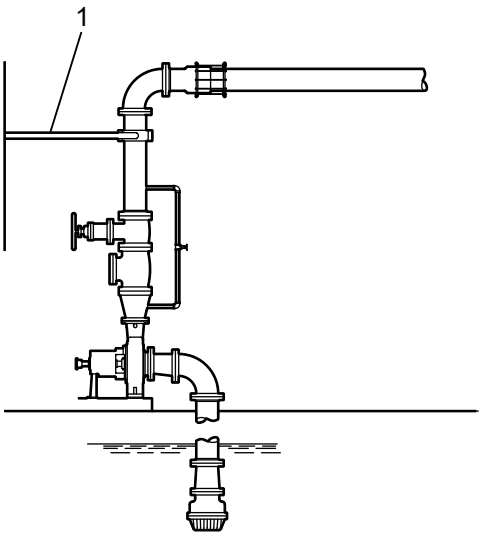
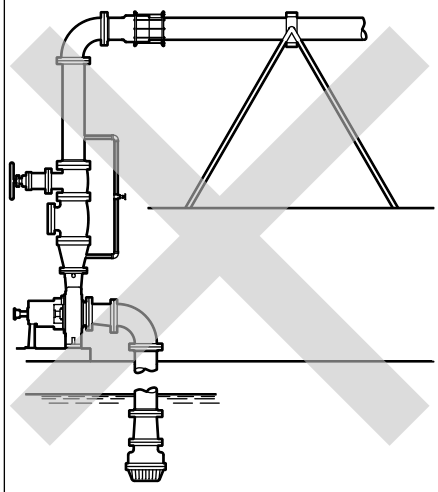
| Type | Criteria |
|---|---|
| Axial | The flange gasket thickness ±0.8 mm \| 0.03 in. |
| Parallel | Align the flange to be within 0.001 mm per mm \| in. per in. of the flange diameter to 0.8mm \| 0.03 in. max. |
| Concentric | You can easily install the flange bolts by hand. |

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:<br>  <br><br>1. Expansion loop/joint | This illustration shows an incorrect installation for expansion:<br>  |

## 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.<br>See the Example sections for illustrations. | |
| Check that elbows in general do not have sharp bends. | See the Example sections for illustrations.<br>— | |
| Check that the suction piping is one or two sizes larger than the suction inlet of the pump.<br>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.<br>See the Example sections for illustrations. | |
| Check that the eccentric reducer at the suction flange of the pump has the following properties:<br>• Sloping side down<br>• Horizontal side at the top | See the example illustrations. | |
| It is recommended that a commissioning (temporary) suction strainer be used.<br>After commissioning it is recommended an operating (permanent) suction strainer be used.<br>Check that the strainer has at least three times the area of the suction piping.<br>Check the location of the suction strainer is at least 5 pipe diameters from the suction nozzle.<br>Continuously monitor the pressure drop across the suction strainer.<br>Limit the pressure drop across the strainer to 68.9 kPa \| 10 psi, or the vapor pressure of the pumped fluid, or the resulting NPSHr is not adequate.<br>After a period of time (24 hours minimum) system flushing should be complete and the commissioning (temporary) suction strainer can be removed. | Suction strainers help to prevent debris from entering the pump<br>Recommended commissioning (temporary) strainer mesh size:<br>• Viscosity≤100cP use 60 mesh<br>• Viscosity>100cP use 40 mesh<br>• Viscosity>300cP use 20 mesh<br>Recommended operating (permanent) strainer mesh size:<br>• Viscosity≤100cP use 40 mesh<br>• Viscosity>100cP use 20 mesh<br>• Viscosity>300cP use 12 mesh | |
| 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. | — | |

| Check | Explanation/comment | Checked |
|---|---|---|
| Assure adequate insulation is applied for liquids with specific gravity less than 0.60. | To assure sufficient NPSHa. | |

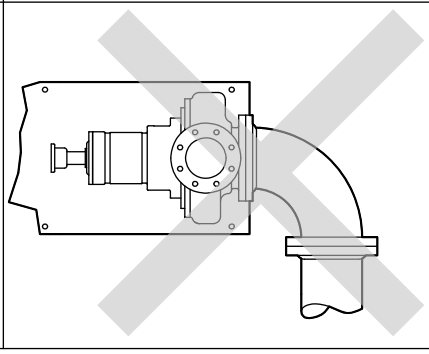
### Liquid source below the pump

| 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. | |

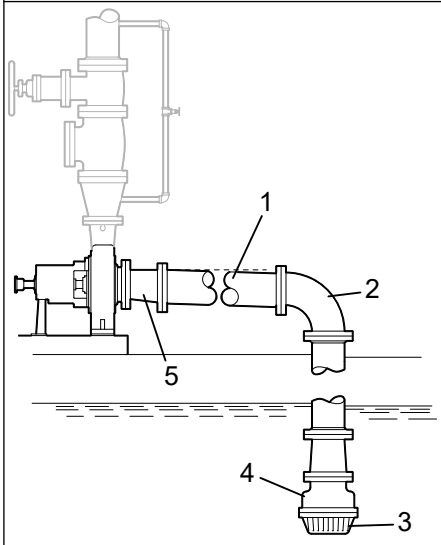
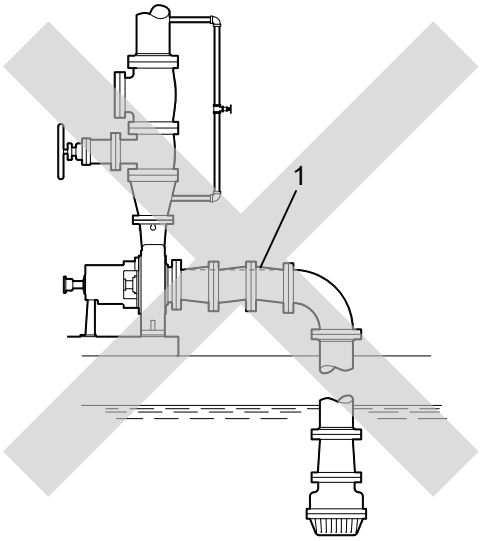
### Liquid source above the pump

| 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.<br>Do not use the isolation valve to throttle the pump. Throttling can cause these problems:<br>• Loss of priming<br>• Excessive temperatures<br>• Damage to the pump<br>• 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. |  |

**Example: Suction piping equipment**

| Correct | Incorrect |
|---|---|
|  |  |
| 1. Suction pipe sloping upwards from liquid source<br>2. Long-radius elbow<br>3. Strainer<br>4. Foot valve<br>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 |

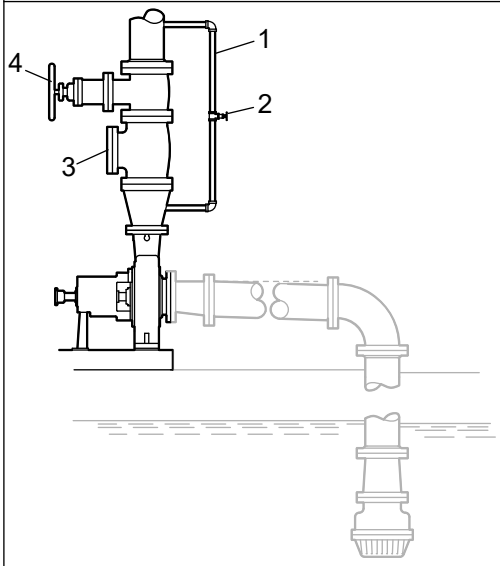
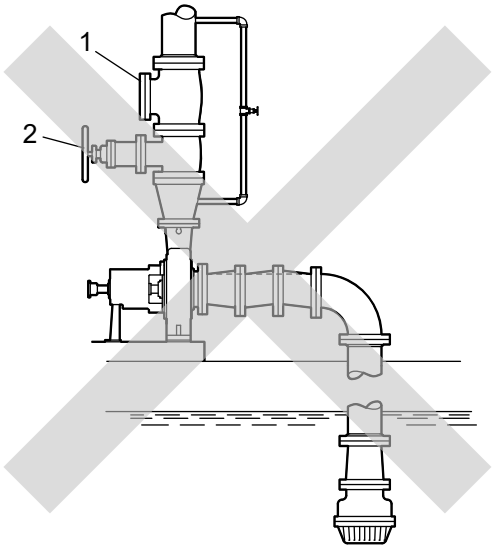
## 4.6.3 Discharge piping checklist

**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:<br>• Priming<br>• Regulation of flow<br>• Inspection and maintenance of the pump<br>• Reduce risk of pumpage vaporization and vapor locking at low flow rates for low specific gravity liquids.<br>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.<br>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.<br>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. | |

| Check | Explanation/comment | Checked |
|---|---|---|
| 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<br>2. Shut-off valve<br>3. Check valve<br>4. Discharge isolation valve | 1. Check valve (incorrect position)<br>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.<br>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 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.
- Excessive warm-up rates can cause equipment damage. Ensure the warm-up rate does not exceed 2.8°C | 5°F per minute.
- The maximum allowable temperature change for an abnormal transient event such as thermal shock is 167°C | 300°F or 150°F (83°C) for austenitic and duplex stainless steel construction.

**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.
- If temperatures of the pumped fluid will exceed 150°C | 300°F, then warm up the pump prior to operation. Circulate a small amount of fluid through the pump until the casing temperature is within 39°C | 70°F of the fluid temperature. Accomplish this by flowing fluid through the casing drain and allowing it to flow through the pump exiting at the discharge nozzle (optionally, fluid may also be allowed to enter the suction nozzle in addition to the drain.). Soak for (2) hours at process fluid temperature.

**NOTICE:**
For pumps with austenitic or duplex stainless steel casing construction, the temperatures stated above must be halved. E.g. for D-1 construction the recommended warm up rate is 1.5°C to 3°C | 2.5°F to 4.5°F per minute.

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 (508) toward the pump.
3. Remove the nut, bolt, and washers from the driver half (508) of the coupling guard.

4. Remove the driver half (508) of the coupling guard:
   a) Slightly spread the bottom apart.
   b) Lift upwards.
5. Remove the remaining nut, bolt, and washers from the pump half of the coupling guard (509).
   It is not necessary to remove the end plate (234A) from the pump side of the bearing frame. You can access the bearing-frame cap screws (370N) without removing this end plate (234A) if maintenance of internal pump parts is necessary.
6. Remove the pump half of the coupling guard (509):
   a) Slightly spread the bottom apart.
   b) Lift upwards.

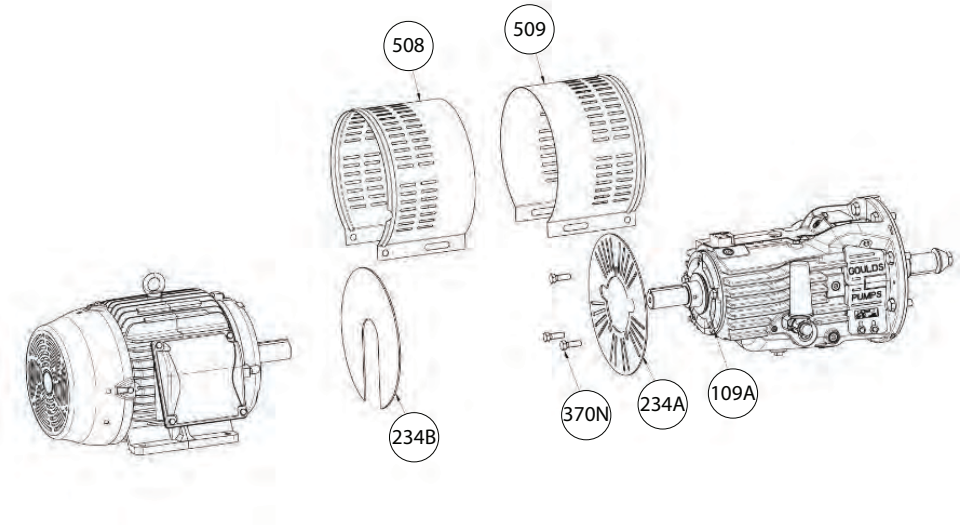



**Figure 21: Coupling guard removal**

# 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.

**Parts required**

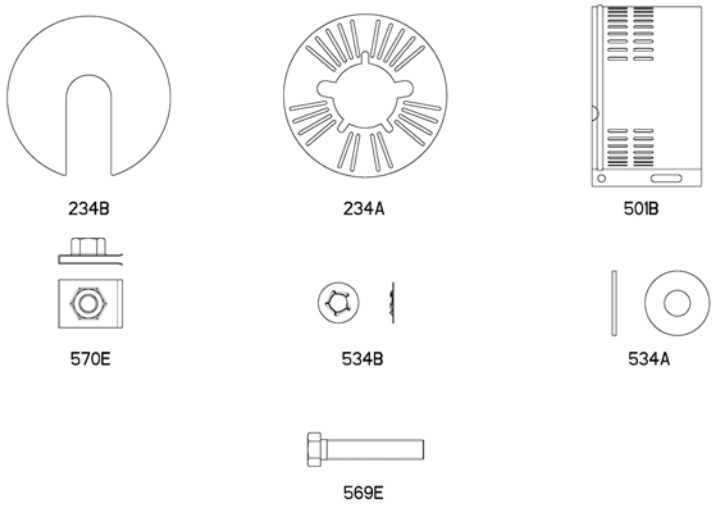



**Figure 22: Coupling guard required parts**

| Item No. | Description | Item No. | Description |
|---|---|---|---|
| 234A | End plate, pump end | 534B | Retainer (qty 3) |
| 234B | End plate, drive end | 569E | Hex cap screw (qty 3) |
| 501B | Guard half (qty 2) | 570E | U-nut (qty 3) |
| 534A | 3/8" washer (qty 3) | | |

## 5.4.1.1 Install the coupling guard

1. Is the end plate (pump end) (234A) 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 five outboard end cover cap screws (370N) and torque to the value shown in the 6.6.10 Assembly references on page 110.

   d) Remove the three thrust bearing end cover cap screws (370N) shown below.

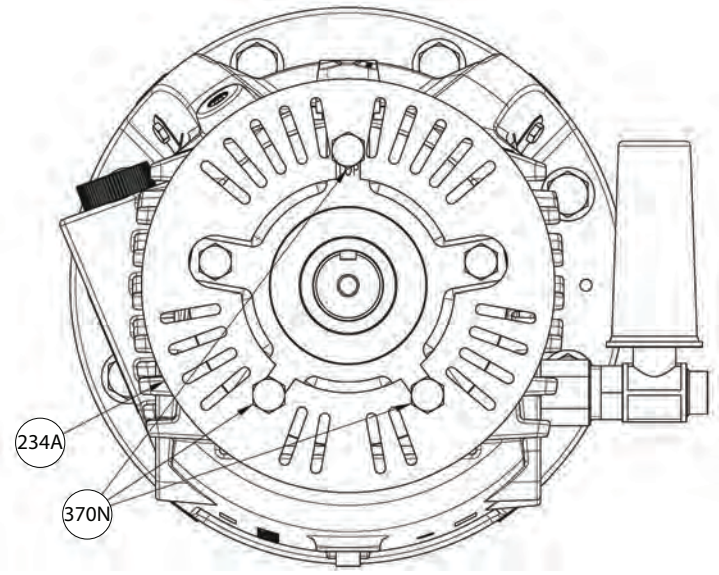



**Figure 23: Thrust bearing end cover removal**

e) Align the end plate to the thrust bearing end cover so that the two slots in the end plate (234A) align with the end cover cap screws (370N) remaining in the end cover, and the five holes in the end plate align with the holes in the end cover.

f) Replace the three bearing end cover cap screws (370N) and torque to the values shown in the Maximum torque values for 3700i 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.

   The annular groove in the guard is located around the end plate (234A).

   Position the opening (flange) so that it does not interfere with the piping but still allows for access when you install the bolts.

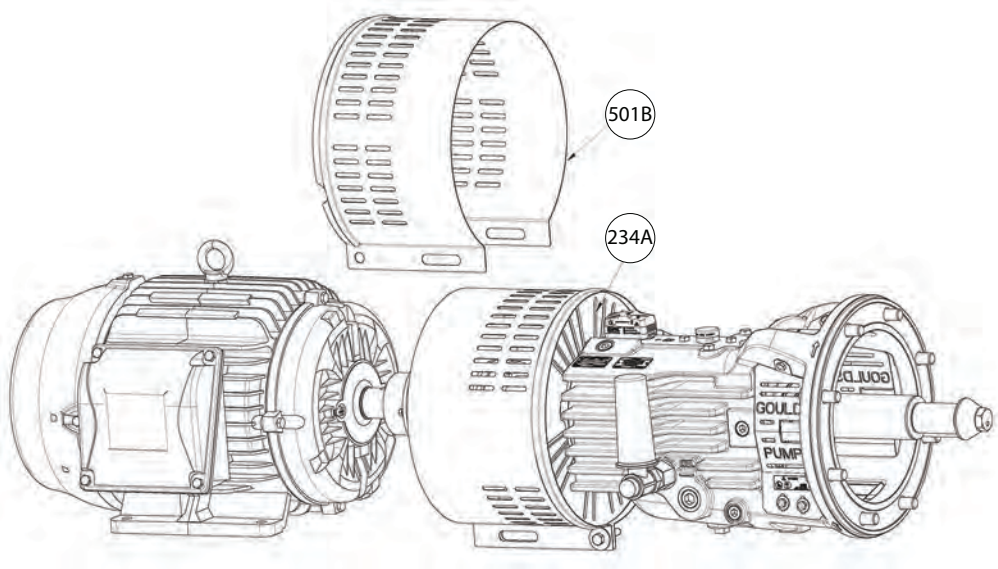



**Figure 24: Coupling guard**

3. Place one washer (534A) over the bolt (569E) and insert the bolt through the round hole at the front end of the guard half.
4. Place a second washer (534B) over the exposed end of the bolt.
5. Thread a nut (570E) onto the exposed end of the bolt and tighten firmly.

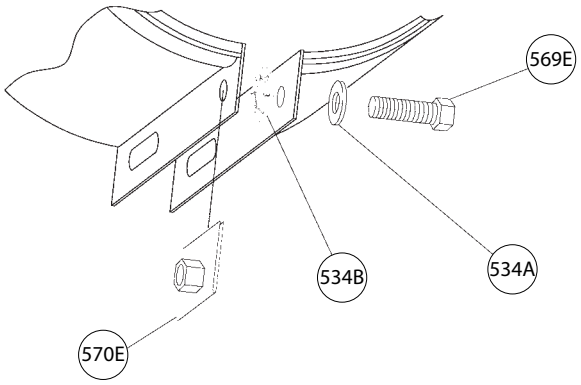



**Figure 25: Coupling guard hardware installation**

6. Slightly spread the opening of the remaining coupling guard half (501B) and place it over the installed coupling guard half so that the annular groove in the remaining coupling guard half faces the driver.

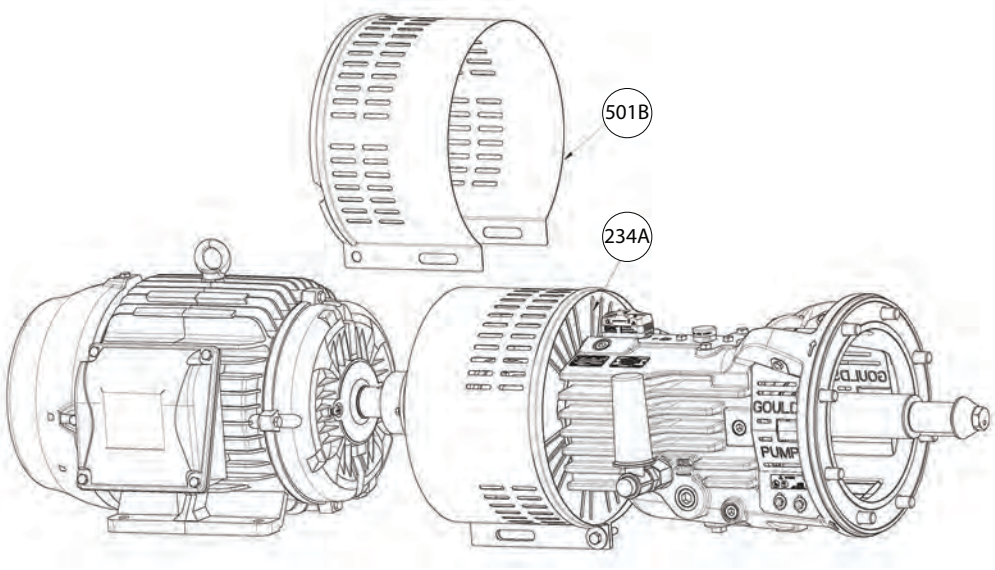



**Figure 26: Coupling guard motor**

7. Place the end plate (234B) over the driver shaft and locate the end plate (234B) in the annular groove at the rear of the coupling guard half (501B).

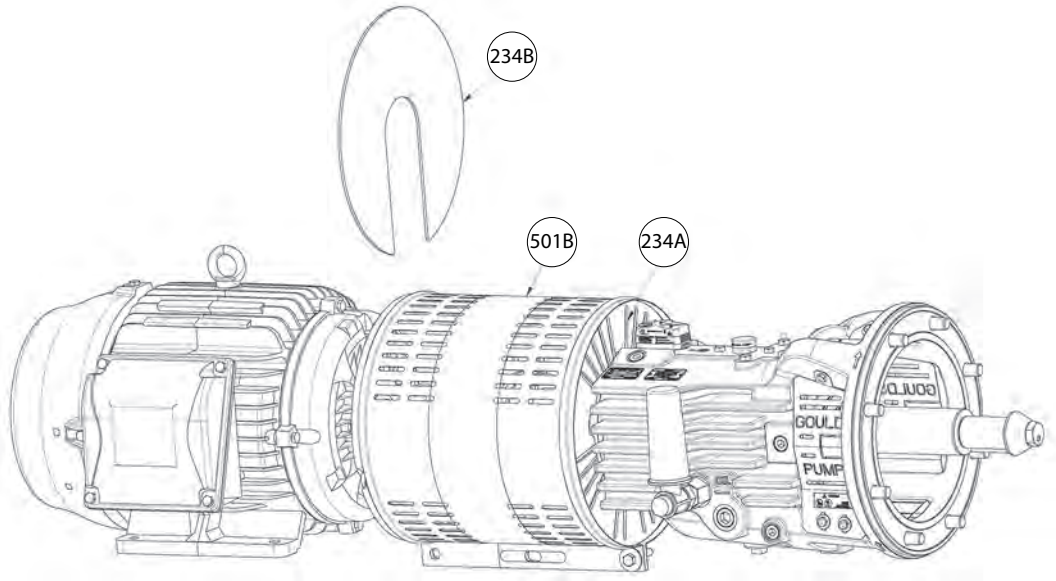



**Figure 27: Coupling guard motor end plate**

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.

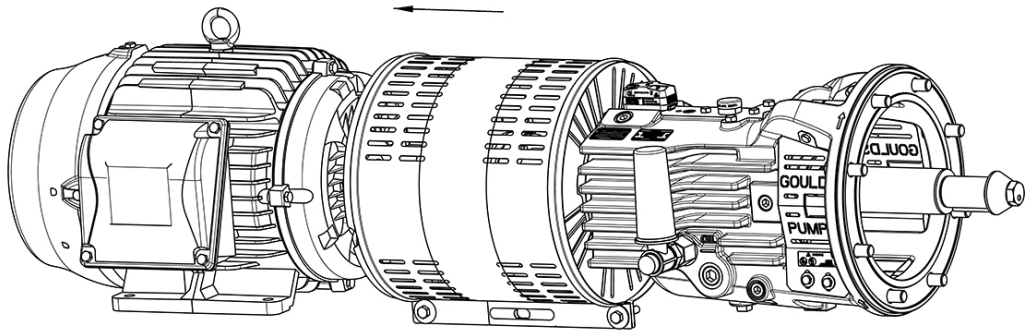



**Figure 28: Slide to fit**

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 forced convection cooling (as required) - cooling fan, guards and cowling

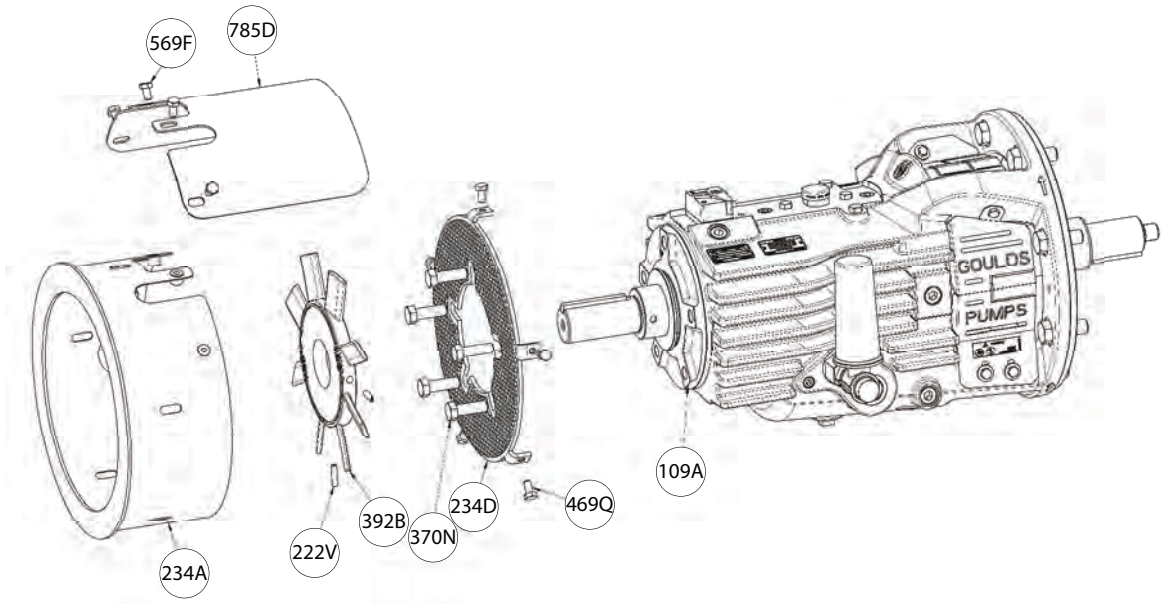



**Figure 29: Install the Forced Convection Cooling (As required)- Cooling Fan, Guards and Cowling**

Is the cooling fan shroud support (234D) already installed?

a) If yes; install cooling fan (392B) and tighten set screws (222V) and then proceed to Step 2.

b) If no; complete these steps.

- Remove quantity 5 bolts (370N) from the thrust bearing frame end cover (109A)
- Align the cooling fan shroud support (234D) to the thrust bearing frame end cover (109A) so the holes in the pump cooling fan shroud align with the holes in the thrust bearing frame end cover and replace quantity 5 bolts (370N).
- Evenly tighten bolts (370N) and torque to the maximum torque values for 3700i fasteners table.

1. Slide the cooling fan (392B) onto the shaft, align set screws (222V) with dimple in shaft and install quantity 2 set screws (222V). Make sure cast in "CCW" lettering and rotational arrow is facing towards the driver.
2. Install the cooling fan shroud (234A) by aligning 4 slots of cooling fan shroud over the cooling fan (392B) and cooling fan shroud support (234D). Fasten with quantity 5 Hex cap screws (469Q).
3. Position cooling fan cowling (785D) over cooling fan shroud (234A) and align matching instrumentation cut outs and fastening slots of cooling fan cowling (785D). Screw 4 hex cap screws (569F) into cooling fan shroud threaded inserts.
4. Install the coupling guard per 5.4.1.1 Install the coupling guard on page 47.

## 5.4.1.3 Install the Radial Heat Flinger (As required)

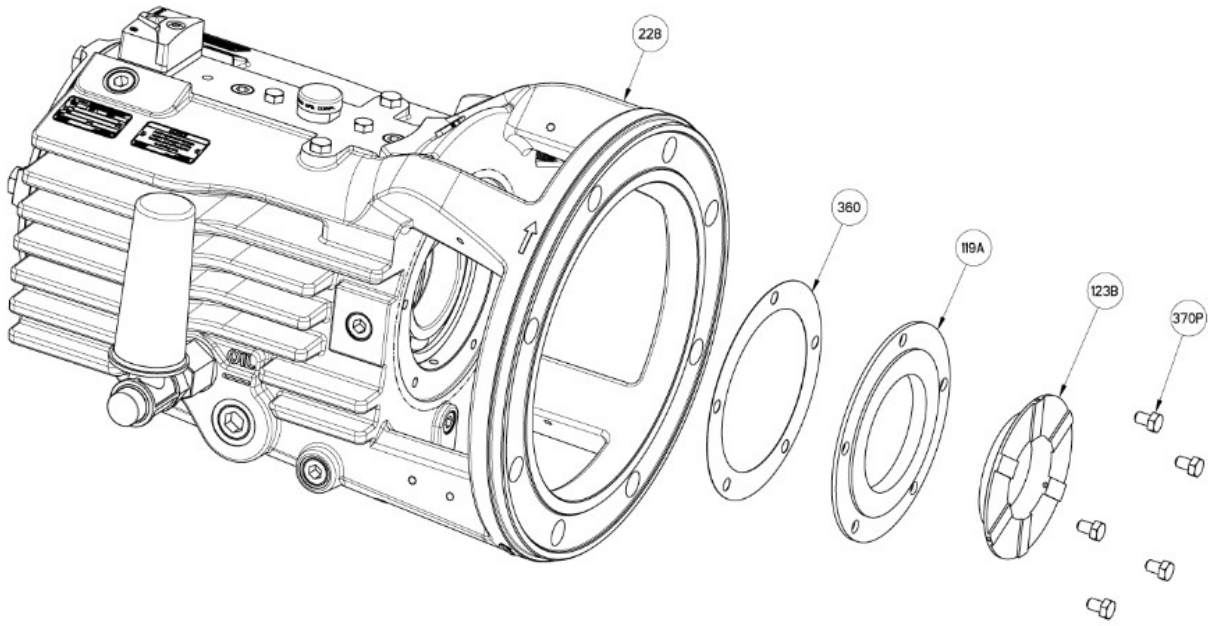



**Figure 30: Install the Air Cooling Package - Radial heat flinger**

1. Remove the standard INPRO seal bearing isolator (123) and replace with INPRO radial heat flinger (123B). Refer to 6.6.1 Assemble the power end on page 93.

## 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.

**Pumps are shipped without oil**

You must lubricate oil-lubricated bearings at the job site.

**Ring oil lubrication**

Ring oil-lubricated bearings are standard. Bearing housings are supplied with constant-level oilers and sight glasses. Make sure that oil ring properly seated in the grooves in the shaft.

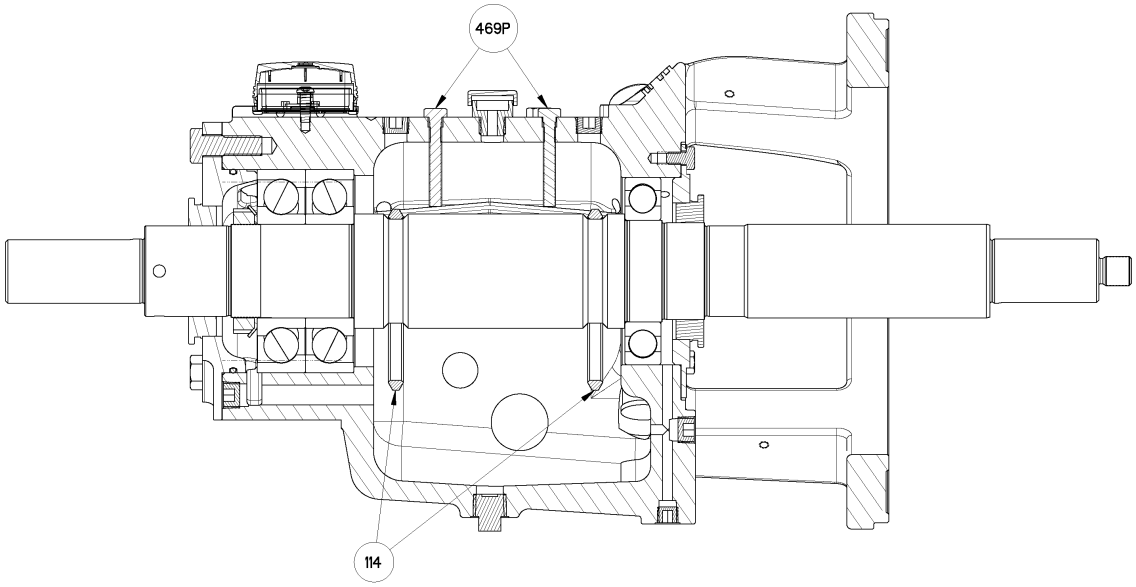



**Figure 31: Frame/shaft/rings in proper location**

### Pure or purge oil-mist lubrication

Pure or purge oil-mist are optional features for the 3700i. Follow the oil-mist generator manufacturer's instructions. The inlet and outlet connections are located on the top and bottom of the bearing frame, respectively.

## 5.4.2.1 Oil volumes

### Oil volume requirements for ball/ball bearings

All frames in this table use a Watchdog Oiler, which has a capacity of 118ml | 4 oz.

| Group | Maximum*1 operating speed RPM | Bearing sizes | | Method of lubrication | Oil Capacity*2 | |
|---|---|---|---|---|---|---|
| | | Radial bearing | Thrust bearing | | oz. | ml |
| 13i | 3600 | 6210 | 7310 | Ring oil (standard)<br>Pure oil and purge oil mist (optional) | 34 | 998 |
| 14i | 3600 | 6212 | 7312 | | 40 | 1183 |
| 24i | 3600 | 6212 | 7312 | | 40 | 1183 |
| 25i | 3600 | 6213 | 7312 | | 66 | 1973 |
| 35i | 3600 | 6213 | 7312 | | 66 | 1973 |
| 36i | 3600 | 6215 | 7313 | | 93 | 2724 |
| 47i | 1800 | 6218 | 7317 | | 133 | 3920 |
| 58i | 1800 | 6220 | 7318 | | 134 | 3953 |

*1 Consult factory for any speed that exceeds CDS curve speed

*2 Includes bearing frame and Watchdog oiler

## 5.4.2.2 Lubricating-oil requirements

### Oil quality requirements

Use a high-quality turbine oil with rust and oxidation inhibitors with rated viscosity shown below at 38°C | 100°F.

### Oil requirements based on temperature

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

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

## 5.4.2.3 Acceptable oil for lubricating bearings

### Acceptable lubricants

**Table 6: Acceptable lubricants**

| Brand | Lubricant type |
|---|---|
| Exxon | ISO VG 68 |
| Mobil | |
| Sunoco | |
| Royal Purple | |

## 5.4.2.4 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.

**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.

1. Fill the oil reservoir in the bearing frame:
   a) Fill the bearing chamber through the main body of the Watchdog or through the oil filter opening 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.

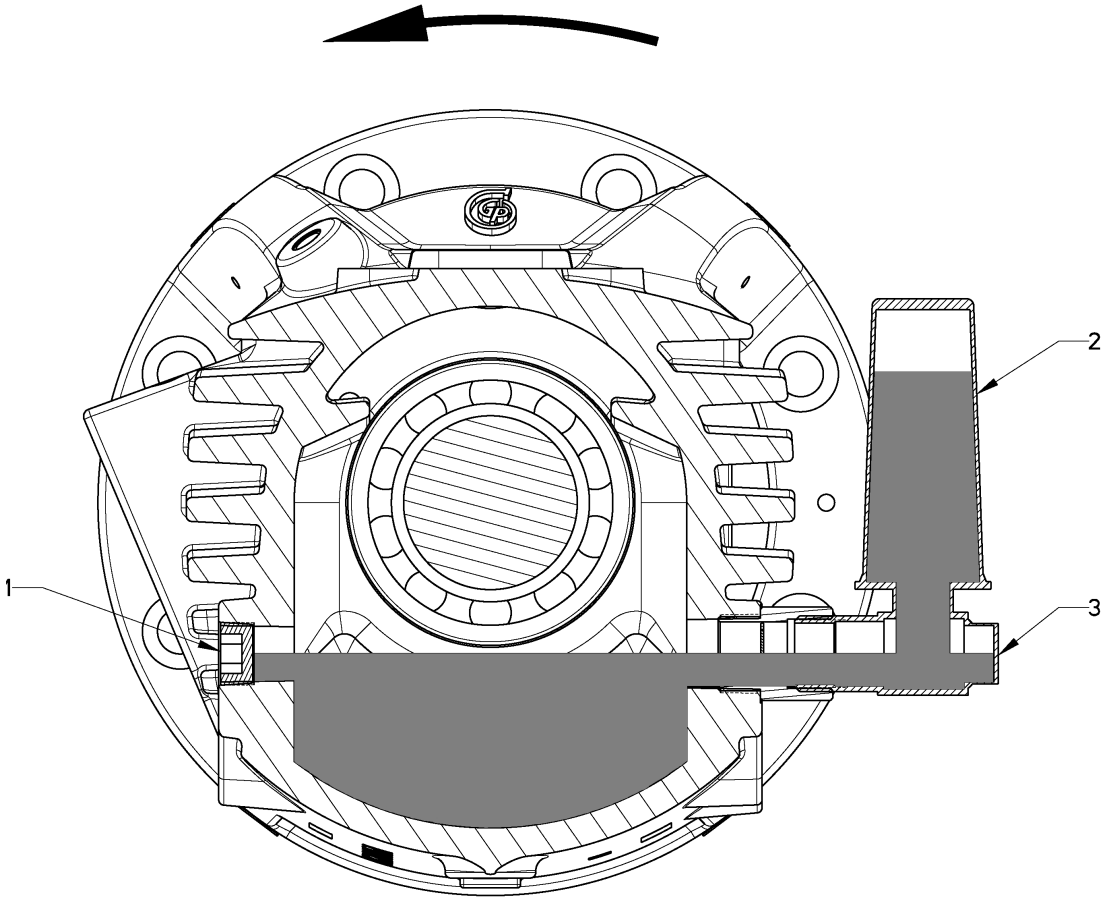



**Figure 32: Checking oil level**

## 5.4.2.5 Replace the oil filter

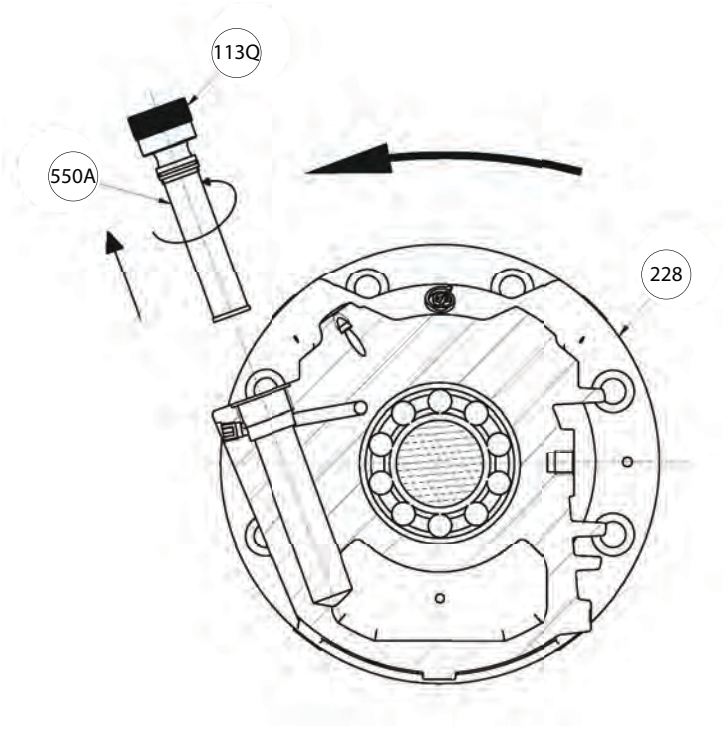



**Figure 33: Oil filter assembly removal**

1. Remove the oil filter (550A) and the oil filter plug (113Q) from the bearing frame (228).

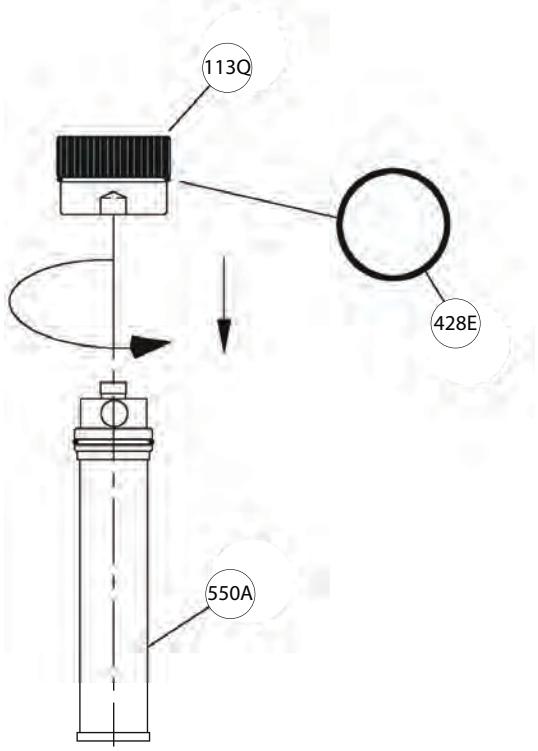



**Figure 34: Oil filter replacement**

2. Unscrew the filter (550A), part number K08174A from the plug (113Q), part number K06818A.

Keep the plug (113Q) and discard the old filter (550A). Please discard the oil filter per your local waste disposal requirements, .

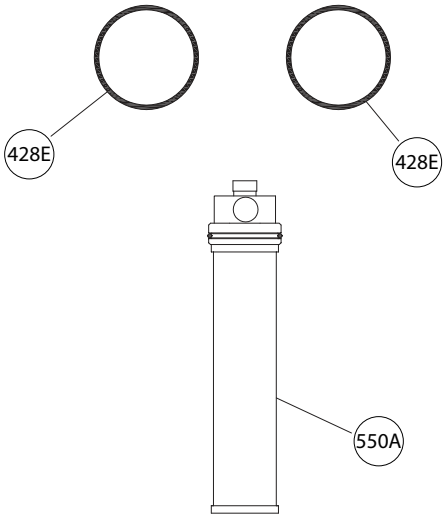



**Figure 35: Filter kit**

3. Repair Filter kit RK08174A consists of a new filter (550A) and two o-rings (428E).
4. Screw the new filter (550A) into the existing plug (113Q) and install the new o-ring (428E) to the plug (113Q) See Figure 37: New filter installation on page 58.

**NOTICE:**

Only one o-ring is required, the other is a spare if needed.

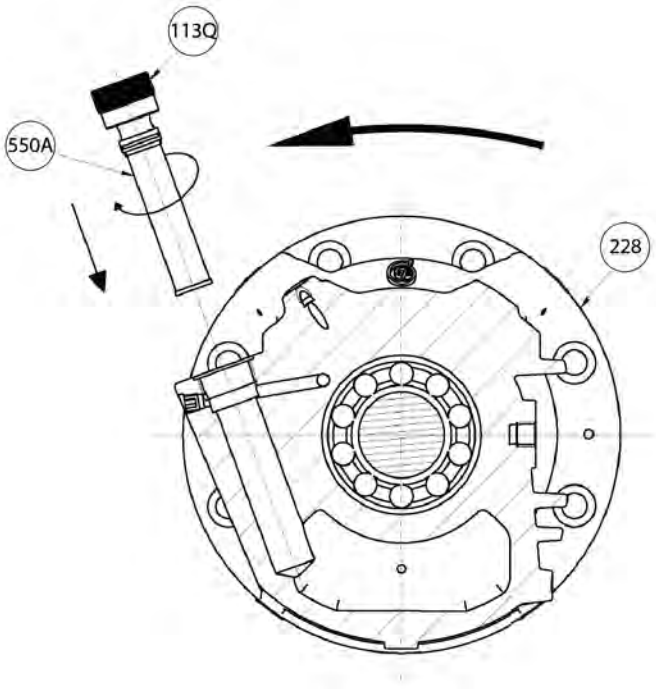



**Figure 36: New filter installation**

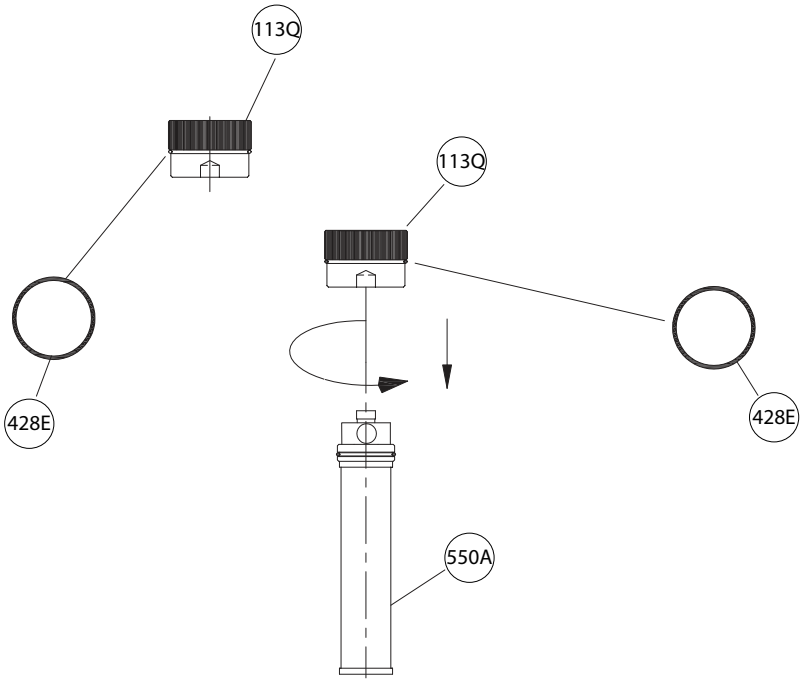


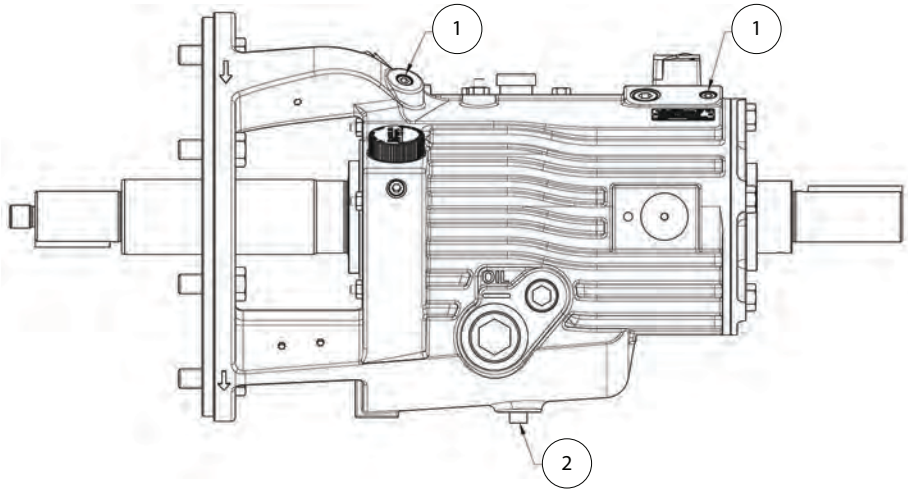

**Figure 37: New filter installation**

5. Screw the oil filter (550A) and the oil filter plug (113Q) back into the bearing frame (228).

## 5.4.2.6 Lubricate the bearings with pure or purge-oil mist (optional)

Before lubricating with purge-oil mist, make sure that the bearing frame is properly lubricated. See Lubricating the bearings.

1. Prepare the oil-mist generator according to the manufacturer's instructions.
2. Connect the oil-mist supply lines to the oil ring inspection plug connections. The oil requirements for ring-oil-lubricated bearings also apply to oil-mist-lubricated bearings.
3. Connect the drain and vent lines to the outlet connections.




1. Oil mist inlet
2. Oil mist outlet

**Figure 38: Oil mist lubrication**

4. For pure-oil mist, connect the drain lines to the outlet connections.

This is not required for purge-oil mist.

## 5.4.2.7 Convert to oil-mist lubrication

**NOTICE:**
Make sure that pipe threads are clean and apply thread sealant to plugs and fittings.

**NOTICE:**
For pure oil mist remove pipe plug (408Z and 408I) and install oil mist plugs (843U and 843V).

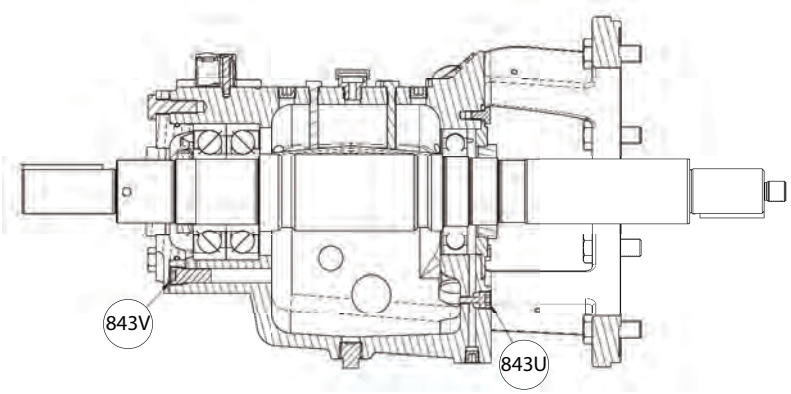



**Figure 39: Oil mist plugs**

Oil mist connections are provided on both the radial and thrust end of the bearing frame:

- 1/4 in. NPT connection on the radial side of the frame (228)
- 1/4 in. NPT connection on the thrust side of the frame (228).

Purge-oil mist lubrication provides intermittent oil mist in the frame. This system uses the oil sump in the housing, and requires the oil ring and the constant-level oiler.

Pure-oil mist lubrication provides constant oil mist in the frame. This system does not use the oil sump, oil ring, or constant-level oiler. The drain connections in the frame are used as part of the oil recirculation system.

1. On both the radial and thrust end replace the ¼" NPT plug (358F) with an oil mist fitting provided by the oil system manufacturer.
2. For pure-oil mist, connect the drain lines (408A) to the outlet connections. This is not required for the purge-oil mist.

## 5.4.2.8 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.
3. Refer to *Reassembly* section. Coat the internal bearing surfaces with lubricant to be used in service.

# 5.5 Shaft sealing with a mechanical seal

### Precautions

**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.

**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

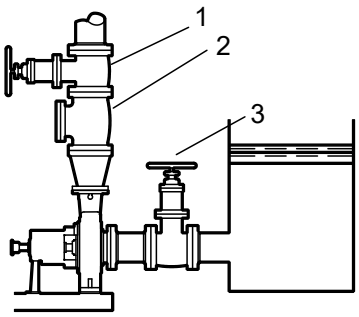
**Table 7: You can use these methods in order to flush or cool the seal:**

| 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 |

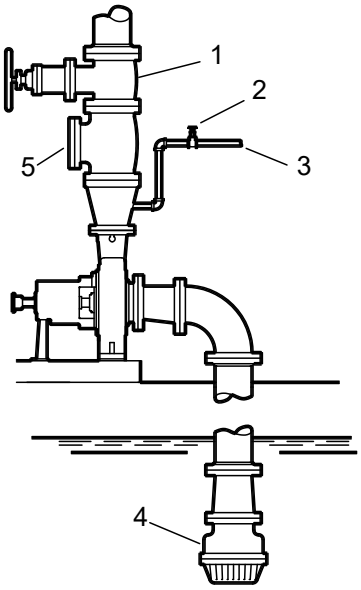
**Figure 40: Suction supply above pump**

## 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:

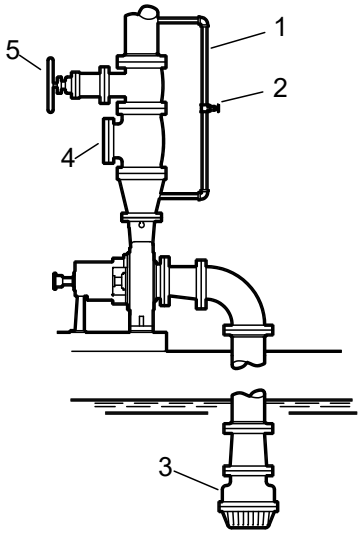
- A priming pump
- A pressurized discharge line
- Another outside supply

1. Close the discharge isolation valve.
2. Open the air vent valves in the casing.
3. Open the valve in the outside supply line until only liquid escapes from the vent valves.
4. Close the vent valves.
5. Close the outside supply line.




| Item | Description |
|---|---|
| 1. | Discharge isolation valve |
| 2. | Shutoff valve |
| 3. | From outside supply |
| 4. | Foot valve |
| 5. | Check valve |

**Figure 41: Pump priming with suction supply below pump with foot valve and an outside supply**




| Item | Description |
|---|---|
| 1. | By-pass line |
| 2. | Shutoff valve |
| 3. | Foot valve |
| 4. | Check valve |
| 5. | Discharge isolation valve |

**Figure 42: Pump priming with suction supply below pump with foot valve 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.

- To avoid risk of equipment damage, observe the pump for vibration levels, bearing temperature, and excessive noise. If normal levels are exceeded, shut down the pump and resolve the issue.
- On frame mounted units, ensure that the oil level is correct prior to starting pump. Close coupled pumps do not have oil lubricated bearings.

**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 i-ALERT® Equipment Health Monitor

**WARNING:**
Explosive hazard and risk of personal injury. Heating to high temperatures could cause combustion of the condition monitor. Never heat the condition monitor to temperatures in excess of 149°C | 300°F or dispose of in a fire.

For all information refer to the i-ALERT® Equipment Health Monitor Installation, Operation and Maintenance manual. https://www.i-alert.com/support/

# 5.10 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:**

On ring oil-lubricated pumps, remove oil ring viewing port plugs to verify the following:

- The oil rings are properly positioned in the grooves on the shaft.
- The oil rings are turning.
- The oil rings are throwing oil.

**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 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.
- Risk of equipment damage from unexpected heat generation. Do not overload the driver. Ensure that the pump operating conditions are suitable for the driver. The driver can overload in these circumstances:
  - The specific gravity or viscosity of the fluid is greater than expected
  - The pumped fluid exceeds the rated flow rate.
- Make sure the oil level has remained steady by checking the oiler.
- 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.
- For venturi pumps - Do not remove the venturi insert (100W) or loosen the fasteners while the unit is under pressure.

**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.

## 5.11 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.

## 5.12 Deactivate the i-ALERT® Equipment Health Monitor

**NOTICE:**
Always deactivate the health monitor when the pump is going to be shut down for an extended period of time. Failure to do so will result in reduced battery life.
Disengage the snap fit of the i-ALERT® using a flat head tool as shown below:


**Figure 43: Disengage the battery from the sensor when shutting the pump for an extended period of time**

## 5.13 Reset the i-ALERT® Health Monitor

To deactivate or reset the i-ALERT® monitor, please refer to the i-ALERT® IOM, http://i-alert.com/

Always reset the health monitor when the pump is started after maintenance, system change, or being shut down for an extended period of time. Failure to do so may result in false baseline levels that could cause the health monitor to alert in error.

## 5.14 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.
   Refer to 5.2 Remove the coupling guard on page 44.
4. Check the alignment while the unit is still hot.
5. Reinstall the coupling guard.

6. Restart the pump and driver.

# 5.15 Dowel the pump casing (Optional in standard pump builds, NOT recommended for hot alignment)

You will need the following tools:

- Two number 7 taper pins
- One number 7 taper pin reamer
- 0.3320 in. or "Q" size drill
- Hardwood block or soft-faced hammer

Also make sure that the final alignment is complete.

Dowel the pump casing to the baseplate pedestals in order to make sure that you maintain the proper pump position.

1. Drill two holes, one in each casing mounting pad, at the locations provided.
   Drill the holes through both the casing mounting pads and the baseplate pedestal, when possible. This makes it easier to clean the metal chips produced from the drilling and reaming operations.
2. Clean all burrs and metal chips from the holes.
3. Ream the holes with a number 7 taper pin reamer to the proper fit with the taper dowel pins.
   Insert the pins deep enough that only the threaded portion is exposed when the pin is fully seated.
4. Seat the taper pins firmly in the holes with a hardwood block or soft-faced hammer.

**NOTICE:**

Always remove the dowel pins before removing the casing. Failure to do so can result in casing damage.

# 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 the level and condition of the oil through the sight glass on the bearing frame.
- 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 that there is no leakage from the mechanical seal

**NOTICE:**
*If equipped, temperature and vibration levels can be retrieved by using your i-ALERT®3 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 oil every three months (2000 operating hours) at minimum.
- Change the oil filter assembly (550A) every 2000 hours.
- Change the oil and oil filter more often if there are adverse atmospheric or other conditions that might contaminate or break down the oil.
- 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.

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

**Table 8: 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 and oil filter after 200 hours for new bearings. | After the first 200 hours, change the oil filter every 2000 operating hours. If you do not change the oil filter as recommended, oil must be changed every 2000 hours. |

## 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
- Torque wrench with sockets
- 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) and casing insert (100W-venturi casings only). 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).Remove the case nuts (425) and washers (533).
2. Tighten the jackscrews (418) 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.

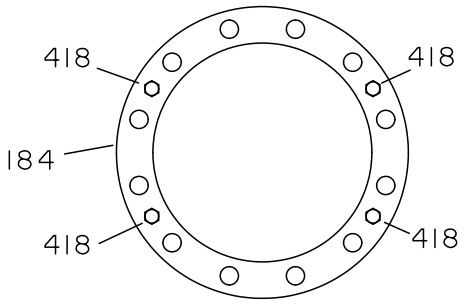



**Figure 44: Jackscrew tightening**

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

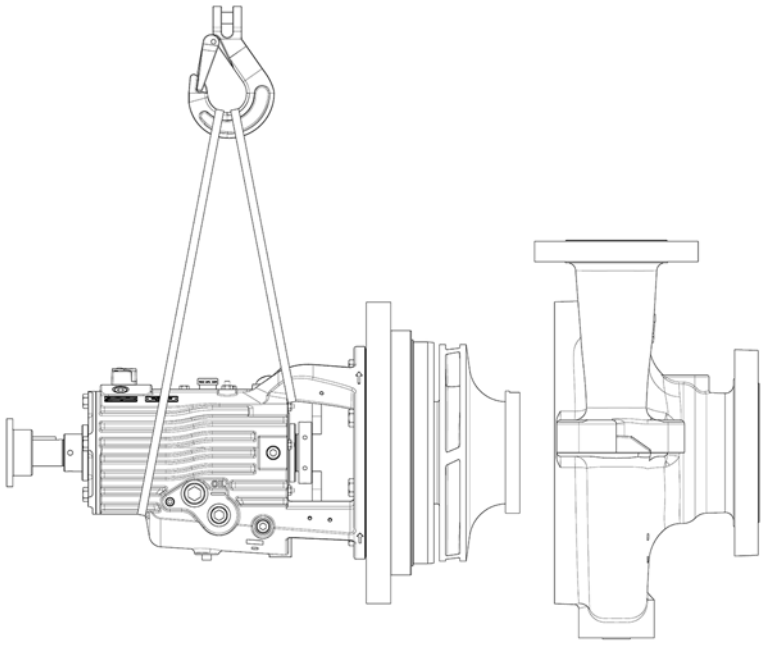


**Figure 45: Lifting sling through bearing frame**

4. Remove and discard the casing gasket (351).
   You will insert a new casing gasket during reassembly.
5. Remove the jackscrews (418).
6. Clean all gasket surfaces.
   Clean surfaces prevent the casing gasket (351) from partially adhering to the casing (100) and cover (184) 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

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

1. Loosen the set screw (198A) at the end of the impeller nut (304).
2. Loosen and remove the impeller nut (304).
   The impeller nut has left-hand threads.

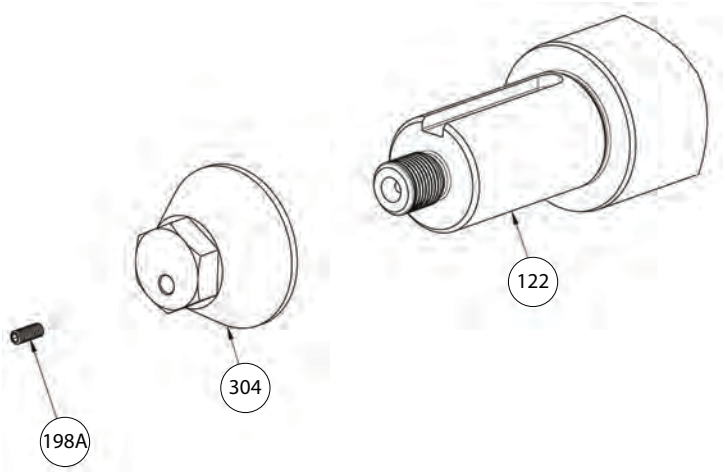



**Figure 46: Impeller removal**

3. Pull the impeller (101) from the shaft (122).
   Use a spanning-type puller if required.
4. Remove the impeller key (178).
   Save the key for reassembly unless it is damaged.

## 6.4.7 Remove venturi insert (venturi pumps only)

1. Loosen insert hex nuts (362B).
2. Tighten the jackscrews (362C) evenly in order to remove the venturi insert (100W).

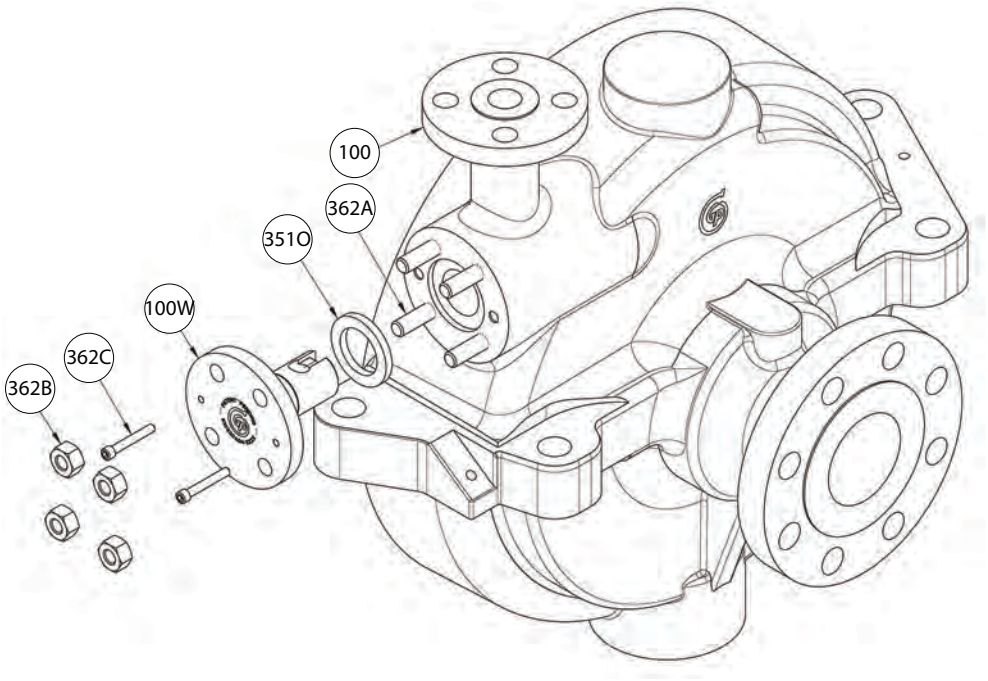



**Figure 47: Venturi insert removal**

3. Clean all gasket surfaces. Clean surfaces prevent the insert gasket (351O) from partially adhering to the case (100) and insert (100W) due to binders and adhesives in the gasket material.

## 6.4.8 Remove the seal-chamber cover

1. Loosen and remove the gland stud nuts (355).
2. Slide the cartridge mechanical seal away from the seal-chamber cover (184).
3. Install the eyebolt in the tapped hole provided in the seal-chamber cover (184).
4. Rig the lifting sling to the eyebolt and the overhead lifting device.
5. Loosen and remove the bearing frame bolts (370H) from the seal chamber cover (184).
6. Separate the seal-chamber cover (184) from the bearing frame (228) by tapping on the cover flange with a hardwood block or a soft-face hammer.

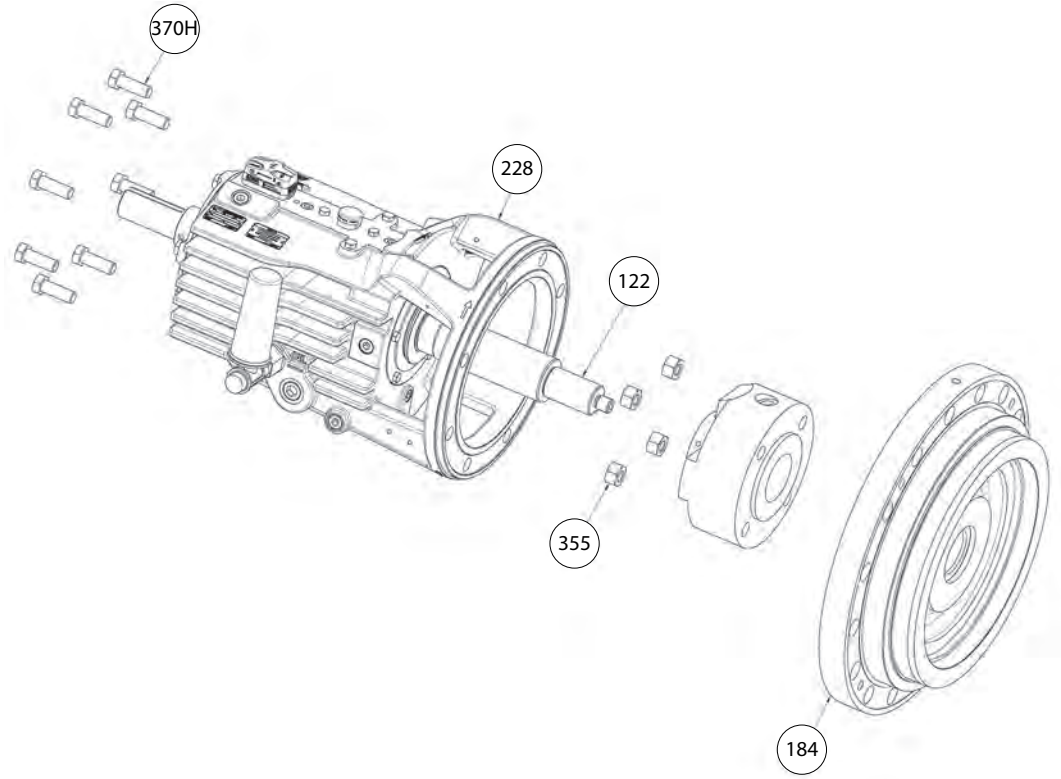



**Figure 48: Seal-chamber cover removal**

7. Guide the seal-chamber cover (184) over the end of the shaft (122) once the cover releases from the bearing frame (228).

**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 (122).
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 Disassemble the Power End

This procedure explains how to disassemble a standard ring-oil or optional 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
- Forced convection cooling

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

1. Does your power end have Forced convection cooling?
   - If no: Go to step 2.
   - If yes:

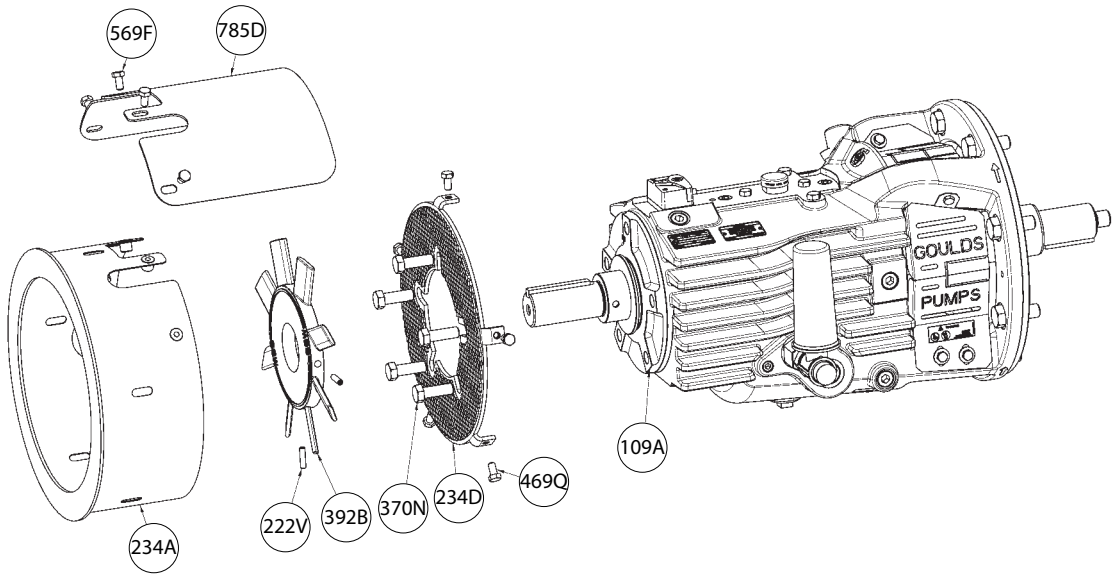



**Figure 49: Power end disassembly**

a) Remove Cowling Hex Cap Screws (569F) and Cooling Fan Cowling (785D).

b) Remove Guard Support Hex Cap Screws (469Q) and Cooling fan shroud (234A).

c) Loosen Fan set screws (222V) and remove Cooling Fan (392B) from shaft (122).

d) Loosen and remove Thrust Cover Frame Hex Cap Screws (370N). Remove cooling fan shroud support (234D).

e) Go to step 3.

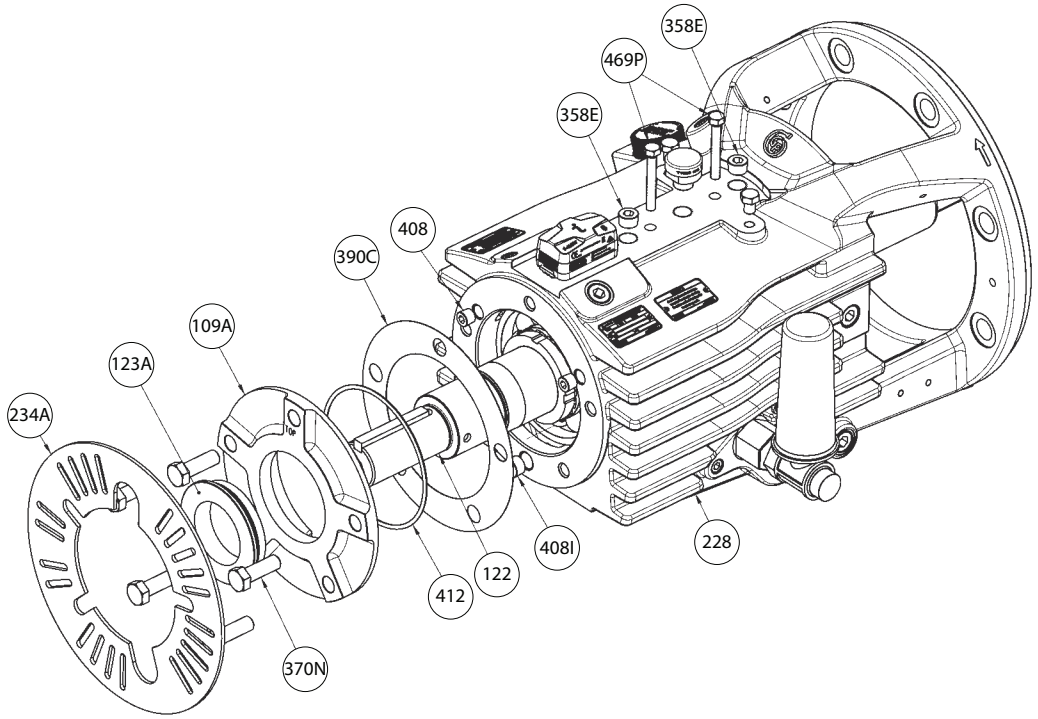



**Figure 50: Thrust cover removal**

2. Loosen and remove the Thrust Cover Frame Hex Cap Screws (370N) and remove the coupling guard support (234A).
3. Gently pry the thrust bearing isolator (123A) and the thrust end cover (109A) out of the bearing frame (228).
4. Remove and discard the thrust-bearing end-cover shims (390C).
5. Remove the two oil ring retainers and the oil ring inspection plugs from the top of the bearing frame.

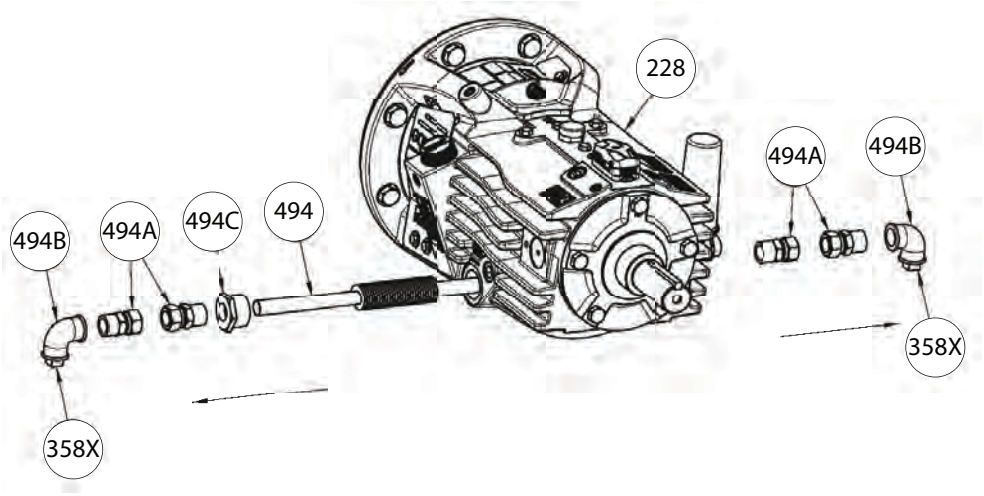



**Figure 51: Frame cooling removal**

6. If your power end has the optional oil sump liquid cooling, then remove the finned-tube cooling assembly from the bearing frame.

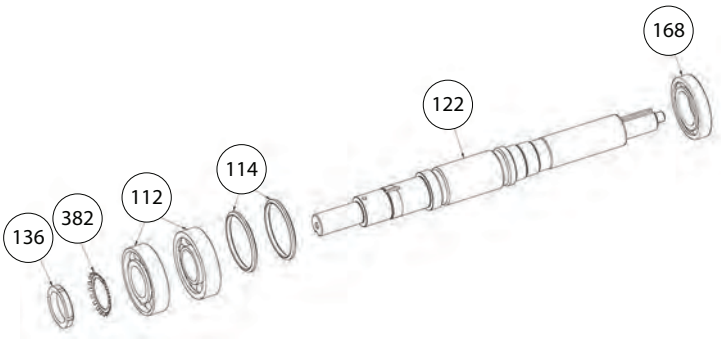



**Figure 52: Shaft and bearing removal**

7. Carefully withdraw the shaft (122) and bearing assembly from the bearing frame. Take care not to damage the oil rings (114) . If the oil rings bind or hang up, you can access them through the inspection holes and reposition them using a hooked tool made from wire. 13i has 1 oil ring, all others have 2 oil rings.
8. Bend the locking tang of the thrust-bearing lockwasher (382) away from the notch in the bearing locknut (136).

**NOTICE:**

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

9. How to remove the bearings from the shaft:
   a) Loosen and remove the thrust bearing locknut (136) and lockwasher (382).
   b) Press or pull the duplex thrust bearing (112) from the shaft (122).

c) Remove the oil ring(s) (114) from the shaft (122).

d) Press or pull the radial bearing (168) from the shaft (122).

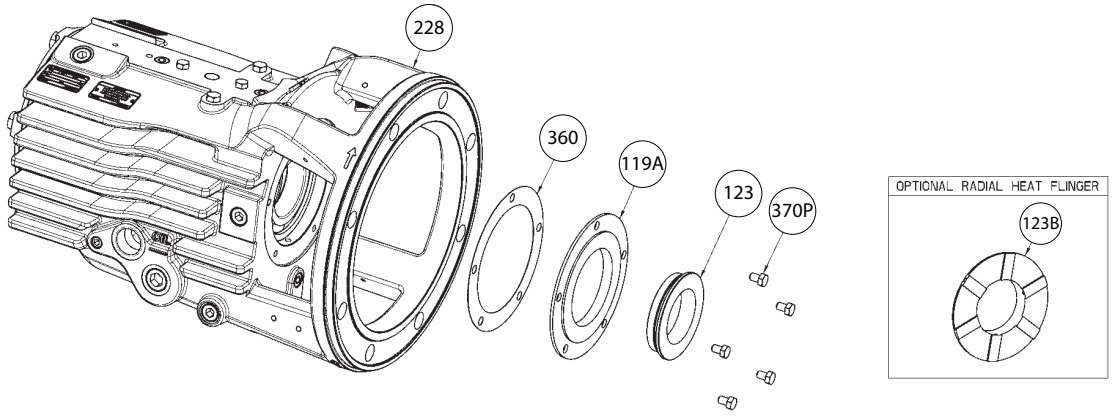



**Figure 53: Radial bearing isolator or optional radial heat flinger removal**

10. For pumps of all frame sizes, except the 13i:

    a) Loosen and remove the radial end cover to frame hex cap screws (370P) and radial bearing end cover (360).

    b) Remove and discard the radial bearing end cover gasket (360). This gasket will be replaced with a new gasket during reassembly.

    c) Gently press out the radial bearing isolator (123) or optional radial heat flinger (123B) from the radial end cover (119A). Note: For optional radial heat flinger loosen 3 set screws prior to removal.

    d) Remove any remaining plugs and fittings.

11. For 13i frame pump sizes:

    a) Gently press out the radial bearing isolator (123) or optional radial heat flinger (123B).

    b) Remove any remaining plugs and fittings.

## 6.4.10 Guidelines for i-ALERT® Equipment Health Monitor disposal

**Precautions**

**WARNING:**

- Explosive hazard and risk of personal injury. Heating to high temperatures could cause combustion of the condition monitor. Never heat the condition monitor to temperatures in excess of 149°C | 300°F or dispose of in a fire.

**Guidelines**

The battery contained in the condition monitor does not contain enough lithium to qualify as reactive hazardous waste. Use these guidelines when disposing of the condition monitor.

- The condition monitor is safe for disposal in the normal municipal waste stream.
- Adhere to local laws when you dispose of the condition monitor.

# 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 components if you notice any of these conditions:

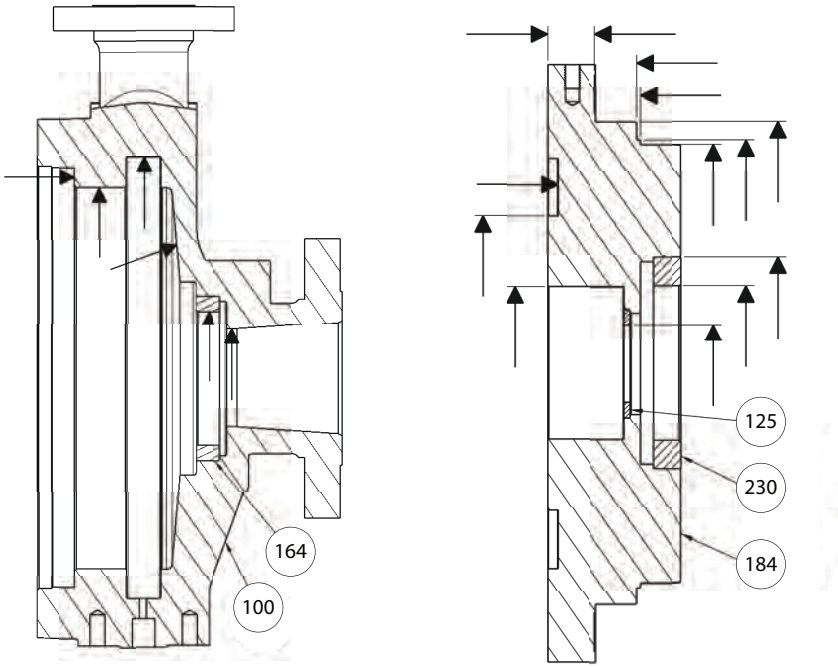
- Localized wear or grooving that is greater than 3.2 mm | 1/8 in. deep
- Pitting that is greater than 3.2 mm | 1/8 in. deep
- Irregularities in the casing-gasket seat surface
- Wear ring clearances that exceed the values in the Minimum running clearances table

**NOTICE:**

When clearances between the rings become excessive (increase by 50%), hydraulic performance decreases substantially.

### Casing and seal chamber cover areas to inspect

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




| | | | |
|---|---|---|---|
| 100 | Casing | 184 | Seal chamber cover |
| 164 | Casing wear ring | 230 | Seal chamber cover wear ring |

**Figure 54: Areas to inspect for wear on casing and seal chamber cover**

### 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<br>• 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 |
| Wear ring surfaces | Wear ring clearances that exceed the values in the minimum running clearances table |

### Impeller checks

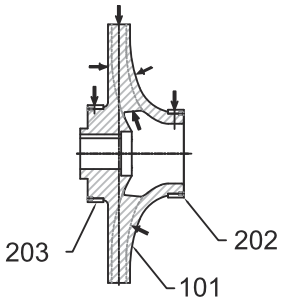
**NOTICE:**
When clearances between the rings become excessive (increase by 50%), hydraulic performance decreases substantially.

**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 G2.5 criteria.

**NOTICE:**
You must have extremely accurate tooling equipment to balance impellers to the ISO 1940 G2.5 criteria. Do not attempt to balance impellers to this criteria unless this type of tooling and equipment is available.

### Impeller areas to inspect

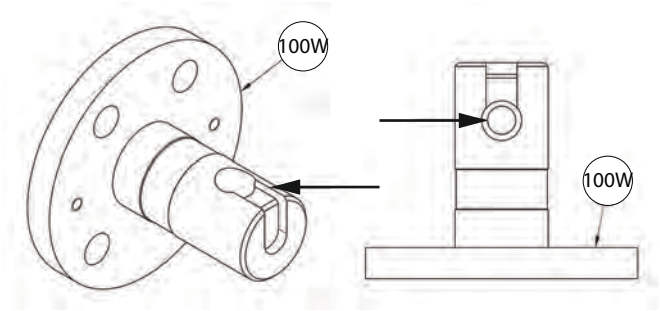



| | |
|---|---|
| 101 | Impeller |
| 202 and 203 | Impeller wear rings |

**Figure 55: Areas to inspect for wear on impeller**

**Venturi Insert Inspection ( Venturi casings only)**

Inspect the insert for excessive wear or pitting. Inspect the notch and the through hole on the end of the venturi insert. Ensure no foreign material is present. Clean thoroughly in order to remove any debris. Replace insert if there is any damage, wear, or pitting present to the notch, through hole, or gasket surfaces.




| | |
|---|---|
| 100W | Venturi insert |

**Figure 56: Venturi insert inspection**

**Oil ring replacement**

Oil rings must be as round as possible in order to function properly. Replace oil rings if they are worn, distorted, or damaged beyond reasonable repair.

**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:

- Venturi Insert (100W)*
- Bearing end covers (109A) and (119A)
- INPRO bearing isolator, radial (123) and thrust (123A)
- Radial heat flinger (123B)*
- Cooling fan (392B)*
- Bearing locknut (136)
- Impeller key (178) and coupling key (400)
- Impeller nut (304)
- Bearing lockwasher (382)
- 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.

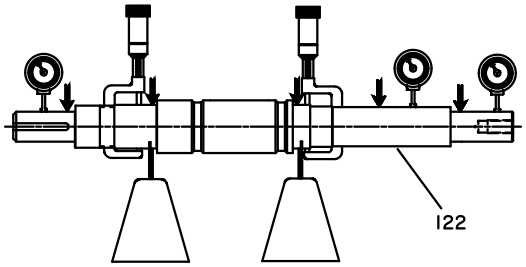



**Figure 57: Shaft inspection**

## 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: 3700i bearings based on SKF designations**

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

| Group | Radial (inboard) | Thrust (outboard) |
|---|---|---|
| 13i | 6210 C3 | 7310 BEGAM |
| 24i | 6212 C3 | 7312 BEGAM |
| 14i | 6212 C3 | 7312 BEGAM |
| 25i, 35i | 6213 C3 | 7312 BEGAM |
| 36i, 46i | 6215 C3 | 7313 BEGAM |
| 47i | 6218 C3 | 7317 BEGAM |
| 58i | 6215 C3 | 7318 BEGAM |

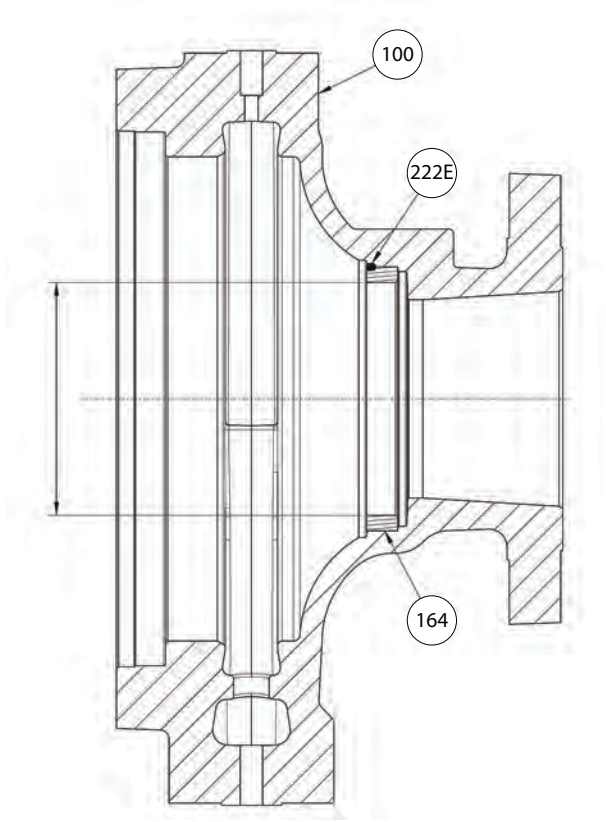
## 6.5.5 Wear rings inspection and replacement

### 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.

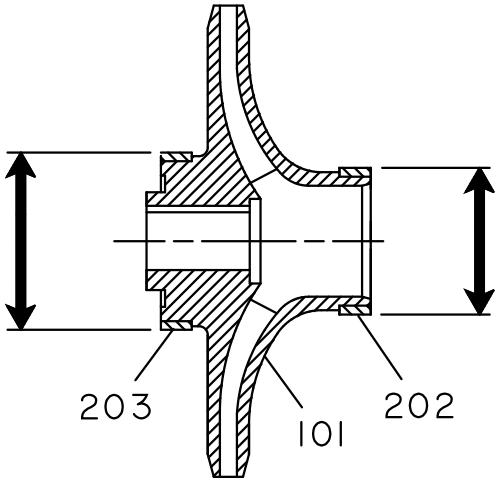
### Wear ring diameter check

Measure all wear ring diameters and then calculate the diametrical wear ring clearances. Refer to Table 10: Minimum running clearances on page 85 for more information.



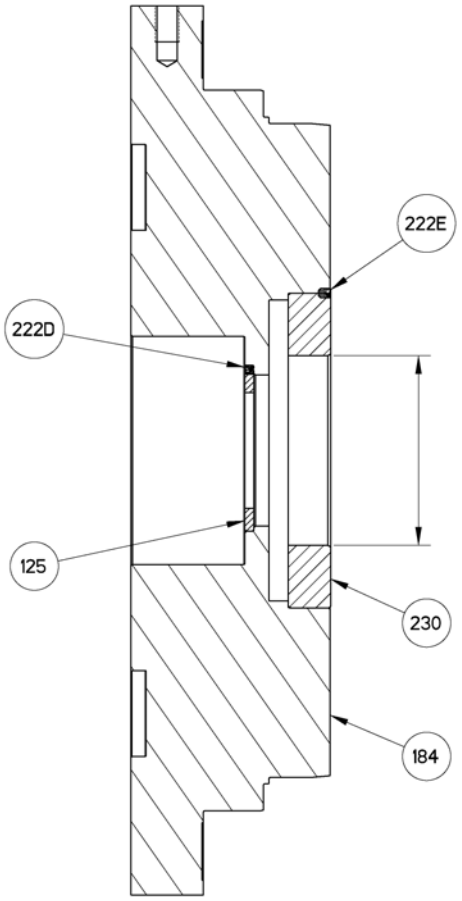

| | |
|---|---|
| 100 | Casing |
| 164 | Casing wear ring |
| 222E | Wear ring set screw |

**Figure 58: Casing wear ring**




| | |
|---|---|
| 101 | Impeller |
| 202 | Impeller wear ring |
| 203 | Impeller wear ring |

**Figure 59: Impeller wear ring**




| | |
|---|---|
| 125 | Seal-chamber throat bushing |
| 184 | Seal-chamber cover |
| 222D | Set screw |
| 222E | Wear ring set screw |
| 230 | Seal-chamber cover wear ring |

**Figure 60: Seal chamber cover wear ring**

### When to replace wear rings

Replace wear rings when the diametrical clearance exceeds 1.5X the values shown in this table or when the hydraulic performance has decreased to unacceptable levels.

**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 |

| Diameter of impeller wear ring | | Minimum diametrical clearance | |
|---|---|---|---|
| 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 and throat busing

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

**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 and throat bushing are held in place by a press fit and three set screws.

1. Remove the wear rings and throat bushing.
   a) Remove the set screws (320, 222E, 222D).
   b) Remove the wear rings (202, 203) from the casing (100), impeller (101), and seal-chamber cover (184) using a pry or puller to force the rings from the fits.
   c) Press the bushing (125) out of the seal chamber cover bore.
2. Clean the wear-ring seats thoroughly, and make sure that they are smooth and free of scratches.

## 6.5.5.1.1 Replace the impeller wear rings

1. Heat the new impeller wear rings (202, 203) 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.
2. Locate, drill, and tap three new setscrew holes equally spaced between the original holes in each new ring and ring seat area.
3. Install the setscrews (320) and upset threads.
4. Turn the impeller wear ring (142) to size after you mount it on the impeller (101).
   All replacement impeller wear rings, except those that are hard-faced, are supplied 0.508 mm to 0.762 mm | 0.020 in. to 0.030 in. oversize. See the table Minimum running clearances for final running clearances. Machine the impeller rings accordingly. Spare hard-faced impeller wear rings are not supplied oversize but are supplied to pre-established proper running clearances when both impeller and casing wear rings are renewed. When the impeller assembly is supplied as a spare part (impeller with wear rings), the wear rings are machined to the required dimension.

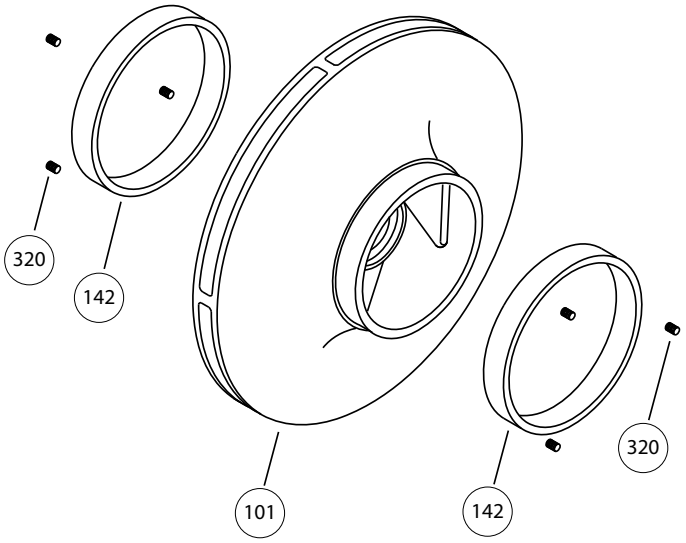



**Figure 61: Replace impeller wear ring**

## 6.5.5.1.2 Replace the Casing wear ring

1. Chill the new casing wear ring (164) 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.

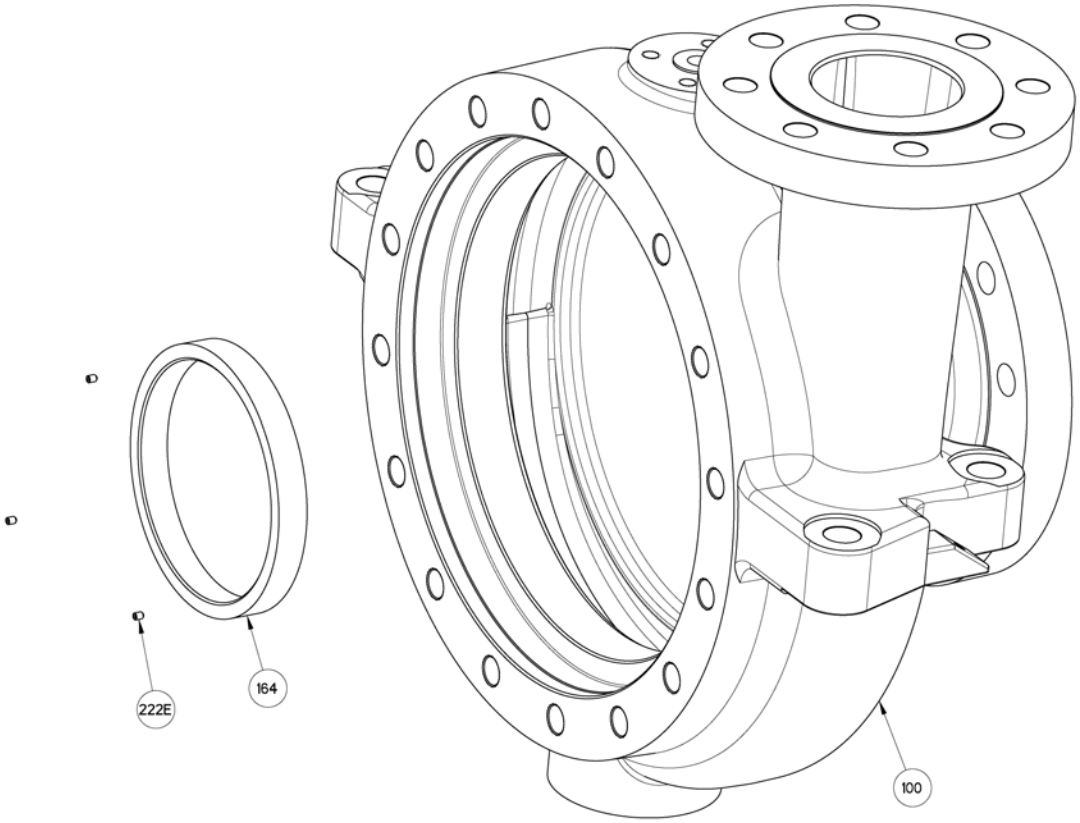



**Figure 62: Casing wear ring**

2. To secure the wear ring (164) locate, drill, and tap three new setscrew holes equally spaced between the original holes in each new wear ring and wear ring seat area. Install setscrews (222E) and upset threads.
3. Confirm the bore diameter of the wear ring (164) after installation.
4. Check the wear-ring (164) runout and distortion by measuring the bore at each setscrew location with inside micrometers or vernier calipers. Machine any distortion in excess of 0.08 mm |0.003 in.

## 6.5.5.1.3 Replace the seal chamber wear ring and throat bushing

1. Chill a new seal-chamber-cover wear ring (230) and throat bushing (125), using dry ice or another suitable chilling substance, Install the wear ring into the cover fit and the throat bushing into the seal chamber fit. Be prepared to tap the wear ring and throat bushing in place with a hardwood block or soft faced hammer.
2. To secure the wear ring (230) locate, drill, and tap three new setscrew holes equally spaced between the original holes in each new wear ring and wear ring seat area. Install setscrews (222E) and upset threads.
3. To secure the throat bushing (125) locate, drill, and tap three new setscrew holes equally spaced between the original holes in each new throat bushing and seal chamber seat area. Install setscrews (222D) and upset threads.
4. Confirm the bore diameter of the wear ring (230) after installation.
5. Check the wear-ring (230) runout and distortion by measuring the bore at each setscrew location with inside micrometers or vernier calipers. Machine any distortion in excess of 0.08 mm |0.003 in.

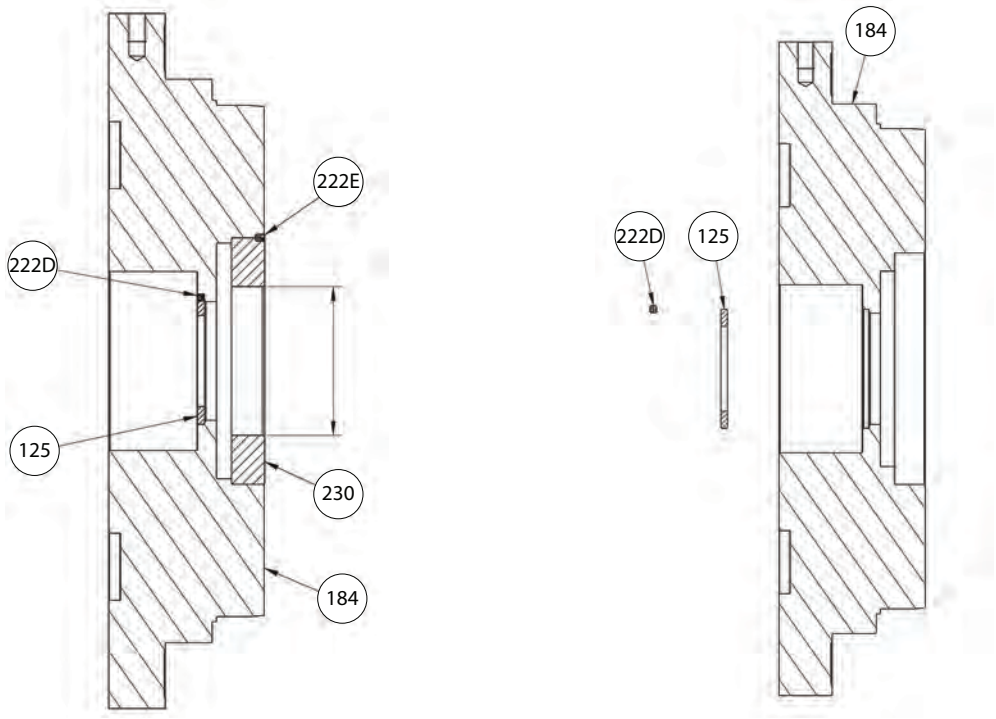



**Figure 63: Seal chamber cover wear ring and throat bushing**

## 6.5.5.2 Impeller wear ring TIR inspection

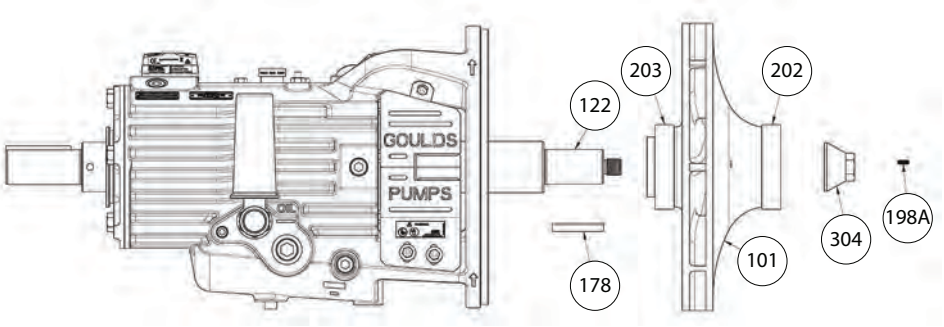



**Figure 64: Impeller**

1. Install the impeller:
   a) Install the impeller key (178) 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 per table below. The key should be at the top (12 o'clock) position for the impeller installation.

| | |
|---|---|
| < 5" diameter | 0.003 |
| 5" to 8" diameter | 0.004 |
| > 8" diamter | 0.005 |

   b) Install the impeller (101) on the shaft (122).
   c) Secure the impeller firmly with an impeller nut (304) and impeller nut set screw (198).
2. 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 (202) surface for 360°.
   c) Repeat steps a and b for the wear ring (203) on the seal-chamber cover side.

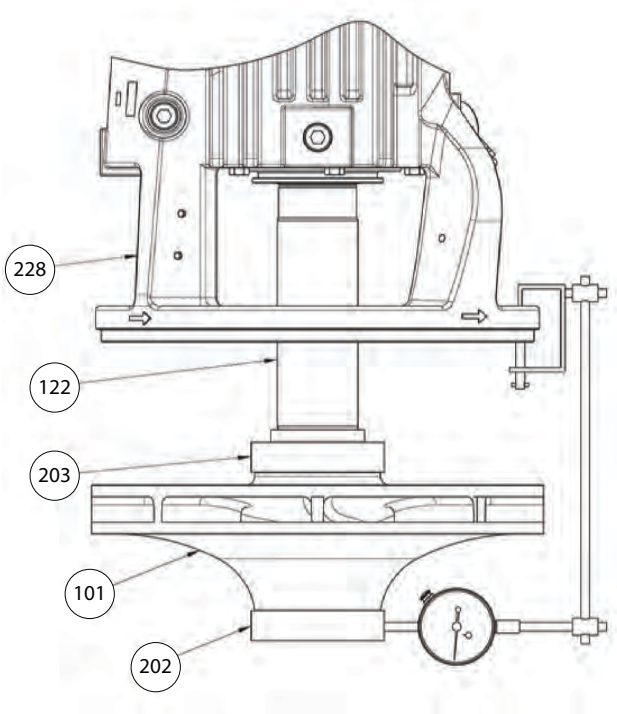



**Figure 65: Impeller wear-ring runout**

If the impeller wear ring runout is in excess of the acceptance criteria in table above:

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 Bearing-frame inspection

### Checklist

Check the bearing frame for these conditions:

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

  If any bores are outside the measurements in the Table 11: Bearing fits and tolerances table (SI units) on page 92 table, replace the bearing frame.

### Surface inspection locations

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

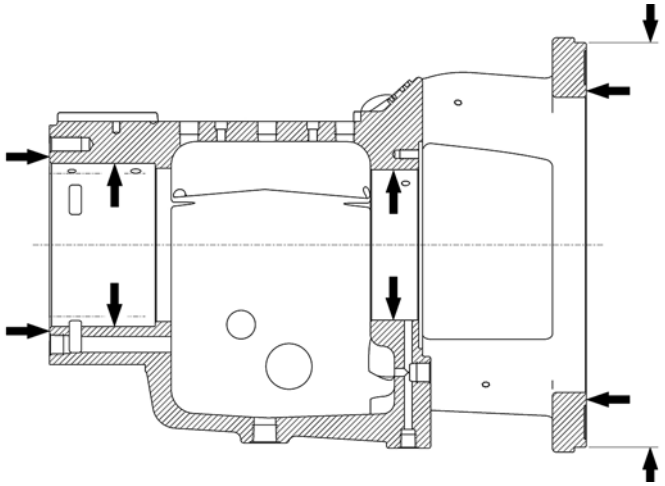


**Figure 66: Surface inspection locations**

## 6.5.7 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 | 13i | | 14i, 24i | | 25i, 35i | | 36i | | 47i | | 58i | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | mm | inch | mm | inch | mm | inch | mm | inch | mm | inch | mm | inch |
| Radial (Inboard) | Shaft OD | Max | 50.013 | 1.9690 | 60.015 | 2.3628 | 65.014 | 2.5596 | 75.014 | 2.9533 | 90.015 | 3.5439 | 100.015 | 3.9376 |
| | | Min | 50.002 | 1.9686 | 60.002 | 2.3623 | 65.001 | 2.5591 | 75.001 | 2.9528 | 90.002 | 3.5434 | 100.002 | 3.9371 |
| | Bearing ID | Max | 50.000 | 1.9685 | 60.000 | 2.3622 | 65.000 | 2.5591 | 75.000 | 2.9528 | 90.000 | 3.5433 | 100.000 | 3.9370 |
| | | Min | 49.987 | 1.9680 | 59.985 | 2.3616 | 64.985 | 2.5585 | 74.985 | 2.9522 | 89.980 | 3.5425 | 99.979 | 3.9362 |
| | Interference | Max | 0.025 | 0.0010 | 0.030 | 0.0012 | 0.029 | 0.0011 | 0.029 | 0.0011 | 0.036 | 0.0014 | 0.036 | 0.0014 |
| | | Min | 0.003 | 0.0001 | 0.003 | 0.0001 | 0.001 | 0.0001 | 0.001 | 0.0001 | 0.003 | 0.0001 | 0.003 | 0.0001 |
| | Bearing OD | Max | 90.000 | 3.5433 | 110.000 | 4.3307 | 120.000 | 4.7244 | 130.000 | 5.1181 | 160.000 | 6.2992 | 180.000 | 7.0866 |
| | | Min | 89.985 | 3.5427 | 109.985 | 4.3301 | 119.985 | 4.7238 | 129.982 | 5.1174 | 159.974 | 6.2982 | 179.974 | 7.0856 |
| | Frame ID | Max | 90.033 | 3.5446 | 110.033 | 4.3320 | 120.033 | 4.7257 | 130.038 | 5.1196 | 160.038 | 6.3007 | 180.038 | 7.0881 |
| | | Min | 90.013 | 3.5438 | 110.012 | 4.3312 | 120.012 | 4.7249 | 130.015 | 5.1187 | 160.015 | 6.2998 | 180.015 | 7.0872 |
| | Clearance | Max | 0.048 | 0.0019 | 0.048 | 0.0019 | 0.048 | 0.0019 | 0.056 | 0.0022 | 0.064 | 0.0025 | 0.063 | 0.0025 |
| | | Min | 0.013 | 0.0005 | 0.013 | 0.0005 | 0.013 | 0.0005 | 0.015 | 0.0006 | 0.015 | 0.0006 | 0.015 | 0.0006 |
| Thrust (Outboard) | Shaft OD | Max | 50.013 | 1.9690 | 60.015 | 2.3628 | 60.015 | 2.3628 | 65.014 | 2.5596 | 85.014 | 3.3470 | 90.015 | 3.5439 |
| | | Min | 50.002 | 1.9686 | 60.002 | 2.3623 | 60.002 | 2.3623 | 65.001 | 2.5591 | 85.001 | 3.3465 | 90.002 | 3.5434 |
| | Bearing ID | Max | 50.000 | 1.9685 | 60.000 | 2.3622 | 60.000 | 2.3622 | 65.000 | 2.5591 | 85.000 | 3.3465 | 90.000 | 3.5433 |
| | | Min | 49.987 | 1.9680 | 59.985 | 2.3616 | 59.985 | 2.3616 | 64.985 | 2.5585 | 84.981 | 3.3457 | 89.980 | 3.5425 |
| | Interference | Max | 0.025 | 0.0010 | 0.030 | 0.0012 | 0.030 | 0.0012 | 0.029 | 0.0011 | 0.033 | 0.0013 | 0.036 | 0.0014 |
| | | Min | 0.003 | 0.0001 | 0.003 | 0.0001 | 0.003 | 0.0001 | 0.001 | 0.0001 | 0.001 | 0.0001 | 0.003 | 0.0001 |
| | Bearing OD | Max | 110.000 | 4.3307 | 130.000 | 5.1181 | 130.000 | 5.1181 | 140.000 | 5.5118 | 180.000 | 7.0866 | 190.000 | 7.4803 |
| | | Min | 109.985 | 4.3301 | 129.982 | 5.1174 | 129.982 | 5.1174 | 139.982 | 5.5111 | 179.974 | 7.0856 | 189.970 | 7.4791 |
| | Frame ID | Max | 110.035 | 4.3321 | 130.038 | 5.1196 | 130.051 | 5.1201 | 140.038 | 5.5133 | 180.038 | 7.0881 | 190.043 | 7.4820 |
| | | Min | 110.012 | 4.3312 | 130.015 | 5.1187 | 130.028 | 5.1192 | 140.015 | 5.5124 | 180.015 | 7.0872 | 190.015 | 7.4809 |
| | Clearance | Max | 0.051 | 0.0020 | 0.056 | 0.0022 | 0.069 | 0.0027 | 0.056 | 0.0022 | 0.063 | 0.0025 | 0.073 | 0.0029 |
| | | Min | 0.013 | 0.0005 | 0.015 | 0.0006 | 0.028 | 0.0011 | 0.015 | 0.0006 | 0.015 | 0.0006 | 0.015 | 0.0006 |

# 6.6 Reassembly

## 6.6.1 Assemble the power end

This procedure explains how to assemble a standard ring-oil or optional oil mist-lubricated power end and includes information for the assembly of these optional features:

- Pure-oil mist-lubricated power end
- Radial-heat-flinger
- Forced convection cooling
- Water-cooling package

**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.

**CAUTION:**

- Risk of physical injury from hot bearings. Wear insulated gloves when using a bearing heater.
- This pump uses duplex bearings mounted back-to-back. Make sure orientation of the bearings is correct.

**NOTICE:**

- There are several methods you can use to install bearings. The recommended method is to use an induction heater that heats and demagnetizes the bearings.
- Make sure that all parts and threads are clean and that you have followed all directions under the Preassembly inspections section.
-  Check for magnetism on the pump shaft and demagnetize the shaft if there is any detectable magnetism. Magnetism attracts ferritic objects to the impeller, seal, and bearings which can result in excessive heat generation, sparks, and premature failure.

Oil-mist lubricated power ends are assembled in the same manner as ring oil-lubricated power ends. Oil rings are not furnished with oiloil-mist lubrication. Disregard any reference to those parts.

1. Assemble the radial bearing (168) onto the shaft (122).
   The bearings are interference fit.

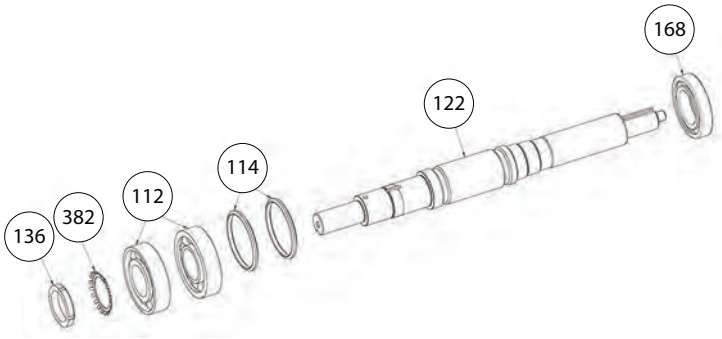



**Figure 67: Radial (inboard) bearing installation**

a) Preheat the bearings to 120°C | 250°F with an induction type bearing heater.
The induction heater also demagnetizes the bearings.

**CAUTION:**

Risk of physical injury from hot bearings. Wear insulated gloves when using a bearing heater.

**NOTICE:**

Do not use a torch and do not use force.

b) Coat the internal surface of the bearings with the lubricant that is to be used in service.

c) Assemble the radial-end bearing (168) onto the shaft (122).

2. Install the oil rings (114) and bearings:

a) Install the oil rings (114) on the shaft.

| Frame Size | Oil Rig Qty |
|---|---|
| 13i | 1 |
| 14i, 24i, 25i, 35i, 36i, 47i, 58i | 2 |

b) Assemble the thrust bearings (112) in a back-to-back arrangement onto the shaft (122).

The bearings are interference fit.

c) Preheat the bearings to 120°C | 250°F with an induction-type bearing heater.

Be sure to also demagnetize the bearings after heating.

**CAUTION:**

Risk of physical injury from hot bearings. Wear insulated gloves when using a bearing heater.

**NOTICE:**

Do not use a torch and do not use force.

d) Install the bearings (112) and the bearing locknut (136) onto the shaft.

e) While the bearings are hot, tighten the locknut by hand with a spanner wrench until the bearing is snug against the shaft shoulder.

f) Allow the bearing assembly to cool slowly to room temperature.

Do not rapidly cool the bearings with compressed air or other means.

g) When the bearing assembly is fully cooled,remove the locknut, install the lockwasher (382), and install the locknut.

h) Hand-tighten the locknut with a spanner wrench. Do not over-tighten the bearing. Tap the end of the spanner wrench with light strikes from a dead blow hammer while you note the location of the next available lockwasher tab aligns with the slots in the locknut.

The turning resistance of the nut increases as it tightens. Plan the alignment of the lockwasher tab with the locknut fully tightened. If the locknut is still turning with light strikes with the hammer, then continue to tighten the locknut until the next available tab is aligned with a slot. Do not use heavy strikes with the hammer. If it is not possible to reach the next tab, then loosen the locknut to align with the previous tab.

i) Check the condition of the outer races by rotating the bearings by hand in opposite directions:

- The outer races generally cannot be counter-rotated by hand, but if they do move, the resistance must be high.
- If the outer races are loose, the bearing is not properly seated and must be retightened.

j) When you have achieved the proper bearing assembly, set the lockwasher tab in the slot in the locknut.

k) Coat the internal bearing surfaces with lubricant to be used in service.

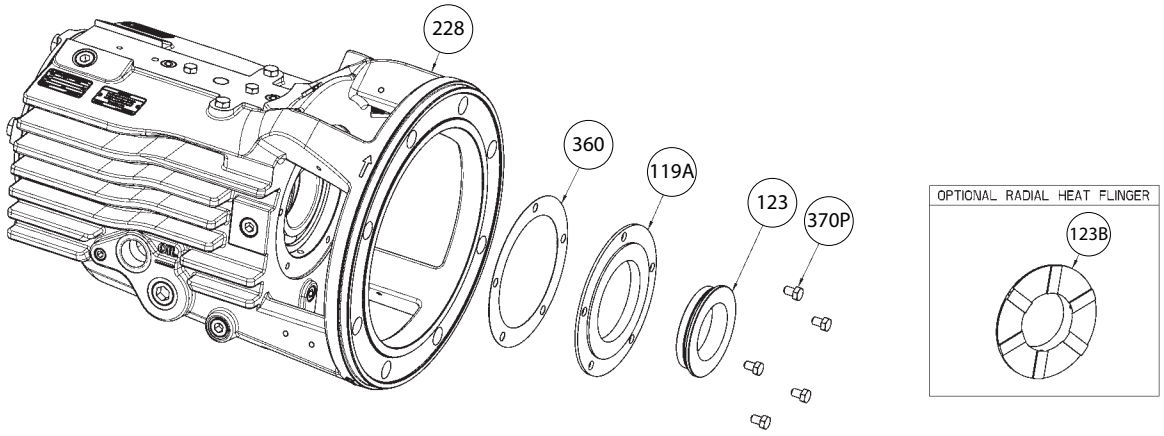



**Figure 68: Bearing frame**

3. Press the radial bearing isolator (123) oil seal into the radial end cover (119A).
4. Install the radial-bearing end cover (119A) and new end-cover gasket (360) on the bearing frame.

   Make sure that the expulsion part is at the 6 o'clock position and is properly seated.

   For the optional radial heat flinger (123B), the radial-heat flinger replaces the standard radial bearing isolator (123).
5. Perform the following based on your pump version:

| If your pump is... | Then... |
|---|---|
| 13i | Press the radial bearing isolator (123) into the bearing frame and make sure that the expulsion part is at the 6 o'clock position and is properly seated. See Figure 66. |
| All other frames sizes | Install the radial end cover gasket (360) and radial end cover/bearing isolator assembly. Secure to the frame with cap screws (370P) and tighten evenly to the torque values show in the Maximum torque values for the 3700i fasteners table. |

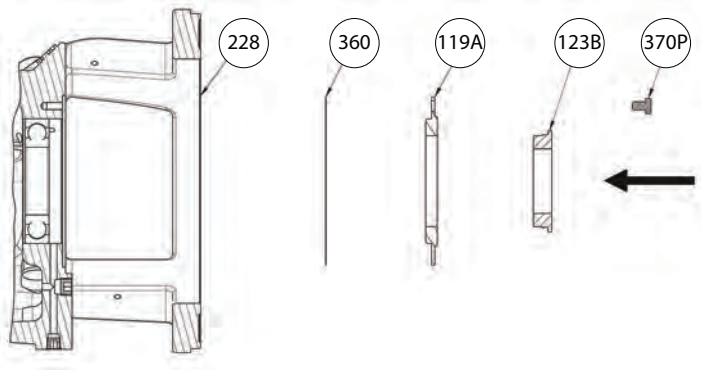



**Figure 69: Radial bearing isolator installation for 13i frame only**

6. Assemble the shaft assembly and bearing frame:
   a) Coat the outer races of the bearings with a compatible oil.
   b) Coat the internal bearing surfaces of the bearing frame with a compatible oil.
   c) Position the oil rings in the grooves of the shaft.

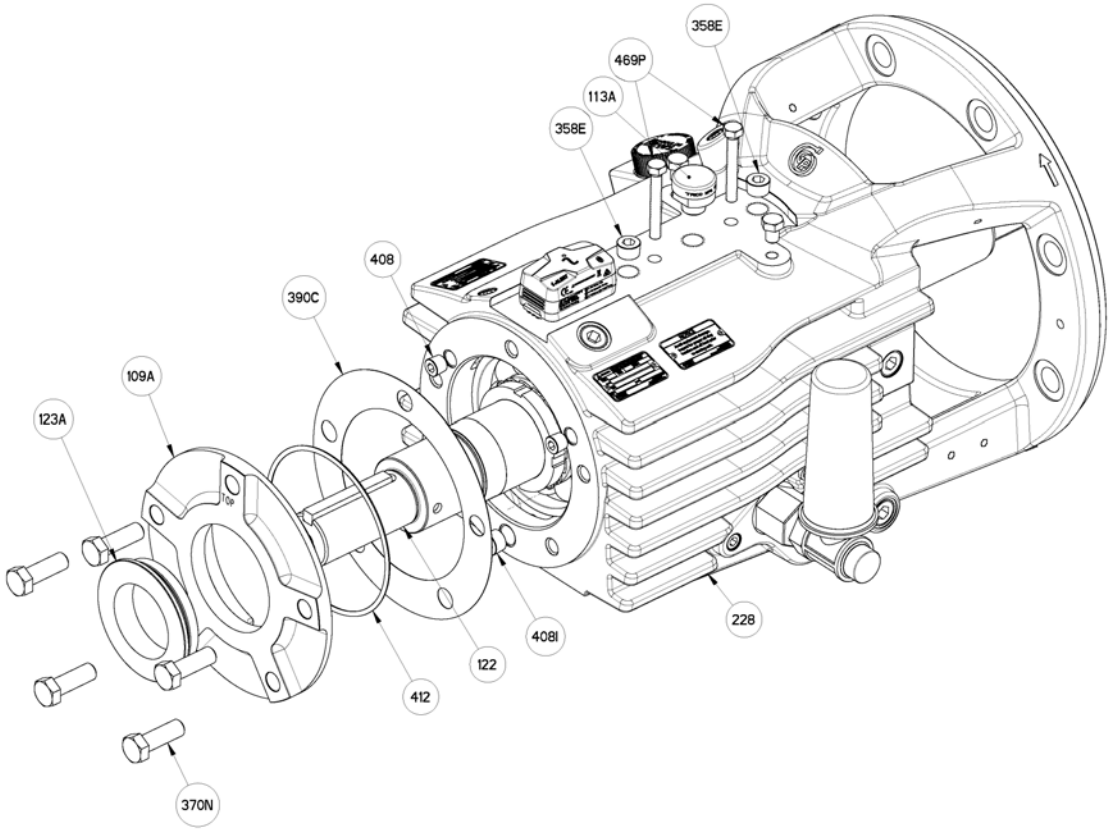



**Figure 70: Shaft and bearing frame assembly**

   d) Carefully guide the shaft and bearing assembly into the bearing frame until the thrust bearing is seated against the shoulder of the frame. Make sure that the oil rings do not bind or become damaged.

Do not force the assembly together.

   e) Observe the oil rings through the sight glass in the bearing frame.

If the oil rings are not properly seated in the grooves in the shaft, insert a hook-shaped tool made from wire through the inspection connections. Reposition the oil rings as necessary to seat them in the grooves.

f) Check that the shaft turns freely.
If you notice rubbing or binding, determine the cause and correct it.

7. Replace the oil-ring inspection connection plugs (358E).
8. Replace the two oil-ring retainers (469P).
   The screw should bottom against the bearing frame.
9. Install breather (113A).
10. For details on the oil filter installation reference 5.4.2.5 Replace the oil filter on page 56.
11. For details on installing the watchdog oiler refer to 5.4.2.4 Lubricate the bearings with oil on page 54.
12. For details on the i-ALERT®3 installation refer to 5.9 i-ALERT® Equipment Health Monitor on page 63.
13. Install all remaining plugs.

## 6.6.2 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. Install quantity 2 plugs (408) and quantity 1 plug (408I).

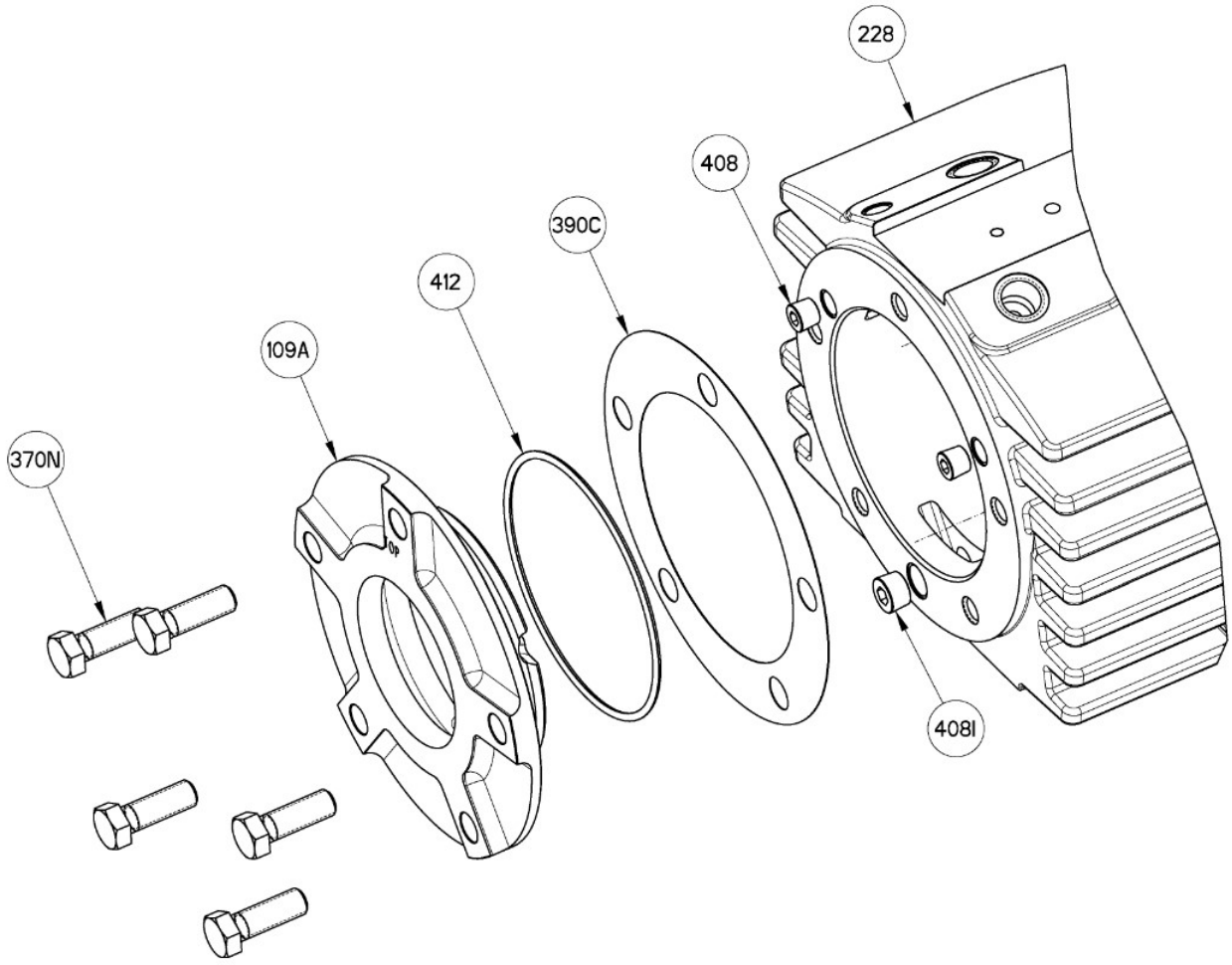



**Figure 71: Bearing frame assembly**

2. Install up to three thrust-bearing end cover shims (390C) on the thrust bearing end cover (109A).
3. Being careful to properly align holes, install the thrust-bearing end cover over the shaft and onto the bearing frame.
4. Install and tighten the thrust-bearing end cover and bearing-frame screws (370N) evenly to the torque values in the Maximum torque values for 3700i fasteners table.

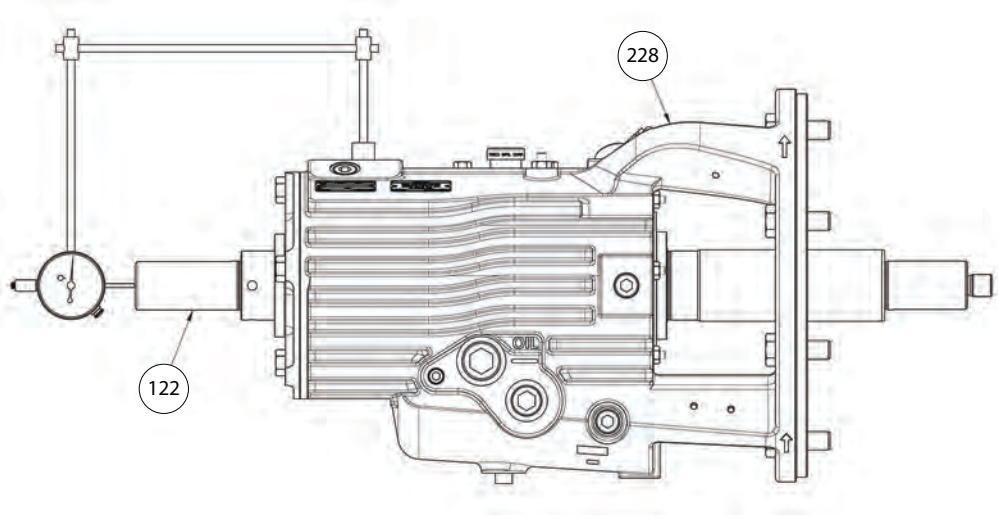


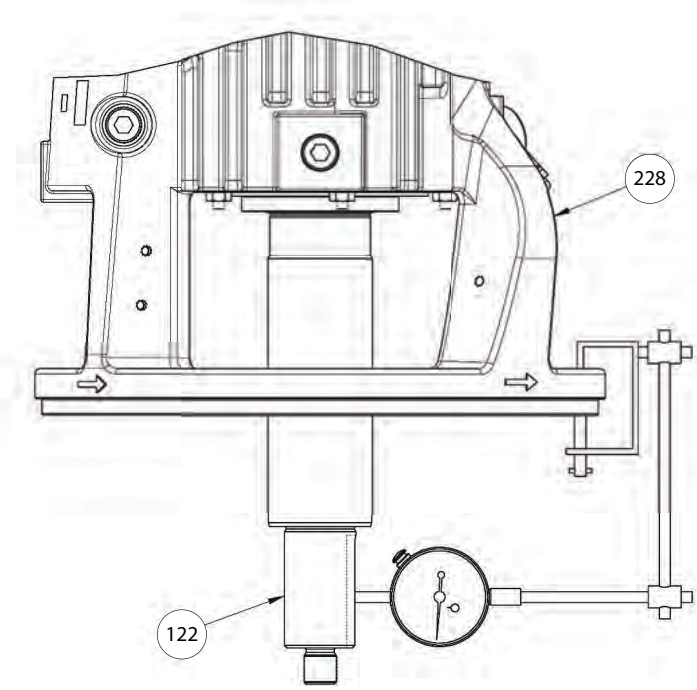
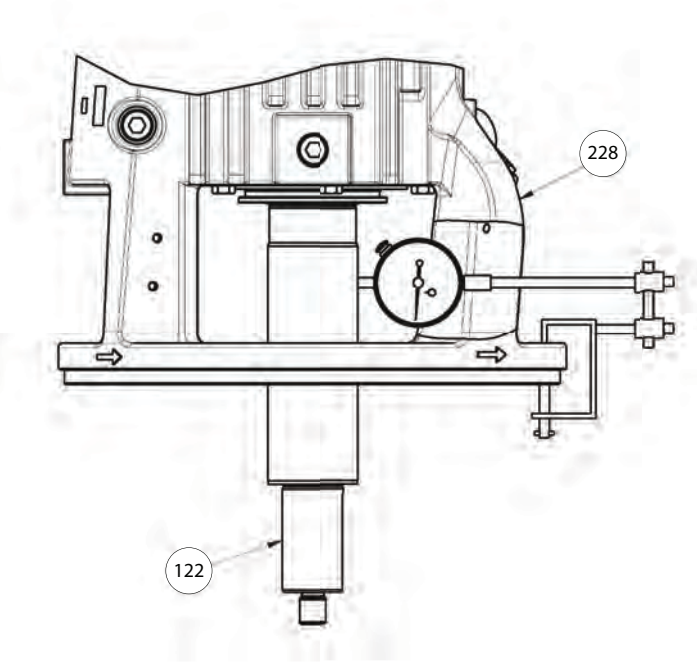

**Figure 72: Axial end play determination**

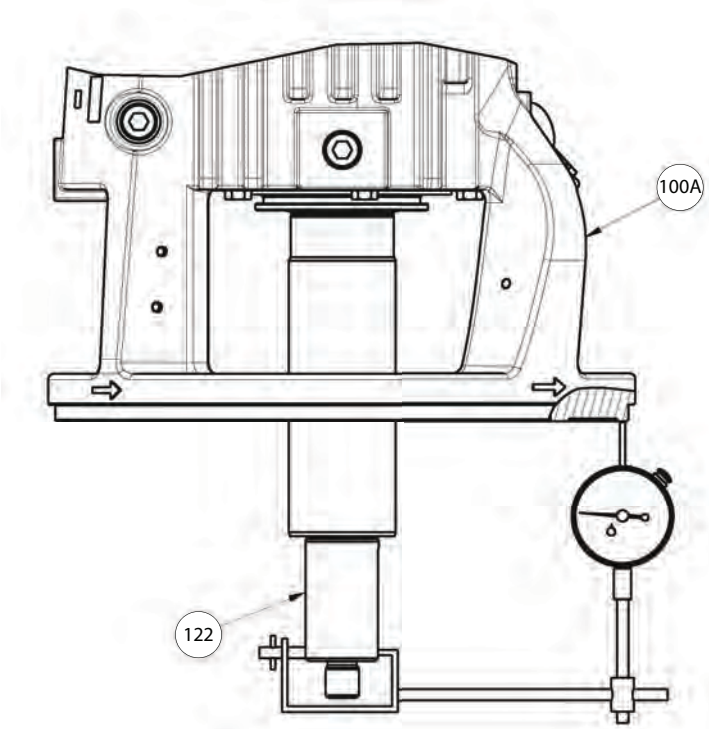
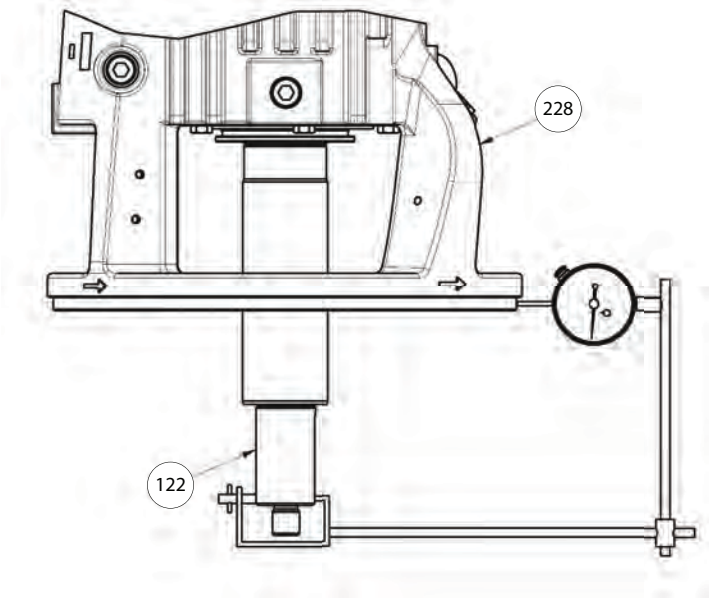
5. Determine the axial end play as follows:
   a) Mount the dial indicator.
   b) Use a lever to apply axial force to the impeller end of the shaft and firmly seat the thrust bearing against the shoulder in the bearing frame.
   c) Apply axial force in the opposite direction and firmly seat the thrust 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 shims between the thrust-bearing end cover and the bearing frame. Add shims if no axial end play is present.
6. 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.
7. Perform the following
   a) Remove the thrust-bearing end cover.
   b) Press the thrust bearing isolator (123A) into the thrust-bearing end cover and ensure that the expulsion part is at the 6 o'clock position and is properly seated.
   c) Install the O-ring (412) into the groove of the thrust-bearing end cover.
   d) Lubricate the O-ring with a suitable lubricant.
8. 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.
9. Perform the following based on whether or not your power end has the optional forced convection cooling:

| If your power end... | Then... |
|---|---|
| Has the optional Forced Convection cooling | Refer to 5.4.1.2 Install the forced convection cooling (as required) - cooling fan, guards and cowling on page 51 for installation details. |
| Does not have the optional Forced Convection cooling | 1. Install and tighten the thrust-bearing end cover and bearing-frame screws evenly to the torque values in the Maximum torque values for 3700i fasteners table.<br>2. Verify that the shaft turns freely. |

10. Check the following runouts:

| Check | Procedure |
|---|---|
| Shaft impeller fit | 1. Mount the dial indicator on the bearing frame.<br>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 0.030mm \| 0.001in., determine the cause and correct it.<br>  |
| Shaft seal fit | 1. Mount the dial indicator.<br>2. Rotate the shaft so that the indicator rides along the shaft surface for 360°. If the total indicator reading is greater than 0.030mm \| 0.001in., then determine the cause and correct it.<br>  |
| Bearing-frame face | 1. Mount the dial indicator on the shaft. |

| Check | Procedure |
|---|---|
| | 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.<br>  |
| Bearing-frame lock | 1. Mount the dial indicator on the shaft.<br>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.<br>  |

11. Install and tighten any plugs and fittings removed during disassembly, including the oil-drain plug, and watchdog oiler.

12. If your power end has the optional water cooling package, install the finned-tube cooling assembly into the bearing frame.

## 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 (184).

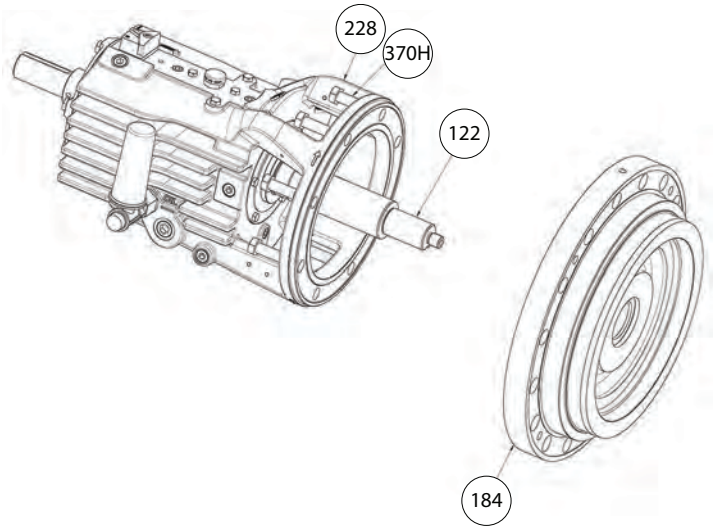



**Figure 73: Seal chamber cover**

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 (122).
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 (370H).

   c) Tighten the bolts evenly using an alternating pattern.

   Torque the bolts to values shown in the Maximum torque values for 3700i 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.

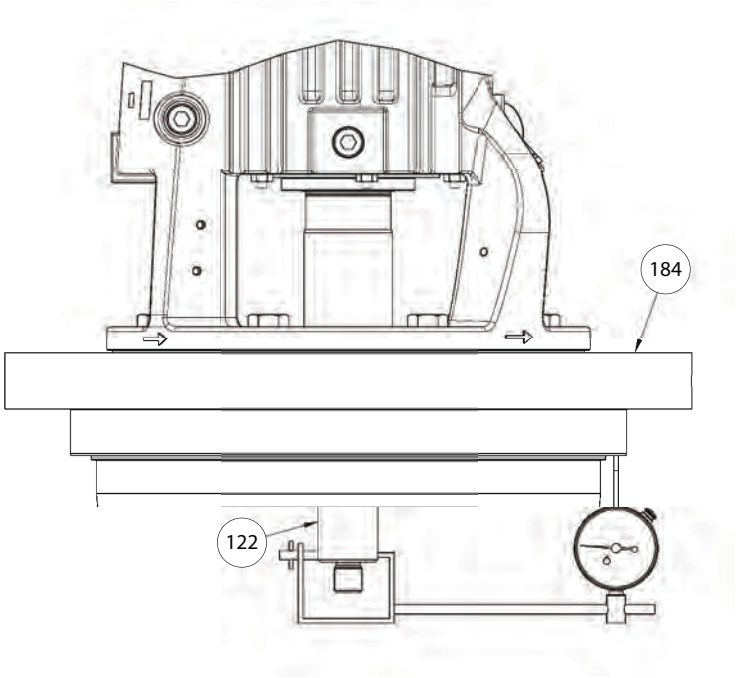



**Figure 74: Seal-chamber cover face runout**

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.

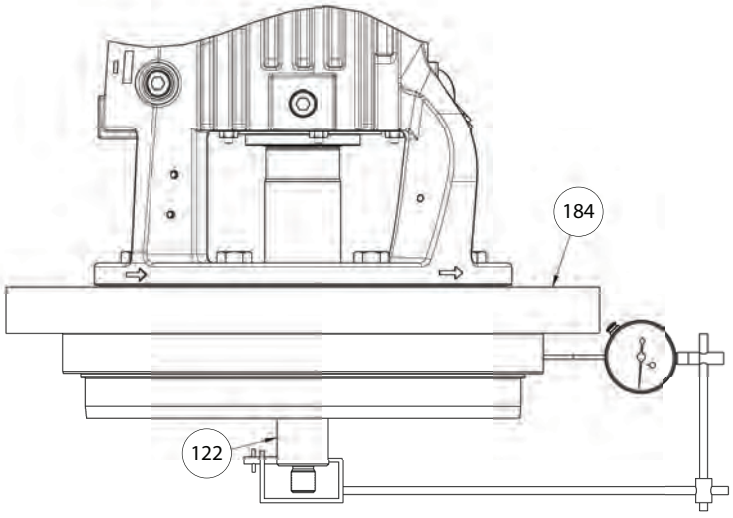



**Figure 75: Seal-chamber cover lock runout**

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.

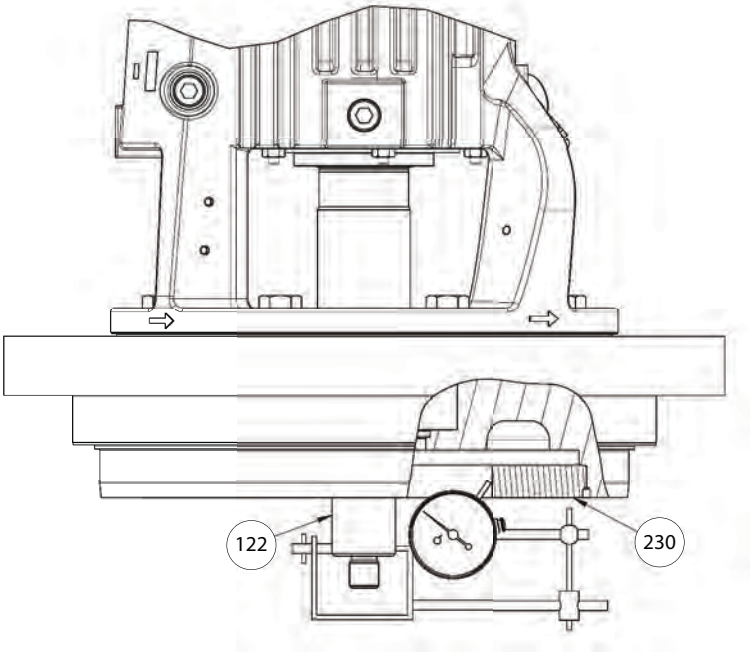



**Figure 76: Seal-chamber cover wear-ring runout**

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 |
|---|---|
| 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. |

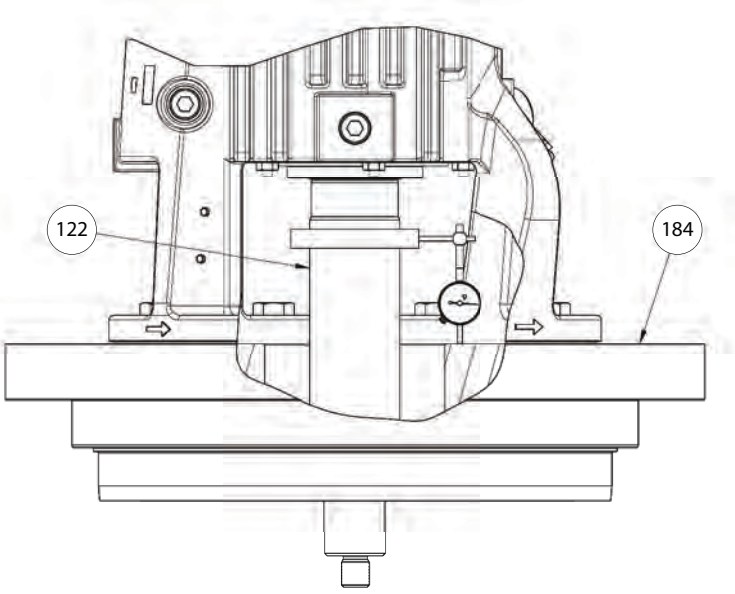



**Figure 77: Seal-chamber face runout**

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.

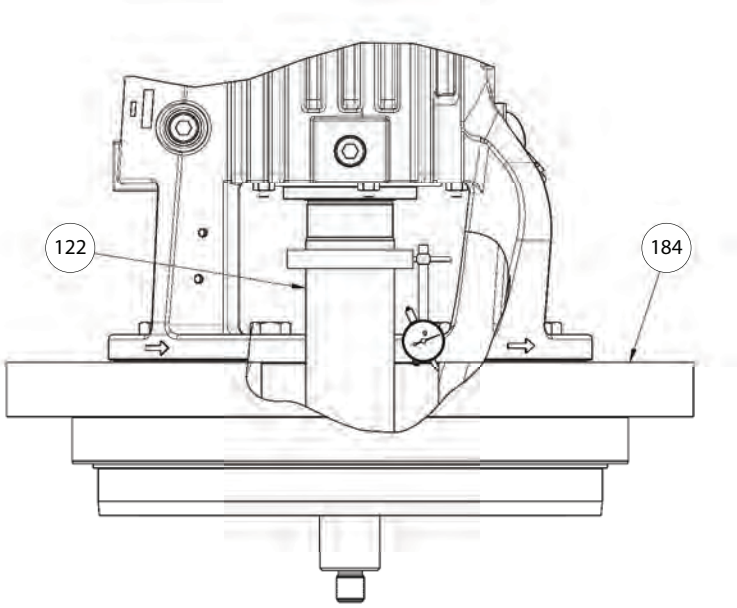



**Figure 78: Seal-chamber lock (register) runout**

## 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 (184) 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 (122).

**NOTICE:**

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

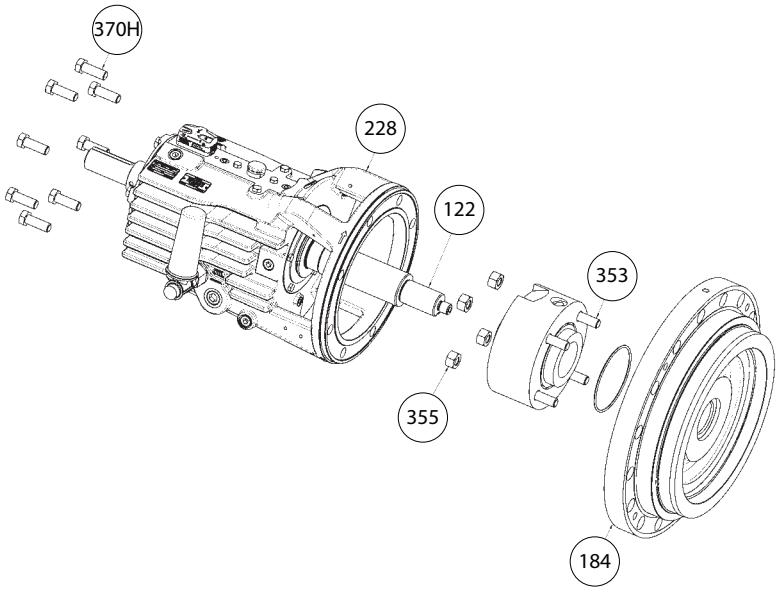



**Figure 79: Cartridge-type mechanical seal and seal-chamber cover**

4. Install the seal-chamber cover (184).
   a) Set up a sling to the eyebolt and to the overhead lifting device.
   b) Lift the seal-chamber cover (184) and position it so that it aligns with the shaft.
   c) Install the seal-chamber cover (184) 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 (184) fits into the bearing frame lock.
   d) Install the seal-chamber cover (184) and bearing-frame bolts (370H) and tighten them using an alternating pattern.
   Torque the bolts to the values shown in the Maximum torque values for 3700i fasteners table.
   e) Install the gland stud nuts (355) and tighten evenly to the torque values shown in the Maximum torque values for 3700i fasteners table.
5. Tighten the setscrews in the locking collar.
6. Disengage the spacer ring or clips.
7. Verify that the shaft (122) turns freely.
   If you detect rubbing or excessive drag, then determine the cause and correct it.

## 6.6.5 Install the impeller

**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 102.

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 3700i 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.

## 6.6.6 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.

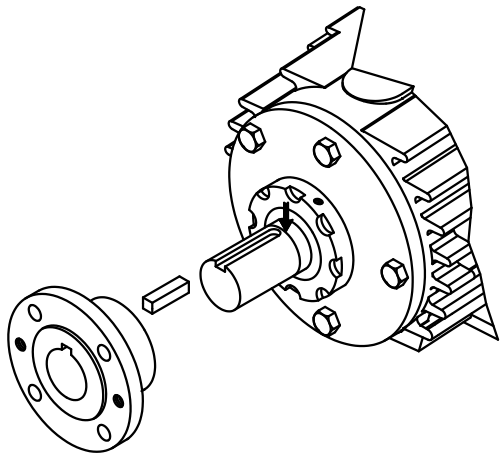


**Figure 80: Coupling hub installation**

## 6.6.7 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.

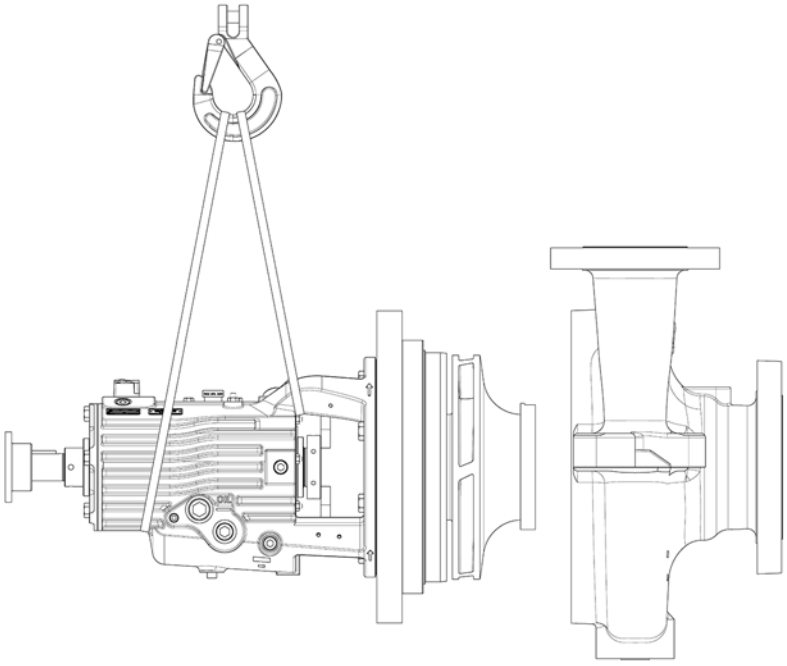


**Figure 81: Back pull-out assembly**

3. Slide the back pull-out assembly into the proper position in the casing.
   Make sure that the casing gasket is not damaged.
4. Install the casing casing washers (533) and stud nuts (425).
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 3700i 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.

## 6.6.8 Install the Venturi Insert (Venturi casings only)

1. Place gasket (351O) onto venturi insert (100W).
2. Install the venturi insert (100W) into the casing (100) so that the through hole is in the vertical orientation and the notch faces up toward the discharge flange.
3. Install the venturi insert studs (362A) and hex nuts (362B) to the casing (100). Tighten the nuts (362B) in an alternating pattern until the insert flange is metal to metal with the casing (100). Tighten each nut to the torque values shown in the maximum torque values table.

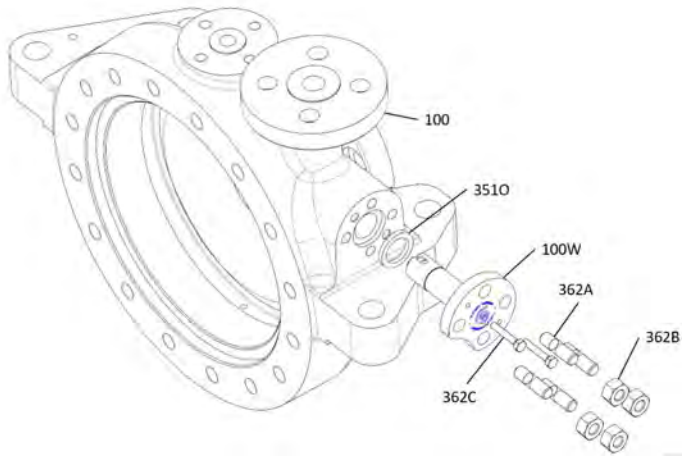



**Figure 82: Venturi insert and casing**

## 6.6.9 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.

## 6.6.10 Assembly references

## 6.6.10.1 Maximum torque values for fasteners

**Preload and Torque for Metal-to-Metal Joints High Strength Steel Fasteners**

The torque values specified in the table are for lubricated threads. These values should be increased for dry threads only. Materials listed in this table are equal to the respective API 610, 12th Edition material classes. In some cases, superior materials are substituted.

**Table 13: Goulds 2239, ASTM A193 B7 and Goulds 2299 ASTM A320 L7**

| Bolt Dia. (D) in. - threads/inch | Tensile Stress Area (Ab), (sq-in) | 2239 (A193 B7) ¼-2 ½ dia: Sult = 125 ksi, Sy=105 ksi over 2 ½ – 4: Sult = 115 ksi, Sy=95 ksi over 4 – 7: Sult = 100 ksi, Sy=75 ksi | | 2299 (A320 L7) ¼-2 ½ dia: Sult = 125 ksi, Sy=105 ksi |
|---|---|---|---|---|
| | | Max preload (lbs) | Torque (ft-lb) Nickel or Moly Anti-seize K=0.15 | Torque (ft-lb) Nickel or Moly Anti-seize K=0.15 |
| 1/4-20 | 0.0318 | 2337 | 7 | 7 |
| 5/16-18 | 0.0524 | 3851 | 15 | 15 |
| 3/8-16 | 0.0775 | 5696 | 27 | 27 |
| 7/16-14 | 0.1063 | 7813 | 43 | 43 |
| 1/2-13 | 0.1419 | 10430 | 65 | 65 |
| 9/16-12 | 0.1819 | 13370 | 94 | 94 |
| 5/8-11 | 0.226 | 16611 | 130 | 130 |

| Bolt Dia. (D) in. - threads/inch | Tensile Stress Area (Ab), (sq-in) | 2239 (A193 B7) ¼-2 ½ dia: Sult = 125 ksi, Sy=105 ksi over 2 ½ – 4: Sult = 115 ksi, Sy=95 ksi over 4 – 7: Sult = 100 ksi, Sy=75 ksi | | 2299 (A320 L7) ¼-2 ½ dia: Sult = 125 ksi, Sy=105 ksi |
|---|---|---|---|---|
| | | Max preload (lbs) | Torque (ft-lb) Nickel or Moly Anti-seize K=0.15 | Torque (ft-lb) Nickel or Moly Anti-seize K=0.15 |
| 3/4-10 | 0.3345 | 24586 | 230 | 230 |
| 7/8-9 | 0.4617 | 33935 | 371 | 371 |
| 1-8 | 0.6058 | 44526 | 557 | 557 |
| 1.125-7 | 0.7633 | 56103 | 789 | 789 |
| 1.125-8 | 0.79045 | 58098 | 817 | 817 |
| 1.25-7 | 0.9691 | 71229 | 1113 | 1113 |
| 1.25-8 | 1 | 73500 | 1148 | 1148 |
| 1.375-6 | 1.155 | 84893 | 1459 | 1459 |
| 1.375-8 | 1.234 | 90699 | 1559 | 1559 |
| 1.5-6 | 1.405 | 103268 | 1936 | 1936 |
| 1.5-8 | 1.492 | 109662 | 2056 | 2056 |
| 1.5-12 | 1.581 | 116204 | 2179 | 2179 |
| 1.625-8 | 1.775 | 130463 | 2650 | 2650 |
| 1.75-5 | 1.899 | 139577 | 3053 | 3053 |
| 1.75-8 | 2.082 | 153027 | 3347 | 3347 |
| 1.875-8 | 2.414 | 177429 | 4158 | 4158 |
| 2-4.5 | 2.498 | 183603 | 4590 | 4590 |
| 2-8 | 2.771 | 203669 | 5092 | 5092 |
| 2.125-8 | 3.152 | 231672 | 6154 | 6154 |
| 2.25-4.5 | 3.248 | 238728 | 6714 | 6714 |
| 2.25-8 | 3.557 | 261440 | 7353 | 7353 |
| 2.375-8 | 3.987 | 293045 | 8700 | 8700 |
| 2.5-4 | 3.999 | 293927 | 9185 | 9185 |
| 2.5-8 | 4.442 | 326487 | 10203 | 10203 |
| 2.625-8 | 4.921 | 327247 | 10738 | Not Applicable due to size restrictions in the material specification |
| 2.75-4 | 4.934 | 328111 | 11279 | |
| 2.75-8 | 5.425 | 360763 | 12401 | |
| 2.875-8 | 5.953 | 395875 | 14227 | |
| 3-4 | 5.967 | 396806 | 14880 | |
| 3-8 | 6.506 | 432649 | 16224 | |

## NOTICE:

1. Prestress = 0.7*yield strength
2. Max preload = prestress* tensile stress area
3. The preload and torque given in this table may need to be adjusted to account for special conditions, such as gaskets.

# 6.6.10.2 Maximum torque values for fasteners

### About this table

The torque values specified in this table are for lubricated threads. These values should be increased for dry threads only. Materials listed in this table are equal to the respective API 610, 12th Edition material classes. In some cases, superior materials are substituted.

### Preload and Torque for Metal-to-Metal Joints, 300 Series Stainless Steel Fasteners

**Table 14: Goulds 2226, 2228, 2229, ASTM A193 B8 and B8M, ASTM A276 Tp 304, ASTM A582 Tp 303, SAE F593**

| Bolt Dia. (D) in. - threads/inch | Tensile Stress Area (Ab), (sq-in) | 2226, 2228: 303, 304SS, SAE F593<br>Group 1 2229: 316SS, SAE F593<br>Group 2 Yield strength:<br>65000 psi for 0.25<=dia<=0.625<br>45000 psi for 0.75<=dia<=1.5 | | A193 B8, B8M Cl 1, A276 Tp 304, A582 Tp 303<br>Yield strength=30000 psi<br>Ultimate tensile=75000 psi | |
|---|---|---|---|---|---|
| | | Max preload (lbs,) | Torque (ft-lb) Nickel or Moly Anti-seize K=0.15 | Max preload (lbs) | Torque (ft-lb) Nickel or Moly Anti-seize K=0.15 |
| 1/4-20 | 0.0318 | 1447 | 5 | 668 | 2 |
| 5/16-18 | 0.0524 | 2384 | 9 | 1100 | 4 |
| 3/8-16 | 0.0775 | 3526 | 17 | 1628 | 8 |
| 7/16-14 | 0.1063 | 4837 | 26 | 2232 | 12 |
| 1/2-13 | 0.1419 | 6456 | 40 | 2980 | 19 |
| 9/16-12 | 0.1819 | 8276 | 58 | 3820 | 27 |
| 5/8-11 | 0.226 | 10283 | 80 | 4746 | 37 |
| 3/4-10 | 0.3345 | 10537 | 99 | 7025 | 66 |
| 7/8-9 | 0.4617 | 14544 | 155 | 9696 | 103 |
| 1-8 | 0.6058 | 19083 | 239 | 12722 | 159 |
| 1.125-7 | 0.7633 | 24044 | 338 | 16029 | 225 |
| 1.125-8 | 0.7904 | 24898 | 350 | 16598 | 233 |
| 1.25-7 | 0.9691 | 30527 | 477 | 20351 | 318 |
| 1.25-8 | 1.000 | 31500 | 492 | 21000 | 328 |
| 1.375-6 | 1.155 | 36383 | 625 | 24255 | 417 |
| 1.375-8 | 1.234 | 38871 | 668 | 25914 | 445 |
| 1.5-6 | 1.405 | 44258 | 830 | 29505 | 553 |
| 1.5-8 | 1.492 | 46998 | 881 | 31332 | 587 |
| 1.5-12 | 1.581 | 49802 | 934 | 33201 | 623 |
| 1.625-8 | 1.775 | 55913 | 1136 | 37275 | 757 |
| 1.75-5 | 1.899 | 59819 | 1309 | 39879 | 872 |
| 1.75-8 | 2.082 | 65583 | 1435 | 43722 | 956 |
| 1.875-8 | 2.414 | 76041 | 1782 | 50694 | 1188 |
| 2-4.5 | 2.498 | 78687 | 1967 | 52458 | 1311 |
| 2-8 | 2.771 | 87287 | 2182 | 58191 | 1455 |
| 2.125-8 | 3.152 | 99288 | 2637 | 66192 | 1758 |
| 2.25-4.5 | 3.248 | 102312 | 2878 | 68208 | 1918 |
| 2.25-8 | 3.557 | 112046 | 3151 | 74697 | 2101 |
| 2.375-8 | 3.987 | 125591 | 3728 | 83727 | 2486 |

| Bolt Dia. (D) in. - threads/inch | Tensile Stress Area (Ab), (sq-in) | 2226, 2228: 303, 304SS, SAE F593<br>Group 1 2229: 316SS, SAE F593 Group 2 Yield strength:<br>65000 psi for 0.25<=dia<=0.625<br>45000 psi for 0.75<=dia<=1.5 | | A193 B8, B8M Cl 1, A276 Tp 304, A582 Tp 303<br>Yield strength=30000 psi<br>Ultimate tensile=75000 psi | |
|---|---|---|---|---|---|
| | | Max preload (lbs,) | Torque (ft-lb) Nickel or Moly Anti-seize K=0.15 | Max preload (lbs) | Torque (ft-lb) Nickel or Moly Anti-seize K=0.15 |
| 2.5-4 | 3.999 | 125969 | 3937 | 83979 | 2624 |
| 2.5-8 | 4.442 | 139923 | 4373 | 93282 | 2915 |
| 2.625-8 | 4.921 | 155012 | 5086 | 103341 | 3391 |
| 2.75-4 | 4.934 | 155421 | 5343 | 103614 | 3562 |
| 2.75-8 | 5.425 | 170888 | 5874 | 113925 | 3916 |
| 2.875-8 | 5.953 | 187520 | 6739 | 125013 | 4493 |
| 3-4 | 5.967 | 187961 | 7049 | 125307 | 4699 |
| 3-8 | 6.506 | 204939 | 7685 | 136626 | 5123 |

**NOTICE:**

1. Prestress = 0.7*yield strength
2. Max preload = prestress* tensile stress area
3. The preload and torque given in this table may need to be adjusted to account for special conditions, such as gaskets

## 6.6.10.3 Maximum torque values for fasteners

### About this table

The torque values specified in this table are for lubricated threads. These values should be increased for dry threads only. Materials listed in this table are equal to the respective API 610, 12th Edition material classes. In some cases, superior materials are substituted.

### Preload and Torque for Metal-to-Metal Joints Carbon Steel Fasteners

**Table 15: Goulds 2210, 2294, ASTM A307 Gr B, SAE Gr 2**

| Bolt Dia. (D) in. - threads/inch | Tensile Stress Area (Ab), (sq-in) | Max preload (lbs) | Torque (ft-lb) Nickel or Moly Anti-seize, K=0.15 |
|---|---|---|---|
| 1/4-20 | 0.0318 | 801 | 3 |
| 5/16-18 | 0.0524 | 1320 | 5 |
| 3/8-16 | 0.0775 | 1953 | 9 |
| 7/16-14 | 0.1063 | 2679 | 15 |
| 1/2-13 | 0.1419 | 3576 | 22 |
| 9/16-12 | 0.1819 | 4584 | 32 |
| 5/8-11 | 0.226 | 5695 | 44 |
| 3/4-10 | 0.3345 | 8429 | 79 |
| 7/8-9 | 0.4617 | 11635 | 124 |
| 1-8 | 0.6058 | 15266 | 191 |
| 1.125-7 | 0.7633 | 19235 | 270 |
| 1.125-8 | 0.7904 | 19918 | 280 |

| Bolt Dia. (D) in. - threads/ inch | Tensile Stress Area (Ab), (sq-in) | Max preload (lbs) | Torque (ft-lb) Nickel or Moly Anti-seize, K=0.15 |
|---|---|---|---|
| 1.25-7 | 0.9691 | 24421 | 382 |
| 1.25-8 | 1.000 | 25200 | 394 |
| 1.375-6 | 1.155 | 29106 | 500 |
| 1.375-8 | 1.234 | 31097 | 534 |
| 1.5-6 | 1.405 | 35406 | 664 |
| 1.5-8 | 1.492 | 37598 | 705 |
| 1.5-12 | 1.581 | 39841 | 747 |
| 1.625-8 | 1.775 | 44730 | 909 |
| 1.75-5 | 1.899 | 47855 | 1047 |
| 1.75-8 | 2.082 | 52466 | 1148 |
| 1.875-8 | 2.414 | 60833 | 1426 |
| 2-4.5 | 2.498 | 62950 | 1574 |
| 2-8 | 2.771 | 69829 | 1746 |
| 2.125-8 | 3.152 | 79430 | 2110 |
| 2.25-4.5 | 3.248 | 81850 | 2302 |
| 2.25-8 | 3.557 | 89636 | 2521 |
| 2.375-8 | 3.987 | 100472 | 2983 |
| 2.5-4 | 3.999 | 100775 | 3149 |
| 2.5-8 | 4.442 | 111938 | 3498 |
| 2.625-8 | 4.921 | 124009 | 4069 |
| 2.75-4 | 4.934 | 124337 | 4274 |
| 2.75-8 | 5.425 | 136710 | 4699 |
| 2.875-8 | 5.953 | 150016 | 5391 |
| 3-4 | 5.967 | 150368 | 5639 |
| 3-8 | 6.506 | 163951 | 6148 |

**NOTICE:**

1. Yield strength = 36000 psi
2. Tensile strength (min) = 60000 psi
3. Prestress = 0.7*yield strength = 25.2ksi
4. Max preload = prestress * tensile stress area
5. The preload and torque given in this table may need to be adjusted to account for special conditions, such as gaskets

## 6.6.10.4 Spare parts

**Critical services spare parts**

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

- Venturi Insert (100W) (Applicable for venturi style casings)
- Impeller (101) with impeller rings (202 and 203)
- Thrust bearing end-cover (109A)
- Radial bearing end cover (119A)
- Shaft (122)
- Radial bearing isolator (123)

- Thrust bearing isolator (123A)
- Radial bearing isolator (123B)
- Cooling Fan (392B) -if supplied
- 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:

#### General repair kits

| Wear Ring Kit | | |
|---|---|---|
| **Item No.** | **Part Name** | **Qty.** |
| 164 | Wear ring, casing | 1 |
| 230 | Wear ring, seal chamber | 1 |
| 202 | Impeller wear ring, suction side | 1 |
| 203 | Impeller wear ring, hub side | 1 |
| 222E | Set screw, stationary wear rings | 6 |
| 320 | Set screw, impeller wear rings | 6 |

| Throat Bushing Kit | | |
|---|---|---|
| **Item No.** | **Part Name** | **Qty.** |
| 125 | Seal chamber, throat busing | 1 |
| 222D | Set screw, throat bushing | 1 |

| Impeller Nut Kit | | |
|---|---|---|
| **Item No.** | **Part Name** | |
| 304 | Impeller nut | 1 |
| 198A | Set screw, impeller nut | 1 |

#### Bearing frame repair kits

| Shaft Kit | | |
|---|---|---|
| **Item No.** | **Part Name** | |
| 122 | Shaft | 1 |
| 136 | Locknut, thrust bearing | 1 |
| 178 | Key, impeller | 1 |
| 198A | Set screw, impeller nut | 1 |
| 304 | Impeller nut | 1 |
| 382 | Lockwasher, thrust bearing | 1 |
| 400 | Key, coupling | 1 |

| Oil Sump Liquid Cooling Kit | | |
|---|---|---|
| **Item No.** | **Part Name** | **Qty.** |
| 494 | Tubing, finned cooling | 1 |
| 494C | Bushing - H.C. reducing | 1 |

| Oil Sump Liquid Cooling Kit | | |
|---|---|---|
| **Item No.** | **Part Name** | **Qty.** |
| 494A | Connector, thermo. | 4 |
| 494B | Elbow 90 | 2 |
| 358X | Pipe plug, frame cooling | 2 |

| Forced Convection Cooling Kit | | |
|---|---|---|
| **Item No.** | **Part Name** | **Qty** |
| 392B | Cooling fan, CCW | 1 |
| 234D | Cooling fan shroud support | 1 |
| 234A | Shroud cooling fan, thrust | 1 |
| 469Q | Hex cap screw, guard support | 5 |
| 222V | Set screw, fan | 2 |
| 785D | Cowling, cooling fan | 1 |
| 569F | Hex cap screw, cowling | 4 |
| 123B | Deflector fan, radial | 1 |

# 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. |
| 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 gland is not adjusted properly. | Tighten the gland nuts. |

| Symptom | Cause | Remedy |
|---|---|---|
| | 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. | Machine or replace the shaft sleeve as necessary. |
| The motor requires excessive power. | The discharge head has dropped below the rated point and is pumping too much liquid. | Install a throttle valve. If this does not help, then trim the impeller diameter. If this does not help, then 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.<br>2. Remove or add shims at the appropriate corners.<br>3. Realign the pump and driver. |

# 7.3 Assembly troubleshooting

**Table 16: 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. (not applicable on 3700LF and 3700LFI) | 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

**Table 17: Parts list with standard materials of construction**

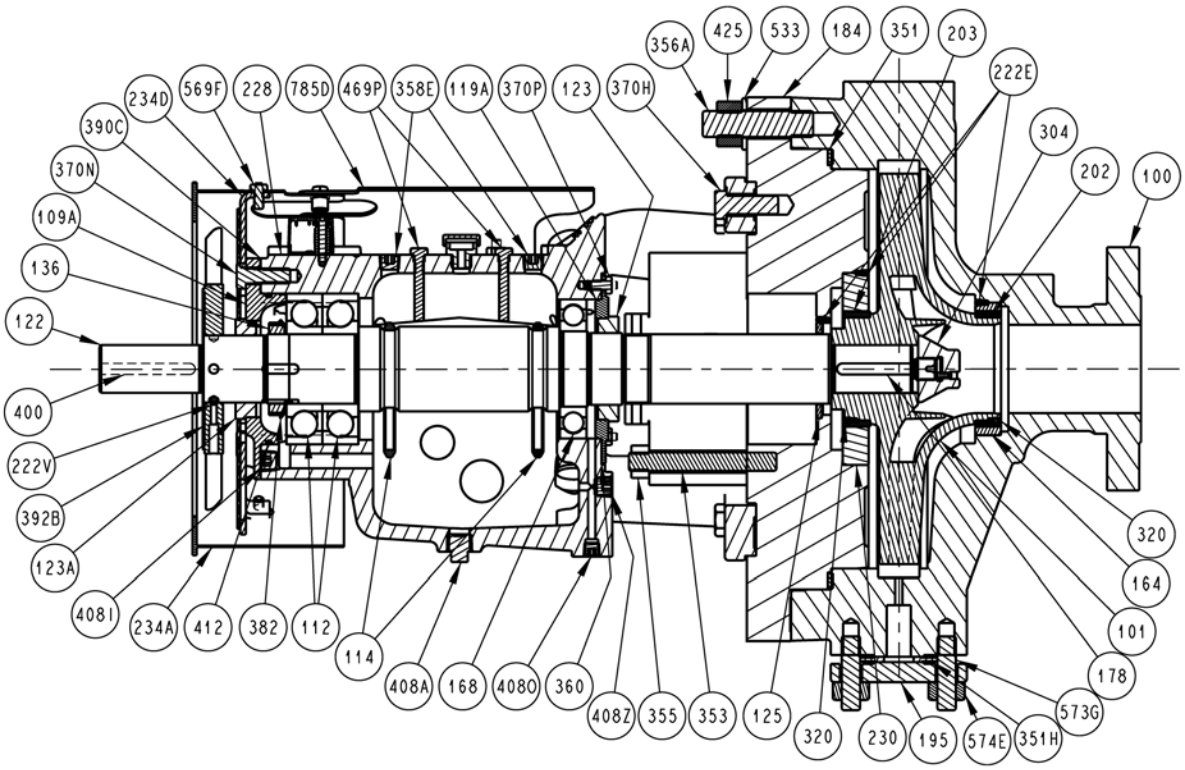
The materials in this table are typical. Refer to the order documentation for the actual materials furnished.

| Item | Part Description | S-4 | S-5 | S-6 | S-8 | C-6 | A-8 | D-1 | D-2 |
|---|---|---|---|---|---|---|---|---|---|
| 100 | Casing | 9020/1344 | | | | 9495/1234 | 9497/1296 | 9698/4120 | 9A01/1396 |
| 100W | Venturi Insert | 2244 | | | | | 2256 | 2435 | 3280 |
| 101 | Impeller | 9803/1212 | 9166/1212 | 9A51/1222 | 9A53/1265 | 9A51/1222 | 9A53/1265 | 9114/1216 | 9110/1361 |
| 109A | Frame End Cover, Thrust | 2501 | | | | | | | |
| 112 | Bearing, Thrust | —-- | | | | | | | |
| 113A | Breather | 316SS | | | | | | | |
| 113Q | Plug, Filter Assembly | 316SS | | | | | | | |
| 113R | Pipe Plug, Oil Filter Cleanout | 2502 | | | | | | | |
| 114 | Ring, Oil | 1618 | | | | | | | |
| 119A | Frame End Cover, Radial | 2501 | | | | | | | |
| 122 | Shaft | 2238[1] | | | 2229 | 2244 | 2229 | 2435 | 3280 |
| 123/123A | Inpro Seal VB45-U | Bronze/Viton as Std. or 316SS/Fluorsilicone | | | | | | | |
| 123B | Deflector Fan, Radial | 1425 | | | | | | | |
| 125 | Seal Chamber Throat Bushing | 1003 | 2244 | 2244 | 2256 | 2147 | 2256 | 2435 | 3280 |
| 132 | Screw, Lifting Holes | 2502 | | | | | | | |
| 136 | Locknut, Thrust Bearing | —-- | | | | | | | |
| 164 | Wear Ring, Casingf | 1001 | 2245 | 2245 | 2371 | 2245 | 2371 | 6942 | 6171 |
| 168 | Radial Bearing | —-- | | | | | | | |
| 178 | Key, Impeller | 2244 | | | 2229 | 2244 | 2229 | 2435 | 3280 |
| 184 | Seal Chamber Cover | 9020/1344 | | | | 9495/1234 | 9497/1296 | 9698/4120 | 9A01/1396 |
| 195G | Cover, Suction Flange | 3201-10018 | | | | | | | |
| 195H | Cover, Discharge Flange | 3201-10018 | | | | | | | |
| 195K | Blind Flange, Drain | 6200 | | | | 6206 | | 6015 | 6230 |
| 195N | Pipe Nipple | 6518 | | | | | | | |
| 195Z | Cover, Vent/Bypass | 3201-10018 | | | | | | | |
| 198A | Set Screw, Impeller Nut | 1410 | | | | | | 2435 | 3280 |
| 202 | Imp. Wear Ring, Suction Side | 1001 | 2446 | 2446 | 2363 | 2446 | 2363 | 6788 | 6170 |
| 203 | Imp. Wear Ring Hub Side | 1001 | 2446 | 2446 | 2363 | 2446 | 2363 | 6788 | 6170 |
| 222E | Set Screw, Stationary Wear Rings | 1410 | | | | | | 2435 | 3280 |
| 222V | Set Screw, Fan | 1410 | | | | | | | |
| 228 | Frame | 1212 | | | | | | | |
| 230 | Wear Ring, Seal Chamber | 1001 | 2245 | 2245 | 2371 | 2245 | 2371 | 6187 | 6171 |
| 234A | Shroud Cooling Fan, Thrust | 3201 | | | | | | | |
| 234D | Cooling Fan Shroud Support | 3201 | | | | | | | |
| 263C | Guard to Frame Screws | 2502 | | | | | | | |

| Item | Part Description | S-4 | S-5 | S-6 | S-8 | C-6 | A-8 | D-1 | D-2 |
|---|---|---|---|---|---|---|---|---|---|
| 251 | Watchdog Oiler | —-- | | | | | | | |
| 251F | OptoMatic Oiler | —-- | | | | | | | |
| 304 | Impeller Nut | 2238 | 1071 | | | | | 2435 | 3280 |
| 319 | Sight Window | —-- | | | | | | | |
| 319A | Pipe Plug, Sight Window | 2502 | | | | | | | |
| 319B | Pipe Plug, Oiler | 2502 | | | | | | | |
| 320 | Set Screw, Impeller Rings | 1410 | | | | | | 2435 | 3280 |
| 351 | Casing Gasket | Spiral Wound Stainless Steel (316) | | | | | | Spiral Wound Duplex | Spiral Wound Duplex |
| 351E | Gasket, Suction Shipping Cover | 5107-0006 | | | | | | | |
| 351F | Gasket, Discharge Shipping Cover | 5107-0006 | | | | | | | |
| 351H | Gasket, Drain Flange | Spiral Wound Stainless Steel (316) | | | | | | Spiral Wound Duplex | Spiral Wound Duplex |
| 351O | Gasket, Venturi Insert | Spiral Wound Stainless Steel (316) | | | | | | Spiral Wound Duplex | Spiral Wound Duplex |
| 351V | Gasket, Vent/Bypass Shipping Cover | 5107-0006 | | | | | | | |
| 353 | Gland Studs | 5426 | | | | | | | |
| 355 | Gland Nuts | 5427 | | | | | | | |
| 356A | Casing Stud | 5426 | | | | | | | |
| 358E | Pipe Plug, Oil Ring Inspection | 2502 | | | | | | | |
| 358F | Pipe Plug, Oil Mist Injection | 2502 | | | | | | | |
| 358X | Pipe Plug, Frame Cooling | 2502 | | | | | | | |
| 360 | Bearing End Cover Gaskets | 5130-0001 | | | | | | | |
| 362A | Insert Stud | 2292 | | | | | | | |
| 362B | Hex Nut, Insert to Case | 2285 | | | | | | | |
| 362C | Jacking Bolt, Insert | 2292 | | | | | | | |
| 370H | Cap Screw, Frame to S.C. | 2502 | | | | | | | |
| 370N | Cap Screw, Thrust Cover to Frame | 2502 | | | | | | | |
| 370P | Cap Screw, Radial Cover to Frame | 2502 | | | | | | | |
| 372T | Cap Screw - i-Alert®3 | 2367 | | | | | | | |
| 382 | Lockwasher, Thrust Bearing | —-- | | | | | | | |
| 390C | Shim, Thrust End Cover | —-- | | | | | | | |
| 392B | Cooling Fan - CCW | 1425 | | | | | | | |
| 400 | Key Coupling | 2213 | | | | | | | |
| 408 | Pipe Plug, Thrust Brg Trough Cleanout | 2502 | | | | | | | |
| 408A | Magnetic Pipe Plug, Oil Drain | —-- | | | | | | | |
| 408B | Pipe Plug, OptoMatic Oiler Port | 2502 | | | | | | | |
| 408I | Pipe Plug, Thrust Brg Drain Clean-out | 2502 | | | | | | | |
| 408L | Pipe Plug, Frame Cooling | 2502 | | | | | | | |
| 408M | Pipe Plug, Frame Cooling | 2502 | | | | | | | |
| 408O | Pipe Plug, Radial Brg Drain Axial Cleanout | 2502 | | | | | | | |

| Item | Part Description | S-4 | S-5 | S-6 | S-8 | C-6 | A-8 | D-1 | D-2 |
|---|---|---|---|---|---|---|---|---|---|
| 408R | Pipe Plug, RTD's | 2502 | | | | | | | |
| 408Z | Pipe Plug, Radial Brg Drain Axial Cleanout | 2502 | | | | | | | |
| 412 | O-Ring, Thrust End Cover | 5304 | | | | | | | |
| 418 | Tap Bolt, Jacking | 2502 | | | | | | | |
| 425 | Hex Nut, Casing to S.C. | 5427 | | | | | | | |
| 428E | O-Ring, Filter plug | 5304 | | | | | | | |
| 469P | Retainer, Oil Ring | 2502 | | | | | | | |
| 469Q | Hex Cap Screw, Guard Support | 2502 | | | | | | | |
| 494 | Tubing, Finned Cooling | —-- | | | | | | | |
| 494A | Connector, Thermo | Brass or 316 Stainless Steel | | | | | | | |
| 494B | Elbow 90 | Brass or 316 Stainless Steel | | | | | | | |
| 494C | Bushing - H.C. Reducing | 2502 | | | | | | | |
| 501F | Guard, Shaft | 3201 | | | | | | | |
| 501P | Flat Washer, Shaft Guard | 2504 | | | | | | | |
| 520 | Nut, Coupling | 2501 | | | | | | | |
| 533 | Washer, Seal Chamber Cover | 2177 | | | | | | | |
| 550A | Filter Assembly | —-- | | | | | | | |
| 569A | Hex Cap Screw, Suction Cover | 5429 | | | | | | | |
| 569B | Hex Cap Screw, Discharge Cover | 5429 | | | | | | | |
| 569F | Hex Cap Screw, Cowling | 2502 | | | | | | | |
| 569G | Hex Cap Screw, Vent/Bypass Shipping Cover | 5429 | | | | | | | |
| 570A | Nut Hex, Suction Cover | 5429 | | | | | | | |
| 570B | Nut Hex, Discharge Cover | 5429 | | | | | | | |
| 571D | Cover, Recirculation Flange Cover | 3201 | | | | | | | |
| 572D | Gasket, Recirculation Flange Cover | 5107 | | | | | | | |
| 573D | Hex Cap Screw, Recirculation Shipping Cover | 5429 | | | | | | | |
| 573G | Stud, Drain Flange | 5426 | | | | | | | |
| 574D | Nut Hex, Recirculation Shipping Cover | 5429 | | | | | | | |
| 574E | Nut Hex, Drain Flange | 5427 | | | | | | | |
| 761B | Monitor, i-Alert®3 | 18-8 Stainless with Nylon 12 Cover | | | | | | | |
| 785D | Cowling, Cooling Fan | 3201 | | | | | | | |
| 843U | Plug, Radial Oil Mist Conversion | 2502 | | | | | | | |
| 843V | Plug, Thrust Oil Mist Conversion | 2502 | | | | | | | |

### Cross sectional




| FRAME ASSEMBLY DETAIL | INSERT ASSEMBLY DETAIL | FILTER ASSEMBLY DETAIL |
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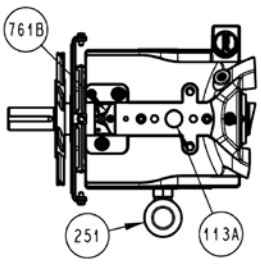
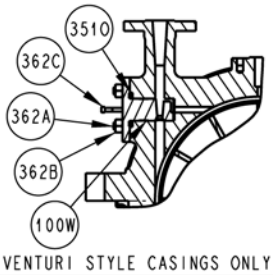
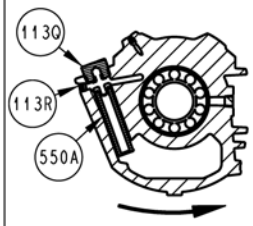
|  |  |  |





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# 9 Other Relevant Documentation of Manuals

## 9.1 For additional documentation

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# 10 Local ITT Contacts

## 10.1 Regional offices

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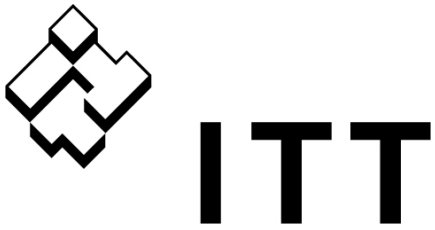

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