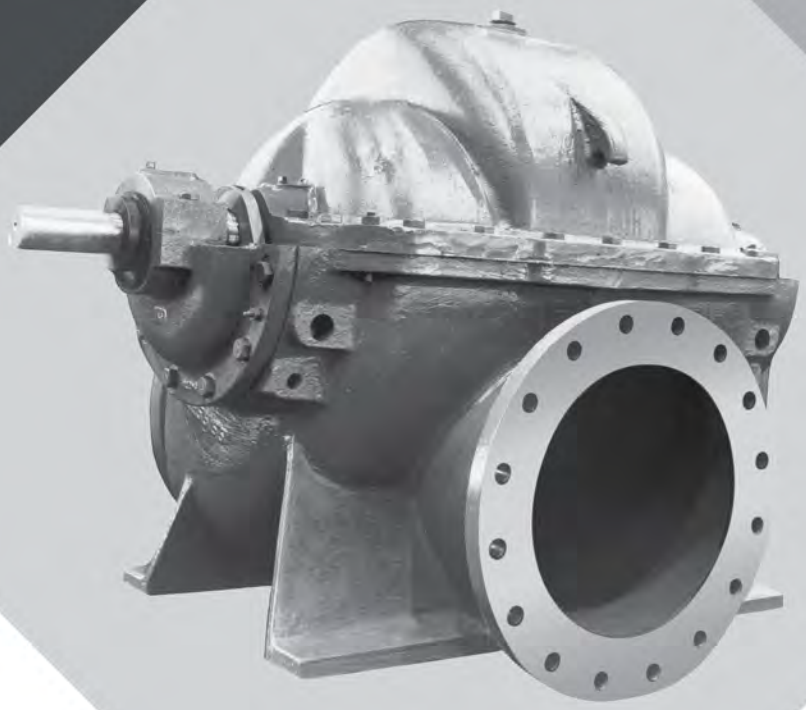
GOULDS PUMPS

Installation, Operation, and Maintenance Manual

Model 3498



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 • 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 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.
- Allow all system and pump components to cool before you handle them.
- Make sure that the product has been thoroughly cleaned.
- Disconnect and lock out power before you service the pump.
- Check the explosion risk before you weld or use electric hand tools.

1.2.3.2 Wash the skin and eyes

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

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

1.2.4 Ex-approved products

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

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

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

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

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

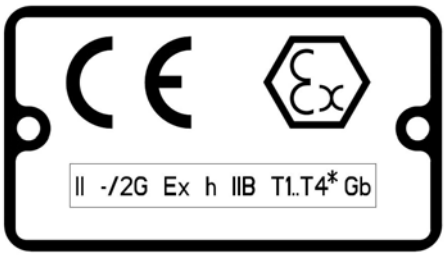


Figure 1: Typical Ex nameplate

Figure 2: Typical UKCA Ex nameplate

Table 1: Temperature class definitions

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

* Maximum liquid temperature may be limited by the pump model and order specific options. Table 1: Temperature class definitions on page 9 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.

1.2.5 Monitoring equipment

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

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

1.3 Product warranty

Coverage

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

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

Limitations

The warranty does not cover faults caused by these situations:

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

ITT assumes no liability for these situations:

- Bodily injuries
- Material damages
- Economic losses

Warranty claim

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

2 Transportation and Storage

2.1 Inspect the delivery

2.1.1 Inspect the package

1. Inspect the package for damaged or missing items upon delivery.
2. Note any damaged or missing items on the receipt and freight bill.
3. File a claim with the shipping company if anything is out of order.
   If the product has been picked up at a distributor, make a claim directly to the distributor.

2.1.2 Inspect the unit

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

2.2 Transportation guidelines

2.2.1 Precautions

WARNING:

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

2.2.2 Pump handling

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

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

2.2.3 Lifting methods

WARNING:

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

- Safe lifting points are specifically identified in this manual. It is critical to lift the equipment only at these points. Integral lifting eyes or eye bolts on pump and motor components are intended for use in lifting the individual components only.
- Lifting and handling heavy equipment poses a crush hazard. Use caution during lifting and handling and wear appropriate Personal Protective Equipment (PPE, such as steel-toed shoes, gloves, etc.) at all times. Seek assistance if necessary.
- Do not attach sling ropes to shaft ends.

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

Pumps mounted horizontally

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

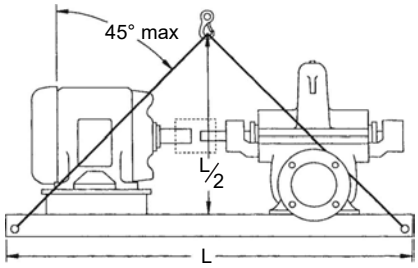


Figure 3: The proper lifting method for a horizontal pump on a base with lifting holes

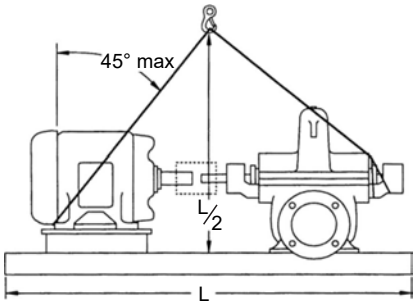
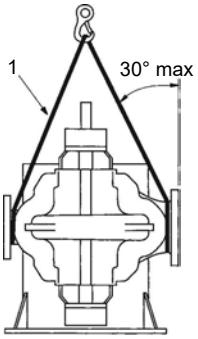


Figure 4: The proper lifting method for a horizontal pump on a base without lifting holes

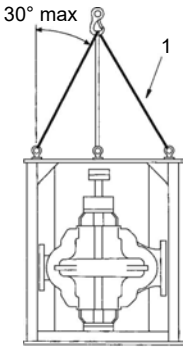
Pumps mounted vertically

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



1. Nylon sling, chain, or wire rope

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



1. Nylon sling, chain, or wire rope

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

2.3 Storage guidelines

2.3.1 Pump storage requirements

Consider a unit to be in storage when any of these conditions apply:

- It has been delivered to the job site and is awaiting installation.
- It has been installed, but operation is delayed pending completion of planned construction.
- There are long periods (30 days) between operation cycles.
- The plant or department is shut down.

Store accessories such as motors, steam turbines, and gears according to the recommendations of the respective manufacturers.

2.3.1.1 Temporary storage

Storage time

These guidelines apply to horizontal and vertical pumps for storage of one month or less.

If the equipment will not be installed and operated soon after arrival, then provide these conditions for storage:

- Clean, dry, well-ventilated location
- Free from vibrations
- Free from rapid or wide variations in temperatures

Storage maintenance

- Oil-lubricated pumps are shipped without lubricant. Fill the frame completely with oil for storage. Before putting equipment into operation, drain the oil to the proper level.
- Every week, rotate the shaft several revolutions in order to coat the bearings with lubricant, to retard oxidation or corrosion, and to prevent possible brinelling.
- Coat the shaft extensions and other exposed machine surfaces with an easily removable rust preventative, such as Tectyl No. 502C from Valvoline Oil Company, Division of Ashland Petroleum Company.

2.3.1.2 Prepare the pump for long-term storage

CAUTION:
Do not store the pump near sources of vibration, such as near a railroad, heavy truck traffic, or impacting machinery. Doing so can result in false brinelling of the pump bearings.

The following procedure applies to horizontal and vertical pumps only for storage of one month or longer.

Follow the same guidelines for temporary storage in addition to this procedure.

1. Prepare oil-lubricated bearing frames for storage:
   Pumps with oil lubrication are shipped from the factory without oil in the bearing frame. To prepare these frames for storage, complete these steps:
   a) Fill the bearing frame with a lubricating oil that contains a rust preventative such as Mobilarma 500 Series oil.
   If this oil will be used for initial operation of the equipment, then take care to select an oil suited to the intended operating temperature of the pump. Check the supplier’s technical data and the pump instruction book for this information.
   b) Seal all vents and apply a waterproof tape around the oil seals in the bearing frames.
2. Prepare grease-lubricated bearing frames for storage:

Pumps are shipped from the factory with the bearings pre-greased and require no further lubrication.

a) If the pump will be stored in a humid environment or outside, then add 0.5 ounce (14.8 ml) of corrosion-inhibiting concentrated oil such as Cortec's VCI-329 to the frame.

b) Seal all vents and apply a waterproof tape around the grease seals in the bearing frame.

3. Prepare the packed stuffing box for storage:

   a) Remove the gland, lantern ring, packing base ring (if applicable), and packing from the stuffing box.

   If the packing is in good condition, then it can be saved. Otherwise, discard it.

   b) Thoroughly clean and dry the interior of the stuffing box and the shaft sleeve.

   c) Coat all interior parts of the stuffing box, except for stainless materials, with a soft film rust preventative such as Valvoline Tectyl 502C or Cortec's VCI-369.

   d) Seal the end of the stuffing box with waterproof tape.

   You will need to remove and replace this tape when you rotate the shaft.

   e) Store the gland, packing base ring, packing, and lantern ring until the pump is ready to be put into service.

4. Prepare the stuffing box with mechanical seal for storage:
   A seal box made of stainless material does not require this procedure.

   a) For a double-face seal, open uppermost flushing tap on the stuffing box and fill the cavity with a lightweight (#10-#20) rust preventative oil such as Mobilarma 500.

   b) For a single-face seal, remove the flushing-water plug to the stuffing box and spray an oil-base volatile corrosion inhibitor such as Cortec's VCI-329 into the stuffing box cavity.

   Be sure to coat as much of the interior of the cavity as possible.

   c) Seal all vent and drain lines. Seal the point where the shaft exits the box with waterproof tape.

   You will need to remove and replace this tape when you rotate the shaft.
   Note that most mechanical seals provided have elastomer materials made of Buna-N, Neoprene, or Viton™, which are not affected by hydrocarbon-based lubricants. If your pump has seals with materials other than these, then you must check the compatibility of that material with the manufacturer of the rust preventative used.

5. For pumps made of non-stainless material, complete these steps:

   a) Coat all exposed machined surfaces (flanges, faces, shafts, exposed locating fits, and so forth.) with a firm rust preventative such as Valvoline Tectyl 890.

   b) Place a volatile corrosion inhibitor device in the pump casing such as Cortec's VCI 309, 101, or 110, depending on the pump size and application.

WARNING:

If pumped liquid includes potable water, food, beverage, etc., then the corrosion inhibitor must be non-toxic. Use of toxic corrosion inhibitors in this circumstance can result in injury or death.

6. Cement the rubber diaphragm flange covers over the suction and discharge flanges. Protect these rubber diaphragm covers with hardboard material.
7. Make sure all vents, drains, or plugs are tightly sealed.

The pump is now ready to be placed in storage.

2.3.1.3 Storage location and care

Indoor storage and care

Preparation is minimal if the indoor storage area is dry and clean.

- Take care to prevent extremes in temperature (below 32°F [0°C] and above 110°F [43°C]).
- Keep the pump out of direct sunlight.
- Cover the pump in order to protect it from dust and dirt.
- Prevent moisture buildup around the pump, either by allowing proper ventilation or by tightly sealing the pump in the cover with a suitable amount of desiccant to ensure dryness.
- Rotate the pump shaft 10–15 turns twice a month. This operation recoats the bearings with grease or oil and prevents false brinelling. Be sure that the shaft comes to rest in different positions.

If the indoor storage area is humid or dirty, such as an unfinished building, treat the pump as if it were to be stored outdoors.

Outdoor storage and care

- Inspect the storage area weekly, and after storms, for damage to protective covers.
- Rotate the shaft 10–15 turns three times a month.
- Repeat the storage preparation procedure every six months in normal environments and every two months in corrosive environments, such as salt air.

Installed but not in service

Preparation for storage under these conditions is the same as for indoor and outdoor storage, except that the suction and discharge piping serve as the flange covers.

- Inspect the casing area once a month for moisture buildup. Replace the volatile corrosion inhibitor at this time.
- Tightly close the suction and discharge valves and remove all fluid from the pump and attached piping.
- The interior of the pump and the piping must be thoroughly dried.
- Repeat the storage preparation procedure every 12 months.

2.3.1.4 Prepare the stored pump for operation

1. Remove all rust inhibitor coating from exposed machined surfaces using the method described by the supplier.
2. Remove all corrosion protection devices or material from the pump casing.
3. If the pump has packing, then repack the pump. See 4.6.1 Packing on page 36.
4. If the pump has mechanical seals, then drain the protective oil from the seal cavity. Flush the cavity with clean water or seal lubricant for five minutes before startup.
5. Remove the flange covers, tape, and all unnecessary pipe plugs.
6. Prepare the oil-lubricated bearing frame:

   a) Drain the rust preventative oil from the frame and replace with fresh oil.
   Note that some rust preventative oils such as Mobilarma 500 can be used in the bearing frame for startup and initial running. Check the supplier's technical data and 6.3.2.1 Lubricating-oil requirements on page 50 in order to make sure that the oil used is of suitable viscosity and grade for the intended application. If this is the case, then drain the oil from the bearing frame to the level indicated on the sight gauge.

   b) When the oil used to protect the bearing frame is used to run the pump on startup, change this oil initially at half the recommended time for oil changes.
7. Prepare the grease-lubricated bearing frame:

- No special methods are required to prepare for startup.
- You can leave the corrosion inhibitor oil in the frame.
- If the pump is started with the factory-supplied grease, then re-grease initially at half the recommended grease interval.

8. Remove the tape from the breather and seals.

3 Product Description

3.1 General description

Product description

This product line consists of 19 sizes of double-suction, horizontally split-case pumps from size 12x18-34 through size 42x48-44.

Casing

The axially-split, double-volute casing has these characteristics:

- The material of construction is close-grained cast iron or ductile iron.
- Suction and discharge flanges and mounting feet are cast integral with the lower-half casing.
- Tapped and plugged holes are provided for priming, vent, drain, and gauge connections.
- The upper half of the casing is removable without disturbing suction or discharge piping.
- The flanges are to ANSI standards.
- Suction and discharge are on a common centerline in both the horizontal and vertical planes.

Impeller

The impeller has these characteristics:

- Enclosed, double-suction
- Made of bronze, cast iron, or 316 stainless steel
- Statically and hydraulically balanced
- Keyed to the shaft
- Positioned axially by the shaft sleeves
- Sufficient metal thickness in the hub to allow machining for installation of impeller rings

Shaft

The shaft has these characteristics:

- Made of AISI 4140, 316 stainless steel, or 17-4 ph
- Sized to operate under load with a minimum of deflection

Shaft sleeves

The shaft sleeves have these characteristics:

- Made of bronze, 420 hardened stainless steel (packing only), 316 stainless steel, or cast iron
- Protection for the shaft from wear and from contact with the pumped liquid
- An O-ring under the sleeve that prevents leaks

Stuffing box

The stuffing box has these characteristics:

- At least six rings of die-formed, graphite, acrylic yarn packing
- A split-type gland that permits removal and access to packing
- Ample space for repacking the stuffing box
- Arranged for field or factory conversion to mechanical seals without machine work

Casing rings

The casing rings have these characteristics:

- Made of bronze, cast iron, or 316 stainless steel
- Installed with an anti-rotation device

Bearings

The bearings have these characteristics:

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

Bearing housings

The bearing housings have these characteristics:

- Bolted and doweled to the end of the lower half of the casing in order to ensure positive alignment of the rotating element
- A fit for the inboard bearing that allows for thermal expansion
- Outboard bearing clamped in place in order to take all thrust loads and to keep the rotating element in its proper axial location

Baseplate

The baseplate has these characteristics:

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

Coupling

The coupling is an all-metal type.

WARNING:

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

Coupling guard

The coupling guard is all metal.

NOTICE:

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

Rotation

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

3.2 Nameplate information

Important information for ordering

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

When you order spare parts, identify this pump information:

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

Item numbers can be found in the spare parts list.

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

Nameplate types

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

Nameplate on the pump casing

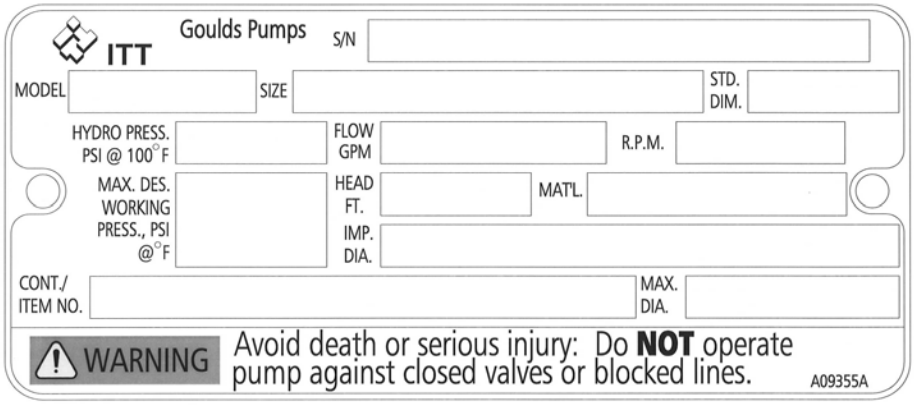


Figure 7: Nameplate on the pump casing

Nameplate field	Explanation
Size	Size of the pump
Type	Type of pump

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

Nameplate on the bearing frame

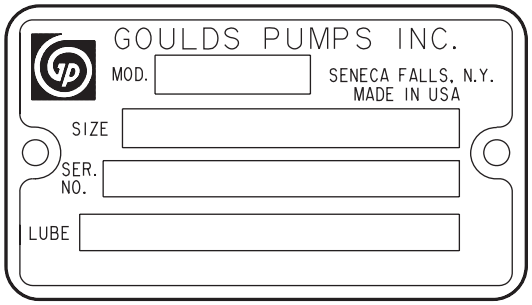


Figure 8: Nameplate on the bearing frame

Table 2: Explanation of the nameplate on the bearing frame

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

Ex nameplate

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

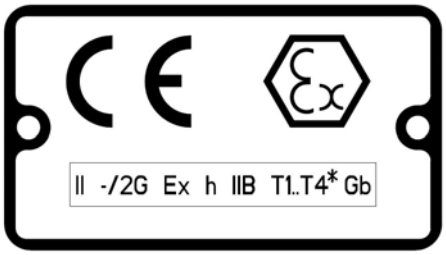


Figure 9: Typical Ex nameplate

Figure 10: Typical UKCA Ex nameplate

Refer to Table 1 for pumpage temperature restrictions.

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

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

4 Installation

4.1 Pre-installation

Precautions

WARNING:

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

NOTICE:

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

4.1.1 Pump location guidelines

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

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

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

4.1.2 Foundation requirements

Requirements

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

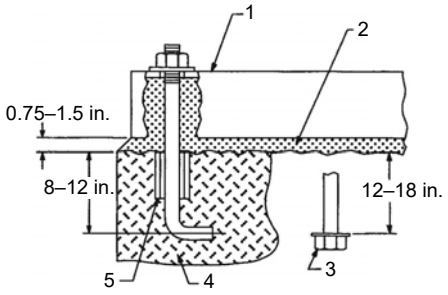
Vertical pumps

- Foundation bolts must be sized and accurately located.
- Each foundation bolt must be located in a bushing two diameters larger than the bolt. This allows free movement of the bolt in conforming to the mounting holes in the pedestal.
- When vertical pumps are used with intermediate shafting, the motor mount baseplate must be securely attached to the floor or support structure.

Horizontal pumps

- The top surface of the foundation must be well-scored and grooved before the concrete sets; this provides a bonding surface for the grout.
- Foundation bolts must be set in concrete as shown in the bolt installation diagram.
- A 10 cm | 4-in. long tube around the bolts at the top of the concrete allows some flexibility in bolt alignment in order to match the holes in the baseplate.
- Allow enough bolt length for grout, shims, lower baseplate flange, nuts, and washers.

Bolt installation diagram



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

Figure 11: Bolt installation

4.1.3 Piping checklists

4.1.3.1 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.

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

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

Piping guidelines

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

Checklist

Check	Explanation/comment	Checked
Check that all piping is supported independently of, and lined up naturally with, the pump flange.	• Strain on the pump • Misalignment between the pump and the drive unit	
Keep the piping as short as possible.	This helps to minimize friction losses.	
Keep the piping as straight as possible. Avoid unnecessary bends. Use 45° or long radius 90° fittings where necessary.	This helps to minimize friction losses.	
Check that only necessary fittings are used.	This helps to minimize friction losses.	
Make sure that the inside diameters match properly when you use flange joints.	—	
Do not connect the piping to the pump until: • The grout for the baseplate or sub-base becomes hard. • The grout for the pit cover becomes hard. • The hold-down bolts for the pump are tightened.	—	
Make sure that all the piping joints and fittings are airtight.		
If the pump handles corrosive fluids, make sure that the piping allows you to flush out the liquid before you remove the pump.		
	This helps to prevent misalignment due to thermal expansion of the piping.	
Make sure that all piping components, valves and fittings, and pump branches are clean prior to assembly.	—	
Make sure that the isolation and check valves are installed in the discharge line.	Locate the check valve between the isolation valve and the pump. This will permit inspection of the check valve. The isolation valve is required for regulation of flow, and for inspection and maintenance of the pump. The check valve prevents pump or seal damage due to reverse flow through the pump when the driver is turned off.	
Use cushioning devices.	This protects the pump from surges and water hammer if quick-closing valves are installed in the system.	
In no case should loads on the pump flanges exceed the limits stated in API Standard 610, 11th Edition (ISO 13709).	Bottom of casing should be supported by a solid foundation or casing feet should be used.	

4.1.3.1.1 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.

4.1.3.2 Suction piping checklist

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

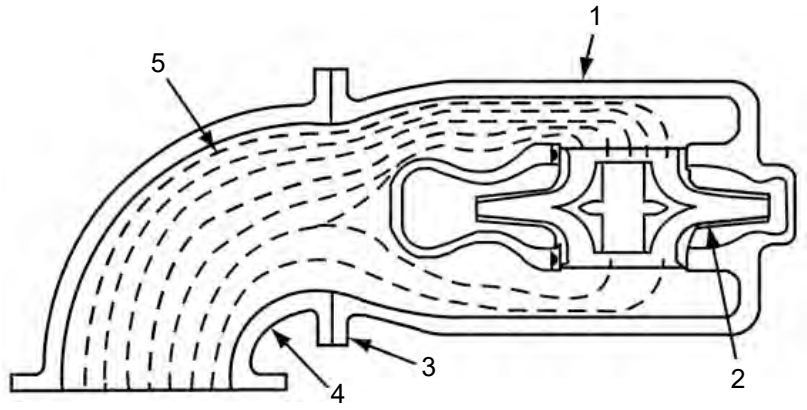
Piping checklist

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

Example of unbalanced loading

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

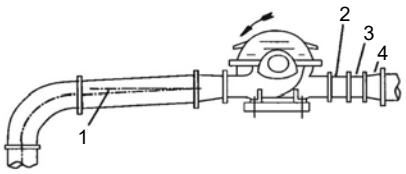
This figure shows the unbalanced loading of a double-suction impeller due to the uneven flow around an elbow that is adjacent to the pump:



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

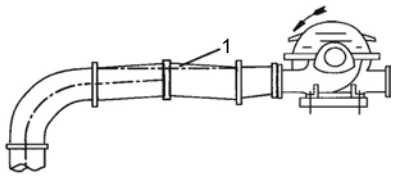
Figure 12: Unbalanced loading of double-suction impeller

Examples



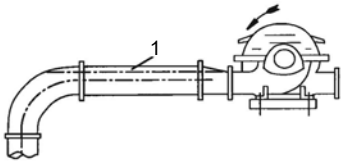
1. Level centerline of pipe
2. Check valve
3. Gate valve
4. Increaser

Figure 13: Suction pipe installed with a gradual rise to the pump – correct



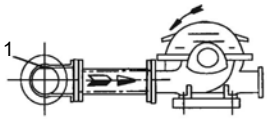
1. Air pocket

Figure 14: Suction pipe installed with a gradual rise to the pump – incorrect



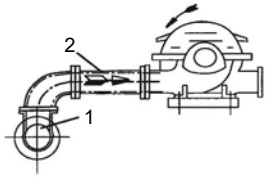
1. Air pocket

Figure 15: Suction pipe installed with a reducer – incorrect



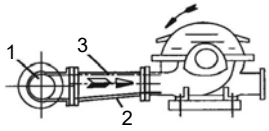
1. Air pocket

Figure 16: Incorrect



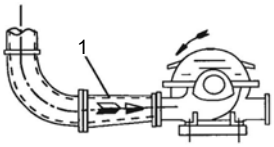
1. No air pockets
2. Gradual rise

Figure 17: Correct



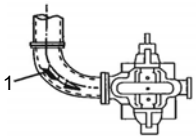
1. No air pockets
2. Eccentric reducer
3. Gradual rise

Figure 18: Gradual rise to the pump – correct



1. Distance plus eccentric reducer straightens the flow

Figure 19: Suction pipe above the pump – correct



1. Path of the water

Figure 20: Suction pipe above the pump – incorrect

4.1.3.3 Suction-piping valve considerations

Suction valves

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

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

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

Foot valves

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

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

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

Check valves

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

Gate valves

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

Before you install gate valves, review these considerations:

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

4.1.3.4 Discharge piping considerations

Before you construct discharge piping, review these considerations:

- If the discharge piping is short, then the pipe diameter can be the same as the discharge opening.
- If the piping is long, then the pipe diameter should be one or two sizes larger than the discharge opening.
- On long horizontal runs, it is desirable to maintain the most even grade possible.

- Avoid high spots, such as loops. High spots will collect air and throttle the system or lead to erratic pumping.
- A check valve and an isolating gate valve should be installed in the discharge line.
  - The check valve is placed between the pump and the gate valve. This protects the pump from excessive backpressure and prevents liquid from running back through the pump in case of power failure.
  - The gate valve is used for priming and starting and also shutting down the pump.

4.1.3.5 Pressure gauges

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

4.2 Set the baseplate

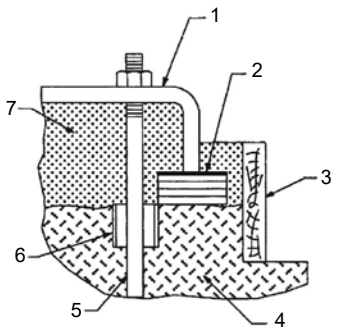
This procedure assumes that a concrete foundation has been prepared with anchor or hold-down bolts that extend up ready to receive the unit. The pump and motor have been mounted and rough aligned at the factory. If the motor will be field mounted, consult the factory for recommendations. ITT cannot assume responsibility for final alignment.

1. Use blocks and shims under the base for support at the anchor bolts and midway between bolts, in order to position the base approximately 2.5 cm | 1.0 in. above the concrete foundation.
   The studs must extend through the holes in the baseplate.
2. Add or remove shims under the base in order to level and plumb the pump shaft and flanges.
   The baseplate does not need to be level.
3. Draw the anchor nuts tight against the base and check the pump and motor shafts or coupling hubs for alignment.
   Temporarily remove the coupling guard for checking alignment.
4. If the alignment needs improvement, then add shims or wedges at the appropriate positions under the base so that the shafts shift into closer alignment when the anchor nuts are retightened.
5. Repeat this procedure until you achieve a reasonable alignment.
   Reasonable alignment is defined as that which the pump contractor and the accepting facility (final operator) mutually agree upon. For final alignment procedures, see 4.4 Pump-to-driver alignment on page 32.

4.3 Grout the baseplate

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

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



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

Figure 21: Baseplate grouting

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

   If necessary, temporarily use air relief tubing or drill vent holes in order to remove trapped air.
4. After the grout has completely hardened, tighten the foundation bolts.

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

4.4 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.

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 misalignment

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

Check and correct angular misalignment before correcting parallel misalignment.

Types of alignment checks

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

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

Initial alignment (cold alignment) checks

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

Final alignment (hot alignment) checks

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

4.4.2 Align the pump using a straight edge

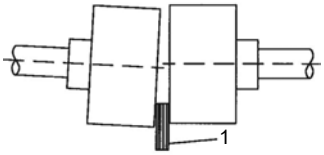
Before you begin, you must have a straight edge and a taper gauge or set of feeler gauges.

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

1. Check for angular alignment by inserting the taper or feeler gauges between the coupling faces at 90° intervals.

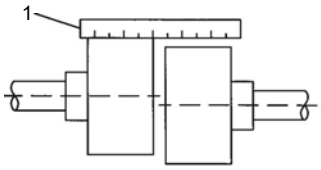
   The unit is in angular alignment when these four measurements are the same or are within recommended tolerances.
2. Check for parallel alignment by placing a straight edge across both coupling rims on all four sides.

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



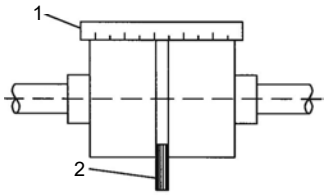
1. Feeler gauge

Figure 22: Incorrect angular alignment



1. Straight edge

Figure 23: Incorrect parallel alignment



1. Straight edge
2. Feeler gauge

Figure 24: Correct alignment

4.4.3 Align the pump using a dial indicator

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

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

1. Fasten the indicator stand or magnetic base to the pump half of the coupling.
2. Adjust the assembly until the indicator button is resting on the periphery of the other coupling half.
3. Set the dial to zero and use chalk to mark the coupling half where the button rests. Then place a separator between the coupling halves so that the bearing slack does not affect the readings.

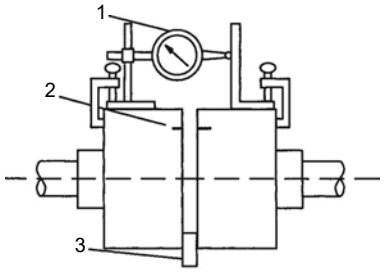
   Chalk and separators are not necessary on the elastomeric couplings that have not been disconnected.
4. Rotate both shafts by the same amount.

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

   The dial readings will indicate whether the driver must be raised, lowered, or moved to either side. You can accurately align the shaft centers with this method even where faces or outside diameters of the coupling are not square or concentric with the bores.

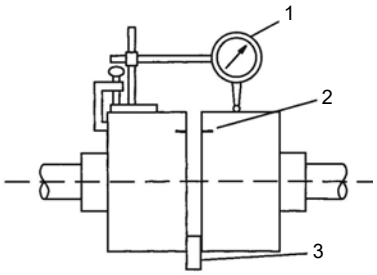
   NOTICE:

   Risk for rotation unbalance. Any gross deviation in squareness or concentricity must be corrected.
5. After each adjustment, recheck both parallel and angular alignments.



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

Figure 25: Angular alignment



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

Figure 26: Parallel alignment

4.5 Pump doweling

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

4.6 Stuffing box lubrication requirements

The stuffing box must be supplied at all times with a source of clean, clear liquid in order to flush and lubricate the packing or seal.

Contaminants in the pumped fluid must not enter the stuffing box. These contaminants can cause the following problems:

- Severe abrasion or corrosion of the shaft or shaft sleeve
- Rapid deterioration of the packing or mechanical seal
- Plugging of the stuffing box flushing and lubrication system

You must establish an optimum flushing pressure that will keep contaminants from the stuffing box cavity. Use a seal water pressure that is 1–1.4 bar | 15–20 psig above the maximum stuffing box pressure.

- If the pressure is too low, then the pumped fluid can enter the stuffing box.
- If the pressure is too high, then it can cause excessive wear on the packing or seal. Extreme heat can develop in the shaft, which will cause higher bearing temperatures.

If pressure conditions vary in the pump system, then packing adjustment becomes difficult. Consider using a mechanical seal.

Grease lubrication

Stuffing boxes can also be grease-lubricated. Several types of grease lubrication are available. When you use a grease lubricator, make sure that the grease pressure to the stuffing box is equal to the pump discharge pressure.

4.6.1 Packing

WARNING:

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

Pumps are normally shipped with the packing set loose. If you install the pump within 60 days after shipment, the packing will be in good condition with a sufficient supply of lubrication. If the pump is stored for a longer period, then you will need to repack the stuffing box. In all cases, however, inspect the packing before you start the pump.

Internal lubrication

On some applications, it is possible to use internal fluid lubrication (pumped fluid) to lubricate the packing. This can be done only when all of these conditions are met:

- The pumped fluid is clean, free from sediment and chemical precipitation, and is compatible with the seal materials.
- The temperature is above 0°C | 32°F and below 71°C | 160°F.
- The suction pressure is below 5.27 kg/cm^2 | 75 psig.
- The pumped fluid has lubricating qualities.
- The pumped fluid is non-toxic and non-volatile.

External lubrication

When the pumped fluid contains solids or is otherwise not compatible with packing materials, you must provide an outside supply of seal lubrication. In general, external-injection liquid (from an outside source) is required when any of the conditions for internal lubrication cannot be met.

The standard stuffing box consists of six rings of packing and a split-type gland. A shaft sleeve extends through the box and under the gland and protects the shaft.

A tapped hole in the stuffing box, directly over the seal cage, is used to introduce a clean, clear sealing fluid.

External lubrication must provide these conditions:

- Volume sufficient to create a definite direction of flow from the stuffing box into the pump casing: 1.9–3.8 lpm | 0.5–1.0 gpm.
- Pressure high enough to keep the stuffing box free from foreign matter: 1.0–1.4 kg/cm^2 | 15–20 psig above the suction pressure.

4.6.2 Mechanical seals

WARNING:

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

Mechanical seals are preferred over packing on some applications because of better sealing qualities and longer serviceability. Leakage is eliminated when a seal is properly installed, and normal life is much greater than that of packing on similar applications.

A mechanical shaft seal is supplied in place of a packed stuffing box when specifically requested. The change from packing to an alternate arrangement can be made in the field by competent service personnel. Conversion parts can be ordered from your ITT Goulds representative.

Just as with packing, you must supply the mechanical seal chamber at all times with a source of clean, clear fluid in order to flush and lubricate the seal.

The most important consideration is to establish the optimum flushing pressure that will keep contaminants from the seal cavity.

- If the pressure is too low, then the pumped fluid can enter the stuffing box.
- If the pressure is too high, then excessive seal wear will result.

External lubrication

When contaminants are present in the pumped fluid, an external source of clean seal water must be supplied.

External lubrication must provide these conditions:

- Volume sufficient to create a definite direction of flow from the stuffing box into the pump casing: 0.5–1.0 gpm (1.9–3.8 lpm).
- Pressure high enough to keep the stuffing box free from foreign matter: 15–20 psig (1.0–1.4 kg/cm^2) above the suction pressure.

A controlled pressure system is recommended for flushing a mechanical seal. See 4.6.4 Controlled pressure system on page 38. Seal water enters the seal chamber, lubricates the seal face, and exits into the pump. Positive flow in the seal water line indicates adequate seal water pressure.

4.6.3 Cartridge seals

CAUTION:

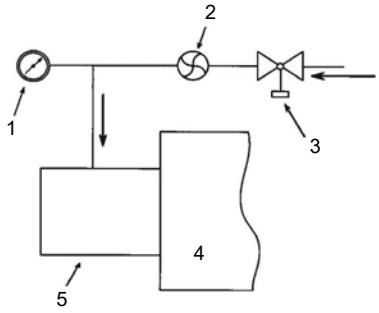
The mechanical seal must have an appropriate seal-flush system. Failure to do so will result in excess heat generation and seal failure.

Follow the appropriate lubrication directions for mechanical seals. Most cartridge seals provide flushing connections on their glands. If provided, use the flushing taps in the cartridge seal gland for your seal water connections instead of the stuffing box tap. Quench taps on the glands are typically used only in chemical applications. Consult the literature from the seal manufacturer for more detailed information.

4.6.4 Controlled pressure system

One recommended method to minimize error in regulating flushing water is a controlled pressure system. This system uses a pressure-reducing valve, a pressure gauge, and a flowmeter on the external flushing piping.

The piping that supplies the sealing liquid to the stuffing box must be sized so that it can supply a sufficient volume of water at the required pressure. Pressure is based on the location of the pump with respect to the liquid source. A small pipe can be used for the connection to the stuffing box.



1. Pressure gauge
2. Flowmeter
3. Pressure-reducing valve
4. Pump casing
5. Stuffing box

The external sealing fluid must be adjusted to the point where the packing runs only slightly warm, with a very slow drip from the stuffing box. Control the drips primarily with the pressure-reducing valve adjusted to a pressure slightly exceeding the maximum stuffing box operating pressure, assuming it is reasonably constant. Make finer adjustments by tightening the packing gland. The life of the packing and sleeve depends on this careful combination of both adjustments.

Use a flowmeter to detect a failing of the bottom packing rings, which would allow leaks into the pump.

Excess pressure from an external source can be very destructive to packing. However, more pressure is required for abrasive slurries than for clear fluids. Examine the leakage in order to determine whether to increase or decrease external pressure.

- If slurry is present in the leaks, then increase the pressure until only clear liquid drips from the box.
- If the leaks are corrosive or harmful to personnel, then you must collect it and pipe it away.

4.6.5 Cyclone separator

If the fluid being pumped contains sediment and there is no external, clean water source available to flush the packing or mechanical seals, then use a cyclone separator. The separator is placed in the seal water piping line and removes the sediment from the pumped fluid into an external drain, typically back to the pump suction line. The pumped fluid can then be used to flush the seals.

4.7 Electrical requirements

Motor

If the motor is sized to operate near the full load at the rated head and capacity of the pump, then you must install a wattmeter in order to record input power to the motor. If you know the motor efficiency, then

you can calculate the shaft horsepower and check it against the motor rating. A motor that operates outside its service factor will overheat and could possibly burn out. Motors are rated with normal temperature requirements stamped on the data plate.

NOTICE:
If a motor is too hot to touch, that does not mean that it is running too hot for proper operation. Check with an accurate temperature-measuring device to be sure. A motor operating outside its service factor will overheat and could possibly burn out. Motors are usually rated with normal temperature requirements stamped on the data plate.

Conduit box

Conduit boxes are mounted on the motors at lead-access openings. Conduit boxes are typically provided for main power leads and other special accessories, such as space heaters, temperature alarms, and control features.

The conduit box openings are sized as shown on the motor dimension drawing, and threaded for standard rigid or flexible conduit. They can be assembled with conduit openings at any of four (4) 90° positions.

Motor controls

Motor controls must conform to all the electrical data stamped on the motor data plate. Complete instructions for installation, operation, and maintenance are included with the controlling device.

External wiring

Install wiring to the motor in conformance with the National Electrical Code and any local codes.

5 Commissioning, Startup, Operation, and Shutdown

5.1 Preparation for startup

WARNING:

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

CAUTION:

- Serious damage to the pump may result if it is started dry. Make sure that the pump is completely filled with liquid before it is started.
-  Cooling systems such as those for bearing lubrication and mechanical-seal systems must be operating properly to prevent 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 attracts ferritic objects to the impeller, seal, and bearings which can result in excessive heat generation, sparks, and premature failure.

NOTICE:

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.

System flushing

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

Initial grease lubrication

CAUTION:

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

Grease-lubricated ball bearings are packed with grease at the factory and usually require no attention before starting, provided that the pump has been stored in a clean, dry place prior to its first operation. Watch the bearings for the first hour or so after the pump has been started in order to make sure that they are operating properly.

Pre-operation inspections

NOTICE:

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

Perform these inspections before you start the pump:

- If the pump has been in storage, follow the steps in 2.3.1.4 Prepare the stored pump for operation on page 16
- Check the alignment between the pump and motor.

  See Coupling alignment in the Installation chapter for alignment requirements.
- Check all connections to the motor and starting device against the wiring diagram.

  Check the voltage, phase, and frequency on the motor nameplate against the line circuit.
- Check the suction and discharge piping and the pressure gauges for proper operation.
- Check that you can turn the rotating element by hand in order to verify that it rotates freely.
- Check the stuffing box adjustment, lubrication, and piping.
- Check the driver lubrication.

  Refer to the driver Installation, Operation, and Maintenance manual.
- Check that the pump bearings are properly lubricated.

- If the pump is oil lubrication, check that the oil level is correct prior to starting pump.
- If the pump is oil mist lubrication, check that the mist is flowing properly prior to starting pump.
- Check that the coupling is properly lubricated, if required.
- Check that the pump is full of liquid and that all valves are properly set and operational, with the discharge valve closed and the suction valve fully open. Purge all air from the top of the casing.
- Check the direction of the rotation.

  Be sure that the driver operates in the direction indicated by the arrow on the pump casing. Serious damage can result if you operate the pump with the incorrect rotation. Check the rotation each time you disconnect the motor leads.

Installation

DANGER:

- Electrical shock hazard. An electrical conduit installed below the surface may require a corrosion-resistant protective coating in order to prevent conduit corrosion and electrical shock. Failure to follow these instructions can result in serious personal injury, death, or property damage.
- Before beginning any alignment procedure, make sure driver power is locked out. Failure to lock out driver power will result in serious physical injury.
- The heating of water and other fluids causes volumetric expansion. The associated forces can cause the failure of system components and the release of high-temperature fluids. In order to prevent this, install properly sized and located compression tanks and pressure-relief valves. Failure to follow these instructions can result in serious personal injury or death, or property damage.

WARNING:

- Do not operate the pump without the proper drive guard in place. Failure to observe this warning could result in personal injury to operating personnel.
- Do not test the motor for direction of rotation when it is coupled to the pump. If the pump is driven in the wrong direction, serious damage to the pump, motor, and personnel could result.
- Avoid working under suspended loads. If necessary to do so, follow the more stringent of local, state or federal safety regulations.
- Lock out driver power to prevent electric shock, accidental start-up and physical injury.

CAUTION:

- Do not over tighten the capscrews on the gland. This can distort the seal seat and cause seal failure.
- Make sure the split gland fits squarely in the stuffing box. A split gland that is not properly seated can cause uneven compression of the packing and damage to the shaft or sleeve.
- Read and follow the motor manufacturer's instructions before lubricating the motor bearings. Excessive lubrication can cause the bearings to overheat and fail prematurely.
- Risk of bearings overheating and failing.
  - Do not over oil the bearings.
  - The maximum operating temperature for ball bearings is 82°C | 180°F.
  - If the temperature of the bearing frame exceeds 82°C | 180°F (measured by thermometer), shut down the pump to determine the cause.

    - Do not mix oils from different suppliers.
- 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 for expansion joint failure. All expansion joints must be properly supported, anchored, and restrained.

-  All equipment being installed must be properly grounded to prevent unexpected static electric discharge. If not, a static electric discharge may occur when the pump is drained and disassembled for maintenance purposes.
- Air pockets can form in the top of the reducer and the pipe when operating on suction lift. Never use a concentric reducer in a horizontal line.
- Do not grout until the initial alignment is made.
- Do not remove the seal spacer or eccentric washer, adjust the seal, or tighten the setscrews until after you adjust the impellers.
- Do not run the pump dry.
- Do not use automotive oils.
-  Flange loads from the piping system, including those from the thermal expansion of the piping, must not exceed the limits of the pump. Casing deformation can result in contact with rotating parts, which can result in excess heat generation, sparks, and premature failure.
- Improper impeller adjustment can cause contact between the rotating and stationary parts. This may result in sparks and heat generation.
- Make sure that all rigging devices are rated to handle more than the pump weight.
- 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.
- Net positive suction head available ($NPSH_A$) must always exceed NPSH required ($NPSH_R$) as shown on the published performance curve of the pump.
- Never throttle the flow from the suction side. Only use suction valves to isolate the pump for maintenance, and install such valves in positions to avoid air pockets.
- Reset the seal after you adjust the impeller.
-  The coupling used in an Ex classified environment must be properly certified.
-  The mechanical seal must have an appropriate seal flush system or excess heat generation and seal failure can occur.

-  When installing in a potentially explosive environment, ensure that the motor is properly certified.
- 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.
- Risk of heat generation, seal failure, and possible physical injury. Sealing systems that are not self-purging or self-venting, such as plan 23, require manual venting prior to operation.
-  All equipment being installed must be properly grounded to prevent unexpected static electric discharge. If not, a static electric discharge may occur when the pump is drained and disassembled for maintenance purposes.
-  Alignment procedures must be followed to prevent unintended contact of rotating parts. Follow coupling manufacturer's installation and operation procedures.
- Guidelines for piping are given in the *Hydraulic Institute Standards*, available from: Hydraulic Institute, 9 Sylvan Way, Parsippany, NJ 07054 and in API RP 686, and must be reviewed prior to pump installation.
- Use Molykote Dow-Corning anti-galling compound or an equivalent for all galling material such as 316 stainless steel.
- When a mechanical seal is provided, make sure it is not secured to the shaft during impeller adjustment. The shaft must move up or down within the seal assembly.
- Follow grout manufacturers SDS sheets for recommended PPE.

5.2 Pump priming

CAUTION:
Do not run the pump dry.

When to prime the pump

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

Methods for pump priming

Pump installation	Priming method
Positive head on the suction	Open the suction valve and loosen the vent plug on top of the casing. This allows air to be purged from the casing. While you vent the

Pump installation	Priming method
	air from the pump body, always rotate the pump shaft a few times by hand.
Suction lift	Priming must be done by other methods such as foot valves, ejectors, or by manually filling the casing and suction line.

5.3 Fill the system

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

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

   a) Mount a dial indicator off of any rigid structure not tied to the piping.

   b) Set the indicator button on the pump flange in the axial direction of the nozzle.

   If the indicator moves as the filling proceeds, then the anchors and supports are not adequate or are not set properly. Take corrective measures.

5.4 Start the pump

1. Close the drain valves.
2. Completely open all valves in the suction and discharge lines.
3. Turn on the seal water to the stuffing box.

   These lines must always be left open if the pumped fluid is dirty or if there is the possibility of air leaks.
4. Prime the pump.

   NOTICE:

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

5. Start the pump driver.

   Turbines and engines can require a brief warm-up period. Consult the instructions provided by the engine manufacturer.
6. When the pump is operating at full speed, make sure that the check valve has opened.

   The check valve must open five seconds or less after startup in order to prevent damage to the pump by operating at zero flow.
7. Adjust the liquid seal valves to produce the recommended pressure for either the mechanical seal or the packed stuffing box.

5.5 Operational checklist

Check	Explanation/comment	Checked
Driver rotation	Check the rotation each time the motor leads are disconnected.  **WARNING:** Check the rotation of the power unit and pump in relation to that of the drive as shown by the arrows on the case. Rotate the drive manually before you apply power-checking rotation. Do not operate in the reverse direction of these arrows as serious damage or injury can occur.	
Stuffing box adjustment	Make stuffing box packing gland and lubrication adjustments.	
Flow	It is difficult to accurately measure flow rate (volume/time). Any of the following methods of measuring can be used: • Venturi meters • Flow nozzles • Orifice plates • Timing the draw down in the wet well Record any reading for future reference.	
Pressure	Check and record both suction and discharge pressure gauge readings for future reference. Also record the following: • Voltage • Amperage per phase • Kilowatts (if an indicating watt meter is available) • Pump speed	
Temperature	Check and record bearing temperatures using a thermometer. The temperature should not exceed 82°C | 180°F. **NOTICE:** Risk of heat generation, sparks and premature failure. Do not insulate bearing housings.	
Vibration and sound	The acceptable vibration level of a centrifugal pump depends on the rigidity of the pump and the supporting structure. Recommended values for vibration can vary between 0.20–0.60 ips (inches per second) velocity depending on the operating characteristics and the structure. Refer to the Centrifugal Pump section of the Hydraulic Institute Standards for a complete description and charts on various pumps. Field sound levels are difficult to measure because of background noise from piping, valves, drivers, gears, and other parts. Follow the recommendations in the Hydraulic Institute Standards.	

5.6 Shut down the pump

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

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

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

5.7 Freeze protection

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

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

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

6 Maintenance

6.1 Maintenance schedule

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

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

Monthly inspections

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

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

Three-month inspections

Perform these tasks every three months:

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

Six-month inspections

Perform these tasks every six months:

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

Annual inspections

Perform these inspections one time each year:

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

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

6.2 Flood-damaged pumps

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

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

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

6.3 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 40K hours of operation.

6.3.1 Grease lubrication

Lubrication schedule

Proper lubrication is extremely important. The frequency depends on the conditions of operation. For average operating conditions, it is recommended that you add 30 ml | 1 oz. of clean grease every 3–6 months. It is always best to stop the unit while grease is added in order to avoid overloading. Excess grease is the most common cause of overheating.

Bearing frame cleaning

Keep the bearing frame clean. Contamination from foreign matter in the housing can destroy bearings in a short time. Use a bearing-cleaning solvent or an industrial cleaning solvent. Do not use gasoline. Use lint-free cloths. Do not use waste rags.

Lubricating-grease requirements

Use a regular ball bearing grease. A standard commercial petrolatum can be substituted if necessary. Do not use graphite.

A No.1 or 2 grease is generally satisfactory for operation at ordinary temperatures. The lighter grease is for operation at high speed or in low ambient temperatures. Mineral greases with a soda-soap base are recommended. Grease made from animal or vegetable oils are not recommended because of the danger of deterioration and forming of acid. Most of the leading oil companies have special bearing greases that are satisfactory. For specific recommendations, consult your ITT representative.

Temperature requirements

The maximum desirable operating temperature for ball bearings is 82°C | 180°F. If the temperature of the bearing frame rises above 82°C | 180°F, then shut down the pump and determine the cause. Grease-lubricated bearings must not be used where the temperature of the pumped fluid exceeds 177°C | 350°F.

NOTICE:
A bearing frame operating outside its service factor will overheat and could possibly burn out. Check the bearing frame temperature regularly with an accurate temperature-measuring device and compare with the temperature rating if the bearing frame feels hot.

6.3.2 Lubricate the oil-lubricated bearings

CAUTION:

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

The oil-lubricated pump has either an oiling ring or an oil slinger. With an oiling ring, the oil is picked up from the reservoir by a rotating oil ring and deposited on the shaft and bearings inside the bearing housing. An oil slinger creates a shower of fine droplets over the entire interior of the bearing cavity.

1. After the pump has been installed, flush the bearing housing in order to remove dirt, grit, and other impurities that may have entered the bearing housing during shipment or installation.
2. Refill the bearing housing with the proper lubricant.
3. Check that the oil is level with the line in the sight glass or oil level indicator.

NOTICE:

Maintain an exact oil level. If the oil level is too high, the bearing temperature can increase. If the oil level is too low, the bearing will not be properly lubricated and could cause operational problems.

6.3.2.1 Lubricating-oil requirements

Oil specifications

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

Do not mix oils from different suppliers.

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

Oil quality

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

Lubrication schedule

In installations with moderate levels of humidity, dirt, and temperature changes, change the oil after approximately 160 hours of operation. Inspect the oil at this time in order to determine the operating period before the next oil change. Oil change periods can be increased up to 2,000–4,000 hours based on an 8,000-hour year. Check the oil frequently for moisture, dirt, or signs of breakdown.

CAUTION:
Risk of bearings overheating and failing.

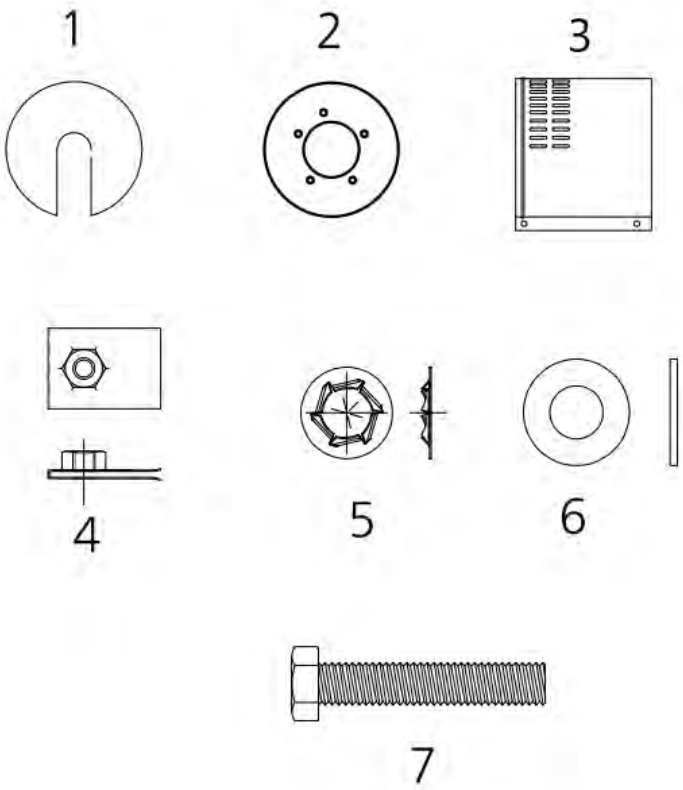
- Do not over oil the bearings.
- The maximum operating temperature for ball bearings is 82°C | 180°F.
- If the temperature of the bearing frame exceeds 82°C | 180°F (measured by thermometer), shut down the pump to determine the cause.
- Do not mix oils from different suppliers.

6.4 Install the coupling guard

WARNING:

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

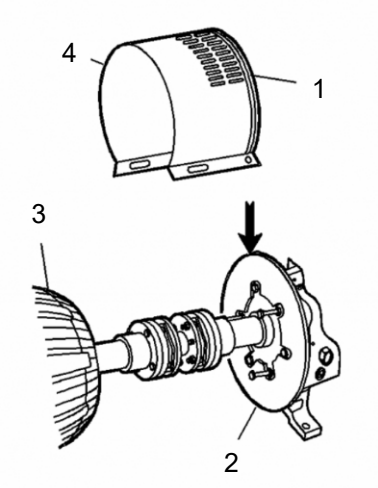
WARNING:
The coupling guard used in an Ex classified environment must be properly certified and constructed from a spark resistant material.



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

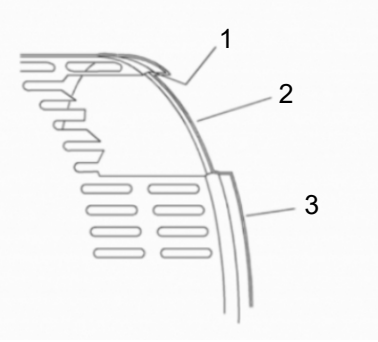
Figure 27: Required parts

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



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

Figure 28: Align pump end guard half with annular groove



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

Figure 29: Annular groove in coupling guard

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

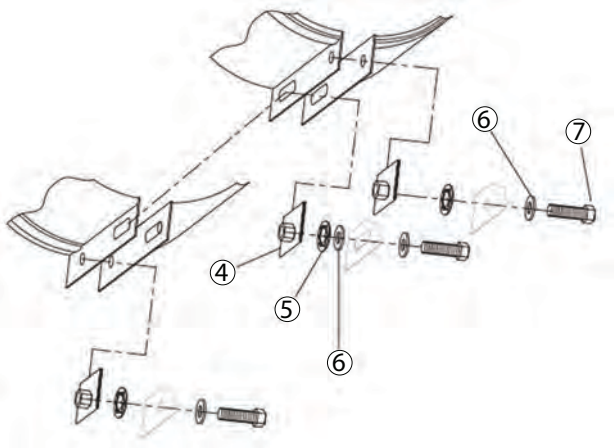


Figure 30: Captured hardware component assembly

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

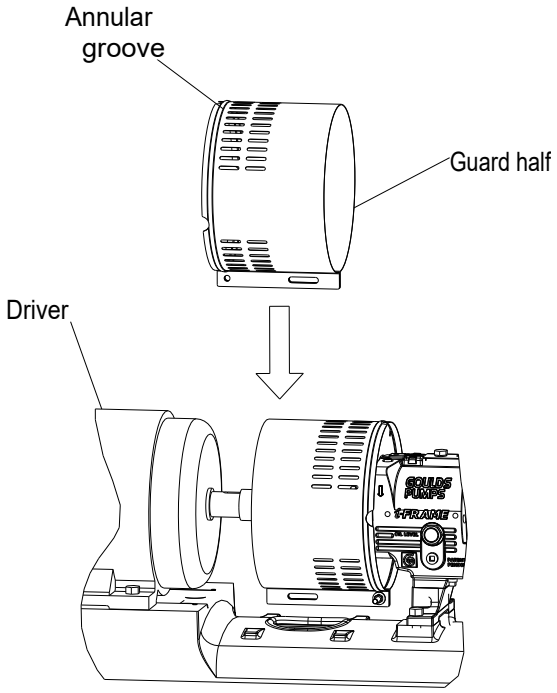


Figure 31: Placement of driver half of coupling guard

8. Place the end plate over the driver shaft and locate the end plate in the annular groove at the rear of the coupling guard half.
9. Hand-tighten only. Repeat Steps 4 through 6 for the rear end of the coupling guard half. The hole is located on the driver-side of the coupling guard half.
10. Slide the driver-half of the coupling guard towards the motor so that the coupling guard completely covers the shafts and coupling.

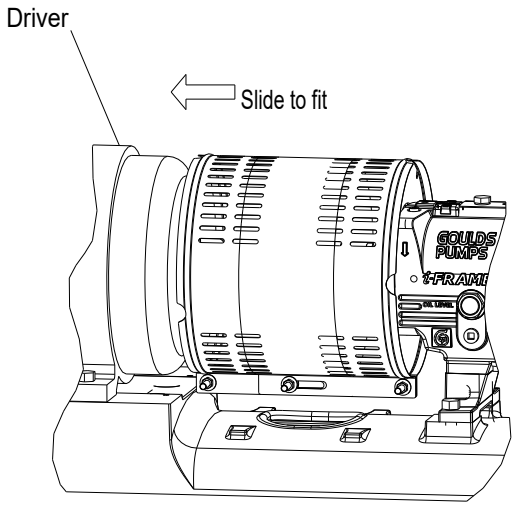


Figure 32: Slide driver-half of coupling guard towards motor

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

6.5 Shaft-seal maintenance

6.5.1 Packed stuffing box maintenance

Check or instruction	Explanation/comment
When starting a pump with fiber packing for the first time, make sure that the packing is slightly loose without causing an air leak. As the pump runs in, gradually tighten the gland bolts evenly.	Never draw the gland to the point where the packing is compressed too tightly and no leakage occurs. This will burn the packing, score the shaft sleeve, and prevent circulation of the liquid that cools the packing.
Turn the rotating element by hand.	The stuffing box is improperly packed or adjusted if friction in the box prevents turning the rotating element by hand. A properly operated stuffing box runs lukewarm with a slow drip of sealing liquid.
After the pump has been in operation for some time and the packing is completely run in, check that the stuffing box leaks at the rate of 40–60 drops per minute.	This indicates proper packing, shaft sleeve lubrication, and cooling. **NOTICE:** Eccentricity of the shaft or sleeve through the packing can result in excess leakage. Make sure that the parts are properly centered.
Check the packing frequently and replace as service indicates.	Six months is a reasonable expected life, depending on operating conditions. Use a packing tool in order to remove all old packing from the stuffing box. Never reuse old packing or add new rings to old packing. Clean the stuffing box thoroughly before you install new packing.
Check the condition of the shaft or sleeve for possible scoring or eccentricity and make replacements as necessary.	—
When placing new, non-asbestos packing into the stuffing box, open the molded rings sideways and push the joints into the stuffing	—

Check or instruction	Explanation/comment
box first. Then install the rings one at a time, making sure to seat each ring firmly. Stagger the joints at a 90° rotation from each preceding joint.	
If coil packing is used, then cut one ring to the accurate size with either a butt or mitered joint. Fit the ring over the shaft to assure the proper length, and then remove and cut all the rings to this first sample. When you place the rings around the shaft, make sure to form a tight joint. Place the first ring in the bottom of the stuffing box. Then install each succeeding ring. Stagger the joints at a 90° rotation.	An accurately cut butt joint is superior to a poorly fitted mitered joint. Make sure that each ring is firmly seated.
If a seal cage is supplied, check that it is properly located in the stuffing box under the sealing water inlet.	The function of the seal cage is to establish a liquid seal around the shaft, to prevent leakage of air through the stuffing box, and to lubricate the packing. If it is not properly located, then it serves no purpose.

6.5.2 Mechanical seal maintenance

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

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

For optimum seal life, always follow these precautions:

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

6.6 Disassembly

6.6.1 Disassembly precautions

WARNING:

- Failure to disconnect and lock out driver power may result in serious physical injury or death. Always disconnect and lock out power to the driver before performing any installation or maintenance tasks.
    - Electrical connections must be made by certified electricians in compliance with all international, national, state, and local rules.
    - Refer to driver/coupling/gear manufacturer's installation and operation manuals (IOM) for specific instructions and recommendations.
- Risk of serious personal injury. Applying heat to impellers, propellers, or their retaining devices can cause trapped liquid to rapidly expand and result in a violent explosion. This

manual clearly identifies accepted methods for disassembling units. These methods must be adhered to. Never apply heat to aid in their removal unless explicitly stated in this manual.

- Handling heavy equipment poses a crush hazard. Use caution during handling and wear appropriate Personal Protective Equipment (PPE, such as steel-toed shoes, gloves, etc.) at all times.
- Precautions must be taken to prevent physical injury. The pump may handle hazardous and/or toxic fluids. Proper personal protective equipment should be worn. Pumpage must be handled and disposed of in conformance with applicable environmental regulations.
- Risk of serious physical injury or death from rapid depressurization. Ensure pump is isolated from system and pressure is relieved before disassembling pump, removing plugs, opening vent or drain valves, or disconnecting piping.
- Risk of serious personal injury from exposure to hazardous or toxic liquids. A small amount of liquid will be present in certain areas like the seal chamber upon disassembly.

CAUTION:

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

6.6.2 Remove the casing cover

1. Disconnect the coupling.
   Refer to the instructions from the coupling manufacturer.
2. Drain the pump:
   a) Open the vent plug.
   b) Remove the drain plug on the discharge and suction nozzles.
3. Remove the gland bolts.
4. Slide the gland plates (107) away in order to release the mechanical seal faces.
5. Remove all casing main joint nuts and dowels.
6. Use jacking screws in two tapped holes to break the joint.
7. Lift the casing cover by its cast lugs.
8. Remove and discard the gasket.

6.6.3 Remove the rotating element

1. Remove the bolts that hold the bearing-housing caps to the bearing housings (134D).
2. Mark the caps so that you know to which end they belong.
3. Lift up the caps.
4. Lift the entire rotating element out of the casing.

6.6.4 Remove the bearings

1. Pull the coupling half and the key off the shaft.
2. Remove the bearing end plate (111).
3. Remove both casing rings (127).
4. Remove the radial bearing (168).
5. Remove the locknut and lockwasher (136 and 382) and pull off the thrust bearing (410).
6. Remove the bearing endplates and the bearing seals (333A and 332A).

6.6.5 Remove the mechanical seal

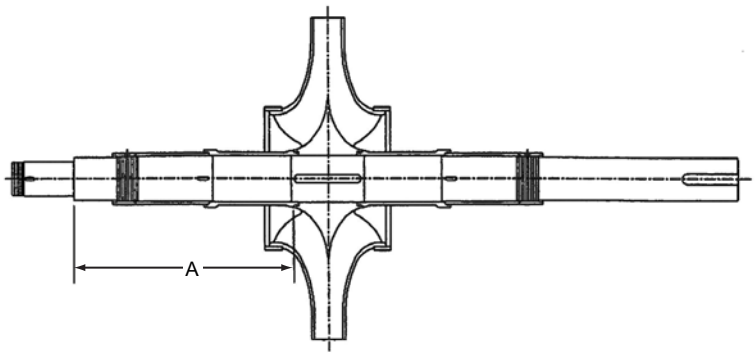
1. Remove the gland plates (107) at both ends.

Take care not to damage the static seal ring, which is mounted inside the gland plate. Refer to the drawing and instructions from the mechanical seal supplier.

2. Note and mark the axial position of the mechanical seal on the shaft sleeve.
   In order for the mechanical seal to work properly, the installation distance from the face of the stuffing box is important. See the mechanical seal drawing for the correct dimension.
3. Remove the mechanical seals.

6.6.6 Remove the sleeves and the impeller

1. Remove the sleeve nuts (124 and 130) with an appropriate crescent wrench.
   Note that one nut has a right-hand thread (124) and one nut has a left-hand thread (130). The hand of the thread is determined by the direction of the shaft rotation. Refer to the cross-sectional drawings for the respective locations of these nuts.
2. Remove the outboard sleeves and keys from each end.
3. Before removing the impeller, record dimension A from the impeller hub face to the thrust bearing shoulder.
   This information will facilitate reassembly.



4. To remove the impeller and the inboard sleeves, hold the shaft vertically and allow it to drop on a block of wood a few times.
   The weight of the impeller will force it and the shaft sleeves off the shaft. If this does not work, then apply a light press.

6.7 Preassembly inspections

6.7.1 Replacement of wear parts

General guidelines

Replace all O-rings, seals, and gaskets with new parts during assembly. All reusable parts must be cleaned of all foreign matter before reassembling.

Gaskets

A strong Garlock 3000 gasket is placed between the pump casing halves at the factory. When necessary, replace the gasket with the same or similar material of the same thickness as the original and cut it to the proper shape. Do not use heavier gaskets because they hold the casing apart, which allows leaks around the wear rings. A lighter gasket places undue stress on the casing rings.

Use the upper half of the casing as a template for the main casing joint gasket. Lay the gasket material on the casing joint and mark it by pressing it against the edges of the casing. Trim the gasket so that it is flush with the inside edges of the casing.

Wear rings

CAUTION:

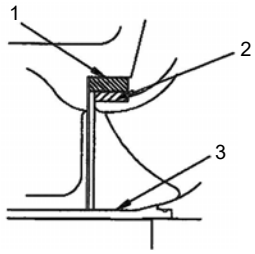
The impeller clearance setting procedure must be followed. Improperly setting the clearance or not following any of the proper procedures can result in sparks, unexpected heat generation, and equipment damage.

Replace wear rings when they have worn to twice the original clearance. Cut the rings on the impeller in two with a cold chisel in order to remove them. Heat each new impeller wear ring to 132°C–149°C | 270°F–300°F and slide it onto the impeller. Hold the rings against the impeller shoulder until they cool.

6.8 Reassembly

6.8.1 Install the impeller and sleeves

1. Install the impeller key on the shaft.
2. Install the impeller on the shaft.
   Position the impeller according to dimension A, which you recorded when you disassembled the unit.
3. Install the spacer sleeves, O-rings, stuffing-box sleeves, and shaft sleeve nuts.
4. Install the mechanical seals on the shaft.
5. Install the casing rings.



1. Casing ring
2. Impeller ring
3. Spacer sleeve

6.8.2 Install the bearings

1. Install the bearing seals (333A and 332A) and bearing endplates onto the shaft.
2. Install the thrust bearing (410) on the shaft with the lockwasher and locknut (382 and 136).
3. Install the radial bearing (168).

6.8.3 Install the rotating element

1. Install the pump coupling half and the key on the shaft.
   Refer to the instructions from the coupling supplier.
2. Install the rotating element in the lower half of the casing, with the casing rings positioned over the pins in the lower half of the casing.
3. Bolt down the bearing housing caps.

6.8.4 Assemble the casing

1. Lower the upper half of the casing into place and position it with the taper dowels.
2. Install the studs and nuts for the casing main joint.
3. Uniformly torque the studs and nuts on the casing main joint according to the torque values, 6.8.7 Torque table on page 61.

6.8.5 Complete the assembly

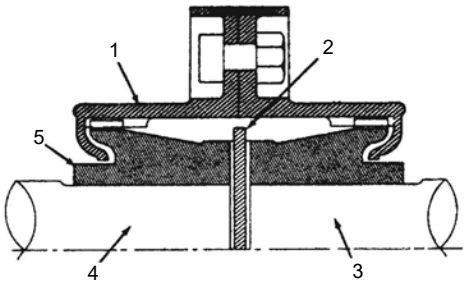
1. Rotate the shaft by hand in order to make sure that it turns smoothly and is free from rubbing and binding.
2. Tighten the mechanical seal glands (107).
3. Install the coupling.
4. Check the alignment to the driver and correct if necessary.

6.8.6 Set the limited end float for coupling

For units with drivers that have sleeve bearings, you must set the coupling halves to limit the total shaft axial movement to less than one-half of the end float of the motor rotor assembly. This is accomplished by inserting a phenolic disc between the motor and pump shafts.

Most pump installations use the all-metal, gear-type coupling. When limited-end-float gear-type couplings are used, the coupling hubs are slip-fit onto the pump and motor shafts.

1. Install the coupling covers and hubs.
   The coupling hubs are slip-fit onto the pump and motor shafts.
2. Set the motor on its magnetic center.
3. Insert a phenolic disc, or equivalent, between the pump shaft and the motor shaft.
   The phenolic disc must be of a specified thickness to accomplish the proper limited end float.



1. Cover
2. Phenolic disc
3. Pump shaft
4. Motor shaft
5. Hub

4. Push the pump and motor shafts against the phenolic disc.

   The thrust bearing of the pump limits the end float toward the pump. The coupling covers limit the end float toward the motor.

   The thrust bearing is large enough to carry any magnetic thrust that is developed by the motor, if the pump and motor are aligned properly.

When this procedure is completed, follow the procedures in 4.4 Pump-to-driver alignment on page 32.

6.8.7 Torque table

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
¼-20	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
½-13	0.1419	3576	22
9/16-12	0.1819	4584	32
5/8-11	0.226	5695	44
¾-10	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
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
2.375-8	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

7 Troubleshooting

7.1 Troubleshooting

Symptom	Cause	Remedy
The pump is not delivering liquid.	The pump is not primed.	Re-prime the pump and check that the pump and suction line are full of liquid.
	The pump has lost prime.	Check for leaks in the suction pipe joints and fittings. Vent the casing to remove accumulated air. Check the mechanical seal or packing.
	The impeller is clogged.	Back-flush the pump in order to clean the impeller.
	The impeller is loose on the shaft.	Check the key, locknut, and setscrews.
	The shaft is rotating in the wrong direction.	Change the rotation. The rotation must match the arrow on the bearing housing or pump casing.
	The shaft is not rotating at all.	Check the power, coupling, line shaft, and shaft keys.
	The foot valve or suction pipe opening is not submerged enough.	Consult an ITT representative for the proper submersion depth. Use a baffle to eliminate vortices.
	The suction lift is too high.	Check for obstructions at the inlet and make sure the suction valves are open. Check for pipe friction losses. Use a vacuum or compound gauge to check the NPSH available.
	The motor speed is too low.	Make sure that the motor wiring is correct and receives full voltage or that the turbine receives full steam pressure. The motor can have an open phase.
	The system static head is too high.	Check with ITT to determine whether a larger impeller can be used. If not, then cut pipe losses, increase the speed, or both. Do not overload the driver.
	The system head or discharge head is too high.	Check for pipe friction losses and that the valves are wide open. The condition can be corrected with larger piping.
The pump is not delivering enough liquid or pressure.	The suction piping has air leaks.	If the pumped liquid is water or another non-explosive and no explosive gas or dust is present, then test the flanges for leaks with a flame or match. When explosive liquids such as gasoline are present, then test the suction line by shutting off or plugging the inlet and putting the line under pressure. A gauge will indicate a leak with a drop of pressure.
	The stuffing box has air leaks.	Check the packing or seal and replace if necessary. Check for the proper amount of lubrication.
	The motor speed is too low.	Make sure that the motor wiring is correct and receives full voltage or that the turbine receives full steam pressure. The motor can have an open phase.
	The discharge head is too high.	Check for pipe friction losses and that the valves are wide open. The condition can be corrected with larger piping.
	The suction lift is too high.	Check for obstructions at the inlet and make sure the suction valves are open. Check for pipe friction

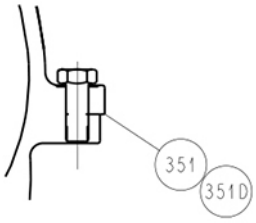
Symptom	Cause	Remedy
		losses. Use a vacuum or compound gauge to check the NPSH available.
	The impeller is clogged.	Back-flush the pump in order to clean the impeller.
	The amount of available NPSH is not sufficient.	1. Increase the positive suction head by lowering the pump or increasing the suction pipe and fittings size. 2. Sub-cool the suction piping at the inlet to lower the temperature of liquid that is entering the pump. 3. Pressurize the suction vessel.
	The impeller or wear rings are worn or broken.	Inspect the impeller and wear rings and replace if any of the following conditions are present: • The impeller or wear rings are damaged. • The vane sections are severely eroded. • The wear ring clearance is three times normal.
	The foot valve is too small or partially obstructed.	Check the valve and replace with the correct size if necessary. The openings of the valve ports must be 1–1.5 times as large as the suction pipe opening. If a strainer is used, then the valve port openings must be 3–4 times as large the suction pipe opening.
	The suction inlet is not submersed deep enough.	If the inlet cannot be lowered or if the problem persists after the inlet is lowered, then chain a board to the suction pipe. The board will be drawn into the eddies and smother the vortex.
	The shaft is rotating in the wrong direction.	Change the rotation. The rotation must match the arrow on the bearing housing or pump casing.
	The system static head is too high.	Check with ITT to determine whether a larger impeller can be used. If not, then you can cut pipe losses, increase the speed, or both. Do not overload the driver.
	The mechanical seal is worn or broken.	Repair or replace the seal as necessary.
	The liquid passages are obstructed.	Make sure that the suction and discharge valves are fully open. Disassemble the pump and inspect the passages and casing. Remove the obstruction.
	Air or gases are trapped in the liquid.	Install a gas separation chamber on the suction line near the pump and periodically exhaust the accumulated gas.
The pump starts and then stops pumping.	The amount of available NPSH is not sufficient.	1. Increase the positive suction head by lowering the pump or increasing the suction pipe and fittings size. 2. Sub-cool the suction piping at the inlet to lower the temperature of liquid that is entering the pump. 3. Pressurize the suction vessel.
	The system static head is too high.	Check with ITT to determine whether a larger impeller can be used. If not, then cut pipe losses, increase the speed, or both. Make sure to not overload the driver.
	The system head or discharge head is too high.	Check for pipe friction losses and that the valves are wide open. The condition can be corrected with larger piping.

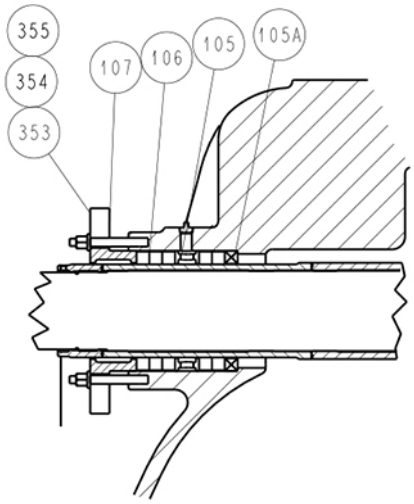
Symptom	Cause	Remedy
The pump leaks excessively at the stuffing box.	The shaft is bent.	Straighten the shaft or replace it if necessary.
	The pump and driver are not aligned properly.	Realign the pump and driver.
	The bearings are worn out or improperly lubricated.	Inspect the bearings and replace them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

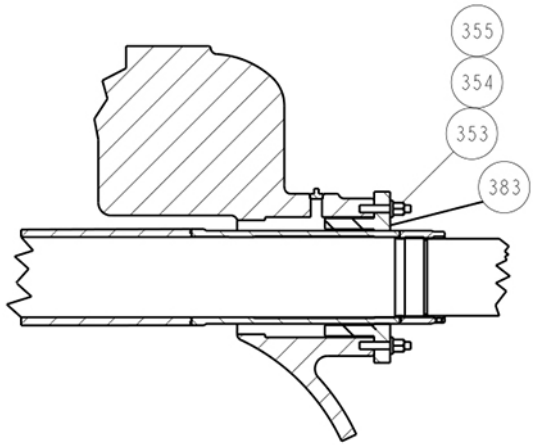
8 Parts List and Cross-Sectionals

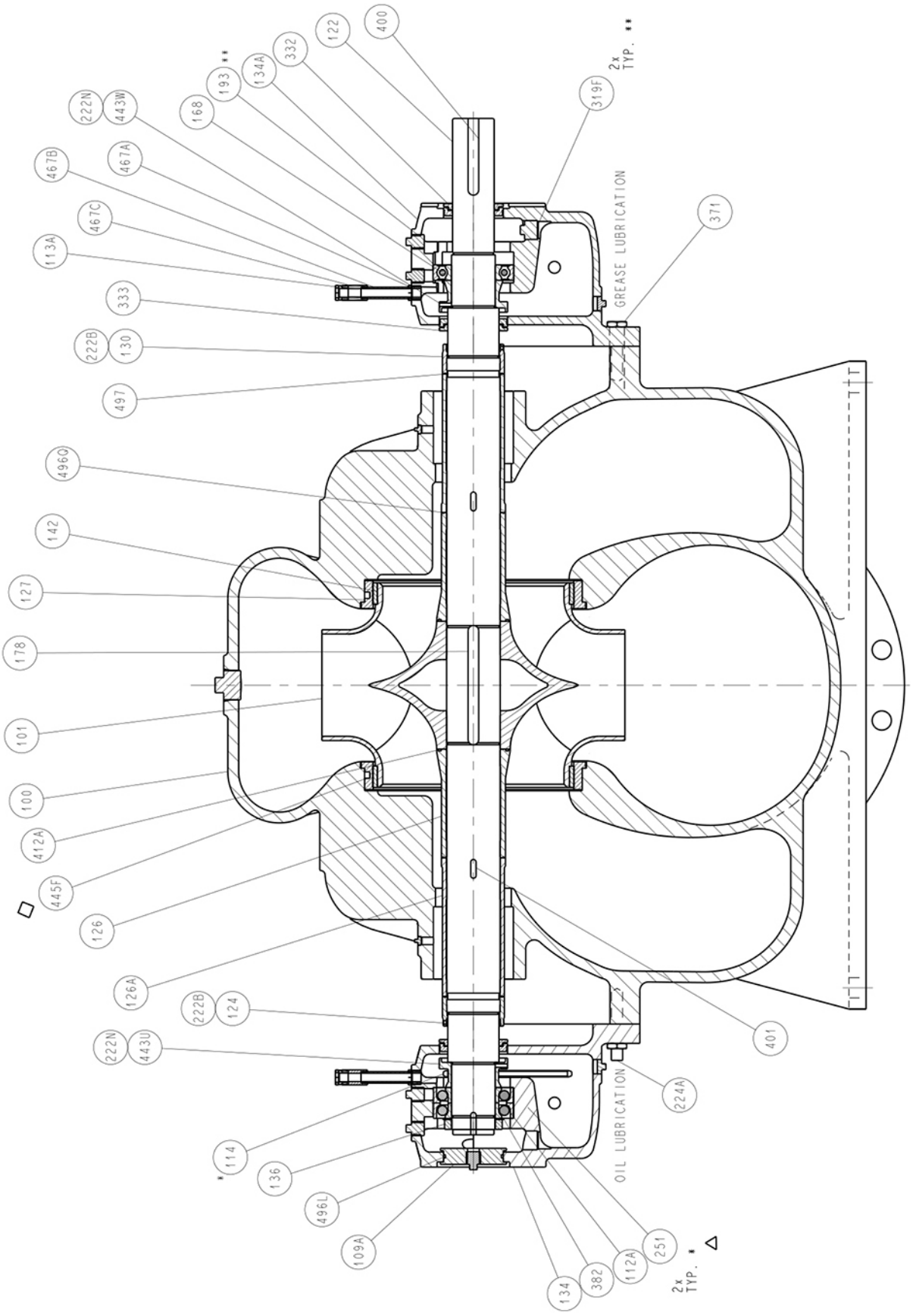
8.1 Parts List and Cross-Sectionals

Drawings - exploded view








400
122
332
134A
193 **
168
222N
443W
467A
467B
467C
113A
333
222B
130
497
496Q
142
127
178
101
100
412A
445F
126
126A
222B
124
222N
443U
114
136
496L
109A
134
382
112A
251
2x TYP. *
319F
2x TYP. **
GREASE LUBRICATION
371
401
224A
OIL LUBRICATION

Parts List

Item	Name	Qty.
100	Casing	1
101	Impeller	1
105	Lantern Ring	2
105A	Packing base ring	2
106	Stuffing box packing	1 set
107	Packing gland	2
109A	Bearing end cover	1
112A	Ball bearing - thrust	1
113A	Breather	2
114	Oil ring	2
122	Shaft	1
124	Sleeve nut, RH	1
126	Shaft sleeve, impeller	2
126A	Shaft sleeve, stuffing box	2
127	Case wear ring	2
130	Sleeve nut, LH	1
134	Bearing housing - thrust	1
134A	Bearing housing - radial	1
136	Bearing locknut	1
142	Impeller wear ring	2
168	Ball bearing - radial	1
178	Impeller key	1
193	Grease fitting	-
222B	Set screws - sleeve nut	4
222N	Set screws - slinger	2
224A	Dowel pin - Housing (casing)	6
251	Sight glass	2
319F	Pipe plug - grease housing	2
332	INPRO seal, O.B.	1
333	INPRO seal, I.B.	2
351	Gasket - casing suction	1
351D	Gasket - casing discharge	1
353	Stud - gland	-
354	Washer - gland	-
355	Hex nut - gland stud	-
371	Hex cap screw - housing (casing)	6
382	Bearing lock washer	1
383	Mechanical seal	2
400	Key - coupling	1
401	Key sleeve	2
412A	O-ring - impeller	2
443U	Slinger, thrust	1

Item	Name	Qty.
443W	Slinger, radial	1
445F	Pin - case ring	2
467A	Bushing - breather	2
467B	Nipple - breather	2
467C	Coupling - breather	2
496L	O-ring - bearing end cap	1
496Q	O-ring - Imp sleeve (SB sleeve)	2
497	O-ring - sleeve nut	2

9 Other Relevant Documentation or Manuals

9.1 For additional documentation

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

10 Local ITT Contacts

10.1 Regional offices

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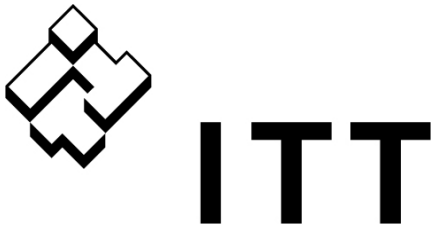
http://www.gouldspumps.com



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