GOULDS PUMPS

Installation, Operation, and Maintenance

Model VIT

ITT

ENGINEERED FOR LIFE

Table of Contents

Introduction and Safety

Safety

WARNING:

- The operator must be aware of the pumpage and take appropriate safety precautions to prevent physical injury.
- Risk of serious injury or death. If any pressure-containing device is over-pressurized, it can explode, rupture, or discharge its contents. It is critical to take all necessary measures to avoid over-pressurization.
- Risk of death, serious personal injury, and property damage. Installing, operating, or maintaining the unit using any method not prescribed in this manual is prohibited. Prohibited methods include any modification to the equipment or use of parts not provided by ITT. If there is any uncertainty regarding the appropriate use of the equipment, please contact an ITT representative before proceeding.
- Risk of serious personal injury. Applying heat to impellers, propellers, or their retaining devices can cause trapped liquid to rapidly expand and result in a violent explosion. This manual clearly identifies accepted methods for disassembling units. These methods must be adhered to. Never apply heat to aid in their removal unless explicitly stated in this manual.
- Risk of serious personal injury or property damage. Dry running may cause rotating parts within the pump to seize to non-moving parts. Do not run dry.
- Never operate the pump below the minimum rated flow, when dry, or without adequate submergence.
- Running a pump without safety devices exposes operators to risk of serious personal injury or death. Never operate a unit unless appropriate safety devices (guards, etc.) are properly installed. See specific information about safety devices in other sections of this manual.
- Risk of death, serious personal injury, and property damage. Heat and pressure buildup can cause explosion, rupture, and discharge of pumpage. Never operate the pump with suction and/or discharge valves closed.
- Never operate the pump when the strainer is clogged.
- Precautions must be taken to prevent physical injury. The pump may handle hazardous and/or toxic fluids. Proper personal protective equipment should be worn. Pumpage must be handled and disposed of in conformance with applicable environmental regulations.
- If the pump or motor is damaged or leaking, electric shock, fire, explosion, liberation of toxic fumes, physical harm, or environmental damage may result. Do not operate the unit until the problem has been corrected or repaired.

CAUTION:

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

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.

NOTICE:

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

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

The Ex symbol

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

Environmental safety

The work area

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

Recycling guidelines

Always recycle according to these guidelines:

1. If the unit or parts are accepted by an authorized recycling company, then follow local recycling laws and regulations.
2. If the unit or parts are not accepted by an authorized recycling company, then return them to the nearest ITT representative.

Waste and emissions regulations

Observe these safety regulations regarding waste and emissions:

- Dispose appropriately of all waste.
- Handle and dispose of the pumped fluid in compliance with applicable environmental regulations.
- Clean up all spills in accordance with safety and environmental procedures.
- Report all environmental emissions to the appropriate authorities.

Reference for electrical installation

For electrical installation requirements, consult your local electric utility.

User health and safety

Safety equipment

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

- Helmet
- Safety goggles (with side shields)
- Protective shoes
- Protective gloves
- Gas mask
- Hearing protection

The work area

Observe these regulations and warnings in the work area:

- 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.

Product and product positioning requirements

Observe these requirements for the product and the product positioning:

- Never operate a pump unless safety devices are installed.
- Never operate a pump unless a coupling guard is installed.
- Never force the piping in order to make a connection with a pump.
- Never start a pump without the proper submergence.
- Never run a pump below the minimum rated flow or with the discharge valve closed.

Electrical connections regulations

Electrical connections must be made by certified electricians in compliance with all international, national, state, and local regulations.

Observe these guidelines and warnings for electrical connections:

- Make sure that the product is isolated from the power supply and cannot be energized by mistake. This guideline also applies to the control circuit.
- Make sure that the thermal contacts are connected to a protection circuit according to the product approvals, and that they are in use.

Earthing (grounding)

Observe the following regulations for earthing (grounding) connections.

Earthing (grounding) regulation	Comment
All electric equipment must be earthed (grounded).	This rule applies to pumps and mixers as well as monitoring equipment.
The earthing (grounding) conductors must be correctly connected.	Failure to follow this rule could result in a fatal accident.
The earthing (grounding) conductors should always be longer than the phase conductor/conductors.	If the motor cable is disconnected by mistake, the earthing (grounding) conductor needs to be disconnected last from its terminal. This rule applies to both ends of the cable.
Risk of electrical shock or burn. You must connect an additional earth- (ground-) fault protection device to the earthed (grounded) connectors if persons are likely to come into physical contact with the pump or pumped liquids.	—

All electric equipment must be earthed (grounded). This rule applies to pumps and mixers as well as monitoring equipment.

Precautions before work

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

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

Precautions during work

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

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

- Never work alone.
- Always wear protective clothing and hand protection.
- Stay clear of suspended loads.
- Always lift the product by its lifting device.
- Beware of the risk of a sudden start if the product is used with an automatic level control.
- Beware of the starting jerk, which can be powerful.
- Rinse the components in water after you disassemble the pump.
- Do not exceed the maximum working pressure of the pump.

- Do not open any vent or drain valve or remove any plugs while the system is pressurized. Make sure that the pump is isolated from the system and that pressure is relieved before you disassemble the pump, remove plugs, or disconnect piping.
- Never operate a pump without a properly installed coupling guard.

Clean chemicals from the eyes

1. Hold your eyelids apart forcibly with your fingers.
2. Rinse the eyes for at least 15 minutes.
   Use an eyewash or running water.
3. Seek medical attention.

Clean chemicals from the body

1. Remove contaminated clothing.
2. Wash the skin with soap and water for at least one minute.
3. Seek medical attention, if required.

Safety regulations for Ex-approved products in potentially explosive atmospheres

Description of ATEX

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

Guidelines for compliance

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.

If there are any questions regarding these requirements, the intended use, or if the equipment requires modification, contact an ITT representative before you proceed.

Personnel requirements

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

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 and/or vapor present in hazardous areas.
- Any maintenance for Ex-approved products must conform to international and national standards (for example IEC/EN 60079-17).

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 stated on the nameplates.
- The Ex-approved product must never run dry during normal operation. Dry running during service and inspection is only permitted outside the classified area.
- Never start a pump with a closed suction valve or blocked suction line.

- Before you start working with 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.
- 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.
- Make sure that the equipment is properly maintained:
  - Monitor the pump components and the end temperature of the liquid.
  - Maintain proper bearing lubrication.
- Do not modify the equipment without approval from an authorized ITT representative.
- Only use parts that have been provided by an authorized ITT representative.

Equipment for monitoring

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

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

Product approval standards

Regular standards

WARNING:
Use of equipment unsuitable for the environment can pose risks of ignition and/or explosion. Ensure that the code classifications on the pump are compatible with the specific environment in which the equipment is to be installed. If they are not compatible, do not operate the equipment and contact an ITT representative before proceeding.

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

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.

Transportation and Storage

Receive the unit

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.

Unpack the unit

1. Remove packing materials from the unit.
   Dispose of all packing materials in accordance with local regulations.
2. Inspect the unit to determine if any parts have been damaged or are missing.
3. Contact your ITT representative if anything is out of order.

Pump handling

WARNING:
Dropping, rolling or tipping units, or applying other shock loads, can cause property damage and 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.

Lifting methods

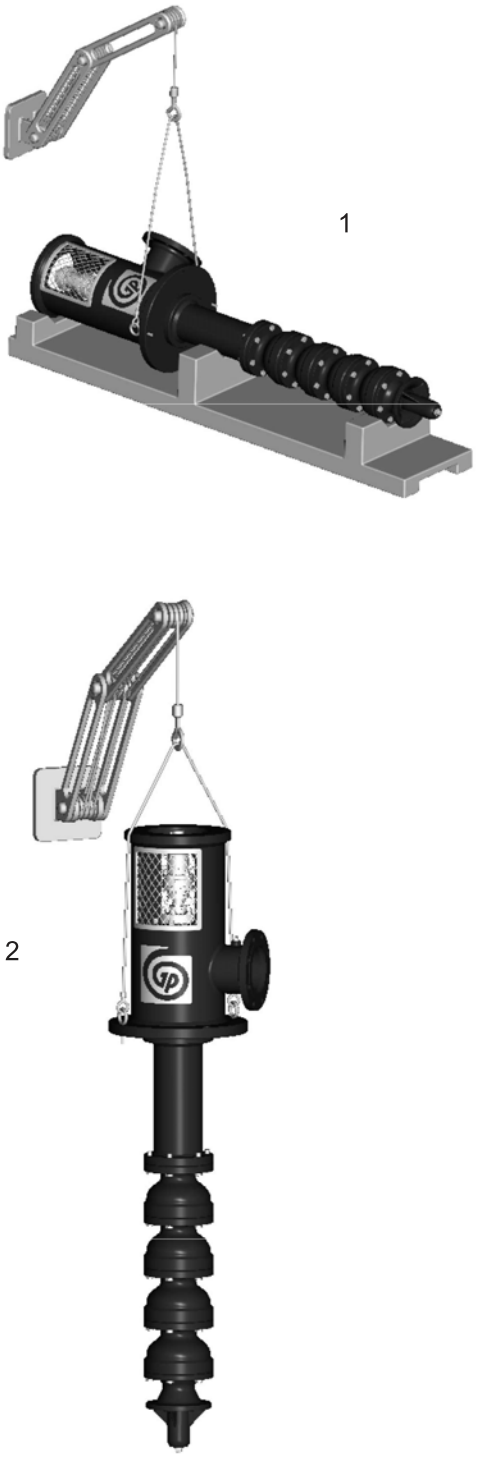
WARNING:

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

Table 1: Methods

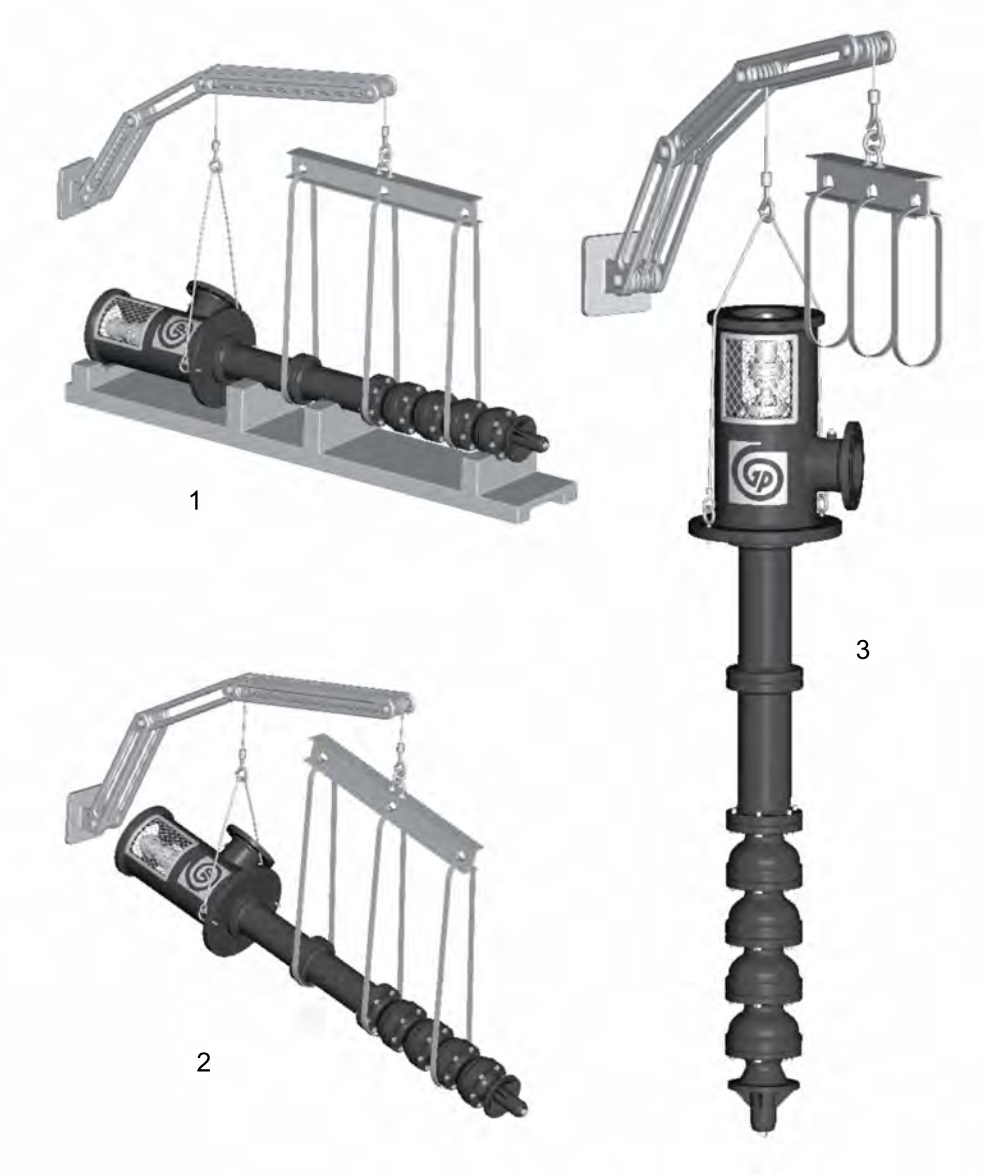
Pump type	Lifting method
A fully-assembled pump	Use suitable lifting devices attached to the lifting lugs on the discharge head or suitable eyebolts through the barrel flange or the discharge head base flange.
A partially-assembled pump	Use suitable lifting devices attached to the component or sub-assembly lifting lugs or suitable eyebolts through the component flanges.
A disassembled pump	Use suitable lifting devices attached to the component lifting lugs or suitable eyebolts through the component flanges.

Examples



1. Horizontal position
2. Vertical position

Figure 1: VIT lifted from horizontal to vertical (for pumps up to 15 feet [4.6 meters] in length)



1. Horizontal position
2. Intermediate position
3. Vertical position

Figure 2: VIT lifted from horizontal to vertical (for pumps up to 30 feet [9.1 meters] in length)

Pump storage requirements

Requirements

Vertical pumps require proper preparation for storage and regular maintenance during storage. The pump is considered in storage when it has been delivered to the job site and is awaiting installation.

For specific requirements for storing motors, gearheads, and engines, contact the equipment manufacturer.

Storage preparation

Condition	Proper preparation
Indoor storage area (preferred)	• Pave the area. • Clean the area. • Drain the area and keep it free from flooding.
Outdoor storage area (when indoor storage is not available)	• Observe all indoor storage requirements. • Use weather-proof coverings such as flame-resistant sheeting or tarpaulins. • Place coverings in a manner that maximizes drainage and air circulation. • Tie coverings down in order to protect the pump from wind damage.
Placement of pumps and component parts	• Place the unit on skids, pallets, or shoring higher than 15 cm | 6 in. from the ground for good air circulation. • Sort the parts in order to permit easy access for inspection and/or maintenance without excessive handling.
Stacking of units or component parts	• Make sure that racks, containers, or crates bear the full weight of units or parts in order to prevent distortion. • Keep identification markings readily visible. • Immediately replace any cover you remove for internal access.
Rotation of the pump and bowl assembly shaft	• Rotate the shaft and bowl assembly shaft counterclockwise once a month, at a minimum. • Never leave the shaft in a previous position or in the extreme raised or lowered lateral position. • Make sure that the shaft rotates freely.
Controlled storage facilities	• Maintain an even temperature of 6°C | 10°F or higher above the dew point. • Keep the relative humidity to less than 50%. • Make sure that there is little or no dust.
Uncontrolled storage facilities that have uneven temperatures, higher humidity, and/or dusty conditions)	• Inspect the unit periodically to make sure that all preservatives are intact. • Seal all pipe threads and flanged pipe covers with tape.

When pump is not in regular operation

If a pump has been installed, but is not in regular operation for an extended period of time, such as during a seasonal shutdown, then operate it for at least 15 minutes every two weeks, if possible.

Prepare the pump for long-term storage

For storage periods over six months, you must follow the pump storage requirements and this procedure:

1. Inspect the lube-oil and seal-flush piping and either fill the piping with rust-preventative oil, or recoat the piping periodically in order to prevent corrosion.
2. Place 4.5 kg | 10 lbs of moisture-absorbing desiccant or 2.3 kg | 5.0 lbs of vapor-phase inhibitor crystals near the center of the pump.
3. If the unit is assembled, place an additional 0.5 kg | 1 lb in the discharge nozzle and securely fasten the nozzle to the discharge elbow.
4. Install a moisture indicator near the perimeter of the unit.
5. Cover the unit with black polyethylene with a minimum thickness of 6.0 mil (0.15 mm), and seal it with tape.
6. Provide a small ventilation hole approximately 12.0 mm | 0.5 in. diameter.
7. Provide a roof or shed shelter in order to protect the unit from direct exposure to the elements.

Product Description

General description

The Model VIT pump is a vertical, industrial, turbine-type pump designed to meet a wide range of applications.

This pump has these capabilities:

- Capacities up to 70,000 gpm (15,900 m3/h)
- Heads up to 4,500 ft. (1,372 m)
- Power up to 5,000 hp (3,730 kW)

WARNING:
Use of equipment unsuitable for the environment can pose risks of ignition and/or explosion. Ensure that the code classifications on the pump are compatible with the specific environment in which the equipment is to be installed. If they are not compatible, do not operate the equipment and contact an ITT representative before proceeding.

Bowl assembly

The bowl construction is flanged for accurate alignment and ease of assembly and disassembly. Impellers are either open or enclosed, depending on the design requirements. For temperatures over 180°F (82°C) and in the larger size bowls, impellers are keyed to the shaft. Low NPSH first-stage impellers are available for special applications.

Column

Flanged column construction provides positive shaft and bearing alignment, and also eases assembly and disassembly. The lineshaft is supported within the column with the use of bearing retainers that are spaced in order to provide vibration-free operation and ensure long bearing and shaft wear.

Discharge head

The discharge head is designed to support the pump and to align the driver to the pump. Driver support windows provide access to seal piping and allow for easy adjustment of seals and couplings.

Thrust pot

A thrust pot is an option that is used when the driver is not designed to carry the axial pump thrust.

Drivers

Solid shaft drivers are used with most industrial applications. The rigidity of the rotor enhances vibration-free operation when mechanical seals are used.

You can use hollow shaft drivers in applications that specify packing or an enclosed lineshaft.

Nameplate information

Important information for ordering

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

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.

Nameplate types

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

Discharge head nameplate

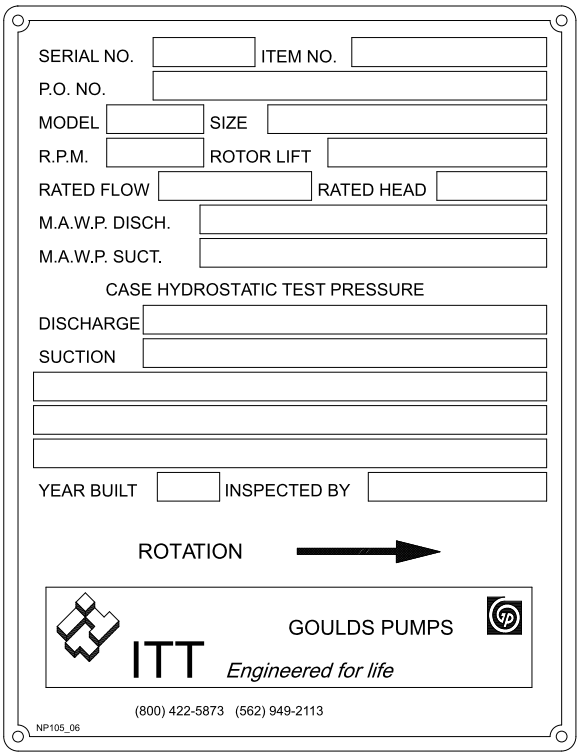


Figure 3: Discharge head nameplate

Table 2: Explanation of discharge head nameplate

Nameplate field	Explanation
SERIAL NO.	Serial number of the pump
ITEM NO.	Pump item number of the customer
P.O. NO.	Purchase order number of the customer
MODEL	Pump model
SIZE	Size of the pump
R.P.M.	Rated pump speed, revolutions per minute
ROTOR LIFT	Axial lift of the pump shaft and impellers
RATED FLOW	Rated pump flow, gpm (m^3/hr)

Nameplate field	Explanation
RATED HEAD	Rated pump head, ft (m)
M.A.W.P. DISCH.	Maximum allowable working discharge pressure, psi (kg/cm^2)
M.A.W.P. SUCT.	Maximum allowable working suction pressure, psi (kg/cm^2)
DISCHARGE	Discharge region hydrostatic test pressure, psi (kg/cm^2)
SUCTION	Suction region hydrostatic test pressure, psi (kg/cm^2)
YEAR BUILT	Year the pump was built
INSPECTED BY	Quality control identification stamp

ATEX nameplate

Figure 4: ATEX nameplate

Nameplate field	Explanation
II	Group 2
2	Category 2
G/D	Pump can be used when gas and dust are present
T4	Temperature class

WARNING:
Use of equipment unsuitable for the environment can pose risks of ignition and/or explosion. Ensure that the code classifications on the pump are compatible with the specific environment in which the equipment is to be installed. If they are not compatible, do not operate the equipment and contact an ITT representative before proceeding.

Installation

Pre-installation

Precautions

WARNING:

- ⟨Ex⟩ When installing in a potentially explosive environment, ensure that the motor is properly certified.
- ⟨Ex⟩ 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.

Inspect the barrel flange or sub-base

1. If an optional sub-base is furnished, remove it from the pump discharge head when it is shipped assembled.
2. Completely clean the underside of the barrel flange or sub-base.
   You might need to coat the underside of the barrel flange or sub-base with an epoxy primer which you can purchase as an option.
3. Remove the rust-preventative solution from the machined topside of the barrel flange with an appropriate solution.

Concrete foundation requirements

Requirements

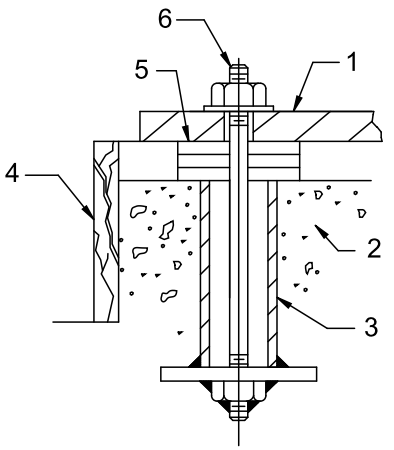
Make sure that you meet these requirements when you prepare the pump foundation:

- The foundation must be able to absorb any vibration.
- The foundation must be able to form a permanent and rigid support for the pumping unit.
- The foundation must be of adequate strength in order to support the complete weight of the pump and driver, plus the weight of the liquid that passes through it.

Typical installation

A typical installation has these characteristics:

- Bolts with a pipe sleeve that is two and a half times the size of the bolt diameter embedded in the concrete
- Properly sized
- Located in accordance with the dimensions given in the example drawing
- Enough space inside the pipe sleeves to allow the final position of the foundation bolts to align with the holes in the sub-base flange



1. Barrel flange or sub-base
2. Foundation
3. Sleeve
4. Dam
5. Shims
6. Anchor bolt

Figure 5: Example of a typical installation

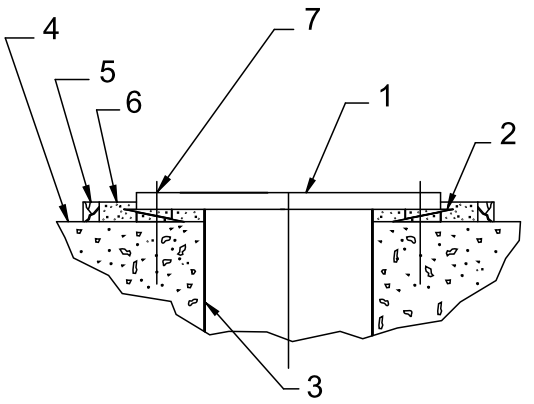
Install the barrel or sub-base on a concrete foundation

CAUTION:

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.

1. Remove water and debris from the anchor bolt holes and sleeves before you start the grout.
2. For sleeve-type bolts, fill the sleeves with packing or rags in order to prevent grout from entering the sleeves.
3. Carefully lower the barrel or sub-base onto the foundation bolts and hand-tighten the bolt nuts.
4. Use a machinist's level in order to level the barrel or sub-base or a machine surface of the discharge head using metal plates and leveling screws.

In order to ensure an accurate reading, check that the surface being leveled is free from all contaminants, such as dust.



1. Barrel flange or Sub-base
2. Leveling wedges
3. Floor sleeve (optional)
4. Foundation
5. Dam
6. Grout
7. Centerline anchor bolt

Figure 6: Example of a foundation

5. Level the barrel or sub-base in two directions at 90° on the machined surface to achieve levelness condition equal to or less than 0.001 inches per foot (0.08mm per meter).

Table 3: Levelness tolerances

Commercial	API
0.005 inch/ft (0.4 mm/m)	0.002 inch/ft (0.2 mm/m)

Grout the barrel or sub-base

Non-shrink grout is recommended for this procedure.

1. Inspect the foundation for dust, dirt, oil, chips, and water.
2. Remove any contaminants.
   Do not use oil-based cleaners since they do not bond well with grout. Refer to the instructions from the grout manufacturer.
3. Build a dam around the foundation.
4. Thoroughly wet the foundation.
5. Pour grout to a minimum thickness of 0.375 in. (9.520 mm) between the barrel or sub-base and concrete foundation, up to the level of the dam.
6. Remove any air bubbles from the grout as it is poured by either puddling, using a vibrator, or pumping the grout into place.
7. Allow the grout to set at least 48 hours.
8. Tighten the foundation bolts to the torque value provided on the pump general arrangement drawing.

Install the pump on a structural-steel foundation

1. Locate the barrel and pump directly over - or as near as possible to - the main building members, beams, or walls.
2. Bolt the barrel or sub-base to the support in order to avoid distortion, prevent vibration, and retain proper alignment.
3. Level the barrel or sub-base using shims.

Piping checklists

General piping checklist

Precautions

WARNING:

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

CAUTION:

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

CAUTION:
Never draw piping into place at the flanged connections of the pump. This can impose dangerous strains on the unit and cause misalignment between the pump and driver. Pipe strain adversely affects the operation of the pump, which results in physical injury and damage to the equipment.
Flange loads from the piping system, including those from the thermal expansion of the piping, must not exceed the limits of the pump. Discharge head deformation can result in contact with rotating parts, which can result in excess heat generation, sparks, and premature failure.

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

Piping guidelines

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

Checklist

Check	Explanation/comment	Checked
Check that all piping is supported independently of, and lined up naturally with, the pump flange.	This helps to prevent: • Strain on the pump • Misalignment between the pump and the drive unit • Wear on the pump bearings, seal, and shafting	
Check that only necessary fittings are used.	This helps to minimize friction losses.	

Check	Explanation/comment	Checked
Do not connect the piping to the pump until: • The grout for the barrel or sub-base has hardened. • The hold-down bolts for the pump are tightened.	—	
Make sure that all the piping joints and fittings are airtight.	This prevents air from entering the piping system or leaks that occur during operation.	
If the pump handles corrosive fluids, make sure that the piping allows you to flush out the liquid before you remove the pump.	—	
If the pump handles liquids at elevated temperatures, make sure that the expansion loops and joints are properly installed.	This helps to prevent misalignment due to thermal expansion of the piping.	
Make sure that all piping components, valves and fittings, and pump branches are clean prior to assembly.	—	

Discharge piping checklist

Checklist

Check	Explanation/comment	Checked
Check that an isolation valve is installed in the discharge line.	The isolation valve is required for:	
Check that a check valve is installed in the discharge line, between the isolation valve and the pump discharge outlet.	The location between the isolation valve and the pump allows inspection of the check valve. The check valve prevents damage to the pump and seal due to the back flow through the pump, when the drive unit is shut off. It is also used to restrain the liquid flow.	
If increasers are used, check that they are installed between the pump and the check valve.	—	
If quick-closing valves are installed in the system, check that cushioning devices are used.	This protects the pump from surges and water hammer.	
If increasers are used, they must be of the eccentric type.	This prevents air from collecting at the top of the discharge pipe.	

Install a partially-assembled pump

Pumps 20 feet (6 meters) or less in length are usually shipped partially assembled, with the exception of these parts:

- Driver
- Packing
- Mechanical seal with piping
- Coupling assembly, spacer or non-spacer type

Refer to the Certified Pump Outline Drawing for the location of the anchor-bolt holes.

1. Clean the barrel flange and the bottom of the discharge head base.
2. Attach shackles to the discharge head lifting lugs or thread two eyebolts through the bolt holes in the mounting flange.
3. Hoist the unit into position over the foundation.
   Make sure that the shackles, eyebolts, and sling are rated to handle in excess of the pump weight. See the outline drawing.
4. Carefully guide the unit so that it does not strike the sides of the sub-base or foundation.

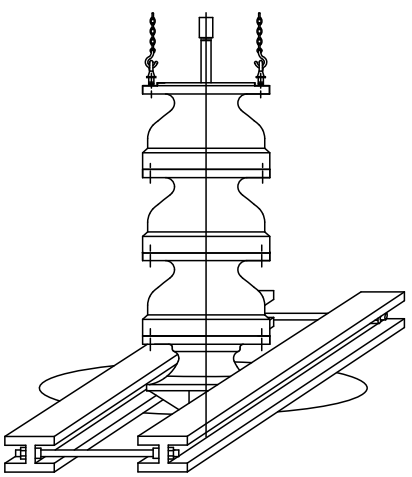
5. Lower the unit until the discharge-head flange engages and rests firmly on the barrel flange, then secure it with the capscrews provided.
6. When a lineshaft is shipped separately, complete these steps:
   a) Check that the average total runout does not exceed 0.005 in. TIR (0.127 mm) for every 10 ft. (3 m).
      The shaft must be within tolerance prior to installation.
   b) Remove the stuffing box, if it is installed.
   c) Carefully slide the shaft through the top column bearing retainer.
   d) Thread the shaft into the coupling after you replace the stuffing box or seal housing.

Install the bowl assembly

WARNING:
Do not work under a heavy and suspended object unless there is a positive support and safeguards that will protect you if a hoist or sling fails.

CAUTION:
- Do not attempt to lift the bowl assembly by the pump shaft. This can result in damage to the pump shaft.
- Do not drop any foreign object into the bowl assembly. This can cause serious damage to the pump and any downstream components. Any foreign object dropped into the bowl assembly must be retrieved before you continue with assembly.

1. Check that all fasteners are tight and turn the pump shaft by hand to make sure it turns freely.
2. Remove all accumulated dust, oil, or other foreign material from the external surfaces.
3. Place two I-beam supports across the barrel opening that are strong enough to safely support the weight of the entire pump assembly.
   Connect these I-beams with threaded rods and nuts so you can clamp them firmly together for the portion to be supported.



4. Place a suitable hoist or derrick over the barrel opening with the hook in the center.
5. Install two threaded eyebolts through the discharge bowl bolt holes 180º apart.
6. Attach a sling to the eyebolts and hoist it into position over the foundation opening.

7. Carefully lower the bowl assembly, guiding the unit so it does not strike the sides of the opening, until the discharge bowl flange rests firmly on the I-beam supports.
8. Place a cover over the discharge bowl opening to prevent the entrance of dirt or other foreign matter until you are ready to install the column assembly.

Install the threaded coupling

If you have a keyed coupling, see the Install the column section of this manual.

CAUTION:
Use Molykote Dow-Corning anti-galling compound or an equivalent for all galling material such as 316 stainless steel.

Shaft threads are left hand.

1. Coat the threads with a light coat of oil for a non-galling material, or Molykote for galling material.
2. Install the threaded coupling onto the pump shaft by threading it on for one-half of its length.
   You can insert a fine wire in the drill hole at the center of the coupling that serves as a gauge in order to determine when the coupling is correctly positioned on the pump shaft.
3. Remove the wire.

Column installation

This section describes how to install the two lineshaft options available for the column assembly:

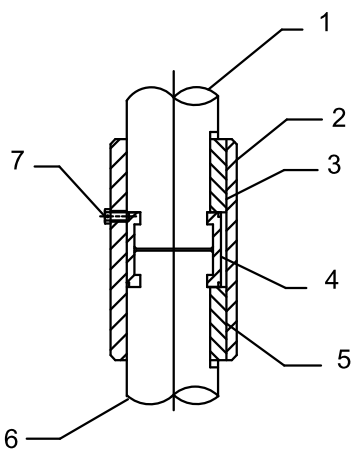
- Open lineshaft
- Enclosed lineshaft

Install the open lineshaft

CAUTION:
Use Molykote Dow-Corning anti-galling compound or an equivalent for all galling material such as 316 stainless steel.

The bearing retainer is integral with the column. The top flange of the column has a male register and the bottom flange of the column has a female register.

1. Check the headshaft and lineshaft for straightness.
   The average TIR should be less than 0.0005 in. (0.013 mm) per ft. (0.305 m) and not exceed 0.005 in. (0.127 mm) for every 10 ft. (3 m).
2. Apply a thin film of oil to the lineshaft.
3. Install the coupling:
   Shaft threads are left hand.

If your lineshaft coupling is...	Then...
Threaded	1. Apply a thin film of oil to the coupling threads if it is a non-galling material. Use a suitable anti-seize if the coupling is a galling material. 2. Manually start the thread until you feel resistance. Use a fine wire inserted in the drill hole at the center of the coupling as a gauge to determine when the coupling is correctly positioned on the shaft. 3. Remove the wire after you install the coupling. 4. Complete the joint using a pair of pipe wrenches, one on top of the pump shaft and the other on the coupling. 5. Run the upper lineshaft into the coupling and hand-tighten. Do not apply wrenches on the bearing journal surfaces. For an illustration of the threaded coupling, see the VIT-FF product lube in the Parts List chapter.
Keyed	1. Insert the key into the pump shaft. 2. Lower the sleeve over the pump shaft, to approximately 1.0 in. (25.4 mm) below the top of the shaft. 3. Lower the lineshaft until it touches the pump shaft. 4. Insert the split ring into the grooves of the pump shaft and lineshaft. 5. Raise the sleeve until it covers the split ring. 6. Insert the key into the lineshaft. 7. Raise the sleeve to the top of the key. 8. Secure the sleeve to the split ring with a lock screw and lock wire.  1. Lineshaft 2. Sleeve 3. Key 4. Split ring 5. Key 6. Pump shaft 7. Lock screw/lock wire

4. Attach the column to the bowl assembly:
   a) Lower the column over the lineshaft, taking care as the shaft passes through the lineshaft bearing, until the column flange engages the top-bowl flange register.
   b) Attach a sling to the eyebolts and to the hoist hook.
   c) Hoist the column section over the bowl assembly.
   d) Lower the column over the lineshaft until the column flange engages the discharge-bowl flange register.
   e) Insert as many capscrews through both flanges as possible and gradually tighten them in diametrically-opposite pairs.
5. Lift the bowl and column assembly high enough to allow for the removal of the I-beam supports.
6. Install and tighten the remaining capscrews.
7. Place the bowl and column assembly on the barrel flange:

a) Lift the entire assembly by the column pipe eyebolts and remove the supports.
b) Slowly lower the bowl and column assembly.
c) Place the supports on the barrel flange and continue to lower the assembly until the upper column flange comes to rest on the supports.

8. If required, install the coupling and lineshaft to the protruding end of the lineshaft.
9. Assemble the next column section, or top column:
   a) Make sure that the bottom-column register engages the top-column register.
   b) Secure the columns with capscrews and hex nuts until all column and lineshaft sections required for the proper pump setting are assembled.
   c) Tighten the capscrews into the hex nuts gradually and uniformly.

Install the enclosed lineshaft

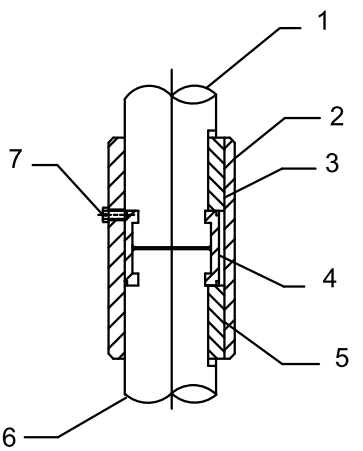
CAUTION:

Pump lineshafts are connected with either threaded or keyed couplings. This section describes both procedures.

See the Certified Pump Outline Drawing for the number of column and shaft sections required.

1. Check the headshaft and lineshaft for straightness.
   The average TIR should be less than 0.0005 in. (0.013 mm) per ft. (0.305 m) and not exceed 0.005 in. (0.127 mm) for every 10 ft. (3 m).
2. Install the coupling:

If your lineshaft coupling is...	**Then...**
Threaded	1. Apply a thin film of oil to the coupling threads if it is a non-galling material. Use a suitable anti-seize if the coupling is a galling material. 2. Manually start the thread until you feel resistance. Use a fine wire inserted in the drill hole at the center of the coupling as a gauge to determine when the coupling is correctly positioned on the shaft. 3. Remove the wire after you install the coupling. 4. Complete the joint using a pair of pipe wrenches, one on top of the pump shaft and the other on the coupling. 5. Run the upper lineshaft into the coupling and hand-tighten. Do not apply wrenches on the bearing journal surfaces. For an illustration of the threaded coupling, see the VIT-FF product lube in the Parts List chapter.

If your lineshaft coupling is...	Then...
Keyed	1. Insert the key into the pump shaft. 2. Lower the sleeve over the pump shaft, to approximately 1.0 in. (25.4 mm) below the top of the shaft. 3. Lower the lineshaft until it touches the pump shaft. 4. Insert the split ring into the grooves of the pump shaft and lineshaft. 5. Raise the sleeve until it covers the split ring. 6. Insert the key into the lineshaft. 7. Raise the sleeve to the top of the key. 8. Secure the sleeve to the split ring with a lock screw and lock wire.  1. Lineshaft 2. Sleeve 3. Key 4. Split ring 5. Key 6. Pumpshaft 7. Lock screw/lock wire

3. Attach a small, adjustable, pipe-vise type of lifting device to a section of enclosing tube. If such a device is not available, use a piece of light manila line, fastened to the tubing by a clove hitch or a double-half hitch.
4. Raise up and then lower the enclosing tube over the first length of shaft attached to the bowl.
5. Apply an anti-sieze compound to the matching threads of the pump-top screw bearing and securely tighten.
6. Install the first length of column pipe over the tube:
   a) Install two eyebolts diametrically opposite each other in the upper flange of the bottom column.
   b) Attach a sling to the eyebolts and to the hoist hook.
   c) Hoist the column section over the bowl assembly.
   d) Lower the column over the enclosing tube until the column flange engages the discharge-bowl flange register.
   e) Insert as many capscrews through both flanges as possible and gradually tighten them in diametrically-opposite pairs.
7. Lift the entire assembly by the column pipe eyebolts and remove the supports.
8. Slowly lower the bowl and column assembly.
9. Place the supports on the foundation and continue to lower the assembly until the upper column flange comes to rest on the supports.
10. Pour one quart of light turbine oil into the top tubing section and screw the tube bearing into the top length until it bottoms, ready to receive the next length of tubing assembly.

11. Install the lineshaft coupling onto the projecting end of the shaft.

If your lineshaft coupling is...	Then...
Threaded	1. Install it on the projecting end of the lineshaft for half the length of the coupling. 2. Repeat this step until all joints are installed.
Keyed	1. Install it onto the projecting end of the shaft as described in step 2. 2. Repeat this step until all joints are installed.

Install the discharge head

CAUTION:

- Do not bump or scrape the shaft protruding above the column. This could result in a bent or damaged shaft.
- Ⓔx Packed stuffing boxes are not allowed in an ATEX-classified environment.
- Ⓔx The mechanical seal used in an Ex-classified environment must be properly certified.

NOTICE:
Make sure that the eyebolts or slings are rated to handle more than the pump weight.

Mechanical seals are shipped separately. If the seal housing is assembled to the discharge head, remove the seal before you begin this procedure.

For the enclosed lineshaft option, only perform steps 3 and 4 in this procedure:

1. If the stuffing box is assembled to the head, remove it and all attached piping.
2. Remove the coupling guard:
   a) Attach shackles to the discharge head lifting lugs, or thread two eyebolts in the head driver-support mounting holes diametrically opposite each other.
   b) Hoist the discharge head over the protruding headshaft.
3. Orient the discharge head in the required position:
   a) Lower the head while you center the vertical hole with the headshaft that protrudes above the column.
      Stop when the discharge head engages the column.
   b) Install the capscrews and secure the discharge head to the column.
   c) Tighten the capscrews gradually in diametrically-opposite pairs.
4. Lift the pump assembly high enough to allow for the removal of the supports.
5. Install and tighten the remaining capscrews until all capscrews are uniformly tight.
6. Hoist the bowl, column, and head assembly and remove the supports.
7. Lower the bowl, column, and head assembly until the discharge-head mounting flange engages the barrel flange.
8. Secure the discharge head to the barrel flange.

Stuffing box installation

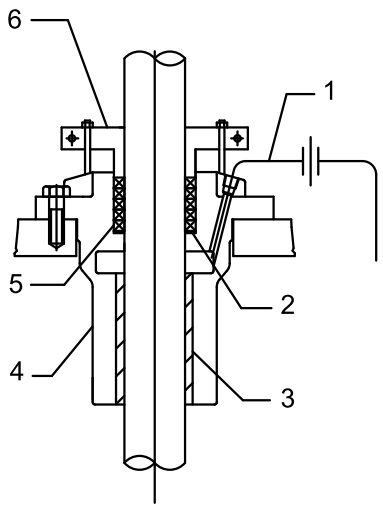
CAUTION:

- 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.
- Ⓔx Packed stuffing boxes are not allowed in an ATEX-classified environment.

Stuffing box types

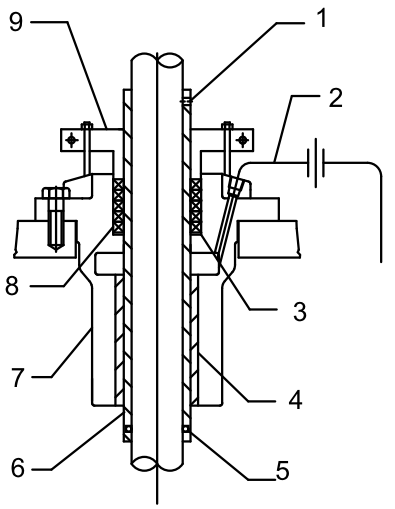
The stuffing box installation has three types:

- Type A
- Type B
- Type C



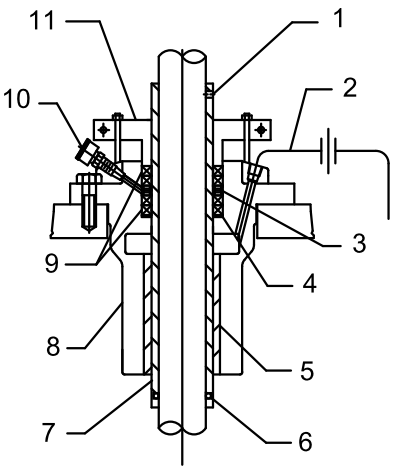
1. Bypass line
2. Packing washer
3. Bearing
4. Packing box
5. Packing rings
6. Split gland

Figure 7: Type A stuffing box



1. Setscrew
2. Bypass line
3. Packing washer
4. Bearing
5. O-ring
6. Sleeve
7. Packing box
8. Packing rings
9. Split gland

Figure 8: Type B stuffing box



1. Setscrew
2. Bypass line
3. Lantern ring
4. Packing washer
5. Bearing
6. O-ring
7. Sleeve
8. Packing box
9. Packing rings
10. Grease cup
11. Split gland

Figure 9: Type C stuffing box

Install the type A and B stuffing boxes

The type B stuffing box is the same as the type A with the exception that it has a shaft sleeve with an O-ring.

1. Lubricate the O-ring and the shaft threads.
2. Slip the sleeve onto the shaft and carefully rotate it counterclockwise while you gently push down until the O-ring is clear of the shaft threads.
3. Locate the sleeve on the shaft and secure it with setscrews.
4. Position the gasket on the discharge head.
5. Slide the stuffing box down over the shaft and into position on the gasket.
6. Secure the stuffing box with capscrews.
7. If the packing washer is provided, insert it into the stuffing box.
   The packing washer is not required on shaft sizes 2.19 in. (55.63 mm) and larger.
8. Grease the packing rings for easier installation.
9. Install the packing rings:
   a) Twist each of the five packing rings sideways in order to easily get them around the shaft.You can set the sixth ring aside until the packing is adjusted for leakage after the first startup.
   b) Start the first ring into the stuffing box.
   c) Use your fingers to position the entire ring in the stuffing box.
   d) Tap each ring down using a split wooden bushing and push the packing ring down firmly until it seals on the shaft and bore of the stuffing box.
   e) Stagger the ring joints 90° apart.
      You can use the split gland as a tamper for the top ring.
10. Install the split gland and thread the nuts on the split gland studs.

11. Hand-tighten the nuts.
12. If an optional bypass line is furnished, attach it to the tube fitting in the stuffing box.

Final adjustment of the stuffing box must be made at pump start up. This final adjustment applies to all stuffing box styles. A properly packed stuffing box needs to be loose enough to allow you to manually turn the shaft.

Install the type C stuffing box

The type C stuffing box is provided with a shaft sleeve, O-ring, lantern ring, and grease cup.

1. Lubricate the O-ring and the shaft threads.
2. Slip the sleeve onto the shaft and carefully rotate counterclockwise while you gently push down until the O-ring is clear of the shaft threads.
3. Locate the sleeve on the shaft and secure it with setscrews.
4. If the packing washer is provided, insert it into the stuffing box.
   The packing washer is not required on shaft sizes 2.19 in. (55.63 mm) and larger.
5. Grease the packing rings for easier installation.
6. Install the packing rings:
   a) Twist each of the five packing rings sideways in order to get them around the shaft easily.You can set the sixth ring aside until the packing is adjusted for leakage after the first startup.
   b) Start the first ring into the stuffing box.
   c) Use your fingers to position the entire ring in the stuffing box.
   d) Tap each ring down using a split wooden bushing and push the packing ring down firmly until it seals on the shaft and bore of the stuffing box.
   e) Stagger the ring joints 90° apart.
      You can use the split gland as a tamper for the top ring.
   f) Insert the lantern ring into the stuffing box so that it aligns with the lubrication passage in the stuffing box.
   g) Install two packing rings and stagger the ring joints 90° apart.
7. Install the split gland and thread the nuts on the split gland studs.
8. Hand-tighten the nuts.
9. Attach a bypass line to the tube fitting in the stuffing box.
10. Grease the stuffing box:
    a) Thread a grease cup into the stuffing box.
    b) Fill the grease cup with a high grade of grease.
    c) After the stuffing box is completely assembled, apply grease to the lantern ring by turning the grease-cup cap several turns.

Final adjustment of the stuffing box must be made at pump start up. This final adjustment applies to all stuffing box styles. A properly packed stuffing box needs to be loose enough to allow you to manually turn the shaft.

Mechanical seal options

Pumps are shipped without mechanical seals installed. If they are not, then refer to the mechanical seal manufacturer's installation instructions.

These are the mechanical seal options for this pump:

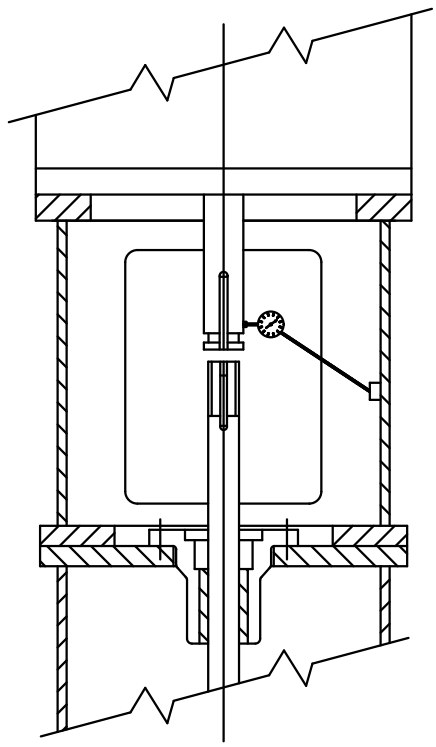
- Cartridge mechanical seal
- Conventional inside component mechanical seal
- Conventional outside component mechanical seal
- High-pressure seal
- Dual mechanical seal

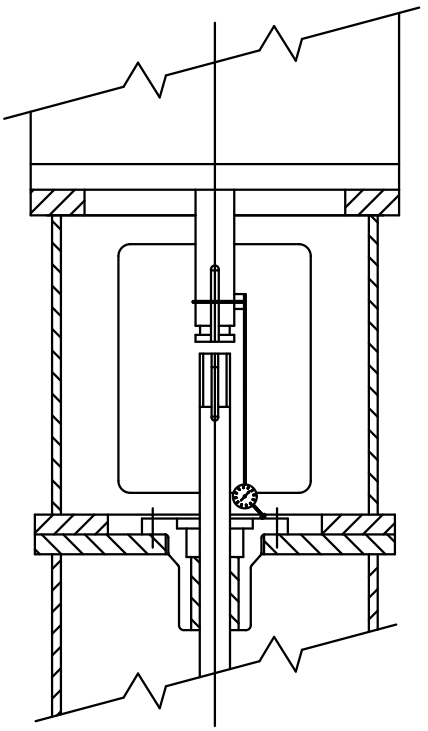
Install the mechanical seal

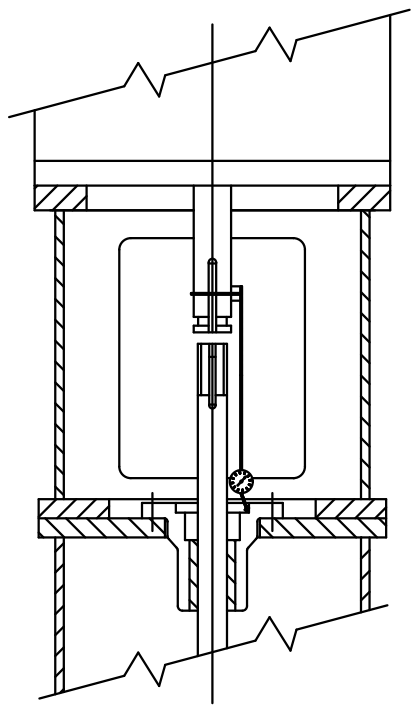
NOTICE:

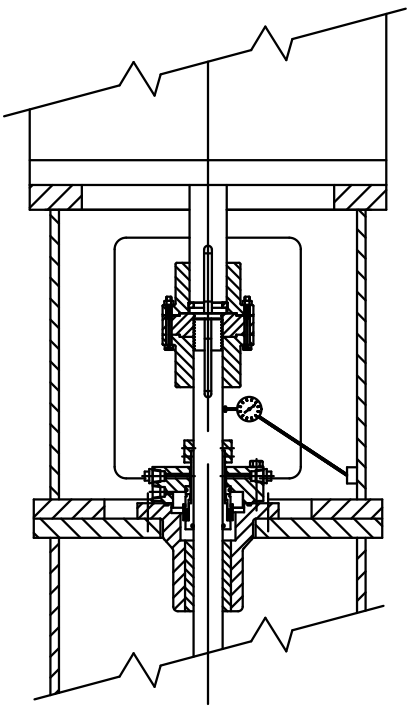
- Do not bump carbon inserts against the shaft as they can chip, crack, or break.
- Do not over tighten the capscrews on the gland. This can distort the seal seat and cause seal failure.
- Do not remove the seal spacer or eccentric washer, adjust the seal, or tighten the setscrews until after you adjust the impellers.
- Reset the seal after you adjust the impeller.

1. Install the O-ring or gasket between the seal housing and seal:
   a) Install the seal over the shaft and ease it into position against the face of the seal box.
   b) Take care when you pass the sleeve and O-ring over the keyways or threads in order to avoid damage to the O-ring.
2. Position the seal gland on the discharge-head seal housing and secure it with capscrews.
3. Tighten the capscrews gradually and uniformly in a criss-cross pattern, taking two or three passes.
4. Install all seal piping as required.
5. Before you make the final connections of the sealing-liquid pressurizing lines, make sure the seal housing and all sealing-liquid lines are flushed free of dirt, scale, and other particles.
6. Install the driver and coupling.
7. Take these flatness and concentricity measurements:

Runout of driver shaft	Procedure
Concen-tricity of driver shaft	1. Install the dial indicator as shown, with the base attached to the motor support. 2. Rotate the driver shaft by hand while you read the dial. Make sure that the runout does not exceed NEMA standards, 0.002 in. (0.05 mm) maximum TIR. 3. If the indicator reads higher than 0.002 in. (0.05 mm) TIR, loosen the four driver hold-down bolts and relocate the driver on the motor base register. 4. Obtain the desired position. 5. Tighten the hold-down bolts and repeat the indicator reading. 

Runout of driver shaft	Procedure
Flatness of the seal housing	For this measurement, remove the mechanical seal if the dial indicator stylus cannot rotate 360° on the top surface of the seal gland. 1. Remove the lower coupling components and attach the base of the dial indicator to the driver shaft. 2. Place the stylus at the top surface of the seal gland, or at the top surface of the seal housing. 3. Slowly rotate the driver shaft 360°. 4. Check that the face of the seal housing is square with the shaft to within 0.002 in. (0.05 mm) TIR. 

Runout of driver shaft	Procedure
Concen-tricity of the seal housing	This measurement requires that you remove the mechanical seal. 1. Install the dial indicator as shown. 2. Rotate the driver shaft by hand and run the indicator in the inside-machined surface of the seal housing in order to determine the concentricity. 3. If the indicator reads higher than 0.004 in. (0.10 mm) TIR, loosen the four driver hold-down bolts and relocate the driver on the motor base register. 4. Obtain the desired position. 5. Tighten the hold-down bolts and repeat the indicator reading. 

Runout of driver shaft	Procedure
Concen-tricity of the head shaft	1. Reinstall the mechanical seal if it was removed for the flatness or concentricity measurement. 2. Install the coupling assembly and adjust the impeller. 3. Attach the base of the dial indicator on the discharge head or driver support. 4. Place the stylus on the shaft between the top of the seal and the bottom of the pump coupling. 5. Slowly rotate the driver shaft 360°. 6. Check that the shaft runout is within 0.004 in. (0.10 mm) TIR, or as required by specification. 7. Drill and dowel the pin in three places in order to secure the driver to the motor base after you obtain the required runouts. 

8. Position and install the drive collar of the seal by tightening the setscrews using the instructions from the mechanical seal manufacturer.
9. Save the seal spacer or eccentric washer.
   You can use these in order to hold the correct seal spacing in the event that you have to remove the seal. You must loosen the seal setscrews in order to re-adjust the impeller lift.
10. Seals that use half-dog-point setscrews might require that the shaft be spot faced or drilled in order to provide a secure placement:
    a) Cover the seal and seal housing.
    b) Remove the setscrews one at a time from the collar and spot face or drill the shaft and then tighten the setscrews into position.
    c) Remove any metal chips in order to avoid damage to the seal.

Assemble a single inside-mounted mechanical seal

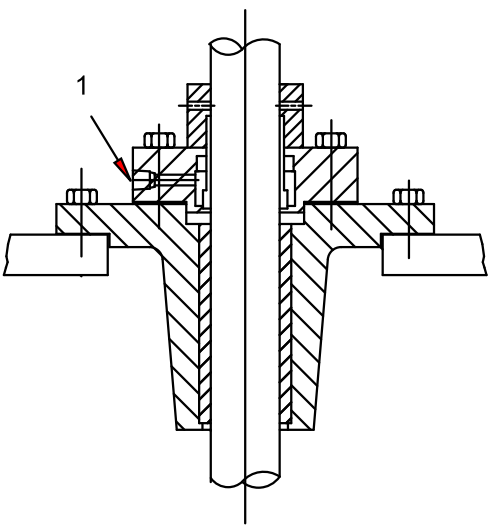
Single inside-mounted mechanical seals have these characteristics:

- They are cartridge seals.
- They have glands and sleeves.
- They are assembled as a unit by the seal manufacturer.

Follow the special instructions from the seal manufacturer in the event that non-cartridge seals are installed.

1. Assemble the seal:

If the seal is...	Then...
An O-ring type	Assemble the complete unit over the shaft. Use care when you pass the sleeve and O-ring over the keyways or threads to avoid damaging the O-ring.
A PTFE wedge-ring type	1. Remove the sleeve collar and PTFE wedge ring. 2. Assemble them separately after the sleeve is in position. 3. Tighten the collar on the threads to seal the PTFE wedge around the shaft.



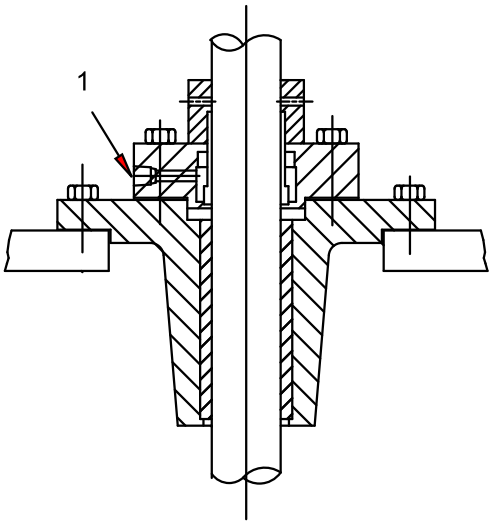
1. Bypass to suction

Assemble a single outside-mounted mechanical seal

These seals are provided in two sub-assemblies:

- Stationary unit
- Rotary unit

1. Install the stationary unit, which is the seal-gland assembly.
   The stationary unit will face up.
2. Install the rotary unit and take care not to disengage the rotary parts.
   Installation becomes difficult when the rotary unit parts become disengaged.
   IMPORTANT: Do not tighten the setscrews or adjust the seal until the impellers are adjusted.
3. Adjust the seal:
   a) Refer to the spring gap which is stamped on the collar and shown on the seal assembly drawing.
   b) Tighten the setscrews so that the compression ring is maintained at the same distance from the collar at all points.
   c) Before you start the pump, make sure that the spring gap and the distance from the face of the stuffing box to the collar are the same as shown on the seal assembly drawing.



1. Bypass to suction

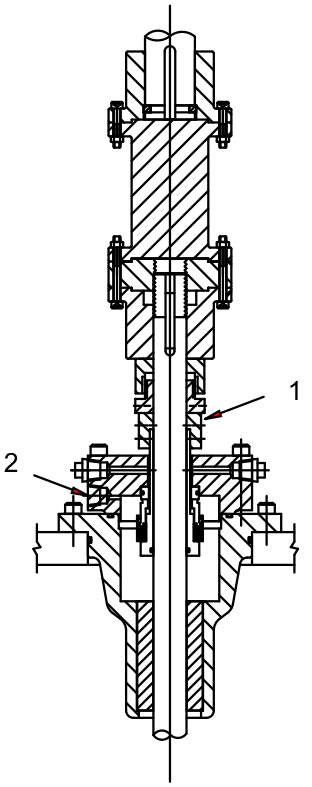
Install the high-pressure seal

High-pressure seals have these characteristics:

- Usually cartridge seals
- Shipped assembled and ready for installation
- Are either single or dual seals

Mechanical seals on pumps with over 1200 psi (85 kg/cm^2) gauge discharge pressure, or a pressure level specified by the seal manufacturer, are normally fitted with backup rings. These rings are installed after the seal installation, between the drive collar of the seal and the bottom of the flanged-pump coupling.

1. Install the backup ring:
   a) Thread the bottom backup ring into the top backup ring until it bottoms out.
   b) Slide the backup ring assembly over the shaft and position it on the seal.
2. Install the spacer coupling and the driver.
3. Set the seal into position.
4. Check the TIR on the headshaft above the mechanical seal.
5. Adjust the backup ring assembly.



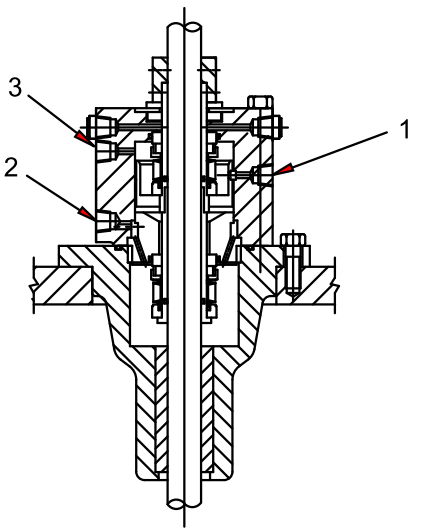
1. Back-up rings
2. Bypass to suction

Install the dual mechanical seals

Dual seals are cartridge seals that are shipped assembled. This procedure only applies if a non-cartridge-type seal is furnished, and there are no instructions provided by the seal manufacturer.

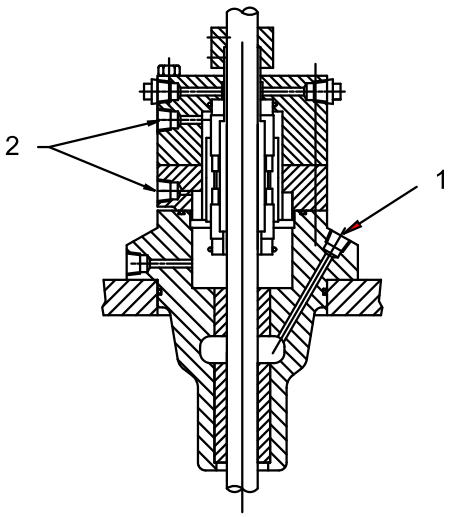
1. Scribe a mark on the shaft or sleeve that is flush with the face of the seal housing. Use this reference mark to set the seal to the seal assembly.
2. Install the inner insert face:
   a) Lubricate the stuffing-box bore and OD of the inner (or lower) stationary insert.
   b) Protect the inner insert face with a soft and clean material, such as gasketing or sheet rubber.
   c) Install the inner insert face into the bottom of the seal housing with hand pressure only.
   d) If the insert includes a holding pin, make sure that the pin is aligned with the slot or hole in the bottom of the seal housing.
3. Carefully place the gland ring and outer stationary insert over the shaft.
4. Lubricate the shaft or sleeve before you install any of the rotary unit parts.
5. Install the seal collar, or collars, on the shaft or sleeve:
   a) Locate the collar so that it aligns with the reference mark you created in step 1 and to the setting dimension given on the seal assembly drawing.
   b) Tighten the setscrews to lock the collar to the shaft or sleeve.
6. Install the remaining rotary unit parts on the shaft or sleeve in the proper sequence and complete the assembly of equipment.
7. If it is provided, install the shaft packing on the shaft or sleeve individually. Use care to avoid nicks or damage that can cause the seal to leak.
8. Seat the gland ring and gland gasket against the face of the seal housing:
   a) Tighten the nuts or bolts evenly and firmly.
   b) Make sure that the gland ring is not cocked.

c) Tighten the nuts or bolts just enough to seal at the gland ring gasket.



1. Connection to external seal lubrication
2. Bypass to suction
3. Connection to external seal lubrication

Figure 10: Tandem-mounted seal (dual unpressurized)

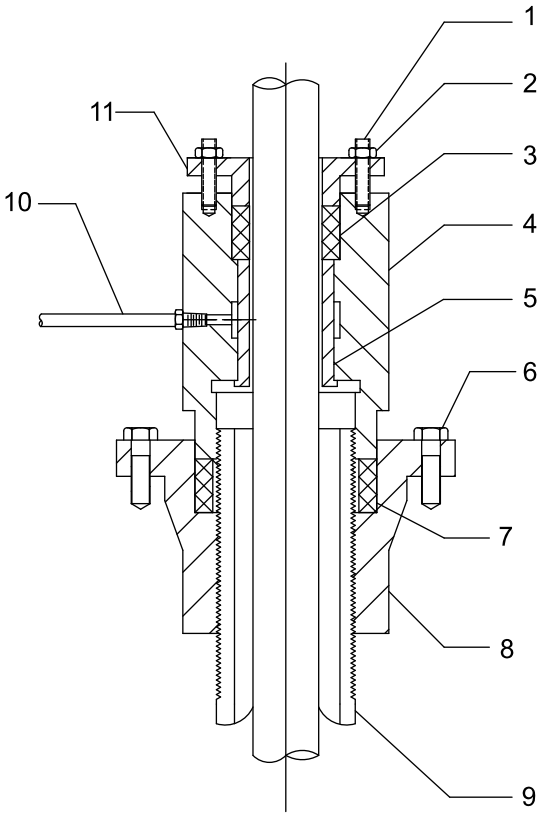


1. Bypass to suction
2. Connection to external seal lubrication

Figure 11: Double-mounted seal (dual pressurized)

Install the tube tension plate

1. Lubricate the tube threads and the underside of the tension-plate flange with a thread compound.
2. Thread the tension plate onto the enclosing tube nipple manually until its shoulder rests on the discharge head.



1. Stud
2. Hex nut
3. Packing
4. Tension nut
5. Bearing
6. Capscrew
7. Packing rings
8. Tension plate
9. Tube nipple
10. Line assembly water flush
11. Gland

Figure 12: Tension plate - water flush

Tension the enclosing tube

The enclosing tube sags from its own weight as it is installed and must be pulled tight (tensioned) to make it straight. This section describes two methods you can use to tension the tube:

- Direct pull method is more precise and is preferred.
- Wrenching method is given as an alternate.

The correct tension is equal to the weight of the enclosing tube plus 10%. Weights per unit length for each tube size are given in this table. Multiply by the total length of the tube to determine the total weight.

Table 4: Tube weight

Tube diameter in inches (millimeters)	Weight in pounds (kilograms) per foot of length
1.25 (31.75)	2.99 (1.36)
1.50 (38.10)	3.63 (1.65)
2.00 (50.80)	5.02 (2.28)
2.50 (63.50)	7.66 (3.47)
3.00 (76.20)	10.25 (4.65)

Tube diameter in inches (millimeters)	Weight in pounds (kilograms) per foot of length
3.50 (88.90)	12.50 (5.67)
4.00 (101.60)	14.98 (6.80)
5.00 (127.00)	20.78 (9.43)
6.00 (152.40)	28.57 (12.96)

Tension the enclosing tube using the direct pull method

This method requires the use of a dynamometer scale and an adapter fitting to grip the tube. A tube tension adapter is available through the factory.

1. Use a hoist to pull the upper end of the tube in order to obtain the predetermined tension value.
2. With the tension plate installed manually but not tightened, thread the special fitting onto the top of the tube to full engagement.
3. Attach the dynamometer scale to the fitting, and connect the upper end of the scale to the hoist hook.
4. Operate the hoist hook to apply the required tension.
   This pulls the tension plate off the discharge head.
5. Manually thread the tension plate in order to reset it.
6. Release the tension from the hoist.
7. Remove the dynamometer scale and special fitting.

Tension the enclosing tube using the wrenching method

If a dynamometer scale is not available, you can tension the tube by wrenching the tube-tension plate.

1. Make up a spanner wrench to straddle the projecting threaded tube end and engage the tube-tension plate capscrew holes by two lugs.
2. Torque the tension plate to take all the slack out of the shaft tubing and induce a reasonable amount of tension by turning the tension plate counterclockwise.
   For tubing 2.50 in. (63.50 mm) and larger, a man's full strength on a 3 ft. (0.9 m) lever arm is sufficient. For smaller sizes, you must utilize less pull.

   Do not turn the tension plate clockwise to align the holes in the tension plate and discharge head.

Install the tension nut

CAUTION:
Be sure that the top of the enclosing tube does not interfere with the tension nut.

1. Install the capscrews in the tension plate.
2. Pour one pint of oil down the oil tube.
3. Install the packing in the tension plate.
4. Thread the tension nut and tighten it firmly against the packing.
5. Perform these steps if a packed-type tension nut is used for water flush:
   a) Install the packing and packing gland.
   b) Secure the packing and the packing gland with a stud and nut and finger tighten.
   c) Install the line assembly and connect it to the flush liquid supply.
6. If the top of the tube interferes with the tension nut, determine the distance:

If the tube is...	Then...
Too short	Replace the tube with a longer tube of the correct length.
Too long	Cut the tube to the correct length and re-thread it.

7. Reinstall and re-level the pump.

Install a solid-shaft driver

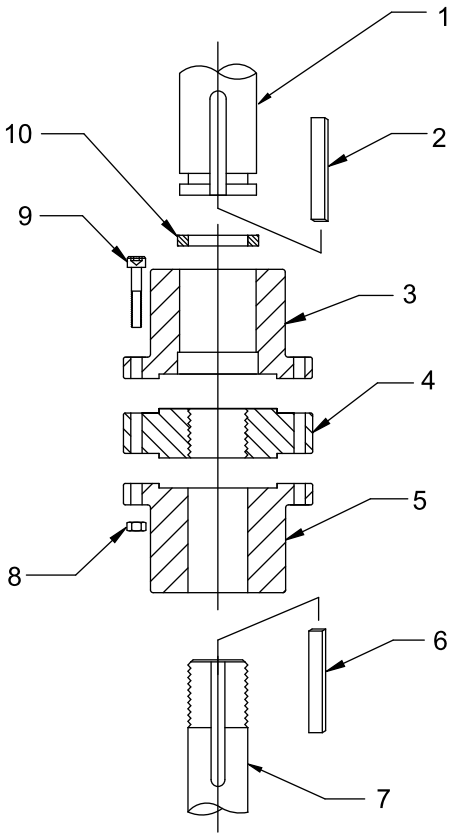
WARNING:

- ⟨Ex⟩ When installing in a potentially explosive environment, ensure that the motor is properly certified.
- Do not test the motor for direction of rotation when it is coupled to the pump. If the pump rotates in the wrong direction, serious damage to the pump, motor, and personnel will result.
- Do not work under a heavy and suspended object unless there is a positive support and safeguards that will protect you if a hoist or sling fails.

NOTICE:

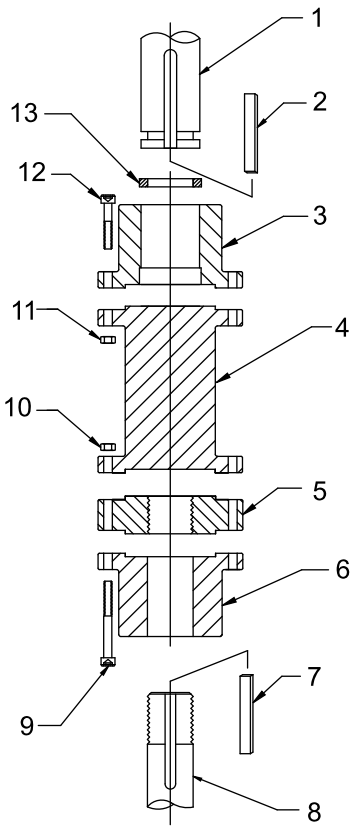
- When the pump is supplied with a thrust pot, do not secure the driver to the discharge head until after the thrust pot and flexible coupling are installed. A separate supplement for thrust pots will be furnished as required.
- Read and follow the motor manufacturer's instructions before lubricating the motor bearings. Excessive lubrication can cause the bearings to overheat and fail prematurely.

The coupling between the driveshaft and the discharge-head shaft can either be a non-spacer type or a spacer type. The spacer type is used on pumps furnished with a mechanical seal to permit servicing of the seal without the removal of the driver.



1. Driveshaft
2. Driver key, supplied by motor vendor
3. Driver hub
4. Adjusting plate
5. Pump hub
6. Pump key
7. Headshaft
8. Hex nut
9. Capscrew
10. Split ring

Figure 13: Non-spacer type coupling



1. Driveshaft
2. Driver key, supplied by motor vendor
3. Driver hub
4. Spacer
5. Adjusting plate
6. Pump hub
7. Pump key
8. Headshaft
9. Capscrew
10. Hex nut
11. Hex nut
12. Capscrew
13. Split ring

Figure 14: Spacer-type coupling

1. If a driver support is furnished and not installed, perform these steps:
   a) Hoist the driver support and inspect the mounting surfaces and register.
   b) Clean these surfaces thoroughly.
   c) Install the driver support on the discharge head and secure it with capscrews.
2. Attach a sling to the lifting lugs of the driver and hoist the motor.
3. Inspect the mounting surface, register, and shaft extension, and then clean these surfaces thoroughly.
   If any burrs are found, remove them with a smooth mill file.
4. Orient the motor-conduit box in the required position:
   a) Align the motor-mounting holes with the mating-tapped holes on the discharge head.
   b) Lower the motor until the registers engage and the motor rests on the discharge head.
   c) Secure the motor with capscrews.
5. On drivers with a non-reverse ratchet or pins, manually turn the driver shaft clockwise when viewed from the top, until the non-reverse ratchet or pins fully engage.

6. Lubricate the motor bearings according to the instructions on the lubrication plate attached to the motor frame.
7. Make temporary electrical connections according to the tagged leads or the diagram attached to the motor.
   The motor must rotate counterclockwise when viewed from the top. See the arrow on the pump nameplate. If the motor does not rotate counterclockwise, change the rotation by interchanging any two leads (for three phase only). For single-phase motors, see the instructions from the motor manufacturer.

If motor shaft-end-play adjustment is required, check it using a dial indicator before you connect the pump coupling to the solid-shaft motor. Consult the applicable motor manufacturer instruction manual for detailed information on motor shaft end play.

Install the coupling hub

1. Apply a thin film of oil on the pump key and insert the key into the headshaft keyway seat.
2. Gently lower the pump half of the coupling hub onto the headshaft.
3. Thread the adjusting plate onto the headshaft until it is flush with the top of the headshaft.
4. Apply a thin film of oil to the driver key and insert the key into the drive-shaft keyway seat.
5. Place the driver half of the coupling hub onto the drive shaft with the key and slide it up the drive shaft until the annular groove is exposed.
6. Install the split ring in the groove and slide the driver half of the coupling hub down over the split ring to capture it.
7. If the pump is supplied with an adjustable spacer coupling, install the spacer between the headshaft and the drive shaft hubs.
8. Secure with capscrews and hex nuts.

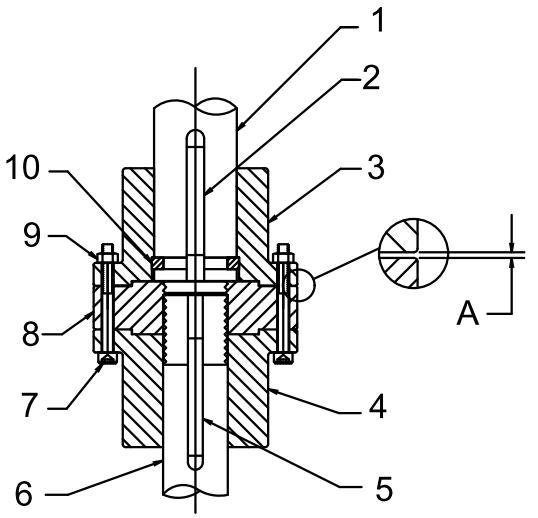
Impeller adjustment

NOTICE:

- 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.
- For pumps that handle liquids between -45°C to 93°C | -50°F to 200°F, you can make impeller adjustments under ambient conditions. For liquids in excess of this range, make any impeller adjustments after the pump reaches the temperature of the liquid. In situations where this is not feasible due to safety considerations, or impossible due to external ice buildup in cryogenic applications, refer to the factory for specific instructions.
- Improper impeller adjustment can cause contact between the rotating and stationary parts. This results in sparks and heat generation.

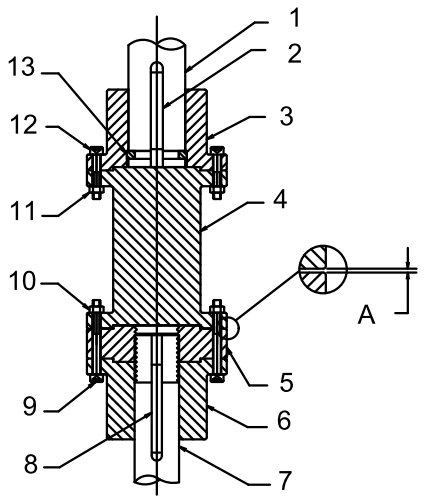
Example figures

Impeller adjustment is identical for all drivers. Adjust the impeller by turning the adjusting plate. At location A in these two figures, measure the impeller adjustment before you tighten the coupling capscrews:



1. Driveshaft
2. Driver key, supplied by the motor vendor
3. Driver hub
4. Pump hub
5. Pump key
6. Headshaft
7. Capscrew
8. Adjusting plate
9. Hex nut
10. Split ring

Figure 15: Adjustable coupling (Type A)



1. Driveshaft
2. Driver key, supplied by motor vendor
3. Driver hub
4. Spacer
5. Adjusting plate
6. Pump hub
7. Headshaft
8. Pump key
9. Capscrew
10. Hex nut
11. Hex nut
12. Capscrew
13. Split ring

Figure 16: Spacer coupling (Type AS)

Adjust the impeller for a solid-shaft driver

IMPORTANT: The determination of the driver-shaft end-play can be critical and should be added to the impeller setting noted in this topic. For larger pumps over 8.00 in. (20.32 cm), this amount might not be sufficient. Refer to the pump outline drawing for details.

When impellers are reset, you must also reset the seal.

1. Complete these steps based on your impeller type:

If your impeller is an...	Then...
Open impeller	1. With the impellers touching the bottom of the bowls, turn the adjusting plate towards the driver hub or spacer to obtain a 0.015 in. (0.381 mm) clearance between the adjusting plate and driver hub or spacer for the first 10 ft. (3 m) of column. 2. Add 0.010 in. (0.254 mm) for each additional 10 ft. (3 m) of column. For example, if the total pump length is 50 ft. (15 m), set the open impellers at 0.055 in. (1.397 mm). 3. Align the adjusting plate with the pump hub, and tightly draw the coupling flanges together with capscrews and nuts. 4. Set the seal: 1. Securely tighten all setscrews in the collar. 2. Remove the spacer between the gland plate and the collar. 3. Retain the spacer for future resetting of the seal.

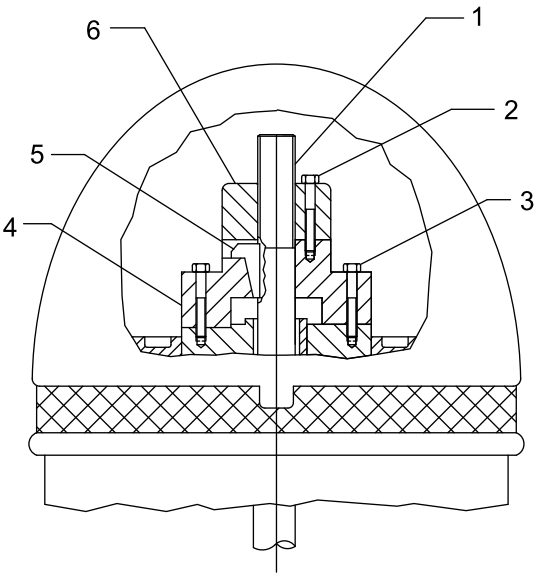
If your impeller is an...	Then...
Enclosed impeller	1. Obtain the impeller setting from the Certified Pump Outline Drawing. 2. Align the adjusting plate with the pump hub, and tightly draw the coupling flanges together with capscrews and nuts. 3. Set the seal: 1. Securely tighten all setscrews in the collar. 2. Remove the spacer between the gland plate and the collar. 3. Retain the spacer for future resetting of the seal.

Install a hollow-shaft driver

WARNING:
Do not work under a heavy and suspended object unless there is a positive support and safeguards that will protect you if a hoist or sling fails.

IMPORTANT: When a pump is supplied with a thrust pot, do not secure the driver to the discharge head until after the thrust pot and flexible coupling are installed.

This figure shows the driving mechanism of all hollow-shaft drives. The drive shaft extends up through the quill or hollow shaft of the motor (or gear drive) and is held in place by an adjusting nut. This adjusting nut carries all the static and hydraulic thrust of the impellers and shaft, and also provides the adjustment for the impeller clearances:



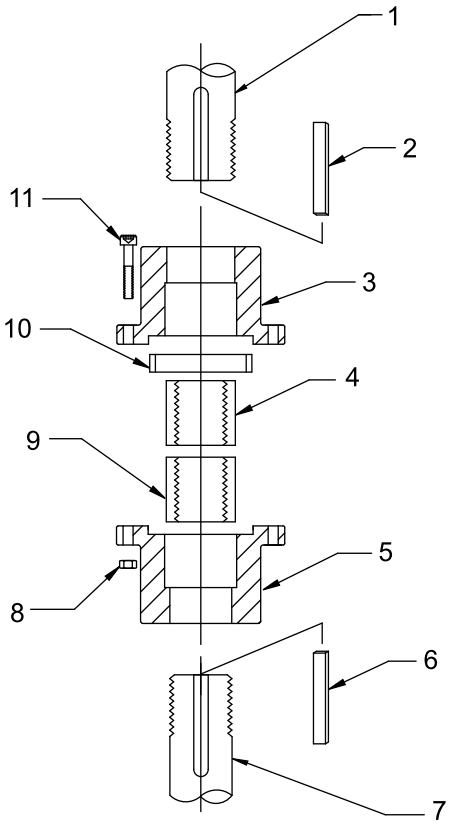
1. Drive shaft
2. Capscrew adjusting nut
3. Hold-down bolt
4. Drive coupling
5. Gib key
6. Adjusting nut

This procedure refers to either a VHS-type electric motor or hollow-shaft type gear drive.

1. If a driver support is furnished and not installed, perform these steps:
   a) Hoist the driver support and inspect the mounting surfaces and register.
   b) Clean these surfaces thoroughly.
   c) Install the driver support on the discharge head and secure it with capscrews.
2. Inspect the driver:
   a) Attach a sling to the lifting lugs of the driver and hoist the motor.
   b) Inspect the mounting surface, register, and shaft extension.
   c) Clean these surfaces thoroughly.

   d) If any burrs are found, remove these burrs with a smooth mill file and then thoroughly clean the driver.
3. Orient the motor-conduit box in the required position:
   a) Align the motor-mounting holes with the mating-tapped holes on the discharge head.
   b) Lower the motor until the registers engage and the motor rests on the discharge head.
   c) Secure the motor with capscrews.
4. On drivers with a non-reverse ratchet or pins, manually turn the driver shaft clockwise when viewed from the top, until the non-reverse ratchet or pins fully engage.
5. Lubricate the motor bearings according to the instructions on the lubrication plate attached to the motor case.
6. Remove the drive coupling and hold-down bolts.
7. Screw the adjusting nut loosely onto the end of the drive shaft.
8. Clean the drive shaft thoroughly and attach a light line below the nut.
9. Lower the drive shaft through the motor-quill shaft and examine closely for dirt or burrs between the shaft ends.
10. Raise the drive shaft and adjusting nut assembly to allow room to install the rigid-flanged coupling.

Assemble the type AR rigid-flanged coupling



1. Drive shaft
2. Driver key
3. Drive hub
4. Threaded ring
5. Pump hub
6. Pump key
7. Headshaft
8. Hex nut
9. Threaded ring
10. Alignment ring
11. Capscrew

1. Disassemble the coupling:
   a) Check that all components are clean and no foreign matter is lodged in any of the machined recesses or registers.
   b) Insert the driver key into the drive shaft keyway and slide the driver hub onto the drive shaft.
   c) Position the hub so that the threaded shaft end is exposed enough to allow for the mounting of threaded sleeves on the shaft end.
   In order to ease the assembly, you can temporarily secure the hub in this position using tape or a rope.
   d) Screw the threaded ring onto the driver shaft until the ring extends beyond the shaft end between 0.06 in. and 0.09 in. (1.52 mm and 2.29 mm).
   This ensures that the driver and pumpshaft ends will not contact each other when the coupling is completely assembled.
2. Insert the pump key into the pumpshaft keyway and slide the pump hub onto the pumpshaft.
   Position the hub so that the threaded shaft end is exposed.

3. Screw the threaded ring onto the pumpshaft until the ring extends beyond the shaft end between 0.06 in. and 0.09 in. (1.52 mm and 2.29 mm).
4. Slide the pump hub towards the threaded ring until the threaded ring is fully seated in its register in the hub.
   Hold the hub in this position.
5. Insert the alignment ring into the register in the pump hub.
6. Slide the driver hub towards the pump hub until the driveshaft threaded ring is fully seated in the register in the driver hub.
7. Insert all the coupling hub capscrews and hex nuts and hand-tighten only.
8. Measure the gap between the coupling hub faces.
   In a properly assembled coupling, the gap is between 0.014 in. and 0.026 in. (0.35 mm and 0.66 mm). This ensures that the threaded rings are properly clamped.
   If the gap is not correct:
   a) Disassemble the coupling.
   b) Check that all parts are clean and free of foreign matter.
   c) Reassemble the coupling.
      The alignment ring will be compressed between the coupling hubs.
9. Tighten all coupling hub capscrews.

Complete the hollow-shaft driver installation

CAUTION:
Never check the motor rotation with the drive coupling in place. The bore clearance between the drive coupling and the pump shaft OD is close enough that if the motor spins while this shaft is stationary, then galling and locking together is likely to occur.

1. Remove the sling and see if the drive shaft centers inside the driver quill within 0.010 in. (0.25 mm).
   If it does not, this indicates misalignment. Perform these steps:
   a) Check to see if you have a bent drive shaft, burrs, or foreign matter between the shaft ends or any of the mounting flanges:
      - Driver-to-driver support
      - Driver support to discharge head
      - Discharge head to sub-base or foundation
   b) Check to see if the sub-base and discharge head are level.
      If it is not, shim between the sub-base and the discharge head in order to correct the problem.
   c) Check the concentricity of the motor-to-motor stand to discharge head.
2. Connect the electricity and check that the motor rotation is counterclockwise when viewed from the top.
   See the arrow on the pump nameplate. If the motor does not rotate counterclockwise and you have a three-phase motor, change the rotation by interchanging any two leads. For single-phase motors, refer to the instructions from the motor manufacturer.
3. Install the motor-drive coupling:
   a) Insert ratchet pins if you are using a non-reverse ratchet.
   b) Match the coupling lugs with the corresponding holes in the motor.
   c) Pull down the hold-down bolts evenly.
   d) Make sure that the drive coupling is properly seated in the register fit.
4. Fit the gib key into the keyway so that there is a snug, but sliding, fit.
   Make sure that you can remove the key with gentle leverage using a screwdriver.
5. Make sure that the gib key is not so high that it prevents the adjusting nut from seating on the drive coupling.
6. Install the adjusting nut and hand-tighten.

Adjust the impeller for a hollow-shaft driver

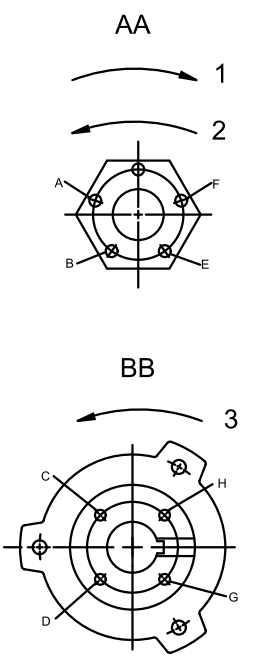
NOTICE:

- If your hollow-shaft driver has a mechanical seal, you must disengage it prior to impeller adjustment.
- Improper impeller adjustment can cause contact between the rotating and stationary parts. This results in sparks and heat generation.

This procedure applies to the open and enclosed impeller:

1. Make sure that the shafting is all the way down and that the impellers are resting on their seats.
2. Turn the adjusting nut in a counterclockwise direction in order to lift the shaft until the impellers just clear their seats and the shaft turns freely by hand.
   This removes all deflection from the shaft.
3. Align hole A in the adjusting nut and hole C in the motor coupling.
   If you are careful, you can reach an initial impeller clearance between 0.001 in. to 0.003 in. (0.02 mm to 0.07 mm) depending on the shaft size and thread data shown in this table:

Shaft size	Thread	Vertical movement in 1/20th turns - adjusting nut
¾ in. (19 mm)	¾-16 LH	0.003 in. (0.076 mm)
1 in. (25 mm)	1-12 LH	0.004 in. (0.10 mm)
1 3/16 in. (30 mm)	1-12 LH	0.005 in. (0.12 mm)
1½ in. (38 mm)	1-10 LH	0.005 in. (0.12 mm)
1 11/16 in. (42 mm)	1-10 LH	0.005 in. (0.12 mm)
1 15/16 in. (49 mm)	1-10 LH	0.005 in. (0.12 mm)
2 3/16 in. (55 mm)	1-10 LH	0.005 in. (0.12 mm)
2 7/16 in. (62 mm)	1-10 LH	0.005 in. (0.12 mm)
2 11/16 in. (68 mm)	1-8 LH	0.006 in. (0.15 mm)



1. Lower impeller
2. Raise impeller
3. Correct impeller rotation

4. Insert a capscrew into hole B provided that these are the nearest-matching holes for counterclockwise rotation of the adjusting nut.
5. Turn the adjusting nut counterclockwise until holes B and D line up.

Table 5: Normal impeller clearances

Impeller type	Distance/size	Clearance
Open	First 10 ft (3 m) of column	0.015 in. (0.381 mm)
	Each additional 10 ft (3 m) of column	0.010 in. (0.254 mm)
Enclosed	Bowl sizes up to 8 in. (20.32 cm)	0.12 in. (3.05 mm)
	Bowls larger than 8 in. (20.32 cm)	0.1875 in. (4.750 mm)

Set up the lubrication system

1. Connect the solenoid valve, if provided, and the oil lines.
2. Fill the oil reservoir with oil.
3. Check the lubricator feed and make sure that the oil reservoir is flowing freely.
   In the case of a solenoid valve, temporary power connections are required.
4. Set the proper drops per minute on the regulator as this table shows:
   The shaft is the headshaft (OD). The adjustment is a manual adjustment on the regulator valve.

Shaft size in inches	Shaft size in millimeters	Drops per minute per 100 feet (30.48 meters) of shaft
0.75 to 1.00	19 to 25 mm	8
1.19 to 1.94	30 to 50 mm	16
2.19 and larger	55 mm and larger	20

Installation and startup checklist

Use this checklist in conjunction with the standard instruction manual furnished with the equipment. Initial each completed item or write N/A if the item is not applicable. After you complete this checklist, forward a copy to the VPD field service for entry into the quality assurance records. Use a separate checklist for each individual pump.

Part 1: System and installation inspections

Check	Checked
Check that the pump foundation is level to within 0.005 in. per ft. (0.0123 cm per m) of diameter. For API units, the level requirement is 0.001 in. per ft. (0.003 cm per m) of diameter.	
Check that the foundation can handle the weight and loading of the pump.	
Check that the foundation is properly grouted using a high quality non-shrink grout.	
Check that all the anchor bolts are tight.	
Check that the suction and discharge piping is properly supported and that there is no excess nozzle loading on the discharge flange.	
On units with flexible or expansion joints attached to the pump suction or discharge, check that tie rods are in place and properly installed.	
Check that the suction valve is fully open.	
Check these items for all valves: • Operate freely • Properly installed for the direction of flow • Have the proper pressure	
Check where the pumped fluid is going and that the system is properly lined up for the test.	
Check that the pumped fluid supply will be continuously available for the duration of the test. It is very important that the initial run is at least ten minutes in duration in order to completely flush the pump.	
If possible, check the cleanliness of the pumped fluid and piping. If you are present during the installation, check that the sump, barrel, and piping are clean.	

Part 2: Pump assembly pre-start inspections

Check	Checked
Verify that the drivers are properly lubricated before start-up. On drives with grease-lubricated motor bearings, insist that the motor vendor grease them on-site. Lubrication information is located on special motor tags or in the motor manuals.	
Determine the allowable number of cold/hot starts with the motor vendor. The general rule of thumb is two cold or one hot start per hour. Exceeding the recommended starts breaks down the motor insulation and can cause failure. Megger the motor if possible.	
Before you couple the driver to the pump, verify the proper rotation of the driver by bumping it. The proper rotation for vertical pumps is counterclockwise when viewed from above. Run the pump uncoupled in order to check that the driver runs smooth and sounds normal. • For VHS motors, remove the driveshaft if a coupling is provided. If a coupling is not provided, then remove the steady bushing and driver coupling. • On drivers with NRRs. remove the rachet pins, if possible. Otherwise, rotate the drive coupling clockwise until the pin stops tight against the rachet plate. If a customer refuses to allow you to check the rotation, have the customer sign and date this checklist before you proceed.	
After you verify the proper rotation of the driver, you can couple the pump to the driver. • On VSS units with a flanged coupling except for the AR type, set the impeller lift. • On VHS units, set the impeller lift using the adjusting nut on top of the motor after you make up the threaded or AR coupling. See either the pump nameplate or the outline drawing for the specific impeller lift required for an individual pump.	
Check the alignment on pumps that are equipped with jacking bolts since they require that the motor be physically aligned to the pump. Special alignment of the pump to the motor is not usually required since all components are equipped with register fits.	
Use a dial indicator in order to check that the shaft runout above the sealing element is not excessive: • Packing limit is a maximum of 0.008 in. (0.020 cm) • Mechanical seal limit is a maximum of 0.005 in. (0.0123 cm) For API, the maximum is 0.002 in. (0.005 cm)	
On units with seals, check these items: • Check that the seal rotates freely. • Check that the seal spacers are removed. • Check that the seal piping is properly installed.	
On water-lubricated, enclosed lineshaft units, check these items: • Check the water PSI and flow rate. • Check the solenoid valve and its connection for proper operation.	
On oil-lubricated, enclosed lineshaft units, check these items: • Check that the oil tank is completely full and allow the oil to drip overnight prior to start-up. • Check the solenoid valve and its connection for proper operation. • Check the oil tank and refill.	

Part 3: Unit startup

Check	Complete
After you complete all of the checks in Parts 1 and 2, conduct a start-up meeting with customer in order to discuss the actual procedures they might require during start-up and commissioning. Also, verify with the customer that their system is ready for pumped fluid.	
When the system is ready, push the start button and adjust the discharge valve in order to meet the design point, if required.	
Watch for signs of trouble. The unit must run at least ten minutes in order to flush out the pump and system.	
Verify that the unit runs smoothly with no unusual noise, vibration, or over heating.	
Run the unit for one hour in order to test the system.	

Measurements

Reading	Value
Impeller lift	
Shaft runout	
Megger	
Vibration	

Commissioning, Startup, Operation, and Shutdown

Preparation for startup

WARNING:

- Risk of serious physical injury or death. Exceeding any of the pump operating limits (e.g. - pressure, temperature, power, etc.) could result in equipment failure, such as explosion, seizure, or breach of containment. Assure that the system operating conditions are within the capabilities of the pump.
- Risk of death or serious injury. Leaking fluid can cause fire and/or burns. Ensure all openings are sealed prior to filling the pump.
- Breach of containment can cause fire, burns, and other serious injury. Failure to follow these precautions before starting the unit may lead to dangerous operating conditions, equipment failure, and breach of containment.
- Risk of breach of containment and equipment damage. Ensure the pump operates only between minimum and maximum rated flows. Operation outside of these limits can cause high vibration, mechanical seal and/or shaft failure, and/or loss of prime.
- Avoid mechanical seal failure or pump seizure by:
  - increasing speed at startup to at least 65% of rated speed within 5 seconds and
  - decreasing speed at shutdown from 65% of rated speed to 0 within 5 seconds
- DO NOT operate the pump below the minimum rated flows or with the discharge valves closed. These conditions can create an explosive hazard due to vaporization of pumped fluid and can quickly lead to pump failure and physical injury.
- 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.
- Starting the pump in reverse rotation can result in the contact of metal parts, heat generation, and breach of containment. Ensure correct driver settings prior to starting any pump.
- Risk of seizure, breach of containment, or explosion. Ensure balance line is installed and piped back to either the pump suction or suction vessel. This prevents rapid vaporization of the pumped fluid.

Precautions

NOTICE:

- Verify the driver settings before you start any pump.
- Excessive warm-up rates can cause equipment damage. Ensure the warm-up rate does not exceed 1.4°C | 2.5°F per minute.

You must follow these precautions before you start the pump:

- Flush and clean the system thoroughly to remove dirt or debris in the pipe system in order to prevent premature failure at initial startup.
- Bring variable-speed drivers to the rated speed as quickly as possible.

- Run a new or rebuilt pump at a speed that provides enough flow to flush and cool the close-running surfaces of the stuffing-box or seal-housing bearing.
- If temperatures of the pumped fluid will exceed 93°C | 200°F, then warm up the pump prior to operation. Circulate a small amount of fluid through the pump until the casing temperature is within 38°C | 100°F of the fluid temperature. Accomplish this by flowing fluid from pump inlet to discharge drain (optionally, the casing vent can be included in warm-up circuit but not required). Soak for (2) hours at process fluid temperature.
- Rubber bearings must be wet prior to startup if the non-submerged (dry column) length is greater than 15 m | 50 ft. You can only use clean water or clean sea water.

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

Prepare for startup

WARNING:

- For the VSS motor, do not check the motor rotation unless the motor is bolted to the pump and the driver hub is disconnected from the pump hub.
- For a VHS motor, do not check the motor rotation unless the motor is bolted to the pump and the drive coupling is removed.
- Do not test the motor for direction of rotation when it is coupled to the pump. If the pump rotates in the wrong direction, serious damage to the pump, motor, and personnel will result.

Consult the applicable manufacturer instructions for detailed information for the prime mover (electric motor, engine, or steam turbine), coupling, drive shaft, gear-head, or mechanical seal.

1. Confirm that you have completed these procedures:
   a) Connected the driver to a power supply.
   b) Verified that the driver rotates counterclockwise when viewed from above.
   c) Checked the alignment between the pump and driver.
   d) Adjusted the impeller.
   e) Attached the mechanical-seal lock collar to the shaft.
2. Verify that the mechanical seal is properly lubricated and that all piping to the seal is connected.
3. Verify that all cooling, heating, and flushing lines are operating and regulated.
4. Verify that all connections to the driver and starting device match the wiring diagram.
5. Verify that the voltage, phase, and frequency on the motor nameplate agree with the line current.
6. Rotate the shaft manually to make sure that the impellers are not binding.
7. Verify that the driver bearings are properly lubricated and check the oil level in the housing.
8. Verify that the auxiliary seal components are properly vented.
9. Inspect the discharge-piping connection and pressure gauges for proper operation.
10. For the enclosed lineshaft construction, turn on the oil drip or water flush for a minimum of five minutes.
11. For oil-lubricated lineshafts, set the sight feed dripper for the number of drops per minute as directed in this table:

Lineshaft size (OD)	Drops per minute per 100 ft. (39 m) of shaft
¾ to 1 in. (19 mm to 25 mm)	8
1 $^{3}/_{16}$ to 1 $^{15}/_{16}$ in. (30 mm to 49 mm)	16
2 $^{3}/_{16}$ in. and larger (55 mm and larger)	20

Pump priming

CAUTION:

- The pump must be properly vented through the discharge head connections. This is important for liquids with suction pressures close to their vapor pressures. Vent piping must continuously rise back to the source so that liquid cannot collect in the vent line.
- 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.

NOTICE:

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

Requirements

- The pump must always be flooded with the suction valve fully open.
- Never run the pump dry as this can cause the rotating parts within the pump to gall and seize to the stationary parts.
- The parts are lubricated by the liquid being pumped unless the enclosed linshaft option is purchased to lubricate the lineshaft bearings with a clean fluid.

Start the pump

WARNING:

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

NOTICE:

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

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

- Open any recirculation or cooling lines.

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

b) If the pump exceeds normal levels, then shut down the pump immediately and correct the problem.
A pump can exceed normal levels for several reasons. See Troubleshooting for information about possible solutions to this problem.

7. Repeat steps 5 and 6 until the pump runs properly.

Pump operation precautions

General considerations

NOTICE:

- Vary the capacity with the regulating valve in the discharge line. Never throttle the flow from the suction side. This action can result in decreased performance, unexpected heat generation, and equipment damage.
- Risk of equipment damage from unexpected heat generation. Do not overload the driver. Ensure that the pump operating conditions are suitable for the driver. The driver can overload in these circumstances:
  - The specific gravity or viscosity of the fluid is greater than expected
  - The pumped fluid exceeds the rated flow rate.
- Make sure to operate the pump at or near the rated conditions. Failure to do so can result in pump damage from cavitation or recirculation.

Operation at reduced capacity

WARNING:

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

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

Operation under freezing conditions

NOTICE:
Do not expose an idle pump to freezing conditions. Drain all liquid that is inside the pump and any auxiliary equipment. Failure to do so can cause liquid to freeze and damage the pump.

Mechanical seal leaks

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

Occasional leaks

If the seal leaks slightly at start-up, allow a reasonable amount of time for the seal to adjust itself. Fluids with good lubricating qualities normally take longer to adjust than fluids with lesser lubricating qualities. When a seal starts out with a slight leak and the leak decreases while running, it indicates leaks across the seal faces. Run the pump continuously in order to eliminate this issue.

Continuous leaks

When immediate leaks occur and remain constant, even during operation, it usually indicates either secondary seal (shaft packing) damage, or seal faces that are warped or cracked. See Troubleshooting for probable causes.

Stuffing box leaks

CAUTION:
Packed stuffing boxes are not allowed in an ATEX-classified environment.

Normal leaks

With the pump in operation, there should be some leaking at the stuffing box packing. The correct leak rate is a rate which keeps the shaft and stuffing box cool. This rate is approximately one drop per second. Check the temperature of the leaked fluid as well as the discharge head.

Decreased leaks

If the pump runs hot and the leaks begin to decrease, stop the pump and allow it to cool down. Loosen the packing gland in order to allow the packing to resume leaking. After the pump has cooled, restart the pump and run it for 15 minutes. Then check the leaks. If the leaks exceed two drops per second, adjust the packing.

Shut down the pump

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

1. Slowly close the discharge valve.
2. Shut down and lock out the driver to prevent accidental rotation.
3. If the driver is not equipped with a non-reverse ratchet (NRR), be certain that the unit is completely stopped before you restart the pump.

Lubricate the thrust pot during a shutdown period

1. Completely immerse the bearings in oil.

This helps to avoid oxidation of the anti-friction bearings during shutdown periods lasting longer than one week.

2. Fill the oil reservoir until the oil runs over the oil retainer tube and down the shaft.

Before startup, drain the oil to its required level.

Maintenance

Maintenance schedule

Maintenance inspections

A maintenance schedule includes these types of inspections:

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

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

Routine maintenance

Perform these tasks whenever you perform routine maintenance:

- Lubricate the bearings on pumps supplied with thrust pots.
- Inspect the packing or mechanical seal.

Routine inspections

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

- Check the level and condition of the oil through the sight glass on the bearing frame.
- Check for unusual noise, vibration, and bearing temperatures.
- Check the pump and piping for leaks.
- Analyze the vibration.

Three-month inspections

Perform these tasks every three months:

- Check that the foundation and the hold-down bolts are tight.
- Check the packing if the pump has been left idle, and replace as required.
- Change the oil filter assembly (item 550A) every 2000 hours.
  - Change the more often if there are adverse atmospheric or other conditions that might contaminate or break down the .

Annual inspections

Perform these inspections one time each year:

- Check the pump capacity.
- Check the pump pressure.
- Check the pump power.

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

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

Adjust and replace the packing

CAUTION:
Do not over-tighten the stuffing box. Excessive pressure can wear out packing prematurely and seriously damage the shaft.

NOTICE:
Ⓔx Packed stuffing boxes are not allowed in an ATEX-classified environment.

Adjust the packing when one of the following conditions occurs:

- The leakage rate exceeds two drops per second.
- There is overheating or no leakage.

Adjust the packing when leaking is excessive

Perform this procedure if leaks exceed two drops per second.

1. With the pump in operation, tighten the gland nuts one-quarter turn.
2. Before you make any more adjustments, check to see if the packing has equalized against the increased pressure by making sure the leaks have decreased to a steady state.If the leaks decrease to two drops per second, then you are finished. If the leaks continue to exceed two drops per second, continue to the next step.
3. Shut down the pump.
4. Allow the packing to compress enough so that the gland is about to contact the upper face of the stuffing box.
5. Remove the split gland, add one extra packing ring, and readjust.
6. If this fails to reduce the leak to two drops per second, then remove all packing rings and replace them with new rings:
   a) Remove the packing with the aid of a packing hook.
   b) If a lantern ring is provided, remove it by inserting a wire hook in the slots of the ring and pull it from the stuffing box.
   c) Thoroughly clean the stuffing box of all foreign matter.
7. If the replacement packing is in the form of a continuous coil or rope, cut it into rings before installing:
   a) Tightly wrap one end of the packing material around the top shaft like one coil spring.
   b) Cut through the coil with a sharp knife.

   See Installation for details about how to properly reinstall the stuffing box.

Adjust the packing when there is overheating or no leaks

CAUTION:
If there are no leaks or the stuffing box overheats, do not back off the gland nuts while the pump is running. This causes the entire set of packing rings to move away from the bottom of the box without relieving pressure of the packing on the shaft.

A small amount of leaking is required in order to prevent overheating.

1. Stop the pump and allow the packing to cool.
2. Restart the pump.
3. Repeat these steps until two drops of liquid per second comes through.
4. If this fails to fix the problem, then you must replace the packing.

Thrust pot lubrication guidelines

Flushing the oil reservoir

Flush the oil reservoir in order to remove all grit particles in the oil reservoir sump. Use the same type of oil to flush the reservoir as specified for lubrication. Always keep a supply of turbine oil on-hand.

NOTICE:
Pumps are shipped without oil. Oil-lubricated anti-friction bearings must be lubricated at the job site.

Oil levels

Pump status	Oil level
Not operating	At or lower than 1/8 in. to 1/4 in. (0.635 to 0.3175 mm) from the top of the oil sight gauge. Never operate the pump when the oil in the sight gauge is not at the required level.
Operating	Lower than the required level as indicated on the oil sight gauge.

Changing the oil

The frequency with which you change the oil depends on the severity of the environment. When the oil in the sight gauge is a dark brown color, it is time for an oil change. However, for a longer bearing life, it is recommended that you change the oil every six months. Be sure to flush the oil reservoir with each oil change.

Disassembly

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.
- Risk of severe physical injury or death from explosion of trapped liquid. Never use heat to remove parts unless explicitly stated in this manual.

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

Disassemble the head and column

WARNING:
Never try to lift the entire pump assembly by the lifting lugs or eyebolts furnished for the driver only. Always lift the pump with shackles through the lifting lugs or with eyebolts inserted through the flanges.

1. If equipped with mechanical seals, loosen the setscrews that fasten the seal to the pump shaft so that the pump shaft can slide up or down within the seal.
2. Remove the necessary components:

If the pump is...	Then remove...
Gear-driven	The driveshaft between the gear and the prime mover.
Electric-motor driven	The electrical connections at the conduit box and label the electrical leads so they can be reassembled correctly.

3. Uncouple the driver, or gear box, from the pump shaft and mounting flanges, and then lift off by the lifting lugs or eyebolts as furnished.
4. Disconnect the discharge head from the discharge piping.
5. Remove all hold-down bolts and integral piping.
6. Remove the coupling, packing box, or mechanical seal.
7. Continue with disassembly down to the bowls as described in the next section.

Bowl disassembly

The bowl assembly is composed of these parts:

- Suction bell
- Intermediate bowls
- Top bowl
- Impellers and securing hardware
- Bearings
- Pump shaft

Turbine bowl impellers are secured to the shaft by either a taper collet or a key and split-thrust ring. Follow only the procedures that apply to your particular construction. These types of impeller attachments can apply to any vertical pump less than 18 in. (46 cm) in diameter.

NOTICE:
Mark the components in sequence in order to aid the reassembly.

Disassemble the taper collet bowl

1. Remove the capscrews that secure the top bowl to the intermediate bowl.
2. Slide the top bowl off the pump shaft.
3. Pull the shaft out as far as possible and strike the impeller hub using a collet driver or equivalent, sliding along the pump shaft to drive the impeller off the taper collet.
4. After the impeller is freed, insert a screwdriver into the slot in the taper collet, spread it, and remove the taper collet.
5. Slide the impeller off the pump shaft.
6. Repeat these steps until the bowl assembly is completely disassembled.

Disassemble the keyed bowl

1. Remove the capscrews that secure the top bowl to the intermediate bowl.

2. Slide the top bowl off the pump shaft.
3. Remove the capscrews and the split-thrust ring from the pump shaft.
4. Slide the impeller off the pump shaft and remove the key.

NOTICE:
If the impeller is seized to the shaft, then strike the impeller with a fiber mallet and drive the impeller off the pump shaft.

5. Repeat these steps until the bowl assembly is completely disassembled.

Remove the turbine bowl and impeller wear rings

1. Remove the setscrews or grind off the tack weld if the rings are furnished with those locking methods.
2. Use a diamond-point chisel in order to cut two V-shaped grooves on the bowl or impeller wear ring approximately 180° apart.
   Use extreme care not to damage the wear ring seat.
3. With a chisel or drift punch, knock the end of one half of the ring in, and pry the ring out.
4. On high-alloy materials such as chrome steel, set up the bowl or the impeller in a lathe and machine the wear ring off, using extreme care not to machine or damage the ring seat.

Remove the bowl, suction bell, and lineshaft bearings

NOTICE:
Bowl bearings are press fit. Do not remove the bowl bearings unless replacement is necessary.

1. Press the bearing out of bearing housing or bowl.
   Use an arbor press and a piece of pipe or sleeve with an outside diameter that is slightly smaller than the diameter of the bowl or lineshaft bearing housing bore.
2. Remove the suction bell bearing by setting the suction bell in a lathe and machining the bearing off.
   The suction bell bearing can also be removed using bearing pullers to pull the bearings out.

Pre-assembly inspections

Guidelines

Before you assemble the pump parts, make sure you follow these guidelines:

- Inspect the pump parts according to the information in these pre-assembly topics before you reassemble your pump. Replace any part that does not meet the required criteria.
- Make sure that the parts are clean. Clean the pump parts in solvent in order to remove oil, grease, and dirt.

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

Replacement guidelines

Casing check and replacement

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

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

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

Casing areas to inspect

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

Impeller replacement

This table shows the criteria for replacing the impeller:

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

Gaskets, O-rings, and seats replacement

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

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

Bearing retainer check

Check the bearing retainer for deformation and wear.

Shaft checks

- Check the shafts for straightness and excessive wear on the bearing surfaces.
- Check the deflection of shafts. The average total runout should not exceed 0.25 mm | 0.010 in. TIR for every 3 m | 10 ft. of shaft length.

Mechanical seal checks

On pumps equipped with a mechanical seal, check that the shaft or sleeve is free of pits, burrs, or sharp edges in order to prevent cutting or improper sealing of the seal O-rings. Remove any burrs and sharp edges by polishing with a fine emery cloth.

Impeller and bowl checks

Visually check impellers and bowls for cracks and pitting. Check all bowl bearings for excessive wear and corrosion.

Reassembly

Install the turbine bowl and impeller wear ring

1. Place the chamfered face of the bowl or impeller wear ring towards the ring seat and press the ring into the seat.
2. Use an arbor press or equivalent and make sure the ring is flush with the edge or the wear ring seat.

Install the bowl, suction bell, and lineshaft bearings

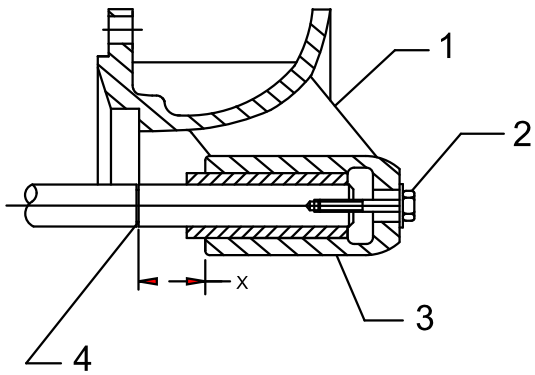
Make sure you have an arbor press or equivalent for pressing the bearings.

1. Press the bearing into the retainer.
2. Press the bearing into the suction bell.
   The top of the bearing should protrude above the suction hub equal to the depth of the counter bore in the sand collar.
3. Press the bearings into the intermediate bowl and the top bowl.
4. Place the bowl with the flange downward and press the bearing through the chamfered side of the bowl hub until the bearing is flush with the hub.

Install the taper collet bowl assembly

WARNING:
Wear protective gloves and use the appropriate eye protection in order to prevent injury when you handle hot parts.

1. Apply a thin film of turbine oil to all mating and threaded parts.
2. If the pump is equipped with a sand collar, then perform these steps:
   a) If the sand collar is not assembled to the shaft, then heat the sand collar until it slips over the shaft and quickly position it so that the top of the sand collar is even with the locating groove before it cools.
   The sand collar is attached to the shaft with a shrink fit. The shaft is machined with a 0.01 in. (0.25 mm) groove to locate the sand collar. The large diameter of the counterbore of the sand collar goes toward the suction bell bearing.
   b) Slide the end of the pump shaft with the sand collar into the suction bell bearing until the sand collar rests against the suction bell.
   c) Skip the next step and proceed to installing the impellers.
3. If the pump is not equipped with a sand collar, then locate the pump shaft with respect to the suction bell:
   a) Insert the pump shaft into the suction bell bearing until it bottoms out.
   b) Pull the shaft out until the distance between the groove on the shaft and the top of the suction bell hub, and not the top of the bearing, is correct for the particular pump.
   Use the X dimension in the Pump shaft dimensions table in the Maintenance chapter.

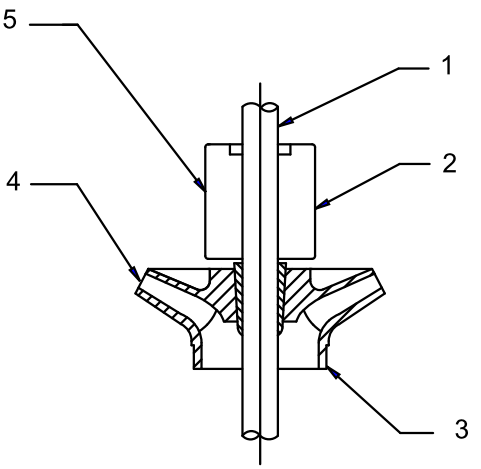


1. Suction bell
2. Capscrew screwed into the tapped hole in the shaft with washers, as required
3. Suction bell hub
4. 0.01 in. (0.25 mm groove)

   c) Hold the shaft in this position by inserting a capscrew with a washer into the hole in the end of the suction bell and then into the threaded hole in the end of the shaft.
4. Install the impeller:
   a) Slide the first impeller over the shaft until it seats on the suction bell.

b) Insert a screwdriver into the slot in the taper collet, spread the slot, and slide the collet over the pump shaft.
c) Hold the impeller against the bowl and slide the collet into the impeller hub.

5. Hold the shaft with a capscrew and washer against the suction bell and drive the taper collet into place with a collet driver.



1. Shaft
2. Collet
3. Impeller
4. Location to hold impeller against the bowl and drive collet into impeller hub
5. Collet driver assembly position

6. After the collet is in place, recheck the X dimension.
7. Slide the intermediate bowl onto the shaft and secure it with the capscrews provided.
8. Repeat this procedure for the number of stages required.
9. Remove the capscrew and washer and perform these checks:
   - Check that the shaft rotates freely without dragging or binding.
   - Check that there is adequate lateral end play.

Install the keyed bowl assembly

1. Install the key into the keyway of the pump shaft, slide the impeller over the shaft, and position the impeller on the key.
2. Install a split-thrust ring on the pump shaft groove and secure it to the impeller with capscrews.
3. Slide an intermediate bowl over the pump shaft and secure it to the suction bell with capscrews.
4. Repeat these steps for the number of stages required.

Pump shaft setup dimensions

The size of the pump is stated on the nameplate and on the Certified Pump Outline Drawing.

Pump size	X dimension (inches)	X dimension (millimeters)
4D	1.31	33.27
6A	1.37	34.80
6D	1.37	34.80
6J	1.37	34.80
7A	1.37	34.80
8A	1.37	34.80
8D	1.37	34.80

Pump size	X dimension (inches)	X dimension (millimeters)
8J	1.37	34.80
9A	1.37	34.80
10A	1.75	44.45
10D	1.75	44.45
10J	1.75	44.45
10L	2.12	53.85
11A	2.12	53.85
12D	2.25	57.15
12J	2.12	53.85
14D	2.75	69.85
14H	2.75	69.85
14J	2.75	69.85
16D - Bell	1.75	44.45
16D - Bowl	2.75	69.85
18H	2.75	69.85
20H	0.87	22.10
28T	4.50	114.30
36T	6.25	158.75

Troubleshooting

Operation troubleshooting

Symptom	Cause	Remedy
Pump does not start.	The electrical circuit is open or not complete.	Check the circuit and make any necessary corrections.
	The impellers are binding against the bowls.	Reset the impeller adjustment. See Installation for details.
	The electric driver is not receiving enough voltage.	Make sure that the driver is wired correctly and receiving full voltage.
	The motor is defective.	Consult an ITT representative.
The pump is not delivering liquid.	The bowl assembly is not submerged enough.	Adjust the liquid level in the sump as necessary.
	The suction strainer is clogged.	Remove the obstructions.
	There is an obstruction in the liquid passage.	Pull the pump and inspect the impeller and bowl.
	The discharge head is not properly vented.	Open the vent.
The pump is not producing the rated flow or head.	The impellers are not rotating fast enough.	Make sure that the driver is wired correctly and receiving full voltage.
	The impellers are rotating the wrong direction.	Make sure the impellers are spinning counterclockwise when viewed from above. Check the engagement of the motor coupling.
	The total pump head is too high.	Check the pipe friction losses. Use larger discharge piping.
	The liquid passages are partially obstructed.	Inspect the impellers and bowls and remove any obstructions.
	There is cavitation.	Insufficient NPSH. Check for and remove any obstructions in pump suction inlet.
	The impellers are too high (semi-open construction only).	Reset the impeller adjustment. See Installation for details.
There is not enough pressure.	The impellers are not rotating fast enough.	Make sure that the turbine is receiving full steam pressure.
	The liquid passage is obstructed.	Inspect the impellers and bowls and remove any obstructions.
	The impellers are rotating in the wrong direction.	Make sure the impellers are spinning counterclockwise when viewed from above. Check the engagement of the motor coupling.
	The impellers are too high (semi-open construction only).	Reset the impeller adjustment. See Installation for details.
The pump starts and then stops pumping.	Excessive power is required.	Use a larger driver. Consult an ITT representative.
	The pump is pumping a higher viscosity or different specific gravity liquid than it was designed to handle.	Test the liquid for viscosity and specific gravity. Consult an ITT representative.
	Critical parts have experienced mechanical failure.	Check the bearings, wear rings, and impellers for damage. Any irregularities in these parts will cause a drag on the shaft. Replace any damaged parts as necessary.
	The impellers are rotating too fast.	Check the frequency on the motor.
	The pump and driver are misaligned.	Realign the pump and driver.
	The discharge head is not properly vented.	Open the vent.

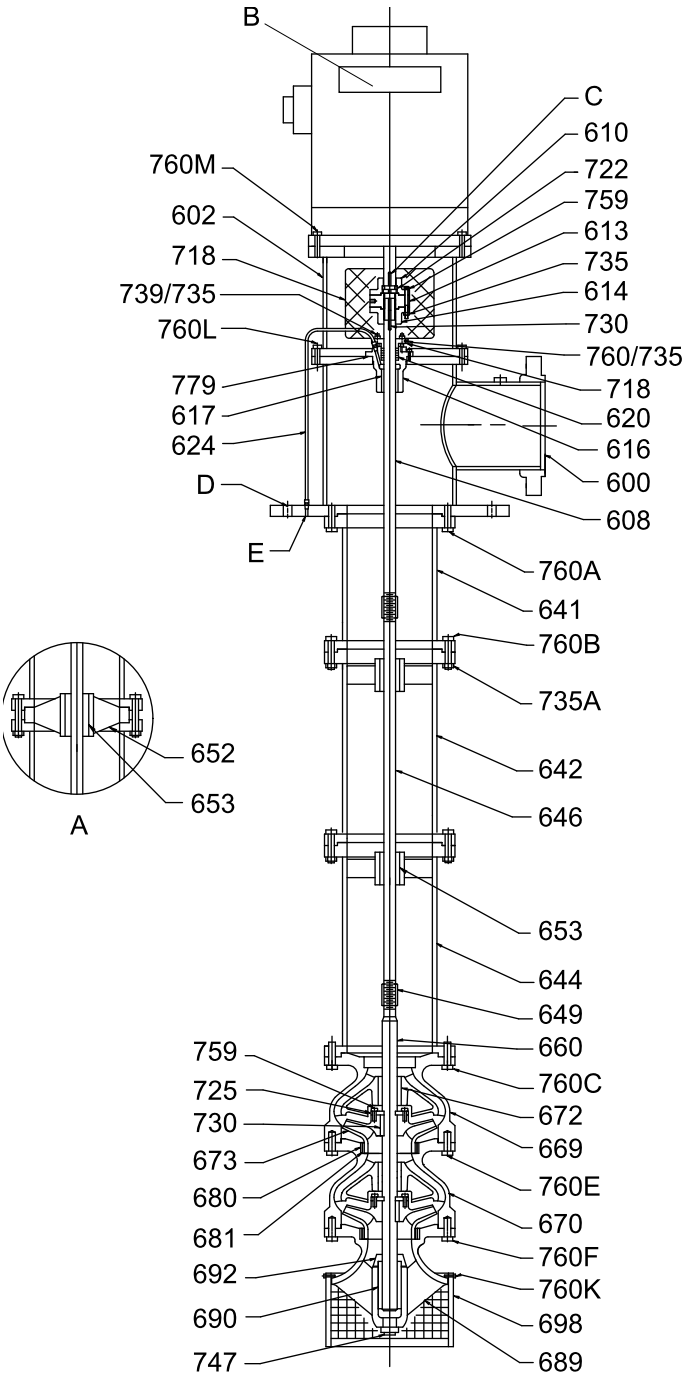
Symptom	Cause	Remedy
The pump requires excessive power.	The impellers are damaged.	Inspect the impellers for damage and replace them if necessary.
	A foreign object is lodged between the impeller and the bowl.	Remove the object.
	The liquid is heavier than expected.	Check the specific gravity and viscosity.
	The liquid viscosity is too high or the pumped fluid is partially freezing.	Check for both conditions. They can cause drag on the impeller. Consult an ITT representative.
	The bearings are defective.	Replace the bearings and check the shaft or shaft sleeve for scoring.
	The stuffing-box packing is too tight.	Release the gland pressure and retighten. Keep the leaking fluid flowing. If there are no leaks, then check the packing, sleeve, or shaft. See Maintenance for details.
The pump is noisy.	The pump is cavitating.	Increase the liquid level in the sump.
	The shaft is bent.	Straighten as necessary.
	Rotating parts are binding, loose, or broken.	Replace parts as necessary.
	The bearings are worn.	Replace the bearings.
	The discharge head is not properly vented.	Open the vent.
The pump is vibrating excessively.	One of these conditions might exist: • The coupling is misaligned. • The shaft is bent. • The impellers are not balanced. • The bearings are worn. • There is cavitation. • There is strain on the discharge piping. • There is resonance.	Determine the cause by using a vibration frequency analyzer or by disassembling the pump. A complex problem might require the assistance of an ITT representative.
	The driver shaft is not adjusted properly.	Readjust the driver. See Installation for details.
There is excessive leakage from the stuffing box.	The packing is defective.	Replace any packing that is worn or damaged.
	The wrong kind of packing was used.	Consult an ITT representative.
The stuffing box is overheating.	The packing is too tight.	Release the gland pressure and retighten. Keep the leakage flowing. If there is no leakage, then check the packing, sleeve, or shaft. See Maintenance for details.
	The packing is not lubricated.	Release the gland pressure and replace any packing that is burned or damaged. Regrease the packing as necessary.
	The wrong grade of packing was used.	Consult an ITT representative.
	The stuffing box was improperly packed.	Repack the stuffing box.
The packing wears out too fast.	The shaft or shaft sleeve is worn or scored.	Remachine or replace any parts as necessary.
	There is insufficient leakage across the packing.	Repack the stuffing box and make sure that the packing is loose enough to allow some leakage.
	The stuffing box was improperly packed.	Repack the stuffing box properly, making sure that all old packing is removed and the stuffing box is clean.
	The wrong grade of packing was used.	Consult an ITT representative.
The mechanical seal leaks.	The seal faces are not flat because the gland bolts are too tight. This causes the gland and insert to warp.	Remove the gland bolts and then reinstall them properly.
	The shaft packing has been chipped during installation.	Replace the packing.
	One of these conditions exists: • The carbon insert is cracked. • The insert face or seal ring was chipped during installation.	Remove the mechanical seal, inspect, and replace as necessary.
	The seal faces are scored from foreign particles between the faces.	Install a strainer, and then filter or cyclone the separator as required in order to filter out any foreign particles.

Symptom	Cause	Remedy
The seal squeals during operation.	There is an inadequate amount of liquid at the seal faces.	A bypass flush line is necessary. If a bypass line is already in use, then enlarge it in order to produce more flow.
Carbon dust is accumulating on the outside of the gland ring.	There is an inadequate amount of liquid at the seal faces.	Bypass the flush line. If a bypass line is already in use, then enlarge it to produce more flow.
	Liquid film is flashing and evaporating between the seal faces and leaving residue, which is grinding away the carbon.	Consult an ITT representative.
The seal leaks but nothing appears to be wrong.	The seal faces are not flat.	Relap or replace the seal faces.
The seal is wearing out too quickly.	This product is abrasive. This causes excessive seal face wear.	Determine the source of the abrasives and install a bypass flushing in order to prevent abrasives from accumulating in the seal area. Install a cyclone separator as necessary.
	Abrasives are forming due to the process liquid cooling and crystallizing or partially solidifying in the seal area.	Install a bypass flush line in order to hold the liquid temperature around the seal above the crystallization point.
	The seal is running too hot.	Check for possible rubbing of the seal components. Recirculation or a bypass line may be necessary.
	The wrong kind of seal was used.	Consult an ITT representative.

Parts Listings and Cross-Sectionals

VIT FF product lube

This image shows the VIT-FF with motor support (two-piece head construction):



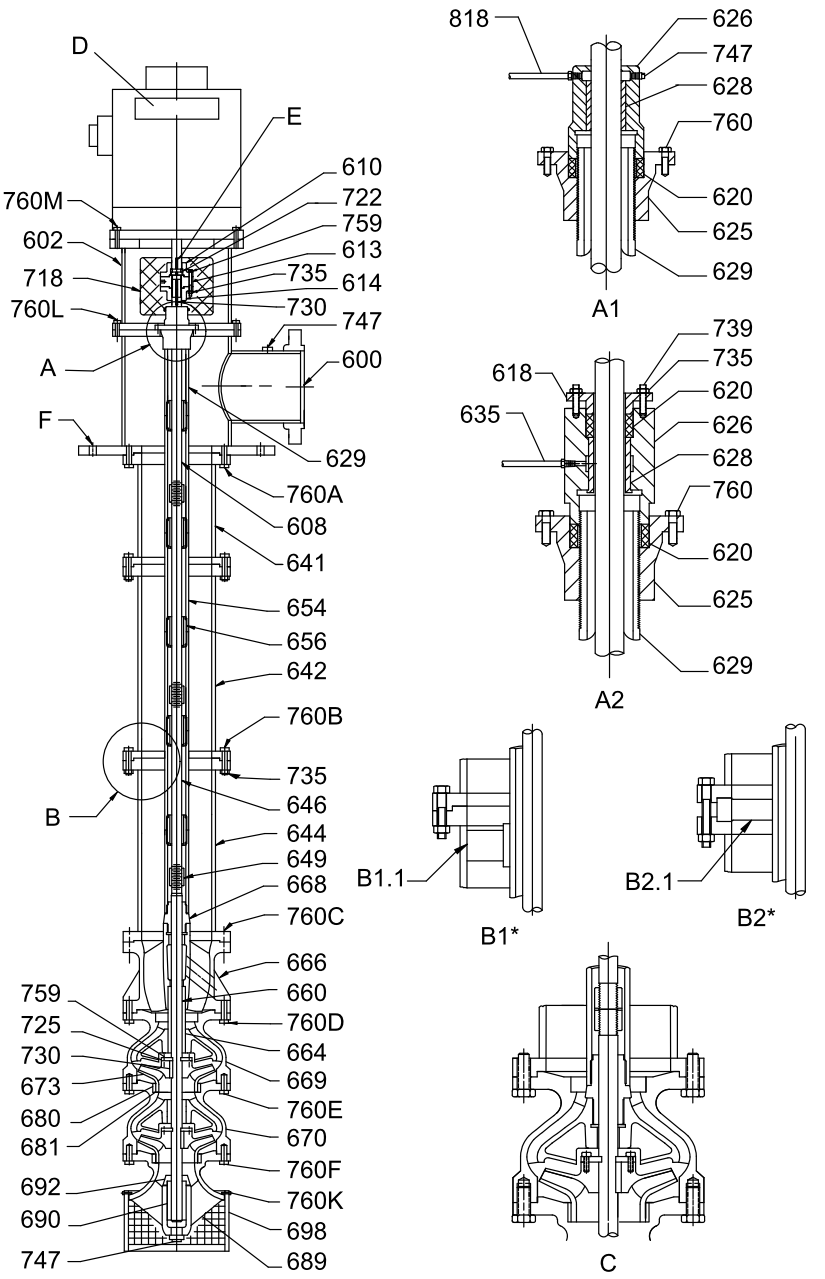
This pump has these features:

- Flanged adjustable coupling
- Standard stuffing box
- Flanged column with integral bearing retainer and lineshaft bearing
- Bowl assembly:

- Keyed impellers
- Bowl and impeller wear rings
- Strainer (basket type)

Label	Part name
A	Optional, on duplicate pumps
B	VSS motor
C	Motor key, supplied by the motor vendor
D	Mounting holes
E	Bypass, return to sump
600	Head
602	Motor support
608	Headshaft
610	Hub motor
613	Adjusting plate
614	Pump hub
616	Stuffing box
617	Bearing
620	Packing
624	Bypass line assembly, tube and fitting
641	Top column
642	Intermediate column
644	Bottom column
646	Lineshaft
649	Lineshaft coupling
652	Bearing retainer
653	Lineshaft bearing
660	Pump shaft
669	Top bowl
670	Intermediate bowl
672	Bowl bearing
673	Impeller
680	Bowl wear ring
681	Impeller wear ring
689	Suction bell
690	Suction bearing
692	Sand collar
698	Basket type strainer
718	Coupling guard
722	Retaining ring
725	Thrust ring
730	Key
735	Hex nut
739	Stud
747	Pipe plug
759	Socket head capscrew
760	Capscrew
760A	Column/head capscrew
760B	Column/column capscrew
760C	Column/bowl capscrew
760E	Bowl/bowl capscrew
760F	Bowl/bell capscrew
760K	Strainer capscrew
760L	Support head capscrew
779	Gasket

VIT FF enclosed lineshaft



Label	Part name
A	Tension plate, oil lube and water flush
A1	Tension plate – oil lubricated
A2	Tension plate – water flushed
B	Tube stabilizer
B1	Tube stabilizer
B1.1	Integral tube stabilizer (welded to column)
B2	Tube stabilizer
B2.1	Tube stabilizer (optional on duplicate pumps)

Label	Part name
C	32 in. (81 cm) and larger bowl assembly (with flush only)
D	VSS motor
E	Motor key, supplied by motor vendor
F	Mounting holes
600	Head
602	Motor support
608	Headshaft
610	Hub motor
613	Adjusting plate
614	Pump hub
618	Gland
620	Packing
625	Tension plate
626	Tension nut
628	Bearing
629	Tube nipple
635	Line assembly, water flush
641	Top column
642	Intermediate column
644	Bottom column
646	Lineshaft
649	Lineshaft coupling
654	Enclosed tube
656	Bearing tube
660	Pump shaft
664	Bearing throttle
666	Discharge bowl
668	Bearing adapter
669	Top bowl
670	Intermediate bowl
673	Impeller
680	Bowl wear ring
681	Impeller wear ring
689	Suction bell
690	Suction bearing
692	Sand collar
698	Basket type strainer
718	Coupling guard
722	Retaining ring
725	Thrust ring
730	Key
735	Hex nut
739	Stud
747	Pipe plug
759	Socket head capscrew
760	Capscrew
760A	Column/head capscrew
760B	Column/column capscrew
760C	Column/bowl capscrew
760D	Bowl/discharge bowl capscrew
760E	Bowl/bowl capscrew
760F	Bowl/bell capscrew
760K	Strainer capscrew

Label	Part name
760L	Support head capscrew
760M	Motor/support capscrew
818	Lubricator assembly
Stabilizers provided: • Every 10 ft. (3 m) up to 40 ft. (12 m) of column • Every 40 ft. (12 m) over 40 ft. (12 m) of column	

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