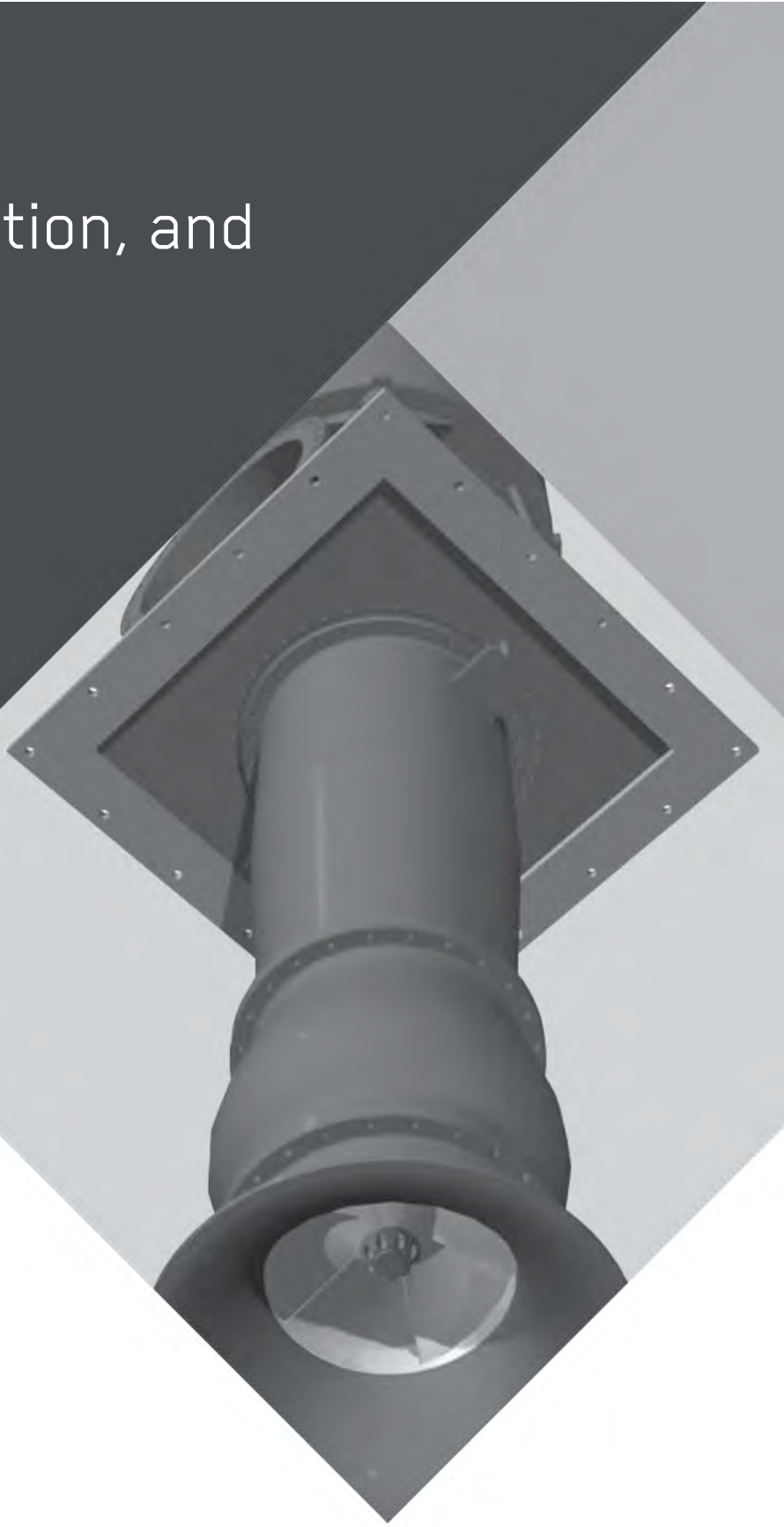
GOULDS PUMPS

Installation, Operation, and Maintenance

Model VCW



ITT

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1 Introduction and Safety

1.1 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:

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.

1.1.1 Safety terminology and symbols

About safety messages

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

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

Hazard levels

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

Hazard categories

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

Electrical hazards are indicated by the following specific symbol:

ELECTRICAL HAZARD:

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

- Crush hazard
- Cutting hazard
- Arc flash hazard

1.1.2 User health and safety

General precautions

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.

Noise

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

Temperature

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

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 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.	—

1.1.2.1 Precautions before work

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

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

1.1.2.2 Precautions during work

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

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

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

- Rinse the components in water after you disassemble the pump.

1.1.2.3 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.

1.1.2.4 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.

1.1.3 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.

Every installation has to be properly analyzed and classified by professional certified personnel that set the areas, zones and any other space to a corresponding hazardous area classification. Classification normally includes the form of the hazardous material the potential exposure, the potential level, the frequency of potential exposure. All equipment installed within such are must be certified accordingly, all activities related to such equipment have to be handled to preserve its certification and the site specification.

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.

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.

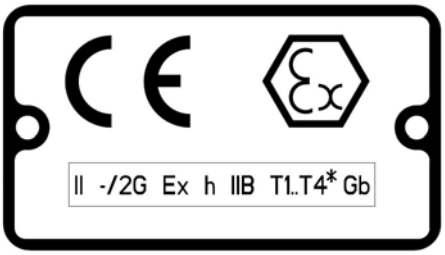

Figure 1: ATEX identification

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

1.1.4 Product warranty

Coverage

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

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

Limitations

The warranty does not cover faults caused by these situations:

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

ITT assumes no liability for these situations:

- Bodily injuries
- Material damages

- Economic losses

Warranty claim

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

2 Transportation and Storage

2.1 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.

2.2 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.

2.3 Pump handling

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

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

2.3.1 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 swivel hoist rings 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 swivel hoist rings through the component flanges.

Pump type	Lifting method
A disassembled pump	Use suitable lifting devices attached to the component lifting lugs or suitable swivel hoist rings through the component flanges.

Examples

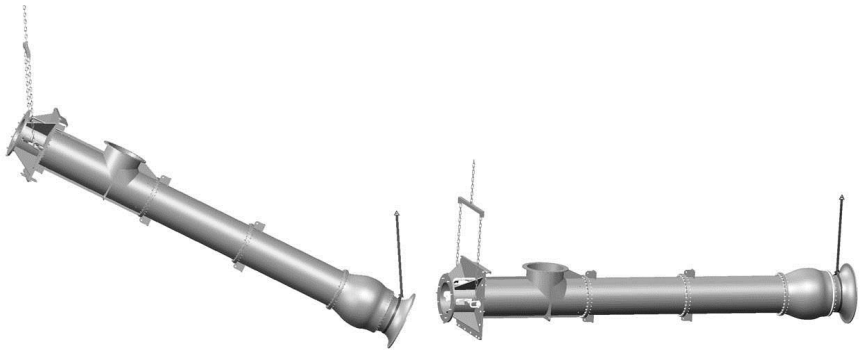

Figure 2: VCW lifted from horizontal to vertical (for pumps up to 15 feet (4.6 meters) in length))

NOTICE:
Actual number of lifting points may vary for specific pump design and installation circumstances. Refer to order-specific drawings for details.

2.4 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, gearboxes, engines, panels, sealing plans and other auxiliaries, 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. • Place moisture absorbing material in the quantity to prevent condensation • 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.

Condition	Proper preparation
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 pump shaft a half turn (180°) and bowl assembly shaft clockwise 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.

2.4.1 Prepare the pump for long-term storage

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

1. Disassemble pump to enable proper long-term storage of sub-assemblies and individual components: Discharge head sub-assembly, individual column pipes, individual shafts and couplings, and bowl sub-assembly.
2. Store bowl sub-assembly indoors in vertical orientation. Store bowl sub-assembly with its suction bell mounted on a flat and level floor with soft wood to protect suction bell material.
3. Store individual column pipes in horizontal orientation. Mount column pipes on the outside diameters of both flanges with soft wood to protect flange material.
4. Store individual shafts indoors in vertical orientation. Hang shafts from horizontal beam with fixtures connected to eye bolts threaded into ends of shafts. Do not stand shaft on floor.
5. Store discharge head sub-assembly in vertical orientation. Store discharge head sub-assembly with its mounting flange mounted on a flat and level floor with soft wood to protect the discharge head material.
6. Store loose parts and hardware from pump assembly in wooden boxes.

3 Product Description

3.1 General description

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

This pump has these capabilities:

- Capacities up to 90850 m3/h | 400,000 gpm
- Heads up to 183 m | 600 ft.
- Power up to 7,457 kW | 10,000 hp

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. Impellers are keyed to the shaft.

Column

Flanged column construction with rabbeted fits provides positive shaft and bearing alignment, and also eases assembly and disassembly. The line shaft 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 packing or seal piping and allow for easy adjustment of seals and couplings. In the case of an underground discharge, these features are part of a separate motor stand above ground.

Suction barrel (can)

The suction barrel flange, or separate mounting flange, is designed to support the weight of the pump and driver when it is full of liquid. You can install the suction barrel in a sleeve or open steel structure with thermal insulation around the suction barrel below its mounting flange.

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.

3.2 Nameplate information

Important information for ordering

Every unit has a nameplate that provides information about it.

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.

Bowl assembly

Nameplate types

Nameplate	Description
	Provides information about the hydraulic characteristics of the pump.
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

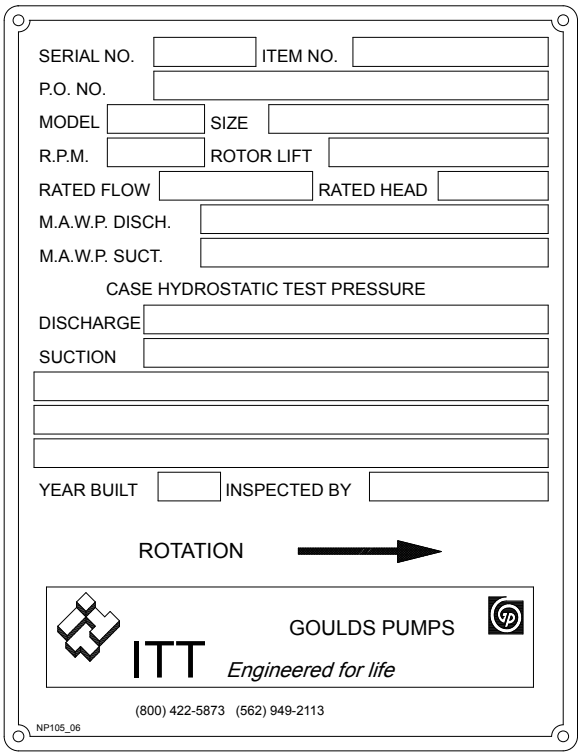

Figure 3: Discharge head nameplate

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

Nameplate field	Explanation
RATED FLOW	Rated pump flow, gpm (m^3/hr)
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	Use when gas and dust are present
T4	Temperature class

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

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

4 Installation

4.1 Pre-installation

Precautions

WARNING:

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

NOTICE:

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

4.2 Pre-installation

Precautions

WARNING:

- When installing in a potentially explosive environment, ensure that the motor is properly certified.
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NOTICE:

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

4.2.1 Inspect the 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 sub-base.
   You might need to coat the underside of the 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.

4.2.2 Concrete foundation requirements

Requirements

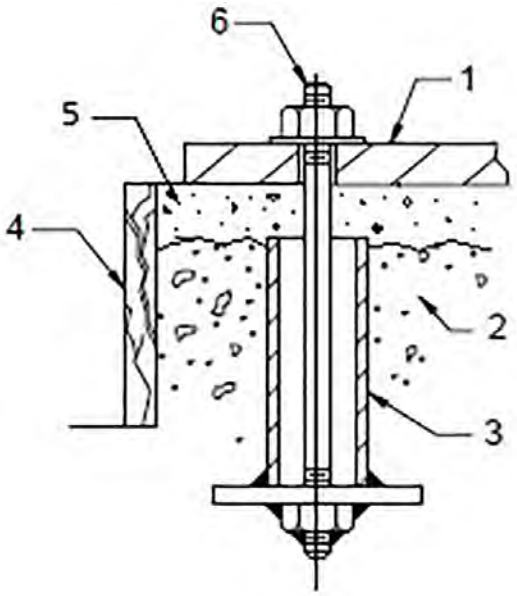
Make sure that you meet these requirements when you prepare the pump foundation:

- 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, sub-base or discharge head
2. Foundation
3. Sleeve
4. Dam
5. Grout
6. Anchor bolt

Figure 5: Example of a typical installation

4.2.2.1 Installing the sub-base on a concrete foundation

WARNING:

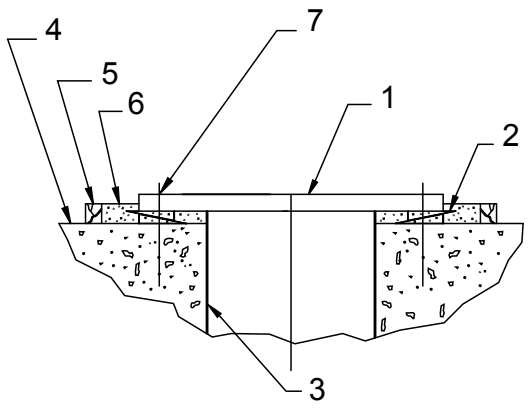
- When installing in a potentially explosive environment, ensure that the motor is properly certified.
- All equipment being installed must be properly grounded to prevent unexpected discharge. Discharge can cause equipment damage, electric shock, and result in serious injury. Test the ground lead to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

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 sub-base onto the foundation bolts and hand-tighten the bolt nuts.
4. Use a machinist's level in order to level sub-base or the machine surface of the discharge head using leveling wedges or leveling screws.

   In order to ensure an accurate reading, check that the surface being leveled is free from all contaminants, such as dust.
5. Level the sub-base in two directions at 90° on the machined surface to achieve levelness condition indicated in this table.

Table 3: Levelness tolerances

Commercial	API
0.4 mm/m | 0.005 inch/ft	0.2 mm/m | 0.002 inch/ft



1. 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

4.2.2.2 Grout the sub-base

Non-shrink grout is recommended for this procedure.

WARNING:
Follow grout manufacturers SDS sheets for recommended PPE.

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 9.520 mm | 0.375 in. between the 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.

4.2.3 Piping checklists

4.2.3.1 General piping checklist

Install the pump on a structural-steel foundation

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

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 as defined on the Certified Outline Drawing.
- 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.	• Strain on the pump • Misalignment between the pump and the drive unit	
Check that only necessary fittings are used.	This helps to minimize friction losses.	
Do not connect the piping to the pump until: • The grout for the pit cover becomes hard. • The grout for the barrel or subbase has hardened.	—	
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.	—	
Make sure that all piping components, valves and fittings, and pump branches are clean prior to assembly.		
Make sure that all piping components, valves and fittings, and pump branches are clean prior to assembly.	—	

4.2.3.2 Discharge piping checklist

Checklist

Check	Explanation/comment	Checked
Check that an isolation valve is installed in the discharge line. Minimize distance from pump discharge.	The isolation valve is required for: • Priming • Regulation of flow • Inspection and maintenance of the pump	
Check that a air-release/vacuum-break 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 air to evacuate pump assembly during starting and water to release from pump after stopping.	
If increasers are used, they must be of the eccentric type.	This prevents air from collecting at the top of the discharge pipe.	
Isolation valve opening after pump start-up and closing prior to pump shutdown are controlled to prevent system surge and water hammer.	Customer's engineer analyzes hydraulic system transients to determine valve opening timing and closing timing to protect system and pump.	

4.3 Installing a partially-assembled pump

Pumps 12 meters | 40 feet or less in length are usually shipped partially assembled, with the exception of these parts:

- Driver - for installation instructions refer to 4.10 Install a solid-shaft driver on page 34 and Installing a hollow-shaft driverThis topic describes how to install a hollow-shaft driver..
- Packing - for assembly instructions refer to 4.7 Stuffing box installation on page 27.
- Mechanical seal with piping - for assembly instructions refer to 4.8 Mechanical seal options on page 29.
- Coupling assembly, spacer or non-spacer type

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

1. If a sub-base is supplied, install it.
2. Clean the sub-base and the bottom of the discharge head base.
3. Attach suitable lifting devices to the discharge head lifting lugs or the hoist rings in the mounting flange. Make sure that the shackles, eye bolts, and sling are rated to handle in excess of the pump weight. Attach suitable lifting sling around suction bell. Lift pump assembly from horizontal position with two separate crane hooks. See the outline drawing.
4. Hoist the unit into position over the foundation.
5. Carefully guide the unit so that it does not strike the sides of the sub-base or foundation.
6. Lower the unit until the discharge-head flange engages and rests firmly on the sub-base surface, then secure it with the capscrews provided.

4.4 Installing the bowl assembly, Install unassembled pump elements

WARNING:
Avoid working under suspended loads. If necessary to do so, follow the more stringent of local, state or federal safety regulations.

CAUTION:
Refer to 2.3.1 Lifting methods on page 11.

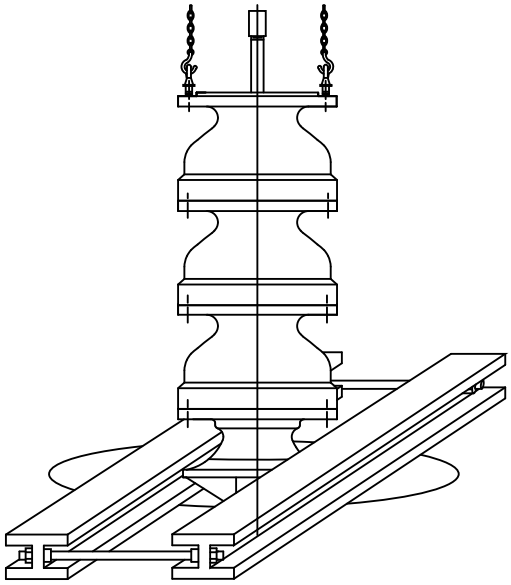
Pump may need to be assembled in a horizontal or vertical position depending on site conditions. Refer to assembly and erection drawing in appendix for specific instructions.

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.

NOTICE:

I-beams and lifting clamps can be provided by ITT upon request. If I-beams and lifting clamps are supplied by ITT the "Pump Installation Instructions (w/ Lifting Clamps)" IOM should be used.

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. Attach a sling to the bowl assembly and hoist it into position over the foundation opening.
6. 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.
7. 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.

4.5 Column installation

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

- Open lineshaft
- Enclosed lineshaft

4.5.1 Install the open lineshaft

NOTICE:
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. Before starting the shafts installation, check the headshaft and lineshaft for straightness.
   The average TIR should be less than 0.013 mm | 0.0005 in. per 0.305 m | foot and not exceed 0.127 mm | 0.005 in. for every 3 m | 10 ft.
2. Apply a thin film of oil to the lineshaft.
3. Install the coupling per 4.5.1 Install the open lineshaft on page 24.
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 swivel hoist rings 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 I-beams across sub base surface:

   a) Lift the entire assembly by the column pipe swivel hoist rings and remove the I-beam 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.

4.5.2 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.

4.5.3 Installing the column - enclosed lineshaft

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

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

1. Before starting the shafts installation, check the headshaft and lineshaft for straightness. The average TIR should be less than 0.013 mm | 0.0005 in. per 0.305 m | foot and not exceed 0.127 mm | 0.005 in. for every 3 m | 10 ft.
2. Install the coupling per 4.5.1 Install the open lineshaft on page 24.
3. If the enclosing tube is threaded, attach the threaded lifting device to a section of enclosing tube. If the enclosing tube is threaded, attached eyebolts to two holes in the flange.
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 swivel hoist rings diametrically opposite each other in the upper flange of the bottom column.

b) Attach a sling to the swivel hoist rings 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 swivel hoist rings and remove the I-beam 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 synthetic turbine oil ISO VG 32 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.

NOTICE:

Do not use automotive oils.

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

If your lineshaft coupling is...	Then...
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.

4.6 Installing the discharge head

CAUTION:

- Do not bump or scrape the shaft protruding above the column. This could result in a bent or damaged shaft, which could affect the performance of the pump.

CAUTION:

- Packed stuffing boxes are not allowed in an Ex-classified environment.
- The mechanical seal used in an Ex-classified environment must be properly certified.

NOTICE:
Make sure that all rigging devices 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 it before you begin this procedure.

For the enclosed lineshaft option, only perform steps 2 and 3 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 sub-base.
8. Secure the discharge head to the sub-base.

4.7 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.

CAUTION:

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

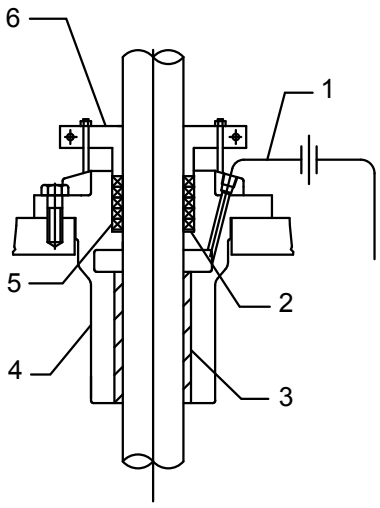
NOTICE:

Below instructions are to be used in case the stuffing box and packing are not mounted on shipped pump.

Stuffing box types

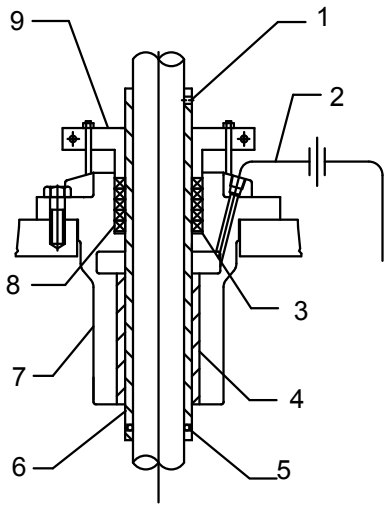
The stuffing box installation has three types:

- Type A (standard version)
- Type B (shaft sleeved version)



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

4.7.1 Installing 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 55.63 mm | 2.19 in. 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.

4.8 Mechanical seal options

Pumps are shipped without mechanical seals installed. 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

4.8.1 Assemble a single inside-mounted mechanical seal

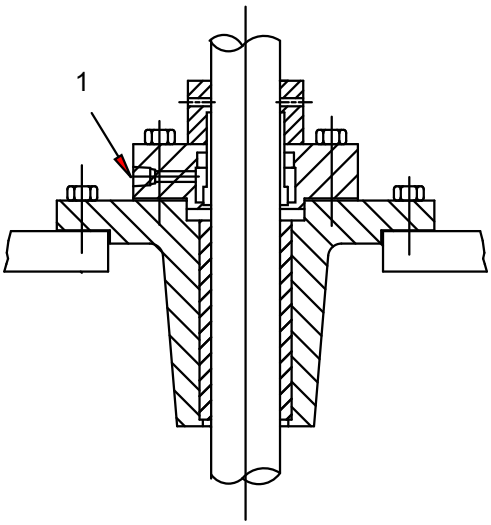
Single inside-mounted mechanical seals have these characteristics:

- 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

4.8.2 Assemble a single outside-mounted mechanical seal

These seals are provided in two sub-assemblies:

- Stationary unit
- Rotary unit

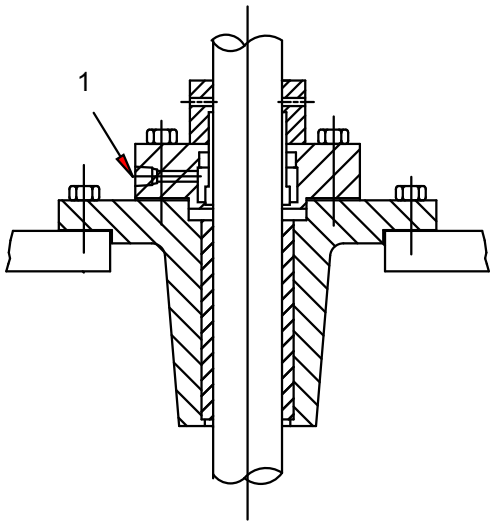
1. Install the stationary unit, which is the seal-gland assembly.
   The stationary unit will face up.
2. Install the rotary unit and take care not to disengage the rotary parts.
   Installation becomes difficult when the rotary unit parts become disengaged.

   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.

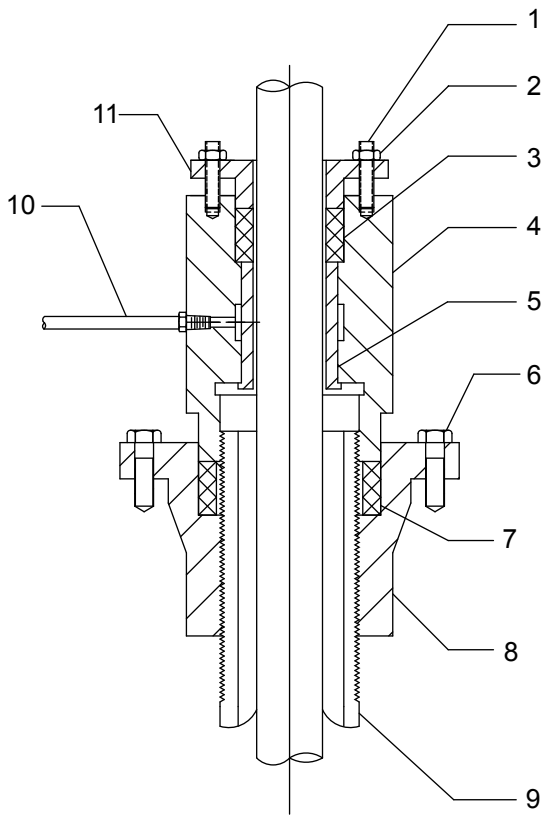
   c) Before you start the pump, make sure that the spring gap and the distance from the face of the stuffing box to the collar are the same as shown on the seal assembly drawing.



1. Bypass to suction

4.9 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 9: Tension plate - water flush

4.9.1 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 millimeters | inches	Weight in kilograms | pounds per foot of length
101.60 | 4.00	6.80 | 14.98

Tube diameter in millimeters | inches	Weight in kilograms | pounds per foot of length
127.00 | 5.00	9.43 | 20.78
152.40 | 6.00	12.96 | 28.57
177.80 | 7.00	13.32 | 35.98
203.2 | 8.00	19.68 | 43.39
228.6 | 9.00	24.43 | 53.86
254.00 | 10.00	29.18 | 64.33
279.40 | 11.00	34.66 | 76.42
304.80 | 12.00	40.15 | 88.51

4.9.1.1 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.

4.9.1.2 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.

4.9.2 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.

4.10 Install a solid-shaft driver

WARNING:
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.

WARNING:

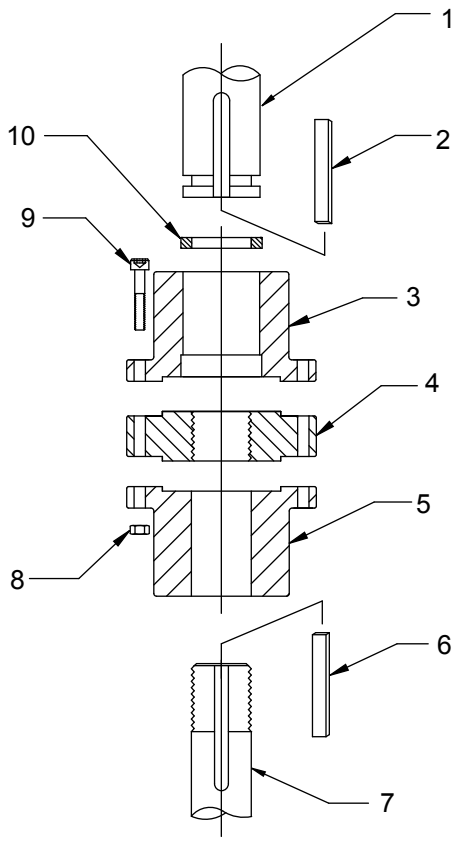
-  When installing in a potentially explosive environment, ensure that the motor is properly certified.
- Do not test the motor for direction of rotation when it is coupled to the pump. If the pump is driven in the wrong direction, serious damage to the pump, motor, and personnel could result.
- Avoid working under suspended loads. If necessary to do so, follow the more stringent of local, state or federal safety regulations.

NOTICE:

- Refer to the separate IOM supplement for thrust pots.
- Read and follow the motor manufacturer's instructions before lubricating the motor bearings. Excessive lubrication can cause the bearings to overheat and fail prematurely.

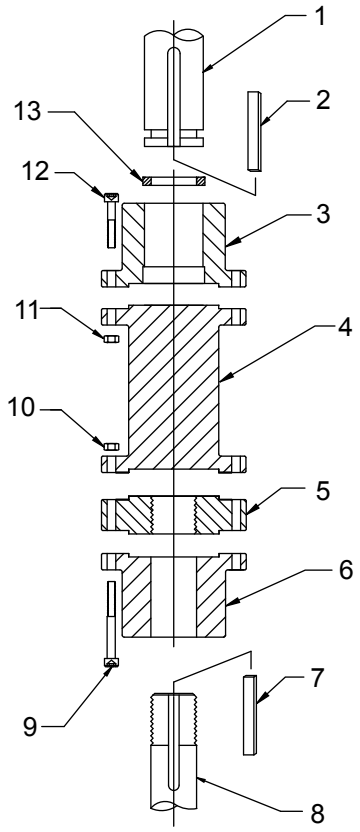
The coupling between the driveshaft and the discharge-head shaft can either be a non-spacer type or a spacer type.

The spacer type is used on pumps furnished with a mechanical seal to permit servicing of the seal without the removal of the driver.



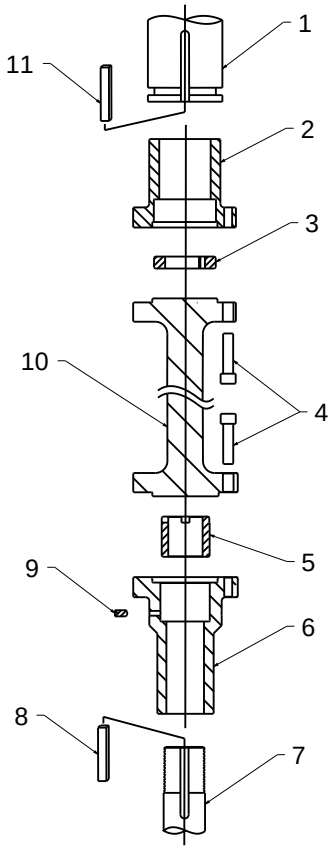
1. Driveshaft
2. Driver key, supplied by motor vendor
3. Driver hub
4. Adjusting plate
5. Pump hub
6. Pump key
7. Headshaft
8. Hex nut
9. Capscrew
10. Split ring

Figure 10: 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 11: Spacer-type coupling



1. Driveshaft
2. Driver hubs
3. Split ring
4. Capscrew
5. Adjusting nut
6. Pump hub
7. Pump rotor
8. Pump key
9. Setscrew
10. Spacer
11. Driver key

Figure 12: Spacer-type adjustable rigid 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 name-plate. 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.

4.10.1 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.

4.10.2 Impeller adjustment

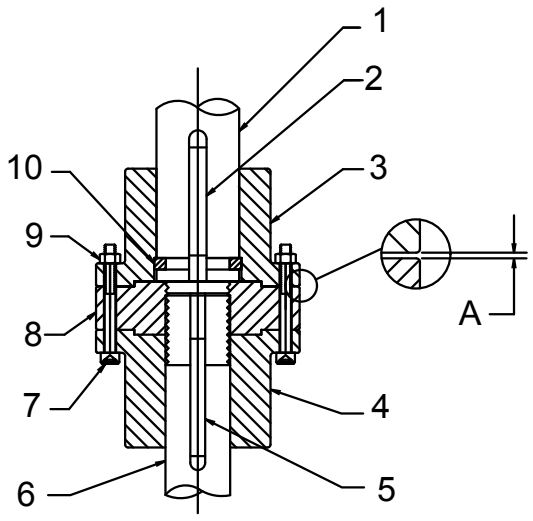
NOTICE:

- 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 may result in sparks and heat generation.

Example figures

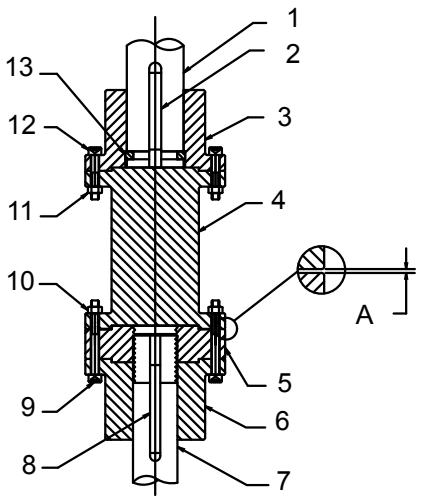
Impeller adjustment is identical for all drivers. Adjust the impeller by turning the adjusting plate.

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 13: 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 14: Spacer coupling (Type AS)

4.10.3 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 impeller resting on the bottom of the bowl assembly, turn the adjusting plate down until it reaches the bottom of the shaft thread. 2. Install the coupling bolts through the driver hub, adjusting plate, and pump hub, and hand tighten the bolts evenly. Measure and record the gap between the adjust plate and the driver hub flange faces. 3. Tighten the coupling bolting evenly in a star pattern and in small increments until the pump rotor begins to turn free. This indicates that the impeller is just lifted off from the bowl assembly. Measure and

If your impeller is an...	Then...
	record the gap between the adjust plate and the driver hub flange faces. 4. Calculate the difference between the two gaps recorded above. To this difference add the specified impeller lift value from the pump general arrangement drawing or from the pump nameplate. Record the calculated sum. 5. Loosen and remove the coupling bolting. Turn the adjusting plate until the measured gap between the flange faces of the adjusting plate and the driver hub is equal to the calculated sum above. 6. Install the coupling bolts and tighten in a star pattern to draw the flanges together. Prestress the bolts in three stages to the final torque value provided on the pump assembly drawing. 7. Set the shaft packing or the mechanical seal.
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.

4.10.4 Adjust the impeller for a hollow-shaft driver

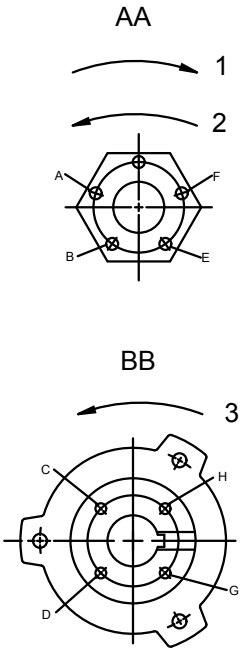
NOTICE:

- If your hollow-shaft driver has a mechanical seal, you must disengage the mechanical seal prior to impeller adjustment.
- Improper impeller adjustment can cause contact between the rotating and stationary parts. This may result 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 0.02 mm to 0.07 mm | 0.001 in. to 0.003 in. depending on the shaft size and thread data shown in this table:



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.

4.11 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 0.0123 cm per m | 0.005 in. per ft. of diameter. For API units, the level requirement is 0.003 cm per m | 0.001 in. per ft. 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	

Check	Checked
• 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.	
Check that electrical conduit and boxes aren't obstructing of the windows of the discharge head.	
Check that electrical conduit and boxes are sized to manufacturers' recommendations along with all appropriate standards and local statutes.	
Check that all control and alarm systems, which may be electrical, hydraulic, or pneumatic, are corrected installed and functioning in accordance with the manufacturer's instructions. All alarm point settings should be verified.	

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 except for the AR type. 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.	
Use a dial indicator in order to check that the shaft runout above the sealing element is not excessive: • Mechanical seal limit is a maximum of 0.13 mm | 0.005 in.	
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 and leak-free.	

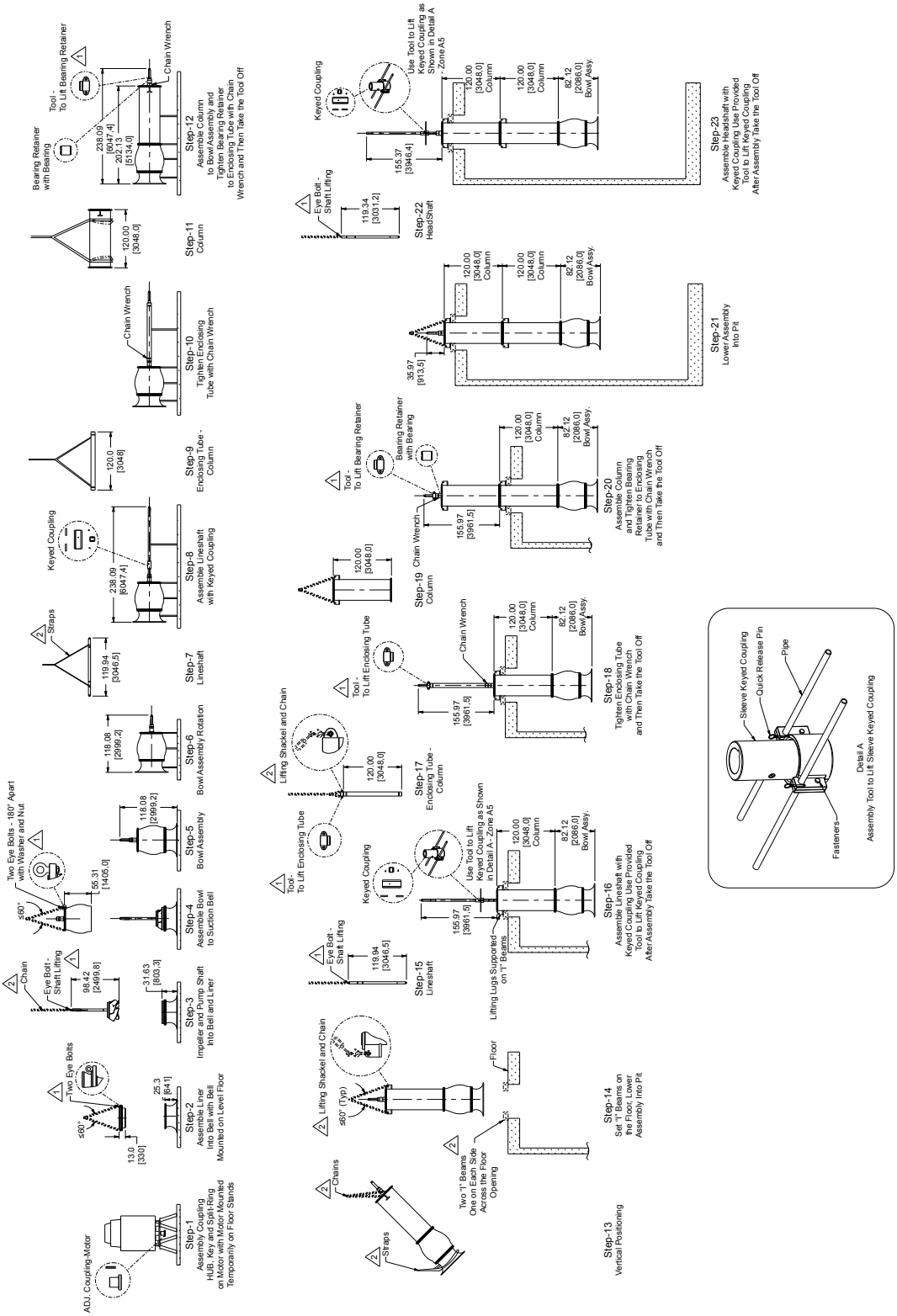
Part 3: Unit startup

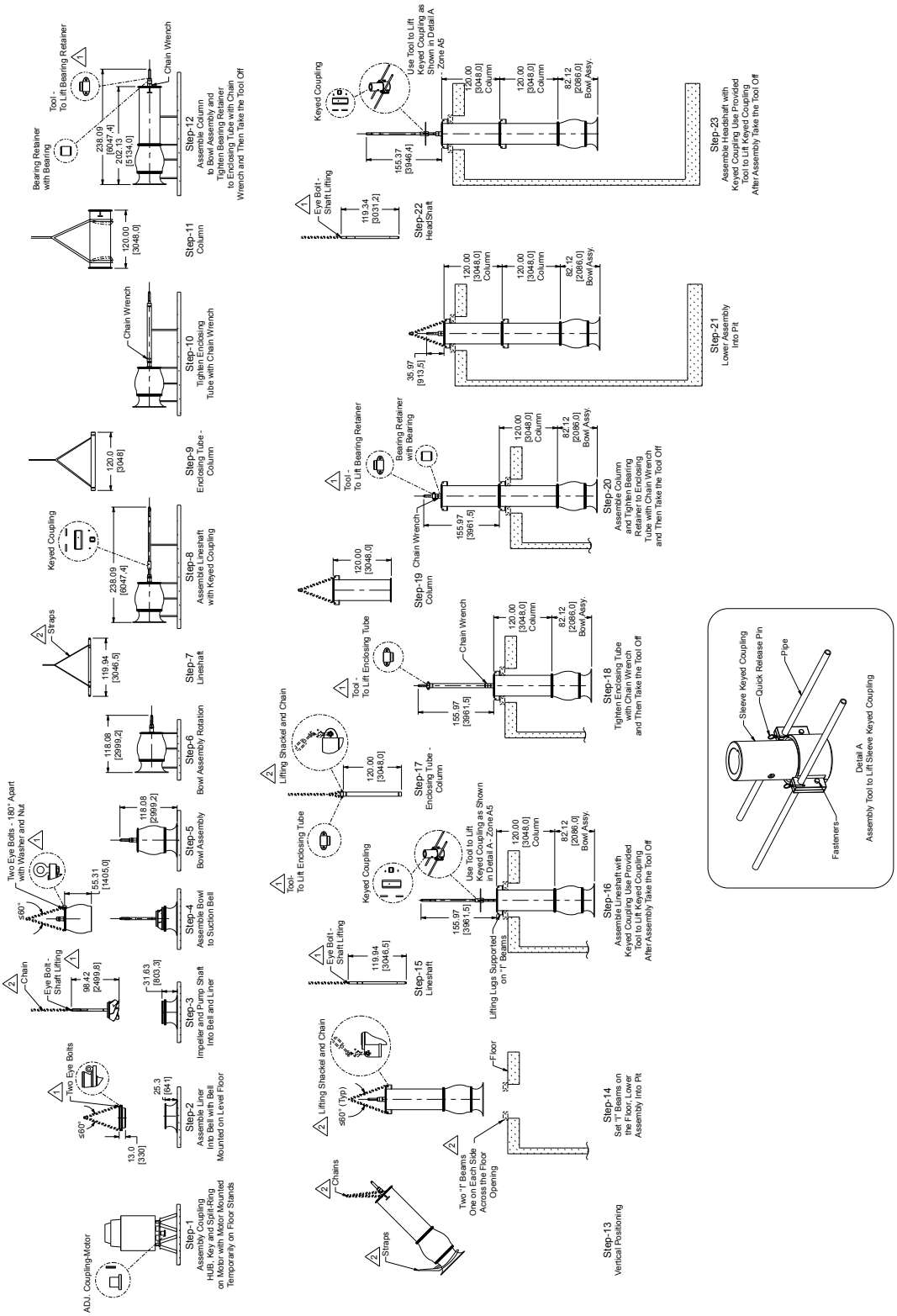
Check	Checked
After you complete all of the checks in Parts 1 and 2, conduct a start-up meeting with customer in order to discuss the actual procedures they might require during start-up and commissioning. Also, verify with the customer that their system is ready for pumped fluid.	
When the system is 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.	

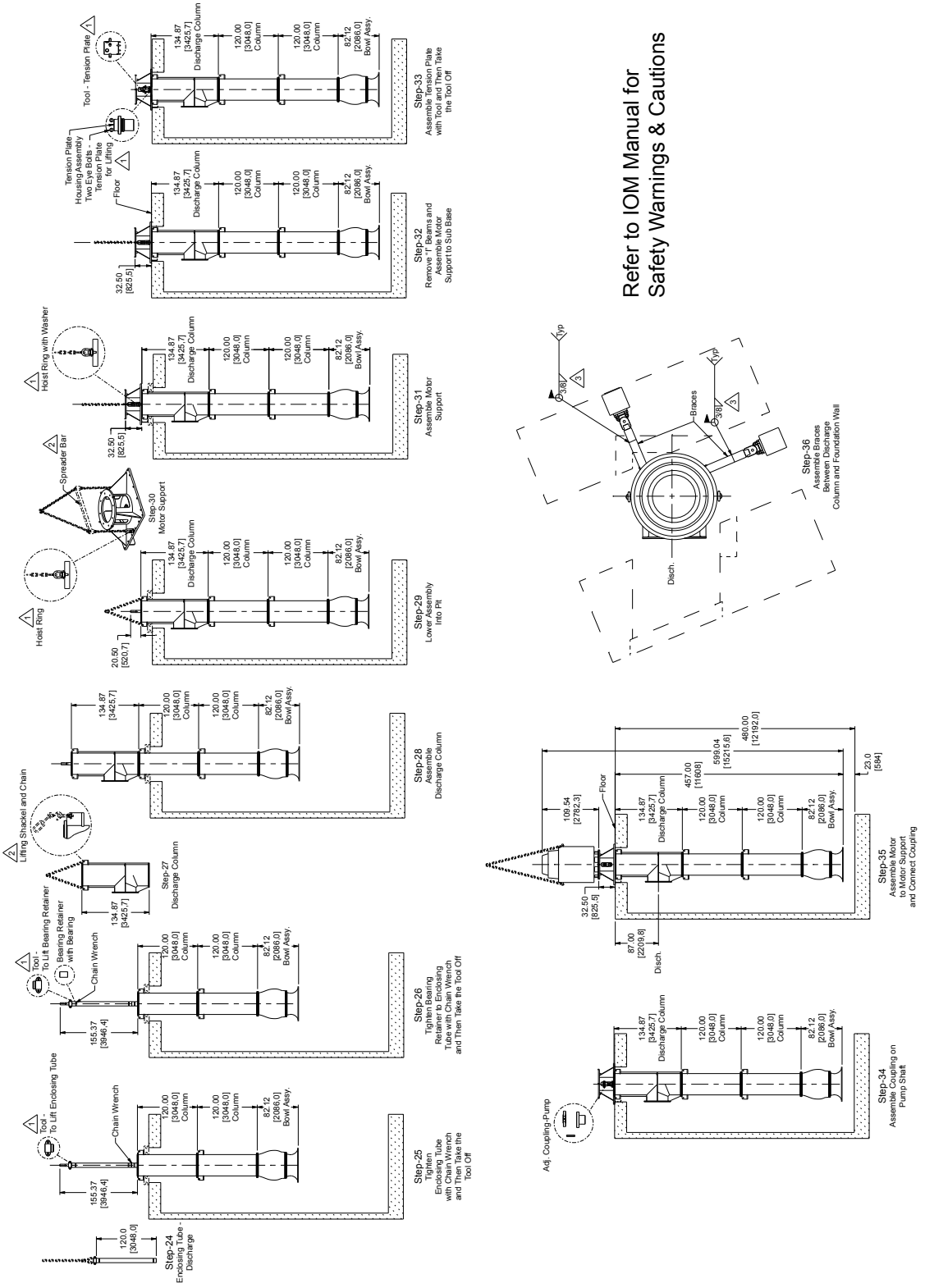
Measurements

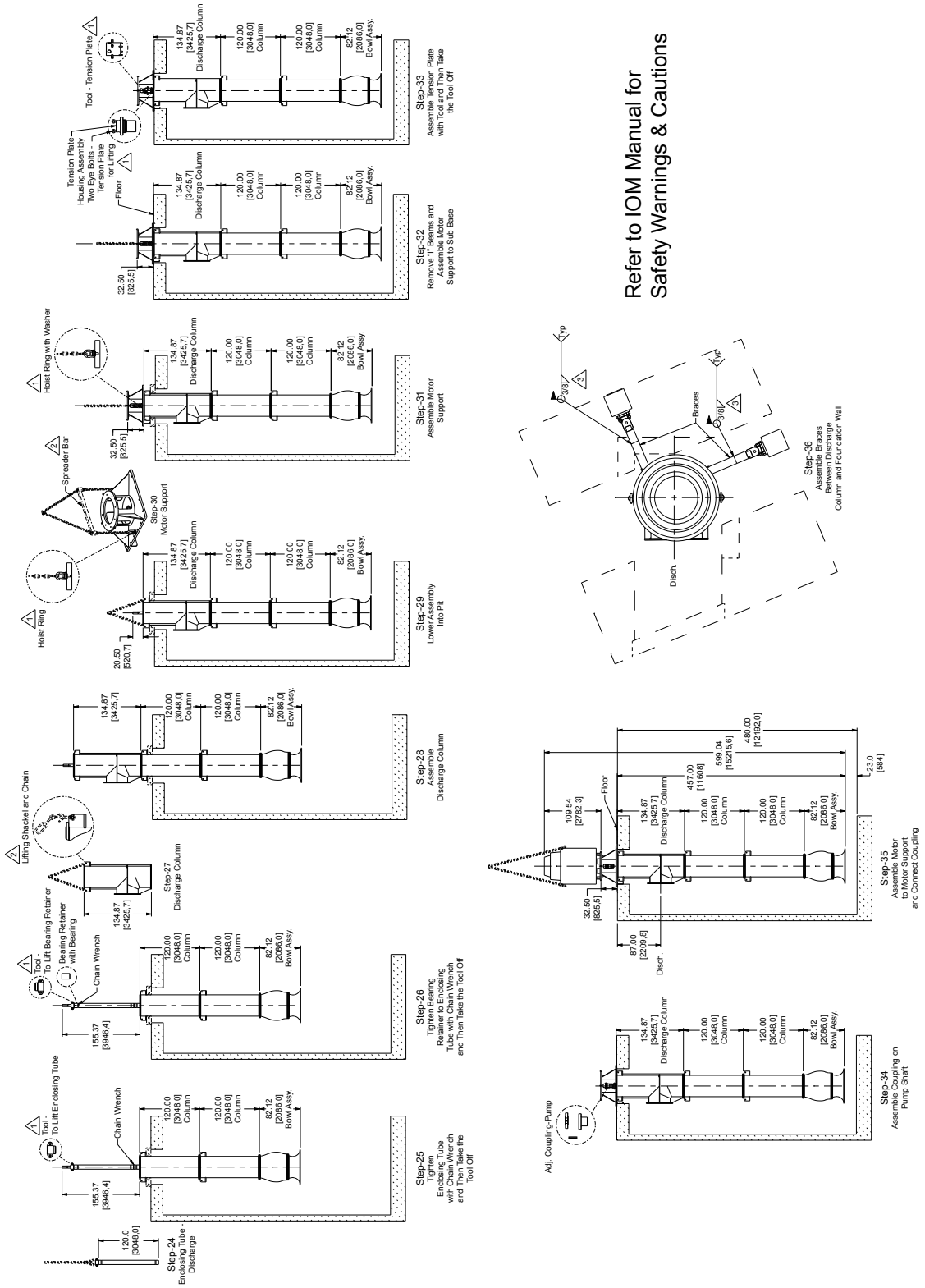
Reading	Value
Impeller lift	
Driver shaft runout	
Pump head shaft runout	
Seal housing face runout	
Seal housing bore runout	
Megger	
Vibration	

4.12 Optional Erection and Rigging of Individual Components




Step-1
Assembly Coupling Hub & Key and Sleeve Ring on Motor with Motor Mounted Temporarily on Floor Stands
ADJ. Coupling-Motor
Step-2
Assemble Liner into Base with Bolt Mounted on Level Floor
Two Eye Bolts
≤60°
13.0 [330]
25.3 [641]
Step-3
Impeller and Pump Shaft into Bowl and Liner
Chain
Eye Bolt - Shaft Lifting
98.42 [2499.8]
31.63 [803.3]
Step-4
Assemble Bowl to Suction Bell
Two Eye Bolts - 180° Apart with Washer and Nut
≤60°
55.31 [1405.0]
Step-5
Bowl Assembly
118.08 [2999.2]
Step-6
Bowl Assembly Rotation
118.08 [2999.2]
Step-7
Lineshaft
Straps
119.94 [3046.5]
Step-8
Assemble Lineshaft with Keyed Coupling
Keyed Coupling
238.09 [6047.4]
Step-9
Enclosing Tube - Column
120.0 [3046]
Step-10
Tighten Enclosing Tube with Chain Wrench
Chain Wrench
Step-11
Column
120.00 [3048.0]
Step-12
Assemble Column to Bowl Assembly and Tighten Bearing Retainer to Enclosing Tube with Chain Wrench and Then Take the Tool Off
Bearing Retainer with Bearing
Tool - To Lift Bearing Retainer
Chain Wrench
238.09 [6047.4]
202.13 [5134.0]
Step-13
Vertical Positioning
Chains
Straps
Step-14
Set "I" Beams on the Floor, Lower Assembly Into Pit
Lifting Shackel and Chain
≤60° (Typ)
Floor
Two "I" Beams One on Each Side Across the Floor Opening
Step-15
Lineshaft
Eye Bolt - Shaft Lifting
119.94 [3046.5]
Step-16
Assemble Lineshaft with Keyed Coupling Use Provided Tool to Lift Keyed Coupling After Assembly Take the Tool Off
Keyed Coupling
Use Tool to Lift Keyed Coupling as Shown in Detail A - Zone A5
155.97 [3961.5]
120.00 [3048.0] Column
82.12 [2086.0] Bowl Assy.
Lifting Lugs Supported on "I" Beams
Step-17
Enclosing Tube - Column
Lifting Shackel and Chain
120.00 [3048.0]
Tool - To Lift Enclosing Tube
Step-18
Tighten Enclosing Tube with Chain Wrench and Then Take the Tool Off
Tool - To Lift Enclosing Tube
Chain Wrench
155.97 [3961.5]
120.00 [3048.0] Column
82.12 [2086.0] Bowl Assy.
Step-19
Column
120.00 [3048.0]
Step-20
Assemble Column and Tighten Bearing Retainer to Enclosing Tube with Chain Wrench and Then Take the Tool Off
Tool - To Lift Bearing Retainer
Bearing Retainer with Bearing
Chain Wrench
155.97 [3961.5]
120.00 [3048.0] Column
82.12 [2086.0] Bowl Assy.
Step-21
Lower Assembly Into Pit
35.97 [913.5]
120.00 [3048.0] Column
120.00 [3048.0] Column
82.12 [2086.0] Bowl Assy.
Step-22
HeadShaft
Eye Bolt - Shaft Lifting
119.34 [3031.2]
Step-23
Assemble Headshaft with Keyed Coupling Use Provided Tool to Lift Keyed Coupling After Assembly Take the Tool Off
Keyed Coupling
Use Tool to Lift Keyed Coupling as Shown in Detail A - Zone A5
155.37 [3946.4]
120.00 [3048.0] Column
120.00 [3048.0] Column
82.12 [2086.0] Bowl Assy.
Sleeve Keyed Coupling
Quick Release Pin
Pipe
Fasteners
Detail A
Assembly Tool to Lift Sleeve Keyed Coupling


Refer to IOM Manual for
Safety Warnings & Cautions
Step-24
Enclosing Tube
Discharge
Step-25
Tighten
Enclosing Tube
with Chain Wrench
and Then Take the
Tool Off
Step-26
Tighten Bearing
Retainer to Enclosing
Tube with Chain Wrench
and Then Take the Tool Off
Step-27
Discharge Column
Step-28
Assemble
Discharge Column
Step-29
Lower Assembly
Into Pit
Step-30
Motor Support
Step-31
Assemble Motor
Support
Step-32
Remove "I" Beams and
Assemble Motor
Support to Sub Base
Step-33
Assemble Tension Plate
with Tool and Then Take
the Tool Off
Step-34
Assemble Coupling on
Pump Shaft
Step-35
Assemble Motor
to Motor Support
and Connect Coupling
Step-36
Assemble Braces
Between Discharge
Column and Foundation Wall
Tool -
To Lift Enclosing Tube
Chain Wrench
Tool -
To Lift Bearing Retainer
with Bearing
Lifting Shackel and Chain
Spreader Bar
Hoist Ring
Hoist Ring with Washer
Tool - Tension Plate
Tension Plate
Housing Assembly
Two Eye Bolts -
Tension Plate
for Lifting
Floor
Braces
Disch.
Adj. Coupling-Pump
155.37
[3944.4]
120.0
[3048.0]
20.50
[520.7]
32.50
[825.5]
87.00
[2209.8]
109.54
[2782.3]
134.87
[3425.7]
Discharge Column
120.00
[3048.0]
Column
82.12
[2086.0]
Bowl Assy.
457.00
[11608]
599.04
[15215.6]
480.00
[12192.0]
23.0
[584]
Typ
3/8"


Refer to IOM Manual for
Safety Warnings & Cautions
Step-24
Enclosing Tube - Discharge
120.0
[3048.0]
Step-25
Tighten
Enclosing Tube
with Chain Wrench
and Then Take the
Tool Off
Tool -
To Lift Enclosing Tube
Chain Wrench
155.37
[3946.4]
Step-26
Tighten Bearing
Retainer to Enclosing
Tube with Chain Wrench
and Then Take the Tool Off
Tool -
To Lift Bearing Retainer
with Bearing
Chain Wrench
Step-27
Discharge Column
Lifting Shackel and Chain
Step-28
Assemble
Discharge Column
Step-29
Lower Assembly
Into Pit
Hoist Ring
Spreader Bar
Step-30
Motor Support
Step-31
Assemble Motor
Support
Hoist Ring with Washer
Step-32
Remove "I" Beams and
Assemble Motor
Support to Sub Base
Floor
Tension Plate
Housing Assembly
Two Eye Bolts -
Tension Plate
for Lifting
Step-33
Assemble Tension Plate
with Tool and Then Take
the Tool Off
Tool - Tension Plate
Step-34
Assemble Coupling on
Pump Shaft
Adj. Coupling-Pump
Step-35
Assemble Motor
to Motor Support
and Connect Coupling
Floor
Disch.
Step-36
Assemble Braces
Between Discharge
Column and Foundation Wall
Braces
Disch.
134.87
[3425.7]
Discharge Column
120.00
[3048.0]
Column
82.12
[2086.0]
Bowl Assy.
32.50
[825.5]
20.50
[520.7]
155.37
[3946.4]
87.00
[2209.8]
109.54
[2782.3]
457.00
[11608]
599.04
[15215.6]
480.00
[12192.0]
23.0
[584]

5 Commissioning, Startup, Operation, and Shutdown

5.1 Preparation for startup

WARNING:

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

WARNING:

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

Precautions

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

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

NOTICE:

- Verify the driver settings before you start any pump. Refer to the applicable drive equipment IOMs and operating procedures.

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

- Flush and clean the system thoroughly to remove dirt or debris in the pipe system in order to prevent premature failure at initial startup.

5.1.1 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.
- Do not test the motor for direction of rotation when it is coupled to the pump. If the pump is driven in the wrong direction, serious damage to the pump, motor, and personnel could result.

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. For flush water lubricated lineshafts, see the instructions on General Arrangement Drawing.

5.2 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 suction source so that liquid cannot collect in the vent line.

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 minimum submergence must always be as indicated on the Certified Pump Outline Drawing.
- 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.

5.3 Start the pump

WARNING:

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

NOTICE:

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

1. Fully close 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) 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.
7. Repeat steps 5 and 6 until the pump runs properly.

5.4 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.

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

5.5 Mechanical seal leaks

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.

5.6 Stuffing box leaks

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.

5.7 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 and fully open minimum flow bypass line or partially open the discharge valve, depending on system conditions.
2. Shut down and lock out the driver to prevent accidental rotation.

5.8 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.

6 Maintenance

6.1 Maintenance schedule

Maintenance inspections

A maintenance schedule includes these types of inspections:

- 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 inspections

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

- Check for unusual noise vibration, and bearing temperatures.
- Check the pump and piping for leaks.
- Analyze the vibration.*

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

Three-month inspections

Perform these tasks every three months:

- Check that the foundation and the hold-down bolts are tight.

Annual inspections

Perform these inspections one time each year:

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

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

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

6.2 Adjust and replace the packing

NOTICE:
Never over-tighten packing to the point where less than one drop per second is observed. Over-tightening can cause excessive wear and power consumption during operation.

WARNING:
Packed stuffing boxes are not allowed in an Ex-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.

If you cannot tighten the packing to obtain less than the specified leakage rate, then replace the packing.

6.2.1 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.

6.2.2 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.

6.3 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.

NOTICE:

- Pumps are shipped without oil. Oil-lubricated bearings must be lubricated at the job site.
- Refer to Thrust Pot IOM for lubrication requirements.

Oil levels

Pump status	Oil level
Not operating	At or lower than 0.635 to 0.3175 mm | 1/8 in. to 1/4 in. 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.

Changing the oil

Observe the instructions in the Thrust Pot IOM.

6.4 Disassembly

6.4.1 Disassembly precautions

WARNING:

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

CAUTION:

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

6.4.2 Disassemble the head and column

WARNING:
Safe lifting points are specifically identified in the general arrangement drawing. It is critical to lift the equipment only at these points. Integral lifting eyes or swivel hoist rings on pump and motor components are intended for use in lifting the individual components only. Never try to lift the entire pump assembly by the lifting points furnished for the driver only.

1. 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.

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

6.4.3 Bowl disassembly

The bowl assembly is composed of these parts:

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

NOTICE:
Match mark the components in sequence in order to aid the reassembly.

6.4.3.1 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. For singe-stage pumps, lift pump shaft and impeller from suction bell as an assembly. Dismantle split ring from impeller and remove shaft from impeller.

6.4.4 Remove the bowl and impeller wear rings

1. 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.
2. With a chisel or drift punch, knock the end of one half of the ring in, and pry the ring out.

3. 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.

6.4.5 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.

6.5 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.

6.5.1 Replacement guidelines

Casing check and replacement

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

Gaskets, O-rings, and seats replacement

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

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

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

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

6.6 Reassembly

6.6.1 Installing the 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.

6.6.2 Installing the bowl, and lineshaft bearings

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

1. Press bowl bearings into bearing housings until bearing is flush with seat.
2. Press line shaft bearings into retainers in column pipes.

6.6.3 Installing 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.

7 Troubleshooting

7.1 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.
	Rotor resists turning due to freezing.	Drain pump and dry internal surfaces with dry air.
	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 clockwise 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 clockwise 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

Symptom	Cause	Remedy
		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.
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.

Symptom	Cause	Remedy
	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 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 gasket 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.
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.

8 Parts Listings and Cross-Sectionals

8.1 Typical Parts List and Cross Sectionals

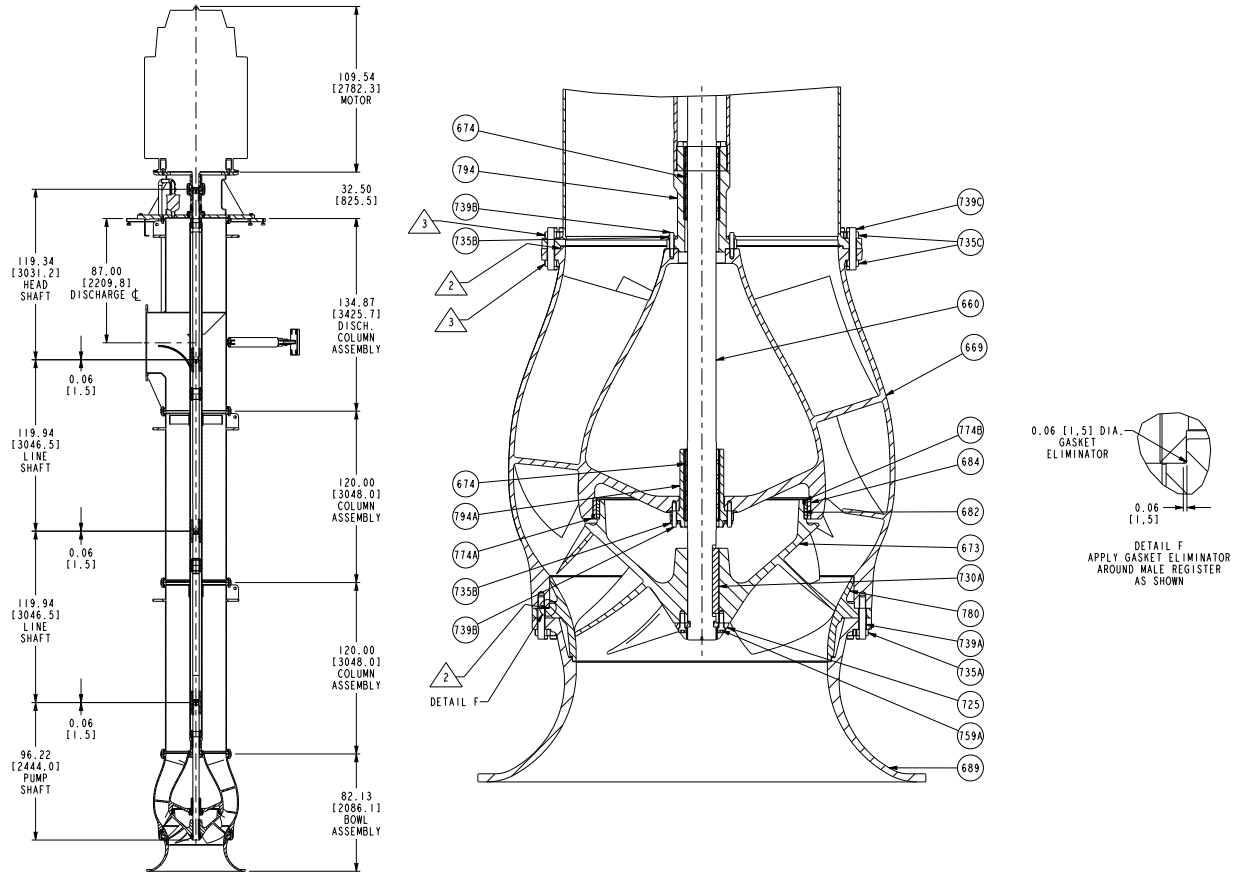


Figure 15: Cross Sectional

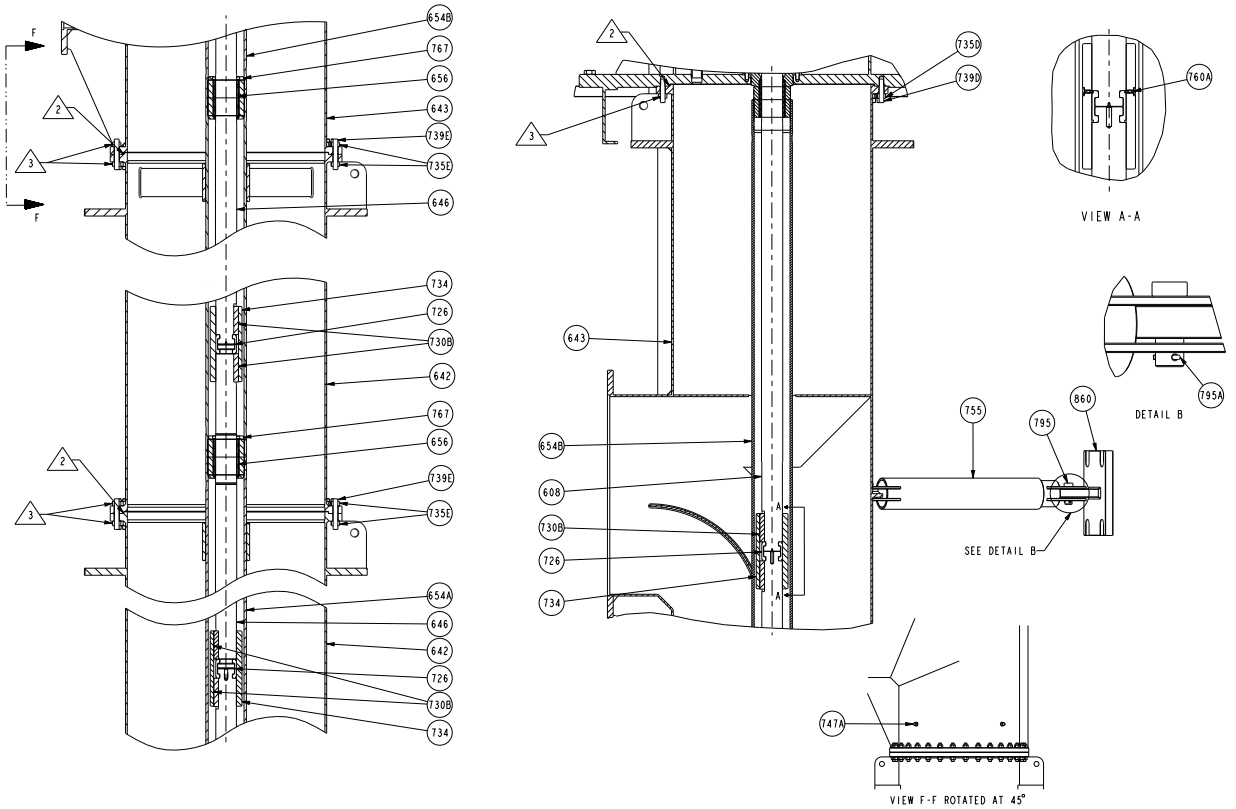


Figure 16: Cross Sectional

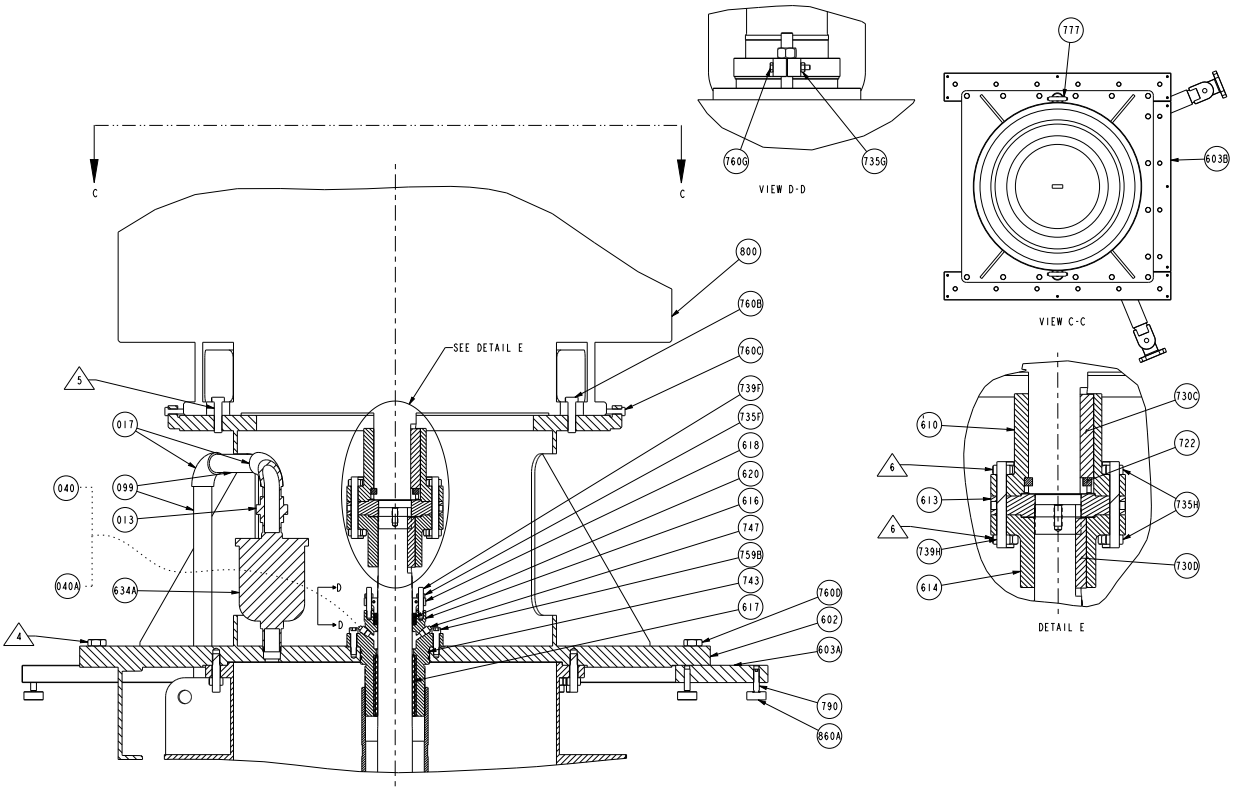


Figure 17: Cross Sectional

Table 5: Sub Assembly - Bowl Assembly Parts List

Item No	Qty	Sub Assembly - Bowl Assembly	Material	GP MATL
689	1	Bell, Suction	ASTM A48 Class 30B with SCOTCHKOTE 134	5853
780	1	Liner	ASTM A744 GR CF3-M, 316L SS	1219
673	1	Impeller	ASTM A744 GR CF3-M, 316L SS	1219
730A	1	Key, Impeller	ASTM A276 Type 316	2229
725	1	Thrust Ring, Impeller	ASTM A276 Type 316	2229
759A	8	SKT HD Screw, Imeller/Thrust Ring	ASTM A276 Type 316	2229
739A	32	Studs, Bell/Liner/bowl	ASTM A193 GR B8M Class 2	2287
735A	32	Hex Nut, Bell/Liner/Bowl	ASTM A194 GR 8M	2291
669	1	Bowl	ASTM A48 Class 30B with SCOTHKOTE 134	5853
682	1	Wear Ring, Impeller	ASTM B148/B505 Alloy 954	1128
684	1	Wear Ring, Bowl	ASTM B148/B505 Alloy 954	1128
774A	3	Set Screw, Bowl/Wear Ring	ASTM A276 Type 316	2229
774B	3	Set Screw, Impeller/Wear Ring	ASTM A276 Type 316	2229
794A	1	Housing, Lower Bearing, Bowl	ASTM A108 GR 1018	2242
794	1	Housing, Bearing, Bowl/Enclosing Tube	ASTM A108 GR 1018	2242
674	2	Bearing, Bowl	Hard Shell Rubber Bearing (Nitrile & Brass)	6106
739B	32	Studs, Bearing Housing	ASTM A193 GR B8M Class 2	2287
735B	32	Hex Nut, Bearing Housing	ASTM A194 GR 8M	2291
660	1	Pump Shaft	ASTM A479-Type 410 Cond. 2 with PT1-25	0000
739C	32	Studs, Bowl, Column	ASTM A193 GR B8M Class 2	2287
735C	32	Hex Nut, Bowl/Column	ASTM A194 GR 8	2291

Table 6: Sub Assembly - Column and Discharge Assembly Parts List

Item No	Qty	Sub Assembly - Bowl Assembly	Material	GP MATL
642	2	Column	ASTM A36, Carbon Steel	9616
643	1	Column, Discharge	ASTM A36, Carbon Steel	9616
739E	64	Studs, Column/Column	ASTM A193 GR B8M Class 2	2287
735E	64	Hex Nut, Column/Column	ASTM A194 GR 8M	2291
646	2	Lineshaft	ASTM A479-Type 410 Cond 2 with PTI-25	0000
608	1	Headshaft	ASTM A479-Type 410 Cond 2 with PTI-25	0000
734	3	Sleeve, Key Coupling	ASTM A564, Type 630	2255
726	3	Splitting, Key Coupling	ASTM A564, Type 630	2255
730B	6	Key, Coupling	ASTM A564, Type 630	2255
760A	6	Hex Hd Screw, Key Coupling	ASTM A564, Type 630	2253
654A	2	Enclosing Tube, Column	ASTM A53, Grade B, Type E	6531

Item No	Qty	Sub Assembly - Bowl Assembly	Material	GP MATL
654B	1	Enclosing Tube, Discharge Column	ASTM A53, Grade B, Type E	6531
767	2	Bearing Retainer, Enclosing Tube	ASTM A108 GR 1018	2242
656	2	Bearing, Enclosed Shaft	Hard Shell Rubber Bearing (Nitrile & Brass)	6106
755	2	Brace	ASTM A36, Carbon Steel	9616
860	2	Plate	ASTM A36, Carbon Steel	9616
795	4	Pin	ASTM A564 Type 630	2255
795A	4	Pin	316 SS	0000
739D	32	Studs, Discharge Column/Motor Support	ASTM A193 GR B8M Class 2	2287
735D	32	Hex Nut, Discharge Column/ Motor Support	ASTM A194 GR 8M	2291
747A	4	Pipe Plug, Tension Plate	ASTM A276 Type 316	2229

Table 7: Sub Assembly - Seal Assembly Parts List

Item No	Qty	Sub Assembly - Bowl Assembly	Material	GP MATL
616	1	Housing, Tension Plate	ASTM A108 GR 1018 UNS G10180	2242
617	1	Bearing, Tension Plate	Hard Shell Rubber Bearing (Nitrile & Brass)	6106
759B	8	SKT HD Screw, Tension Plate/ Motor Mount	ASTM A276 Type 316	2229
743	2	O-Ring, Tension Plate	Nitrile BUNA-N	5302
747	2	Pipe Plug, Tension Plate	ASTM A276 Type 316	2229
620	3	Packing Ring	JOHN CRANE Packing Style 1340	5017
618	1	Gland, Split	ASTM B148/B505 Alloy 954	1128
739F	2	Studs, Split Gland/Tension Plate	ASTM A276 Type 316	2229
735F	2	Hex Nut, Split Gland/Tension Plate	ASTM A276 Type 316	2229
760G	2	Hex Hd Screw, Split Gland	ASTM A276 Type 316	2229
735G	2	Hex Nut, Split Gland	ASTM A276 Type 316	2229

Table 8: Sub Assembly - Adj. Coupling Assembly Parts List

Item No	Qty	Sub Assembly - Bowl Assembly	Material	GP MATL
610	1	Hub, Driver	ASTM A108 GR 1018 with Zinc Phosphate Coating	5933
722	1	Ring, Retaining	ASTM A434 Grade 4140/4142 Class BC	2467
730C	1	Key, Hub Driver	ASTM A564, Type 630	2255
613	1	Plate, Adjusting	ASTM A108 GR 1018 with Zinc Phosphate Coating	5933
614	1	Hub, Pump	ASTM A108 GR 1018 with Zinc Phosphate Coating	5933
730D	1	Key, Hub Pump	ASTM A564, Type 630	2255

Item No	Qty	Sub Assembly - Bowl Assembly	Material	GP MATL
739H	12	Studs, Adj Coupling	ASTM A193 GR B7	2239
735H	24	Hex Nut, Adj Coupling	SAE J995 Grade 8	2318

Table 9: Sub Assembly - Motor Support Assembly Parts List

Item No	Qty	Sub Assembly - Bowl Assembly	Material	GP MATL
602	1	Support	ASTM A36, Carbon Steel	9616
603A	2	Sub Base	ASTM A36, Carbon Steel	3236
603B	1	Sub Base	ASTM A36, Carbon Steel	3236
760D	16	Hex Hd Screw, Motor Support/Sub Base	ASTM A354 Grade BD or SAE 5429 GR8	2298
790	18	Jacking Bolt, Sub Base	ASTM A582 Type 303	2226
860A	18	Plate, Jacking Bolt	ASTM A108 GR 1018	2242
777	2	Lifting Lug, Motor Support	Alloy Steel Generic	0000
760B	8	Hex Hd Screw, Motor Support/ Motor	ASTM A354 Grade BD or SAE S429 GR 8	2298
760C	4	Hex Hd Screw, Alignment, Motor Support/Motor	ASTM A354 Grade BD or SAE S429 GR 8	2298

Table 10: Accessories

Item No	Qty	Sub Assembly - Bowl Assembly	Material	GP MATL
800	1	Driver - Motor	Vendor: GE	0000
634A	1	Air Release Valve - APCO	Cast Iron Brass Fitted	0000
099	1	Pipe - cut to length	ASTM A53, Grade B, Type E	6531
017	2	Elbow, Pipe	MAL Iron	7201
013	1	Union, Pipe	Mal Iron	7611
040	1	Flow Switch	Vendor: IFM EFECTOR, Model: SI5002	0000
040A	1	Pressure Switch	Vendor: IFM EFECTOR, Model: PA3226	0000

9 Local ITT Contacts

9.1 Regional offices

Region	Address	Telephone	Fax
North America (Headquarters)	ITT - Goulds Pumps 240 Fall Street Seneca Falls, NY 13148 USA	+1 315-568-2811	+1 315-568-2418
Houston office	12510 Sugar Ridge Boulevard Stafford, TX 77477 USA	+1 281-504-6300	+1 281-504-6399
Los Angeles	Vertical Products Operation 3951 Capitol Avenue City of Industry, CA 90601-1734 USA	+1 562-949-2113	+1 562-695-8523
Asia Pacific	ITT Fluid Technology Asia Pte Ltd 1 Jalan Kilang Timor #04-06 Singapore 159303	+65 627-63693	+65 627-63685
Asia Pacific	ITT Goulds Pumps Ltd 35, Oksansandan-ro Oksan-myeon, Heungdeok-gu, Cheongju-si, Chungcheongbuk-do 28101, Rep. of KOREA	+82 234444202	
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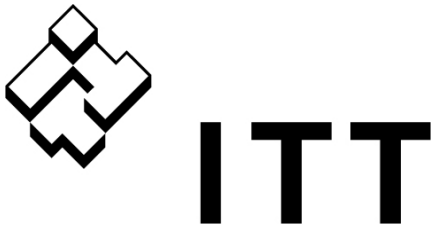

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