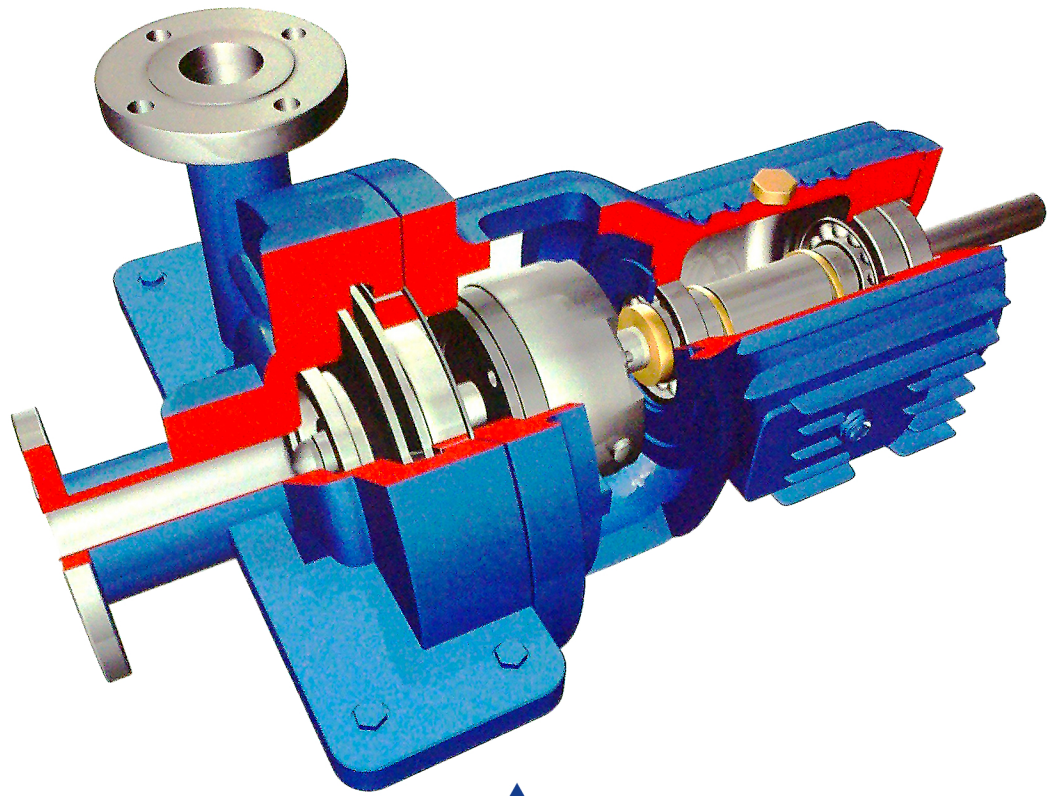


Single-Stage Process Pump
API 610 - 11th Edition

Installation, Operation, & Maintenance Manual



TRUFLO™
QUALITY • VALUE • SERVICE

A New Vision For Quality Pumps

TS Series

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Introduction and Safety

Safety message levels

Definitions

Safety message level



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



Electrical Hazard:

The possibility of electrical risks if instructions are not followed in a proper manner.

NOTICE:

- A potential situation which, if not avoided, could result in an undesirable result or state
- A practice not related to personal injury

Safety



WARNING:

- The operator must be aware of pump and safety precautions to prevent physical injury.
- A pump is a pressure-containing device with rotating parts that can be hazardous. Any pressure-containing device can explode, rupture, or discharge its contents if it is sufficiently over-pressurized. This can cause death, personal injury, property and environmental damage. All necessary measures must be taken to ensure over-pressurization does not occur. TRUFLO will not accept responsibility for physical injury, damage, or delays caused by a failure to observe the instructions in this manual.
- Operating, installing, or maintaining the pump unit in any way that is not covered in this manual could cause death, serious personal injury, or damage to the equipment. This includes any modification to the equipment or use of parts not provided by TRUFLO. If there is a question regarding the intended use of the equipment, please contact a TRUFLO representative before proceeding.
- Pump equipment Installation, Operation, and Maintenance manuals clearly identify accepted methods for disassembling pump units. These methods must be adhered to. Specifically, applying heat to impellers and/or impeller retaining devices to aid in their removal is strictly forbidden. Trapped liquid can rapidly expand and result in a violent explosion and injury.
- DO NOT change the service without the approval of an authorized TRUFLO representative.
- NEVER operate the pump below the minimum rated flow, when dry, or without prime.
- NEVER operate the pump without safety devices installed.
- NEVER operate the pump with the discharge valve closed.
- NEVER operate the pump with the suction valve closed.

Recycling

Always recycle according to these guidelines:

- Follow local recycling laws and regulations.
- If the unit or parts are not accepted by an authorized recycling company, then return them to the nearest TRUFLO representative.

Waste and emissions regulations

Observe these safety regulations regarding waste and emissions:

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

Reference for electrical installation

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

Health and Safety

Safety equipment

Use safety equipment according to the company regulations. The following safety equipment should be used within the work area:

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

The work area

- Observe these regulations and warnings in the work area:
- Always keep the work area clean.
- Pay attention to the risks presented by gas and vapors in the work area.
- Avoid all electrical dangers. Pay attention to the risks of electric shock or arc flash hazards.

Product and product positioning requirements

Observe these requirements for the product and the product positioning:



WARNING:

- Use hardware of the correct size and material.
- Replace all corroded hardware.
- Make sure that all hardware are properly tightened and that there are no missing hardware.
- Do not operate a pump unless safety devices are installed.
- Do not operate a pump unless a coupling guard is installed.
- Do not force piping to make a connection with a pump.
- Do not start a pump without the proper priming.
- Do not run a pump below the minimum flow or with any suction or 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 the following guidelines and warnings for electrical connections:

- Make sure that the product is isolated from the power supply and cannot be energized by accident, this applies to the control circuit as well.
- 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)

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

Precautions before work

Observe the following safety precautions before working with the product or in connection with the product:

- Provide a suitable barrier around the work area..
- Make sure that all safety guards are in place and secure.
- Make sure that the equipment is properly insulated when operating at extreme temperatures.
- Allow all system and pump components to cool before you handle them.
- Make sure that you have a clear path of escape..
- Make sure that the product cannot roll or fall over and injure people or damage property.
- Make sure that the lifting equipment is in proper condition.
- Use a lifting harness, a safety line, and a breathing device as required.
- Make sure that the product has been thoroughly cleaned.
- Make sure that there are no poisonous gases within the work area.
- Make sure that a first-aid kit is close at hand.
- Disconnect and lock out power before servicing.
- Check the explosion risk before welding or using electric hand tools.

Precautions during work

Observe the following safety precautions when working with the product or in connection with 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 disassembling the pump.
- Do not exceed the maximum working pressure of the pump.
- Do not open any vent or drain valve or remove any plugs while the system is pressurized. Make sure that the pump is isolated from the system and that pressure is relieved before you disassemble the pump, remove plugs, or disconnect piping.
- Never operate a pump without a coupling guard that has been correctly installed.
- Remember to keep in mind the risk of drowning, electrical accidents, and burn injuries.

Clean chemicals from the eyes

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

Clean chemicals from the body

1. Remove contaminated clothing.

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

Safety regulations for Ex-approved products in potentially explosive atmospheres

Description of ATEX

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

General guidelines

ATEX compliance is only fulfilled when the pump is operated within its intended use, for example within its intended hydraulic range. The conditions of the service must not be changed without approval of an authorized TRUFLO representative. When installing or maintaining ATEX-compliant pumps, follow these guidelines:

- Always install ATEX-approved equipment in compliance with the directive and applicable standards (IEC/EN 60079–14).
- Do not install FM-approved products in locations that are classified as hazardous in the national electric code, ANSI/NFPA 70–2005.



WARNING:

Pump equipment Installation, Operation, and Maintenance manuals clearly identify accepted methods for disassembling pump units. These methods must be adhered to. Specifically, applying heat to impellers and/or impeller retaining devices to aid in their removal is strictly forbidden. Trapped liquid can rapidly expand and result in a violent explosion and injury.

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

Personnel requirements

All work on the product must be carried out by certified electricians and TRUFLO-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.

Maintenance done within the EU must be done in compliance with international, national, and local standards (IEC/EN 60079–17).

Product and product handling requirements

- The product may be used only 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.
- Do not start a pump without the proper priming.
- 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 hardware must be in accordance with the approval drawing and the product specification.
- Do not modify the equipment without approval from an authorized TRUFLO representative.
- Only use parts that have been provided by an authorized TRUFLO representative.

Equipment for monitoring

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

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

Product approval standards

Regular standards

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

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

Product warranty

Personnel requirements

All work on the product, standard version or Ex-approved version, must be carried out by certified electricians and TRUFLO authorized mechanics. TRUFLO disclaims all responsibility for work done by untrained and unauthorized personnel.

Modification and spare parts

Modifications or changes to the product and installation should only be carried out after consulting with TRUFLO. OEM spare parts and accessories authorized by TRUFLO are essential for compliance. The use of other parts can invalidate any claims for warranty or compensation.

Only Ex-approved spare parts and accessories authorized by TRUFLO are allowed in Ex-approved products.

Warranty claims

For warranty claims, contact your TRUFLO representative.

Transportation and Storage

Receive the unit

- 1 Inspect the package for damaged or missing items upon delivery.
- 2 Note any damaged or missing items on the receipt and freight bill.
- 3 File a claim with the shipping company if anything is out of order.

Unpack the unit

- 1 Remove packing materials from the unit. Dispose of all packing materials correctly.
- 2 Inspect the unit to determine if any parts have been damaged or are missing.
- 3 Contact your TRUFLO representative if anything seems out of order.

Pump handling



WARNING:

Make sure that the pump cannot roll or fall over and injure people or damage property.

NOTICE: Use a forklift truck with sufficient capacity to move the pallet with the pump unit on top. Failure to do so may result in equipment damage.

Lifting methods



WARNING:

- Assembled pumping units and their components are heavy. Failure to properly lift and support this equipment can result in serious physical injury and/or equipment damage. Lift equipment only at the specifically identified lifting points. Lifting devices such as eyebolts, slings, and spreaders must be rated, selected, and used for the entire load being lifted.
- The pump and the components are heavy. Use proper lifting methods, and wear steel-toed shoes at all times. Failure to do so can result in physical injury.

Table 1: Methods

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



Warning: Do not attach sling ropes to shaft ends. Doing so may result in equipment damage.

Examples

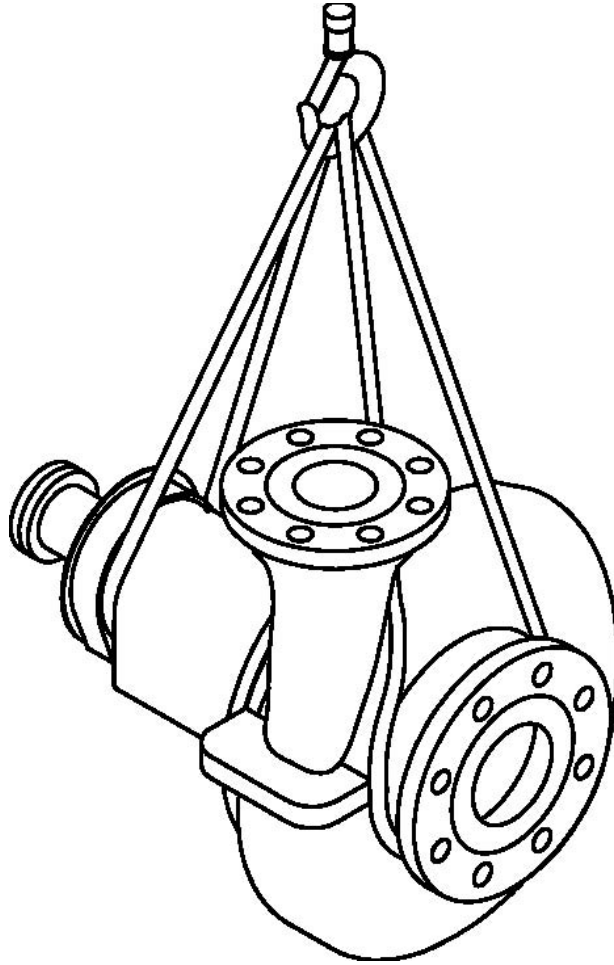


Figure 1: Proper lifting method

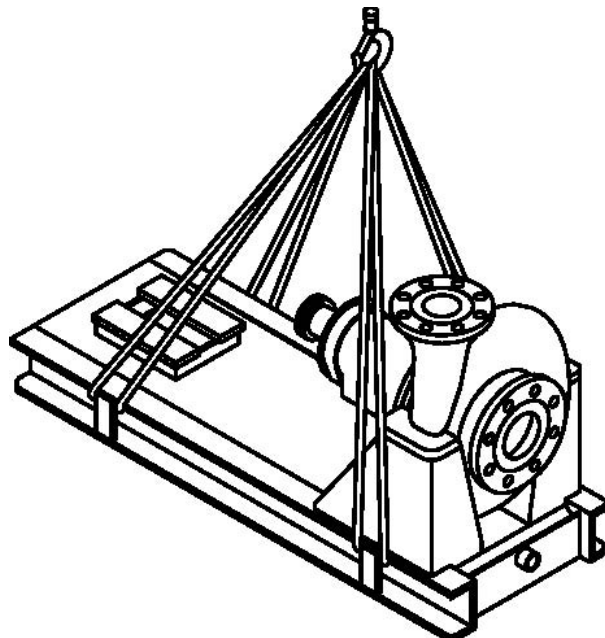


Figure 2: Proper lifting method

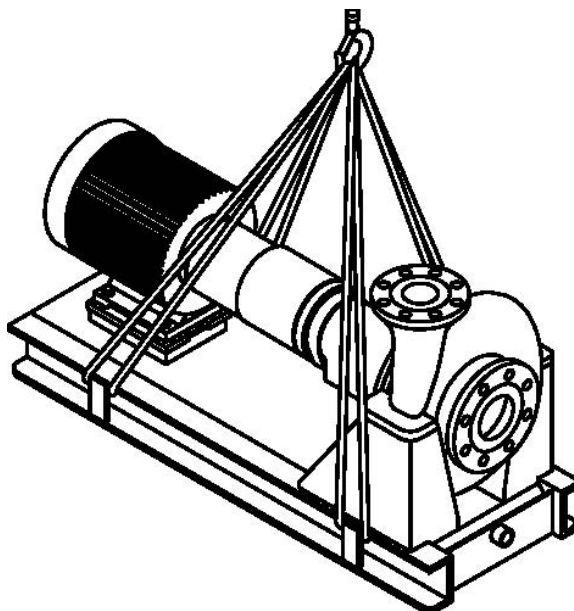


Figure 3: Proper lifting method

Pump storage requirements

Storage requirements are dependent on the amount of time the pump is stored. The normal packaging is designed only to protect the pump during shipping.

Length of time in storage	Storage requirements
---------------------------	----------------------

- Store in a covered and dry location.
- Store the unit free from dirt and vibrations.
- Store in a covered and dry location.
- Store the unit free from heat, dirt, and vibrations.
- Rotate the shaft by hand several times at least every three months.

Treat bearing and machined surfaces so that they are well preserved. Refer to drive unit and coupling manufacturers for their long-term storage procedures. You can purchase long-term storage treatment with the initial pump order or you can purchase it and apply it after the pumps are already in the field. Contact your local TRUFLO sales representative.

Product Description

General description TSP

Product description

The Model TSP is a high-pressure, high-temperature centrifugal pump that meets the requirements of API Standard 610 11th Edition (ISO 13709).

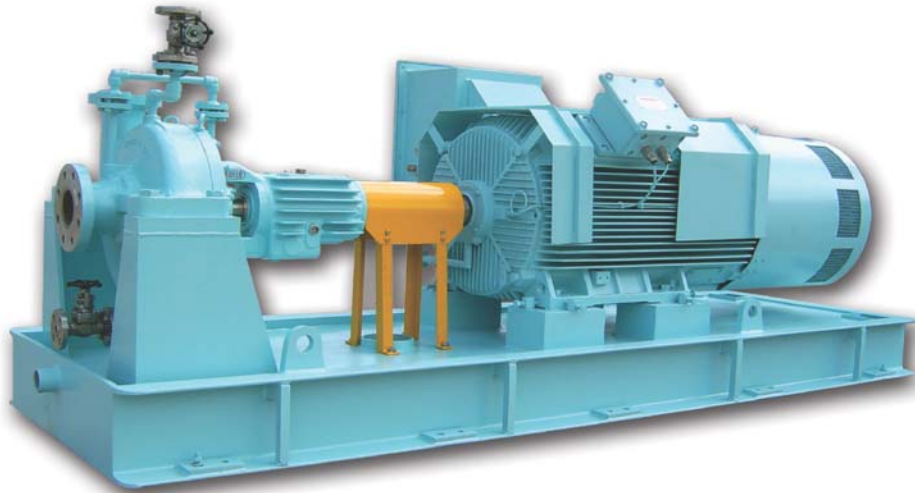


Figure 4: TSP pump

Casing

The casing is a centerline-mounted design. The gasket is fully confined. The standard flanges are ANSI Class 300 raised-face serrated. The following flanges are also available:

- ANSI Class 300 flat-face serrated
- ANSI Class 300 ring joint
- ANSI Class 600 flat-face serrated
- ANSI Class 600 ring joint
- Other higher flange option available.

Impeller

The impeller is fully enclosed and key driven by the shaft. One of the following parts prevents axial movement:

- Impeller nut with a locking set screw

Seal-chamber cover

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

Power end

The power end has the following characteristics:

- Standard ring oil-lubricated bearings
- Labyrinth seals on the power end
- Optional pure and purge oil mist lubrication (some machining is required to convert from ring oil lubrication to oil mist)

Shaft

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

Bearings Bearing type

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

Baseplate

The fabricated steel baseplate supports the pump, driver, and accessories in accordance with API-610 11th Edition (ISO 13709) requirements.

Direction of rotation

The shaft rotates counterclockwise when viewed from the drive end.

Nameplate information

Important information for ordering

Every pump has nameplates that provide information about the pump. The nameplates are located on the casing and the bearing frame. When ordering spare parts, you must identify the following pump information:

- Model
- Size
- Serial number

• Item numbers of the required parts Refer to the nameplate on the pump casing for most of the information. Item numbers can be found in the parts list.

Nameplate types Nameplate

Nameplate	Description
	Provides information about the hydraulic characteristics of the pump.
Pump casing	The formula for the pump size is: Discharge x Suction - Nominal Maximum Impeller Diameter in inches. (Example: 2x1-11)

TRUFLO		www.TRUFLO.com	
MODEL		ITEM #	
MAT'L		HP	
OS/N			○
MFR #			
GPM		TDH	
		RPM	
TRUFLO PUMP CO., GREENSBORO, NC			
MADE IN KOREA		HQ & ASSEMBLY IN U.S.A.	

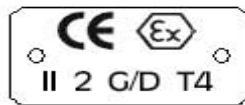
Table 3: Explanation of the nameplate on the pump casing in English units

Nameplate field	Explanation
MODEL	Pump model & Size
ITEM NO.	User's equipment number
MAT'L	Material of the pump
HP	Motor power, in horsepower
S/N	Serial Number
MFR#.	Manufacturer's reference number
GPM	Rated flow rate, in gallons per minute
TDH	Total Differential Head in feet
RPM	Rated pump speed, revolutions per minute

Nameplate Using Metric Units

Table 4: Explanation of the nameplate on the pump casing

Nameplate field	Explanation
MODEL	Pump model & Size
ITEM NO.	User's equipment number
MAT'L	Material of the pump
KW	Motor power, in KW
S/N	Serial Number
MFR#.	Manufacturer's reference number
M³/H	Rated flow rate, cubic meter per hour
TDH	Total Differential Head in meter
RPM	Rated pump speed, revolutions per minute



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

Table 6: Temperature class definitions

Code	Maximum permissible surface temperature in °F (°C)	Minimum permissible surface temperature in °F (°C)
T1	842 (450)	700 (372)
T2	572 (300)	530 (277)
T3	392 (200)	350 (177)
T4	275 (135)	235 (113)
T5	212 (100)	Option not available Option
T6	185 (85)	not available

NOTICE: Make sure that the code classifications on the pump are compatible with the specific environment in which you plan to install the equipment. If they are not compatible, do not operate the equipment and contact your TRUFLO representative before proceeding.

Note : Above nameplate is available in U.S.A only

Installation

Preinstallation

Precautions WARNING:



When installing in a potentially explosive environment, make sure that the motor is properly certified.
All electrical equipment must be earthed (grounded). This applies to the pump equipment, the driver, and any monitoring equipment. Make sure that the earth (ground) lead is correctly connected by testing it.

NOTICE: Supervision by an authorized TRUFLO representative is recommended to ensure proper installation. Failure to do so may result in equipment damage or decreased performance.

Pump location guidelines



WARNING:
Assembled pumping units and their components are heavy. Failure to properly lift and support this equipment can result in serious physical injury and/or equipment damage. Lift equipment only at the specifically identified lifting points. Lifting devices such as eyebolts, slings, and spreaders must be rated, selected, and used for the entire load being lifted.

Guideline	Explanation/comment
Keep the pump as close to the liquid source as possible.	This minimizes the friction loss and keeps the suction piping as short as possible.
Make sure that the space around the pump is sufficient.	This facilitates ventilation, inspection, maintenance, and service.
If lifting equipment (for example, hoist or tackle) is needed, make sure that there is enough space above.	This makes it easier to use the lifting equipment properly.
Protect the unit from weather and water damage due to rain, flooding, and freezing temperatures.	This is applicable if nothing else is specified. Such devices include the following:
Do not install and operate the equipment in closed systems unless the system is constructed with properly-sized safety devices.	<ul style="list-style-type: none">• Pressure relief valves• Compression tanks• Pressure controls• Temperature controls• Flow controls
Take into consideration the occurrence of unwanted noise and vibration.	The best pump location for noise and vibration absorption is on a concrete floor with sub soil underneath.
If the pump location is overhead, undertake special precautions to reduce possible noise transmission.	Consulting a noise specialist is recommended.

Foundation requirements

Requirements

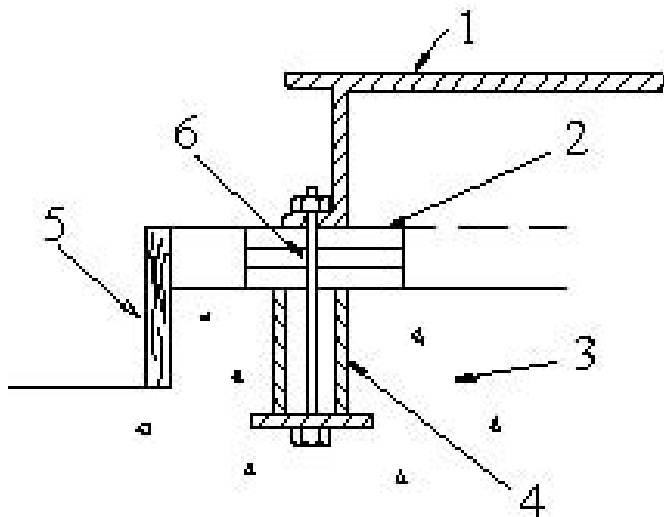
The foundation must be able to absorb any type of vibration and form a permanent, rigid support for the pump unit. The location and size of the foundation bolt holes are shown on the assembly drawing provided with the pump data package.

The foundation must weigh between two and three times the weight of the pump.

A flat substantial foundation of concrete must be provided to prevent strain and distortion when tightening the foundation bolts.

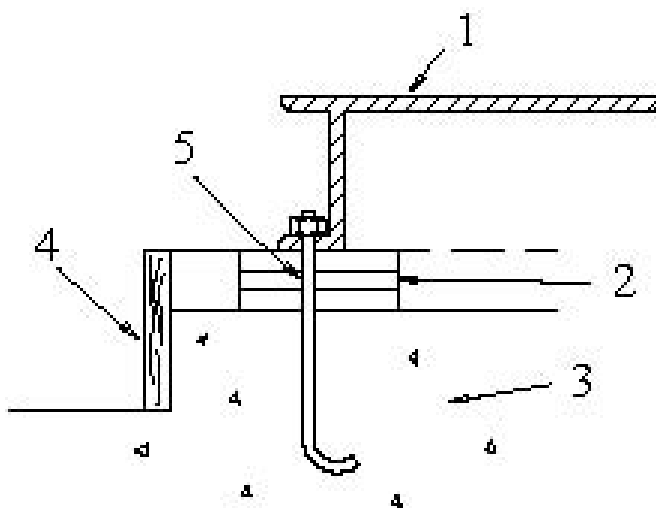
Sleeve-type and J-type foundation bolts are most commonly used. Both designs allow movement for the final bolt adjustment.

Diagram: sleeve-type bolts



1. Baseplate
2. Shims or wedges
3. Foundation
4. Sleeve
5. Dam
6. Bolt (sleeve type)

Diagram: J-type bolts



1. Baseplate
2. Shims or wedges
3. Foundation
4. Dam
5. Bolt (J type)

Piping checklists

General piping checklist

Precautions



CAUTION:
Never pull piping into place by using force 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 will adversely affect the operation of the pump, resulting in physical injury and damage to the equipment. Vary the capacity with the regulating valve in the discharge line. Never throttle the flow from the suction side. Doing so may result in decreased performance, unexpected heat generation, and equipment damage.

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

Piping guidelines Please use best known practices.

Checklist

Check	Explanation/comment Checked
Check that all piping is supported independently of, and lined up naturally with, the pump flange. See the Alignment criteria for pump flanges section below.	This helps to prevent the following: -Strain on the pump -Misalignment between the pump and the drive unit -Wear to the pump bearings and the coupling -Wear to the pump bearings, seal, and shafting
Keep the piping as short as possible.	This helps to minimize friction losses.
Check that only necessary fittings are used.	This helps to minimize friction losses.
Do not connect the piping to the pump until the following has occurred: The grout for the baseplate or sub-base has hardened. The hold-down bolts for the pump and the power end have been tightened.	—
Make sure that all the piping joints and fittings are air tight.	This prevents air from entering the piping system or leakage during operation.
If the pump handles corrosive liquids, make sure that the piping allows the liquid to be flushed out before the pump is removed.	—
If the pump handles liquids at elevated temperatures, make sure that the expansion loops and joints are properly installed.	This helps to prevent misalignment due to linear expansion of the piping.

Alignment criteria for pump flanges

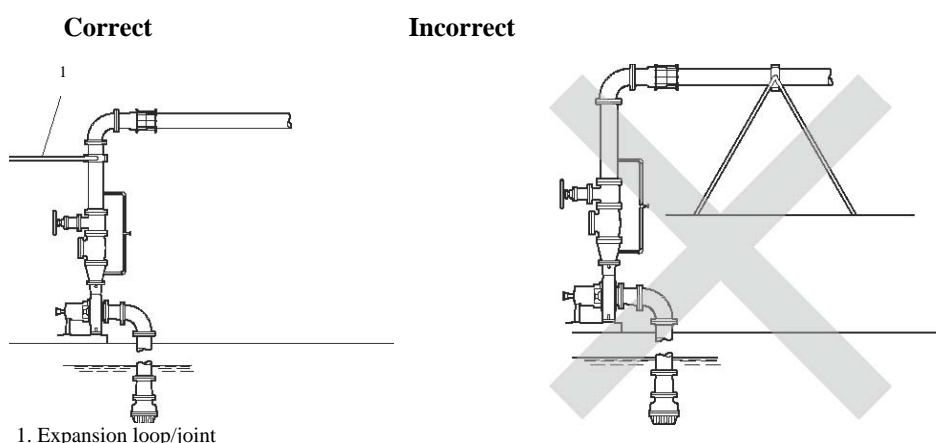
Type Criteria

Axial -The flange gasket thickness is ± 0.03 in. (0.8 mm).

Parallel- Align the flange to be within 0.001 in./in. to 0.03 in./in. (0.025 mm/mm to 0.8 mm/mm) of the flange diameter.

Concentric- You should be able to install the flange bolts easily by hand.

Example: Installation for expansion



Suction-piping checklist

Performance curve reference

Net positive suction head available (NPSHA) must always exceed NPSH required (NPSHR) as shown on this pump's published performance curve.

Suction-piping checks

Check Explanation/comment Checked

Check that the distance between the inlet flange and suction elbow and is at least five pipe diameters distant.

Check that elbows in general do not have sharp bends. See the illustrations that follow.

An eccentric reducer should be installed between the pump inlet and the suction piping.

See the illustrations that follow.

Check that the eccentric reducer at the pump's flange has the following properties:

- Sloping side down
- Horizontal side at the top

If suction strainers or suction bells are used, check Suction strainers to make sure they are clean and at least 3 times the area of the suction piping.

- Mesh holes with a diameter of minimum 1/16 in. (1.6 mm) are recommended.

If necessary, make sure that the suction piping includes a drain valve and that it is correctly installed.

Liquid source below the pump

Check

Make sure that the suction piping is free from air pockets.

Check that the suction piping slopes upwards from the liquid source to the pump inlet.

If the pump is not self-priming, check that a device for priming the pump is installed.

Explanation/comment Checked

This helps to prevent occurrence of air and cavitation in the pump inlet.

Use a foot valve with a diameter at least equivalent to the diameter of the suction piping.

Liquid source above the pump

Check

Check that an isolation valve is installed in the suction piping at a distance of at least two times the pipe diameter from the suction inlet.

Explanation/comment Checked

This permits closing the line during pump inspection and maintenance. Do not use the isolation valve to throttle the pump. Throttling may cause the following problems

Loss of priming
Excessive temperatures
Damage to the pump
Voiding the warranty

Make sure that the suction piping is free from air pockets.

Check that the piping is level or slopes downward from the liquid source.

Make sure that no part of the suction piping extends below the suction flange of the pump.

This helps to prevent occurrence of air and cavitation in the pump inlet.

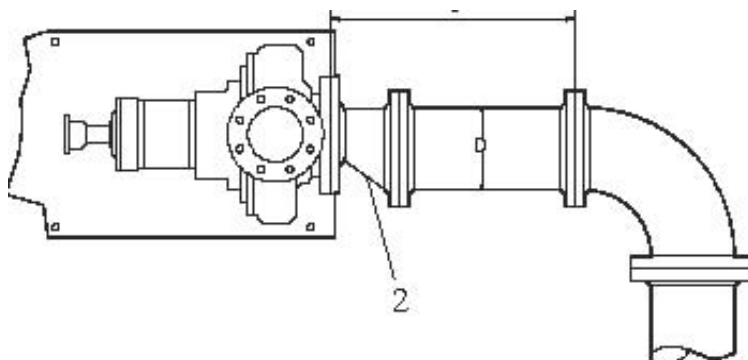
Make sure that the suction piping is adequately submerged below the surface of the liquid source.

This prevents air from entering the pump through a suction vortex.

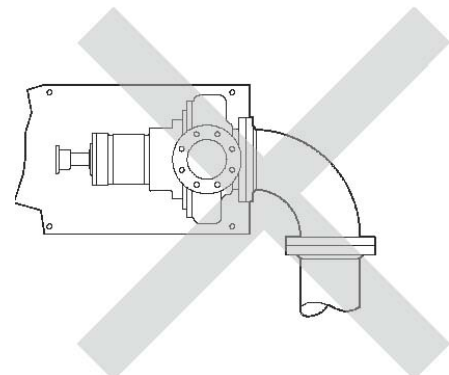
Example: Elbow close to the pump suction inlet

Correct

The correct distance between the inlet flange of the pump and the closest elbow must be at least five pipe diameters.



Incorrect



Final piping checklist

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

Baseplate-mounting procedures

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

1. Make sure that all baseplate surfaces that will contact grout are free from contamination such as rust, oil, and grime.
2. Thoroughly clean all baseplate surfaces that will come in contact with grout. Make sure to use a cleaner that will not leave residue.
3. Make sure that all machined surfaces are free from burrs, rust, paint, or any other type of contamination.
4. If necessary, use a honing stone to remove burrs.

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

Prepare the foundation for mounting

1. Chip the top of the foundation a minimum of 1.0 in. (25 mm) to remove porous or low-strength concrete. If you are using a pneumatic hammer, make sure that it does not contaminate the surface with oil or other moisture.

NOTICE: Do not chip the foundation using heavy tools such as jackhammers. Doing so can damage the structural integrity of the foundation.

2. Remove water or debris from the foundation bolt holes or sleeves.
3. Does your base use sleeve-type bolts?
 - If yes: Fill the sleeves with a non-binding, moldable material and seal to prevent the grout from entering.
 - If no: Proceed to step 4.
4. Coat the exposed portion of the anchor bolts with a non-bonding compound such as paste wax to prevent the grout from adhering to the anchor bolts. Do not use oils or liquid wax.
5. If recommended by the grout manufacturer, coat the foundation surface with a compatible primer.

Install the baseplate using jackscrews

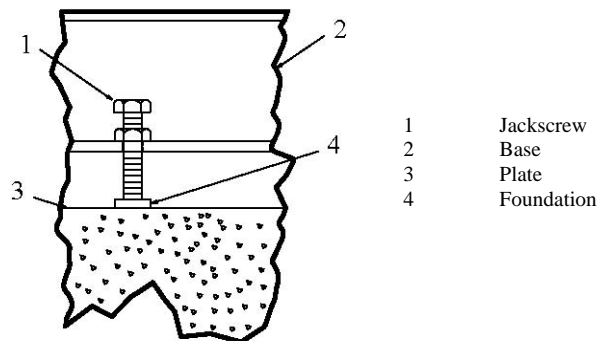
You will need the following:

- Anti-seizing compound
- Jackscrews
- Bar stock
- Two Machinist level

1 Apply an anti-seizing compound on the jackscrews. The compound makes it easier to remove the screws after the grouting.

2 Lower the base carefully onto the foundation bolts and do the following: a) Cut the plates from the bar stock and chamfer the edges of the plates to reduce stress concentrations. b) Put the plates between the jackscrews and the foundation surface. c) Raise the base above the foundation with the four jackscrews in the corners. The distance between the base and the foundation surface should be between 0.75 in.

(20 mm) and 1.50 in. (40 mm). d) Make sure that the center jackscrews do not touch the foundation surface yet.



3. Level the driver's mounting pads as follows:

NOTICE: Remove all dirt from the mounting pads to ensure correct leveling. Failure to do so may result in equipment damage or decreased performance.

a) Put one machinist's level lengthwise on one of the two pads. b) Put the other machinist's level across the ends of the two pads. c) Level the pads by adjusting the four jackscrews in the corners.

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

Turn the center jackscrews down so they rest on their plates on the foundation surface. Level the pump's mounting pads as follows:

NOTICE: Remove all dirt from the mounting pads to ensure correct leveling. Failure to do so may result in equipment damage or decreased performance.

a) Put one machinist's level lengthwise on one of the two pads. b) Put the other level across the center of the two pads. c) Level the pads by adjusting the four jackscrews in the corners.

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

Tighten the nuts for the foundation bolts by hand.

Check that the driver's mounting pads are level and adjust the jackscrews and the foundation bolts if necessary.

Correct level measurements are maximum 0.002 in./ft (0.167 mm/m). The maximum variation from one side of the baseplate to the other is 0.015 in. (0.38 mm).

Install the pump, driver, and coupling

- 1 Mount and fasten the pump on the base. Use applicable bolts.
- 2 Mount the driver on the base. Use applicable bolts and hand tighten.
- 3 Install the coupling. See the coupling manufacturer's installation instruction.

Pump-to-driver alignment

Precautions



WARNING:

- Follow shaft alignment procedures to prevent catastrophic failure of drive components or unintended contact of rotating parts. Follow the coupling manufacturer's coupling installation and operation procedures.
- ALWAYS lock out power to the driver before performing any installation or maintenance tasks. Failure to lock out driver power will result in serious physical injury.

NOTICE: Proper alignment is the responsibility of the installer and the user of the unit. You must check the alignment of frame-mounted units before the unit is operated. Failure to do so may result in equipment damage or decreased performance.

Alignment methods

Three common alignment methods are used:

- Dial indicator
- Reverse dial indicator
- Laser

Follow the equipment manufacturer's instructions when using the reverse dial indicator or laser methods. Detailed instructions for using the dial indicator method are contained in this section.

Alignment checks

When to perform alignment checks

Alignment checks must be performed when the following occurs:

- The process temperature changes.
- The piping changes.
- The pump has been serviced.

Types of alignment checks

Type of check

When it is used

Initial alignment (cold alignment)check

Prior to operation when the pump and the driver are at ambient temperature.

Final alignment (hot alignment)check

After operation when the pump and the driver are at operating temperature.

Initial alignment (cold alignment) checks

When

Before grouting the baseplate

Why

This ensures that alignment can be accomplished.

After grouting the baseplate
the piping

This ensures that no changes have occurred during the grouting . After connecting
This ensures that pipe strains have not altered the alignment.

Final alignment (hot alignment) checks

After the first run This ensures correct alignment when both the pump and the driver are at operating temperature.

Periodically This follows the plant operating procedures.

Indicator values for alignment checks

NOTICE: The specified perm reading values are valid at operating temperature only. For cold settings, other values are permTRUFLOed. You must use the correct tolerances. Failure to do so may result in misalignment and reduced pump reliability.

IMPORTANT

For electric motors, the motor shaft initial (cold) parallel vertical alignment setting should be 0.002 to 0.004 in. (0.05 to 0.10 mm) lower than the pump shaft.

For other drivers such as turbines and engines, follow the driver manufacturers' recommendations.

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

- 1-The total indicator runout is a maximum of 0.002 in. (0.05 mm) at operating temperature.
- 2-The tolerance of the indicator is 0.0005 in./in. (0.0127 mm/mm) of indicator separation at operating temperature.

Alignment measurement guidelines

Rotate the pump coupling half and the driver's coupling half. This prevents incorrect measurement. together so that the indicator rods have contact with the same points on the driver's coupling half.

Move or shim only the driver to make adjustments. This prevents strain on the piping installations.

Ensure that the hold-down bolts for the driver's feet are tight. This prevents the driver from moving as when you take indicator measurements.

Ensure that the hold-down bolts for the driver's feet are loose This makes it possible to move the driver when correcting before you make alignment corrections.

Check the alignment again after any mechanical adjustments. This corrects any misalignments that an adjustment may have caused.

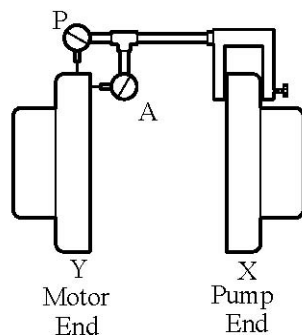
Attach the dial indicators for alignment

You must have two dial indicators to complete this procedure.

1. Attach two dial indicators on the pump's coupling half:

- a) Attach one indicator so that the indicator rod comes into contact with the perimeter of the driver's coupling half. This indicator is used to measure parallel misalignment.

b) Attach the other indicator so that the indicator rod comes into contact with the inner end of the driver's coupling half. This indicator is used to measure angular misalignment.



- 1 Rotate the pump's coupling half to check that the indicators are in contact with the driver's coupling half but do not bottom out.
- 2 Adjust the indicators if necessary.

Pump-to-driver alignment instructions Perform

angular alignment (vertical correction)

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

If your reading value is...

Then...

negative

- raise the driver's feet at the shaft end (add shims), or
- lower the driver's feet at the other end (remove shims).

positive

- lower the driver's feet at the shaft end (remove shims), or
- raise the driver's feet at the other end (add shims).

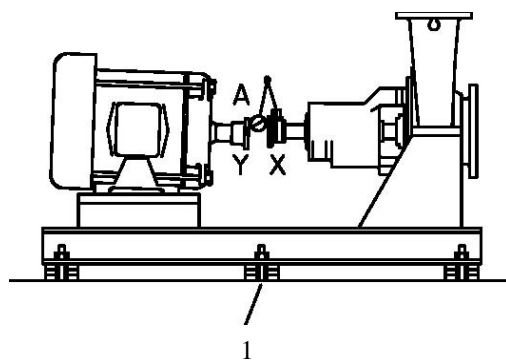


Figure 5: Example of incorrect vertical alignment (side view)

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

Perform angular alignment (horizontal correction)

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

When the reading value is...

Then the coupling halves are...

negative

farther apart on the right side than the left.

positive

closer together on the right side than the left.

4. Do as follows:

If your reading value is...

Then slide...

negative

- the shaft end of the driver to the left, or
- the opposite end to the right.

positive

- the shaft end of the driver to the right, or
- the opposite end to the left.

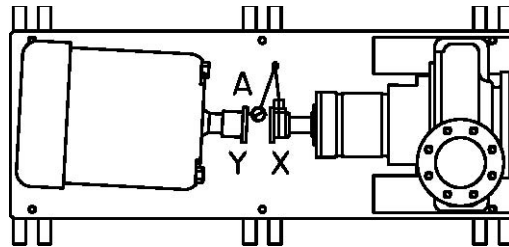


Figure 6: Example of incorrect horizontal alignment (top view)

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

Perform parallel alignment (vertical correction)

Before you start this procedure, make sure that the dial indicators are correctly set up. A unit is in parallel alignment when indicator P (parallel indicator) does not vary by more than 0.002 in. (0.05 mm) as measured at four points 90° apart at the operating temperature.

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

When the reading value is...

Then the pump's coupling half is...

negative positive

lower than the driver's coupling half.

higher than the driver's coupling half.

4. Do as follows:

If the reading value is..

Then...

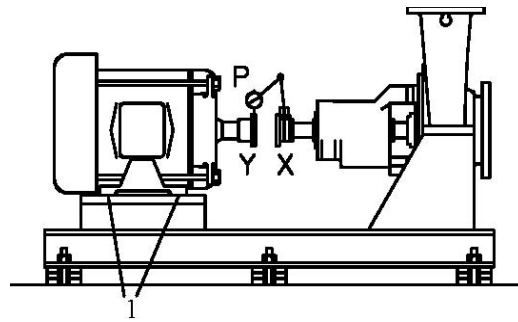
negative

remove shims of a thickness equal to half of the indicator reading value under each driver's foot.

positive

add shims of a thickness equal to half of the indicator reading value to each driver's foot.

NOTICE: You must use an equal amount of shims with each driver foot to prevent misalignment. Failure to do so may result in equipment damage or decreased performance.



1. Shims

Figure 7: Example of incorrect vertical alignment (side view)

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

Perform parallel alignment (horizontal correction)

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

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

When the reading value is...	Then the driver's coupling half is...
negative	to the left of the pump's coupling half.
positive	to the right of the pump's coupling half.

4. Do as follows:

If your reading value is...	Then...
------------------------------------	----------------

negative or positive slide the driver carefully in the appropriate direction.

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

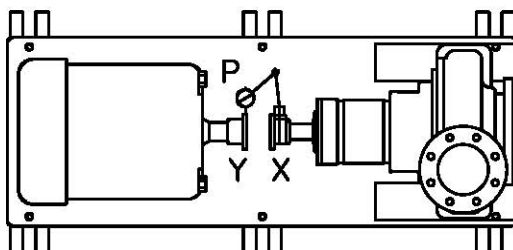


Figure 8: Example of incorrect horizontal alignment (top view)

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

Perform complete alignment (vertical correction)

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

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

Perform complete alignment (horizontal correction)

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

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

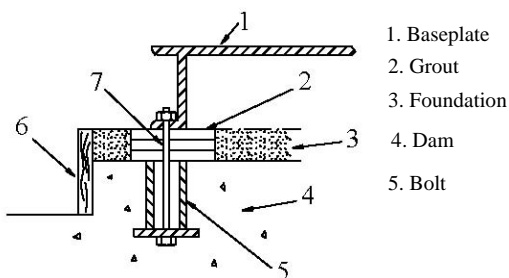
Grouting the baseplate

You need the following:

- Cleaners: Do not use oil-based cleaners because the grout will not bond to it. See the grout manufacturer's instructions.
- Grout: Non-shrink grout is recommended.

NOTICE: It is assumed that the installer who grouts the base has knowledge of acceptable methods. More detailed procedures are described in various publications, including API Standard 610, 10th Edition, Appendix L; API RP 686, Chapter 5; and other industry standards.

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



6. Remove the leveling screws after the grout hardens to remove any stress points.
7. Tighten the foundation bolts.

Commissioning, Startup, Operation, and Shutdown

NOTICE:

Verify the driver settings before you start the pump.
Make sure that the warm-up rate does not exceed 2.5°F (1.4°C) per minute.

Precautions

You must follow these precautions before you start the pump:

- Flush and clean the system thoroughly to remove dirt or debris in the pipe system in order to prevent premature failure at initial startup.
- Bring variable-speed drivers to the rated speed as quickly as possible.
- Run a new or rebuilt pump at a speed that provides enough flow to flush and cool the close-running surfaces of the stuffing-box bushing or .
- If temperatures of the pumped fluid will exceed 200°F (93°C), then warm up the pump prior to operation. Circulate a small amount of fluid through the pump until the casing temperature is within 100°F (38°C) of the fluid temperature.

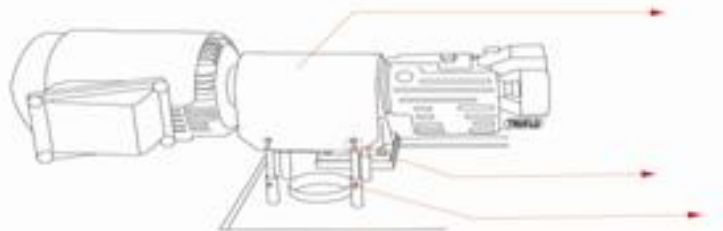
At initial startup, do not adjust the variable-speed drivers or check for speed governor or over-speed trip settings while the variable-speed driver is coupled to the pump. If the settings have not been verified, then uncouple the unit and refer to instructions supplied by the driver manufacturer.



WARNING:

Remove the coupling guard

1. Remove the bolt from the leg of coupling guard.
2. Remove the coupling guard from the leg.



Check the rotation

- Operating the pump in reverse rotation can result in the contact of metal parts, heat generation, and breach of containment.
 - ALWAYS lock out power to the driver before performing any installation or maintenance tasks. Failure to lock out driver power will result in serious physical injury.
- 1 Lock out power to the driver.
 - 2 Make sure that the coupling hubs are fastened securely to the shafts.
 - 3 Make sure that the coupling spacer is removed. The pump ships with the coupling spacer removed.
 - 4 Unlock power to the driver.
 - 5 Make sure that everyone is clear, and then jog the driver long enough to determine that the direction of rotation corresponds to the arrow on the bearing housing.
 - 6 Lock out power to the driver.

Couple the pump and driver



WARNING:

ALWAYS lock out power to the driver before performing any installation or maintenance tasks. Failure to lock out driver power will result in serious physical injury.

Couplings must have proper certification to be used in an ATEX classified environment. Use the instructions from coupling manufacturer to lubricate and install the coupling.

Coupling guard assembly

Precautions



WARNING:

- NEVER operate the pump without the coupling guard correctly installed.
- ALWAYS lock out power to the driver before performing any installation or maintenance tasks. Failure to lock out driver power will result in serious physical injury.
- The coupling used in an Ex-classified environment must be properly certified and must be constructed from a non-sparking material.

Install the coupling guard

1. Adjust coupling alignment before install guard.
2. Place coupling guard on support of coupling guard.
3. Fasten bolt to support of coupling guard.

Bearing lubrication

Precautions



WARNING:
Make sure to properly lubricate the bearings. Failure to do so can result in excess heat generation, sparks, and premature failure.

Pumps are usually shipped without oil

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

Ring oil lubrication

Ring oil-lubricated bearings are standard on Model TSP 10th Edition pumps. Make sure that oil rings are properly seated in the grooves in the shaft.

Pure or purge oil-mist lubrication

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

Oil volumes

Oil volume requirements This table shows the required amount of oil for oil-lubricated bearings. All frames in this table use Trico Oiler #5 and have an oiler volume of 8 oz. (237 ml).

Frame	Frame oil volume	
	ounces	milliliters
S	20	600
M	38	1115
L	32	950
XL	47	1385
	72	2120
	89	2625

Lubricating-oil requirements

Oil quality requirements

Use a high-quality turbine oil with rust and oxidation inhibitors rated at 68 cSt. at 100°F (38°C).

Oil requirements based on temperature For the majority of operational conditions, bearing temperatures run between 120°F (49°C) and 180°F (82°C) and you can use an oil of ISO viscosity grade 68 at 100°F (40°C). If temperatures exceed 180°F (82°C), refer to the table for temperature requirements.

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

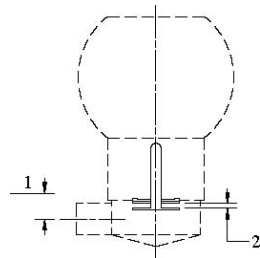
Acceptable oil for lubricating bearings

Acceptable lubricants : ISO VG 46 or ISO VG 68

Lubricate the bearings with oil

Ring oil-lubricated pumps are supplied with an oiler that maintains a constant oil level in the bearing housing.

1. Set the oiler adjusting stem so that the oil is at the level of the mark on the side of the frame, which corresponds to the center of the bullseye sight glass. Adjust the setting dimension to 0 by removing the oiler-adjusting stem.



1. Oil level (3/16 in. (4.8 mm))
2. Setting dimension of "0"

2. Fill the oil reservoir in the bearing frame:
 - a) Fill the oiler bottle with oil. b) Place the oiler bottle into the oiler housing. You will need to fill the oiler bottle several times.

NOTICE: Do not fill the oil reservoir of the bearing frame through the vent or through the oiler housing without using the oiler bottle.

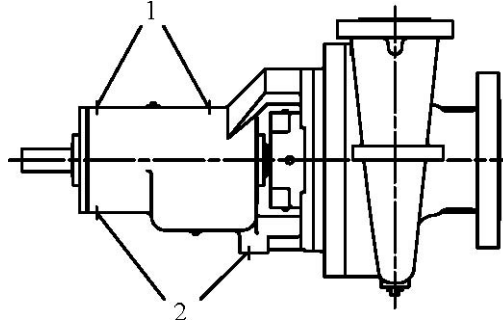
3. Verify that the oil level is correct by comparing the oil level as viewed in the bullseye sight glass with the oil level line on the side of the bearing frame.

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

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

The oil requirements for ring-oil-lubricated bearings also apply to oil-mist-lubricated bearings.

1. Prepare the oil-mist generator according to the manufacturer's instructions.
2. Connect the oil-mist supply lines to the inlet connections.



3. Connect the drain and vent lines to the outlet connections.

Oil mist inlet

Oil mist outlet

Lubricate the bearings after a shutdown period

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

Shaft sealing with a mechanical seal

Precautions



WARNING:

The mechanical seal used in an Ex-classified environment must be properly certified. Prior to startup, make sure that all areas that could leak pumped fluid to the work environment are closed.

NOTICE:

- The mechanical seal must have an appropriate seal-flush system. Otherwise, excess heat generation and seal failure can occur.
- Cooling systems such as those for bearing lubrication and mechanical-seal systems must be operating properly to prevent excess heat generation, sparks, and premature failure.
- Sealing systems that are not self-purging or self-venting, such as plan 23, require manual venting prior to operation. Failure to do so will result in excess heat generation and seal failure.

Shipping

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

Cartridge-type mechanical seals

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

Other mechanical seal types

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

Connection of sealing liquid for mechanical seals

Seal lubrication is required

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

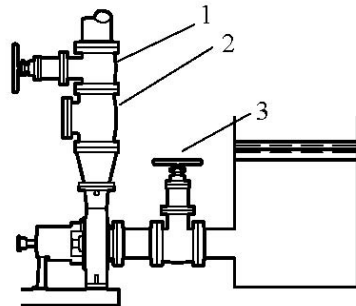
Seal flushing methods

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

Pump priming

Prime the pump with the suction supply above the pump

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



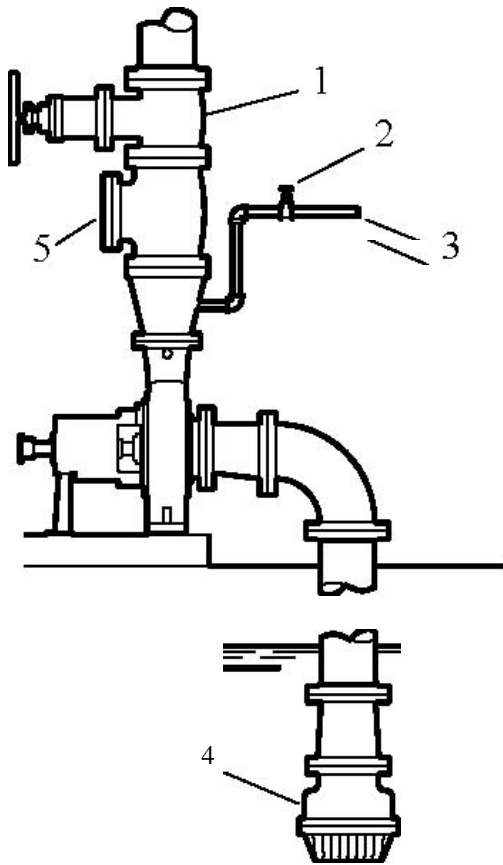
1. Discharge isolation valve
2. Check valve
3. Suction isolation valve

Prime the pump with the suction supply below the pump

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

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

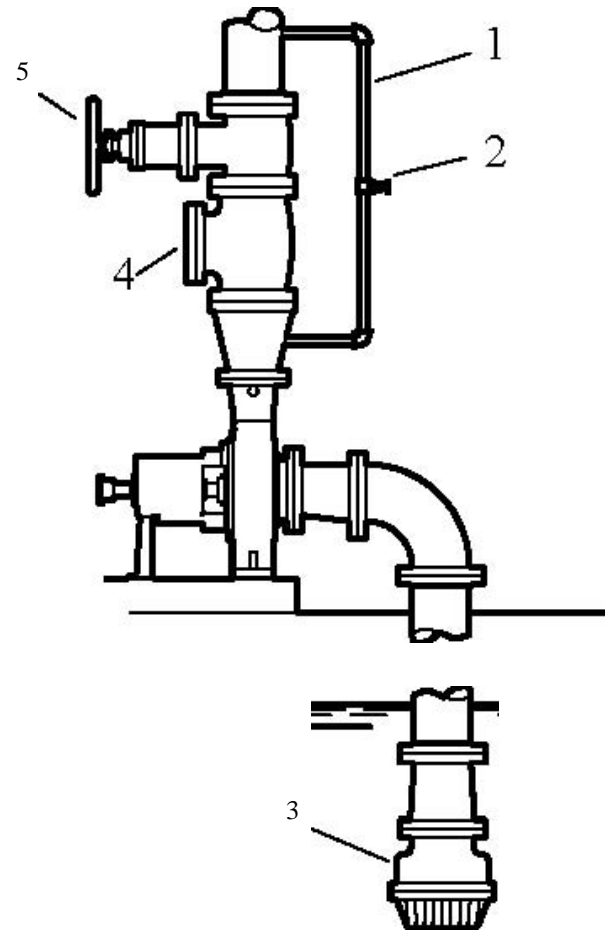
1. Close the discharge isolation valve.
2. Open the air vent valves in the casing.
3. Open the valve in the outside supply line until only liquid escapes from the vent valves.
4. Close the vent valves.
5. Close the outside supply line. This illustration is an example of priming the pump with a foot valve and an outside supply.



1. Discharge isolation valve
2. Shutoff valve
3. From outside supply
4. Foot valve
5. Check valve

This illustration is an example of priming the pump with a foot valve using a bypass around the check valve.

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



Other methods of priming the pump

Besides the methods described in the procedures in this section, you can also prime the pump using the following methods:

- Priming by ejector
- Priming by automatic priming pump

Start the pump



CAUTION:

- Immediately observe the pressure gauges. If discharge pressure is not quickly attained, stop the driver, reprime, and attempt to restart the pump.
- Observe the pump for vibration levels, bearing temperature, and excessive noise. If normal levels are exceeded, shut down the pump and resolve the issue.

Before you start the pump, you must do the following:

- Open the suction valve.
 - Open any recirculation or cooling lines.
1. Fully close or partially open the discharge valve, depending on system conditions.
 2. Start the driver.
 3. Slowly open the discharge valve until the pump reaches the desired flow.
 4. Immediately check the pressure gauge to ensure that the pump quickly reaches the correct discharge pressure.
 5. If the pump fails to reach the correct pressure, do the following: stop the motor, prime again, then restart motor
 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.

Pump operation precautions

General considerations



CAUTION:

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

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

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

The oil rings are turning. The oil rings are throwing oil. Replace the plugs.

NOTICE:

- On pure or purge-oil mist-lubricated units, remove the viewing port plugs to verify that oil mist is flowing properly. Replace the plugs.
- On ring oil and purge-oil mist-lubricated pumps, make sure the oil level has remained steady by checking the oiler.
- Check the bearing temperatures using a pyrometer or other temperature-measuring device. Monitor the bearing temperature frequently during initial operation in order to determine if a bearing problem exists, as well as to establish normal bearing operating temperature.
- For pumps with auxiliary piping, make sure that proper flows have been established and that the equipment is operating properly.
- Establish baseline vibration readings in order to determine normal running conditions. If the unit is running roughly, then consult the factory.
- Monitor all gauges to ensure that the pump is running at or near rating and that the suction screen (when used) is not clogged.

Operation at reduced capacity



WARNING:

Never operate any pumping system with a blocked suction and discharge. Operation, even for a brief period under these conditions, can cause enclosed pumped fluid to overheat, which results in a violent explosion. You must take all necessary measures to make sure that this condition is avoided.



CAUTION:

Avoid excessive vibration levels. Excessive vibration levels can damage the bearings, stuffing box or seal chamber, and the mechanical seal, which may result in decreased performance.
Avoid increased radial load. Failure to do so may cause stress on the shaft and bearings.
Avoid heat build-up. Failure to do so may cause rotating parts to score or seize.
Avoid cavitation. Failure to do so may cause damage to the internal surfaces of the pump.

Operation under freezing conditions

NOTICE:

Do not expose an idle pump to freezing conditions. Drain all liquid that is inside the pump and the cooling coils. Failure to do so can cause liquid to freeze and damage the pump.

Shut down the pump



WARNING:

The pump can handle hazardous and toxic fluids. Identify the contents of the pump and observe proper decontamination procedures to eliminate the possible exposure to any hazardous or toxic fluids. Proper personal protective equipment should be worn. Potential hazards include, but are not limited to, high temperature, flammable, acidic, caustic, explosive, and other risks. Pumped fluid must be handled and disposed of in compliance with applicable environmental regulations.

1. Slowly close the discharge valve.
2. Shut down and lock the driver to prevent accidental rotation.

Make the final alignment of the pump and driver



WARNING:

ALWAYS lock out power to the driver before performing any installation or maintenance tasks. Failure to lock out driver power will result in serious physical injury. Follow shaft alignment procedures to prevent catastrophic failure of drive components or unintended contact of rotating parts. Follow the coupling manufacturer's coupling installation and operation procedures.

You must check the final alignment after the pump and driver are at operating temperature. For initial alignment instructions, refer to the Installation chapter.

- Run the unit under actual operating conditions for enough time to bring the pump, driver, and associated system to operating temperature.
- Shut down the pump and the driver.
- Remove the coupling guard.
- Check the alignment while the unit is still hot. Refer to the instructions in *Pump-to-driver alignment* on page 24 for details.
- Reinstall the coupling guard.
- Restart the pump and driver.

Dowel the pump casing (optional)

You will need the following tools:

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

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

1. Drill two holes, one in each casing mounting pad, at the locations provided.

Drill the holes through both the casing mounting pads and the baseplate pedestal, when possible. This makes it easier to clean the metal chips produced from the drilling and reaming operations.

NOTICE: If water-cooled pedestals have been provided, then do not drill through the baseplate pedestal. Doing so can result in leakage of cooling water.

-Clean all burrs and metal chips from the holes.

-Ream the holes with a number 7 taper pin reamer to the proper fit with the taper dowel pins. -Insert the pins deep enough that only the threaded portion is exposed when the pin is fully seated.

-Seat the taper pins firmly in the holes with a hardwood block or soft-faced hammer.

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

Maintenance

Maintenance schedule

Maintenance inspections

A maintenance schedule includes these types of inspections:

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

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

Routine maintenance

Perform the following tasks whenever you perform routine maintenance:

- Lubricate the bearings.
- Inspect the seal.

Routine inspections

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

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

Three-month inspections

Perform the following tasks every three months:

Check that the foundation and the hold-down bolts are tight.
Check the mechanical seal if the pump has been left idle, and replace as required.
Change the oil every three months (2000 operating hours) at minimum.
Change the oil more often if there are adverse atmospheric or other conditions that might contaminate or break down the oil.
Check the shaft alignment, and realign as required.

Annual inspections

Perform the following 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 do the following:

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

Bearing maintenance

These bearing lubrication sections list different pumped-fluid temperatures. If your pump is ATEX certified and your pumped-fluid temperature exceeds the permitted temperature values, then consult your TRUFLO representative.

Bearing lubrication schedule

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

Mechanical-seal maintenance



WARNING:

The mechanical seal used in an Ex-classified environment must be properly certified. Prior to startup, make sure that all areas that could leak pumped fluid to the work environment are closed.



CAUTION:

Never operate the pump without liquid supplied to mechanical seal. If you run a mechanical seal dry, even for a few seconds, this can cause seal damage. Physical injury can occur if a mechanical seal fails.

NOTICE:

- Sealing systems that are not self-purging or self-venting, such as plan 23, require manual venting prior to operation. Failure to do so will result in excess heat generation and seal failure.
- Cooling systems such as those for bearing lubrication and mechanical-seal systems, must be operating properly to prevent excess heat generation, sparks, and premature failure.
- The mechanical seal must have an appropriate seal flush system or excess heat generation and seal failure can occur.

Before you start the pump

Check the seal and all flush piping.

Mechanical seal life

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

Disassembly precautions



WARNING:

- Make sure that the pump is isolated from the system and that pressure is relieved before you disassemble the pump, remove plugs, open vent or drain valves, or disconnect the piping.
- ALWAYS lock out power to the driver before performing any installation or maintenance tasks. Failure to lock out driver power will result in serious physical injury.
- The pump and the components can be heavy. Make sure to use proper lifting methods, and wear steel-toed shoes at all times. Failure to do so can result in physical injury or equipment damage.
- The pump can handle hazardous and toxic fluids. Identify the contents of the pump and use proper decontamination procedures to eliminate the possible exposure to any hazardous or toxic fluids. Proper personal protective equipment should be worn. Potential hazards include, but are not limited to, high temperature, flammable, acidic, caustic, explosive, and other risks. Pumped fluid must be handled and disposed of in compliance with applicable environmental regulations.

NOTICE:

Make sure that all replacement parts are available before you disassemble the pump for overhaul.

Tools required

To disassemble the pump, you will need the following tools:

- Hex wrenches in sizes 12, 14, 16, 19, and 22 mm
- Brass drift punch
- Cleaning agents and solvents
- Dial indicators
- Drill
- Feeler gauges
- Induction bearing heater
- Lifting sling
- Micrometer
- Open end wrenches
- Press
- Soft face hammer
- Spanner wrench
- Spanning type puller
- Tap
- Torque wrench with sockets

Drain the pump



CAUTION:

- Allow all system and pump components to cool before you handle them to prevent physical injury.
- Close the isolation valves on the suction and discharge sides of the pump.

You must drain the system if no valves are installed.

- Open the drain valve. Do not proceed until liquid stops coming out of the drain valve. If liquid continues to flow from the drain valve, the isolation valves are not sealing properly and you must repair them before you proceed.
- Leave the drain valve open and remove the drain plug located on the bottom of the pump housing. -Do not reinstall the plug or close the drain valve until the reassembly is complete.
- Drain the liquid from the piping and flush the pump if it is necessary.
- Disconnect all auxiliary piping and tubing.
- Remove the oiler bottle and store it in a safe place.
- Remove the coupling guard.
- *Remove the coupling guard*
- Remove the coupling spacer.

Remove the back pull-out assembly



CAUTION:

Never remove the back pull-out assembly without assistance.

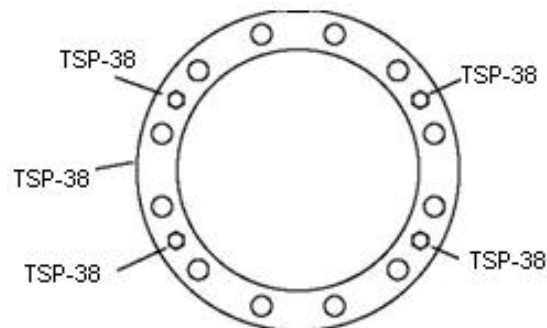
1. Remove the casing stud nuts.



WARNING:

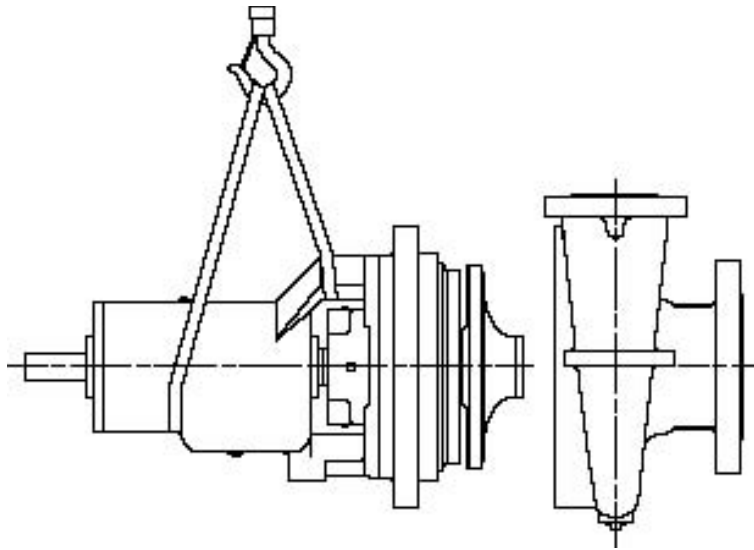
- If you must use heat to remove parts, you must drain all liquid and remove all vapor. To do this, purge the casing, seal chamber, and so forth, with dry compressed air or inert gas.

2. Tighten the jack screws evenly, using an alternating pattern, to remove the back pull-out assembly, you can use penetrating oil if the adapter to the casing joint is corroded.



- TSP-38 – Jack Screw

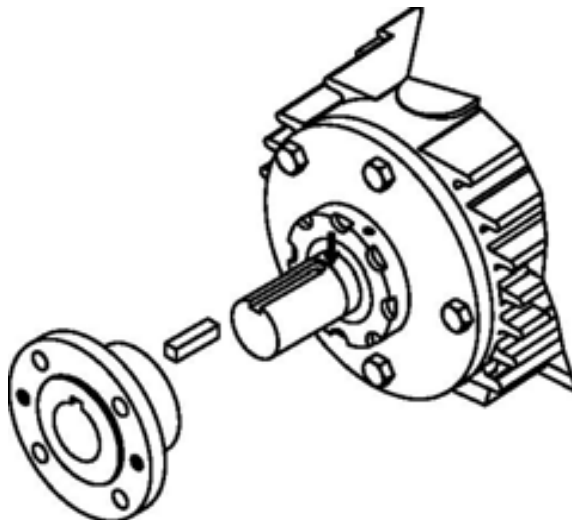
3. Remove the back pull-out assembly using a lifting sling through the bearing frame.



4. Remove and discard the casing gasket. Use a new casing gasket during reassembly.
5. Remove the jack screws.
6. Clean all gasket surfaces.
7. Secure the back pull-out assembly to prevent movement during transport.
8. Transport the back pull-out assembly to a clean work area for further disassembly.

Remove the coupling hub

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



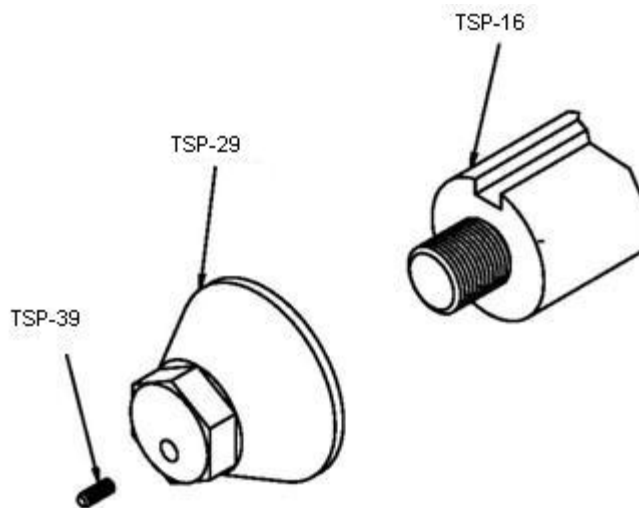
Remove the impeller



CAUTION:

Wear heavy work gloves when you handle impellers. The sharp edges can cause physical injury.

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



- TSP-16 – Shaft
- TSP-39 – Set Screw
- TSP-29 – Impeller nut

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

Remove the End cover

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

Disassemble the power end

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

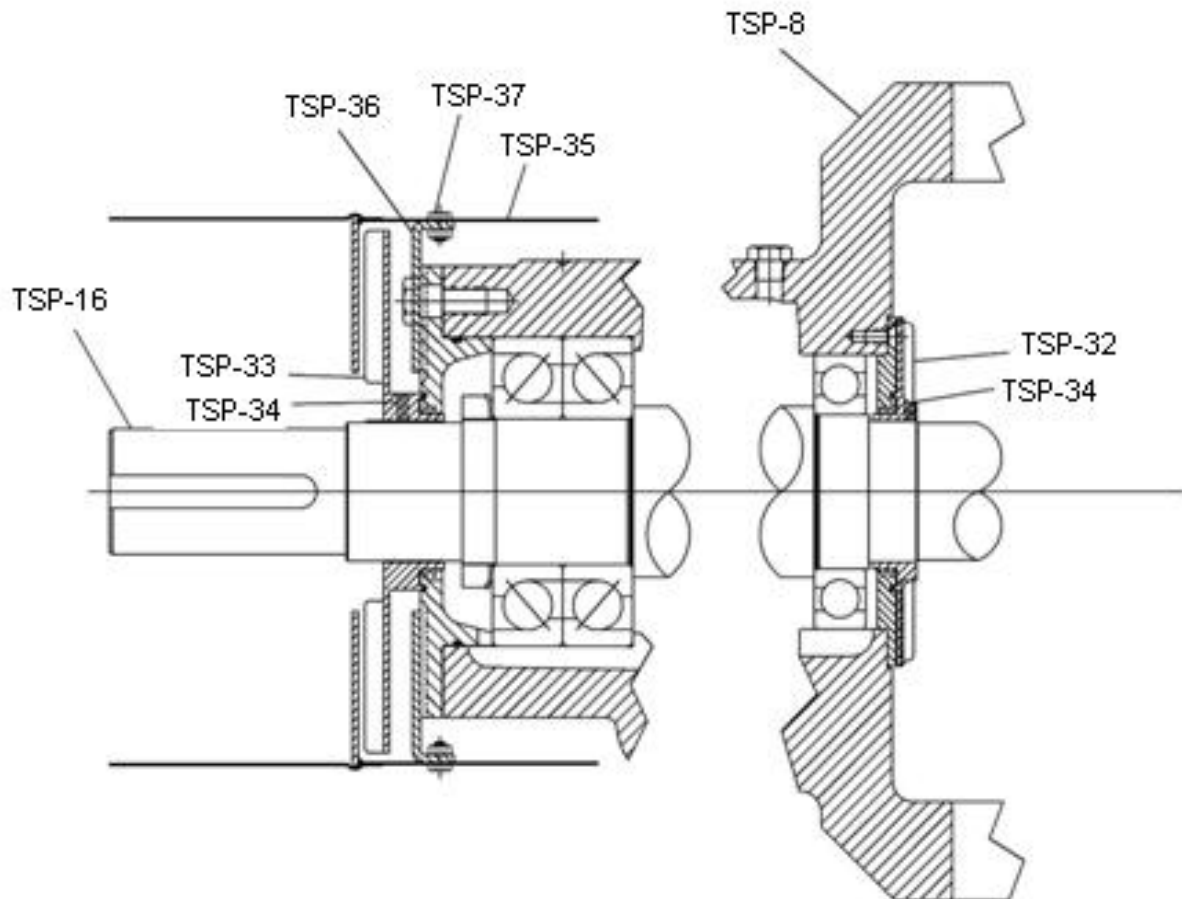
- Pure oil-mist-lubricated power end
- Radial-heat-flinger end
- Air-cooling package
- Water-cooling package



CAUTION:

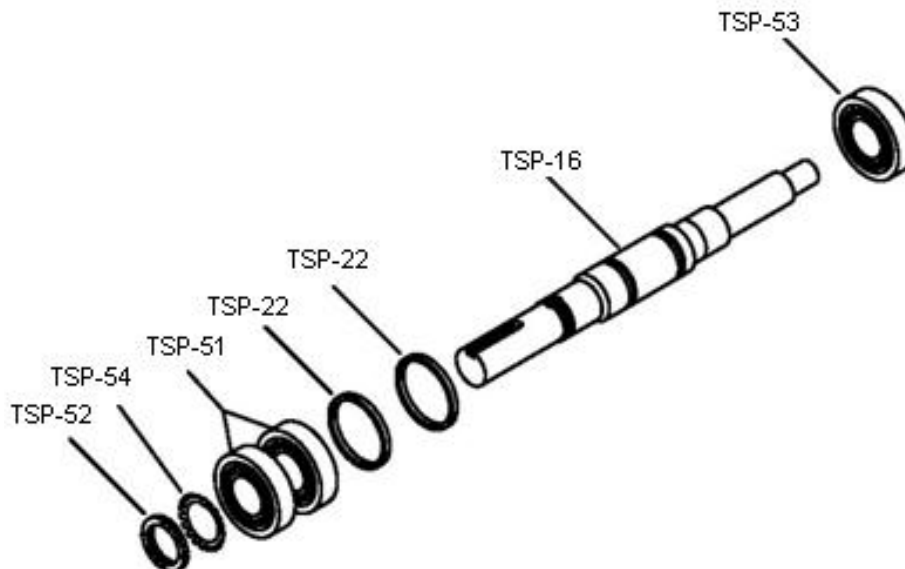
Do not remove bearings from the shaft unless you need to replace them.

The optional pure-oil mist-lubricated power ends are disassembled in the same manner as ring oil-lubricated power ends. Oil rings are not furnished with pure-oil-mist lubrication. Disregard any references to those parts.



- TSP-16 – Shaft
- TSP-32 – Radial Deflector fan
- TSP-33 – Thrust deflector fan
- TSP-34 – Deflector set screw
- TSP-8 – Bearing frame
- TSP-35 – Thrust deflector-fan guard
- TSP-36 – Thrust deflector-fan guard support
- TSP-37 – Support screws

1. Loosen and remove bolts on bearing cover.
2. Remove the two oil ring retainers and the oil ring inspection plugs from the top of the bearing frame.
3. If your power end has the optional water-cooling package, then remove the finned-tube cooling assembly from the bearing frame.
4. Carefully withdraw the shaft and bearing assembly from the bearing frame. Take care not to damage the oil rings. If the oil rings bind or hang up, you can access them through



5. TSP-51 – Duplex thrust bearing
6. TSP-22 – Oil rings
7. TSP-16 – Shaft
8. TSP-52 – Thrust-bearing locknut
9. TSP-54 - Lockwasher

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

6. Remove the radial bearing from the shaft: a) Loosen and remove the thrust-bearing locknut and lockwasher. b) Press or pull the duplex thrust bearing from the shaft. c) Remove the oil ring(s) from the shaft. d) Press or pull the radial bearing from the shaft.

Preassembly inspections Replacement guidelines

Casing check and replacement

- Inspect the casing for cracks and excessive wear. Thoroughly clean gasket surfaces and alignment fits to remove rust and debris. Repair or replace the casing if you notice any of these conditions:
- Localized wear or grooving that is greater than $\frac{1}{8}$ in. (3.2 mm) deep
- O-Ring that is greater than $\frac{1}{8}$ in. (3.2 mm) deep
- Case-gasket-seat surface that has irregularities

Casing areas to inspect

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

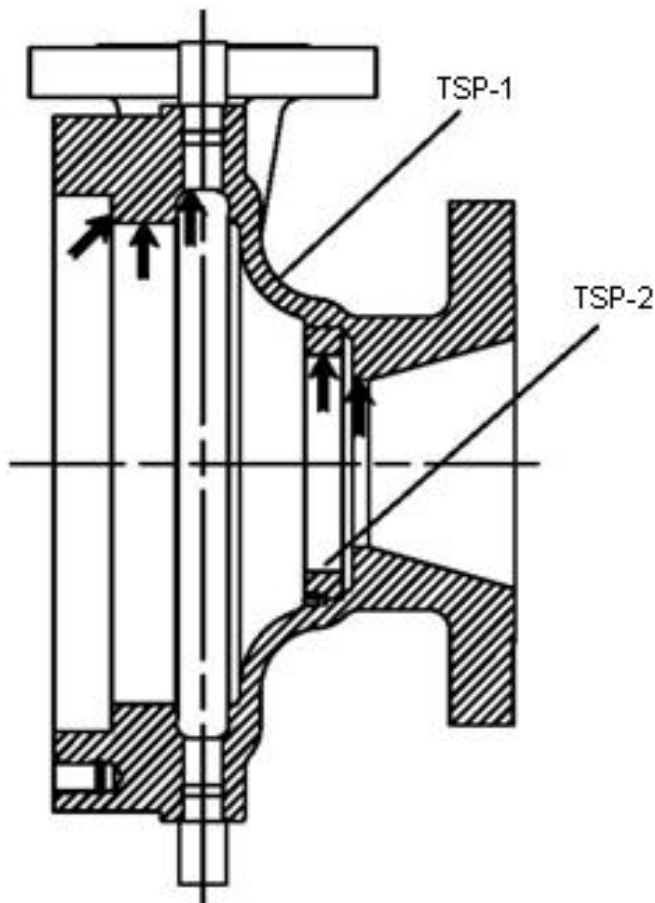


Figure 9: TSP casing

Impeller replacement

Impeller parts	When to replace
Impeller vanes	<ul style="list-style-type: none">• When grooved deeper than $\frac{1}{16}$ in. (1.6 mm), or• When worn evenly more than $\frac{1}{32}$ in. (0.8 mm)
Pumpout vanes	When worn or bent more than $\frac{1}{32}$ in. (0.8 mm)
Vane edges	When you see cracks, pitting, or corrosion damage

Impeller checks

Check and clean the impeller bore diameter.

Check the impeller balance. Rebalance the impeller if it exceeds the ISO 1940 G1.0 criteria.

NOTICE:

You must have accurate tooling equipment to balance impellers to the ISO 1940 G1.0 criteria.

Do not attempt to balance impellers to this tolerance unless this type of tooling and equipment is available.

Impeller areas to inspect

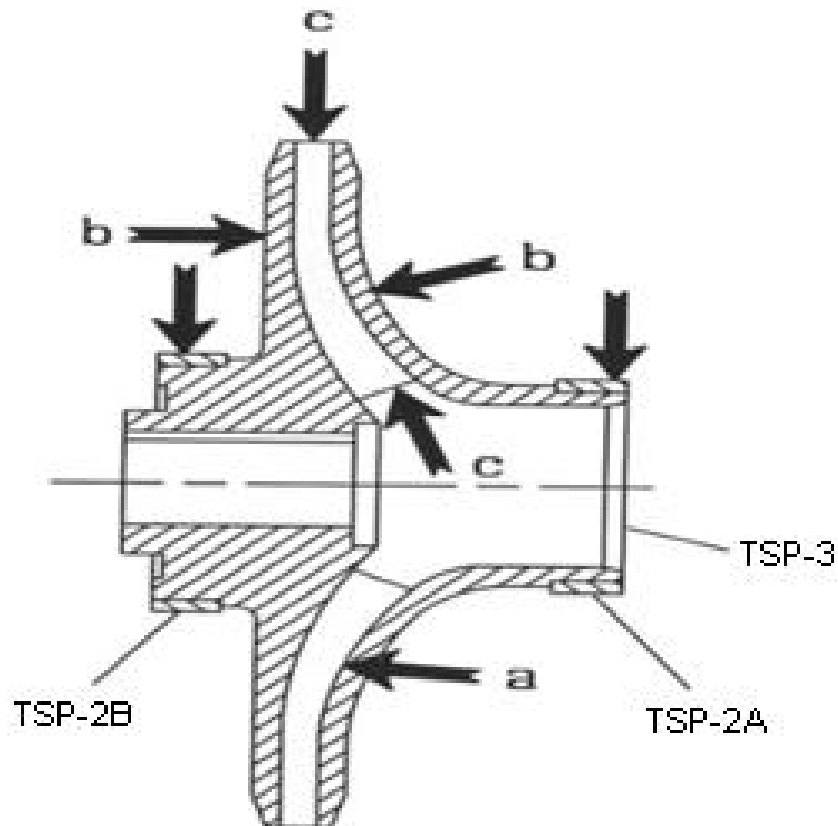


Figure 10: Areas to inspect for wear on the TSP pump

Oil ring replacement

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

Cartridge mechanical seal replacement

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

Coupling guard replacement

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

Gaskets, O-rings, shims, and seats replacement

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

Additional parts

Inspect and either repair or replace all other parts, if inspection indicates continued use would be harmful to satisfactory and safe pump operation. Inspection must include the following items:

- Bearing end covers (TSP-45) and (TSP-55)
- INPRO radial deflector (TSP-56) and thrust deflector (TSP-46)
- Radial heat flinger (TSP-32)*
- Thrust fan (TSP-33)*
- Bearing locknut (TSP-53)
- Impeller key (TSP-69) and coupling key
- Impeller screw (TSP-70)
- Impeller washer (TSP-71)
- Impeller lockwasher (TSP-72)
- Impeller nut (TSP-29)
- Bearing lockwasher (TSP-54)
- Water jacket cover (TSP-64)*
- All nuts, bolts, and screws

* If supplied.

Shaft replacement guidelines

Shaft measurement check

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

Shaft straightness check

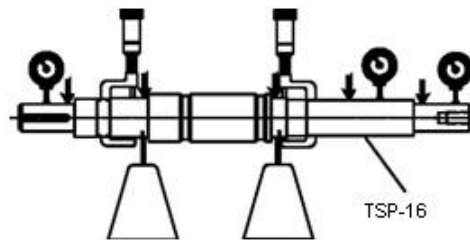
Check the shaft straightness. Use “V” blocks or balance rollers to support the shaft on the bearing fit areas. Replace the shaft if runout exceeds 0.001 in. (0.03 mm).

NOTICE:

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

Shaft surface check

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



Bearings inspection

Condition of bearings

Bearings should not be reused. The condition of the bearings provides useful information on operating conditions in the bearing frame.

Checklist

Perform these checks when you inspect the bearings:

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

Replacement bearings

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

Table 7: TSP bearings based on SKF / MRC designations

Group	Radial (inboard)	Thrust (outboard)
	6210 C3	7310 BEGAM
	6211 C3	7311 BEGAM
	6212 C3	7312 BEGAM
	6213 C3	7312 BEGAM
	6215 C3	7313 BEGAM
	6218 C3	7317 BEGAM
	6220 C3	7318 BEGAM

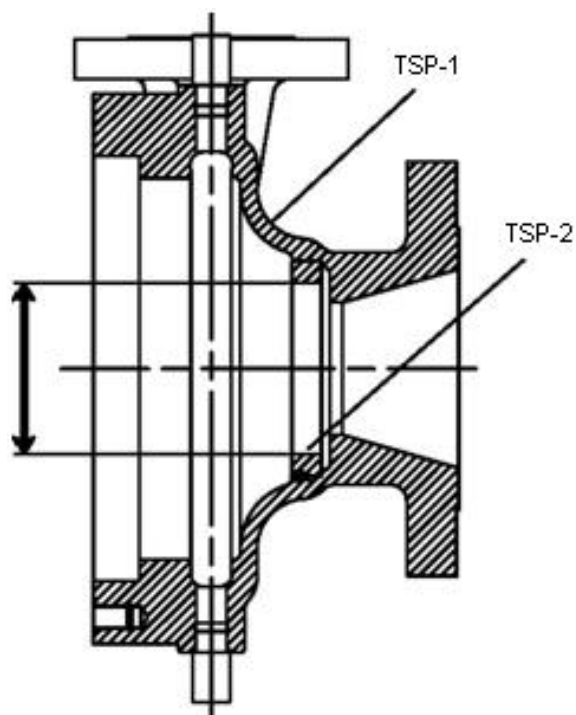
Wear rings inspection and replacement

Wear ring types

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

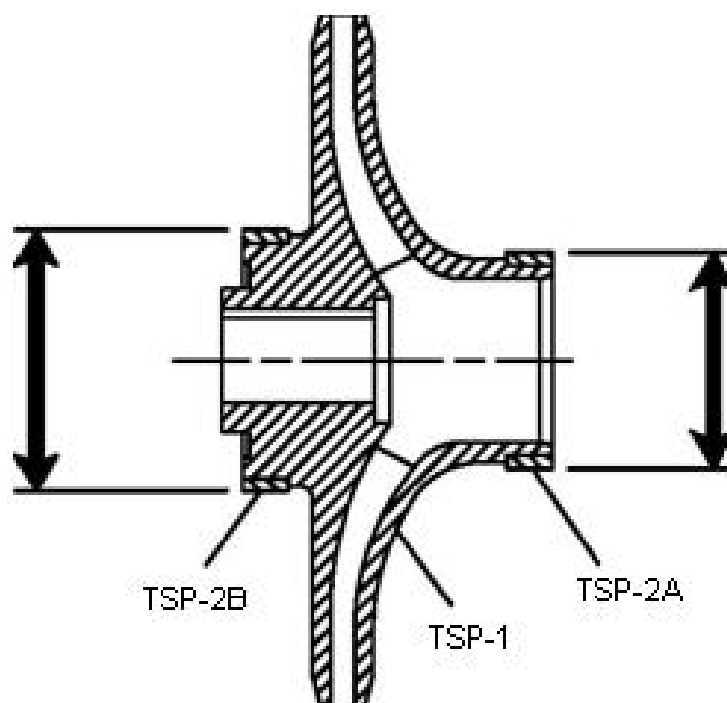
Wear ring diameter check

Measure all wear ring diameters and then calculate the diametrical wear ring clearances. See the Minimum running clearances table for more information.



- TSP-1 – Casing
- TSP-2 – Casing wear ring

Figure 11: Casing wear ring

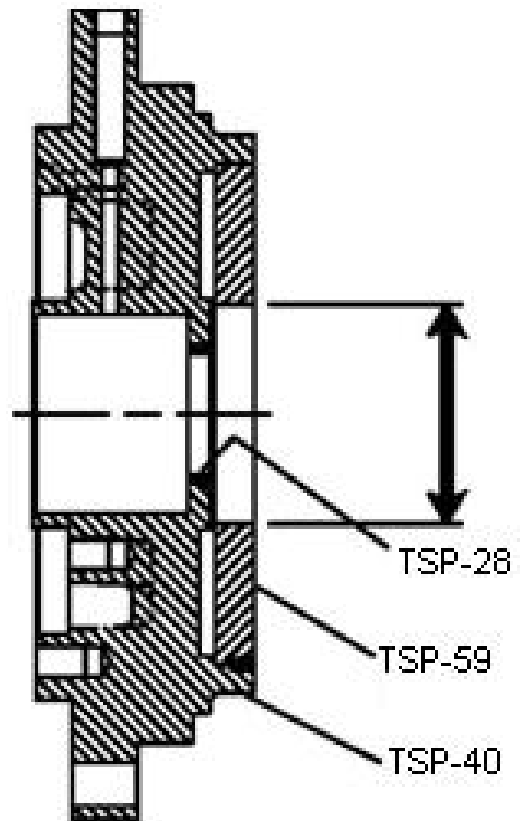


- TSP-1 – Impeller
- TSP-2A – Impeller wear ring
- TSP-2B – Impeller wear ring

Figure 12: Impeller wear ring

- TSP-28 – Seal-chamber throat bushing
- TSP-40 – Seal-Chamber cover
- TSP-59 – Seal-chamber cover wear ring

Figure 13: Seal chamber cover wear ring



When to replace wear rings

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

Replace the wear rings



WARNING:

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



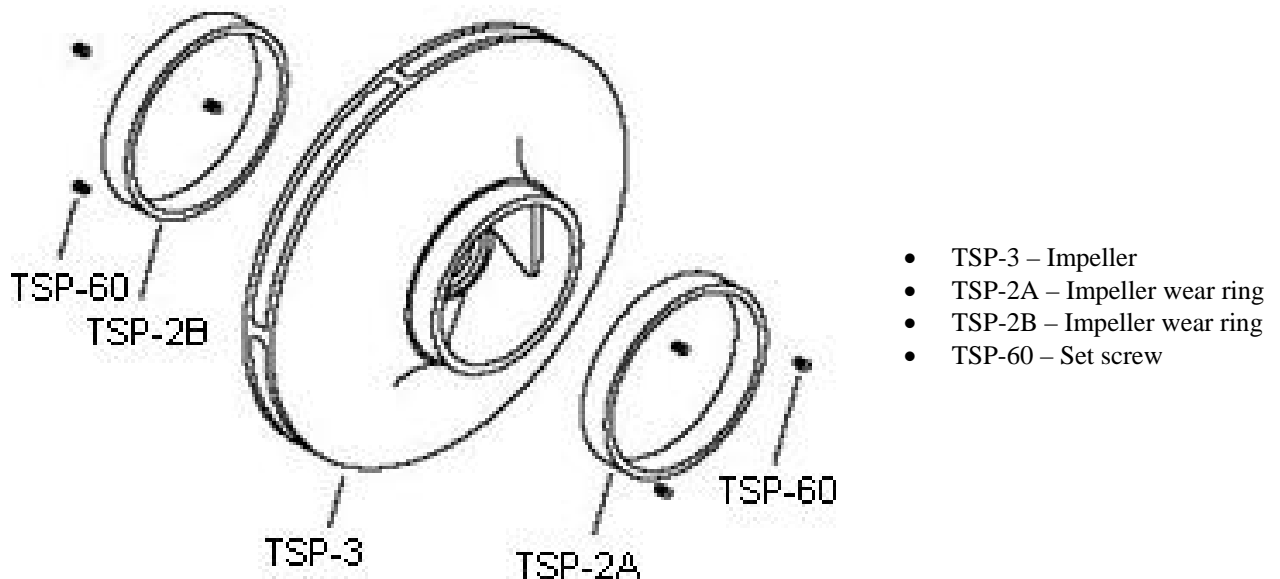
CAUTION:

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

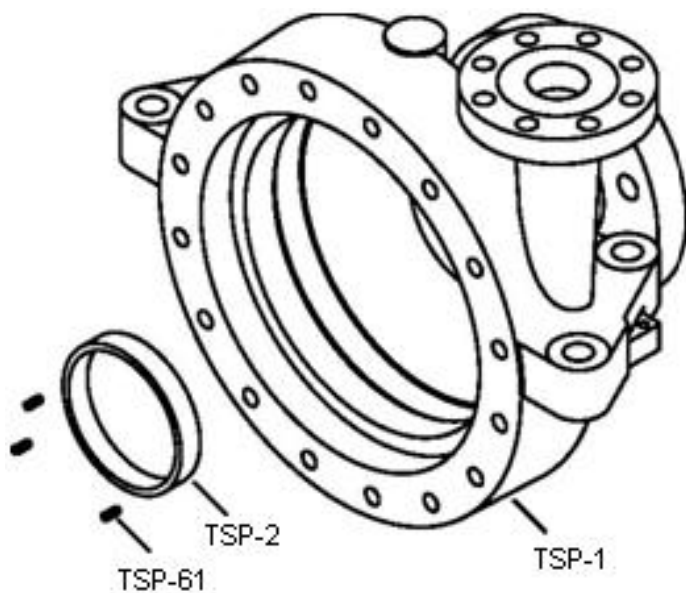
NOTICE:

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

1. Remove the wear rings: a) Remove the set screws. b) Remove the wear rings from the casing, impeller, and seal-chamber cover using a pry or puller to force the rings from the fits.
2. Clean the wear-ring seats thoroughly, and make sure that they are smooth and free of scratches.
3. Heat the new impeller wear rings to 180° to 200°F (82° to 93°C) using a uniform method for heating, such as an oven, and place them on the impeller wear-ring seats.



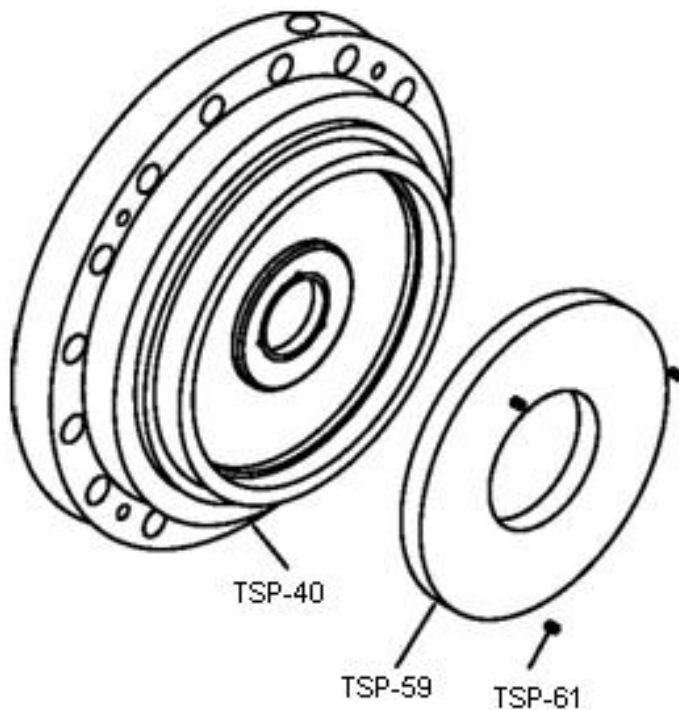
4. Chill the new casing wear ring using dry ice or another suitable chilling substance and install the ring into the casing fit. Be prepared to tap the ring in place with a wood block or soft-faced hammer.



- TSP-1 – Casing
- TSP-2 – Casing wear ring
- TSP-61 – Set screw

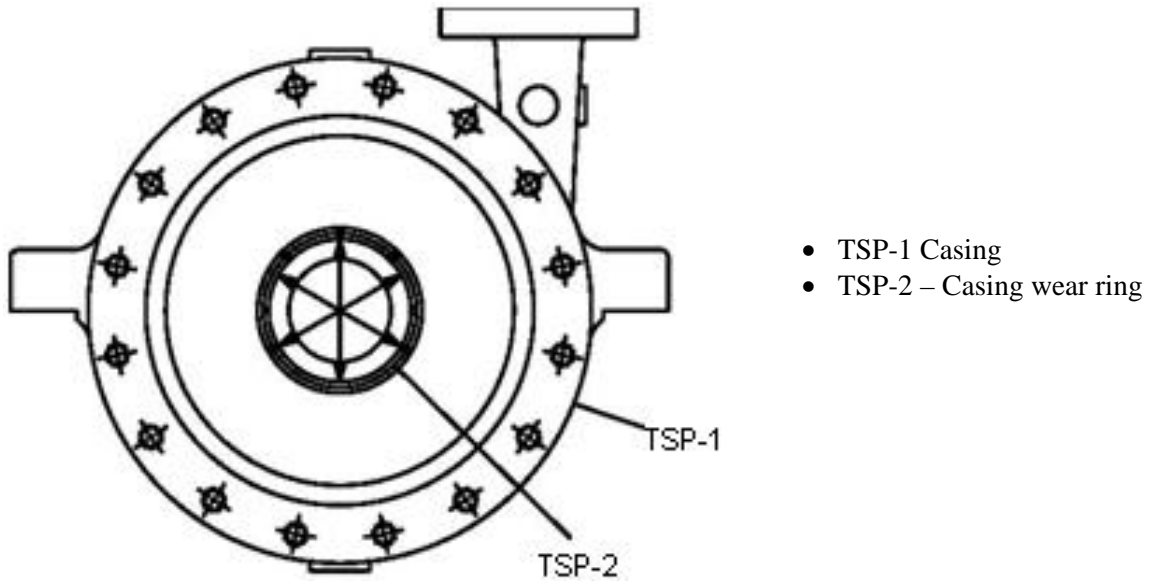
5. Insert a new seal-chamber-cover wear ring:

- Chill a new seal-chamber-cover wear ring, using dry ice or another suitable chilling substance, and install the ring into the cover fit. Be prepared to tap the ring in place with a hardwood block or soft faced hammer.
- Locate, drill, and tap three new equally-spaced set screw holes between the original holes in each new ring and ring-seat area.
- Install the set screws and upset threads.



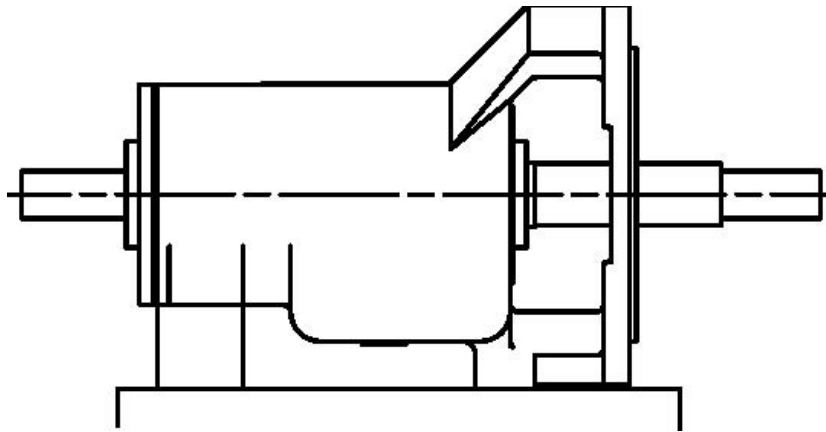
- TSP-40 – Cover
- TSP-61 – Set screw
- TSP-59 – Seal-chamber-cover wear ring

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



NOTICE:

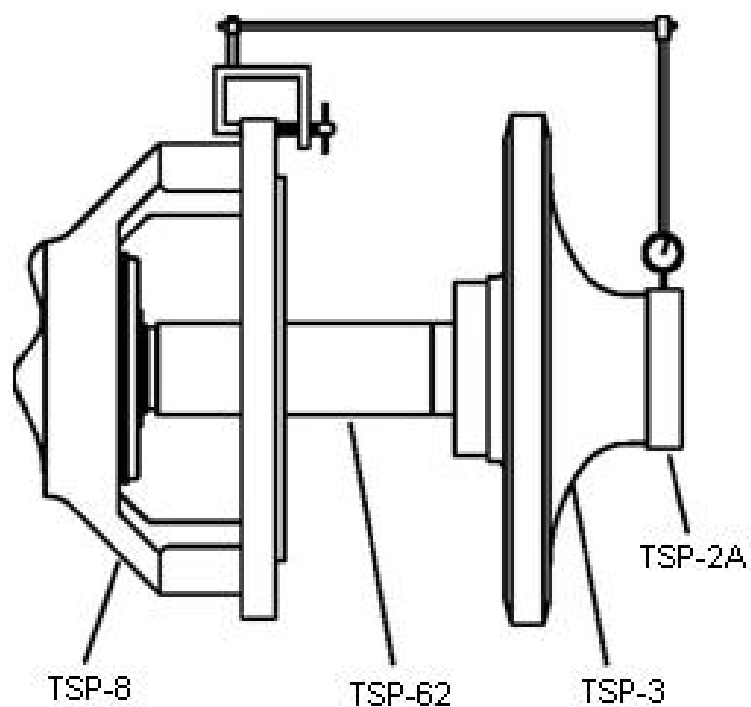
- All replacement impeller wear rings, except those that are hard-faced, are supplied 0.020 in. to 0.030 in. (0.51 mm to 0.75 mm) oversize.
- Spare hard-faced impeller wear rings are not supplied oversize but are supplied to pre established proper running clearances when both impeller and casing wear rings are renewed.



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

11. Check the impeller wear-ring runout: a) Mount the dial indicator. b) Rotate the shaft so that the indicator rides along the casing-side impeller wear-ring surface for

360°. c) Repeat steps a and b for the wear ring on the seal-chamber cover side.



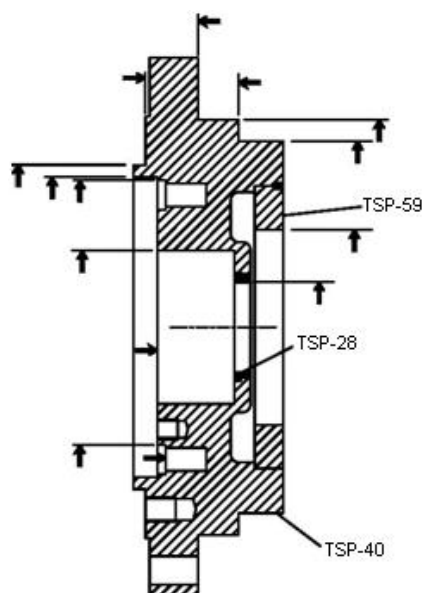
- TSP-3 – Impeller
- TSP-2A – Casing-side Impeller wear ring
- TSP-8 – Seal-chamber cover side wear ring

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

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

End cover inspection and replacement

Seal-chamber cover areas to inspect



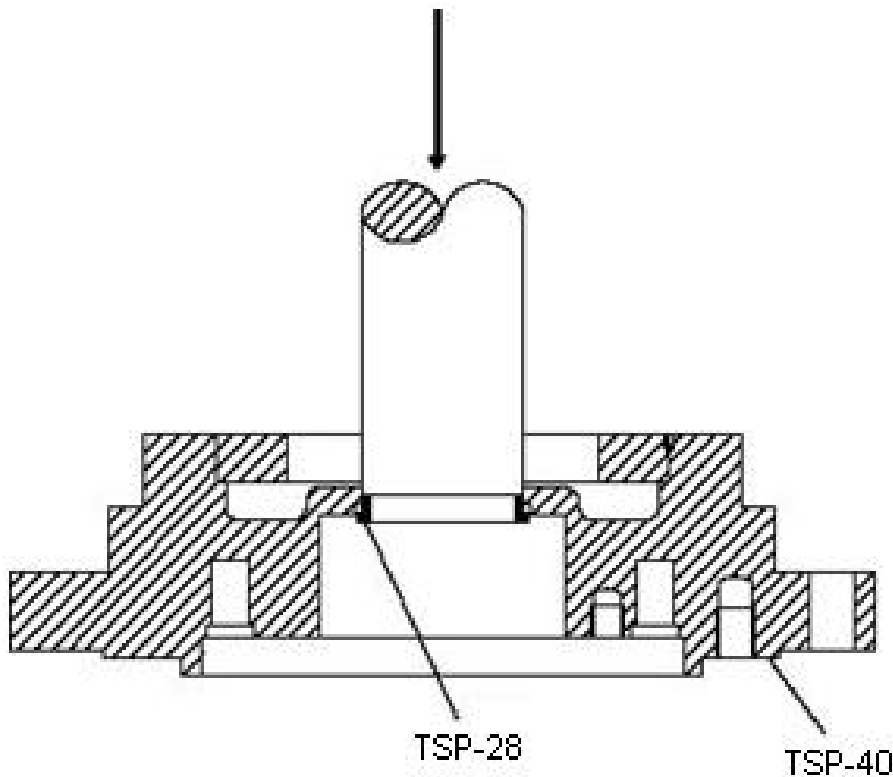
- Ensure all gasket/O-ring sealing surfaces are clean and have no damage that would prevent sealing.
- Ensure that all cooling (where applicable), flush, and drain passages are clear.

Replace the Throat bushing

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

1. Remove the bushing:

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



- TSP-28 – Bushing
- TSP-40 – Seal-chamber cover

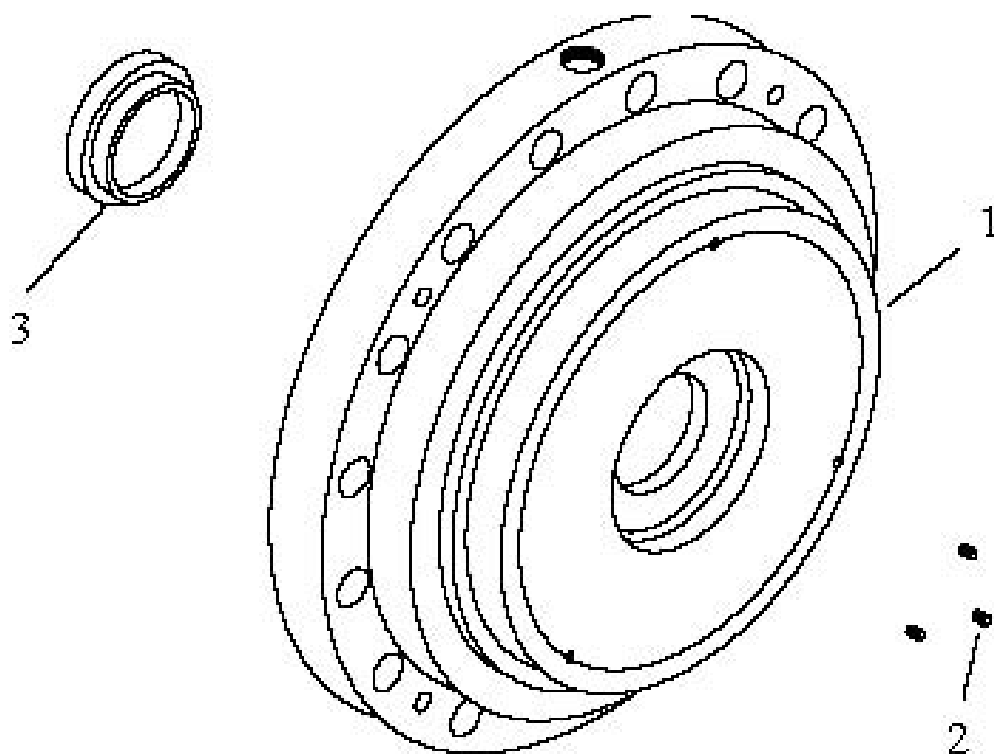
2. Install the new seal-chamber cover bushing: a) Thoroughly clean the bushing fit in the seal-chamber cover. b) Chill the new bushing using dry ice or another suitable chilling substance, and install the bushing into the cover fit. Tap the bushing in place with a wood block or soft-faced hammer.



WARNING:

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

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



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

Bearing-frame inspection

Checklist

Check the bearing frame for the following conditions:

- Visually inspect the bearing frame and frame foot for cracks.
 - Check the inside surfaces of the frame for rust, scale, or debris. Remove all loose and foreign material.
 - Make sure that all lubrication passages are clear.
 - Inspect the inboard-bearing bores.
- If any bores are outside the measurements in the Bearing fits and tolerances table, replace the bearing frame.

Surface inspection locations

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

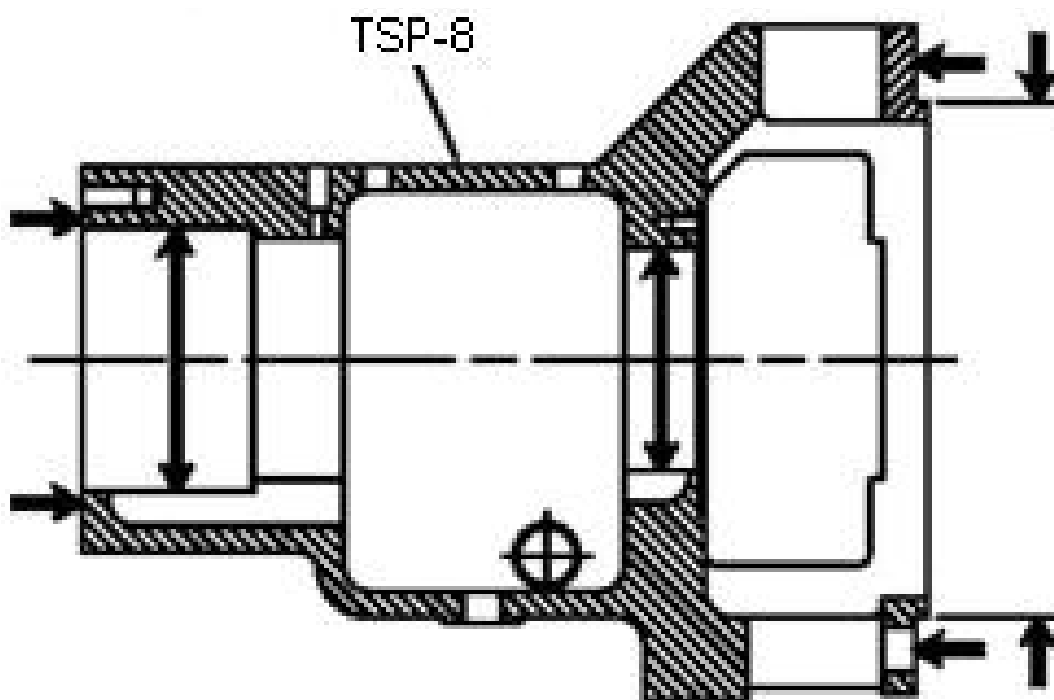


Figure 14: Surface inspection locations

Bearing fits and tolerances

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

Reassembly Assemble the power end

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

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



WARNING:

The pump and the components can be heavy. Make sure to use proper lifting methods, and wear steel-toed shoes at all times. Failure to do so can result in physical injury or equipment damage.



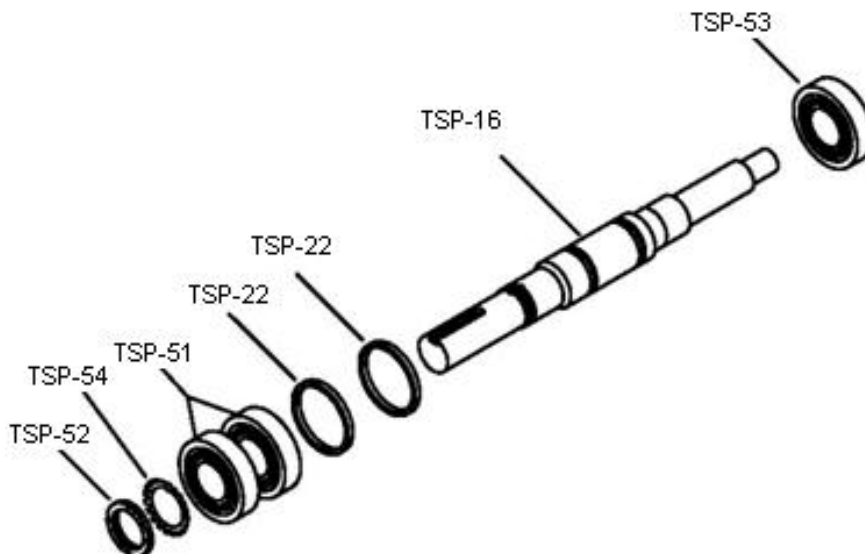
CAUTION:

- Wear insulated gloves when you use a bearing heater. Bearings get hot and can cause physical injury.
- This pump uses duplex bearings mounted back-to-back. Make sure orientation of the bearings is correct.

NOTICE:

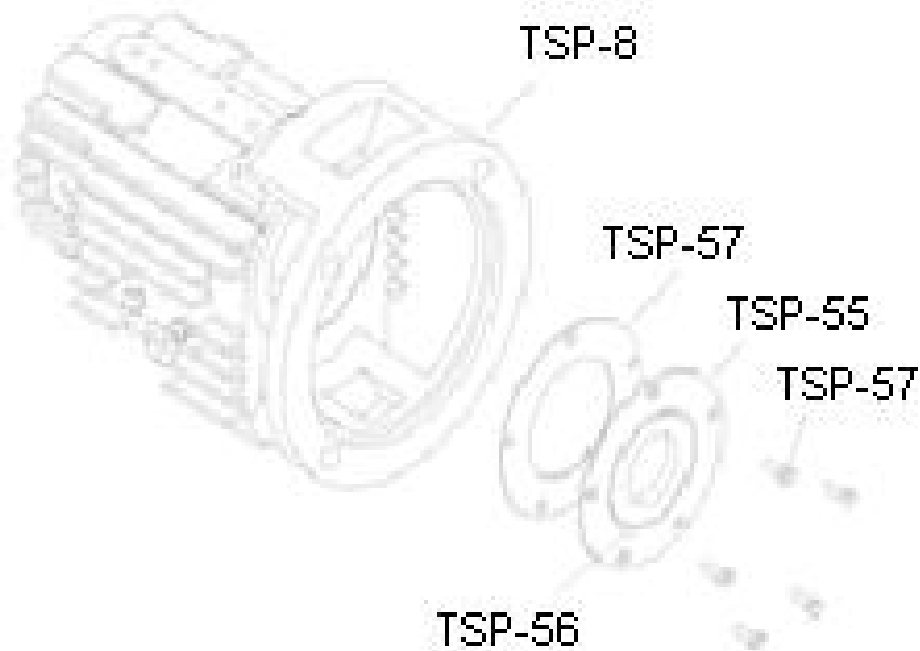
- There are several methods used to install bearings. The recommended method is to use an induction heater that heats and demagnetizes the bearings.
- Make sure that all parts and threads are clean and that you have followed all directions under the Preassembly inspections section.
- Check for magnetism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

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



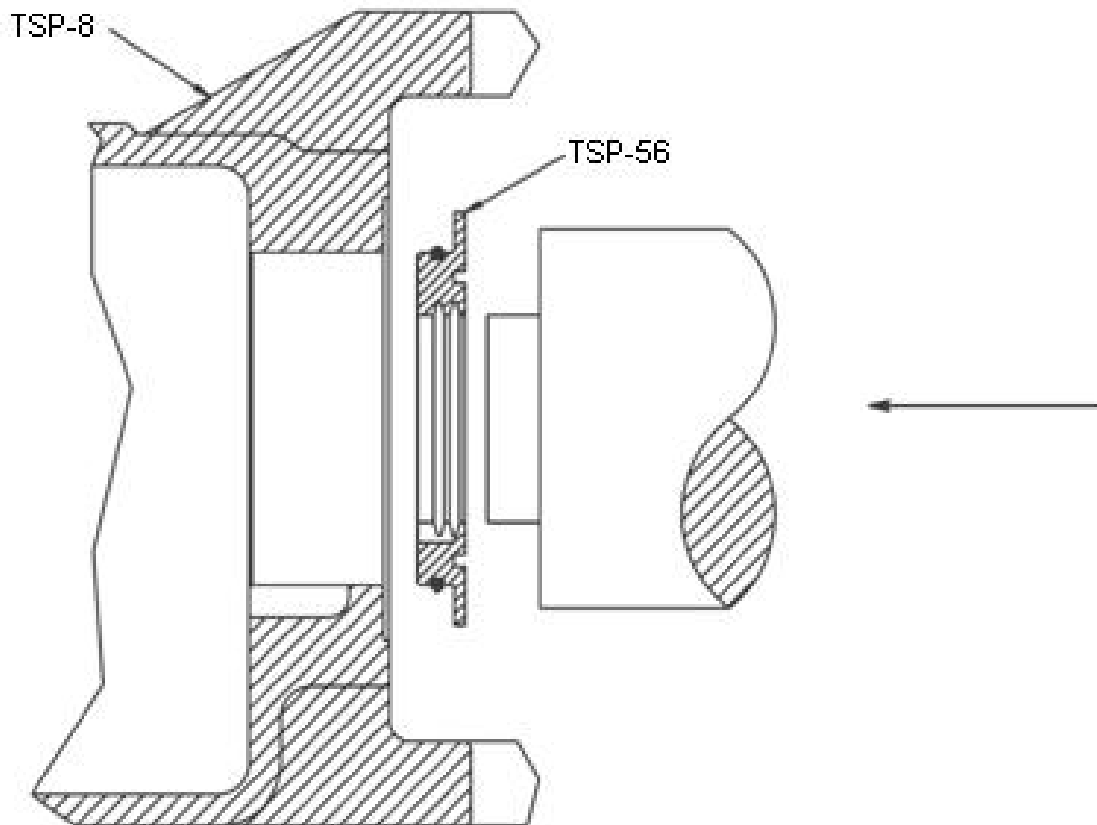
- TSP-51 – Duplex thrust bearing
- TSP-22 – Oil rings
- TSP-16 – Shaft
- TSP-52 – Thrust-bearing locknut
- TSP-53 – Radial bearing
- TSP-54 - Lockwasher

2. Install the oil rings and bearings:
- Install the oil rings on the shaft.
 - Install the thrust (outboard) bearings on the shaft.
 - Place the bearing lockwasher on the shaft and the tang of the lockwasher in the keyway.
 - Thread the bearing locknut onto the shaft. After the bearings and the shaft have cooled to the ambient temperature, tighten the locknut to the torque values shown in the Maximum torque values for TSP hardware table.
 - Bend a tang of the bearing lockwasher into a slot of the locknut.
 - Coat the internal bearing surfaces with lubricant to be used in service.



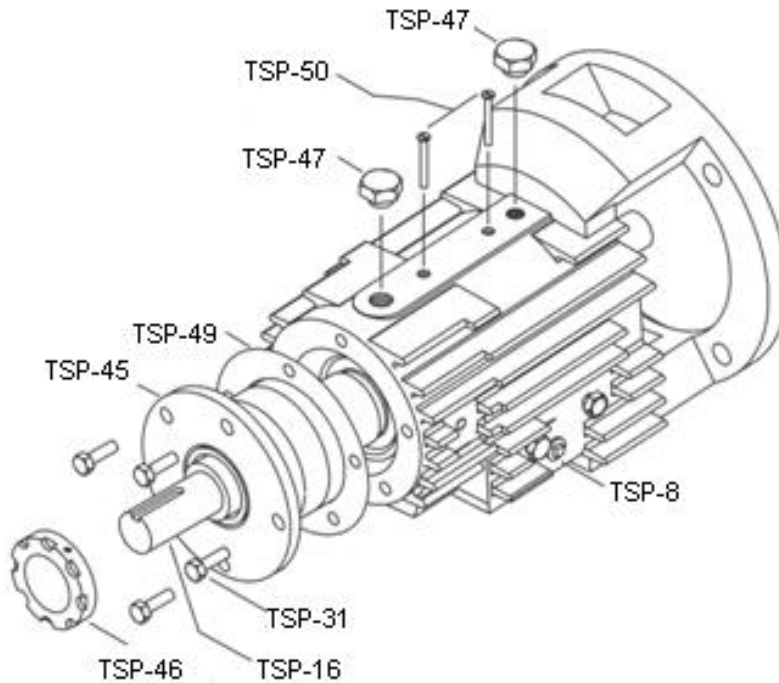
- TSP-55 – Thrust end cover
- TSP-56 – Deflector
- TSP-8 – Bearing frame
- TSP-57 – Radial-bearing end-cover gasket
- TSP-58 – Bearing-frame screws

- Press the oil seal into the radial end cover.
- Install the radial-bearing end cover and new end-cover gasket on the bearing frame. Make sure that the expulsion part is at the 6 o'clock position and is properly seated.
- Perform the following based on your pump version:



- TSP-56 – Radial INPRO oil seal
- TSP-8 – Bearing frame

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



- TSP-45 – Thrust-bearing end cover
- TSP-16 – Shaft
- TSP-46 – Thrust deflector
- TSP-8 – Bearing frame
- TSP-47 – Oil ring inspection plug
- TSP-48 – gasket
- TSP-31 – Bearing-frame screw
- TSP-49 – Thrust-bearing end-cover shim
- TSP-50 – Oil ring retainer

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

Do not force the assembly together.

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

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

- 1 Replace the oil-ring inspection connection plugs.
- 2 Replace the two oil-ring retainers. The screw should bottom against the bearing frame.

Assemble the frame



CAUTION:

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

1. Perform the following based on your pump:

If your pump is...

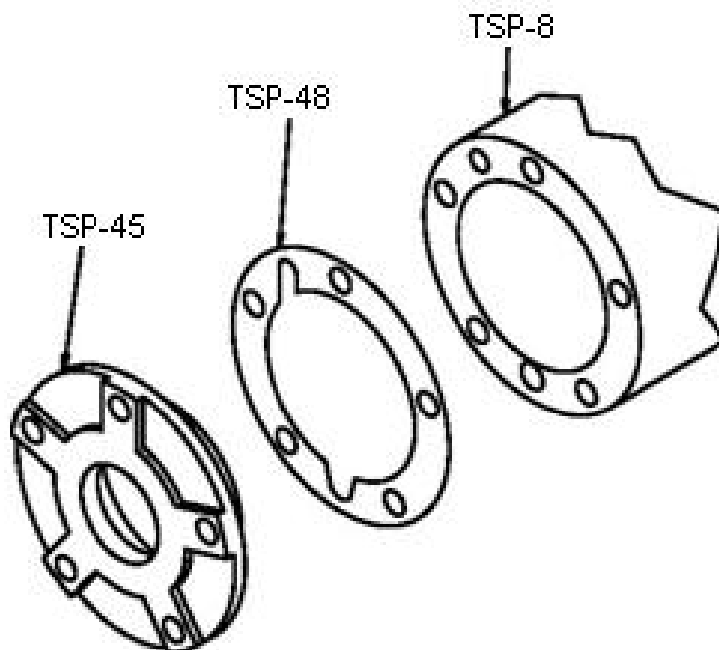
Then...

F1,F2,F3

- 1 Install three thrust-bearing end-cover shims on the thrust-bearing end cover.
- 2 Align the holes.

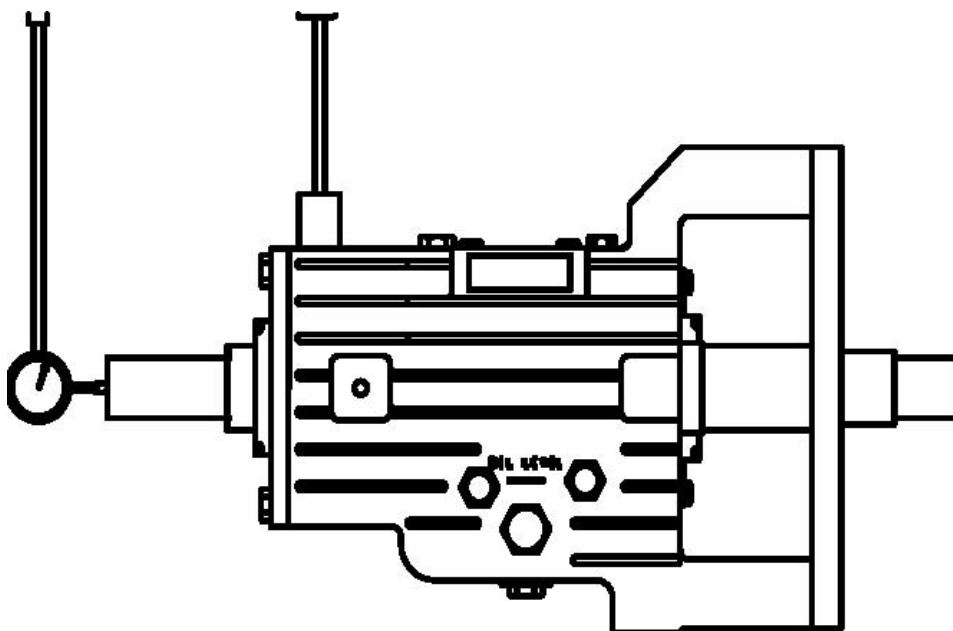
F1,F2

- 1 Install three thrust-bearing end-cover gaskets on the bearing-end cover.
- 2 Align the gaskets to the end cover so that the openings in the gaskets align with the oil grooves on the end cover.



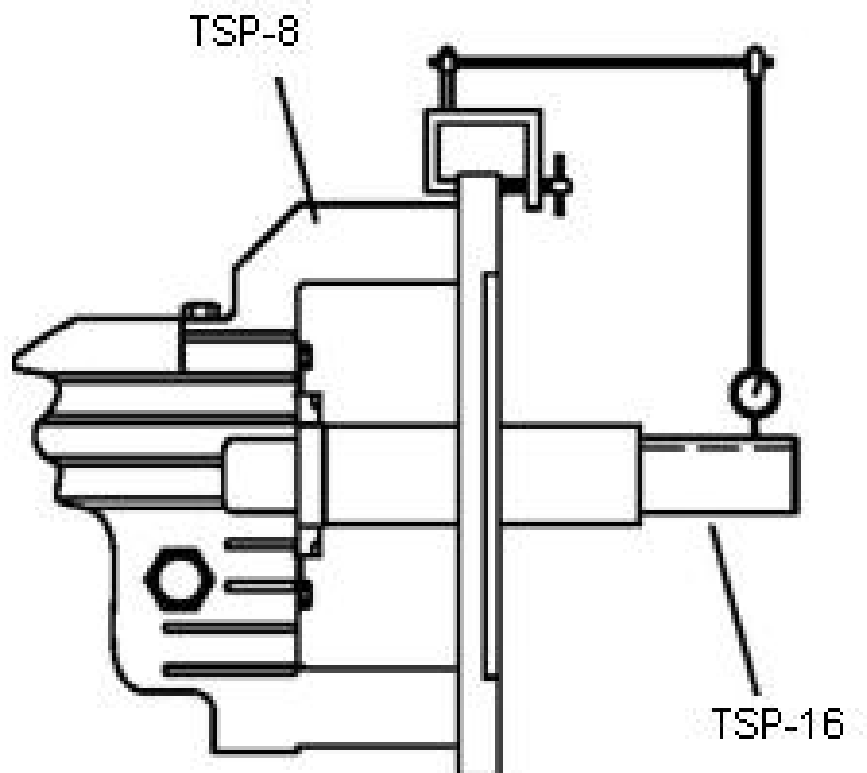
- TSP-45 – Thrust-bearing end cover
- TSP-8 – Bearing frame
- TSP-48 – Thrust-bearing end-cover gaskets

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



4. Determine the axial end play as follows: a) Mount the dial indicator. b) Use a lever to apply axial force to the impeller end of the shaft and firmly seat the thrust bearing against the shoulder in the bearing frame. c) Apply axial force in the opposite direction and firmly seat the thrust bearing against the thrust-bearing end cover. d) Repeat steps b and c several times and record the total travel (end play) of the rotating element. Total travel (end play) must fall in the range of 0.001 to 0.005 in. (0.025 to 0.125 mm).

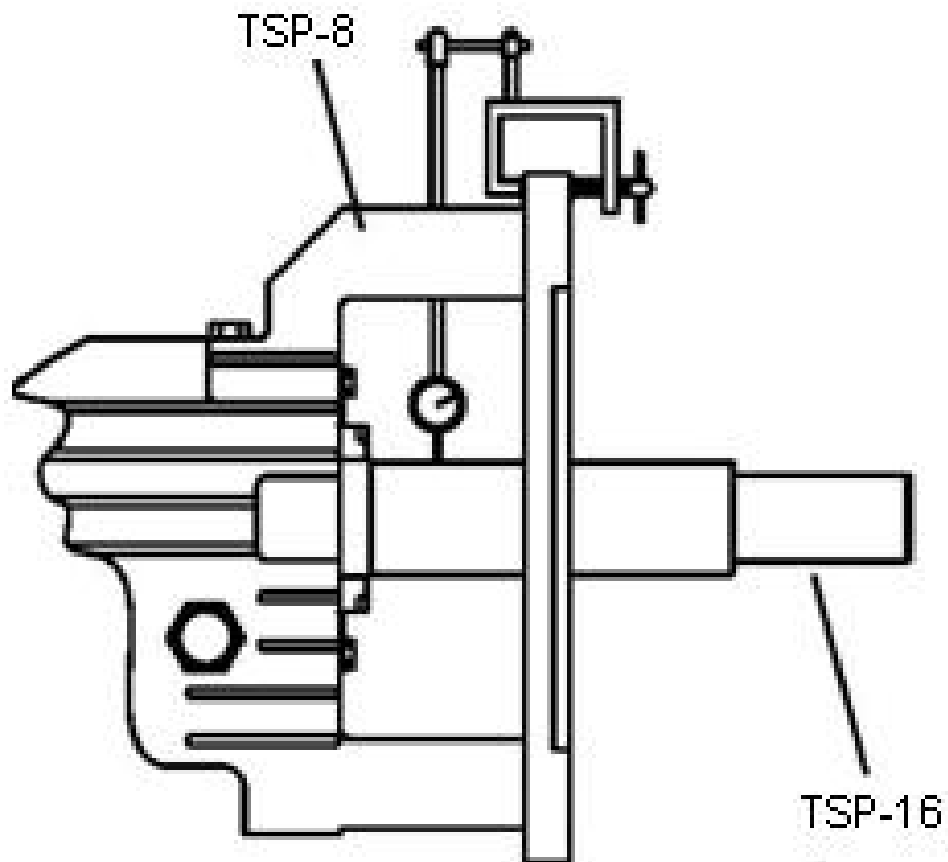
Check Procedure



Mount the dial indicator.

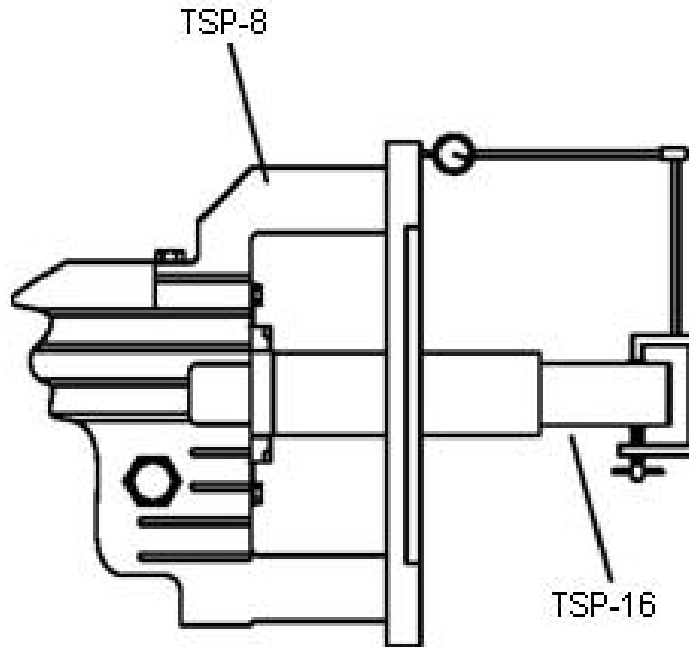
Rotate the shaft so that the indicator rides along the shaft surface for 360°. If the total indicator reading is greater than 0.002 in. (0.050 mm), then determine the cause and correct it.

Shaft seal



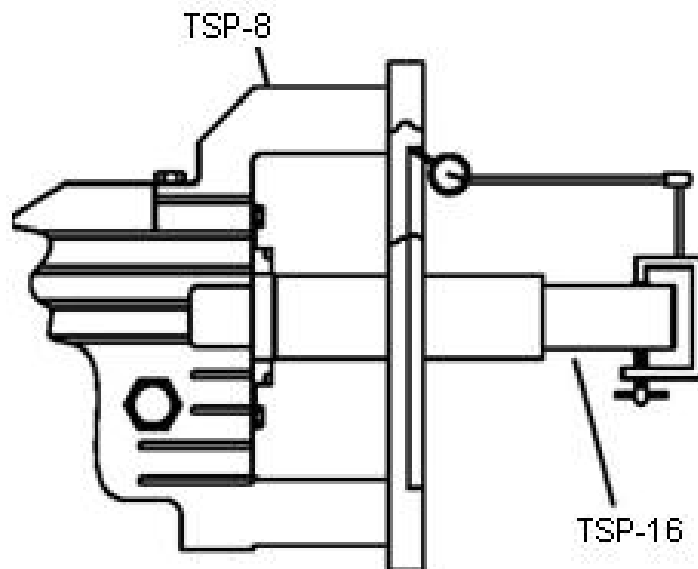
Bearing- 1. Mount the dial indicator on the shaft, frame face 2. Rotate the shaft so that the indicator rides along the bearing-frame face for 360°. If the total indicator reading is greater than 0.004 in. (0.10 mm), then disassemble and determine the cause and correct it.

Check Procedure



Bearing-frame lock

- 1 Mount the dial indicator on the shaft.
- 2 Rotate the shaft so that the indicator rides along the bearing-frame lock for 360°. If the total indicator reading is greater than 0.004 in. (0.10 mm), then disassemble and determine the cause and correct it.

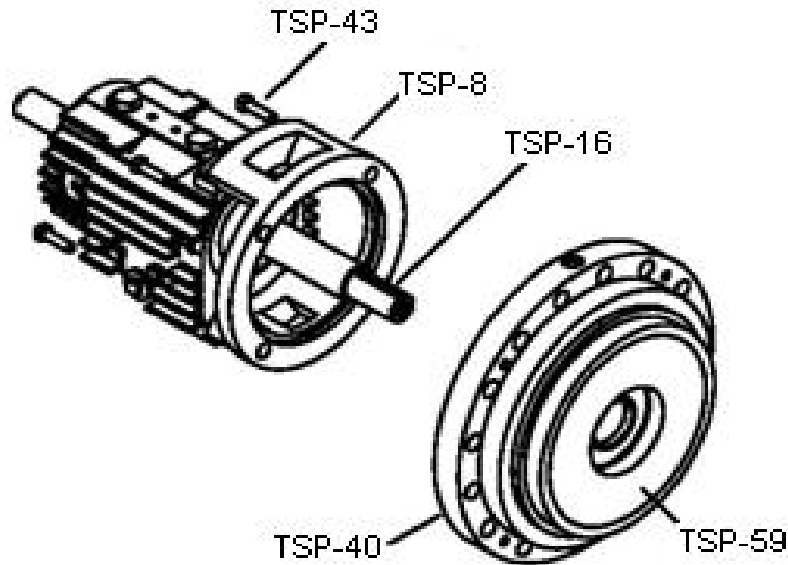


10. Install and tighten any plugs and Orings removed during disassembly, including the oil-drain plug, and the sight glass.

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

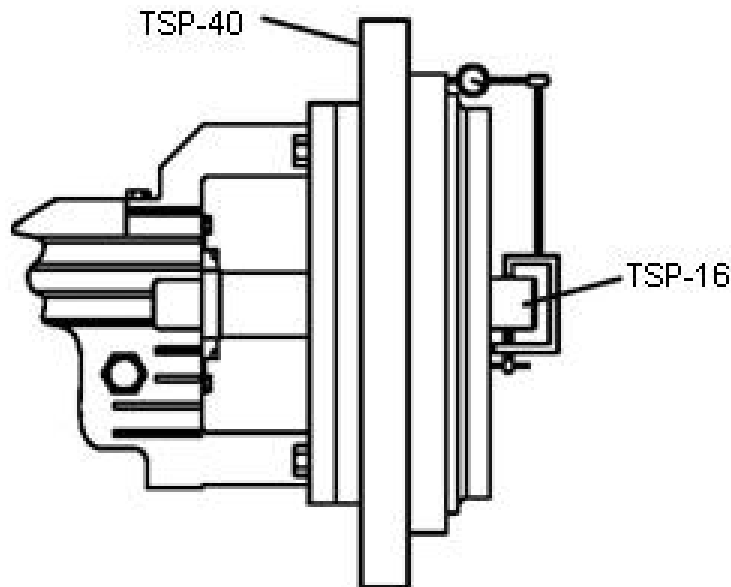
Install the seal-chamber cover

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



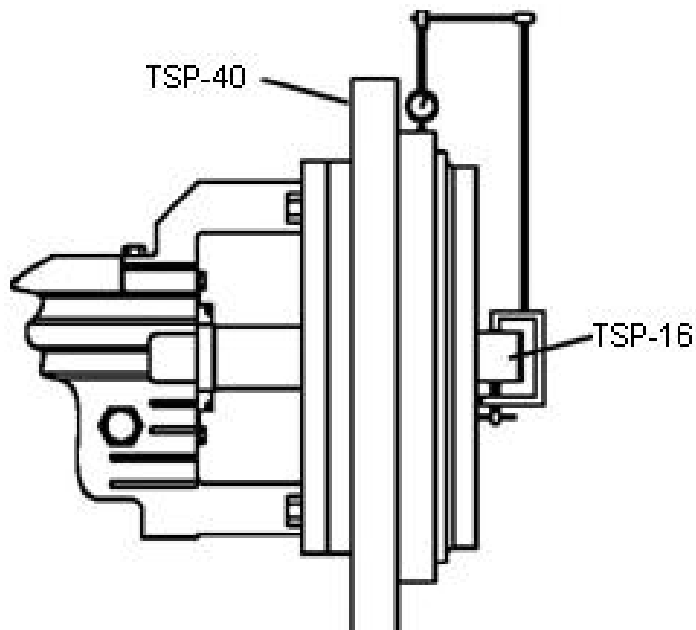
- TSP-16 – Shaft
 - TSP-40 – Seal-chamber cover
 - TSP-8 – Bearing frame
 - TSP-59 – Seal-chamber cover wear-ring
 - TSP-43 – Bearing-frame bolts
2. Set up a sling from the eyebolt to the overhead lifting device.
 3. Lift the seal-chamber cover and position it so that it aligns with the shaft.
 4. Install the seal-chamber cover on the bearing-frame assembly: a) Guide the cover carefully over the shaft and into the bearing-frame lock. b) Install the seal-chamber cover and bearing-frame bolts. c) Tighten the bolts evenly using an alternating pattern. Torque the bolts to values shown in the Maximum torque values for TSP hardware table.
 5. Check the seal-chamber cover face runout: a) Mount the dial indicator on the shaft. b) Rotate the shaft so that the indicator rides along the seal-chamber cover gasket face for 360°.

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



6. Check the seal-chamber cover lock runout: a) Mount the dial indicator on the shaft.
b) Rotate the shaft so that the indicator rides along the seal-chamber cover lock for 360°.

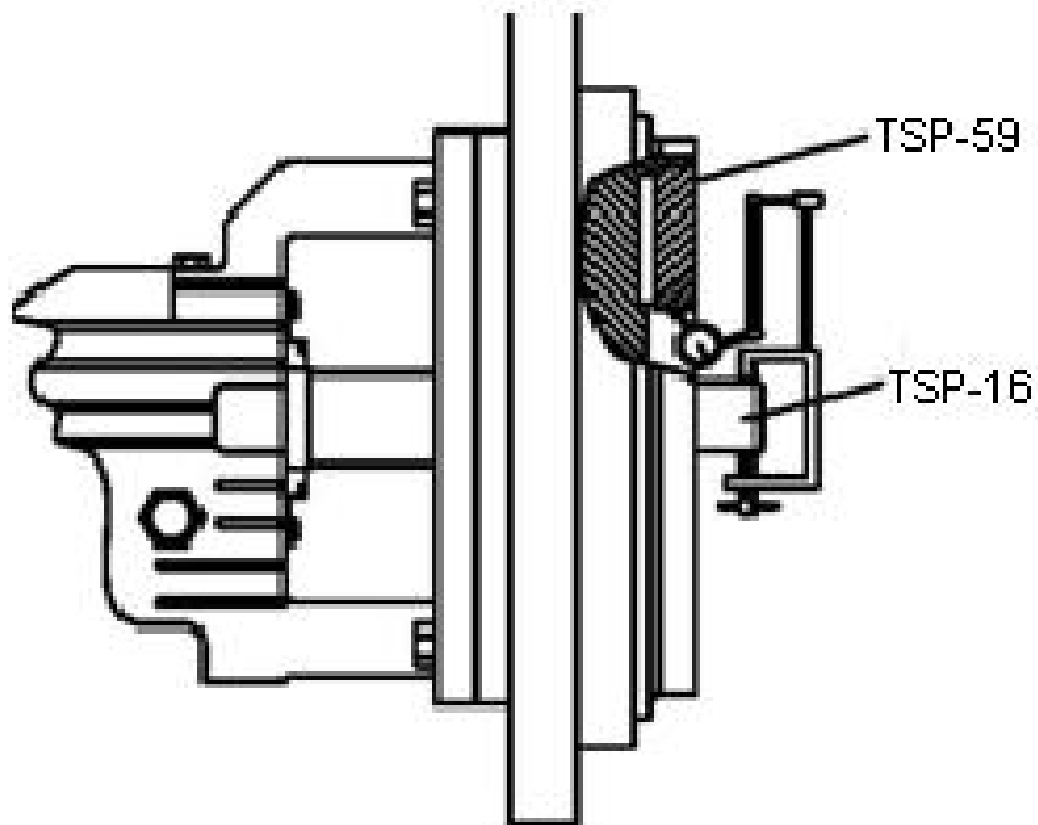
If the total indicator reading is greater than 0.005 in. (0.13 mm), determine the cause and correct it.



NOTICE:

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

7. Check the seal-chamber cover wear-ring runout: a) Mount the dial indicator on the shaft.
b) Rotate the shaft so that the indicator rides on the seal-chamber cover wear-ring surface for 360°. If the total indicator reading exceeds 0.006 in. (0.15 mm), determine the cause and correct it.

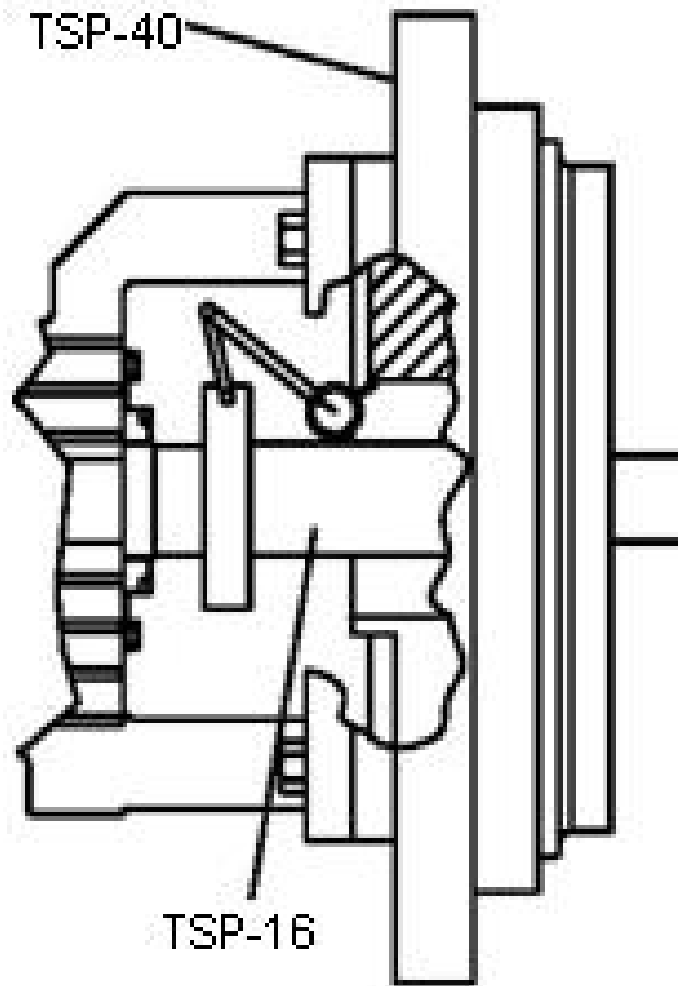


8. Check the seal-chamber face runout: a) Mount a dial indicator on the shaft. b) Rotate the shaft so that the indicator rides along the seal-chamber face for 360°.

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

9. Check the seal-chamber lock (register) runout: a) Mount a dial indicator on the shaft or shaft sleeve. b) Rotate the shaft so that the indicator rides along the seal-chamber lock (register) for 360°.

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



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

NOTICE:

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

1. Remove the impeller. a) Loosen and remove the impeller nut. The impeller nut has left-hand threads. b) Remove the impeller, impeller key, and seal-chamber cover as described in the Disassembly section.
2. Lubricate all O-rings with suitable lubricant, unless the seal manufacturer's instructions indicate otherwise.
3. Slide the cartridge seal assembly (rotary, stationary gland, gland gasket, and sleeve) onto the shaft.

NOTICE:

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

1 Install the bearing frame and seal-chamber cover gasket into the recess of the bearing frame and align the holes.
Install the seal-chamber cover. a) Set up a sling to the eyebolt and to the overhead lifting device. b) Lift the seal-chamber cover and position it so that it aligns with the shaft. c) Install the seal-chamber cover on the power end by guiding the cover carefully over the cartridge seal rotary. Ensure that the gland studs smoothly enter the holes in the cartridge-seal gland and that the cover fits into the bearing frame lock. d) Check that the bearing frame and seal-chamber cover gasket are not dislodged or damaged. e) Install the gland stud nuts and tighten evenly to the torque values shown in the Maximum torque values for TSP hardware table

- 1 Tighten the set screws in the locking collar.
- 2 Disengage the spacer ring or clips.
- 3 Verify that the shaft turns freely. If you detect rubbing or excessive drag, then determine the cause and correct it.

Install the impeller

CAUTION:

Wear heavy work gloves when you handle impellers. The sharp edges can cause physical injury.

It is recommended that you repeat the runout checks on the seal-chamber cover face, lock, and wear-ring surfaces as described in *Install the seal-chamber cover* on page 84.

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

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

Install the coupling hub



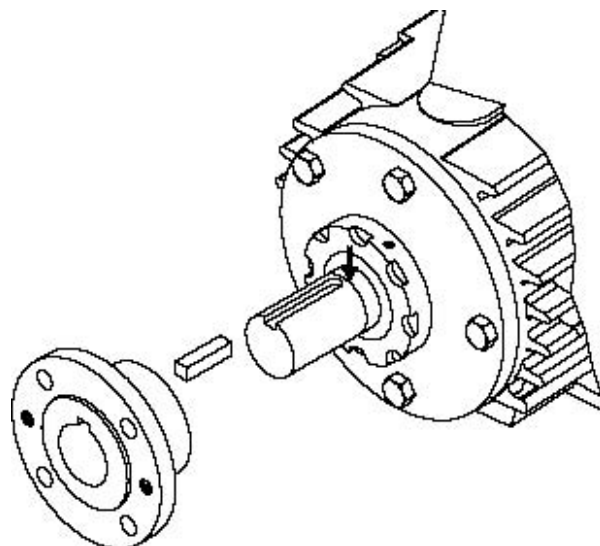
CAUTION:

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

NOTICE:

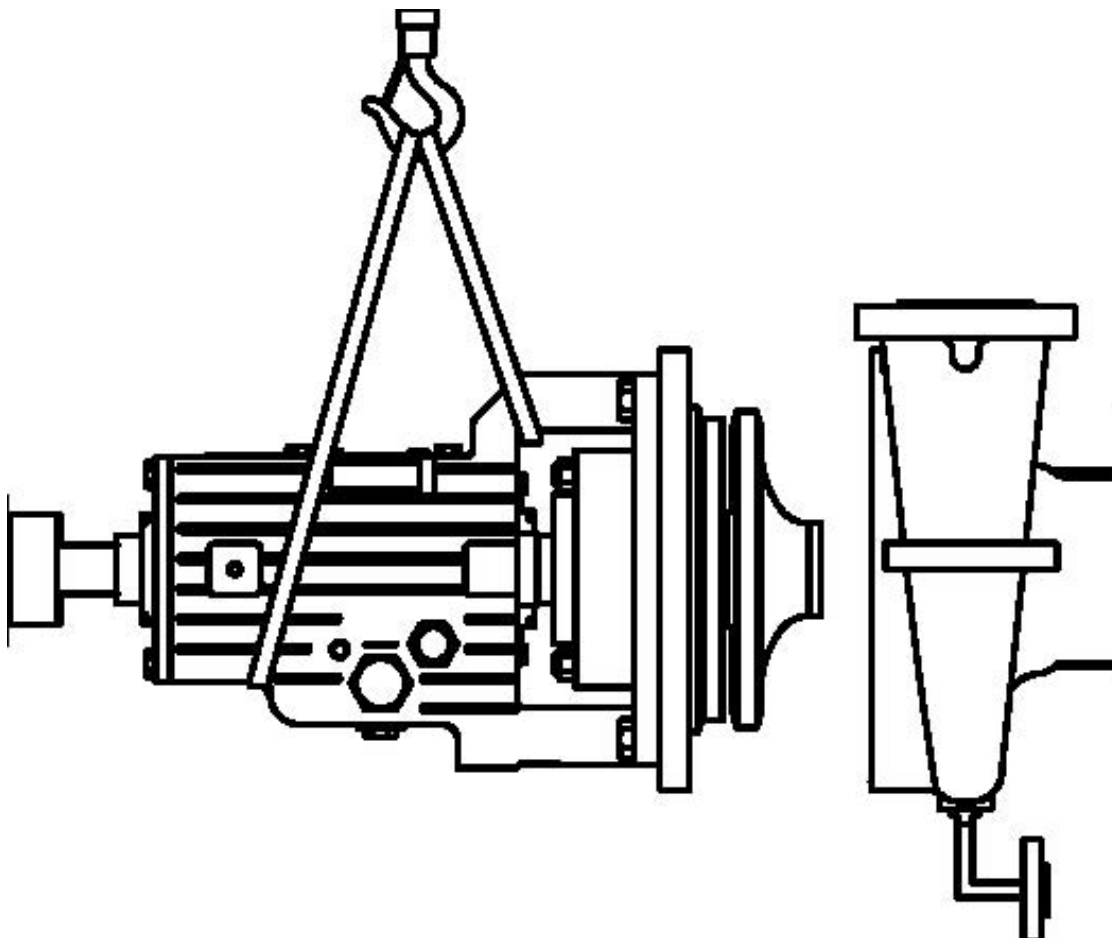
If it is necessary to heat the coupling hub due to an interference fit, do not use a torch. Use a heating device such as an oven which uniformly heats the coupling hub.

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



Install the back pull-out assembly in the casing

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



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

Spare parts

Critical services spare parts

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

- Impeller (TSP-3) with impeller rings (TSP-2A and TSP-2B)
- Thrust bearing end-cover (TSP-45)
- Radial bearing end cover (TSP-55)
- Shaft (TSP-16)
- Radial oil seal (TSP-56)
- Thrust oil seal (TSP-46)
- Radial heat flinger (TSP-32)
- Impeller key (TSP-69)

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

Recommended spare parts

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

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

- Bearing locknut (TSP-52)
- Bearing lockwasher (TSP-54)
- Cartridge mechanical seal (TSP-73)
- Casing gasket (TSP-5)
- Casing wear ring (TSP-2)
- Finned-tube cooling assembly (TSP-74)
- Frame and seal-chamber cover gasket (TSP-44)
- Impeller nut (TSP-29)
- Impeller wear ring - casing side (TSP-2A)
- Impeller wear ring - cover side (TSP-2B)
- Oil rings (TSP-22)
- Oiler with wire guard (TSP-75)
- Radial bearing (TSP-53)
- Radial bearing end-cover gasket (TSP-57)
- Seal-chamber cover wear ring (TSP-59)
- Set screws (TSP-61 and TSP-60)
- Throat bushing - seal-chamber cover (TSP-28)
- Thrust bearing (duplex pair) (TSP-51)
- Thrust bearing end-cover gaskets (TSP-48)
- Thrust bearing end-cover O-ring (TSP-76)
- Thrust bearing end-cover shim pack (TSP-49)
- Water jacket cover O-rings (TSP-63 and TSP-77)

Troubleshooting

Operation Troubleshooting

Symtop	Cause	Remedy
The Pump is not delivering liquid.	The pump is not primed.	Re-prime the pump and check that the pump and suction line are full of liquid.
	The suction line is clogged.	Remove the obstructions.
	The impeller is clogged.	Back-flush the pump to clean the impeller.
	The shaft is rotaing in the wrong direction.	Change the rotation. The rotation must match the arrow on the bearing housing or pump casing.
	The foot valve or suction pipe opening is not submerged enough.	Consult a Truflo representative for proper submersion depth. Use a baffle to eliminate vortices.
	The suction lift is too high.	Shorten suction pipe.
The pump is not producing the rates flow or head.	The gasket or O-ring has an air leak.	Replace the gasket or O-ring.
	The stuffing box has an air leak.	Replace or readjust the mechanical seal.
	The impeller is partly clogged.	Back-flush the pump to clean the impeller.
	The clearance between the impeller and the pump casing is excessive.	Adjust the impeller clearance.
	The suction head is insufficient.	Ensure that the suction-line shutoff valve is fully open and that the line is unobstructed.
	The impeller is worn or broken.	Inspect and replace the impeller if necessary.
The pump starts and then stops pumping.	The pump is not primed.	Re-prime the pump and check that the pump and suction line are full of liquid.
	The suction line has air or vapor pockets.	Rearrange the piping to eliminate air pockets.
	The suction line has an air leak.	Repair the leak.
The bearings are running hot.	The pump and driver are not aligned properly.	Realign the pump and driver.
	There is insufficient lubrication.	Check the lubricant for suitability and level.
	The lubrication was not cooled properly.	Check cooling system.
The pump is noisy or vibrates.	The pump and driver are not aligned properly.	Realign the pump and driver.
	The impeller is partly clogged.	Back-flush the pump to clean the impeller.
	The impeller shaft is broken or bent.	Replace the impeller of shaft as necessary.
	The foundation is not rigid.	Tighten the hold-down bolts of the pumpand motor. Make sure the bae plate is properly grouted without voids or air pockets.
	The bearings are worn.	Replace the bearings.
	The suction or discharge piping is not anchored or properly supported.	Anchor the suction or discharge piping as necessary according to recommendations in the Hydraulic Insitute Standards Manual.
	The pump is cavitating.	Locate and correct the system problems.
There is excessive leakage from the stuffing box.	The packing gland is not adjusted properly.	Tighten the gland nuts.
	The stuffing box in not packed properly.	Check the packing and repack box.
	The mechanical-seal parts are worn.	Replace worn parts.
	The mechanical seal is overheating.	Check the lubricant and cooling lines.

	The shaft sleeve is scored.	Machine or replace the shaft sleeve as necessary.
The motor requires excessive power.	The discharge head has dropped below the rated point and is pumping too much liquid.	Install a throttle valve. If this does not help, trim the impeller diameter. If this does not help, contact your Truflo representative.
	The liquid is heavier than expected.	Check the specific gravity and viscosity.
	The stuffing box packing is too tight.	Readjust the packing. If the packing is worn, then replace the packing.
	Rotating parts are rubbing against each other.	Check the parts that are wearing for proper clearances.
	The impeller clearance is too tight.	Adjust the impeller clearance.

Alignment Troubleshooting

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

Assembly Troubleshooting

Table 11: Troubleshooting procedure

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

Parts list with standard Materials of construction							
Item	Part Name	Quantity Pump per	Construction - API designation				
			S-4	S-6	S-8	C-6	A-8
TSP-1	Casing	1	1212			1234	1296
TSP-3	Impeller	1	1212	1222	1265	1222	1265
TSP-45	Thrust Bearing end cover	1	1212				
TSP-51	Ball bearing, thrust	1 pair	Steel				
TSP-22	Oil rind (S and L frames)	1	1618				
TSP-78	Oil ring (M and XL frames)	2	1618				
TSP-55	Radial bearing end cover	1	Steel				
TSP-16	Shaft	1	2238		2256	2244	2256
TSP-56	Deflector, radial	1	1618				
TSP-46	Deflector, thrust	1	1425				
TSP-32	Deflector fan, radial	1	1425				
TSP-79	Deflector fan, thrust	1	1425				
TSP-28	Throat bushing, seal chamber	1	1001	2244	2256	2244	2256
TSP-52	Locknut, bearing	1	Steel				
TSP-2	Wear ring, casing	1	1001	1232	1265	1232	1265
TSP-53	Ball bearing, radial	1	Steel				
TSP-69	Key, Impeller	1	2229				
TSP-40	Seal-Chamber cover	1	1212			1234	1296
TSP-2a	Wear ring, imepller	1	1001	1299	1071	1299	1071
TSP-2b	wear ring, imepller	1	1001	1299	1071	1299	1071
TSP-34	Set screw, deflector	2	2229				
TSP-61	Set screw, stationary wear rings	6	2229				
TSP-8	Bearing frame	1	1212				
TSP-59	Wear ring, seal-chamber cover	1	1001	1232	1265	1232	1265
TSP-35	Deflector fan guard	1	3201				
TSP-36	Support, deflector fan guard	1	3201				
TSP-29	Impeller nut	1	2210	2229			
TSP-60	Set screw, impeller wear ring	6	2229				
TSP-5	Gasket, casing	1	spiral wound 316 stainless steel				
TSP-66	Stud, gland	4	2239				
TSP-41	Nut, gland stud	4	2285				
TSP-6	Stud, casing	Varies	2239				
TSP-57	Gasket, radial bearing end cover	1	Vellumoid				
TSP-48	Gasket, thrust bearing end cover	3	Vellumoid				
TSP-43	Screw, bearing frame and seal-chamber cover	4	2210				
TSP-31	Screw, thrust bearing end cover	5	2210				
TSP-58	Screw, radial bearing end cover	5	2210				
TSP-54	Lockwasher, bearing	1	Steel				
TSP-49	Shim pack, thrust bearing end cover	1	304SS				
TSP-76	O-ring, thrust bearing end cover	1	Buna N				
TSP-38	Bolt, jacking	4	2210				
TSP-67	Nut, casing stud	Varies	2239				
TSP-50	Retainer, oil ring	2	2285				
TSP-74	Finned tube cooling assembly	1	Stainless steel with cooper fins				
TSP-49	Gasket, frame and seal-chamber	1	Aramid fiber				



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