OH2 Pumps

Installation, Operation, and Maintenance Manual

Model OH2, API 610 10th Edition/ISO 13709

ARYA SEPEHR KAYHAN

Table of Contents

Introduction and Safety

Safety Massage levels

Definitions

Safety message level		Indication
	**DANGER:**	A hazardous situation which, if not avoided, will result in death or serious injury
	**WARNING:**	A hazardous situation which, if not avoided, could result in death or serious injury
	**CAUTION:**	A hazardous situation which, if not avoided, could result in minor or moderate injury
	**Electrical Hazard:**	The possibility of electrical risks if instructions are not followed in a proper manner
		Safety sign to IEC 417 - 5036. and special instructions concerning explosion protection are marked
NOTICE:		• A potential situation which, if not avoided, could result in an undesirable result or state • A practice not related to personal injury

General

	**Caution** This ASK product has been developed in accordance with state-of-the-art technology; it is manufactured with utmost care and subject to continuous quality control. These operating instructions are intended to facilitate familiarization with the unit and its designated use. The manual contains important information for reliable, proper and efficient operation. Compliance with the operating instructions is of vital importance to ensure reliability and a long service life of the unit and to avoid any risks. These operating instructions do not take into account local regulations; the operator must ensure that such regulations are strictly observed by all, including the personnel called in for installation.
	This pump / unit must not be operated beyond the limit values for the fluid handled, capacity, speed, density, pressure, temperature and motor rating specified in the technical documentation. Make sure that operation is in accordance with the instructions laid down in this manual or in the contract documentation. Contact the manufacturer, if required.

	The name plate indicates the type series / size, main operating data and works number; please quote this information in all queries, repeat orders and particularly when ordering spare parts. If you need any additional information or instructions exceeding the scope of this manual or in case of damage please contact ASK's nearest customer service centre.

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. ASK 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 ASK. If there is a question regarding the intended use of the equipment, please contact an ASK 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 application without the approval of an authorized ASK 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.
Explosion protection	
	It is assumed that the system of suction and discharge lines and thus the wetted pump internals are completely filled with the product to be handled at all times during pump operation, so that an explosive atmosphere is prevented. If the operator cannot warrant this condition, appropriate monitoring devices must be used. In addition, it is imperative to make sure that the seal chambers, auxiliary systems of the shaft seal and the heating and cooling systems are properly filled.
Marking	
	The marking on the pump only refers to the pump part, i.e. the coupling and motor must be regarded separately. The driver must be regarded separately. Example of marking on the pump part: Ex II 2 G T1 - T5 The marking indicates the theoretically available temperature range as stipulated by the respective temperature classes.

Temperature limits

WARNING:
Both gland packings and mechanical seals may exceed the specified temperature limits if run dry.
Dry running may not only result from an inadequately filled seal chamber, but also from excessive gas content in the fluid handled.
Pump operation outside its specified operating range may also result in dry running. In potentially explosive atmospheres, gland packings shall only be used if combined with a suitable temperature monitoring device.

In normal pump operation, the highest temperatures are to be expected on the surface of the pump casing, at the shaft seal and in the bearing areas. The surface temperature at the pump casing corresponds to the temperature of the fluid handled.
If the pump is heated, it must be ensured that the temperature classes stipulated for the plant are observed.
In the bearing bracket area, the unit surfaces must be freely exposed to the atmosphere.
In any case, responsibility for compliance with the specified fluid temperature (operating temperature) lies with the plant operator. The maximum permissible fluid temperature depends on the temperature class to be complied with.
The table below lists the temperature classes to EN 13463-1 and the resulting theoretical temperature limits of the fluid handled. In stipulating these temperatures, any temperature rise in the shaft seal area has already been taken into account.

Temperature class to EN 13463-1:	Temperature limit of fluid handled
T5	85 C
T4	120 C
T3	185 C
T2	280 C
T1	max. 400 C *)
*) depending on material variant	

NOTICE:
The permissible operating temperature of the pump in question is indicated on the data sheet. If the pump is to be operated at a higher temperature, the data sheet is missing or if the pump is part of a pool of pumps, the maximum permissible operating temperature must be enquired from the pump manufacturer.
Based on an ambient temperature of 40 C and proper maintenance and operation, compliance with temperature class T4 is warranted in the area of the rolling element bearings.
A special design is required to comply with temperature class T6 in the bearing area. In such cases, and if ambient temperature exceeds 40 C, contact the manufacturer.

Environmental safety

The work area	
	Always keep the pump station clean to avoid and/or discover emissions.
Recycling guidelines	
	Always recycle according to these guidelines: 1. If the unit or parts are accepted by an authorized recycling company, then follow local recycling laws and regulations. 2. If the unit or parts are not accepted by an authorized recycling company, then return them to the nearest ASK representative.
Waste and emissions regulations	
	Observe these safety regulations regarding waste and emissions: • Dispose appropriately of all waste. • Handle and dispose of the pumped fluid in compliance with applicable environmental regulations. • Clean up all spills in accordance with safety and environmental procedures. • Report all environmental emissions to the appropriate authorities.
Reference for electrical installation	
	For electrical installation requirements, consult your local electric utility.

User Health and safety

Safety equipment	
	Use safety equipment according to the company regulations. 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:** • Only use fasteners of the proper size and material. • Replace all corroded fasteners. • Make sure that all fasteners are properly tightened and that there are no missing fasteners.
	• Never operate a pump unless safety devices are installed. • Never operate a pump unless a coupling guard is installed. • Never force piping to make a connection with a pump. • Never start a pump without the proper priming. • Never run a pump below the minimum rated 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 mistake. This guideline 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 and mixers as well 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, for example, a guard rail. • Make sure that all safety guards are in place and secure. • Make sure that the equipment is properly insulated when 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 retreat. • Make sure that the product cannot roll or fall over and injure people or damage property. • Make sure that the lifting equipment is in good condition. • Use a lifting harness, a safety line, and a breathing device as required. • Make sure that the product 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. Ensure 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. • Always bear 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 eye wash or running water. 3. Seek medical attention.

Clean chemicals from the body

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

Safety regulations for Ex-approved products in potentially explosive atmospheres

Description of ATEX	
	The ATEX directives are a specification enforced in Europe for electrical and non-electrical equipment. ATEX deals with the control of potentially explosive atmospheres and the standards of equipment and protective systems used within these atmospheres. The relevance of the ATEX requirements is not limited to Europe. You can apply these guidelines to equipment installed in any potentially explosive atmosphere.
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 ASK 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 an ASK representative before you proceed.
Personnel requirements	
	ASK disclaims all responsibility for work done by untrained and unauthorized personnel. These are the personnel requirements for Ex-approved products in potentially explosive atmospheres: • All work on the product must be carried out by certified electricians and ASK-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	
	These are the product and product handling requirements for Ex-approved products in potentially explosive atmospheres: • 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. • Never 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 fasteners must be in accordance with the approval drawing and the product specification. • Do not modify the equipment without approval from an authorized ASK representative. • Only use parts that have been provided by an authorized ASK 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 • Pump Smart control system

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 ASK authorized mechanics. ASK 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 ASK. Original spare parts and accessories authorized by ASK 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 ASK are allowed in Ex-approved products.
Warranty claims	
	For warranty claims, contact your ASK representative.

Transportation and Storage

Receive the unit	
	1. Inspect the package for damaged or missing items upon delivery. 2. Note any damaged or missing items on the receipt and freight bill. 3. File a claim with the shipping company if anything is out of order.
Unpack the unit	
	1. Remove packing materials from the unit. Dispose of all packing materials in accordance with local regulations. 2. Inspect the unit to determine if any parts have been damaged or are missing. 3. Contact your ASK representative if anything is 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.

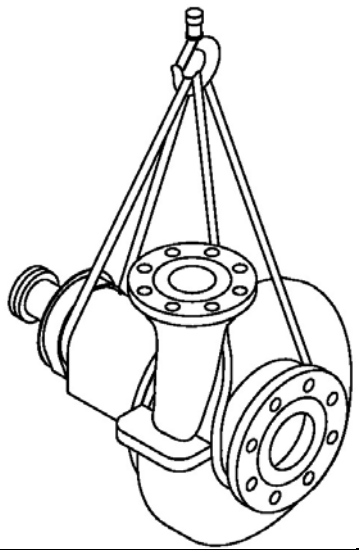
• The pump and the components can be heavy. Make sure to use proper lifting methods, and wear steel-toed shoes at all times. Failure to do so can result in physical injury or equipment damage.

Methods

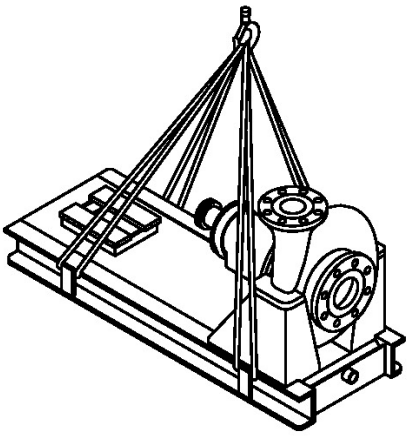
Pump type	Lifting Method
A bare pump without lifting handles	Use a suitable sling attached properly to solid points like the casing, the flanges, or the frames.
A bare pump with lifting handles	Lift the pump by the handles.
A base-mounted pump	Use slings under the pump casing and the drive unit, or under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

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

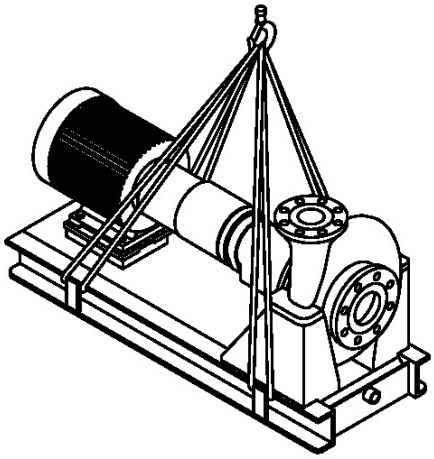
Examples



Example of a proper lifting method



Example of a proper lifting method



Example of a 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
Upon receipt/short-term (less than six months)	• Store in a covered and dry location. • Store the unit free from dirt and vibrations.
Long-term (more than six months)	• 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 ASK sales representative.

Frost proofing

Table 2: Situations when the pump is or is not frost proof

When the pump is...	Then...
Operating	The pump is frost proof.
Immersed in a liquid	The pump is frost proof.
Lifted out of a liquid into a temperature below freezing	The impeller might freeze.

Product Description

Product overview

General description	
	A range of OH2 single stage, centerline mounted centrifugal end suction pumps with centerline or tangential discharge manufactured in a variety of alloys.
Construction	
	Back pullout design with metal to metal fits
Design methodology	
	Advanced computer techniques including 3D modeling, FEA & CFD
Design standards	
	• API 610 10th : 2004 / ISO 13709 : 2003 • ATEX EC-Directive 94/9/EC
Design pressure rating	
	51.8 bar g @ 20°C
Suction pressure rating	
	• 20 bar g (standard construction) • 40 bar g (heavy duty construction)
Temperature rating	
	• -40°C to 200°C (standard construction) • -40°C to 400°C (with cooling)
Design temperature	
	150°C (standard construction)

Performance envelope	
	Flow rate : Up to 550 m³/h **Differential head:** Up to 260 m **Speed:** Up to 3000 rpm
Configurations	
	• Long coupled pump • Bare shaft pump • Rotating assembly
Frame sizes	
	050x025x160 to 200X150X450
Design life	
	20 years (3 years uninterrupted operation)

Key features

- OH2 single stage centerline mounted centrifugal pumps.
- 51 bar pumps to API 610 (10th edition) & ATEX Compliant
- -40°C to 400°C temperature applications
- Shrouded or Semi-Open Impellers
- A range of alloys available on request including NACE compliant materials
- Tested to API610 / ISO13709 procedures – Head, Flow, NPSH, Noise & Vibration
- A range of API 682 Seals & systems (PED compliant)
- Grouted and Non-Grouted Base plates to API 610 dimensions

Casing:

Features	Technical Notes	Standards
Construction	One piece casting with integral suction cover and 3mm corrosion allowance	X
Flange standard	ISO PN20 / ANSI 150 / ANSI 300 & 600	
Nozzle loading	API610	X
Fasteners	ASTM 320 Grade B8MX	X
Gasket	Reinforced graphite	X
	Expanded PTFE	
	Customer specified	
Wear rings	Suction side (shrouded impeller only)	X
Drain	½ / ¾“ butt weld flange	X
	No drain	
Jacking screws	SS 316	X

Impeller:

Features	Technical Notes	Standards
Construction	One piece casting	X
Vanes	Radial type	X

Style	Shrouded	X
	Semi open	
Fixing	Keyed with retention nut & lock washer	X
Wear rings	Suction side (shrouded only)	X
Hydraulic balancing	Radial ribs / Balancing holes	X
Dynamic balancing	ISO 1940 G 2.5	X
	ISO 1940 G 1.0	

Seal & Seal Plans:

Features	Technical Notes	Standards
Shaft diameters	30mm, 40mm, 50mm, 60mm, 70mm, 80 mm	
Seal types	API 682 single cartridge	X
	API 682 double cartridge	
Seal plans	Plan 11/61	X
	Plans 11/62, 13, 21, 31, 52, 53, 54	
	Customer specified	
Manufacturers	Burgmann, John Crane	
	or customer specified	

Bearing Bracket

Features	Technical Notes	Standards
Style	One piece casting	X
Construction	Heavy duty casting with machined abutments	X
Bearings	Dual angular contact (axial) plus Roller bearing (radial)	X
	Triple angular contact (axial) plus Roller bearing (radial)	
Design bearing life	25,000 hours (L10) @ standard duties	X
Shaft materials	stainless steel	X
	Customer specified	

Documentation

ASK understand that the documentation for our pumps is as important as the pump we supply. We have identified three levels of documentation package that we offer as standard aimed at matching the level of documentation to the application for the pump:

- Bronze pack - comes as standard with each order and includes the basic test certificates
- Silver pack - includes GA drawings along with Type 3.1 certificates for major components and a quality plan detailing the build and testing requirements

- Gold pack - is aimed at customers with high specifications for their pumps and comes with a variety of contract management and technical datasheets

The table below lists all of the documents contained within each pack.

Documentation Pack	Inclusive documents	Standard
Bronze pack	Order acknowledgement (electronic) Installation, Operating & Maintenance manual Declaration of conformity ATEX Declaration of conformity - only if contracted Hydrostatic test certificate Pump HQ performance test certificate Spare parts list – commissioning	X
Silver pack (Includes bronze pack)	Documentation schedule Quality plan Spare parts list - operating Customer specific pump GA drawing Pump SA & parts list Type 3.1 certificates (* pressure containing + process wetted parts only) -only if contracted Certification databook Pump datasheet Motor type test certificate Motor GA drawing Motor datasheet Motor Declaration of conformity Motor ATEX Declaration of conformity	
Gold pack (Includes Silver pack)	Manufacturing databook Material traceability Progress reports (monthly) Paint certificate Nameplate drawing Spare parts interchangeability report Spare parts list - insurance & commissioning	
Documentation format	Hard copy	X
	Electronic CD - Adobe (.pdf), ms office (.xls.doc)	

Testing & NDT

All OH2 Series pumps are built to stringent quality control procedures as part of our ISO9001:2008 quality management system. We offer a variety of tests and NDT to suit your exact requirements as detailed below:

Pump Test	Test Standard	Acceptance criteria	Standard
Hydrostatic	API 610 / ISO 13709	API 610 / ISO 13709 (1.5 X MAWP)	X
Head and flow	API 610 / ISO 13709	ISO 9906 Grade 1	X
Mechanical run 1 hour at rated duty	API 610 / ISO 13709	API 610 / ISO 13709	
Mechanical run 4 hours at rated duty	API 610 / ISO 13709	API 610 / ISO 13709	
NPSH at each test point	API 610 / ISO 13709	API 610 / ISO 13709	
Noise - single point at 1m	API 610 / ISO 13709	Customer datasheet	
Vibration - FFT spectrum at each test point	API 610 / ISO 13709	API 610 / ISO 13709	X
Bearing bracket resonance	API 610 / ISO 13709	Mutual agreement	

To compliment the final test we also have a number of Non Destructive Tests (NDT) that can be supplied with the pump. The following table details our standard tests:

Visual examination of cast surfaces	ASME V Article 9 / MSS SP55 (pressure containing castings only)
Dyepenetrant of machined surfaces	Pressure containing castings only
Dyepenetrant of cast surfaces	Pressure containing castings only
Dyepenetrant of welds	Drain & seal pipe work (if fitted)
Positive Material Identification	Excludes minor components (nuts & bolts etc)
Radiography	Welds (pressure pipe work)
	Castings - shot plan (critical areas)
Hardness report	NACE (Certain materials only - please ask for details)

	• *Pressure containing parts include; volute casing, Casing cover & mechanical seal. Process wetted parts include additional shaft, impeller, wear rings & impeller hub cap, lock washer and nut.*

Installation

Pre installation

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 ASK 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.
	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 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.
	Guideline / **Explanation/comment** Keep the pump as close to the liquid source as practically possible. / This minimizes the friction loss and keeps the suction piping as short as possible. Make sure that the space around the / This facilitates ventilation, inspection,

	pump is sufficient.	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.
	Do not install and operate the equipment in closed systems unless the system is constructed with properly sized safety devices and control devices.	Such devices include the following: • Pressure relief valves • Compression tanks • Pressure controls • Temperature controls • Flow controls If the system does not include these devices, consult the engineer or architect in charge before operating the pump.
	Take into consideration the occurrence of unwanted noise and vibration.	The best pump location for noise and vibration absorption is on a concrete floor with subsoil underneath.
	If the pump location is overhead, undertake special precautions to reduce possible noise transmission.	Consulting a noise specialist is recommended.

Foundation requirements

Precautions	
	**CAUTION:** If the pumped fluid is non-conductive, drain and flush the pump with a conductive fluid under conditions that will not allow for a spark to be released to the atmosphere.
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

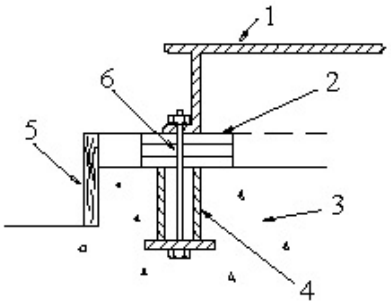
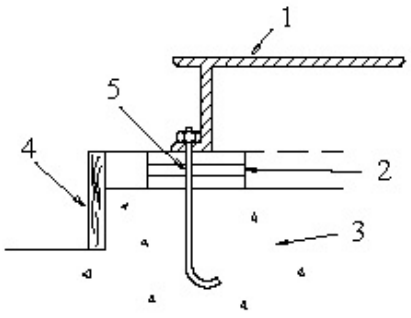
		**1. Base plate** **2. Shims or wedges** **3. Foundation** **4. Sleeve** **5. Dam** **6. Bolt (sleeve type)**

Diagram: J-type bolts

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

Piping checklists

General piping checklist

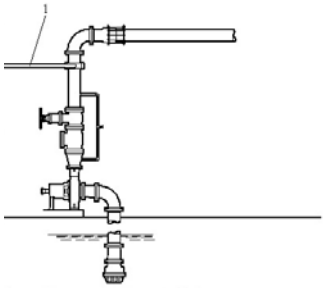
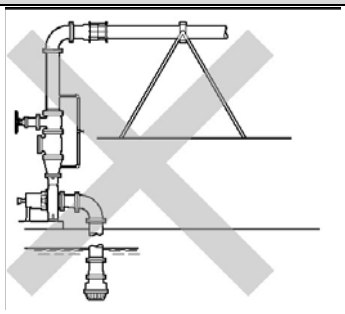
Precautions	
⚠	**CAUTION:** • Never draw piping into place by using force at the flanged connections of the pump. This can impose dangerous strains on the unit and cause misalignment between the pump and driver. Pipe strain will adversely affect the operation of the pump, resulting in physical injury 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	
	Guidelines for piping are given in the “Hydraulic Institute Standards” available from: Hydraulic Institute, 9 Sylvan Way, Parsippany, NJ 07054-3802. Before installing the pump, you must review this document.

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 base plate 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 airtight.	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		
	Correct	**Incorrect**
	 1. Expansion loop/joint	

Suction-piping checklist

Performance curve reference	
	Net positive suction head available ($NPSH_A$) must always exceed NPSH required ($NPSH_R$) as shown on this pump's published performance curve.

Suction-piping checks

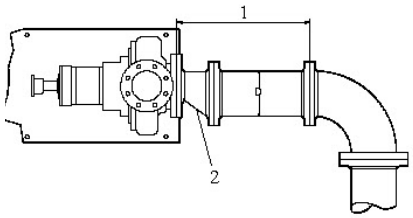
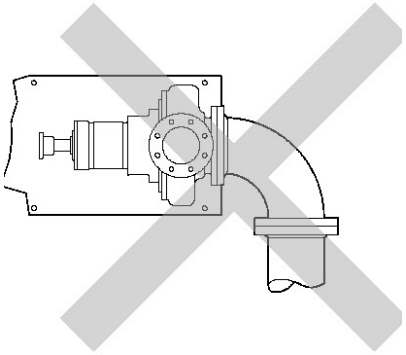
Check	Explanation / comment	Checked
Check that the distance between the inlet flange of the pump and the closest elbow is at least five pipe diameters.	This minimizes the risk of cavitation in the suction inlet of the pump due to turbulence. See the illustrations that follow.	
Check that elbows in general do not have sharp bends.	See the illustrations that follow.	
Check that the suction piping is one or two sizes larger than the suction inlet of the pump. An eccentric reducer should be installed between the pump inlet and the suction piping.	The suction piping should never have a smaller diameter than the suction inlet of the pump. See the illustrations that follow.	
Check that the eccentric reducer at the pump's suction flange has the following properties: • Sloping side down • Horizontal side at the top	See the illustrations that follow.	
If suction strainers or suction bells are used, check that they are at least three times the area of the suction piping.	Suction strainers help to prevent clogging. Mesh holes with a diameter of minimum 1/16 in. (1.6 mm) are recommended.	
If more than one pump operates from the same liquid source, check that separate suction piping lines are used for each pump.	This is generally recommended to get the highest performance from each pump.	
If necessary, make sure that the suction piping includes a drain valve and that it is correctly installed.	-	

Liquid source below the pump

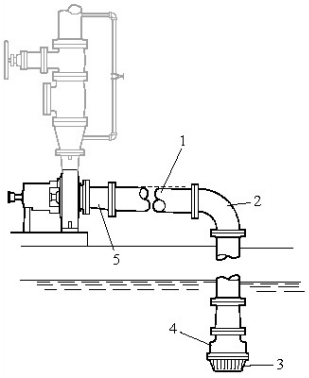
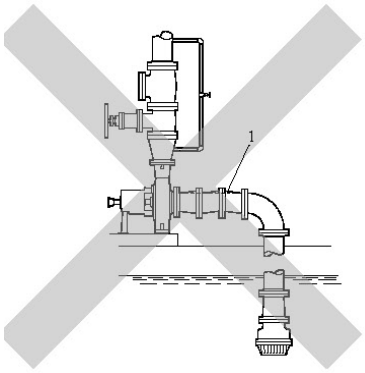
Suction-piping checks			
	Check	**Explanation / comment**	**Checked**
	Make sure that the suction piping is free from air pockets.	This helps to prevent occurrence of air and cavitation in the pump inlet.	
	Check that the suction piping slopes upwards from the liquid source to the pump inlet.	-	
	If the pump is not self-priming, check that a device for priming the pump is installed.	Use a foot valve with a diameter at least equivalent to the diameter of the suction piping.	

Liquid source above the pump			
	Check	**Explanation / comment**	**Checked**
	Check that an isolation valve is installed in the suction piping at a distance of at least two times the pipe diameter from the suction inlet.	This permits 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.	This helps to prevent occurrence of air and cavitation in the pump inlet.	
	Check that the piping is level or slopes downward from the liquid source.	-	
	Make sure that no part of the suction piping extends below the suction flange of the pump.	-	
	Make sure that the suction piping is adequately submerged below the surface of the liquid source.	This prevents air from entering the pump through a suction vortex.	

Example: Elbow close to the pump suction inlet

Correct	Incorrect
The correct distance between the inlet flange of the pump and the closest elbow must be at least five pipe diameters.  **1. Enough distance to prevent cavitation** **2. Eccentric reducer with a level top**	

Example: Suction piping equipment

Correct	Incorrect
 **1. Suction pipe sloping upwards from liquid source** **2. Long-radius elbow** **3. Strainer** **4. Foot valve** **5. Eccentric reducer with a level top**	 **1. Air pocket, because the eccentric reducer is not used and because the suction piping does not slope gradually upward from the liquid source**

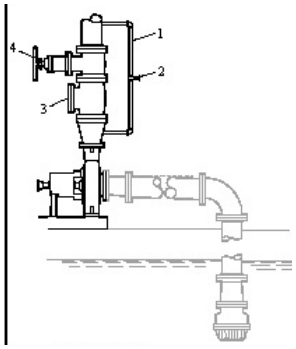
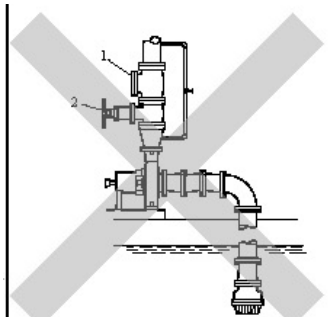
Discharge-piping checklist

Checklist

Check	Explanation/comment	Checked
Check that an isolation valve is installed in the discharge line.	The isolation valve is required for the following: • Priming • Regulation of flow • Inspection and maintenance of the pump See the illustration that follows.	
Check that a check valve is installed in the discharge line,	The location between the isolation valve and the pump	

	between the isolation valve and the pump discharge outlet.	allows inspection of the check valve. The check valve prevents damage to the pump and seal due to the back flow through the pump, when the drive unit is shut off. It is also used to restrain the liquid flow. See the illustration that follows.	
	If increasers are used, check that they are installed between the pump and the check valve.	See the illustration that follows.	
	If quick-closing valves are installed in the system, check that cushioning devices are used.	This protects the pump from surges and water hammer.	

Example: Discharge piping equipment

	Correct	Incorrect
	 **1. Bypass line** **2. Shut-off valve** **3. Check valve** **4. Discharge isolation valve**	 **1. Check valve (incorrect position)** **2. The isolation valve should not be positioned between the check valve and the pump.**

Bypass piping considerations

When to use a bypass line	
	Provide a bypass line for systems that require operation at reduced flows for prolonged periods. Connect a bypass line from the discharge side (before any valves) to the source of suction.
When to install a minimum-flow orifice	
	You can size and install a minimum-flow orifice in a bypass line to prevent bypassing excessive flows. Consult your ASK representative for assistance in sizing a minimum-flow orifice.
When a minimum-flow orifice is unavailable	
	You should consider an automatic recirculation control valve or solenoid-operated valve if a constant bypass (minimum-flow orifice) is not possible.

Auxiliary piping checklist

Precautions	
⚠	**Warning:** • 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.
	NOTICE: The mechanical seal must have an appropriate seal-flush system. Otherwise, excess heat generation and seal failure can occur.
When to install	
	You may need to install auxiliary piping for bearing cooling, seal-chamber cover cooling, mechanical seal flush, or other special features supplied with the pump. Consult the pump data sheet for specific auxiliary piping recommendations.
Checklist	

Check	Explanation / comment	Checked
Check that the minimum flow for each component is 1 gpm (4 lpm).	Make sure that these guidelines are followed.	
If the bearing and seal chamber cover cooling are provided, then the auxiliary piping must flow at 2 gpm (8 lpm).	-	
Check that the cooling water pressure does not exceed 100 psig (7.0 kg/cm2).	Make sure that these guidelines are followed.	

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

Prepare the baseplate for mounting

	This procedure assumes you have a basic knowledge of baseplate and foundation design and installation methods. Follow industry-standard procedures, such as API RP 686/ PIP REIE 686, or this procedure before you grout the baseplate. 1. Make sure that all baseplate surfaces that will contact grout are free from contamination such as rust, oil, and grime. 2. Thoroughly clean all baseplate surfaces that will come in contact with grout. Make sure to use a cleaner that will not leave residue.

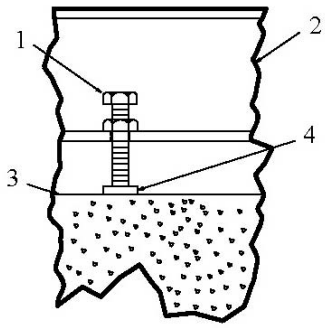
	NOTICE: You may need to sandblast the surfaces of a baseplate that come in contact with grout, and then coat those surfaces with a primer that is grout-compatible. Make sure to remove all equipment before sandblasting.
	3. Make sure that all machined surfaces are free from burrs, rust, paint, or any other type of contamination. 4. If necessary, use a honing stone to remove burrs.

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 baseplate 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's levels This procedure is applicable to the feature-fabricated steel baseplate and the advantage base baseplate. 1. Apply an anti-seizing compound on the jackscrews. The compound makes it easier to remove the screws after the grouting. 2. Lower the baseplate 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 baseplate above the foundation with the four jackscrews in the corners. The distance between the baseplate 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.

		**1. Jackscrew** **2. Baseplate** **3. Foundation** **4. Plate**
	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. 4. Turn the center jackscrews down so they rest on their plates on the foundation surface. 5. 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.	
	6. Tighten the nuts for the foundation bolts by hand. 7. 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 baseplate. Use applicable bolts. 2. Mount the driver on the baseplate. 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	Why
Before grouting the baseplate	This ensures that alignment can be accomplished.
After grouting the baseplate	This ensures that no changes have occurred during the grouting process.
After connecting the piping	This ensures that pipe strains have not altered the alignment. If changes have occurred, you must alter the piping to remove pipe strains on the pump flanges.

Final alignment (hot alignment) checks

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

Permitted indicator values for alignment checks

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

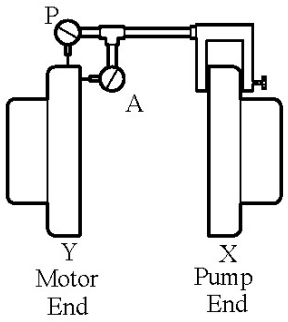
	IMPORTANT • For electric motors, the motor shaft initial (cold) parallel vertical alignment setting should be 0.002 to 0.004 in. (0.05 to 0.10 mm) lower than the pump shaft. • For other drivers such as turbines and engines, follow the driver manufacturers' recommendations. When dial indicators are used to check the final alignment, the pump and drive unit are correctly aligned when the following conditions are true: • The total indicator runout is a maximum of 0.002 in. (0.05 mm) at operating temperature. • The tolerance of the indicator is 0.0005 in./in. (0.0127 mm/mm) of indicator separation at operating temperature.

Alignment measurement guidelines

Guideline	Explanation
Rotate the pump coupling half and the driver's coupling half together so that the indicator rods have contact with the same points on the driver's coupling half.	This prevents incorrect measurement.
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 when you take indicator measurements.	This prevents the driver from moving as this causes incorrect measurement.
Ensure that the hold-down bolts for the driver's feet are loose before you make alignment corrections.	This makes it possible to move the driver when correcting.
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.



2. 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.
3. 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.

When the reading value is...	Then the coupling halves are...
Negative	Farther apart at the bottom than at the top.
Positive	Closer at the bottom than at the top.

4. Do as follows:

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).

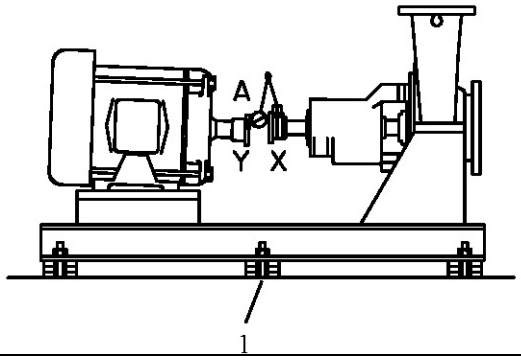


Figure 5: Example of incorrect vertical alignment (side view)

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

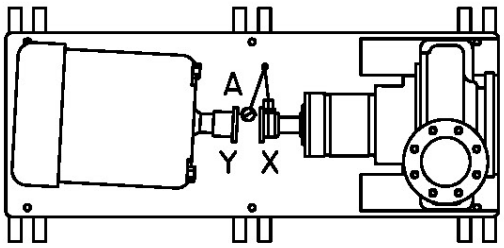
Perform angular alignment (horizontal correction)

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...
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.



Example of incorrect horizontal alignment (top view)

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

Perform parallel alignment (vertical correction)

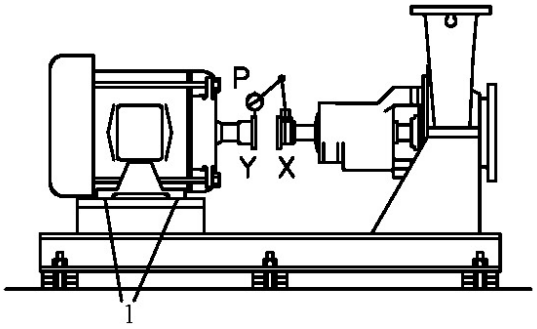
Before you start this procedure, make sure that the dial indicators are correctly set up.
A unit is in parallel alignment when indicator P (parallel indicator) does not vary by more than 0.002 in. (0.05 mm) as measured at four points 90° apart at the operating temperature.
1. Set the parallel alignment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

4. Do as follows:

If your 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

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.

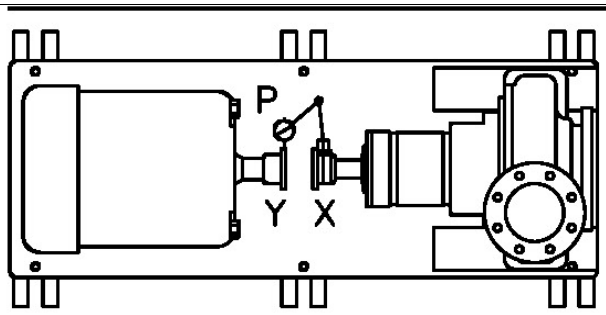
1. Set the parallel alignment indicator to zero on the left side of the driver's coupling half, 90° from the top-center position (9 o'clock).
2. Rotate the indicator through the top-center position to the right side, 180° from the start position (3 o'clock).
3. Record the indicator reading.

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.



Example of incorrect horizontal alignment (top view)

5. Repeat the previous steps until the permitted 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 permitted reading values are obtained.

Perform complete alignment (horizontal correction)

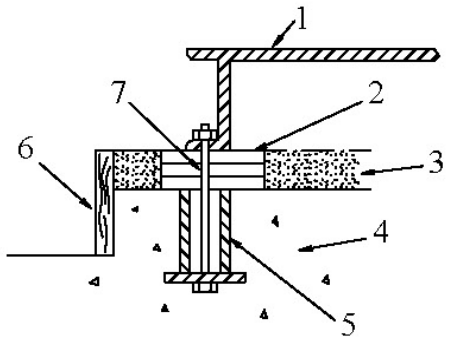
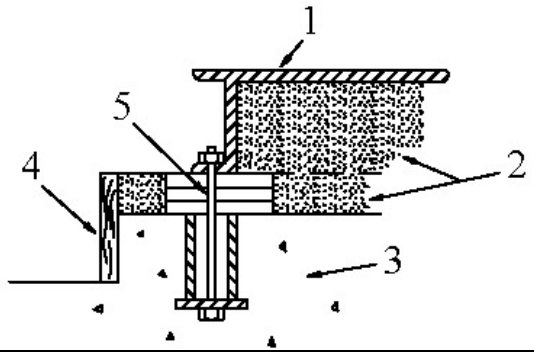
A unit is in complete alignment when both indicators A (angular) and P (parallel) do not vary by more than 0.002 in. (0.05 mm) as measured at four points 90° apart.
1. Set the two dial indicators (angular and parallel) to zero at the left side of the driver's coupling half (9 o'clock), 90° from the top-center 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 permitted reading values are obtained.

Grout 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 baseplate 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 baseplate that will come into contact with the grout.
2. Build a dam around the foundation.
3. Thoroughly wet the foundation that will come into contact with the grout.
4. Pour grout through the grout hole into the baseplate up to the level of the dam. When you pour the grout, remove air bubbles from it one using one of the following

	methods: • Puddle with a vibrator. • Pump the grout into place, and allow the grout to set.	
		**1. Baseplate** **2. Shims or wedges** **3. Grout** **4. Foundation** **5. Sleeve** **6. Dam** **7. Bolt**
	5. Fill the remainder of the baseplate with grout, and allow the grout to set for at least 48 hours.	
		**1. Baseplate** **2. Grout** **3. Foundation** **4. Dam** **5. Bolt**
	6. Remove the leveling screws after the grout hardens to remove any stress points. 7. Tighten the foundation bolts.	

Commissioning, Startup, Operation, and Shutdown

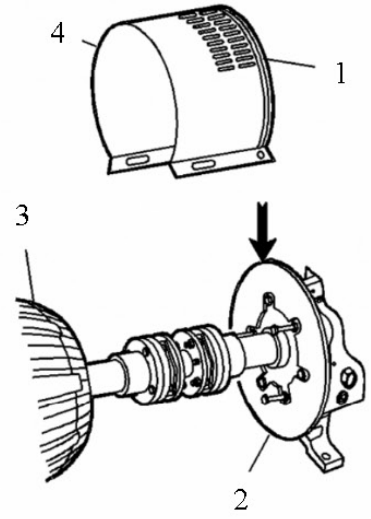
Preparation for startup

Hazard statements	
⚠	**WARNING:** • Failure to follow these precautions before you start the pump will lead to serious personal injury and equipment failure. • DO NOT operate the pump below the minimum rated flows or with suction and discharge valve closed. These conditions can create an explosive hazard due to vaporization of pumped fluid and can quickly lead to pump failure and physical injury. • 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. • Operating the pump in reverse rotation can result in the contact of metal parts, heat generation, and breach of containment.
	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.

Remove the coupling guard

⚠	1. Remove the nut, bolt, and washers from the slotted hole in the center of the coupling guard. 2. Slide the driver half of the coupling guard toward the pump. 3. Remove the nut, bolt, and washers from the driver half of the coupling guard. 4. Remove the driver-side end plate. 5. Remove the driver half of the coupling guard: a) Slightly spread the bottom apart. b) Lift upwards. 6. Remove the remaining nut, bolt, and washers from the pump half of the coupling guard. It is not necessary to remove the end plate from the pump-side of the bearing housing. You can access the bearing-housing tap bolts without removing this end plate if maintenance of internal pump parts is necessary. 7. Remove the pump half of the coupling guard: a) Slightly spread the bottom apart. b) Lift upwards.

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

Check the rotation

⚠	**WARNING:** • 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.

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 shipped without oil	
	You must lubricate oil-lubricated bearings at the job site.
Ring oil lubrication	
	Ring oil-lubricated bearings are standard on Model OH2 pumps. Make sure that oil rings are properly seated in the grooves in the shaft.

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.

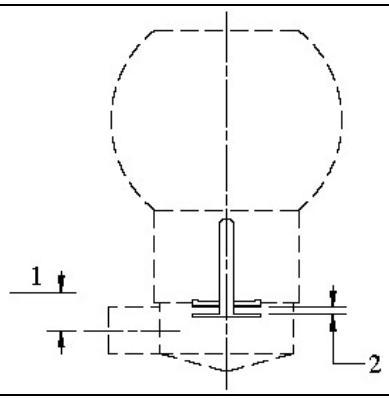
Acceptable oil for lubricating bearings

Acceptable lubricants

Brand	Lubricant type
Exxon	Teresstic EP 68
Mobil	Mobil DTE 26 300 SSU @ 100°F (38°C)
Sunoco	Sunvis 968
Royal Purple	SYNFILM ISO VG 68 Synthetic Lube

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 bulls eye 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 bulls eye sight glass with the oil level line on the side of the bearing frame.	

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 ASK, 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.

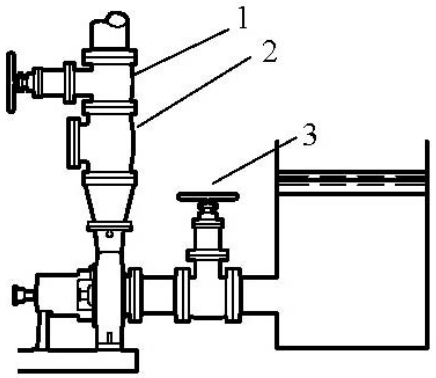
Connection of sealing liquid for mechanical seals

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	
	You can use the following methods to flush or cool the seal.

Method	Description
Product flush	Run the piping so that the pump pushes the pumped fluid from the casing and injects it into the seal gland. If necessary, an external heat exchanger cools the pumped fluid before it enters the seal gland.
External flush	Run the piping so that the pump injects a clean, cool, compatible liquid directly into the seal gland. The pressure of the flushing liquid must be 5 to 15 psi (0.35 to 1.01 kg/cm2) 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

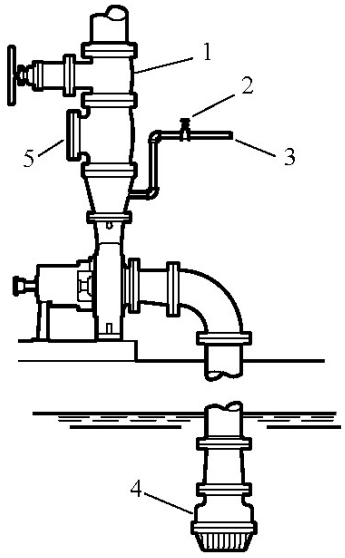
	1. Slowly open the suction isolation valve. 2. Open the air vents on the suction and discharge piping until the pumped fluid flows out. 3. Close the air vents.
	1. Discharge isolation valve 2. Check valve 3. Suction isolation valve

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:

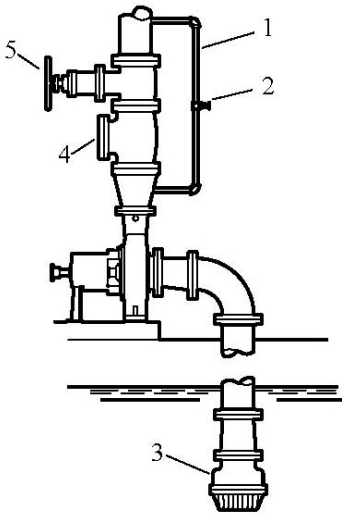
- A priming pump
- A pressurized discharge line
- Another outside supply

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.



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, re-prime, 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: a) Stop the driver. b) Prime the pump again. c) Restart the driver. 6. Monitor the pump while it is operating: a) Check the pump for bearing temperature, excessive vibration, and noise. b) If the pump exceeds normal levels, then shut down the pump immediately and correct the problem. A pump can exceed normal levels for several reasons. Refer to the Troubleshooting chapter for information about possible solutions to this 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. 1. Run the unit under actual operating conditions for enough time to bring the pump, driver, and associated system to operating temperature. 2. Shut down the pump and the driver. 3. Remove the coupling guard. 4. Check the alignment while the unit is still hot. 5. Reinstall the coupling guard. 6. Restart the pump and driver.

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 it. 3. Replace worn parts.

Bearing maintenance

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 for 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

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

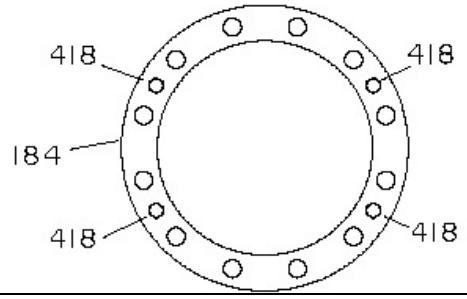
Tools required

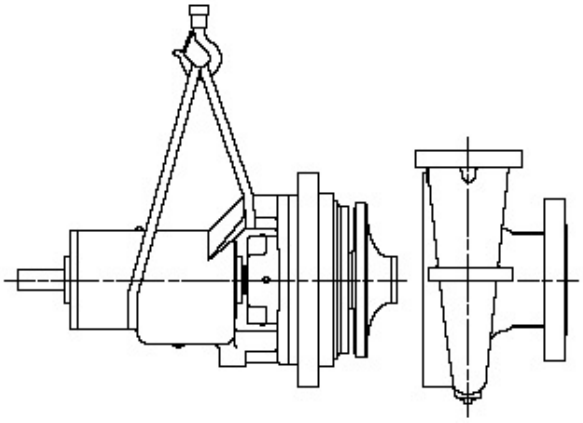
	To disassemble the pump, you will need the following tools: • Hex wrenches in sizes 12, 14, 16, 19, and 22 mm • Brass drift punch • Cleaning agents and solvents • Dial indicators • Drill • Feeler gauges • Induction bearing heater • Lifting sling • Micrometer • Open end wrenches • Press • Soft face hammer • Spanner wrench • Spanning type puller • Tap • Torque wrench with sockets

Drain the pump

	1. Close the isolation valves on the suction and discharge sides of the pump. You must drain the system if no valves are installed. 2. 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. 3. 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. 4. Drain the liquid from the piping and flush the pump if it is necessary. 5. Disconnect all auxiliary piping and tubing. 6. Remove the oiler bottle and store it in a safe place. 7. Remove the coupling guard. 8. Remove the coupling spacer. Follow the coupling manufacturer's instructions for assistance. 9. Disconnect the coupling.

Remove the back pull-out assembly

<table>
<tr><td>  </td><td>CAUTION:
Never remove the back pull-out assembly without assistance.</td></tr>
<tr><td></td><td>1. Remove the casing stud nuts.</td></tr>
<tr><td>  </td><td>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.</td></tr>
<tr><td rowspan="3"></td><td>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.</td></tr>
<tr><td> 
</td><td>418 - Jack screw</td></tr>
<tr><td>3. Remove the back pull-out assembly using a lifting sling through the bearing frame.</td></tr>
</table>



4. Remove and discard the casing gasket.
You will insert a new casing gasket during reassembly.
5. Remove the jack screws.
6. Clean all gasket surfaces.
Clean surfaces to prevent the casing gasket from partially adhering to the casing due to binders and adhesives in the gasket material.
7. Secure the back pull-out assembly to prevent movement during transport.
8. Transport the back pull-out assembly to a clean work area for further disassembly.

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.

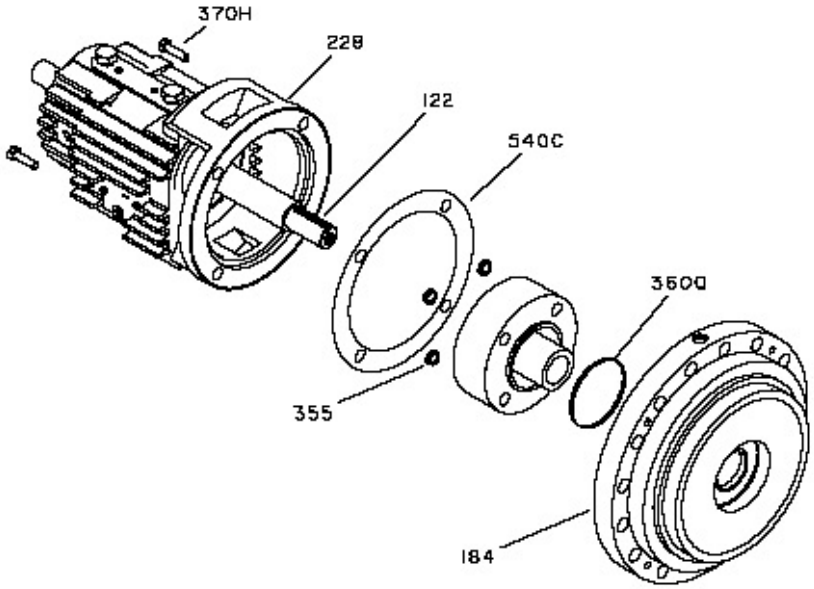
Remove the impeller

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

1. Loosen and remove the impeller nut.
The impeller nut has left-hand threads.
2. Pull the impeller from the shaft.
Use a spanning-type puller if required.
3. Remove the impeller key.
Save the key for reassembly unless it is damaged.

Remove the seal-chamber 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.

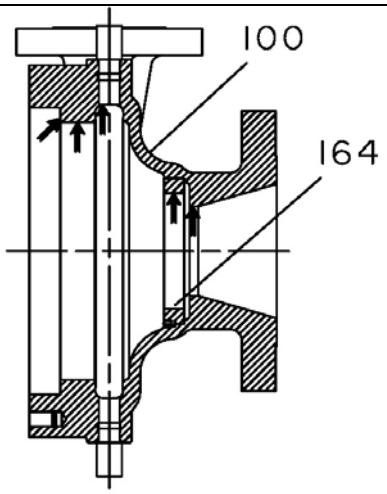
	5. Loosen and remove the seal-chamber cover and the bearing frame bolts. 6. Separate the seal-chamber cover from the bearing frame by tapping on the cover flange with a hardwood block or a soft-face hammer.
	
	7. Guide the seal-chamber cover over the end of the shaft once the cover releases from the bearing frame.
	NOTICE: The cartridge mechanical seal may become damaged if the cover is allowed to come in contact with it.
	8. Remove and discard the bearing frame and seal-chamber cover gasket. You will replace this with a new gasket during reassembly. 9. Loosen the set screws and remove the cartridge mechanical seal from the shaft. 10. Remove and discard the mechanical seal O-ring or gland gasket. You will replace this with a new O-ring or gasket during reassembly.

122	Shaft
184	Seal-chamber cover
228	Bearing frame
355	Gland stud nuts
360Q	Gland gasket
370H	Bearing frame bolts
540C	Seal-chamber cover gasket

Preassembly inspections

Replacement guidelines

Casing check and replacement	
	Inspect the casing for cracks and excessive wear or pitting. 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 1/8 in. (3.2 mm) deep • Pitting that is greater than 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.



Impeller replacement

This table shows the criteria for replacing the impeller parts.

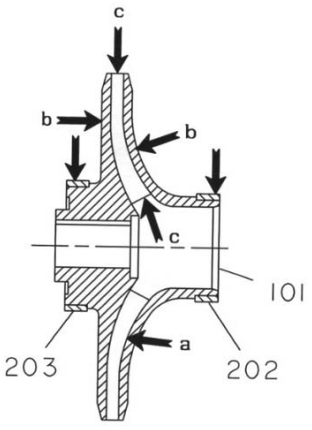
Impeller parts	When to replace
Impeller vanes	• When grooved deeper than 1/16 in. (1.6 mm), or • When worn evenly more than 1/32 in. (0.8 mm)
Pump-out vanes	When worn or bent more than 1/32 in. (0.8 mm)
Vane edges	When you see cracks, pitting, or corrosion damage

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 extremely accurate tooling equipment to balance impellers to the ISO 1940 G1.0 criteria. Do not attempt to balance impellers to this criterion unless this type of tooling and equipment is available.

Impeller areas to inspect



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.

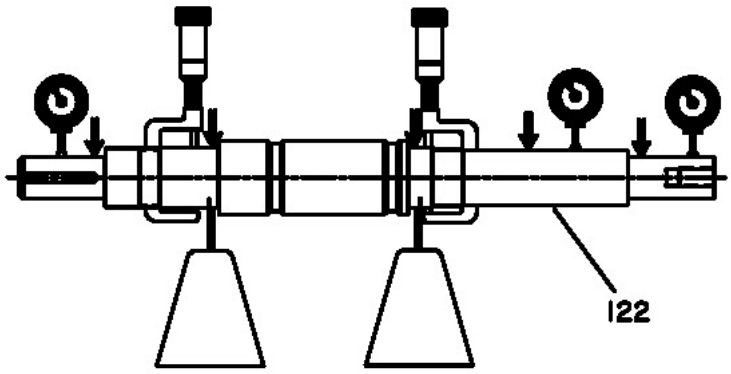
Cartridge mechanical seal replacement

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.

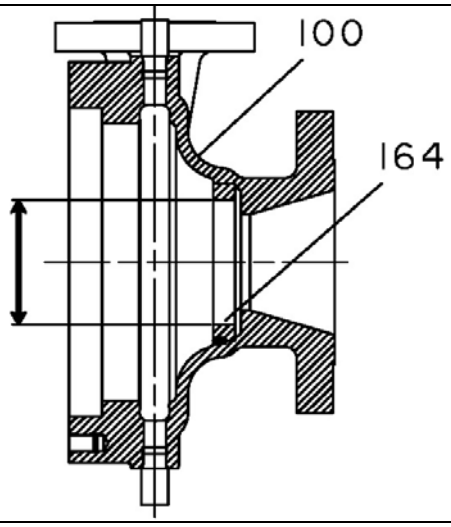
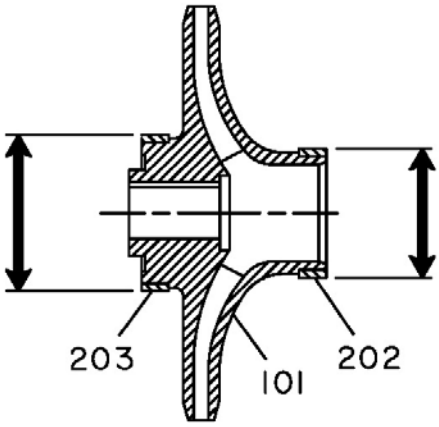
Shaft replacement guidelines

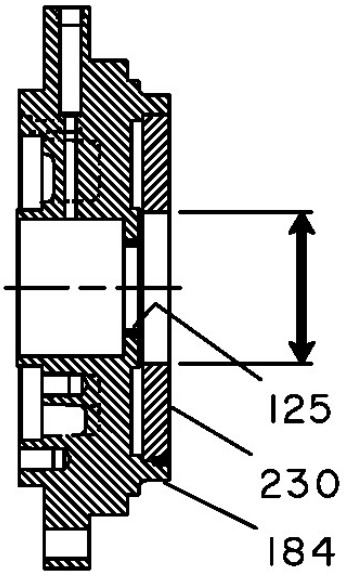
Shaft measurement check	
	Check the bearing fits of the shaft. If any are outside the tolerances shown in the Bearing fits and tolerances table, then replace the shaft.
Shaft straightness check	
	Check the shaft straightness. Use “V” blocks or balance rollers to support the shaft on the bearing fit areas. 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.

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.	
		Casing wear ring 100 - Casing 164 - Casing wear ring
		Impeller wear ring 101 - Impeller 202 - Impeller wear ring 203 - Impeller wear ring



Seal chamber cover wear ring

125 - Seal-chamber throat bushing
184 - Seal-chamber cover
230 - Seal-chamber cover wear ring

When to replace wear rings

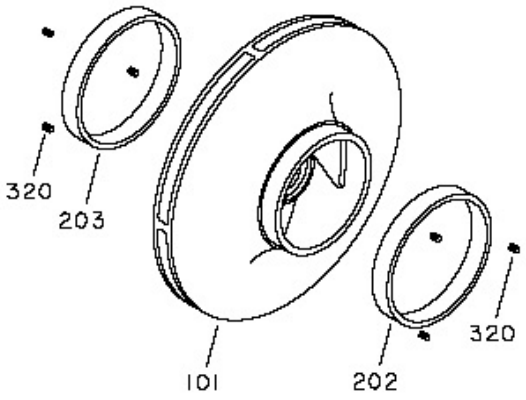
Replace wear rings when the diametrical clearance exceeds two times the minimum clearance as shown in this table or when the hydraulic performance has decreased to unacceptable levels.

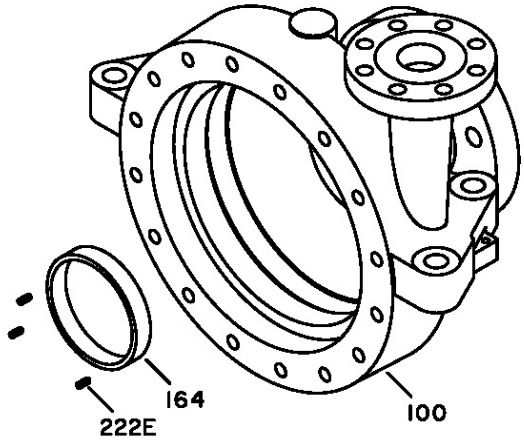
Minimum running clearances:

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

Replace the wear rings

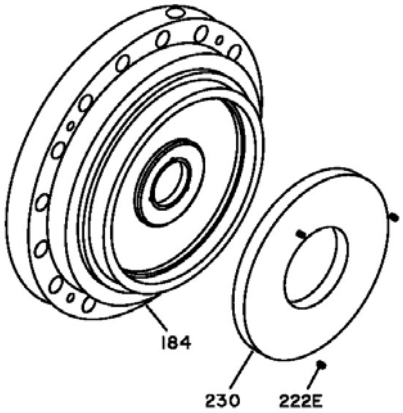
WARNING:
Dry ice and other chilling substances can cause physical injury. Contact the supplier for information and advice for proper handling precautions and procedures.

<table>
<tr><td></td><td>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.</td></tr>
<tr><td rowspan="4"></td><td>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.</td></tr>
<tr><td>Casing, impeller, and seal chamber cover wear rings are held in place by a press fit and three set screws.
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.</td></tr>
<tr><td> 
</td><td>101 - Impeller
202 - Impeller wear ring
203 - Impeller wear ring
320 - Set screw</td></tr>
<tr><td>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.</td></tr>
</table>



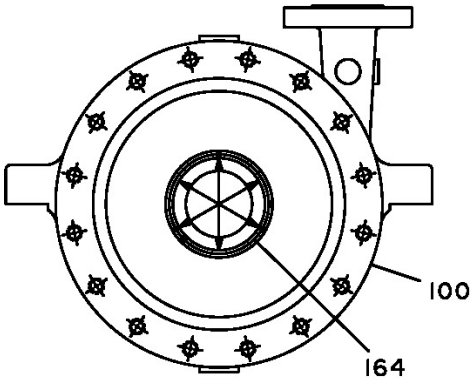
100 - Casing
164 - Casing wear ring
222E - Set screw

5. Insert a new seal-chamber-cover wear ring:
a) 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.
b) Locate, drill, and tap three new equally-spaced set screw holes between the original holes in each new ring and ring-seat area.
c) Install the set screws and upset threads.



184 - Cover
222E - Set screw
230 - Seal-chamber-cover wear ring

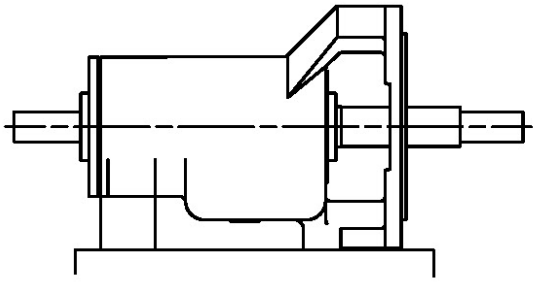
6. Check the casing wear ring runout and distortion:
a) Measure the bore at each set screw location with inside micrometers or vernier calipers.
b) Correct any distortion in excess of 0.003 in. (0.08 mm) by machining before you trim the new impeller wear rings.



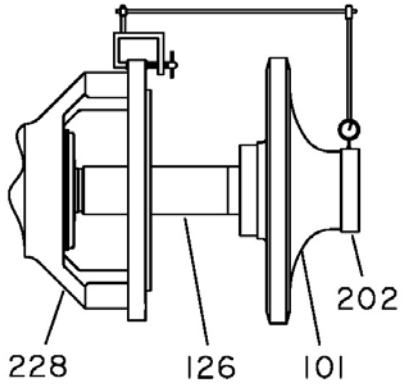
100 - Casing
164 - Casing wear ring

7. Measure the bore of the casing wear ring to establish the required impeller wear-ring diameter you use to provide the recommended running clearances.
8. Repeat steps 6 and 7 for the seal-chamber wear ring.
9. Turn the impeller wear rings to size after you mount them on the impeller:

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.



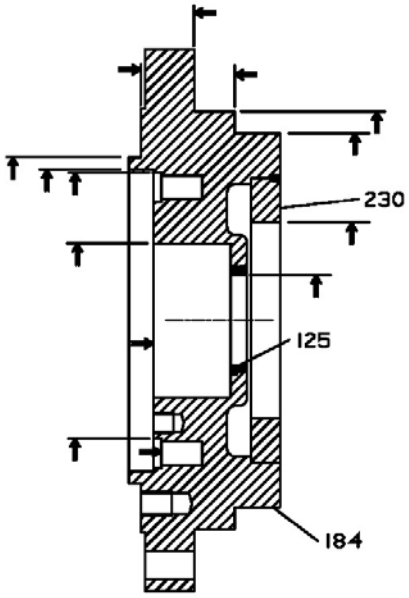
10. Install the impeller:
a) Install the impeller key on the shaft of the assembled bearing frame from which the seal chamber cover has been removed, and on which the runouts are within the established specifications. The key should be at the top (12 o'clock) position for the impeller installation.
b) 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.



101 - Impeller
202 - Casing-side impeller wear-ring
228 - 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.

Seal-chamber cover inspection and replacement

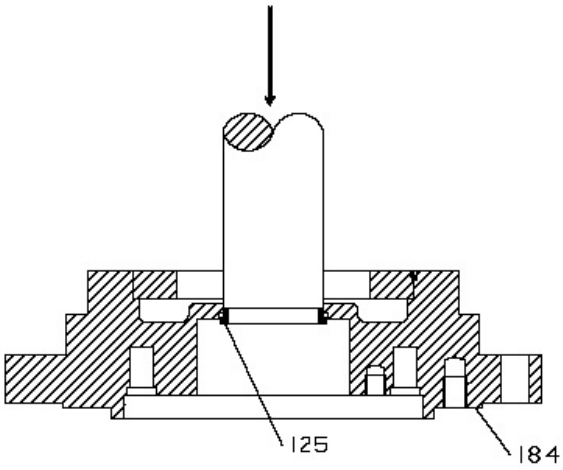
Two seal-chamber cover versions	
	The seal-chamber cover is available in two versions: • Standard • Optional The optional version has a cooling chamber and water jacket cover (490) and is used when elevated pumped-fluid temperatures are present.
Seal-chamber cover areas to inspect	
	• Ensure all gasket/O-ring sealing surfaces are clean and have no damage that would prevent sealing. • Ensure that all cooling (where applicable), flush, and drain passages are clear.
	

Seal-chamber cover replacement

Seal-chamber cover part	When to replace
Seal-chamber cover surfaces	When worn, damaged, or corroded more than 0.126 in. (3.2 mm) deep
Inside diameter of seal-chamber cover bushing (125)	When the diametral clearance between the bushing and the impeller hub exceeds 0.047 in. (1.20 mm)

Replace the seal-chamber cover 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.

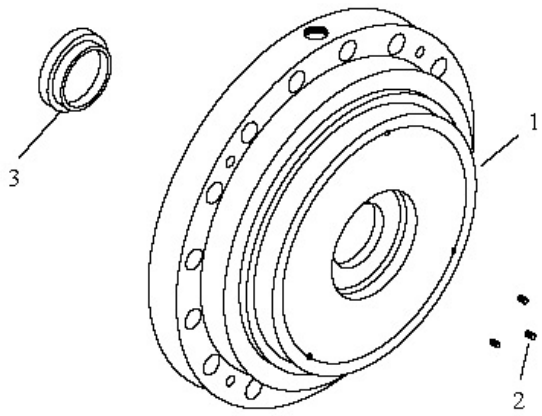


125 - Bushing
184 - Seal-chamber cover

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.

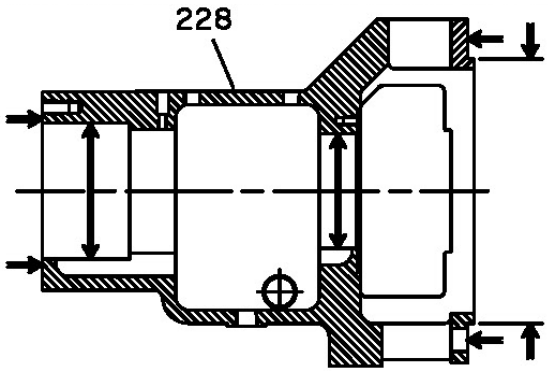
c) Locate, drill, and tap three new equally-spaced set screw holes on the impeller side of the cover between the original set screw holes.
d) Install the set screws and upset threads.



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.  **Surface inspection locations**

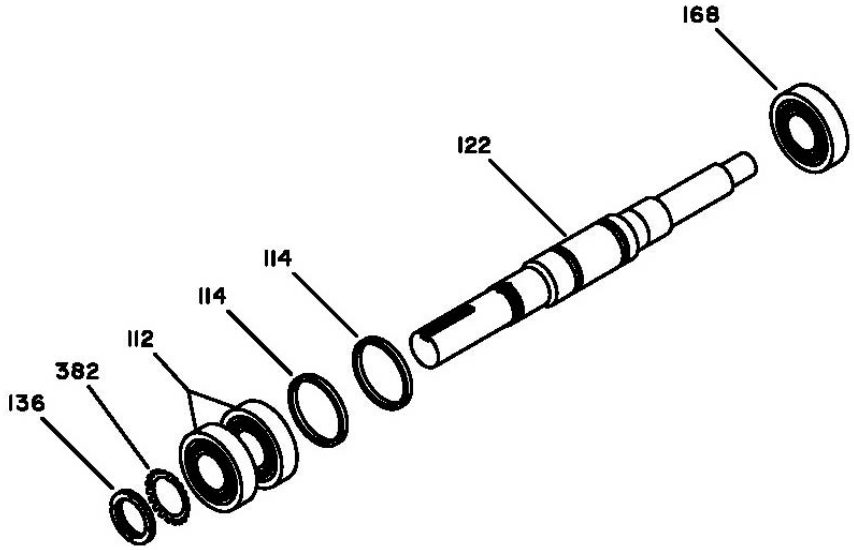
Bearing fits and tolerances

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

Reassembly

Assemble the power end

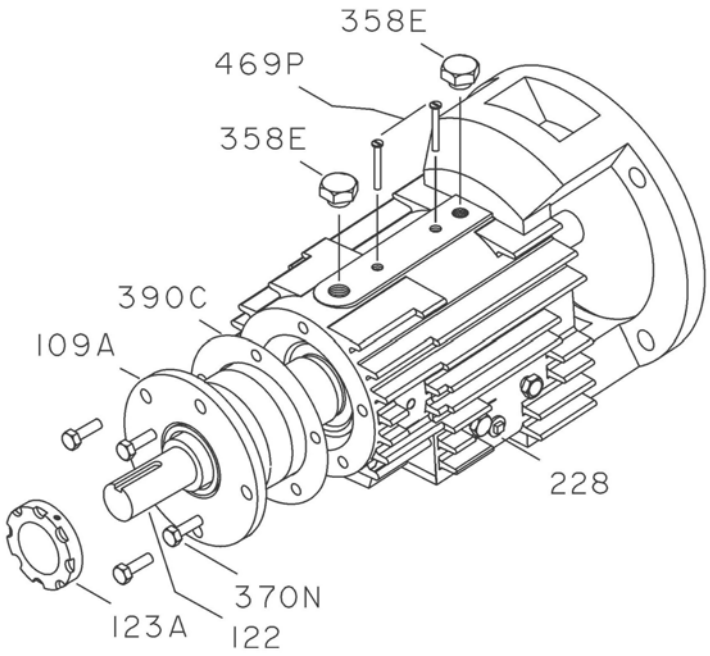
⚠	**WARNING:** The pump and the components can be heavy. Make sure to use proper lifting methods, and wear steel toed shoes at all times. Failure to do so can result in physical injury or equipment damage.
⚠	**CAUTION:** • Wear insulated gloves when you use a bearing heater. Bearings get hot and can cause physical injury.
	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.
	1. Install the radial (inboard) bearing on the shaft.



112 - Duplex thrust bearing
114 - Oil rings
122 - Shaft
136 - Thrust-bearing locknut
168 - Radial bearing
382 - Lock washer

2. Install the oil rings and bearings:
a) Install the oil rings on the shaft.
b) Install the thrust (outboard) bearings on the shaft.
c) Place the bearing lock washer on the shaft and the tang of the lock washer in the keyway.
d) Thread the bearing locknut onto the shaft.
After the bearings and the shaft have cooled to the ambient temperature, tighten the locknut.
e) Bend a tang of the bearing lock washer into a slot of the locknut.
f) Coat the internal bearing surfaces with lubricant to be used in service.

3. 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.



109A - Thrust-bearing end cover
122 - Shaft
123A - Thrust deflector
228 - Bearing frame
358E - Oil ring inspection plug
360A - Gasket
370N - Bearing-frame screw
390C - Thrust-bearing end-cover shim
469P - Oil ring retainer

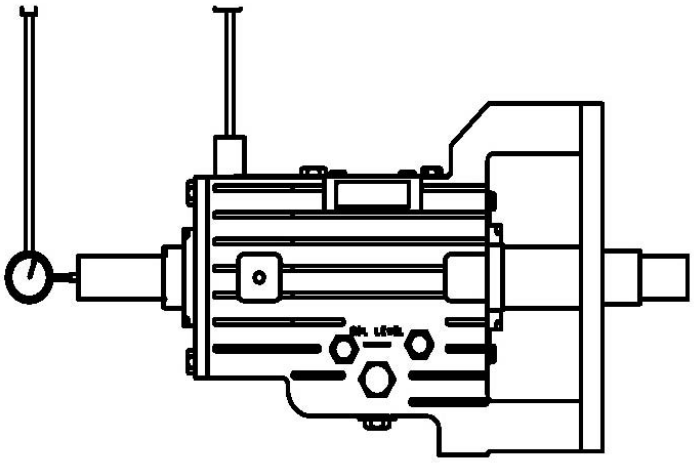
d) Carefully guide the shaft and bearing assembly into the bearing frame until the thrust bearing is seated against the shoulder of the frame. Make sure that the oil rings do not bind or become damaged.
Do not force the assembly together.
e) Observe the oil rings through the sight glass in the bearing 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.
7. Replace the oil-ring inspection connection plugs.
8. 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

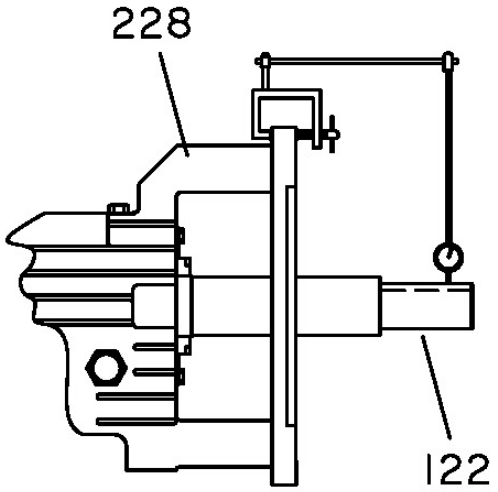
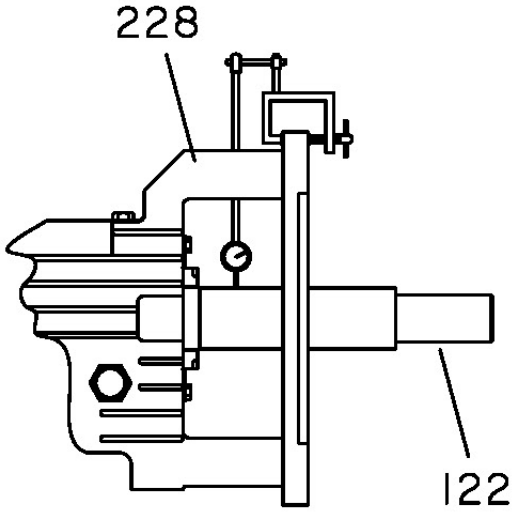
position.

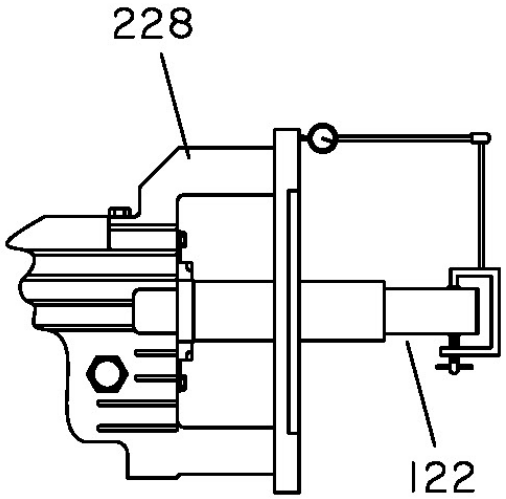
Determine the axial end play as follows:
a) Mount the dial indicator.
b) Use a lever to apply axial force to the impeller end of the shaft and firmly seat the thrust bearing against the shoulder in the bearing frame.
c) Apply axial force in the opposite direction and firmly seat the thrust bearing against 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).
Achieve the correct axial end play by adding or removing end-cover gaskets or end-cover shims between the thrust-bearing end cover and the bearing frame. Add gaskets and shims if no axial end play is present.
If the measured total travel falls outside the accepted range in step 4, remove or add the appropriate quantity of individual shims or gaskets to obtain the proper total travel.



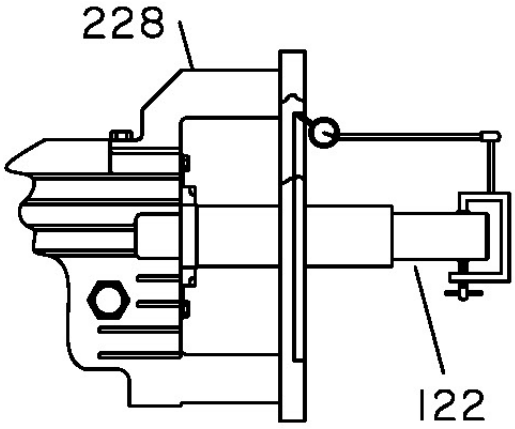
Check the following runouts:

Check	Procedure
Shaft impeller fit	1. Mount the dial indicator on the bearing frame. 2. Rotate the shaft through a maximum arc from one side of the keyway to the other. If the total indicator reading is greater than 0.002 in. (0.050 mm), determine the cause and correct it.

		
	Shaft seal fit	1. Mount the dial indicator. 2. 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. 
	Bearing frame face	1. Mount the dial indicator on the shaft. 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.

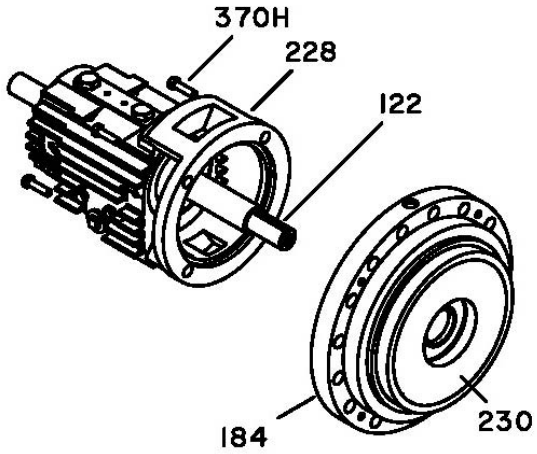


Bearing frame lock	1. Mount the dial indicator on the shaft. 2. Rotate the shaft so that the indicator rides along the bearing-frame lock for 360°. If the total indicator reading is greater than 0.004 in. (0.10 mm), then disassemble and determine the cause and correct it.

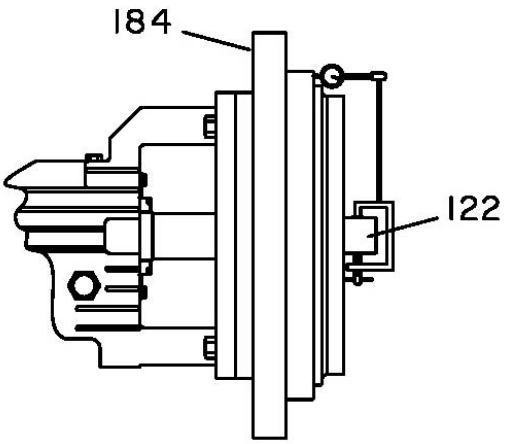


Install the seal-chamber cover

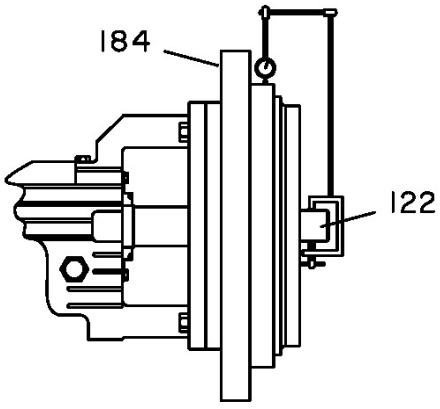
	1. Install the eyebolt in the tapped hole provided in the seal-chamber cover. 2. Lift the seal-chamber cover and position it so that it aligns with the shaft. 3. Install the seal-chamber cover on the bearing-frame assembly: a) Guide the cover carefully over the shaft and into the bearing-frame lock. b) Install the seal-chamber cover and bearing-frame bolts. c) Tighten the bolts evenly using an alternating pattern. 4. 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.



122 - Shaft
184 - Seal-chamber cover
228 - Bearing frame
230 - Seal-chamber cover wear-ring
370H - Bearing-frame bolts

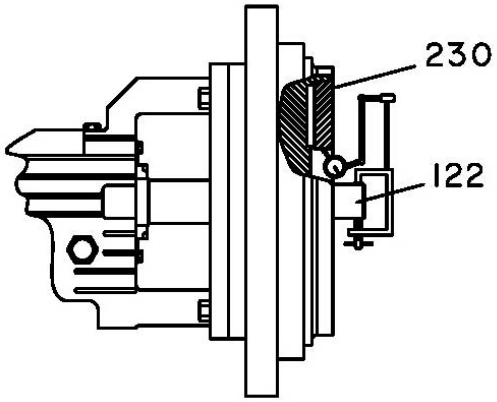


5. Check the seal-chamber cover lock runout:
a) Mount the dial indicator on the shaft.
b) Rotate the shaft so that the indicator rides along the seal-chamber cover lock for 360°. If the total indicator reading is greater than 0.005 in. (0.13 mm), determine the cause and correct it.



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.

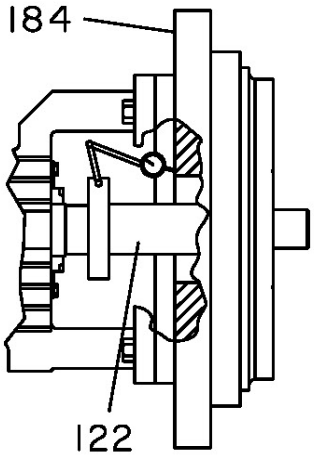
6. Check the seal-chamber cover wear-ring runout:
a) Mount the dial indicator on the shaft.
b) Rotate the shaft so that the indicator rides on the seal-chamber cover wear-ring surface for 360°. If the total indicator reading exceeds 0.006 in. (0.15 mm), determine the cause and correct it.



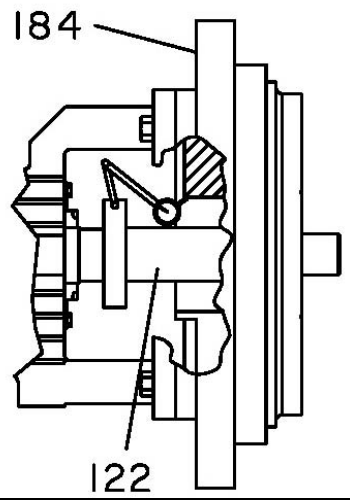
7. Check the seal-chamber face runout:
a) Mount a dial indicator on the shaft.
b) Rotate the shaft so that the indicator rides along the seal-chamber face for 360°.
If the total indicator reading is greater than the values shown in this table, determine the cause and correct it.

Maximum Allowable Seal Chamber Face Runout

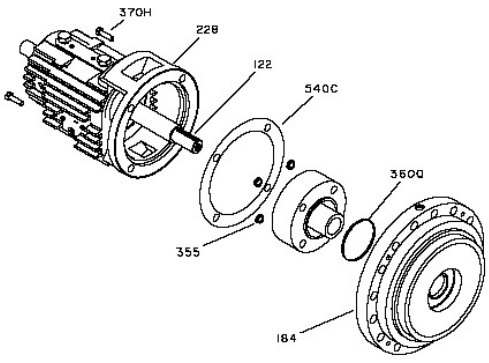
Group	Maximum Allowable Total Indicator Reading
SA	0.0018 in. (0.045 mm)
SX, MA	0.002 in. (0.05 mm)
MX, LA	0.0024 in. (0.06 mm)
LX, XLA	0.0026 in. (0.065 mm)
XLX	0.0028 in. (0.07 mm)
XXL	0.0031 in. (0.08 mm)



8. 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.
	 122 - Shaft 184 - Seal-chamber cover 228 - Bearing frame 355 - Gland stud nut 370H - Bearing-frame bolts 540C - Seal-chamber cover gasket
	4. Install the bearing frame and seal-chamber cover gasket into the recess of the bearing frame and align the holes. 5. 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 seal-chamber cover and bearing-frame bolts and tighten them using an alternating pattern. f) Install the gland stud nuts and tighten evenly. 6. Tighten the set screws in the locking collar. 7. Disengage the spacer ring or clips. 8. Verify that the shaft turns freely. If you detect rubbing or excessive drag, then determine the cause and correct it.

Post-assembly checks

	Perform these checks after you assemble the pump, then continue with pump start-up: • Make sure you can rotate the shaft easily by hand to ensure that it rotates smoothly and that there is no rubbing. • Open the isolation valves and check the pump for leaks.

Troubleshooting

Operation troubleshooting

Symptom	Cause	Remedy
The pump is not delivering liquid.	The pump is not primed.	Re-prime the pump and check that the pump and suction line are full of liquid.
	The suction line is clogged.	Remove the obstructions.
	The impeller is clogged.	Back-flush the pump to clean the impeller.
	The shaft is rotating in the wrong direction.	Change the rotation. The rotation must match the arrow on the bearing housing or pump casing.
	The foot valve or suction pipe opening is not submerged enough.	Consult an ASK representative for the proper submersion depth. Use a baffle to eliminate vortices.
	The suction lift is too high.	Shorten the suction pipe.
The pump is not producing the rated flow or head.	The gasket or O-ring has an air leak.	Replace the gasket or O-ring.
	The stuffing box has an air leak.	Replace or readjust the mechanical seal.

	The impeller is partly clogged.	Back-flush the pump 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 the cooling system.
The pump is noisy or vibrates.	The pump and driver are not aligned properly.	Realign the pump and driver.
	The impeller is partly clogged.	Back-flush the pump to clean the impeller.
	The impeller or shaft is broken or bent.	Replace the impeller or shaft as necessary.
	The foundation is not rigid.	Tighten the hold-down bolts of the pump and motor. Make sure the base 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 Institute Standards Manual.
	The pump is cavitating.	Locate and correct the system problem.
There is excessive leakage from the stuffing box.	The packing gland is not adjusted properly	Tighten the gland nuts.
	The stuffing box is not packed properly.	Check the packing and repack the box.
	The mechanical-seal parts are worn.	Replace the worn parts.
	The mechanical seal is overheating.	Check the lubrication 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 ASK 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 base plate are high or low. 2. Remove or add shims at the appropriate corners. 3. Realign the pump and driver.

Assembly troubleshooting

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.

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