



ASK

OH3 Pumps

Installation, Operation, and Maintenance Manual

Model OH3, API 610 10th Edition/ISO 13709



Installation/Operating Manual OH3
Original operating manual

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Introduction and Safety

Safety Message 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:	<ul style="list-style-type: none">• A potential situation which, if not avoided, could result in an undesirable result or state• A practice not related to personal injury

General

	<p>Caution</p> <p>This product has been developed in accordance with state-of-the-art technology; it is manufactured with utmost care and subject to continuous quality control.</p> <p>These operating instructions are intended to facilitate familiarization with the unit and its designated use.</p> <p>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.</p> <p>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.</p>
	<p>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.</p> <p>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.</p> <p>If you need any additional information or instructions exceeding the scope of this manual or in case of damage please contact nearest customer service centre.</p>

Safety

	<p>WARNING:</p> <ul style="list-style-type: none"> • 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. <p>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.</p> <ul style="list-style-type: none"> • 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 us. 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.
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	<p>Trapped liquid can rapidly expand and result in a violent explosion and injury.</p> <ul style="list-style-type: none"> • 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.
<p>Explosion protection</p>	
	<p>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.</p> <p>If the operator cannot warrant this condition, appropriate monitoring devices must be used.</p> <p>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.</p>
<p>Marking</p>	
	<p>The marking on the pump only refers to the pump part, i.e. the coupling and motor must be regarded separately.</p> <p>The coupling must have an EC manufacturer's declaration. The driver must be regarded separately.</p> <p>Example of marking on the pump part: Ex II 2 G T1 - T5</p> <p>The marking indicates the theoretically available temperature range as stipulated by the respective temperature classes.</p>
<p>Temperature limits</p>	
 	<p>WARNING:</p> <p>Both gland packings and mechanical seals may exceed the specified temperature limits if run dry.</p> <p>Dry running may not only result from an inadequately filled seal chamber, but also from excessive gas content in the fluid handled.</p> <p>Pump operation outside its specified operating range may also result in dry running.</p> <p>In potentially explosive atmospheres, gland packings shall only be used if combined with a suitable temperature monitoring device.</p>



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: <ol style="list-style-type: none"> 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: <ul style="list-style-type: none"> • 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: <ul style="list-style-type: none"> • 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: <ul style="list-style-type: none"> • 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:
	<p>WARNING:</p> <ul style="list-style-type: none"> • 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.
	<ul style="list-style-type: none"> • 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	
	<p>Electrical connections must be made by certified electricians in compliance with all international, national, state, and local regulations.</p> <p>Observe the following guidelines and warnings for electrical connections:</p> <ul style="list-style-type: none"> • Make sure that the product is isolated from the power supply and cannot be energized by mistake. <p>This guideline applies to the control circuit as well.</p> <ul style="list-style-type: none"> • 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

	<p>Observe the following safety precautions before working with the product or in connection with the product:</p> <ul style="list-style-type: none"> • 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.
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Precautions during work

	<p>Observe the following safety precautions when working with the product or in connection with the product:</p> <ul style="list-style-type: none">• 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.
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Clean chemicals from the eyes

	<ol style="list-style-type: none">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.
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Clean chemicals from the body

	<ol style="list-style-type: none">1. Remove contaminated clothing.2. Wash the skin with soap and water for at least one minute.3. Seek medical attention, if required.
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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: <ul style="list-style-type: none"> • 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: <ul style="list-style-type: none"> • 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: <ul style="list-style-type: none"> • 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

	<p>classified area.</p> <ul style="list-style-type: none">• 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.
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Equipment for monitoring

	<p>For additional safety, use condition-monitoring devices. Condition-monitoring devices include but are not limited to these devices:</p> <ul style="list-style-type: none">• Pressure gauges• Flow meters• Level indicators• Motor load readings• Temperature detectors• Bearing monitors• Leak detectors• Pump Smart control system
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Product approval standards



Regular standards

	<p>All standard products are approved according to CSA standards in Canada and UL standards in USA.</p> <p>The drive unit degree of protection follows IP68. See the nameplate for maximum submersion, according to standard IEC 60529.</p> <p>All electrical ratings and performance of the motors comply with IEC 600341.</p>
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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.

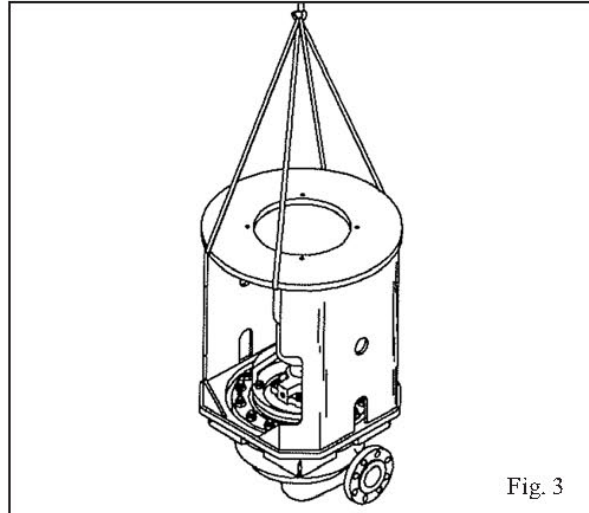
Transportation and Storage

Receive the unit	
	Inspect the pump as soon as it is received. Carefully check that everything is in good order. Make notes of damaged or missing items on the receipt and freight bill. File any claims with the transportation company as soon as possible.
Unpack the unit	
	<ol style="list-style-type: none"> 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: <ul style="list-style-type: none"> • 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.
	Use care when moving pumps. Lifting equipment must be able to adequately support the entire assembly. Hoist bare pump using suitable hooks through the holes in the frame mounted support or suitable slings through the large openings in the casing mounted support Units with drivers mounted are moved with slings under the pump casing and driver Or with hooks through the holes in the frame mounted support or with slings through the large openings in the casing mounted support.

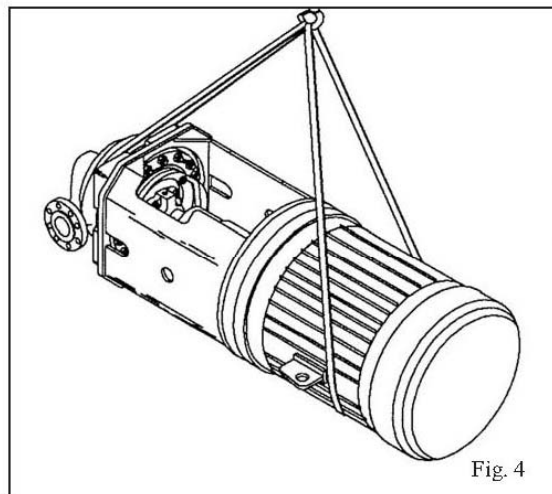


Warning: *Units with drivers mounted can be top heavy. Driver weight could cause the assembled unit to overturn and could result in serious physical injury, or damage to pumps.*

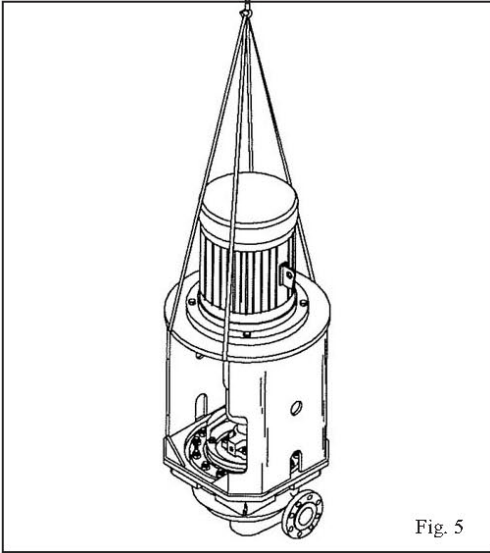
Examples



Example of a proper lifting method



Example of a proper lifting method




	 <p style="text-align: right;">Fig. 5</p>
	<p>Example of a proper lifting method</p>

Pump storage requirements

	<p>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.</p>							
	<table border="1"> <thead> <tr> <th data-bbox="422 1087 850 1121">Length of time in storage</th> <th data-bbox="857 1087 1432 1121">Storage requirements</th> </tr> </thead> <tbody> <tr> <td data-bbox="422 1121 850 1251">Upon receipt/short-term (less than six months)</td> <td data-bbox="857 1121 1432 1251">normal packaging procedure is designed to protect the pump during shipping. Upon receipt, store in a covered and dry location.</td> </tr> <tr> <td data-bbox="422 1251 850 1472">Long-term (more than six months)</td> <td data-bbox="857 1251 1432 1472">Preservative treatment of bearings and machined surfaces will be required. Rotate shaft several times every 3 months. Refer to driver and coupling manufacturers for their long term storage procedures. Store in a covered and dry location.</td> </tr> </tbody> </table>	Length of time in storage	Storage requirements	Upon receipt/short-term (less than six months)	normal packaging procedure is designed to protect the pump during shipping. Upon receipt, store in a covered and dry location.	Long-term (more than six months)	Preservative treatment of bearings and machined surfaces will be required. Rotate shaft several times every 3 months. Refer to driver and coupling manufacturers for their long term storage procedures. Store in a covered and dry location.	
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Long-term (more than six months)	Preservative treatment of bearings and machined surfaces will be required. Rotate shaft several times every 3 months. Refer to driver and coupling manufacturers for their long term storage procedures. Store in a covered and dry location.							
	<p>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.</p>							

Installation

Pre installation

Precautions							
	<p>WARNING:</p> <ul style="list-style-type: none"> • 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. 						
	<p>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.</p>						
Pump location guidelines							
	<p>WARNING:</p> <p>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.</p>						
	<p>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.</p>						
Lifting methods							
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	<table border="1"> <thead> <tr> <th>Guideline</th> <th>Explanation/comment</th> </tr> </thead> <tbody> <tr> <td>Keep the pump as close to the liquid source as practically possible.</td> <td>This minimizes the friction loss and keeps the suction piping as short as possible.</td> </tr> <tr> <td>Make sure that the space around the pump is sufficient.</td> <td>This facilitates ventilation, inspection, maintenance, and service.</td> </tr> </tbody> </table>	Guideline	Explanation/comment	Keep the pump as close to the liquid source as practically possible.	This minimizes the friction loss and keeps the suction piping as short as possible.	Make sure that the space around the pump is sufficient.	This facilitates ventilation, inspection, maintenance, and service.
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Make sure that the space around the pump is sufficient.	This facilitates ventilation, inspection, maintenance, and service.						

	If lifting equipment (for example, hoist or tackle) is needed, make sure that there is enough space above.	This makes it easier to use the lifting equipment properly.
	Protect the unit from weather and water damage due to rain, flooding, and freezing temperatures.	This is applicable if nothing else is specified.
	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: <ul style="list-style-type: none"> • 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	
	<p>CAUTION:</p> <p>If the pumped fluid is non-conductive, drain and flush the pump with a conductive pumped fluid under conditions that will not allow for a spark to be released to the atmosphere.</p>
Requirements	
	<ul style="list-style-type: none"> • 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

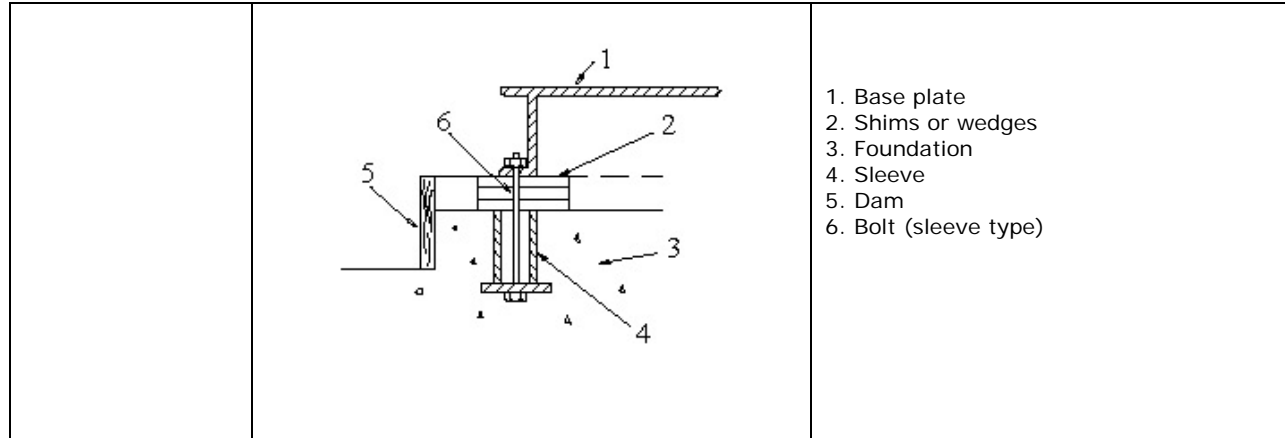
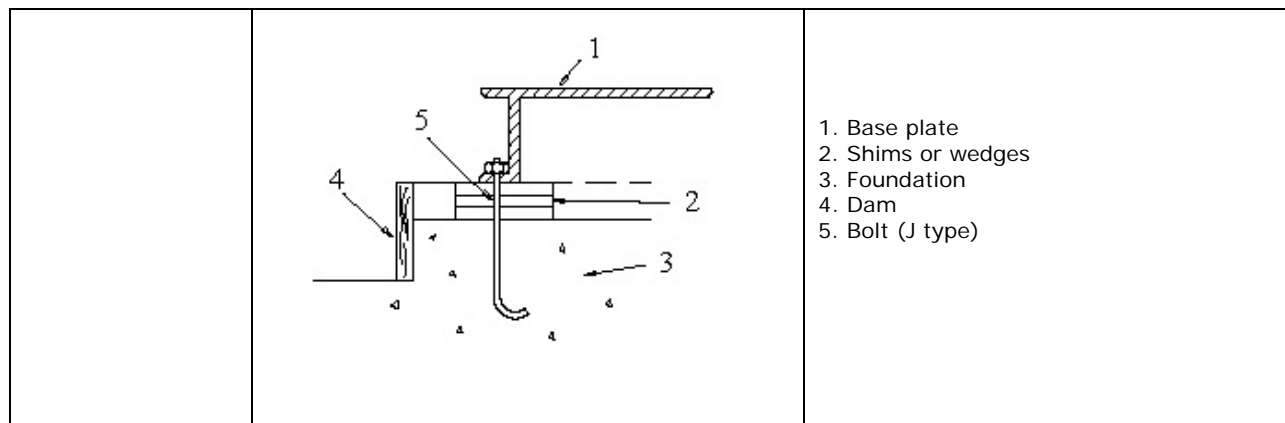


Diagram: J-type bolts



Piping checklists

General piping checklist

Precautions	
	<p>CAUTION:</p> <ul style="list-style-type: none"> • 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.
	<p>NOTICE:</p> <p>Flange loads from the piping system, including those from the thermal expansion of the piping, must not exceed the limits of the pump. Casing</p>

	deformation can result in contact with rotating parts, which can result in excess heat generation, sparks, and premature failure.
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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.
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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: <ul style="list-style-type: none"> • 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: <ul style="list-style-type: none"> • 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.

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.	

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: <ul style="list-style-type: none"> • 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, between the isolation valve and the pump discharge outlet.	The location between the isolation valve and the pump allows inspection of the check valve. The check valve prevents damage to the pump and seal due to the back flow through the pump, when the drive unit is shut off. It is also used to restrain the liquid flow. 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.	
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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			
	<p>Warning:</p> <ul style="list-style-type: none"> • 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. 		
	<p>NOTICE:</p> <p>The mechanical seal must have an appropriate seal-flush system. Otherwise, excess heat generation and seal failure can occur.</p>		
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).	-	

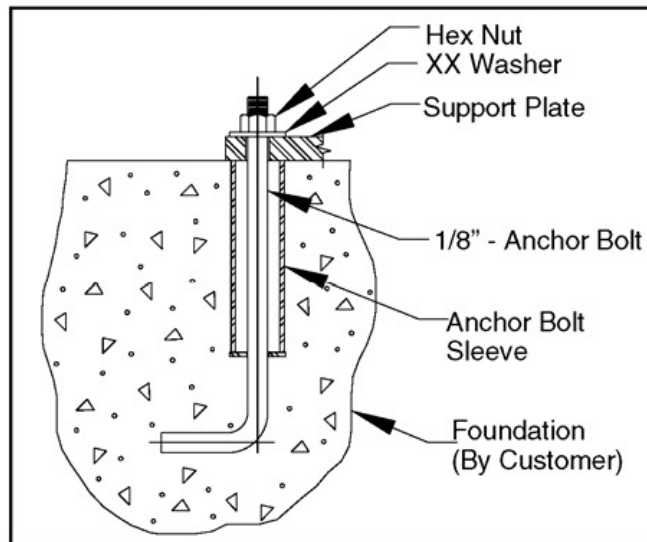
	Check that the cooling water pressure does not exceed 100 psig (7.0 kg/cm ²).	Make sure that these guidelines are followed.	
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Final piping checklist

	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.	

Site/Foundation

The pump should be located where there is adequate space for installation, operation, maintenance, and inspection. Make sure there is adequate overhead clearance for installing and removing the pump. There should be at least 1/2" clearance between the sides of the pump and any portion of the pit. Vertical sump pumps are normally bolted to a concrete sump or steel tank. The supporting structure must provide a permanent rigid support for the pumping unit(s) to eliminate any possible vibration. Support plates and/or pit covers are not normally grouted in place. The location and size of the mounting bolt holes are shown on the pump outline drawing provided with the pump data package. If anchor bolts are to be poured into the concrete, we recommend a sleeve type as shown to allow for adjustment.




Install the pump, driver, and coupling


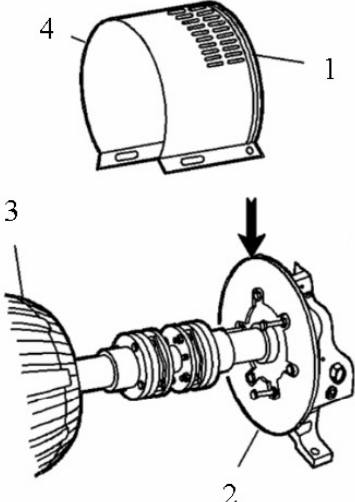
	<ol style="list-style-type: none">1. Mount and fasten the pump on the baseplate. Use applicable bolts.2. Mount the driver on the baseplate. Use applicable bolts and hand tighten.3. Install the coupling. <p>See the coupling manufacturer's installation instruction.</p>
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Commissioning, Startup, Operation, and Shutdown


Preparation for startup

Hazard statements	
	<p>WARNING:</p> <ul style="list-style-type: none"> • 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.
	<p>NOTICE:</p> <ul style="list-style-type: none"> • 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	
	<p>You must follow these precautions before you start the pump:</p> <ul style="list-style-type: none"> • 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. <p>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.</p>

Remove the coupling guard

	<ol style="list-style-type: none"> 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: <ol style="list-style-type: none"> 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: <ol style="list-style-type: none"> a) Slightly spread the bottom apart. b) Lift upwards.
	<div style="display: flex; align-items: center;">  <div style="margin-left: 20px;"> <ol style="list-style-type: none"> 1. Annular groove 2. Pump-side end plate 3. Driver 4. Pump half of the coupling guard </div> </div>

Check the rotation

	<p>WARNING:</p> <ul style="list-style-type: none"> • 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. <p>Failure to lock out driver power will result in serious physical injury.</p>
	<ol style="list-style-type: none"> 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.
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Pumps are shipped without oil

	You must lubricate oil-lubricated bearings at the job site.
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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.
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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).
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Oil requirements based on temperature

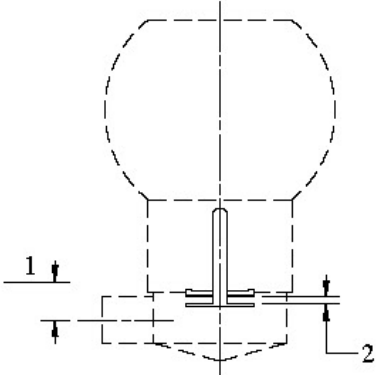
	For the majority of operational conditions, bearing temperatures run between 120°F (49°C) and 180°F (82°C) and you can use an oil of ISO viscosity grade 68 at 100°F (40°C). If temperatures exceed 180°F (82°C), refer to the table for temperature requirements.
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Temperature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

	<p>Ring oil-lubricated pumps are supplied with an oiler that maintains a constant oil level in the bearing housing.</p> <p>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.</p> <p>Adjust the setting dimension to 0 by removing the oiler-adjusting stem.</p>
	 <p>1. Oil level (3/16 in. (4.8 mm)) 2. Setting dimension of "0"</p>
	<p>2. Fill the oil reservoir in the bearing frame:</p> <p>a) Fill the oiler bottle with oil.</p> <p>b) Place the oiler bottle into the oiler housing.</p> <p>You will need to fill the oiler bottle several times.</p>
	<p>NOTICE: Do not fill the oil reservoir of the bearing frame through the vent or through the oiler housing without using the oiler bottle.</p>
	<p>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.</p>

Lubricate the bearings after a shutdown period

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


Precautions	
	<p>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.</p>
	<p>NOTICE:</p> <ul style="list-style-type: none"> • 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							
	<p>You can use the following methods to flush or cool the seal.</p> <table border="1"> <thead> <tr> <th>Method</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>Product flush</td> <td>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.</td> </tr> <tr> <td>External flush</td> <td>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).</td> </tr> </tbody> </table>	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/cm ²) greater than the seal chamber pressure. The injection rate must be 0.5 to 2 gpm (2 to 8 lpm).
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	Other	You can use other methods that employ multiple gland or seal chamber connections. Refer to the mechanical seal reference drawing and piping diagrams.
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Start the pump

	<p>CAUTION:</p> <ul style="list-style-type: none"> • 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.
	<p>Before you start the pump, you must do the following:</p> <ul style="list-style-type: none"> • Open the suction valve. • Open any recirculation or cooling lines. <ol style="list-style-type: none"> 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: <ol style="list-style-type: none"> a) Stop the driver. b) Prime the pump again. c) Restart the driver. 6. Monitor the pump while it is operating: <ol style="list-style-type: none"> 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


	<p>CAUTION:</p> <ul style="list-style-type: none"> • Vary the capacity with the regulating valve in the discharge line. • Do not overload the driver. Doing so may result in unexpected heat generation and equipment damage. The driver can overload in the following circumstances: <ul style="list-style-type: none"> • 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.
	<p>NOTICE:</p> <ul style="list-style-type: none"> • 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. <p>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.</p> <ul style="list-style-type: none"> • 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.
<p>Operation at reduced capacity</p>	
	<p>WARNING:</p> <p>Never operate any pumping system with a blocked 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.</p>
	<p>CAUTION:</p> <ul style="list-style-type: none"> • 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.
<p>Operation under freezing conditions</p>	
	<p>NOTICE:</p> <p>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</p>

	freeze and damage the pump.
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Shut down the pump

	<p>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.</p>
	<ol style="list-style-type: none"> 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

	<p>WARNING:</p> <ul style="list-style-type: none"> • 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.
	<p>You must check the final alignment after the pump and driver are at operating temperature. For initial alignment instructions, refer to the Installation chapter.</p> <ol style="list-style-type: none"> 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	
	<p>A maintenance schedule includes these types of inspections:</p> <ul style="list-style-type: none"> • Routine maintenance • Routine inspections • Three-month inspections • Annual inspections <p>Shorten the inspection intervals appropriately if the pumped fluid is abrasive or corrosive or if the environment is classified as potentially explosive.</p>
Routine maintenance	
	<p>Perform the following tasks whenever you perform routine maintenance:</p> <ul style="list-style-type: none"> • Lubricate the bearings. • Inspect the seal.
Routine inspections	
	<p>Perform the following tasks whenever you check the pump during routine inspections:</p> <ul style="list-style-type: none"> • 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	
	<p>Perform the following tasks every three months:</p> <ul style="list-style-type: none"> • 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	
	<p>Perform the following inspections one time each year:</p> <ul style="list-style-type: none"> • Check the pump capacity. • Check the pump pressure. • Check the pump power. <p>If the pump performance does not satisfy your process requirements, and the process requirements</p>

	<p>have not changed, then do the following:</p> <ol style="list-style-type: none"> 1. Disassemble the pump 2. Inspect it. 3. Replace worn parts.
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Bearing maintenance


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

	<p>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.</p>
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	<p>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.</p>
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	<p>NOTICE:</p> <ul style="list-style-type: none"> • Sealing systems that are not self-purging or self-venting, such as plan 23, require manual venting prior to operation. Failure to do so will result in excess heat generation and seal failure. • Cooling systems such as those for bearing lubrication and mechanical-seal systems, must be operating properly to prevent excess heat generation, sparks, and premature failure. • The mechanical seal must have an appropriate seal flush system or excess heat generation and seal failure can occur.
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Before you start the pump

	<p>Check the seal and all flush piping.</p>
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Mechanical seal life

	<p>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.</p>
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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.

Troubleshooting

	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
Vertical (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.	<ol style="list-style-type: none"> 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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