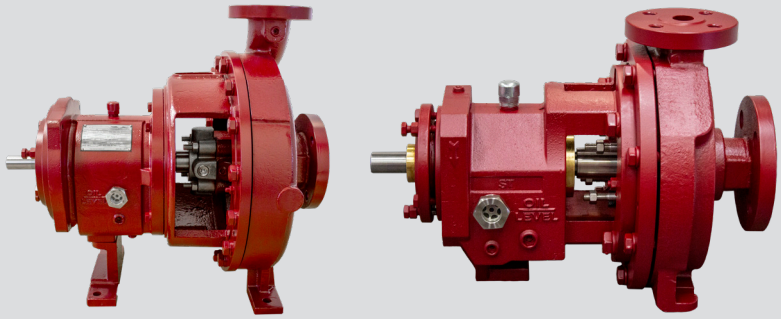
AMERICAN-MARSH PUMPS

A WILO BRAND



460 Series OSG and LF OSG ANSI B73.1 Process Pumps

Installation and Operating Manual

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PART 1: INTRODUCTION AND SAFETY

INTRODUCTION

This installation, operation, and maintenance manual is designed to assist you in achieving the longest life and best performance from your American-Marsh Pumps, A Wilo Brand 460 Series OSG and/or OSG LF chemical process end suction pump.

The American-Marsh Pumps OSG or OSG LF is a horizontal, single stage, centerline discharge, chemical process, end suction centrifugal pump. It conforms to the ASME B73.1 standard. The pump impeller is of the fully open type, and the pump is designed for handling mild industrial corrosives.

If you have any questions regarding the pump, which are not covered in this manual, please contact your American-Marsh Pumps distributor. For questions or technical assistance regarding the driver, please contact the driver's local dealer or representative.

SAFETY

The American-Marsh Pumps OSG or OSG LF has been designed and manufactured for safe operation. To ensure safe operation, it is very important that this manual be read in its entirety prior to installing, operating, or maintaining the pump. American-Marsh Pumps shall not be liable for physical injury, damage, or delays caused by a failure to observe the instruction for installation, operation, and maintenance contained in this manual. These instructions must always be kept close to the product's operating location or directly with the product.

Information in these user instructions is believed to be reliable. Despite all the efforts to provide sound and necessary information, the content of this manual may appear insufficient and is not guaranteed as to its completeness or accuracy. The instructions may not reflect all current legal requirements and local regulations; ensure that such requirements and regulations are observed by all, including those installing the product. Always coordinate repair and maintenance activity with operations personnel, and follow all plant safety requirements and applicable safety and health laws and/or regulations.

Genuine parts and accessories have been designed, tested, and incorporated into the products to help ensure their continued product quality and performance. Incorrect incorporation of substitute parts from other suppliers and accessories may adversely affect the performance and safety features of the products. The failure to properly select, install, or use authorized parts and accessories is considered misuse. Damage or failure caused by misuse is not covered by the warranty. In addition, modification of products or removal of original components may impair the safety of these products in their use.

If the agreed on conditions of service are going to be changed, it is recommended that the end user seek the pump manufacturer's written agreement before startup. The product must not be operated beyond the parameters specified for the application. If there is any doubt as to the suitability of the product for the intended application, contact the manufacturer for advice.

All personnel involved in the installation, operation, inspection, and maintenance of the pump unit must be qualified to carry out the work involved. If the personnel in question do not already have the necessary skill and knowledge, appropriate training and instruction

must be provided.

Remember that every pump has the potential to be dangerous because of the following factors:

1. Parts rotating at high speeds.
2. High pressures may be present.
3. High temperatures may be present.
4. Highly corrosive and/or toxic chemicals may be present.

Paying constant attention to safety is always extremely important; however, there are often situations that require special attention. These situations are indicated throughout this manual by the following symbols:

⚠ DANGER!
Hazardous situation which, if not avoided, will result in death or serious injury.

⚠ WARNING!
Hazardous situation which, if not avoided, could result in death or serious injury.

⚠ CAUTION!
Hazardous situation which, if not avoided, could result in minor or moderate injury.

ⓘ NOTICE!
A potential situation which could result in undesirable conditions such as equipment damage, or a practice not related to personal injury.

If in a climate where the fluid in the casing could freeze, never leave fluid in the pump casing. Drain the casing completely. During winter months and cold weather, the fluid could freeze and damage the pump casing.

Do not run the equipment dry or start the pump without the proper prime.

Do not exceed the maximum design pressure (MDP) at the temperature shown on the nameplate.

Never operate the pump for more than a short interval with the discharge valve closed. The length of the interval depends on several factors including the nature of the fluid pumped and its temperature.

Never operate the pump with a closed suction valve.

Excessive pump noise or vibration may indicate a dangerous operating condition. The pump must be shut down immediately.

Do not operate the pump for an extended period of time below the recommended minimum flow.

The pump shaft must turn clockwise when viewed form the motor end. It is essential that the rotation of the motor be checked before installation of the coupling spacer and starting

the pump. Incorrect rotation of the pump for even a short period of time can unscrew the impeller, which can cause severe damage.

If the fluid is hazardous, take all necessary precautions to avoid damage and injury before emptying the pump casing.

Residual fluid may be found in the pump casing, head and suction line. Take the necessary precautions if the fluid is hazardous, flammable, corrosive, poisonous, infected, etc.

Always lock out power to the driver before performing pump maintenance.

Never operate the pump without the coupling guard and all other safety devices correctly installed.

Do not apply heat to disassemble the pump or to remove the impeller. Entrapped fluid could cause an explosion.

If any external leaks are found while pumping hazardous fluid, immediately stop operations and repair.

Excessive warm-up rates can cause equipment damage. Ensure the warm-up rate does not exceed 2.5°F (1.4°C) per minute.

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.

Flush and clean the system to remove dirt or debris in the pipe system before initial startup.

Sound pressure levels may exceed 80 dbA in operating process plants. Clear visual warnings or other indicators should be available to those entering an area with unsafe noise levels. Personnel should always wear appropriate hearing protection when working on or around equipment. Local law may provide specific guidance regarding exposure of personnel to noise and when noise exposure reduction is required.

Equipment and piping system surfaces may exceed 130°F (54°C) in operating process plants. Clear visual warnings or other indicators should be available to alert personnel to surfaces that may reach an unsafe temperature. Do not touch hot surfaces. Allow pumps operating at high temperatures to cool sufficiently before performing maintenance. Personnel should always wear appropriate gloves, clothes, and other personal protective equipment as necessary when handling or touching a hot surface.

When working on the pump, maintenance personnel should always use the following safety equipment within the work area:

1. Hardhat
2. Safety glasses with side shields
3. Protective shoes with hard toes
4. Protective gloves
5. Hearing protection

PART 2: TRANSPORTATION AND STORAGE

RECEIVING THE PUMP

Immediately upon arrival, the pump and driver unit should be carefully inspected for evidence of damage during shipment or missing items. Any damage or missing items should be immediately reported to your American-Marsh Pump Distributor, and a claim filed with the shipping company. Always include the pump type and serial number stamped on the pump nameplate. Do not unpack any more than required to verify that the equipment is complete and undamaged unless installation is to be done immediately. Do not leave the pump unit or any accessories exposed to weather or construction hazards, which may cause damage to the equipment.

HANDLING AND LIFTING

⚠ **WARNING:** Dropping or tipping units, or applying other shock loads, can cause damage to the unit or cause personal injury. Ensure the unit is properly supported and secured during handling and lifting.

⚠ **WARNING:** Risk of damage to the unit or personal injury from the use of inadequate lifting methods. Ensure the lifting methods (ex. slings, chains, cranes, forklifts, etc.) are rated with sufficient capacity to lift the unit.

⚠ **WARNING:** Always wear proper personal protective equipment (PPE) while lifting and handling heavy components and equipment. Exercise caution and seek assistance, if necessary, as lifting and handling heavy components and equipment poses a crush hazard which could result in serious injury.

The pump must be transported in the horizontal position.

During installation and maintenance, all components must be handled and transported securely using suitable slings. Handling must be carried out by specialized personnel to avoid damage to the pump and persons.

For a bare pump without lifting lugs, lift the unit using a suitable sling attached properly to solid points of the pump such as under the suction flange and bearing housing frame. For a bare pump with lifting lugs, lift the pump by the lifting lugs. For a base mounted pump, lift the unit using suitable slings attached properly under the pump suction flange and driver, or under the baseplate.

STORING THE PUMP

Storage requirements for the pump unit depends on the length of time that it is to be stored.

1. Short-term storage:
    a. American-Marsh Pumps standard packaging is designed to protect the pump unit during shipment and for short-term storage.
    b. Short-term storage is defined as a period of 2 months or less.
    c. Store pump unit in a covered and dry location.

d. Store pump unit such that it is free from dirt and vibrations.
e. Loose unmounted items, including, but not limited to, oilers, packing, coupling spacers, stilts, and mechanical seals are packaged in a water proof plastic bag and placed under the coupling guard. Larger items are cartoned and metal banded to the baseplate. For bare pumps, the bag and/or carton is placed inside the shipping carton. All bags and cartons are identified with the American-Marsh Pumps sales order number, the customer purchase order number, and the pump item number (if applicable).
f. Inner surfaces of the bearing housing, shaft area through bearing housing, and bearings are coated with Cortec VCI-329 rust inhibitor, or equal.

 **NOTICE:** Bearing frames are not filled with oil prior to shipment.

g. Regreasable bearings are packed with grease (Royal Purple NLGI#2).
h. After a performance test, if required, the pump is tipped on the suction flange for drainage. Then, internal surfaces of ferrous casing, covers, flange faces, and the impeller surface are sprayed with Calgon Vestal Labs RP-743m, or equal.

 **NOTICE:** Some residual water may remain in the casing after drainage.

i. Exposed shafts are taped with Polywrap, if applicable.
j. Flange faces are protected with plastic covers secured with plastic drive bolts. Steel or wood covers with rubber gaskets, steel bolts, and nuts are available at extra cost.
k. All pump unit assemblies are bolted to a wood skid which confines the assembly within the perimeter of the skid.
l. Pump unit assemblies with special paint are protected with a plastic wrap.
m. Bare pump units are packed in hard paper cartons mounted on wood skids.
n. All pump unit assemblies having external auxiliary piping (ex. seal flush and cooling water plans, etc.) are packaged and braced to withstand normal handling during shipment. In some cases, components may be disassembled for shipment.

2. Long-term storage:
   a. Long-term storage is defined as a period of more than 2 months, but less than 12 months.
   b. Store pump unit in a covered and dry location.
   c. Store pump unit such that it is free from dirt and vibrations.
   d. Rotate the pump and driver shaft by hand a minimum of 10 revolutions every 3 months.
   e. Refer to the driver and coupling manufacturers for their long-term storage requirements.

NOTICE: The following long-term storage procedures are in addition to the standard packaging short-term storage procedures.

f. Solid wood skids are utilized. Holes are drilled in the skid to accommodate the anchor bolt holes in the baseplate, or the casing and bearing housing feet holes on bare pump units.
g. Tackwrap sheeting is placed on top of the skid, and the pump unit assembly is placed on top of the Tackwrap.
h. Metal bolts with washers and rubber bushings are inserted through the skid, the Tackwrap, and the pump unit assembly from the bottom of the skid and are then secured with hex nuts. When the nuts are tightened down to the top of the baseplate or casing and bearing housing feet, the rubber bushing is expanded, sealing the hole from the atmosphere.
i. Desiccant bags are placed on the Tackwrap.
j. The Tackwrap is drawn up around the assembly and hermetically sealed across the top.
k. A solid wood box is used to cover the assembly to provide protection from the elements and handling.

NOTICE: This long-term storage packaging will provide protection for the pump unit assembly up to 12 months without damage to mechanical seals, bearings, labyrinth oil seals, etc. due to humidity, salt laden air, dust, dirt, etc.

NOTICE: After unpacking, protection of the pump unit assembly will be the responsibility of the user.

NOTICE: Addition of oil to the bearing frame will remove the inhibitor. If pump units are to be idle for extended periods after addition of lubricants, inhibitor oils and greases should be used.

PART 3: PRODUCT DESCRIPTION

PUMP IDENTIFICATION

Manufacturer:
American-Marsh Pumps, A Wilo Brand
550 E. South Street
Collierville, TN 38017
United States of America

Type of Pump:
460 Series OSG or OSG LF

The American-Marsh Pumps OSG or OSG LF is a horizontal, single stage, centerline discharge, chemical process, end suction centrifugal pump. It conforms to the ASME B73.1 standard. The pump impeller is of the fully open type, and the pump is designed for

handling mild industrial corrosives.
Installation, Operation, and Maintenance Manual Identification:
Prepared: April 1, 2024
Edition: 02
Revision: Replaced OSD model with OSG
Date of Revision: April, 1 2024

Pump Nameplate Information:

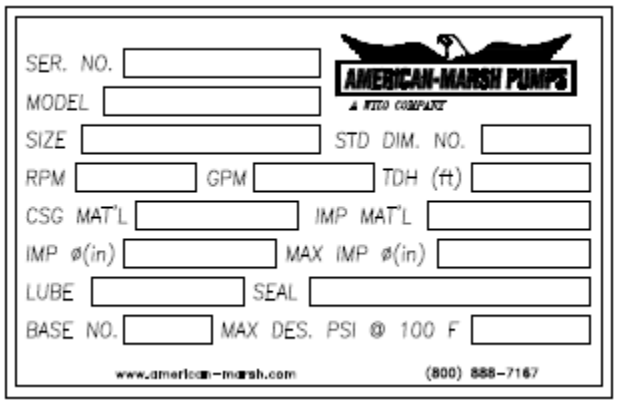


Figure 1: Pump Nameplate

SER. NO.	Serial number of the pump issued by the manufacturer.
MODEL	Model of the pump.
SIZE	Size of the pump.
STD DIM. NO.	Standard dimension designation per ASME B73.1.
RPM	Rated speed of the pump.
GPM	Rated capacity of the pump.
TDH (ft)	Rated total dynamic head of the pump.
CSG MAT'L	Casing material of construction.
IMP MAT'L	Impeller material of construction.
IMP. Ø (in)	Installed impeller diameter.
MAX IMP Ø (in)	Maximum impeller diameter.
LUBE	Bearing lubrication type.
SEAL	Seal type.
BASE NO.	Baseplate size designation per ASME B73.1.
MAX DES. PSI @ 100 F	Maximum design pressure for 100°F (38°C)

Table 1: Pump Nameplate Data Definitions

WARRANTY

American-Marsh Pumps guarantees that only high quality materials are used in the construction of our pumps, and that machining and assembly are carried out to high standards.

The pumps are guaranteed against defective materials and/or faulty craftsmanship for a period of one year from the date of shipment unless specifically stated otherwise.

Replacement of parts or of the pump itself can only be carried out after careful examination of the pump by qualified personnel. The warranty is not valid if third parties have tampered

with the pump.

This warranty does not cover parts subject to deterioration or wear and tear (mechanical seals, pressure and vacuum gauges, rubber or plastic items, bearings, etc.) or damage caused by misuse or improper handling of the pump by the end user.

Parts replaced under warranty become the property of American-Marsh Pumps.

Contact the American-Marsh Pumps factory:

American-Marsh Pumps, A Wilo Brand
550 E. South Street
Collierville, TN 38017
United States of America
Phone: (901) 860-2300

PART 4: INSTALLATION

LOCATION OF THE PUMP

When choosing a location for the pump, select an area with sufficient space around the pump for lifting equipment, if required, and that provides easy access for installation, operation, inspection, and maintenance of the pump. Locate the pump as close as possible to the fluid source which keeps the suction piping line as short as possible, minimizes friction losses, and help provide NPSH available equal to or greater than the NPSH required by the pump at any capacity over its expected operating range. The pump should be adequately protected from weather. Consideration should be taken to select the best location to minimize pump noise and vibration.

FOUNDATION

The concrete foundation should be sufficient in size to absorb vibration and form a permanent, rigid support for all points of the pump baseplate. The foundation should weigh at least 3-5 times the weight of the pump unit. Level and grout the baseplate per standard construction practices (see ANSI/HI 1.4). The foundation should be flat and substantial enough to prevent strain and distortion when tightening the foundation anchoring bolts. The location and size of the foundation anchoring bolt holes must match those given on the pump general assembly drawing provided with the pump quote and/or submittal package. Sleeve-type foundation anchoring bolts should be used and embedded in the concrete. A pipe sleeve larger in diameter than the bolt should be used to allow movement for final positioning of the bolts, so that proper tension can be applied to retain the equipment to the foundation.

INSTALLING THE PUMP BASEPLATE

If the baseplate has machined coplanar mounting surfaces, these machined surfaces are to be referenced when leveling the baseplate. This may require all equipment be removed from the baseplate, including the pump, driver, and coupling guard, in order to reference the machined coplanar mounting surfaces.

If the baseplate does not have machined coplanar mounting surfaces, the equipment should

be left on the baseplate, including the pump, driver, and coupling guard. The proper surfaces to reference when leveling the pump baseplate are the pump suction and discharge flanges.

Do not stress the baseplate and do not bolt the suction and/or discharge piping to the pump flanges until the baseplate is completely installed and grouted.

Clean the bottom of the baseplate, including all surfaces that will come in contact with the grout. Do not use an oil-based cleaner because the grout will not bond to it. If using an epoxy-based grout, coat the bottom of the baseplate with an epoxy primer. Remove the rust-proofing coat from the machined coplanar mounting surfaces using an appropriate solvent, if applicable. Make sure the machined mounting surfaces are clean.

Remove water and debris from the foundation anchoring bolt holes. Clean the top of the concrete foundation of debris and leave it rough. Fill the bolt sleeves with rags or packing material to prevent grout from entering the bolt holes.

Place sets of shims or wedges on each side of each foundation anchoring bolt. Shims or wedges should be placed at all the baseplate foundation anchoring bolt locations, and in the middle of each of the baseplate's longer sides if the baseplate exceeds 5 feet in length.

Carefully lower the baseplate onto the foundation anchoring bolts. A gap of approximately 1-2 in (25-50 mm) should be allowed between the baseplate and the foundation for grouting and to facilitate leveling.

Check the baseplate for levelness in both the lengthwise and widthwise directions using machinist's levels. Level the baseplate by adding or removing shims or moving the wedges. The baseplate should be level to a maximum difference of 0.125 in (3.2 mm) lengthwise and to a maximum difference of 0.063 in (1.6 mm) widthwise.

Tighten the nuts for the foundation anchoring bolts by hand.

> ⓘ **NOTICE:** Make sure that shims or wedges were placed near to and on either side of each foundation anchoring bolt before tightening. Failure to do so may result in a twist of the baseplate, which could make it impossible to achieve final alignment.

Recheck the level of the baseplate to make sure that tightening the nuts for the foundation anchoring bolts did not disturb the level of the baseplate.

INITIAL ALIGNMENT

> ⚠ **DANGER:** Failure to lock out power to the driver may result in death or serious injury. Always disconnect and lock out power to the driver before beginning any installation or maintenance tasks.

> ⓘ **NOTICE:** Check for soft foot under the driver feet. An indicator placed on the driver coupling hub, reading in the vertical direction, should not indicate more than 0.002 in (0.05 mm) movement when any driver fastener is loosened.

The alignment of the pump and drive shaft is one of the most important considerations

when installing the pump.

All American-Marsh Pumps OSG or OSG LF pumps are factory aligned. The purpose of the factory alignment is to ensure that the installer or end user will have proper utilization of the clearance in the driver holes for initial and final field alignment. To achieve this, the factory alignment procedure specifies the pump be aligned in the horizontal plane to the driver, with the driver foot hold-down bolts centered in the driver holes. This procedure ensures there is sufficient clearance in the driver holes for the installer or end user to field align the driver to the pump. This philosophy requires the installer or end user to be able to place the baseplate in the same condition as the factory. Therefore, the factory alignment will be performed with the baseplate sitting in an unrestrained condition on a flat and level surface. This standard also emphasizes the need to ensure the shaft spacing is adequate to accept the specified coupling spacer. The factory alignment procedure is as follows:

1. The baseplate is placed on a flat and level work bench in a free and unstressed position.
2. The baseplate is level as necessary. Leveling is accomplished by placing shims under the rails of the baseplate at the appropriate anchor bolt hole locations. Levelness is checked in both the longitudinal and lateral directions.
3. The driver and appropriate driver mounting hardware is placed on the baseplate and the driver is checked for any planar soft-foot condition. If any is present, it is eliminated by shimming.
4. The driver feet holes are centered around the driver mounting fasteners.
5. The driver is fastened in place by tightening the nuts on two diagonal driver mounting studs.
6. The pump is placed on the baseplate and leveled. The bearing frame foot is adjustable. It is used to level the pump, if necessary. If an adjustment is required, shims are added or removed between the bearing frame foot and the bearing frame.
7. The spacer coupling gap is verified.
8. The parallel and angular vertical alignment is made by shimming under the driver.
9. The pump and driver shafts are then aligned horizontally, both parallel and angular, by moving the pump to the fixed driver. The hold-down bolts on the pump feet are tightened down.
10. The horizontal and vertical alignment, both parallel and angular, are check again as well as the spacer coupling gap.

The factory alignment does not negate the need for initial and final alignment. Misalignment of the pump and driver can result in decreased performance and equipment damage which can lead to catastrophic failure. Proper alignment of pump and driver is the responsibility of the installer and end user of the pump unit. All pumps should receive initial and final alignment checks at the jobsite. Refer to this section for initial alignment (cold alignment) checks, and refer to the final alignment section of this manual for more information on final alignment (hot alignment) checks.

Initial alignment (cold alignment) checks should be performed prior to operating the pump while the unit is at ambient temperature. Initial alignment checks should be performed during installation at the following times:

- Before grouting the baseplate to ensure that alignment is possible.
- After grouting the baseplate to ensure that misalignment has not occurred due to the grouting process.
- After connecting the system piping to ensure that misalignment has not occurred due to pipe strain.

You must have two dial indicators to perform an alignment. Both dial indicators should be securely attached to the pump coupling hub. Attach the first dial indicator such that the indicator button contacts the perimeter of the driver coupling hub. This dial indicator is used to measure the parallel misalignment. Attach the second dial indicator such that the indicator button contacts the face of the driver coupling hub. This dial indicator is used to measure the angular misalignment. Ensure that both dial indicators are in contact with the driver coupling hub but do not bottom out. Rotate the pump coupling hub to verify.

To perform an alignment of the pump and driver, use the following instructions:

NOTICE: Make sure to rotate the pump and driver coupling hubs together so the dial indicator buttons are in contact with the same points on the driver coupling hub. This will prevent incorrect measurements.

NOTICE: To make alignment corrections, only shim or move the driver. This will prevent causing pipe strain.

NOTICE: Make sure the driver hold-down bolts are loose before making an alignment correct and make sure the driver hold-down bolts are tight before taking dial indicator measurements.

NOTICE: If the pump and driver were properly installed on the baseplate before beginning to make alignment corrections, the cold settings for parallel misalignment should give an indicator reading value of 0.015 in (0.38 mm) or less, and the cold settings for angular misalignment should give an indicator reading value of 0.0025 in/in (0.064 mm/mm) or less. If the values are exceeded, refer to the factory alignment procedure above.

1. Perform angular alignment for a vertical correction.
    a. Set the angular alignment dial indicator to zero at the 12 o'clock position on the driver coupling hub.
    b. Carefully rotate the pump coupling hub to move the angular alignment dial indicator to the 6 o'clock position on the driver coupling hub.
    c. Take and record the dial indicator reading value.
    d. Make the necessary correction by adding or removing shims under the feet on one end of the driver.
    e. Repeat the previous steps as needed until the proper indicator reading value is achieved.

2. Perform angular alignment for a horizontal correction.
    a. Set the angular alignment dial indicator to zero at the 9 o'clock position on the driver coupling hub.
    b. Carefully rotate the pump coupling hub to move the angular alignment dial indicator through the 12 o'clock position to the 3 o'clock position on the driver coupling hub.
    c. Take and record the dial indicator reading value.
    d. Make the necessary correction by sliding the feet on one end of the driver in the appropriate direction.

e. Repeat the previous steps as needed until the proper indicator reading value is achieved.

3. Perform parallel alignment for a vertical correction.
    a. Set the parallel alignment dial indicator to zero at the 12 o'clock position on the driver coupling hub.
    b. Carefully rotate the pump coupling hub to move the parallel alignment dial indicator to the 6 o'clock position on the driver coupling hub.
    c. Take and record the dial indicator reading value.
    d. Make the necessary correction by adding or removing shims of a thickness that is equal to half of the dial indicator reading value from under all the driver feet. Add shims if the value is positive. Remove shims if the value is negative.
    e. Repeat the previous steps as needed until the proper indicator reading value is achieved.

4. Perform parallel alignment for a horizontal correction.
    a. Set the parallel alignment dial indicator to zero at the 9 o'clock position on the driver coupling hub.
    b. Carefully rotate the pump coupling hub to move the parallel alignment dial indicator through the 12 o'clock position to the 3 o'clock position on the driver coupling hub.
    c. Take and record the dial indicator reading value.
    d. Make the necessary correction by sliding all the motor feet in the appropriate direction. Make sure to slide the driver feet evenly so as not to negatively affect the horizontal angular alignment.
    e. Repeat the previous steps as needed until the proper indicator reading value is achieved.

The pump and driver are in complete alignment when both the angular and parallel dial indicators do not vary more than 0.002 in (0.05 mm) as measured at four points 90° apart. Make corrections according to the instructions above for angular and parallel alignment until the proper indicator reading values are achieved.

Alternatively, a laser alignment tool may be used to align the pump and driver shafts. Refer to the laser alignment tool manufacturer's instructions and procedures for more information.

GROUTING THE BASEPLATE

The baseplate should be grouted in accordance with the grout manufacturer's instructions, standard construction practices, and ANSI/HI 1.4.

The top surface of the foundation should be left rough, cleaned of debris, and thoroughly wetted down before grouting.

A gap of approximately 1-2 in (25-50 mm) should be allowed between the baseplate and the foundation for grouting and to facilitate leveling.

Place forms around the shims and wedges to isolate them from the initial application of grout. Build a dam/wood frame around the foundation. The dam/wood frame should extend up just past the gap between the baseplate and the foundation.

The grout material that supports the baseplate is a critical element of the pump support

structure and should be carefully selected, as well as applied per the grout manufacturer's recommendations. If the grout cracks or fails, the support structure will be compromised. A non-shrinking grout is recommended.
Pour the non-shrinking grout through the grout hole into the baseplate up to the level of the dam/wood frame. When pouring the grout, make sure to remove air bubbles from the grout and/or properly vent the baseplate. Baseplates that might capture air during grouting should be vented to prevent voids between the baseplate and the grout. Allow the grout to set.

Fill the remainder of the baseplate with grout and allow the grout to fully cure and harden. The grout is usually cured and hardened 48-72 hours after pouring.

After the initial grout has cured, the forms, shims, and wedges should be removed and the void filled with another application of grout. It is not recommended to grout leveling shims or wedges in place because they introduce discontinuities and stress concentrations that may cause the grout to crack.

After the final application of grout has cured and hardened, the foundation anchoring bolts should be fully tightened. The grout is usually cured and hardened 48-72 hours after pouring.

PIPING CONNECTION – SUCTION AND DISCHARGE

Guidelines for piping are given in the Hydraulic Institute Standards, ANSI/HI 1.4. This document must be reviewed before installing the pump. All piping must be independently supported and accurately aligned to the pump suction and discharge flanges. The allowable flange loading imposed by the piping shall be in accordance with ANSI/HI 9.6.2.

1. Check that all piping is independently supported of and accurately aligned with the pump suction and discharge flanges.
2. Keep the piping as short as possible to help minimize friction losses.
3. Keep the piping as straight as possible to help minimize friction losses. Unnecessary bends should be avoided, using long radius 90 degree or 45 degree fittings where necessary.
4. Check that only necessary fittings are used to help minimize friction losses.
5. When using flange joints, check that the inside diameters match properly.
6. Do not connect the suction and discharge piping to the pump flanges until the grout for the baseplate becomes hard.
7. Do not connect the suction and discharge piping to the pump flanges until the hold-down bolts for the pump and driver are properly tightened.
8. Check that all piping joints and fittings are airtight.
9. If the pumped fluid is corrosive, make sure the piping allows the fluid to be flushed out before removing the pump.
10. If the pump handles fluids at high temperatures, make sure the expansion loops and joints are properly installed.
11. Check that all piping components, fittings, and valves are clean prior to assembly.
12. Consideration should be taken to use cushioning devices. This protects the pump from water hammer and surges if quick-closing valves are used in the piping system.
13. Verify there are no loads on the pump suction and discharge flanges that exceeds the limits given in API Standard 610, 11th Edition (ISO 13709).
14. Use fasteners of the proper size and material only. All corroded fasteners should be replaced.

SUCTION PIPING

1. Verify the NPSH available exceeds the NPSH required as given on the published performance curve of the pump.
2. Check that the distance between the pump suction flange and the closest elbow is a minimum of 10 pipe diameters. This minimizes the risk of cavitation in the suction inlet of the pump.
3. Check that the suction piping is 1-2 sizes larger than the pump suction flange.
4. Install an eccentric reducer between the suction piping and the pump suction flange. The eccentric reducer should be mounted with the flat side at the top.
5. If multiple pumps operate from the same fluid source, check that separate suction piping lines are used for each pump.
6. If the fluid source is below the pump:
    a. Make sure that the suction piping line is free from air.
    b. Check that the suction piping line slopes upwards from the fluid source to the pump suction flange.
    c. Check that a device is installed for priming the pump.
7. If the fluid source is above the pump:
    a. Make sure that the suction piping line is free from air.
    b. Check that the suction piping line is level or slopes downward from the fluid source to the pump suction flange.
    c. Verify that no portion of the suction piping line extends below the pump suction flange.
    d. Check that the suction piping line is properly submerged below the surface of the fluid source to prevent vortexing.
    e. Check that an isolation valve is installed in the suction piping line at a minimum of 2 suction pipe diameters from the pump suction flange.

DISCHARGE PIPING

1. Check that an isolation valve is installed in the discharge piping line. The isolation valve is required for priming, regulating flow, and isolating the pump for inspection and maintenance.
2. Check that a check valve is installed in the discharge piping line, located between the isolation valve and the pump discharge flange. The check valve prevents backflow through the pump which can cause damage to the pump and mechanical seal.
3. If discharge pipe diameter increasers are used, check that they are installed between the pump discharge flange and the check valve.

    ⚠ **WARNING:** When fluid velocity in the pipe is high, ex. 10 ft/s (3 m/s) or greater, a rapidly closing discharge valve can cause a damaging pressure surge. In this case, a dampening arrangement should be provided in the piping.

PART 5: COMMISSIONING, STARTUP, OPERATION, AND SHUTDOWN

PREPARATION FOR STARTUP

Prior to starting the pump, it is essential that the following pre-startup checks are completed.

1. Check that the pump and driver are properly secured to the baseplate.
2. Remove the coupling guard.
3. Check the driver rotation.
4. Check the impeller clearance setting.
5. Couple the pump and driver.
6. Reinstall the coupling guard.
7. Lubricate the bearings.
8. Check the shaft seal (packing or mechanical seal) for proper installation.
9. Check that the shaft seal support system is operational.
10. Check that the pump instrumentation is operational.
11. Prime the pump.

CHECK THE DRIVER ROTATION

⚠ **DANGER:** Failure to lock out power to the driver may result in death or serious injury. Always disconnect and lock out power to the driver before beginning any installation or maintenance tasks.

⚠ **WARNING:** Operating the pump in reverse rotation can result in the contact of metal parts, heat generation, and breach of containment. Reverse rotation, even for a short time, can cause significant damage to the impeller, casing, shaft, and shaft seal. Always make sure the driver settings and rotation are correct before starting the pump.

1. Lock out power to the driver.
2. Remove the coupling guard and coupling spacer.
3. Make sure the coupling hubs are securely fastened to the shafts.
4. Unlock power to the driver.
5. Jog the driver long enough to verify the driver rotation corresponds to the proper pump rotation. Refer to the arrow on the bearing housing (134) or casing (100). The proper pump rotation is clockwise when viewed from the driver end.
6. Lock out power to the driver.

IMPELLER CLEARANCE SETTING

⚠ **DANGER:** Failure to lock out power to the driver may result in death or serious injury. Always disconnect and lock out power to the driver before beginning any installation or maintenance tasks.

⚠ **WARNING:** If a cartridge mechanical seal is used, make sure the set screws in the seal locking ring are loosened and the centering clips have been installed before beginning to set the impeller clearance. Failure to do so could result in mechanical seal damage. This could lead to breach of containment.

⚠ **CAUTION:** Make sure the impeller clearance setting is correct before starting the pump. Failure to do so may result in sparks, unexpected heat buildup, and severe pump damage.

Impeller clearance is the measurement between the open impeller vanes and the inside

surface of the casing. A gradual loss in pump head and/or capacity can occur due to casing or impeller wear. Pump performance may be restored by adjusting the impeller clearance. Higher impeller clearances are used above 200°F (93°C) to prevent the impeller from coming in contact with the casing due to thermal expansion. There are two methods that may be used to set the proper impeller clearance: the feeler gauge method and the dial indicator method.

Impeller Clearances			
Temperature – °F (°C)	STX – in (mm)	MTX/LTX- in (mm)	XLTX – in (mm)
-20 to 200 (-29 to 93)	0.005 (0.13)	0.008 (0.20)	0.015 (0.38)
201 to 250 (94 to 121)	0.006 (0.15)	0.009 (0.23)	0.016 (0.41)
251 to 300 (122 to 149)	0.007 (0.18)	0.010 (0.25)	0.017 (0.43)
301 to 350 (150 To 176)	0.009 (0.23)	0.012 (0.30)	0.019 (0.48)

Table 2: Impeller Clearance Settings

FEELER GAUGE METHOD

1. Lock out power to the driver before beginning to work on the pump.
2. Remove the coupling guard.
3. Loosen the jam nuts (423) on the jack bolts (370D). Back the jack bolts out 2-3 turns.
4. Tighten the bearing housing clamp screws (370C) evenly to move the bearing housing (134) towards the bearing frame (228) until the impeller starts to rub on the casing. Turn the shaft (122) to ensure the impeller is in contact with the casing.
5. Using a feeler gauge, measure and set the gap between the three bearing housing clamp screws (370C) and the bearing housing (134). For the impeller clearance settings, refer to Table 2.
6. Tighten the jack bolts (370D) evenly until the bearing housing (134) backs out and contacts the bearing housing clamp screws (370C).
7. Tighten the jam nuts (423) evenly while rotating the pump shaft to ensure the pump assembly turns freely.
8. Install the coupling guard.
9. Unlock power to the driver.

DIAL INDICATOR METHOD

1. Lock out power to the driver before beginning to work on the pump.
2. Remove the coupling guard.
3. Place a dial indicator with a magnetic base on the pump baseplate, and place the dial indicator button against the end face of the pump shaft (122)
4. Loosen the jam nuts (423) on the jack bolts (370D). Back the jack bolts out 2-3 turns.
5. Tighten the bearing housing clamp screws (370C) evenly to move the bearing housing (134) towards the bearing frame (228) until the impeller starts to rub on the casing. Turn the shaft (122) to ensure the impeller is in contact with the casing.
6. Set the dial indicator to zero.
7. Loosen the bearing housing clamp screws (370C) about 1 turn.
8. Tighten the jack bolts (370D) evenly until they contact the bearing frame (228). Continue to evenly tighten the jack bolts (370D) to move the bearing housing (134) away from the bearing frame (228) until the dial indicator reads the proper impeller clearance setting. For the impeller clearance settings, refer to Table 2.
9. Tighten bearing housing clamp screws (370C) evenly then tighten the jack bolts

(370D) evenly while rotating the pump shaft to ensure the pump assembly turns freely. Be certain the dial indicator does not move from the proper impeller clearance setting.
10. Install the coupling guard.
11. Unlock power to the driver.

COUPLE THE PUMP AND DRIVER

The coupling should be installed in accordance with the instructions from the coupling manufacturer. Refer to the coupling manufacturer's installation, operation, and maintenance manual (IOM) for specific instructions and recommendations. The American-Marsh Pumps OSG and OSG LF are shipped without the coupling spacer installed. Make sure to remove protective material from the couplings and any exposed portions of the shaft before installing the coupling.

PRIMING THE PUMP

A standard centrifugal pump such as the OSG and OSG LF will not move fluid unless the pump is primed. A pump is said to be primed when the casing and the system suction piping are completely filled with fluid.

1. Suction supply above the pump
    a. Slowly open the suction piping line isolation valve.
    b. Open the air vents on the suction and discharge piping lines until fluid comes out.
    c. Close the air vents on the suction and discharge piping lines.

2. Suction supply below the pump
    a. An outside source of fluid must be used in conjunction with a foot valve to prime the pump. The fluid source may come from one of the following: a pressured discharge line, a priming pump, or another outside source.
    b. Close the discharge piping line isolation valve.
    c. Open the air vent valves in the pump casing.
    d. Open the valve in the outside fluid source supply line until fluid comes out of the air vent valves.
    e. Close the air vent valves.
    f. Close the valve in the outside fluid source supply line.

STARTING THE PUMP

NOTICE: Never operate the pump dry as this will cause damage to the pump unit. Operating the pump dry may cause rotating parts to seize or gall to stationary parts. When starting the pump, immediately observe the pressure gauges. If the rated design discharge pressure is not quickly reached, immediately shut down the pump, re-prime the pump, and restart the pump. Refer to the troubleshooting section of this manual for information on possible solutions.

1. Open the suction piping line isolation valve.
2. Open any cooling, flushing, or recirculation lines.
3. Fully close or partially open the discharge piping line isolation valve, depending on the system conditions.

4. Start up the driver.
5. Slowly open the discharge piping line isolation valve until the pump reaches the rated design flow.
6. Check the discharge pressure gauge to make sure the pump reaches the rated design discharge pressure. If the pump fails to reach the rated design discharge pressure, do the following:
    a. Stop the driver.
    b. Re-prime the pump. Refer to the section on priming the pump in this manual.
    c. Restart the driver.
7. Make sure to carefully monitor the pump while it is operating. While monitoring the pump, check for the following: excessive bearing temperature, excessive vibration, excessive noise. If any of these exceed normal values, immediately shut down the pump and troubleshoot the problem.

OPERATION CONSIDERATIONS

⚠ **WARNING:** Always handle and dispose of the pumping fluid in conformance with applicable environmental regulations. Proper personal protective equipment (PPE) should always be used when handling the pumping fluid as the fluid may be toxic, corrosive, and/or hazardous. Failure to do so may result in severe injury.

⚠ **CAUTION:** Never operate the pump dry as this will cause damage to the pump unit. Operating the pump dry may cause rotating parts to seize or gall to stationary parts. When starting the pump, immediately observe the pressure gauges. If the rated design discharge pressure is not quickly reached, immediately shut down the pump, re-prime the pump, and restart the pump. Refer to the troubleshooting section of this manual for information on possible solutions.

For the pump to operate properly, the net positive suction head available ($NPSH_A$) must always be greater than the net positive suction head required ($NPSH_R$). The value for $NPSH_R$ is given on the published pump performance curve. Good general industry practice dictates that this margin should be at least 3 ft (0.9 m) or a margin ratio of 1.2, whichever is greater. Ensuring the $NPSH_A$ always exceeds the $NPSH_R$ will enhance pump performance and reliability. It will also reduce the possibility of cavitation, which can cause severe damage to the internal surfaces of the pump.

⚠ **WARNING:** Never operate the pump with a blocked system piping or with both the suction and discharge valves closed. Failure to do so may result in rapid unexpected heat buildup and vaporization of the pumping fluid. This could cause an explosion and serious injury or death.

⚠ **CAUTION:** Do not overload the driver. Failure to do so may cause damage to the equipment from unexpected heat buildup. Make sure the pump operating conditions are suitable for the driver.

To throttle or adjust the pump flow, use the regulating valve in the discharge piping line. Never throttle the pump flow from the suction side. Partially closing the suction valve can create serious NPSH problems, decreased pump performance, unexpected heat buildup, and equipment damage. Make sure the pump operating conditions are suitable for the driver. Note that when the discharge head drops, the pump flow rate usually increases rapidly. The

driver can overload when the pumping fluid exceeds the rated flow rate or when the pumping fluid specific gravity or viscosity is greater than expected. Check the driver for temperature rise as this may result in driver overload. If driver overload occurs, throttle the discharge valve to increase the discharge head. Refer to the troubleshooting section of this manual for information on possible solutions.

⚠ **WARNING:** Do not operate the pump below the minimum continuous stable flow (MCSF). Doing so may result in severe damage to the pump.

⚠ **WARNING:** Check the pump for excessive heat buildup. Excessive heat buildup may result in pump damage or injury. If normal levels are exceeded, shut down the pump, determine the cause, and resolve the problem.

⚠ **CAUTION:** Check the pump for excessive vibration, bearing temperature, and noise. Excessive vibration may result in pump damage. If normal levels are exceeded, shut down the pump, determine the cause, and resolve the problem.

Avoid operating the pump at excessively reduced capacities or with the discharge valve closed for extended periods of time. This can cause excessive heat buildup and the fluid in the pump may reach its boiling point. This may result in rotating parts to score or seize. Thermal protection devices such as thermostats may be used to safeguard against excessive heat buildup by shutting down the pump at a predetermined temperature. The minimum continuous stable flow (MCSF) is the lowest flow at which the pump can operate and still conform to the bearing life, shaft deflection, and bearing housing vibration limits of ANSI/ASME B73.1. All OSG and OSG LF pumps also have a minimum thermal flow defined as the minimum flow that will not cause an excessive temperature rise. The minimum thermal flow is application dependent. The OSG and OSG LF pumps are designed to be operated continuously between 110% of the best efficiency point (BEP) and the minimum flows shown on Table 3.

NOTICE: The values in Table 3 do not consider minimum thermal flow for a specific application; therefore, the practical minimum operating flow may be higher than shown. Refer to HI 1.3 for detailed application information.

ASME B73.1 Dimension Designation	Pump Size	MCSF (% of BEP)	
		3500/2900 rpm 60/50 Hz	1750/1450 rpm 60/50 Hz
AA	1X1.5-6	15	10
AB	1.5x3-6	15	10
AC	2x3-6	20	10
AA	1x1.5-8	20	10
AB	1.5x3-8	20	10
A60	2x3-8	20	10
A70	3x4-7	20	10
A70	3x4-8	20	10
A70	3x4-8G	20	10
A05	1x2-10	25	10
A50	1.5x3-10	25	10
A60	2x3-10	30	15
A70	3x4-10	30	15
A40	3x4-10H	30	15
A80	4x6-10H	40	20
A80	4x6-10G	40	20
A20	1.5x3-13	30	15
A30	2x3-13	40	15
A40	3x4-13	40	40
A80	4x6-13	NA	40
A90	6x8-13	NA	40
A100	8x10-13	NA	40
A110	6x8-15	NA	50
A120	8x10-15	NA	50
A120	8x10-15G	NA	50
A105	4x6-17	NA	50
A110	6x8-17	NA	50
A120	8x10-17	NA	50

Table 3: Minimum Continuous Stable Flow

CAUTION: Never expose an idle pump to sub-freezing conditions. Failure to properly drain the pump can cause the liquid to freeze and damage the pump.

When operating the pump in sub-freezing conditions where the pump will be periodically idle, the pump and any auxiliary equipment should be properly drained of all liquid that will freeze. Make note of the liquid being pumped as different liquids freeze at different temperatures. If the pump design does not allow the liquid to be completely drained, flushing with a liquid that does not freeze may be required. Alternatively, the pump may be protected with thermal devices which are designed to keep the liquid in the pump from freezing.

SHUTTING DOWN THE PUMP

1. Slowly close the discharge piping line isolation valve.
2. Stop the driver. Make sure to lock out power to the driver.
3. Close the suction piping line isolation valve.

FINAL ALIGNMENT

⚠ **DANGER:** Failure to lock out power to the driver may result in death or serious injury. Always disconnect and lock out power to the driver before beginning any installation or maintenance tasks.

⚠ **CAUTION:** Be careful and wear proper personal protective equipment (PPE) when performing the final alignment of the pump and driver as the unit may be hot. Failure to do so may result in injury.

Misalignment of the pump and driver can result in decreased performance and equipment damage which can lead to catastrophic failure. Proper alignment of pump and driver is the responsibility of the installer and end user of the pump unit. The final alignment of the pump must be checked after the pump and driver have reached operating temperature. Make sure to check the initial alignment prior to operating the pump. Refer to the initial alignment section of this manual for more information.

Run the pump at the design operating conditions for just long enough to bring the pump and driver to the operating temperature. Shut down the pump and lock out power to the driver. Remove the coupling guard. Perform the final alignment check while the pump and driver are still hot. Reinstall the coupling guard. Once the final alignment check has been completed, you are ready to operate the pump.

A final alignment (hot alignment) check should be performed right after the first run, periodically during quarterly inspections as part of the maintenance schedule, and after the pump has been serviced. Refer to the maintenance section of this manual.

When using dial indicators to check the final alignment, the pump and driver are properly aligned when the following reading values are achieved:

- The total indicator reading is at 0.002 in (0.05 mm) or less for parallel misalignment while the pump and driver are at operating temperature.
- The total indicator reading is at 0.0005 in/in (0.013 mm/mm) or less for angular misalignment while the pump and driver are at operating temperature.

PART 6: MAINTENANCE

MAINTENANCE

The following sections of this manual give instructions on how to perform a complete maintenance overhaul. However, it is also important to periodically repeat the Pre-Start-up Checks given in this manual. These checks will help extend pump life as well as the length of time between major pump overhauls.

A procedure for keeping accurate maintenance records is a critical part of any program to improve pump reliability. There are many variables that can contribute to pump failures. Often, long-term and repetitive problems can only be solved by analyzing these variables through pump maintenance records.

Maintenance Schedule

A maintenance schedule includes the following types of inspections:

1. Routine maintenance
2. Routine inspections
3. Quarterly inspections
4. Annual inspections

NOTICE: The maintenance inspection intervals should be shortened as needed if the fluid being pumped is corrosive, abrasive, or the environment is classified as potentially explosive.

Routine maintenance:

1. Lubricate the bearings.
2. Inspect the seal.
    a. If using a mechanical seal, ensure that there are no leaks from the mechanical seal. Replace the mechanical seal if you notice leaks.
    b. If using packing, adjust or replace the packing if you notice excessive leaking.

Routine inspections:

1. Check the level and condition of the oil through the sight glass on the bearing housing frame.
2. Check for unusual noise, vibration, and bearing temperatures.
3. Inspect the piping and pump for leaks.
4. Analyze the vibration.
5. Inspect the discharge pressure.
6. Inspect the temperature.
7. Check the seal chamber/stuffing box for leaks.

Quarterly inspections (every three months):

1. Check that the foundation anchoring bolts and the pump, driver, and coupling guard hold-down bolts are tight.
2. If the pump has been left idle, check the packing. Replace the packing if required.
3. Change the oil every three months (2000 operating hours) at a minimum.
    a. The oil should be changed more frequently if there are any adverse atmospheric conditions or other conditions which might contaminate or break down the oil.
    b. If the oil is cloudy or contaminated as seen by inspection through the sight glass on the bearing housing frame, the oil should be changed immediately.
4. Check the shaft alignment. Realign if required.

Annual inspections (one time each year):

1. Check the pump capacity.
2. Check the pump pressure.
3. Check the pump power.

If the pump performance does not satisfy your process requirements, and the process

requirements have not changed, the pump should be disassembled, inspected, and worn parts replaced. Otherwise, a system inspection should be performed.

DRAIN THE PUMP

⚠ **CAUTION:** Always allow the system to cool down after shutting down the pump. Failure to do so may result in injury.

⚠ **WARNING:** Always handle and dispose of the pumping fluid in conformance with applicable environmental regulations. Proper personal protective equipment (PPE) should always be used when handling the pumping fluid as the fluid may be toxic, corrosive, and/or hazardous. Failure to do so may result in severe injury.

⚠ **WARNING:** Always make sure the pump is isolated from the system and pressure is fully relieved before removing plugs or opening vent or drain valves. Failure to do so may result in rapid depressurization, leading to possible severe injury or death.

1. Open the suction piping line drain valve and allow the pump casing to drain as much as possible.
2. Leaving the suction piping line drain valve open, remove the pump casing drain plug.

DISASSEMBLY

⚠ **DANGER:** Failure to lock out power to the driver may result in death or serious injury. Always disconnect and lock out power to the driver before beginning any installation or maintenance tasks.

⚠ **WARNING:** Always wear proper personal protective equipment (PPE) while lifting and handling heavy components and equipment. Exercise caution and seek assistance, if necessary, as lifting and handling heavy components and equipment poses a crush hazard which could result in serious injury.

⚠ **WARNING:** Always make sure the pump is isolated from the system and pressure is fully relieved before beginning to disassemble the pump. Failure to do so may result in rapid depressurization, leading to possible severe injury or death.

⚠ **WARNING:** Make sure the pump unit is thoroughly cleaned and there are no residual contaminants that could cause injury. Any decontamination of pumps handling hazardous or toxic fluids must comply with all applicable OSHA requirements and all local codes and ordinances. Proper personal protective equipment should be worn.

⚠ **CAUTION:** Always wear proper gloves during disassembly as worn pump parts may have sharp edges. Failure to do so may result in injury.

1. Lock out power to the driver before beginning to work on the pump.

2. Close the discharge and suction isolation valves.
3. Drain the casing of all fluid.
4. Close all valves on auxiliary equipment and piping lines.
5. Disconnect all auxiliary piping lines.
6. Decontaminate the pump as necessary.
7. Remove the coupling guard.
8. Remove the spacer from the coupling.
9. Remove the oil-drain plug (408A) and drain all oil from the bearing frame (228). Reinstall the oil-drain plug when all the oil has been drained.

   NOTICE: Do not discard the drained oil. Oil analysis should be part of a preventative maintenance program. Save the oil for inspection.

10. Place a lifting sling through the bearing frame adapter (108) or bearing frame (228) to ensure safe handling during disassembly.
11. Remove the bolts (370) holding the bearing frame adapter (108) to the casing (100).

    NOTICE: The back pull-out assembly includes all parts except the casing. The casing does not need to be disconnected from the baseplate or piping unless it is damaged and requires replacement.

12. Remove the bolts holding down the bearing frame foot (241) to the baseplate.
13. Tighten the casing jack bolts evenly to remove the back pull-out assembly from the casing (100).
14. Remove and discard the casing gasket (351). Make sure to clean all gasket surfaces.
15. Mark and remove the shims from under the bearing frame foot (241), if applicable. Save the shims for reassembly.
16. Remove the casing jack bolts.
17. Take the back pull-out assembly to a work bench and clamp it securely to the work bench.
18. Blue and scribe the shaft to mark the location of the coupling hub on the shaft (122) for reassembly.
19. Remove the coupling hub.
20. Slide a shaft wrench or strap wrench over the shaft (122) and coupling key (400). The wrench handle should be pointing to the left when viewed from the impeller end of the shaft.
21. Grasp the impeller (101) firmly with both hands and rotate the impeller clockwise when viewed from the impeller end of the shaft to raise the wrench handle off the work bench. Rotate the impeller until the wrench handle is in the 11 o'clock position.

    CAUTION: Risk of personal injury from sharp edges. Heavy gloves should be worn when handling the pump impellers.

22. To loosen the impeller, quickly spin the impeller counterclockwise when viewed from the impeller end of the shaft so that the wrench handle impacts a hard surface on the work bench.
23. Repeat the previous step until the impeller loosens.

    WARNING: Risk of severe injury or death from explosion of trapped fluid. Never use heat to remove the impeller. If the impeller cannot be removed using the

method given above, cut the shaft between the gland and the frame.

24. Unscrew the impeller (101) and remove it from the shaft (122).
25. Remove and discard the impeller O-ring (412).
26. Remove the seal chamber cover (184). If the pump is packed and a stuffing box cover is used, proceed to step 26.
    a. Remove the gland nuts (355).
    b. Remove the seal chamber nuts.
    c. Remove the seal chamber cover (184).
    d. [Cartridge mechanical seal only]

       NOTICE: If the cartridge mechanical seal is to be reused, the spacing clips or tabs should be reinstalled prior to loosening the set screws. This will ensure that the proper seal compression is maintained.

       i. Loosen the set screws which lock the seal to the shaft (122) or shaft sleeve (126) and remove the complete seal assembly.
       ii. Proceed to step 25.f.
    e. [Component mechanical seal only]
       i. Loosen the set screws on the rotary portion of the seal and remove it from the shaft (122) or shaft sleeve (126).
       ii. Remove the seal gland (250) and stationary portion of the seal from the shaft (122) or shaft sleeve (126).
       iii. Remove the stationary portion of the seal from the seal gland (250).
       iv. Remove and discard the seal gland gasket (360Q).
    f. Remove the shaft sleeve (126), if applicable.
27. Remove the stuffing box cover (184). If the pump is mechanically sealed and a seal chamber cover is used, proceed to step 27.
    a. Remove the gland nuts (355) and the packing gland (210).
    b. Remove the stuffing box cover nuts.
    c. Remove the stuffing box cover (184).
    d. Remove the packing (106) and lantern ring (105) from the stuffing box cover (184).
    e. Remove the shaft sleeve (126), if applicable.
28. [MTX, LTX, and XLTX only] Remove the dowel pins (469B) and the bolts (370B) attaching the bearing frame adapter (108) to the bearing frame (228).
29. [MTX, LTX, and XLTX only] Remove the bearing frame adapter (108).
30. [MTX, LTX, and XLTX only] Remove and discard the bearing frame adapter gasket (360D).
31. Remove the inboard labyrinth oil seal (333). For the STX, it is an O-ring fit into the bearing frame (228). For the MTX, LTX, and XLTX, it is an O-ring fit into the bearing frame adapter (108). Refer to Appendix C for more information on the inboard labyrinth oil seal.

POWER END DISASSEMBLY [STX AND MTX]

1. Remove the clamp screws (370C) and back off the jam nuts (423).
2. Tighten the jack screws (370D) evenly to move the bearing housing (134) out of the bearing frame (228).
3. Remove the shaft assembly from the bearing frame (228).
4. Remove the jack screws (370D) with the jam nuts (423).
5. Remove the bearing housing O-ring (496). Discard the O-ring.

6. Remove the outboard bearing retaining snap ring (361A).
7. Remove the bearing housing (134) from the shaft (122).
8. Remove the bearing locknut (136) and lock washer (382). Discard the lock washer.
9. Remove the inboard bearing (168).
10. Remove the outboard bearing (112).

NOTICE: An arbor or hydraulic press may be used to remove the inboard and outboard bearings. Apply force evenly and only on the inner race. Failure to do so may cause damage to the pump unit.

NOTICE: If removed from the shaft, inboard and outboard bearings should not be reused. Reusing the bearings may cause damage to the pump unit. Replace the inboard and outboard bearings before reassembly.

11. Remove the outboard labyrinth oil seal (332) from the bearing housing (134). Refer to Appendix C for more information on the outboard labyrinth oil seal.

POWER END DISASSEMBLY [LTX]

1. Remove the clamp screws (370C) and back off the jam nuts (423).
2. Tighten the jack screws (370D) evenly to move the bearing housing (134) out of the bearing frame (228).
3. Remove the shaft assembly from the bearing frame (228).
4. Remove the jack screws (370D) with the jam nuts (423).
5. Remove the clamp ring screws (236A). Separate the clamp ring (253B) from the bearing housing (134).
6. Remove the bearing housing (134) from the shaft (122).
7. Remove the bearing housing O-ring (496). Discard the O-ring.
8. Remove the inboard bearing (168).
9. Remove the oil flinger (248).
10. Remove the bearing locknut (136) and lock washer (382). Discard the lock washer.
11. Remove the outboard bearings (112).

NOTICE: An arbor or hydraulic press may be used to remove the inboard and outboard bearings. Apply force evenly and only on the inner race. Failure to do so may cause damage to the pump unit.

NOTICE: If removed from the shaft, inboard and outboard bearings should not be reused. Reusing the bearings may cause damage to the pump unit. Replace the inboard and outboard bearings before reassembly.

12. Remove the clamp ring (253B).
13. Remove the outboard labyrinth oil seal (332) from the bearing housing (134). Refer to Appendix C for more information on the outboard labyrinth oil seal.

POWER END DISASSEMBLY [XLTX]

1. Remove the clamp screws (370C) and back off the jam nuts (423).
2. Tighten the jack screws (370D) evenly to move the bearing housing (134) out of the

bearing frame (228).
3. Remove the shaft assembly from the bearing frame (228).
4. Remove the jack screws (370D) with the jam nuts (423).
5. Remove the bearing housing O-ring (496). Discard the O-ring.
6. Remove the inboard bearing (168).
7. Remove the bolts (371C), the bearing end cover (109), and the gasket (360). Discard the gasket.
8. Remove the outboard labyrinth oil seal (332) from the bearing end cover (109). Refer to Appendix C for more information on the outboard labyrinth oil seal.
9. Remove the bearing housing (134) from the shaft (122).
10. Remove the bearing locknut (136) and lock washer (382). Discard the lock washer.
11. Remove the outboard bearing (112).

NOTICE: An arbor or hydraulic press may be used to remove the inboard and outboard bearings. Apply force evenly and only on the inner race. Failure to do so may cause damage to the pump unit.

NOTICE: If removed from the shaft, inboard and outboard bearings should not be reused. Reusing the bearings may cause damage to the pump unit. Replace the inboard and outboard bearings before reassembly.

BEARING FRAME DISASSEMBLY [STX, MTX, LTX, AND XLTX]

1. Remove the oil-fill plug (113).
2. Remove the oil-drain plug (408A).
3. Remove the sight-oiler plug (408J).
4. Remove the oil mist/grease connection plugs (408H).
5. Remove the oil cooler plugs (408L and 408M)
6. Remove the oil sight glasses (319).
7. [MTX, LTX, and XLTX only] Remove the bearing frame foot (241) from the bearing frame (228) by removing the bearing frame foot bolts (370F).

PRE-ASSEMBLY CLEANING AND INSPECTION

Before you assemble the pump, all parts should be thoroughly cleaned and inspected. Protect machined surfaces while cleaning the parts. All parts that were discarded during disassembly should be replaced with new parts. Any parts showing wear or corrosion should be replaced with new parts.

The following parts should always be replaced at each maintenance overhaul and disassembly where applicable:

1. All O-rings and gaskets
    a. Casing gasket (351)
    b. End cover gasket (360)
    c. Bearing frame gasket (360D)
    d. Gland gasket (360Q)
    e. Impeller O-ring (412)
    f. Bearing housing O-ring (496)
2. Lock Washer (382)

The following parts should always be replaced if completely disassembled:

1. Outboard bearing (112)
2. Inboard bearing (168)
3. Outboard labyrinth oil seal (332)
4. Inboard labyrinth oil seal (333)

The following inspection criteria should be followed:

1. Casing (100): Inspect for cracks. Check for excessive wear or pitting in the volute, suction inlet, and impeller running surfaces. Clean the gasket surfaces and alignment fits.
2. Impeller (101): Inspect the impeller vanes, pumpout vanes, and vane edges for cracks, pitting, corrosion damage, or excessive wear. Replace the impeller if the vanes or pumpout vanes are worn more than 0.031 in (0.8 mm).
3. Bearing frame adapter (108): Inspect for cracks or corrosion damage. Clean the gasket surfaces.
4. Shaft (122) and shaft sleeve (126): Inspect surfaces for nicks, grooves, scoring, or pitting. Dimensionally check shaft bearing fits and runout tolerances. Refer to Appendix B for the acceptable values.
5. Bearing frame (228): Inspect for cracks. Check for corrosion damage or pitting if exposed to the pumping fluid. Clean the inside surfaces of any rust, scale, or debris. Dimensionally check the inboard bearing bore. Refer to Appendix B for the acceptable values.
6. Bearing frame foot (241): Inspect for cracks. Check for corrosion damage or pitting if exposed to the pumping fluid.
7. Seal chamber cover or stuffing box cover (184): Inspect for pitting, corrosion damage, or excessive wear. Clean the gasket and mounting surfaces.
8. Bearing housing (134): Inspect for cracks. Check for corrosion damage or pitting if exposed to the pumping fluid. Clean the O-ring groove, retaining ring groove, and gasket surfaces where applicable. Dimensionally check the outboard bearing bore. Refer to Appendix B for the acceptable values.
9. Fasteners: Inspect for corrosion damage.

To maximize reliability of pumps, it is important that certain parameters and dimensions are measured and maintained within specified tolerances. Please refer to Appendix B for a summary of these various physical parameters and the associated tolerances which are vital for maximizing pump reliability. It is very important that all parts be checked as specified in Appendix B. Any parts that do not conform to the specifications should be replaced with new American-Marsh Pumps parts.

ASSEMBLY

⚠ **WARNING:** Always wear proper personal protective equipment (PPE) while lifting and handling heavy components and equipment. Exercise caution and seek assistance, if necessary, as lifting and handling heavy components and equipment poses a crush hazard which could result in serious injury.

ASSEMBLY OF THE BEARING FRAME [STX, MTX, LTX, AND XLTX]

ⓘ **NOTICE:** Make sure that all pipe threads are clean and properly sealed. Apply thread sealant to the plugs and fittings. Failure to do so may result in oil leakage.

1. Install the oil-fill plug (113).

2. Install the oil-drain plug (408A).
3. Install the sight-oiler plug (408J).
4. Install the oil mist/grease connection plugs (408H).
5. Install the oil cooler plugs (408L and 408M)
6. Install the oil sight glasses (319).
7. [MTX, LTX, and XLTX only] Mount the bearing frame foot (241) to the bearing frame (228) by installing the bearing frame foot bolts (370F). Tighten the bolts by hand.

ASSEMBLY OF THE ROTATING ELEMENT AND BEARING FRAME [STX AND MTX]

1. Install the outboard bearing (112) on the shaft (122).

   ⚠ **CAUTION:** Wear insulated gloves when using an induction heater during bearing installation. Failure to do so may result in injury.

   ⚠ **CAUTION:** Never heat the bearings above 230°F (110°C). Doing so may cause damage to the bearing fits, leading to early pump failure.

   ⓘ **NOTICE:** Always install bearings on the shaft in a clean environment. Failure to do so may result in bearing contamination, leading to early bearing failure.

   ⓘ **NOTICE:** Apply force evenly and only on the inner race of the bearing. Failure to do so may cause damage to the bearing.

   a. Carefully inspect the shaft (122). Make sure that it is clean, dimensionally correct, and free of nicks and scoring.
   b. Lightly coat the outboard bearing seating with oil.
   c. Remove the outboard bearing (112) from its packaging. Bearings should only be removed from their protective packaging immediately before assembly to limit exposure to possible contamination.
   d. Remove any preservative from the outboard bearing (112) bore and outside diameter.
   e. Use an induction heater with a demagnetizing cycle to heat the outboard bearing (112) to an inner ring temperature of 230°F (110°C).
   f. Install the outboard bearing (112) on the shaft (122) in the proper position against the shaft shoulder. Install the locknut (136) snugly against the outboard bearing (112) until the bearing cools down to ambient temperature.
   g. Remove the locknut (136) after the outboard bearing (112) has fully cooled. Do not remove the locknut while the bearing is still hot as it prevents the bearing from moving away from the shaft shoulder while cooling.

2. Put the lock washer (382) on the shaft (122). Place the tang of the lock washer in the keyway of the shaft.
3. Thread the locknut (136) onto the shaft (122). Tighten the locknut until it is snug. Bend one tang of the lock washer into a slot on the locknut.
4. Put the bearing retaining ring (361A) on the shaft (122). Ensure the flat side of the bearing retaining ring is facing towards the bearing.
5. Install the inboard bearing (168) on the shaft (122).
6. Install a new bearing housing O-ring (496).

7. Coat the outside of the outboard bearing (112) and the bore of the bearing housing (134) with oil.
8. Install the bearing housing (134) on the shaft (122).

   NOTICE: Do not use force when installing the bearing housing on the shaft.

9. Insert the bearing retaining ring (361A) into the groove in the bore of the bearing housing (134).

   NOTICE: Check that the shaft rotates freely.

   NOTICE: Check that the space between the ends of the bearing retaining ring is located in the oil return groove. Failure to do so may obstruct oil-flow which can cause damage to the pump unit.

10. Install the outboard labyrinth oil seal (332) into the bearing housing (134). Make sure the drain slots of the outboard labyrinth oil seal are placed at the bottom 6 o'clock position. Refer to Appendix C for more information on the installation of labyrinth oil seals.

    NOTICE: Check that the edges of the shaft keyway are free from burrs. To protect the O-ring, cover the shaft keyway lengthwise with a strip of electrical tape before installing the outboard labyrinth oil seal.

11. Coat the outside of the bearing housing (134) with oil.
12. Coat all the internal surfaces of the bearing frame (228) with oil.
13. Install the shaft assembly into the bearing frame (228).

    NOTICE: Check that the shaft rotates freely.

    NOTICE: Make sure to leave approximately 0.125 inches of clearance between the face of the bearing housing and bearing frame.

14. Install the clamp screws (370C) in the bearing housing (134). Tighten the clamp bolts by hand.
15. Install the jack bolts (370D) with the jam nuts (423) in the bearing housing (134). Tighten the jack bolts and jam nuts by hand.

ASSEMBLY OF THE ROTATING ELEMENT AND BEARING FRAME [LTX]

1. Install the oil flinger (248) on the shaft (122).
2. Place the clamp ring (253B) on the shaft (122).
3. Install the outboard bearings (112) on the shaft (122).

   CAUTION: Wear insulated gloves when using an induction heater during bearing installation. Failure to do so may result in injury.

⚠ **CAUTION:** Never heat the bearings above 230°F (110°C). Doing so may cause damage to the bearing fits, leading to early pump failure.

ⓘ **NOTICE:** Always install bearings on the shaft in a clean environment. Failure to do so may result in bearing contamination, leading to early bearing failure.

ⓘ **NOTICE:** Apply force evenly and only on the inner race of the bearing. Failure to do so may cause damage to the bearing.

a. Carefully inspect the shaft (122). Make sure that it is clean, dimensionally correct, and free of nicks and scoring.
b. Lightly coat the outboard bearings seating with oil.
c. Remove the outboard bearings (112) from their packaging. Bearings should only be removed from their protective packaging immediately before assembly to limit exposure to possible contamination.
d. Remove any preservative from the outboard bearings (112) bore and outside diameter.
e. Use an induction heater with a demagnetizing cycle to heat the outboard bearings (112) to an inner ring temperature of 230°F (110°C).
f. Install both outboard bearings (112) on the shaft (122) in the proper position against the shaft shoulder. The duplex bearings are mounted back-to-back. Make sure the bearing orientation is correct. Install the locknut (136) snugly against the outboard bearings (112) until the bearings cool down to ambient temperature.
g. Remove the locknut (136) after the outboard bearings (112) have fully cooled. Do not remove the locknut while the bearings are still hot as it prevents the bearings from moving away from the shaft shoulder while cooling.

4. Put the lock washer (382) on the shaft (122). Place the tang of the lock washer in the keyway of the shaft.
5. Thread the locknut (136) onto the shaft (122). Tighten the locknut until it is snug. Bend one tang of the lock washer into a slot on the locknut.
6. Install the inboard bearing (168) on the shaft (122).
7. Coat the outside of the outboard bearing (112) and the bore of the bearing housing (134) with oil.
8. Install the bearing housing (134) on the shaft (122).

ⓘ **NOTICE:** Do not use force when installing the bearing housing on the shaft.

9. Install the clamp ring bolts (236A).

ⓘ **NOTICE:** Make sure that the clamp ring bolts are tightened to the specified torque values. Refer to Appendix B.

ⓘ **NOTICE:** Check that the shaft rotates freely.

10. Install a new bearing housing O-ring (496).
11. Install the outboard labyrinth oil seal (332) into the bearing housing (134). Make sure the drain slots of the outboard labyrinth oil seal are placed at the bottom 6 o'clock position. Refer to Appendix C for more information on the installation of labyrinth oil seals.

    NOTICE: Check that the edges of the shaft keyway are free from burrs. To protect the O-ring, cover the shaft keyway lengthwise with a strip of electrical tape before installing the outboard labyrinth oil seal.

12. Coat the outside of the bearing housing (134) with oil.
13. Coat all the internal surfaces of the bearing frame (228) with oil.
14. Install the shaft assembly into the bearing frame (228).

    NOTICE: Check that the shaft rotates freely.

    NOTICE: Make sure to leave approximately 0.125 inches of clearance between the face of the bearing housing and bearing frame.

15. Install the clamp screws (370C) in the bearing housing (134). Tighten the clamp bolts by hand.
16. Install the jack bolts (370D) with the jam nuts (423) in the bearing housing (134). Tighten the jack bolts and jam nuts by hand.

ASSEMBLY OF THE ROTATING ELEMENT AND BEARING FRAME [XLTX]

1. Install the outboard bearings (112) on the shaft (122).

   CAUTION: Wear insulated gloves when using an induction heater during bearing installation. Failure to do so may result in injury.

   CAUTION: Never heat the bearings above 230°F (110°C). Doing so may cause damage to the bearing fits, leading to early pump failure.

   NOTICE: Always install bearings on the shaft in a clean environment. Failure to do so may result in bearing contamination, leading to early bearing failure.

   NOTICE: Apply force evenly and only on the inner race of the bearing. Failure to do so may cause damage to the bearing.

   h. Carefully inspect the shaft (122). Make sure that it is clean, dimensionally correct, and free of nicks and scoring.
   i. Lightly coat the outboard bearing seating with oil.
   j. Remove the outboard bearing (112) from its packaging. Bearings should only be removed from their protective packaging immediately before assembly to limit exposure to possible contamination.

k. Remove any preservative from the outboard bearing (112) bore and outside diameter.
l. Use an induction heater with a demagnetizing cycle to heat the outboard bearing (112) to an inner ring temperature of 230°F (110°C).
m. Install the outboard bearing (112) on the shaft (122) in the proper position against the shaft shoulder. Install the locknut (136) snugly against the outboard bearing (112) until the bearing cools down to ambient temperature.
n. Remove the locknut (136) after the outboard bearing (112) has fully cooled. Do not remove the locknut while the bearing is still hot as it prevents the bearing from moving away from the shaft shoulder while cooling.

2. Put the lock washer (382) on the shaft (122). Place the tang of the lock washer in the keyway of the shaft.
3. Thread the locknut (136) onto the shaft (122). Tighten the locknut until it is snug. Bend one tang of the lock washer into a slot on the locknut.
4. Coat the outside of the outboard bearing (112) and the bore of the bearing housing (134) with oil.
5. Install the bearing housing (134) on the shaft (122).

NOTICE: Do not use force when installing the bearing housing on the shaft.

6. Install the gasket (360) and the bearing end cover (109). Fasten with the bolts (371C).

NOTICE: Make sure that the bearing end cover bolts are tightened to the specified bolt torque values. Refer to Appendix B.

NOTICE: Check that the shaft rotates freely.

7. Install the inboard bearing (168) on the shaft (122).
8. Install a new bearing housing O-ring (496).
9. Install the outboard labyrinth oil seal (332) into the bearing end cover (109). Make sure the drain slots of the outboard labyrinth oil seal are placed at the bottom 6 o'clock position. Refer to Appendix C for more information on the installation of labyrinth oil seals.

NOTICE: Check that the edges of the shaft keyway are free from burrs. To protect the O-ring, cover the shaft keyway lengthwise with a strip of electrical tape before installing the outboard labyrinth oil seal.

10. Coat the outside of the bearing housing (134) with oil.
11. Coat all the internal surfaces of the bearing frame (228) with oil.
12. Install the shaft assembly into the bearing frame (228).

NOTICE: Check that the shaft rotates freely.

NOTICE: Make sure to leave approximately 0.125 inches of clearance between the face of the bearing housing and bearing frame.

13. Install the clamp screws (370C) in the bearing housing (134). Tighten the clamp bolts by hand.
14. Install the jack bolts (370D) with the jam nuts (423) in the bearing housing (134). Tighten the jack bolts and locknuts by hand.

ASSEMBLY OF THE FRAME [STX, MTX, LTX, AND XLTX]

1. Support the bearing frame assembly in a horizontal position.
2. Check the shaft end play. Move the shaft (122) forward and backward by hand, noting any indicator movement.

   NOTICE: If the total indicator reading is greater than the values in Appendix B, disassemble and determine the cause.

3. Install the shaft sleeve (126).
4. Install the impeller (101). Thread the impeller on the shaft until hand tight.
5. Check the shaft sleeve runout. Rotate the shaft 360 degrees, noting any indicator movement.

   NOTICE: If the total indicator reading is greater than 0.002 inches, disassemble and determine the cause.

6. Remove the impeller (101) and shaft sleeve (126).
7. Check the bearing frame face runout. Rotate the shaft so that the indicator measures the fit for 360 degrees.

   NOTICE: If the total indicator reading is greater than 0.001 inches, disassemble and determine the cause.

8. Install the bearing frame gasket (360D) on the bearing frame (228). Hold the bearing frame gasket in place by installing the dowel pins (469B).
9. Install the bearing frame adapter (108). Align the bolt hole and dowel pin locations of the bearing frame adapter with those on the bearing frame. Install the bolts (370B) and tighten in a crisscross pattern.

   NOTICE: Make sure the bolts are tightened to the specified bolt torque values. Refer to Appendix B.

10. Check the bearing frame adapter fit. Rotate the shaft so that the indicator measures the fit for 360 degrees.

    NOTICE: If the total indicator reading is greater than 0.005 inches, disassemble and determine the cause.

11. Install the inboard labyrinth oil seal (333) into the bearing frame adapter (108) and the bearing frame (228). Make sure the drain slots of the inboard labyrinth oil seal are placed at the bottom 6 o'clock position. Refer to Appendix C for more information on the installation of labyrinth oil seals.

SEAL THE SHAFT WITH A COMPONENT MECHANICAL SEAL

⚠ **CAUTION:** Running a component mechanical seal dry, even for a few seconds, can cause damage to the seal resulting in potential seal failure and personal injury. Never operate the pump without fluid properly supplied to the component mechanical seal.

1. Install the seal chamber cover (184). Fasten with nuts.
2. Check the seal chamber cover runout. Rotate the shaft 360 degrees.

ⓘ **NOTICE:** If the total indicator reading is greater than 0.005 inches (0.13 mm), determine the cause and correct before proceeding.

3. Install the shaft sleeve (126), if applicable. Make sure the shaft sleeve is fully seated.
4. Install the impeller (101) with a new impeller O-ring (412). Refer to the assembly of the impeller section of this manual for more information.
5. Install the back pull-out assembly in the casing (100).
6. Set the impeller clearance. Refer to the impeller clearance setting section of this manual for more information.
7. Blue and scribe a mark on the shaft (122) or shaft sleeve (126), if applicable, at the face of the seal chamber. This mark will serve as the datum for installation of the component mechanical seal.
8. Remove the back pull-out assembly from the casing (100).
9. Remove the impeller (101) and the shaft sleeve (126), if applicable.
10. Remove the seal chamber cover (184).
11. Install the stationary seat of the mechanical seal into the seal gland (250) in accordance with the component mechanical seal manufacturer's instructions.
12. Slide the seal gland (250) with the stationary seat and seal gland gasket installed onto the shaft (122) until it contacts the bearing frame adapter face (108).
13. Reinstall the shaft sleeve (126), if applicable.
14. Install the rotary portion of the component mechanical seal on the shaft (122) or shaft sleeve (126), if applicable, per the component mechanical seal manufacturer's instructions. Use the scribed line and the seal-reference dimension.
15. Reinstall the seal chamber cover (184) with nuts.
16. Slide the seal gland (250) over the seal chamber cover studs. Make sure the seal gland gasket is in the proper position. Fasten the seal gland (250) to the seal chamber cover (184) with nuts.
17. Tighten the nuts evenly so the seal gland (250) is seated properly on the seal chamber cover (184) and it is perpendicular to the shaft (122).
18. Reinstall the impeller (101). Refer to the assembly of the impeller section of this manual for more information.
19. Complete the reinstallation of the back pull-out assembly.

SEAL THE SHAFT WITH PACKING

ⓘ **NOTICE:** Pumps are shipped without the packing, lantern ring, and packing gland installed. These parts are packaged and shipped separately and must be properly installed before start-up.

1. Install the stuffing box cover (184). Fasten with nuts.
2. Check the stuffing box cover runout. Rotate the shaft 360 degrees.

    a. **NOTICE:** If the total indicator reading is greater than 0.005 inches (0.13 mm), determine the cause and correct before proceeding.

3. Install the shaft sleeve (126), if applicable. Make sure the shaft sleeve is fully seated.
4. Install the impeller (101) with a new impeller O-ring (412). Refer to the assembly of the impeller section of this manual for more instructions.
5. Clean the stuffing box bore in the stuffing box cover (184).
6. Install 2-3 rings of packing into the stuffing box bore. Twist the rings of packing enough to get it around the shaft (122) or shaft sleeve (126), if applicable. Press the ring of packing down into the bore, making sure to stagger the joints of each ring of packing by 90°.
7. Install the lantern ring (105) into the stuffing box bore. The lantern ring is a two-piece design.

    a. **NOTICE:** Check to ensure the lantern ring is properly located at the flushing port. Add or remove a ring of packing as needed to locate the lantern ring. Failure to do so may cause damage to the packing and decreased performance.

8. Install 2-3 rings of packings into the stuffing box bore. Twist the rings of packing enough to get it around the shaft (122) or shaft sleeve (126), if applicable. Press the ring of packing down into the bore, making sure to stagger the joints of each ring of packing by 90°.
9. Install the packing gland (210). The packing gland is a two-piece design.
10. Tighten the nuts evenly by hand.
11. Complete the reinstallation of the back pull-out assembly.

SEAL THE SHAFT WITH A CARTRIDGE MECHANICAL SEAL

CAUTION: Running a cartridge mechanical seal dry, even for a few seconds, can cause damage to the seal resulting in potential seal failure and personal injury. Never operate the pump without fluid properly supplied to the cartridge mechanical seal.

NOTICE: The pump may be provided with the standard sleeved shaft or optional solid shaft configurations. Verify the type of shaft configuration before beginning to install the cartridge mechanical seal. For the standard sleeved shaft configuration, the cartridge mechanical seal will be slid onto the shaft sleeve. For the optional solid shaft configuration, the cartridge mechanical seal will be slid onto the shaft.

1. Install the shaft sleeve (126), if applicable.
2. Slide the cartridge mechanical seal onto the shaft (122) or shaft sleeve (126), if applicable, until it contacts the inboard labyrinth oil seal (333).
3. Install the seal chamber cover (184). Fasten with nuts.

4. Slide the cartridge mechanical seal into the seal chamber. Secure the cartridge mechanical seal with the four studs and nuts.
5. Continue with the pump reassembly.
6. Set the impeller clearance. Refer to the impeller clearance setting section of this manual for more information.
7. Tighten the set screws in the cartridge mechanical seal locking ring to secure the seal to the shaft (122) or shaft sleeve (126), if applicable.
8. Remove the centering clips from the cartridge mechanical seal.

ASSEMBLY OF THE IMPELLER [STX, MTX, LTX, AND XLTX]

⚠ **CAUTION:** Risk of personal injury from sharp edges. Heavy gloves should be worn when handling the pump impellers.

1. [STX, MTX, and LTX] Install the impeller (101) on the shaft (122). Use a new impeller O-ring (412).
2. [XTLTX] Install the impeller (101) and a Teflon gasket on the plug. Use a new impeller O-ring (412).
3. Tighten the impeller (101) by hand until it makes firm contact with the shaft (122) or shaft sleeve (126), if applicable.
4. Put a shaft wrench or strap wrench and the coupling key (400) on the shaft (122).
5. Rotate the impeller (101) counterclockwise, when viewed from the impeller end of the shaft, to raise the shaft wrench off the workbench.
6. Quickly rotate the impeller (101) clockwise, when viewed from the impeller end of the shaft, to slam the shaft wrench down on the workbench.
7. Repeat the previous step a few times to properly tighten the impeller (101).
8. Loosen the clamp screws (370C) and the jack bolts (370D).
9. Measure the gap between the impeller (101) and the seal chamber cover or stuffing box cover (184) with a feeler gauge. When 0.030 in (0.76 mm) clearance is reached, tighten the clamp screws (370C), jack bolts (370D), and jam nuts (423).

   ⓘ **NOTICE:** This approximates the impeller position when set to 0.015 in (0.38 mm) from the casing. Final impeller adjustment must be made after installation into the casing. Refer to the impeller clearance setting section of this manual.

10. Check the impeller (101) runout.

    ⓘ **NOTICE:** Check the impeller vane tip to vane tip. If the total indicator reading is greater than 0.005 in (0.13 mm), determine the cause and correct the issue before proceeding.

REINSTALL THE BACK PULL-OUT ASSEMBLY [STX, MTX, LTX, AND XLTX]

1. Clean the casing fit.
2. Install the casing gasket (351) in the proper position on the seal chamber/stuffing box cover.
3. Loosen the clamp screws (370C) and jack bolts (370D) on the bearing housing (134).
4. Install the back pull-out assembly in the casing (100).
5. Install the casing bolts (370). Tighten the casing bolts by hand.

NOTICE: Casing bolts may be coated with an anti-galling compound to aid disassembly.

NOTICE: Tighten the casing bolts to the specified bolt torque vales. Refer to Appendix B.

6. Install the casing jack bolts (418). Tighten the casing jack bolts by hand.

   NOTICE: Do not overtighten the casing jack bolts. Doing so may cause damage to the pump unit.

7. Replace the shims under the bearing frame foot, if applicable. Tighten the bearing frame foot hold-down bolting to the baseplate.

   NOTICE: Make sure the proper shims are used. To verify, a dial indicator should be mounted to measure the distance between the top of the bearing frame and the baseplate. This distance should not change as the bearing frame foot hold-down bolting is tightened.

8. Check the total impeller clearance in the casing (100).

   NOTICE: With new parts, the acceptable range is 0.030 in to 0.065 in (0.76 mm to 1.65mm) for the STX, MTX, and LTX. With new parts, the acceptable range is 0.040 in to 0.105 in (1.02 mm to 2.67 mm) for the XLTX. If the impeller clearance is outside of this range, either the parts are incorrect, the installation is improper, or there is too much pipe strain present. Determine the cause and correct.

9. Adjust the impeller clearance.

   NOTICE: Refer to the impeller clearance setting section of this manual for more information.

10. Install auxiliary piping, if applicable.
11. Fill the pump with the proper lubricant. Refer to Appendix A.
12. Install the coupling hub on the shaft in the proper location, noting the previously marked location.
13. Install the coupling spacer.
14. Install the coupling guard.

PART 7: TROUBLESHOOTING GUIDE

OPERATION TROUBLESHOOTING

Symptom	Cause	Solution
Pump not delivering fluid.	The pump is not primed.	Re-prime the pump.
	The impeller is clogged.	Back-flush the pump to

		clean the impeller.
	The suction piping line is clogged.	Remove the obstruction.
	The pump is rotating in the wrong direction.	Change the rotation by adjusting the motor wiring. The rotation must match the arrow located on the pump bearing housing or casing.
	The suction lift is too high.	Install shorter suction pipe.
Pump operates for a short period and then stops pumping.	The pump is not properly primed.	Re-prime the pump.
	The suction piping line has an air leak.	Locate and repair the air leak. Check the suction piping line gaskets, replace as needed.
	The suction piping line has entrapped air.	Rearrange the suction piping to eliminate the entrapped air.
Pump not producing the rated design flow or head.	The impeller clearance is excessive.	Adjust the impeller clearance.
	The impeller is partially clogged.	Back-flush the pump to clean the impeller.
	The impeller is worn or damaged.	Replace the impeller.
	The casing rear cover is worn.	Replace the casing rear cover.
	The impeller is too small.	Check the impeller diameter. Replace the impeller with the proper trim impeller as needed.
	The pump is rotating in the wrong direction.	Change the rotation by adjusting the motor wiring. The rotation must match the arrow located on the pump bearing housing or casing.
	The pump operating speed is too low.	Check the motor operating speed against the rated design speed located on the pump nameplate.
	The stuffing box/seal chamber has an air leak.	Readjust the packing/mechanical seal or replace if damaged.
	The suction head is not sufficient.	Check the suction piping line for obstructions. Make sure the suction piping line shutoff valve is fully open.
Pump has excessive noise or vibration.	The pump is cavitating.	Locate and correct the system problem. Make sure there is sufficient NPSH available.
	The inboard and/or outboard bearings are worn	Replace the inboard and outboard bearings.

	or damaged.	
	The pump and driver are misaligned.	Realign the pump and driver.
	The shaft is bent.	Replace the shaft.
	The foundation is not sufficiently rigid.	Tighten the pump and driver hold-down bolts. Check that the baseplate is properly grouted without air pockets or voids.
	Rotating parts are rubbing against stationary parts.	Check the clearances of the parts that are rubbing.
	The impeller is worn or damaged.	Replace the impeller.
	The impeller is partially clogged.	Back-flush the pump to clean the impeller.
	The suction and/or discharge piping line is not properly supported.	Support the suction and/or discharge piping line as required in accordance with HI specifications.
Pump bearings are running hot.	The pump and driver are misaligned.	Realign the pump and driver.
	There is not sufficient lubrication.	Check the oil level. Add or remove oil as required.
	The lubricant has broken down or is contaminated.	Change the oil.
Mechanical seal is leaking.	The mechanical seal is worn or damaged.	Replace the mechanical seal.
	The shaft or shaft sleeve is worn or scored.	Replace the shaft or shaft sleeve.
	The shaft is bent.	Replace the shaft.
	The mechanical seal is overheating.	Check the mechanical seal lubrication and cooling lines.
Packing is leaking excessively.	The packing gland is not properly adjusted.	Tighten the packing gland nuts.
	The stuffing box is not properly packed.	Adjust the packing. Replace the packing if necessary.
	The shaft or shaft sleeve is worn or scored.	Replace the shaft or shaft sleeve.
	The shaft is bent.	Replace the shaft.
The motor is pulling excessive amperage.	The discharge head is too low.	Install a throttle valve in the discharge piping line. If this does not solve the problem, reduce the impeller diameter by trimming it.
	Rotating parts are rubbing against stationary parts.	Check the clearances of the parts that are rubbing.
	The packing gland is too tight.	Adjust the packing and packing gland. Replace the packing if worn.
	The fluid is heavier than specified.	Check the fluid specific gravity and viscosity.

ASSEMBLY TROUBLESHOOTING

Symptom	Cause	Solution
Excessive shaft end play.	The internal clearance of the inboard and outboard bearings exceeds the recommended amount.	Replace the bearings.
	The snap ring is loose in the bearing housing groove.	Replace the snap ring in the bearing housing groove.
Excessive shaft and/or shaft sleeve runout.	The shaft sleeve is too worn.	Replace the shaft sleeve.
	The shaft is bent.	Replace the shaft.
Excessive impeller vane tip runout.	The impeller vane is bent.	Replace the impeller.
	The impeller vane is worn.	Replace the impeller.
Excessive stuffing box/seal chamber rear cover runout.	The stuffing box/seal chamber rear cover is not correctly seated in the bearing frame adapter.	Re-seat the stuffing box/seal chamber rear cover.
	The stuffing box/seal chamber rear cover is worn.	Replace the stuffing box/seal chamber rear cover.
Excessive bearing frame adapter runout.	The bearing frame adapter gasket is not seated correctly.	Re-seat the bearing frame adapter gasket.
	The bearing frame adapter has corrosion.	Replace the bearing frame adapter.
Excessive bearing frame flange runout.	The shaft is bent.	Replace the shaft.

APPENDIX A – LUBRICATION AND BEARING MAINTENANCE

OIL LUBRICATION

> ⚠ **CAUTION:** Oil lubricated pumps are shipped with NO oil in the bearing frame. The proper type and amount of oil will need to be added to the bearing frame prior to starting up the pump.

The standard bearing housing bearings are oil bath lubricated and are not lubricated by American-Marsh Pumps. Oil bath lubricated bearings are open on both sides.

BEARING MAINTENANCE AND OIL LUBRICATION SCHEDULE

For oil lubricated bearings, the pump is shipped without oil. Oil must be added to the pump bearing frame before installation is complete and starting the pump for the first time.

Change the oil after 200 hours of operation for new bearings. In many pumping applications, lubricating oil becomes contaminated before it loses its lubricating qualities and breaks down. After the first oil change, the used oil should be carefully examined for contaminants. During the initial operating period of 200 hours, monitor the bearing housing operating temperature. Make sure to record the external bearing housing temperature.

After the first 200 hours, change the oil every three months or 2000 hours of operation.

ADDING OIL

1. Remove oil-fill plug (113) from the bearing frame (228).
2. Fill the oil reservoir in the bearing frame (228) with the proper type of oil. Refer to Table A-2 for recommended types of oil.
3. Fill the oil reservoir until the proper oil level is reached. The oil level should be ±0.125 inches (±3 mm) from the center of the oil sight glass.

   ⚠ **CAUTION:** Make sure to NOT under fill or over fill the bearing frame with oil. Under filling or over filling the bearing frame can cause damage to the pump unit.

   ⓘ **NOTICE:** Make sure the oil level in the bearing frame is maintained at ±0.125 inches (±3 mm) from the center of the oil sight glass. The oil sight glass has a 0.250 inches (6 mm) hole in the center of its reflector. The oil level must be maintained within the circumference of the center hole to ensure adequate lubrication of the bearings.

4. Replace the oil-fill plug (113).

REMOVING OIL

1. Prepare an appropriate container in place to collect the excess oil.
2. Remove the oil-fill plug (113) from the bearing frame (228).
3. Loosen the oil-drain plug (408A). Do not completely remove the oil-drain plug from the bearing frame (228).
4. Collect the excess oil in the container until the proper oil level is reached.

5. Tighten the oil-drain plug (408A).
6. Replace the oil-fill plug (113).

CHANGING OIL

1. Prepare an appropriate container in place to collect the oil.
2. Remove the oil-fill plug (113) from the bearing frame (228).
3. Remove the oil-drain plug (408A) from the bearing frame (228).
4. Inspect the drained oil for excess contaminates or moisture.
5. Replace the oil-drain plug (408A).
6. Fill the oil reservoir in the bearing frame (228) with the proper type of oil. Refer to Table A-2 for recommended types of oil.
7. Fill the oil reservoir until the proper oil level is reached. The oil level should be ±0.125 inches (±3 mm) from the center of the oil sight glass.

   ⚠ **CAUTION:** Make sure to NOT under fill or over fill the bearing frame with oil. Under filling or over filling the bearing frame can cause damage to the pump unit.

   ⓘ **NOTICE:** Make sure the oil level in the bearing frame is maintained at ±0.125 inches (±3 mm) from the center of the oil sight glass. The oil sight glass has a 0.250 inches (6 mm) hole in the center of its reflector. The oil level must be maintained within the circumference of the center hole to ensure adequate lubrication of the bearings.

8. Replace the oil-fill plug (113).

OIL VOLUME

The following Table A-1 shows the approximate amount of oil required for oil bath lubricated bearings. Make sure to not under fill or over fill the bearing frame with oil as this can cause damage to the pump. Refer to the instructions given in this manual for adding oil.

Power Frame Size	Oil Reservoir Capacity
STX	16 oz (400 ml)
MTX	42 oz (1250 ml)
LTX	48 oz (1400 ml)
XLTX	96 oz (3000 ml)

Table A-1: Amount of Oil Required

ACCEPTABLE OIL TYPE

Only acceptable high quality turbine oils with rust and oxidation inhibitors should be used to lubricate the pump bearings. Examples of acceptable oils are given in Table A-2.

Manufacturer	Oil Type
Chevron	GST Oil 68
Exxon	Teresstic EP 68 or NUTO H68
Mobil	DTE 26 300
Phillips 66	Turbine Oil VG68
Sunoco	Sunvis 968
Shell	Turbo T 68
Royal Purple	SYNFILM ISO VG 68 Synthetic Oil

Table A-2: Recommended Oils

TEMPERATURE REQUIREMENTS

For the majority of operating conditions, bearing temperatures should run between 120°F (49°C) and 180°F (82°C), and an oil of ISO viscosity grade 68 at 100°F (38°C) can be used. If the bearing temperatures exceed 180°F (82°C), an oil of ISO viscosity grade 100 should be used with a bearing frame oil cooler.

APPENDIX B – CRITICAL MEASUREMENTS, TOLERANCES, AND ASSEMBLY REFERENCES

BOLT TORQUE VALUES

Casing Bolt Torque Values									
Flange Rating		150 lb				300 lb			
Casing Material		Ductile Iron		316 SS, CD4MCu		Ductile Iron		316 SS, CD4MCu	
Bolt Material		ASTM A307 Grade B (Carbon Steel)		F593 Grade 1 (304 SS) or F593 Grade 2 (316 SS)		ASTM A193 Grade B7 (Carbon Steel)		ASTM A193 Grade B8/B8M Class 2 (304 SS/316 SS)	
Frame	**Casing Bolt Size**	**Torque**		**Torque**		**Torque**		**Torque**	
		Dry	**Lube**	**Dry**	**Lube**	**Dry**	**Lube**	**Dry**	**Lube**
8″ STX	1/2″-13	30 (40)	22 (29)	54 (73)	40 (54)	40 (54)	NA	83 (112)	62 (84)
6″ STX MTX LTX XLTX	5/8″-11	59 (80)	44 (59)	107 (145)	80 (108)	70 (94)	NA	165 (223)	124 (168)
XLTX-17	7/8″-9	170 (230)	124 (168)	212 (287)	155 (210)	150 (203)	NA	377 (511)	283 (383)

NOTES:
1. Dimensions are in lb-ft.
2. All other dimensions in parentheses are approximate equivalents in Nm.

Pump Bolt Torque Values					
Item No.	**Location**	**STX**	**MTX**	**LTX**	**XLTX**
	Bearing Frame to Frame Adapter Bolts	30 (40)	30 (40)	30 (40)	30 (40)
	Bearing End Cover Bolts	NA	NA	NA	12 (16)
	Bearing Clamp Ring Bolt	NA	NA	6.9 (9.4)	NA

NOTES:
3. Dimensions are in lb-ft.
4. All other dimensions in parentheses are approximate equivalents in Nm.

SHAFT END PLAY

Power Frame Size	Double Row Bearing	Duplex Bearing
STX	0.0011/0.0019 in (0.028/0.048 mm)	0.0007/0.0010 in (0.018/0.025 mm)
MTX	0.0013/0.0021 in (0.033/0.053 mm)	0.0009/0.0012 in (0.023/0.030 mm)
LTX	NA	0.0010/0.0015 in (0.025/0.038 mm)
XLTX	0.0014/0.0023 in (0.036/0.058 mm)	0.0010/0.0015 in (0.025/0.038 mm)

SHAFT RUNOUT TOLERANCES

	Sleeve Fit – in (mm)	Coupling Fit – in (mm)
With Sleeve	0.001 (0.025)	0.001 (0.025)
Without Sleeve	0.002 (0.051)	0.001 (0.025)

BEARING TYPES

Power Frame Size	Inboard Bearing	Outboard Bearing	
		Double Row	Duplex
STX	6207	3306	7306
MTX	6309	3309	7309
LTX	6311	NA	7310
XLTX	6313	3313	7313

BEARING FITS AND TOLERANCES

	STX	MTX	LTX	XLTX
Shaft OD (inboard)	1.3785/1.3781 (35.014/35.004)	1.7722/1.7718 (45.014/45.004)	2.1660/2.1655 (55.016/55.004)	2.5597/2.5592 (65.016/65.004)
Clearance	0.0010/0.0001 T (0.025/0.003 T)	0.0010/0.0001 T (0.025/0.003 T)	0.0012/0.0001 T (0.030/0.003 T)	0.0012/0.0001 T (0.030/0.003 T)
Bearing ID (inboard)	1.3780/1.3775 (35.000/34.989)	1.7717/1.7712 (45.000/44.988)	2.1654/2.1648 (55.000/54.986)	2.5591/2.5585 (65.000/64.986)
Frame ID (inboard)	2.8346/2.8353 (72.000/72.017)	3.9370/3.9379 (100.000/100.023)	4.7244/4.7253 (120.000/120.023)	5.5118/5.5128 (140.000/140.025)
Clearance	0.0012/0.0000 L (0.030/0.000 L)	0.0015/0.0000 L (0.038/0.000 L)	0.0015/0.0000 L (0.038/0.000 L)	0.0017/0.0000 L (0.043/0.000 L)
Bearing OD (inboard)	2.8346/2.8341 (72.000/71.986)	3.9370/3.9364 (100.000/99.985)	4.7244/4.7238 (120.000/119.985)	5.5118/5.5111 (140.000/139.982)
Shaft OD (outboard)	1.1816/1.1812 (30.013/30.002)	1.7722/1.7718 (45.014/45.004)	1.9696/1.9686 (50.013/50.002)	2.5597/2.5592 (65.016/65.004)
Clearance	0.0009/0.0001 T (0.023/0.003 T)	0.0010/0.0001 T (0.025/0.003 T)	0.0010/0.0001 T (0.025/0.003 T)	0.0012/0.0001 T (0.030/0.003 T)
Bearing ID (outboard)	1.1811/1.1807 (30.000/29.990)	1.7717/1.7712 (45.000/44.988)	1.9685/1.9680 (50.000/49.987)	2.5591/2.5585 (65.000/64.986)
Housing ID (outboard)	2.8348/2.8353 (72.004/72.017)	3.9373/3.9379 (100.007/100.023)	4.3310/4.3316 (110.007/110.023)	5.5121/5.5128 (140.007/140.025)
Clearance	0.0012/0.0002 L (0.030/0.005 L)	0.0015/0.0003 L (0.038/0.008 L)	0.0015/0.0003 L (0.038/0.008 L)	0.0017/0.0003 L (0.043/0.008 L)
Bearing OD (outboard)	2.8346/2.8341 (72.000/71.986)	3.9370/3.9364 (100.000/99.985)	4.3307/4.3301 (110.000/109.985)	5.5118/5.5111 (140.000/139.982)

DUPLEX ANGULAR CONTACT BEARINGS

Duplex angular contact bearings must be mounted back to back with the wider thrust sides of the outer races in contact with each other as shown in Figure 2. Only bearings designed for universal mounting should be used. A special shaft may be required when using duplex angular contact bearings.

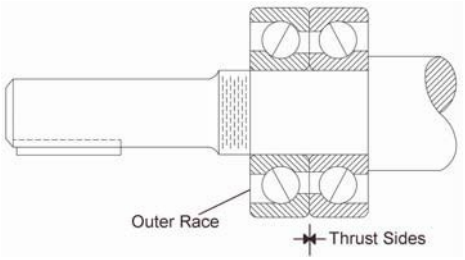


Figure 2: Duplex Angular Contact Bearings

POWER FRAME HORSEPOWER LIMITS

Power Frame Size	Maximum Brake Horsepower (BHP)
STX	40 HP
MTX	122 HP
LTX	200 HP
XLTX	250 HP

APPENDIX C – LABYRINTH OIL SEAL MAINTENANCE

NOTICE: The inboard and outboard labyrinth oil seals are a one-piece design. Do not attempt to separate the rotor from the stator as this will damage the labyrinth oil seal. If the rotor can be removed from the stator, the entire labyrinth oil seal must be replaced.

The American-Marsh Pumps OSG and OSG LF are provided with high quality bearing isolators of the labyrinth type. The labyrinth oil seals isolate the inboard and outboard bearings from the environment to protect the bearings from contaminants and retains the oil in the bearing frame. Each labyrinth oil seal consists of a rotor and a stator. The rotor rotates with the shaft, driven by a close-fitted drive ring. The stator is a stationary component, including an O-ring gasket seal, that is pressed into a housing bore with an interference fit (nominal 0.002 in (0.05 mm) interference fit). The rotor and stator are assembled as a one-piece design, and they are axially locked together with an O-ring. There is no mechanical (metal-to-metal) contact between the rotor and stator when the pump is operating.

REMOVE THE LABYRINTH OIL SEAL

1. Remove the shaft (122) as described in the pump disassembly instructions.
2. From the inside of the bearing housing (134), bearing frame (228), or bearing frame adapter (108), place a bar made from a soft material such as wood or plastic against the inside face of the labyrinth oil seal. Carefully push the labyrinth oil seal out by tapping the bar with a rubber mallet or using an arbor press.

INSTALL A NEW OUTBOARD LABYRINTH OIL SEAL [STX, MTX, LTX, and XLTX]

1. Wrap electrical tape around the coupling end of the shaft (122) to completely cover the keyway. The keyway may have sharp edges which can cause damage to the labyrinth oil seal during installation.
2. Lightly lubricate the shaft (122) and the drive ring.
3. While using a block large enough to cover the entire rotor side of the labyrinth oil seal, use an arbor press to install the outboard labyrinth oil seal (332) onto the shaft and into the bore in the bearing housing (134). The bore has an interference fit. Make sure that the expulsion port is in the 6 o'clock position.
4. Continue to press the outboard labyrinth oil seal (332) down until the stator location ramp begins to avoid angular misalignment.
5. Remove and discard any residual material from the stator gasket. The elastomer O-ring acts as a gasket to ensure damming up of small imperfections in the bore. The O-ring is designed to be compressed to the point of overfilling its groove. The overfilled material is sheared off during installation.

INSTALL A NEW INBOARD LABYRINTH OIL SEAL [STX]

1. Lightly lubricate the shaft (122) and the drive ring.
2. While using a block large enough to cover the entire rotor side of the labyrinth oil seal, use an arbor press to install the inboard labyrinth oil seal (333) onto the shaft (122).
3. Continue to press the inboard labyrinth oil seal (333) along the shaft (122) and into the bore in the bearing frame (228). The bore has an interference fit. Make sure that

the expulsion port is in the 6 o'clock position.
4. Continue to press the labyrinth oil seal down until the stator location ramp begins to avoid angular misalignment.
5. Remove and discard any residual material from the stator gasket. The elastomer O-ring acts as a gasket to ensure damming up of small imperfections in the bore. The O-ring is designed to be compressed to the point of overfilling its groove. The overfilled material is sheared off during installation.

INSTALL A NEW INBOARD LABYRINTH OIL SEAL [MTX, LTX, and XLTX]

1. After installing the bearing frame adapter (108) on the bearing frame (228), lightly lubricate the shaft (122) and the drive ring.
2. While using a block large enough to cover the entire rotor side of the labyrinth oil seal, use an arbor press to install the inboard labyrinth oil seal (333) onto the shaft (122).
3. Continue to press the inboard labyrinth oil seal (333) along the shaft (122) and into the bore in the bearing frame adapter (108). The bore has an interference fit. Make sure that the expulsion port is in the 6 o'clock position.
4. Continue to press the labyrinth oil seal down until the stator location ramp begins to avoid angular misalignment.
5. Remove and discard any residual material from the stator gasket. The elastomer O-ring acts as a gasket to ensure damming up of small imperfections in the bore. The O-ring is designed to be compressed to the point of overfilling its groove. The overfilled material is sheared off during installation.

LABYRINTH OIL SEAL MAINTENANCE

The labyrinth oil seals are not intended to be removed from the bearing housing (134), bearing frame (228), and/or bearing frame adapter (108) unless they are being replaced. If a labyrinth oil seal is removed from its housing bore for any reason, the labyrinth oil seal must be replaced with a new part to ensure a proper seal. Replacement of a labyrinth oil seal is typically only necessary when excessive oil leakage is evident, or if excessive contaminants are in the bearings. However, if for any other reason, the power end is disassembled, it is recommended that the rotor drive ring O-ring be replaced.

APPENDIX D – SEAL LUBRICATION

⚠ **WARNING:** If the pump has a seal support system, it is mandatory that this system be fully installed and operational before the pump is started.

SEALING LIQUID FOR A MECHANICAL SEAL

When using a mechanical seal, the seal faces must have a liquid film between them for proper lubrication.

Two common seal flushing methods that can be used to flush or cool the mechanical seal are product flush and external flush.

For a product flush, the mechanical seal is flushed with the pumped fluid. Attach piping from the discharge portion of the casing volute to the seal gland so that the pump pushes the pumped fluid from the casing and injects it into the seal gland. An external heat exchanger may be used to cool the pumped fluid before it is injected into the seal gland, if necessary. The product flush method should not be used if the pumped fluid contains abrasives.

For an external flush, the mechanical seal is flushed with a clean, cool, and compatible external fluid source. Attach piping from the external fluid source to the seal gland so that the pump injects the clean, cool fluid into the seal gland. The pressure of the external flushing fluid should be 15 psi greater than the pressure in the seal chamber. The external flushing fluid injection rate should be 0.5 to 2 gpm.

Refer to the mechanical seal manufacturer's instructions and ASME B73.1 for additional information on mechanical seal piping plans. Seal and the seal support system must be installed and operational as specified by the seal manufacturer. The seal chamber and seal gland may have ports that have been temporarily plugged at the factory to keep out foreign matter. It is the installer's responsibility to determine if these plugs should be removed and external piping connected.

SEALING LIQUID FOR PACKING

During normal operation, the packing should have a leakage rate of approximately 1 drop per second. A leakage rate of 40-60 drops per minute is usually adequate to cool and lubricate the packing. The packing gland should be adjusted if the leakage rate is greater than or less than the specified acceptable leakage rate. Evenly tighten or loosen the packing gland nuts to adjust the packing gland. Do not over tighten the packing gland to the point where less than the specified acceptable leakage rate is observed. This can cause excessive wear and power consumption during pump operation. If the packing gland cannot be tightened to achieve the specified acceptable leakage rate, then you need to replace the packing.

Grease lubrication, when compatible with the pumped fluid, may be used. The grease should be introduced into Tap V as shown in Figure 3.

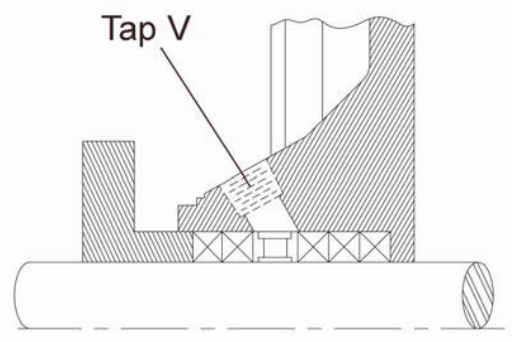


Figure 3: Standard Packing Arrangement

An external sealing liquid must be used if the pumped fluid contains abrasives or if the stuffing box pressure is below atmospheric pressure when the pump is running with a suction lift or when the suction source is in a vacuum. The external fluid source should be clean, cool, and compatible with the packing. Attach piping to Tap V as shown in Figures 3 and 4. The piping should be connected to the lantern ring connection with a 40-60 drop per minute leak rate. The pressure must be 15 psi above the stuffing box pressure.

For an abrasive packing arrangement, the installation procedures are the same as the standard packing with some exceptions. A lip seal is installed first, followed by two lantern rings, and then two of the packing rings. A flush line from a clean external source should be connected to Tap V as shown in Figure 4.

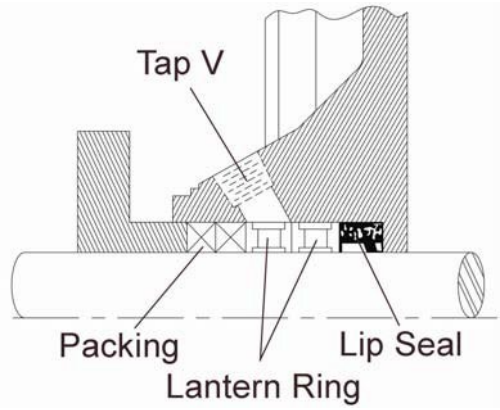


Figure 4: Abrasive Packing Arrangement

APPENDIX E – SPARE PARTS

It is imperative for pump service reliability to have a sufficient stock of readily available spare parts. The decision on what spare parts to stock varies greatly depending on many factors such as the criticality of the application, the time required to buy and receive new spare parts, the erosive and/or corrosive nature of the application, and the cost of the spare parts.

RECOMMENDED SPARE PARTS

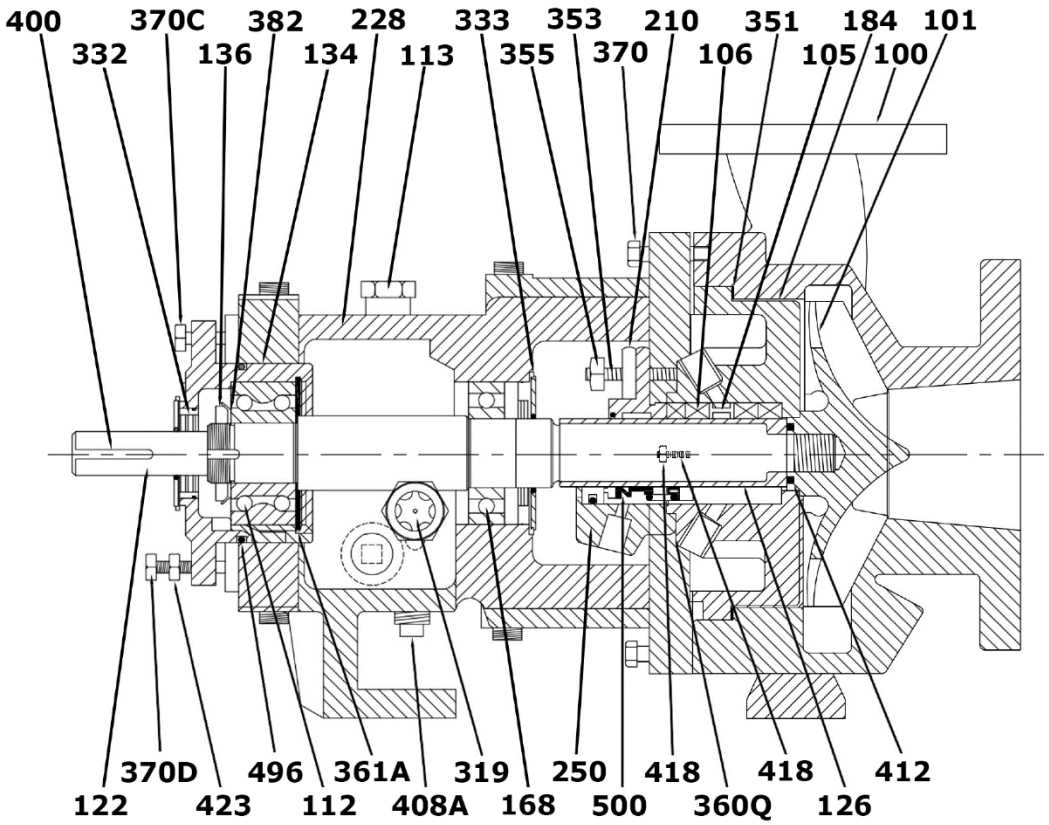
The spare parts recommended by American-Marsh Pumps are the following:

1. Impeller (101)
2. Shaft (122)
3. Shaft sleeve (126)
4. Lantern ring (105)
5. Bearing lock washer (382)
6. Inboard bearing (168)
7. Outboard bearing (112)
8. Inboard labyrinth oil seal (333)
9. Outboard labyrinth oil seal (332)
10. Stuffing box/seal chamber gland gasket (360Q)
11. Packing (106)
12. Mechanical seal (500)
13. Impeller O-ring (412)
14. Bearing frame adapter gasket (360D)
15. Casing gasket (351)
16. Bearing housing O-ring (496)

HOW TO ORDER SPARE PARTS

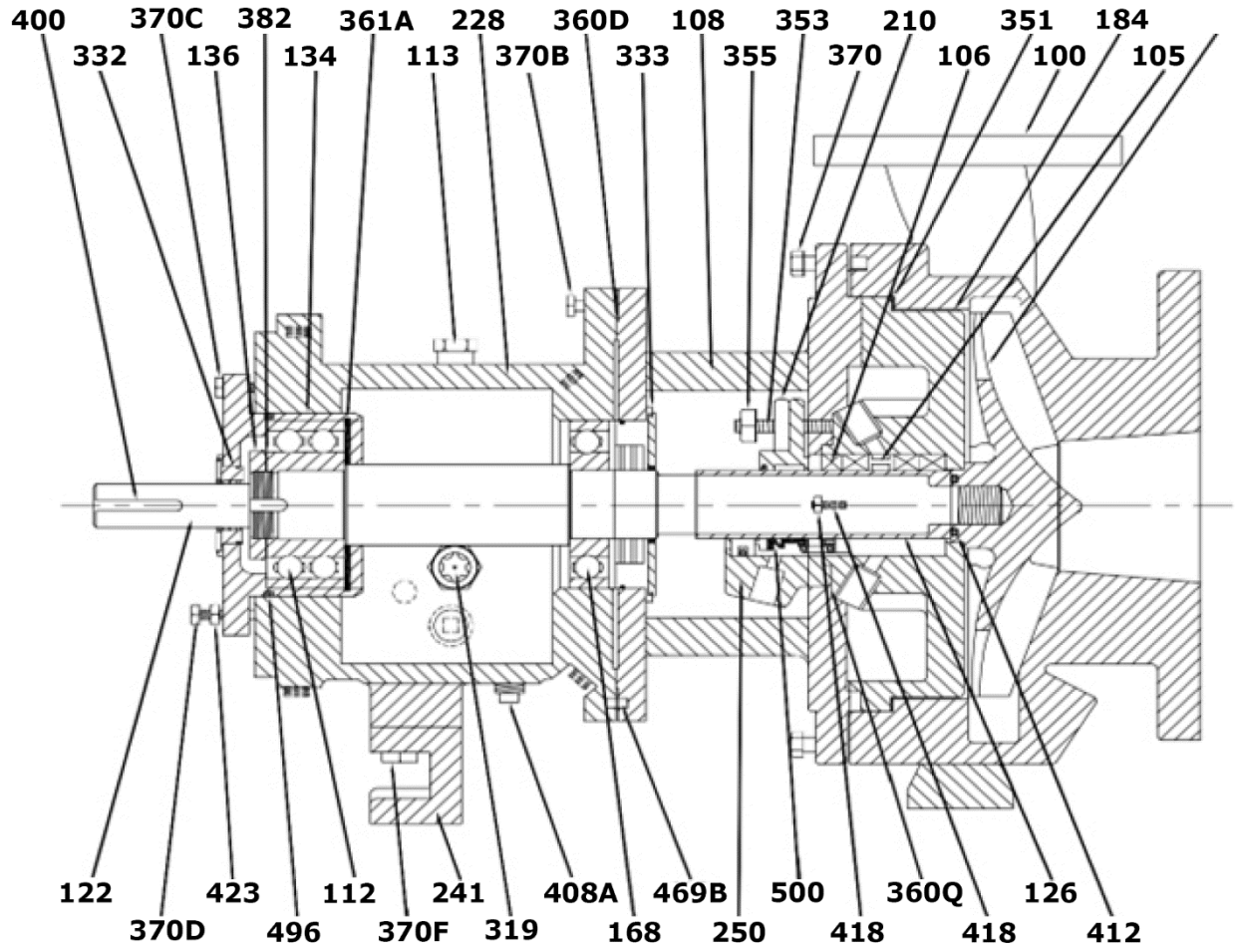
Spare parts can be ordered from your local American-Marsh Pumps Distributor or Representative. Make sure to provide the pump unit serial number, model, and type which can be found on the pump nameplate located on the bearing frame. Also indicate the item number, description, and material for the part(s) to be ordered. For the item numbers, refer to the applicable pump sectional drawing in this manual.

APPENDIX F – STX SECTIONAL VIEW AND ITEM LIST



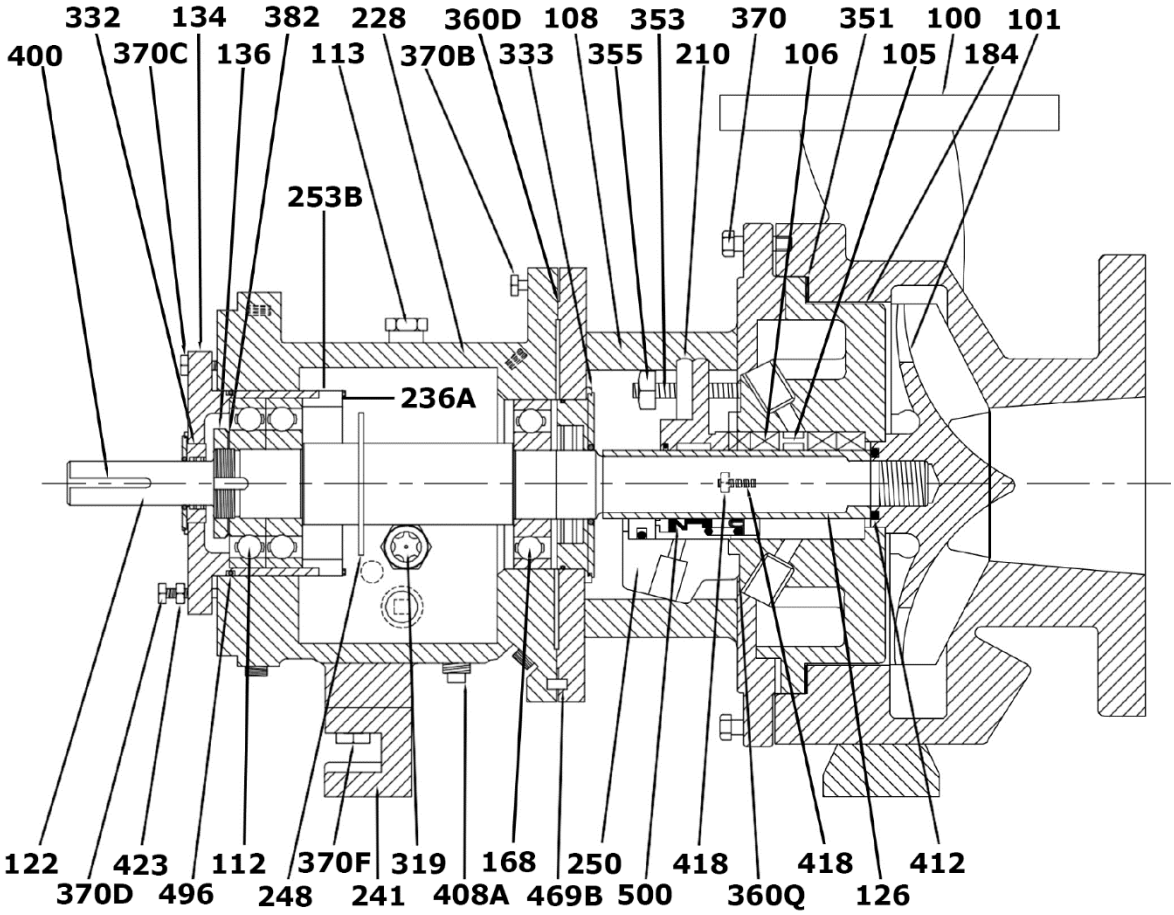
Item No.	Description	Qty.		Item No.	Description	Qty.
100	Casing	1		355	Gland Nut	4
101	Impeller	1		360Q	Gland Gasket	1
105	Lantern Ring	1		361A	Retaining Ring	1
106	Packing Set	1		370	Casing Bolt	VAR
112	Outboard Bearing	1		370C	Bearing Housing Clamp Screw	3
113	Oil-Fill Plug	1		370D	Jack Bolt	3
122	Shaft	1		382	Lock Washer	1
126	Shaft Sleeve	1		400	Coupling Key	1
134	Bearing Housing	1		408A	Oil-Drain Plug	1
136	Locknut	1		408J	Sight-Oiler Plug	1
168	Inboard Bearing	1		408H	Oil Mist Plug	4
184	Seal Chamber/Stuffing Box Cover	1		408L	Oil Cooler Plug	1
210	Packing Gland	1		408M	Oil Cooler Plug	1
228	Bearing Frame	1		412	Impeller O-Ring	1
250	Seal Gland	1		418	Casing Jack Bolt	3
319	Oil Sight Glass	1		423	Jam Nut	3
332	Outboard Labyrinth Oil Seal	1		496	Bearing Housing O-Ring	1
333	Inboard Labyrinth Oil Seal	1		500	Mechanical Seal	1
351	Casing Gasket	1				
353	Gland Stud	4				

APPENDIX G – MTX SECTIONAL VIEW AND ITEM LIST



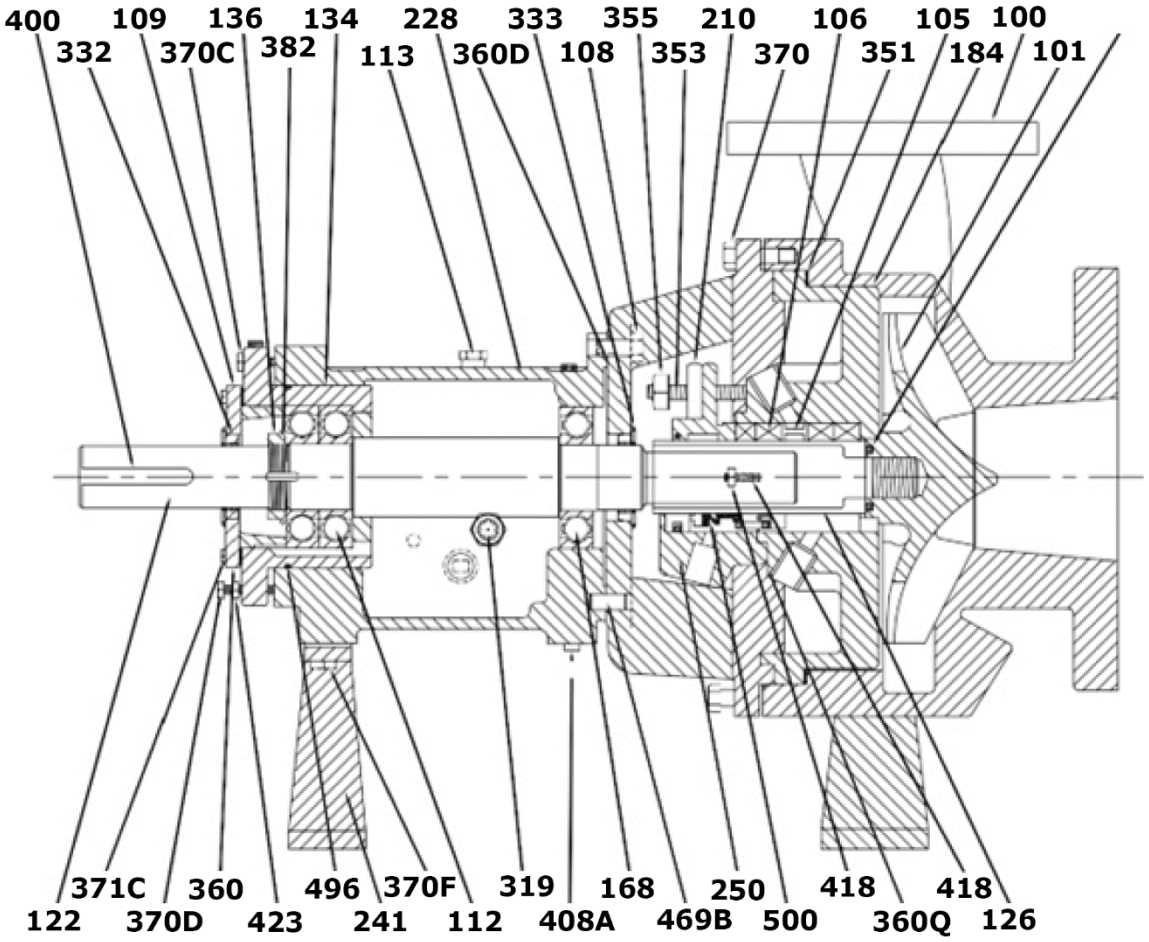
Item No.	Description	Qty.		Item No.	Description	Qty.
100	Casing	1		355	Gland Nut	4
101	Impeller	1		360D	Bearing Frame Gasket	1
105	Lantern Ring	1		360Q	Gland Gasket	1
106	Packing Set	1		361A	Retaining Ring	1
108	Bearing Frame Adapter	1		370	Casing Bolt	VAR
112	Outboard Bearing	1		370B	Bearing Frame To Adapter Bolts	4
113	Oil-Fill Plug	1		370C	Bearing Housing Clamp Screw	3
122	Shaft	1		370D	Jack Bolt	3
126	Shaft Sleeve	1		370F	Bearing Frame Foot Bolt	2
134	Bearing Housing	1		382	Lock Washer	1
136	Locknut	1		400	Coupling Key	1
168	Inboard Bearing	1		408A	Oil-Drain Plug	1
184	Seal Chamber/Stuffing Box Cover	1		408J	Sight-Oiler Plug	1
210	Packing Gland	1		408H	Oil Mist Plug	4
228	Bearing Frame	1		408L	Oil Cooler Plug	1
241	Bearing Frame Foot	1		408M	Oil Cooler Plug	1
250	Seal Gland	1		412	Impeller O-Ring	1
319	Oil Sight Glass	1		418	Casing Jack Bolt	3
332	Outboard Labyrinth Oil Seal	1		423	Jam Nut	3
333	Inboard Labyrinth Oil Seal	1		469B	Dowel Pin	2
351	Casing Gasket	1		496	Bearing Housing O-Ring	1
353	Gland Stud	4		500	Mechanical Seal	1

APPENDIX H – LTX SECTIONAL VIEW AND ITEM LIST



Item No.	Description	Qty.		Item No.	Description	Qty.
100	Casing	1		353	Gland Stud	4
101	Impeller	1		355	Gland Nut	4
105	Lantern Ring	1		360D	Bearing Frame Gasket	1
106	Packing Set	1		360Q	Gland Gasket	1
108	Bearing Frame Adapter	1		370	Casing Bolt	VAR
112	Outboard Bearing	1		370B	Bearing Frame To Adapter Bolts	4
113	Oil-Fill Plug	1		370C	Bearing Housing Clamp Screw	3
122	Shaft	1		370D	Jack Bolt	3
126	Shaft Sleeve	1		370F	Bearing Frame Foot Bolt	2
134	Bearing Housing	1		382	Lock Washer	1
136	Locknut	1		400	Coupling Key	1
168	Inboard Bearing	1		408A	Oil-Drain Plug	1
184	Seal Chamber/Stuffing Box Cover	1		408J	Sight-Oiler Plug	1
210	Packing Gland	1		408H	Oil Mist Plug	4
228	Bearing Frame	1		408L	Oil Cooler Plug	1
241	Bearing Frame Foot	1		408M	Oil Cooler Plug	1
250	Seal Gland	1		412	Impeller O-Ring	1
236A	Clamp Ring Bolt	10		418	Casing Jack Bolt	3
248	Oil Flinger	1		423	Jam Nut	3
253B	Clamp Ring	1		469B	Dowel Pin	2
319	Oil Sight Glass	1		496	Bearing Housing O-Ring	1
332	Outboard Labyrinth Oil Seal	1		500	Mechanical Seal	1
333	Inboard Labyrinth Oil Seal	1				
351	Casing Gasket	1				

APPENDIX I – XLTX SECTIONAL VIEW AND ITEM LIST



Item No.	Description	Qty.		Item No.	Description	Qty.
100	Casing	1		355	Gland Nut	4
101	Impeller	1		360	Bearing End Cover Gasket	1
105	Lantern Ring	1		360D	Bearing Frame Gasket	1
106	Packing Set	1		360Q	Gland Gasket	1
108	Bearing Frame Adapter	1		370	Casing Bolt	VAR
109	Bearing End Cover	1		370B	Bearing Frame To Adapter Bolts	4
112	Outboard Bearing	1		370C	Bearing Housing Clamp Screw	4
113	Oil-Fill Plug	1		370D	Jack Bolt	4
122	Shaft	1		370F	Bearing Frame Foot Bolt	2
126	Shaft Sleeve	1		371C	Bearing End Cover Bolts	6
134	Bearing Housing	1		382	Lock Washer	1
136	Locknut	1		400	Coupling Key	1
168	Inboard Bearing	1		408A	Oil-Drain Plug	1
184	Seal Chamber/Stuffing Box Cover	1		408J	Sight-Oiler Plug	1
210	Packing Gland	1		408H	Oil Mist Plug	4
228	Bearing Frame	1		408L	Oil Cooler Plug	1
241	Bearing Frame Foot	1		408M	Oil Cooler Plug	1
250	Seal Gland	1		412	Impeller O-Ring	1
319	Oil Sight Glass	1		418	Casing Jack Bolt	3
332	Outboard Labyrinth Oil Seal	1		423	Jam Nut	3
333	Inboard Labyrinth Oil Seal	1		469B	Dowel Pin	2
351	Casing Gasket	1		496	Bearing Housing O-Ring	1
353	Gland Stud	4		500	Mechanical Seal	1

APPENDIX J – BARE PUMP DIMENSIONS

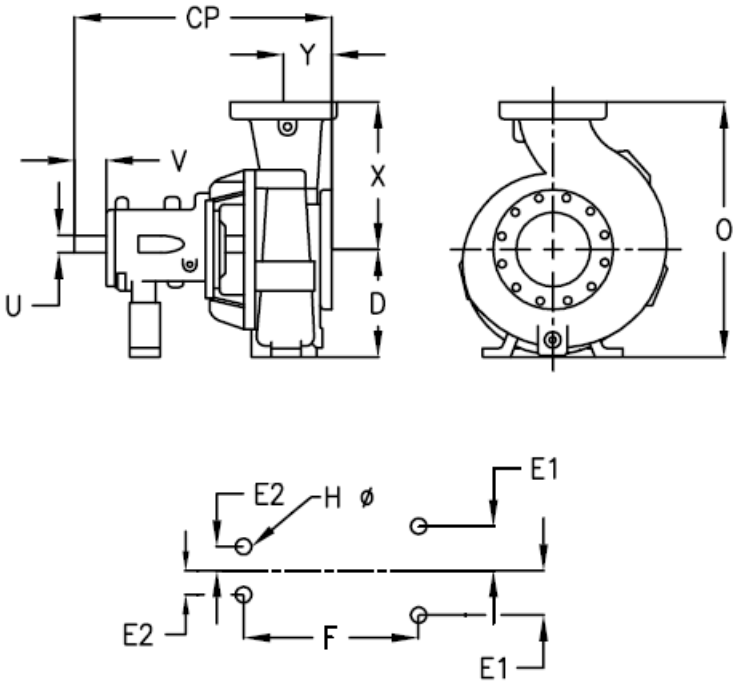


Figure 5: OSG and OSG LF Bare Pump Dimensions

OSG BARE PUMP DIMENSIONS

DIM DESIG.	SIZE	CP	D	2E1	2E2	F	H	O	U	V	X	Y
AA	1X1.5-6	17.5 (445)	5.25 (133)	6 (152)	0 (0)	7.25 (184)	0.625 (16)	11.75 (298)	0.875 (22.23)	2 (51)	6.5 (165)	4 (102)
AB	1.5x3-6	17.5 (445)	5.25 (133)	6 (152)	0 (0)	7.25 (184)	0.625 (16)	11.75 (298)	0.875 (22.23)	2 (51)	6.5 (165)	4 (102)
AC	2x3-6	17.5 (445)	5.25 (133)	6 (152)	0 (0)	7.25 (184)	0.625 (16)	11.75 (298)	0.875 (22.23)	2 (51)	6.5 (165)	4 (102)
AA	1x1.5-8	17.5 (445)	5.25 (133)	6 (152)	0 (0)	7.25 (184)	0.625 (16)	11.75 (298)	0.875 (22.23)	2 (51)	6.5 (165)	4 (102)
AB	1.5x3-8	17.5 (445)	5.25 (133)	6 (152)	0 (0)	7.25 (184)	0.625 (16)	11.75 (298)	0.875 (22.23)	2 (51)	6.5 (165)	4 (102)
A60	2x3-8	23.5 (597)	8.25 (210)	9.75 (248)	7.25 (184)	12.5 (318)	0.625 (16)	17.75 (450)	1.125 (28.58)	2.625 (67)	9.5 (242)	4 (102)
A70	3x4-7	23.5 (597)	8.25 (210)	9.75 (248)	7.25 (184)	12.5 (318)	0.625 (16)	19.25 (490)	1.125 (28.58)	2.625 (67)	11 (280)	4 (102)
A70	3x4-8	23.5 (597)	8.25 (210)	9.75 (248)	7.25 (184)	12.5 (318)	0.625 (16)	19.25 (490)	1.125 (28.58)	2.625 (67)	11 (280)	4 (102)
A70	3x4-8G	23.5 (597)	8.25 (210)	9.75 (248)	7.25 (184)	12.5 (318)	0.625 (16)	19.25 (490)	1.125 (28.58)	2.625 (67)	11 (280)	4 (102)
A05	1x2-10	23.5 (597)	8.25 (210)	9.75 (248)	7.25 (184)	12.5 (318)	0.625 (16)	16.75 (425)	1.125 (28.58)	2.625 (67)	8.5 (216)	4 (102)
A50	1.5x3-10	23.5 (597)	8.25 (210)	9.75 (248)	7.25 (184)	12.5 (318)	0.625 (16)	16.75 (425)	1.125 (28.58)	2.625 (67)	8.5 (216)	4 (102)
A60	2x3-10	23.5 (597)	8.25 (210)	9.75 (248)	7.25 (184)	12.5 (318)	0.625 (16)	17.75 (450)	1.125 (28.58)	2.625 (67)	9.5 (242)	4 (102)
A70	3x4-10	23.5 (597)	8.25 (210)	9.75 (248)	7.25 (184)	12.5 (318)	0.625 (16)	19.25 (490)	1.125 (28.58)	2.625 (67)	11 (280)	4 (102)
A40	3x4-10H	23.5 (597)	10 (254)	9.75 (248)	7.25 (184)	12.5 (318)	0.625 (16)	22.5 (572)	1.125 (28.58)	2.625 (67)	12.5 (318)	4 (102)
A80	4x6-10H	23.5 (597)	10 (254)	9.75 (248)	7.25 (184)	12.5 (318)	0.625 (16)	23.5 (597)	1.125 (28.58)	2.625 (67)	13.5 (343)	4 (102)
A80	4x6-10G	23.5 (597)	10 (254)	9.75 (248)	7.25 (184)	12.5 (318)	0.625 (16)	23.5 (597)	1.125 (28.58)	2.625 (67)	13.5 (343)	4 (102)

A20	1.5x3-13	23.5 (597)	10 (254)	9.75 (248)	7.25 (184)	12.5 (318)	0.625 (16)	20.5 (520)	1.125 (28.58)	2.625 (67)	10.5 (266)	4 (102)
A30	2x3-13	23.5 (597)	10 (254)	9.75 (248)	7.25 (184)	12.5 (318)	0.625 (16)	21.5 (546)	1.125 (28.58)	2.625 (67)	11.5 (292)	4 (102)
A40	3x4-13	23.5 (597)	10 (254)	9.75 (248)	7.25 (184)	12.5 (318)	0.625 (16)	22.5 (572)	1.125 (28.58)	2.625 (67)	12.5 (318)	4 (102)
A80	4x6-13	23.5 (597)	10 (254)	9.75 (248)	7.25 (184)	12.5 (318)	0.625 (16)	23.5 (597)	1.125 (28.58)	2.625 (67)	13.5 (343)	4 (102)
A90	6x8-13	33.875 (860)	14.5 (368)	16 (406)	9 (229)	18.75 (476)	0.875 (22)	30.5 (775)	2.375 (60.33)	4 (102)	16 (406)	6 (152)
A100	8x10-13	33.875 (860)	14.5 (368)	16 (406)	9 (229)	18.75 (476)	0.875 (22)	32.5 (826)	2.375 (60.33)	4 (102)	18 (457)	6 (152)
A110	6x8-15	33.875 (860)	14.5 (368)	16 (406)	9 (229)	18.75 (476)	0.875 (22)	32.5 (826)	2.375 (60.33)	4 (102)	18 (457)	6 (152)
A120	8x10-15	33.875 (860)	14.5 (368)	16 (406)	9 (229)	18.75 (476)	0.875 (22)	33.5 (851)	2.375 (60.33)	4 (102)	19 (483)	6 (152)
A120	8x10-15G	33.875 (860)	14.5 (368)	16 (406)	9 (229)	18.75 (476)	0.875 (22)	33.5 (851)	2.375 (60.33)	4 (102)	19 (483)	6 (152)
A105	4x6-17	33.875 (860)	14.5 (368)	16 (406)	9 (229)	18.75 (476)	0.875 (22)	30.5 (775)	2.375 (60.33)	4 (102)	16 (406)	6 (152)
A110	6x8-17	33.875 (860)	14.5 (368)	16 (406)	9 (229)	18.75 (476)	0.875 (22)	32.5 (826)	2.375 (60.33)	4 (102)	18 (457)	6 (152)
A120	8x10-17	33.875 (860)	14.5 (368)	16 (406)	9 (229)	18.75 (476)	0.875 (22)	33.5 (851)	2.375 (60.33)	4 (102)	19 (483)	6 (152)

NOTES:

5. Dimensions are in inches.
6. All other dimensions in parentheses are approximate equivalents in millimeters.

OSG LF BARE PUMP DIMENSIONS

DIM DESIG.	SIZE	CP	D	2E1	2E2	F	H	O	U	V	X	Y
AA	1x1.5-8	17.5 (445)	5.25 (133)	6 (152)	0 (0)	7.25 (184)	0.625 (16)	11.75 (298)	0.875 (22.23)	2 (51)	6.5 (165)	4 (102)
A05	1x2-10	23.5 (597)	8.25 (210)	9.75 (248)	7.25 (184)	12.5 (318)	0.625 (16)	16.75 (425)	1.125 (28.58)	2.625 (67)	8.5 (216)	4 (102)
A20	1.5x3-13	23.5 (597)	10 (254)	9.75 (248)	7.25 (184)	12.5 (318)	0.625 (16)	20.5 (520)	1.125 (28.58)	2.625 (67)	10.5 (266)	4 (102)

NOTES:

1. Dimensions are in inches.
2. All other dimensions in parentheses are approximate equivalents in millimeters.

APPENDIX K – OSG BASEPLATE MOUNTED DIMENSIONS

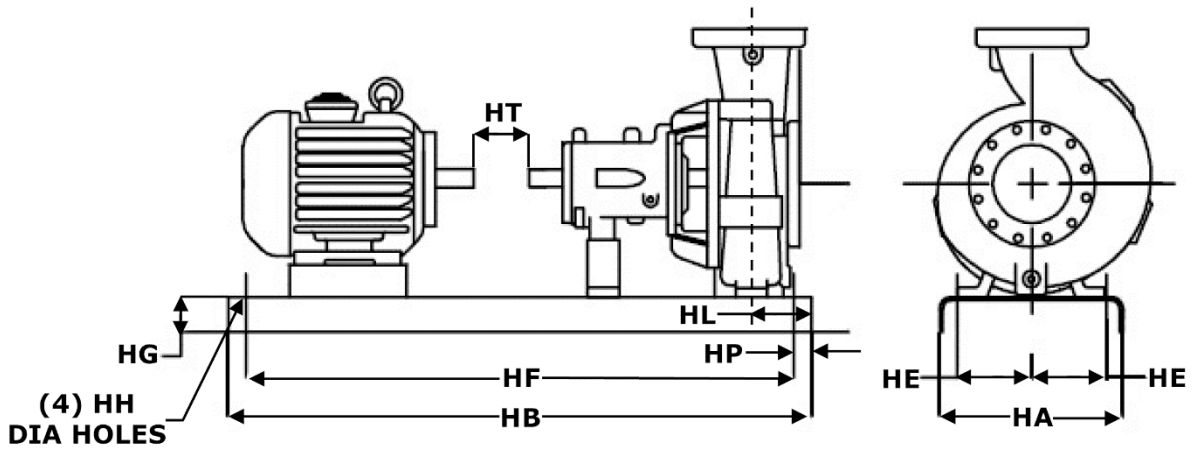


Figure 6: OSG Baseplate Mounted Dimensions

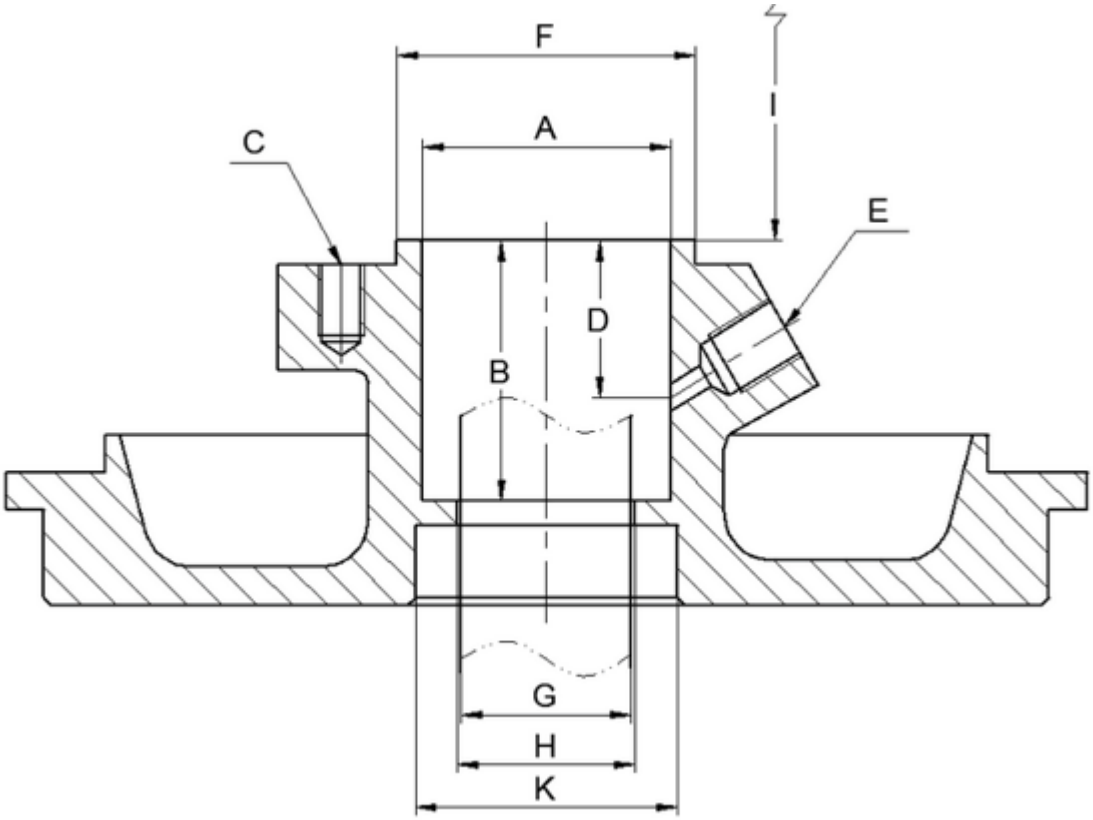
MAX NEMA FRAME	BASEPLATE NO.	HA	HB	HE	HF	HG	HH	HL	HP	HT
184T	139	15 (381)	39 (991)	4.5 (114)	36.5 (927)	3.75 (95)	0.75 (19)	4.5 (114)	1.25 (32)	5 (127)
256T	148	18 (457)	48 (1219)	6 (152)	45.5 (1156)	4.13 (105)	0.75 (19)	4.5 (114)	1.25 (32)	5 (127)
326TS	153	21 (533)	53 (1346)	7.5 (191)	50.5 (1283)	4.75 (121)	0.75 (19)	4.5 (114)	1.25 (32)	5 (127)
184T	245	15 (381)	45 (1143)	4.5 (114)	42.5 (1080)	3.75 (95)	0.75 (19)	4.5 (114)	1.25 (32)	5 (127)
215T	252	18 (457)	52 (1321)	6 (152)	49.5 (1257)	4.13 (105)	0.75 (19)	4.5 (114)	1.25 (32)	5 (127)
286T	258	21 (533)	58 (1473)	7.5 (191)	55.5 (1410)	4.75 (121)	1 (25)	4.5 (114)	1.25 (32)	5 (127)
365T	264	21 (533)	64 (1626)	7.5 (191)	61.5 (1562)	4.75 (121)	1 (25)	4.5 (114)	1.25 (32)	5 (127)
405TS	268	26 (660)	68 (1727)	9.5 (241)	65.5 (1664)	4.75 (121)	1 (25)	4.5 (114)	1.25 (32)	5 (127)
449TS	280	26 (660)	80 (2032)	9.5 (241)	77.5 (1969)	4.75 (121)	1 (25)	4.5 (114)	1.25 (32)	5 (127)
286T	368	26 (660)	68 (1727)	9.5 (241)	65.5 (1664)	4.75 (121)	1 (25)	6.5 (165)	1.25 (32)	5 (127)
405T	380	26 (660)	80 (2032)	9.5 (241)	77.5 (1969)	4.75 (121)	1 (25)	6.5 (165)	1.25 (32)	5 (127)
449T	398	26 (660)	98 (2489)	9.5 (241)	95.5 (2426)	4.75 (121)	1 (25)	6.5 (165)	1.25 (32)	5 (127)

NOTES:

1. Dimensions are in inches.
2. All other dimensions in parentheses are approximate equivalents in millimeters.

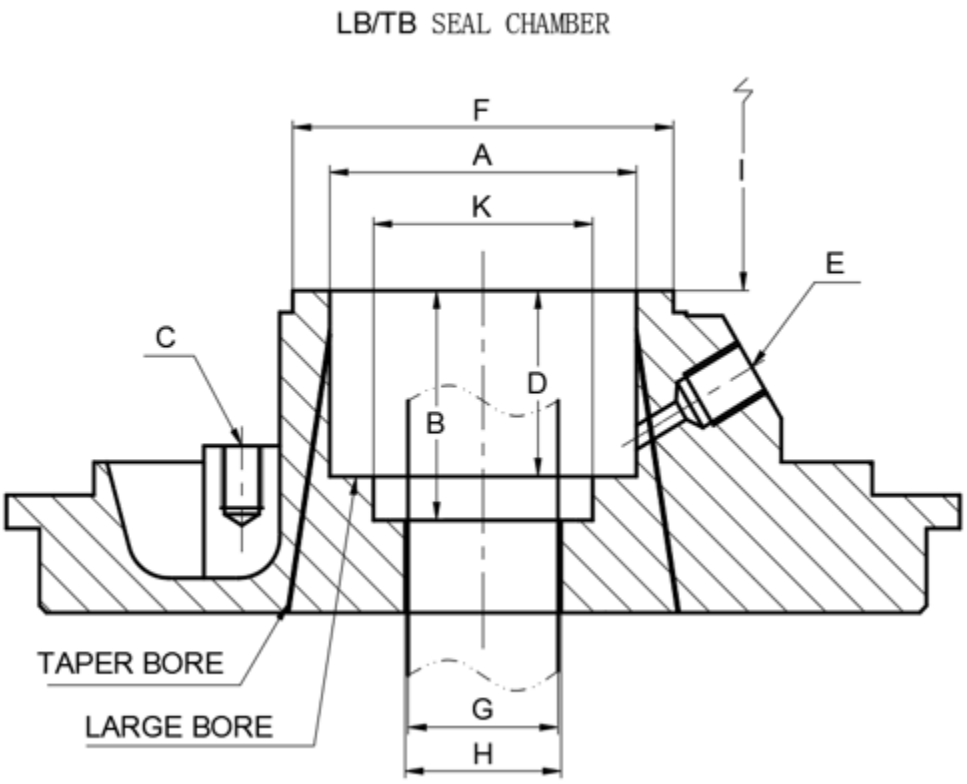
APPENDIX L – STANDARD BORE AND LARGE BORE STUFFING BOX/SEAL CHAMBER DIMENSIONS

STANDARD BORE (SMALL CYLINDRICAL BORE)



FRAME	A	B	C		D	E	F	G	H	K	I
			B.C.	TAP							
STX	2.000 (50.8)	2.118 (53.8)	3.252 (82.6)	3/8-16UNC	1.023 (26.0)	1/4-18NPT	2.394 (60.8)	1.375 (34.93)	1.401 (35.6)		2.177 (55.3)
MTX	2.500 (63.5)	2.618 (66.5)	4.122 (104.7)	1/2-13UNC	1.575 (40.0)	3/8-18NPT	3.000 (76.2)	1.750 (44.45)	1.791 (45.5)	2.638 (67.0)	3.000 (76.2)
LTX	2.878 (73.1)	2.618 (66.5)	4.500 (114.3)	1/2-13UNC	1.693 (43.0)	3/8-18NPT	3.520 (89.4)	2.125 (53.98)	2.153 (54.7)	2.625 (66.7)	3.000 (76.2)
XLTX	3.375 (85.7)	3.000 (76.2)	5.375 (136.5)	5/8-11UNC	1.653 (42.0)	3/8-18NPT	4.375 (111.1)	2.500 (63.50)	2.527 (64.2)	3.425 (87.0)	2.929 (74.4)
XLTX-17	3.625 (92.1)	3.000 (76.2)	5.375 (136.5)	5/8-11UNC	1.831 (46.5)	1/4-18NPT	4.375 (111.1)	2.750 (69.85)	2.815 (71.5)	3.575 (90.8)	2.772 (70.4)

LARGE CYLINDRICAL BORE / LARGE TAPER BORE



FRAME	A	B	C		D	E	F	G	H	K	I
			B.C.	TAP							
STX	2.875 (73.0)	2.118 (53.8)	4.500 (114.3)	3/8-16UNC	1.688 (42.9)	1/4-18NPT	3.594 (91.3)	1.375 (34.93)	1.401 (35.6)	2.000 (50.8)	2.188 (55.6)
MTX	3.488 (88.6)	2.618 (66.5)	5.500 (139.7)	1/2-13UNC	2.118 (53.8)	3/8-18NPT	4.338 (110.2)	1.750 (44.45)	1.791 (45.5)	2.500 (63.5)	2.811 (71.4)
LTX	3.875 (98.4)	2.618 (66.5)	6.000 (152.4)	1/2-13UNC	2.118 (53.8)	3/8-18NPT	4.708 (119.6)	2.125 (53.98)	2.153 (54.7)	2.875 (73.0)	2.811 (71.4)
XLTX	4.500 (114.3)	3.000 (76.2)	6.750 (171.5)	5/8-11UNC	2.500 (63.5)	3/8-18NPT	5.448 (138.4)	2.500 (63.50)	2.527 (64.2)	3.375 (85.7)	2.850 (72.4)
XLTX-17	4.500 (114.3)	3.000 (76.2)	6.750 (171.5)	5/8-11UNC	2.500 (63.5)	1/4-18NPT	5.448 (138.4)	2.750 (69.85)	2.814 (71.5)	3.375 (85.8)	2.771 (70.4)

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