SUMMIT™ 2996

Installation, Operation, and Maintenance Manual

2996

In-Line Process Pump

SUMMIT™
PUMP, Inc
www.SUMMITPUMP.com

I.WARRANTY

Pumping units assembled by Summit Pump, Inc., Green Bay, WI are guaranteed to be free from defects in material and workmanship for one year from date of shipment from factory in Green Bay, WI. The obligation under this warranty, statutory or otherwise, is limited to replacement or repair at Green Bay, WI, of such part as shall appear to us upon inspection at such point, to have been defective in material or workmanship.

This warranty does not obligate Summit Pump, Inc. to bear the cost of labor or transportation charges in connection with replacement or repair of defective parts; nor shall it apply to a pump upon which repairs or alterations have been made unless authorized by Summit Pump, Inc.

No warranty is made in respect to engines, motors, or trade accessories, such being subject to warranties of their respective manufacturers.

No express implied or statutory warranty, other than herein set forth is made or authorized to be made by Summit Pump, Inc.

In no event shall Summit Pump, Inc. be liable for consequential damages or contingent liabilities arising out of the failure of any Summit Pump, Inc. pump or parts thereof to operate properly.

II.LIABILITY

Summit Pump, Inc. shall not be liable for personal physical injury, damage or delays caused by failure to follow the instructions and procedures for installation, operation and maintenance contained in this manual.

The equipment is not for use in or with any nuclear facility or fire sprinkler system. Buyer accepts the responsibility for insuring that the equipment is not used in violation and Buyer shall indemnify and hold Seller harmless from any and all liability (including such liability resulting from seller’s negligence) arising out of said improper use.

III.COPYRIGHT

The information contained herein is for informational use only and is subject to change without notice. Summit Pump assumes no responsibility or liability for any errors or inaccuracies that may appear in this manual.

1 CONTENTS

2 INTRODUCTION

This installation, operation, and maintenance manual is designed to help you achieve the best performance and longest life from your Summit Pump. This pump is an open impeller centrifugal type with an in-line suction/discharge. The pump is designed for handling mild industrial corrosives.

This pump is a centrifugal pump which generates pressure, not flow. Velocity imparted to the casing from the impeller tip is converted from velocity energy to pressure energy; flow is a byproduct of the differential pressure.

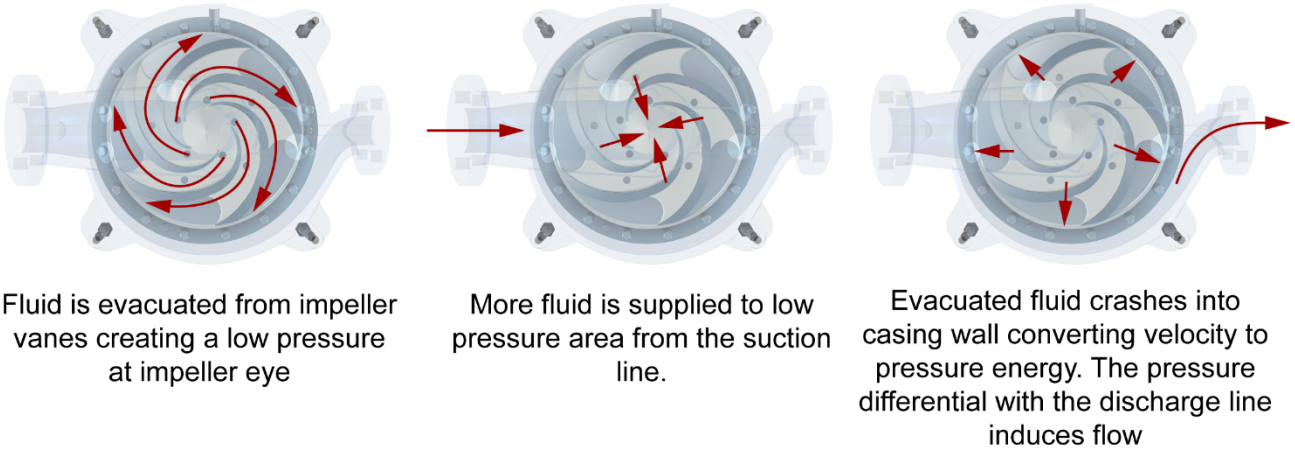


Figure 2-1: Basics of centrifugal design

Fluid from the suction eye is dispersed through the impeller in the volume between the impeller vanes. Fluid leaves the impeller at approximately the same speed as the vane tip and collides with the casing wall; the velocity energy is converted to pressure energy. If allowed, the fluid will leave the discharge port towards a lower pressure.

If there are any questions regarding this pump or its application, which are not covered in this manual, please contact your local Summit Pump, Inc. Distributor.

For information or technical assistance on the driver service, contact the driver manufacturer's local dealer or representative.

3 SAFETY

The following message types are used in this manual to alert maintenance personnel to procedures that require special attention for the protection and safety of both personnel and equipment:

⚠ DANGER

Imminently hazardous situation which, if not avoided, will result in death or serious injury.

⚠ WARNING

Potentially hazardous situation which, if not avoided, could result in death or serious injury.

⚠ CAUTION

Potentially hazardous situation which, if not avoided, may result in minor or moderate injury.

NOTICE

Includes Information on operation, maintenance, rules or directions. May indicate possible property damage.

3.1 PUMP SAFETY WARNINGS

The safety information below should be followed and observed to prevent damage to equipment or injury to operators:

⚠ DANGER

Ensure discharge line is open and free of clogs before operation. Negligent acts may result in serious injury or death.

⚠ CAUTION

Feeding very hot or very cold fluid into the pump at room temperature may result in fracture of pump wet end.

⚠ WARNING

Follow all auxiliary equipment (motors, drives, couplings etc.) manufacturer's manuals, instructions or procedures during installation, operation and maintenance of the pump.

NOTICE

Check all clearances, drive to shaft alignments, fastener torques, equipment lubrication, gaskets and seals for leaks and that all equipment is fastened into place before operation.

4 NOMENCLATURE

4.1 Nameplate information

On page 48 of this manual, record the nameplate data from your pump. This will assist with any maintenance questions or pump identification in the future.

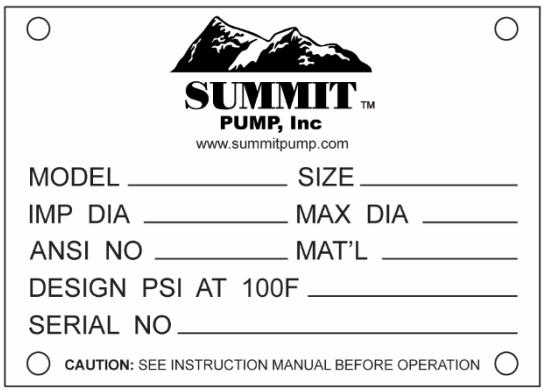


Figure 4-1 shows the pump nameplate for the 2996, 2196, 2196LF, 2196R, 2796, 2175 and Clark product lines. This will be applied to the completed pump and should be permanently fastened for the life of the pump.

Removal of this tag is highly discouraged. The manufacturer and distributor use this information to trace the origins of the pump and to help with troubleshooting.

Figure 4-1: ANSI nameplate (pump tag)

4.2 Model & Size

Summit 2996 pumps are primarily defined by the pump model and size. The size is made up of three identifiers, "*Discharge port size" x "Suction port size" – "Approximate maximum impeller diameter"*

Example: 2996 1.5x3-8

In this example, the pump is a 2996 with a 1.5 inch discharge and a 3 inch suction. The approximate maximum impeller diameter is 8 inches.

4.3 Imp Dia

This field identifies the exact trim diameter of the impeller as it was sent from the manufacturer.

4.4 Max Dia

This is the maximum diameter of the impeller for this pump. This information is also found as the largest trim size on the catalog pump performance curve for the pump.

4.5 ANSI NO

Model 2996 has pump sizes that conform to ASME B73.2 standard. Pump sizes that comply with this standard will have the *Dimension Designation* as defined in ASME B73.2 printed in this field. If the field is left blank the pump is not defined by this standard.

4.6 MAT'L

Material code of the wetted materials. The code is related to Table 5 in ASME B76.2-2016. Common material codes are: DI, DI/SS, SS, CD4, A20.

4.7 Design PSI at 100°F

This value is based on the combination of casing material, pressure and temperature of water at 100°F to reach the MAWP (Maximum Allowable Working Pressure). Always be sure to know the MAWP based upon the specific application.

4.8 Serial NO

This is the number generated by the Manufacturer for traceability. Make reference to this number when troubleshooting with the distributor or manufacturer.

5 RECEIPT AND STORAGE

5.1 RECEIVING THE PUMP

Immediately upon arrival, carefully inspect the pump for evidence of damage during transit. Immediately report any damage to your local Summit Pump, Inc. Distributor or the transportation company as soon as possible.

5.2 STORING THE PUMP

5.2.1 Temporary

Temporary storage: less than six months.

1. Flush the pump with clean water. If pumped product is water reactive, remove the suction and discharge line after draining the pump, and with compressed air blow all liquid from cavity. Lightly cover all internal metal parts with oil and replace the suction and discharge lines if needed.
2. Store pump in a clean, dry place, free from extreme swings in temperature and humidity.
3. Cover with a protective covering to reduce dust contamination.
4. Rotate the shaft once a week to protect the bearings from brinelling the raceway and/or balls.

5.2.2 Long Term

Long Term Storage: more than six months.

1. Follow temporary storage guidelines 1-4 in section 5.2.1.
2. Coat all unpainted and machined surfaces with a rust inhibitor, such as LPS-3.
3. Refer to Summit Pump's document SP-ENG-030 Long Term Pump Storage for more information.

5.3 HANDLING

Use proper equipment when handling or moving the pump assembly or parts.

⚠ WARNING

Pump and assemblies are heavy, improper handling could result in serious injury.

5.4 LIFTING

Proper slings will be used for lifting of the pump unit and parts. The slings should be placed so lift is equally supported at four or more points.

⚠ WARNING

Be sure all components are securely fastened to motor support before lifting.

When lifting the assembled 2996 use extreme care. Lifting straps and equipment must support the entire assembly accounting for movement of load. Use large opening in motor support to lift pump assembly, common lifts points are shown below.

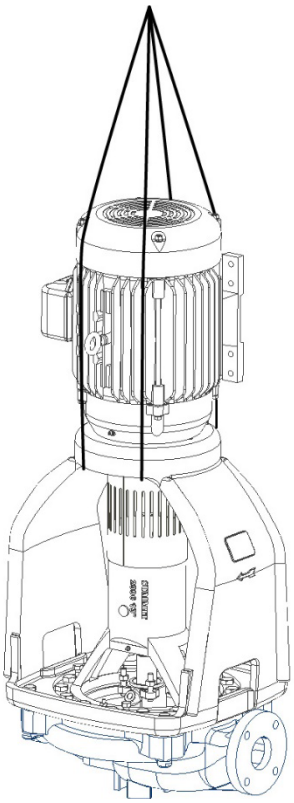


Figure 5-2: Vertical lift with motor

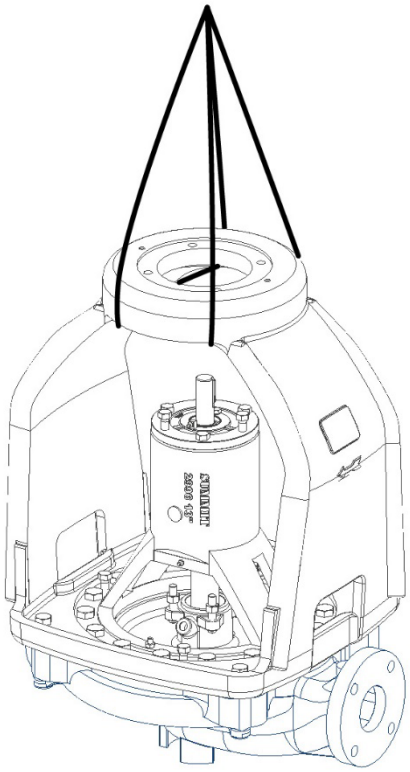


Figure 5-1: Vertical lift no motor

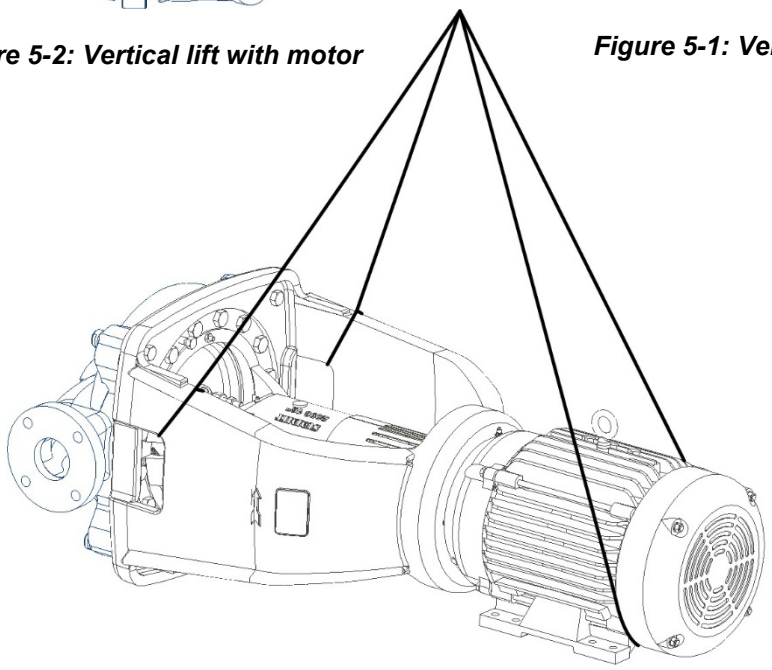


Figure 5-3: Horizontal Lift

6 INSTALLATION

6.1 GENERAL

Summit Pumps are assembled at the factory, the pumps are ready to be installed. Make sure seals have been set and all auxiliary piping is attached if applicable. Set impeller clearance and follow all instruction tags on the pump. Ensure all fluid properties and application requirements have been considered and relayed to manufacturer and/or distributor. Suction piping should be as short and direct as possible.

6.2 LOCATION

If the pump is going to have a water flush, it should be located as close as possible to the supply of water. Suction and discharge lines should follow standards provided in ANSI/HI 9.6.6 Rotodynamic Pump for Pump Piping and ANSI/HI 9.8 Pump Intake Design. Location considerations are easy access for inspection, maintenance and ample overhead space for lifting with crane or hoist. Pump should be located as close as possible to fluid source.

6.3 PUMP SUPPORT

2996 will be supported by the piping. Piping support must be located close to the pump and designed to support the weight of the piping, pump and motor assembly. Supports under the pump are not required but recommended. Installation design must be reviewed for pump supports.

Use a foundation that is sufficient to support all points of the pump and motor assembly as well as the piping and piping supports.

6.4 PIPING

Piping, suction and discharge, should follow ANSI/HI 9.6.6 Rotodynamic Pump for Pump Piping and ANSI/HI 9.8 Pump Intake Design. Ensure piping is aligned as to eliminate moments and forces generated when connected to pump. Arrange piping to allow for pump flushing before pump unit is removed, especially when product is hazardous.

⚠ DANGER

Lock out driver power before beginning to work on pump.

⚠ CAUTION

Never operate pump with suction valve closed

⚠ CAUTION

Never use force to align piping to the pump flanges

6.4.1 Suction Piping

Use suction pipe that is the same size or one size larger than the flange. If needed use an eccentric reducer to meet the suction pipe with the pump. Mount the reducer flat side up. Use non-obstructed straight pipe, as a guideline, for minimum of 5 pipe diameters (10 diameters recommended) from the pump suction flange.

6.4.2 Discharge Piping

The discharge piping should include isolation and check valves. The check valve prevents the pump from rotating backward. Place the check valve between the pump and isolation valve. The isolation valve is used for priming, starting, and shutting down the system. If you use pipe diameter increasers, place them between the pump and the check valve.

6.4.3 Piping Inspection

Rotate the pump shaft after all piping and auxiliary piping is installed and attached to the pump. Listen for rubbing and feel for any indication of binding. This is a very robust check, remove piping and ensure alignment of piping if rubbing or binding occurs. If no obvious rubbing or binding is present, shaft alignment should be checked at this point.

6.5 SHAFT ALIGNMENT

Alignment of the pump shaft (122) to the motor shaft is normally acceptable using the machine fits of the pump build and C-face fit of the motor and motor support (240). It is possible to build a 2996 with a standard 2196 power end (grease lubed) of which standard shaft alignment practices must take place as the 2196 is not machined to fit into the motor support.

If a shaft alignment of 0.002” T.I.R or less is required by the end user follow the procedure to fine tune the shaft alignment. This procedure uses the casing bolts and a range of +/-10% of the recommended torque setting to adjust the alignment of the pump shaft.

6.5.1 Fine Tune Shaft Alignment

1. Ensure all machined surfaces are free from debris and damage. Even the smallest particle of dirt will affect the alignment.
2. Reset the pump components and motor my loosening the motor, motor support (240) and casing (100). Loosen the bolts just enough to allow some movement with the components.
3. Increase the impeller clearance by using the jack bolts (370D) on the bearing housing (134). A quarter turn is all that is needed to provide the extra space between the impeller (101) and casing (100) to avoid any contact issues during alignment.
4. Tighten and torque down motor bolts (370U) in a four-point star pattern. Use Table 13-2 on page 37 for recommended torque values.
5. Tighten and torque down motor support bolts (372J) to 90% of their recommended torque value.

6. Tighten casing bolts (370) in a star pattern to 60% of their recommended torque value. Go around the star pattern again and torque to 90% of the recommended torque value. Recommended casing bolt torque values can be found in Table 13-1 on page 37.
7. Connect a dial indicator to the coupling end of the pump shaft (122) as shown in Figure 6-1. Mark the pump shaft (122) in one location to indicate the position to take measurements.
8. Rotate the motor and pump shaft together taking dial indicator measurements every 90 degrees for a total of four measurements.

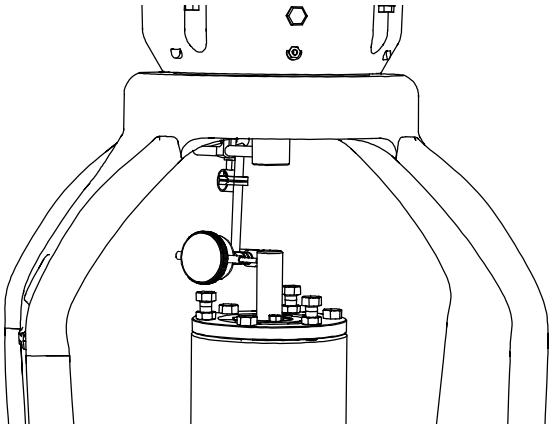


Figure 6-1: Fine Tune shaft alignment

9. Increase torque on casing bolts (370) incrementally to adjust the alignment of the pump shaft with the motor shaft. Do not exceed 110% of the recommended torque value. After each series of casing bolt (370) adjustments repeat step 5 and 8 until desired shaft alignment is reached.
10. Reset the impeller clearance to the stated clearance in Table 7-3 on page 11.

6.6 SEALING

6.6.1 Packed Box

NOTICE
Packing must be lubricated. See ANSI/ASME B73.2 M-2016

Braided packing is optional on all pumps. Install gland bolt nuts (355) finger-tight only. Adjust the gland bolt nuts (355) during operation to achieve 40-65 drops of leakage per minute. No not run packing dry. Specific packing type is dependent on pH, temperature, etc. of the liquid being pumped. If process fluid is dirty, a clean liquid flush to the lantern ring (105) must be supplied to keep packing (106) clean and lubricated.

Pumps are shipped with packing consisting of a total of 5 rings of packing (106) and one lantern ring (105). Packing (106) is installed with ring ends 90 degrees apart starting with three packing rings, followed by the lantern ring and two more packing rings moving inboard to outboard.

Table 6-1: Packing Sizes

	Pump Model				
	STO	MTO	LTO	XLO	XLO-17
Lantern Ring Width	7/16”	5/8”	5/8”	5/8”	5/8”
Packing Size	5/16"	3/8"	3/8"	7/16"	7/16"
Number of Rings	5				

6.6.2 Cartridge Mechanical Seal

⚠ WARNING

Failure of the mechanical seal could result in serious injury and environmental damage.

⚠ DANGER

Lock out driver power and make sure seal is depressurized before beginning work

Unless specified otherwise, pumps are shipped with mechanical seals installed in the pump. They will NOT be set and will have clips still installed to separate the seal faces during shipment. The seal must have clips removed and the seal must be set before operation.

Refer to the manufacturer's installation, operating, and maintenance instructions. Failure to do so can result in environmental damage, personal injury, and seal malfunction and/or seal failure. As a guideline, Figure 6-3, Figure 6-2 and Figure 6-4 show inspections that should be done prior to installing the seal.

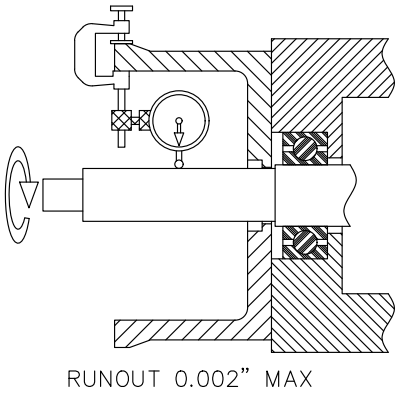


Figure 6-3: Measuring Runout

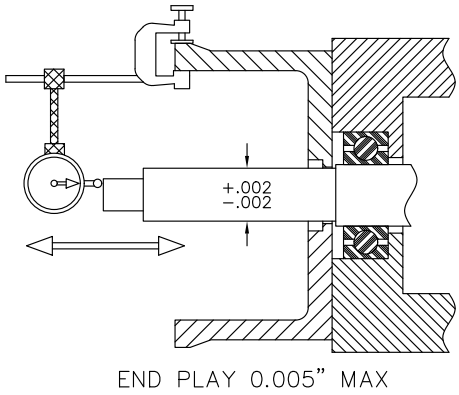


Figure 6-2: Measuring End Play

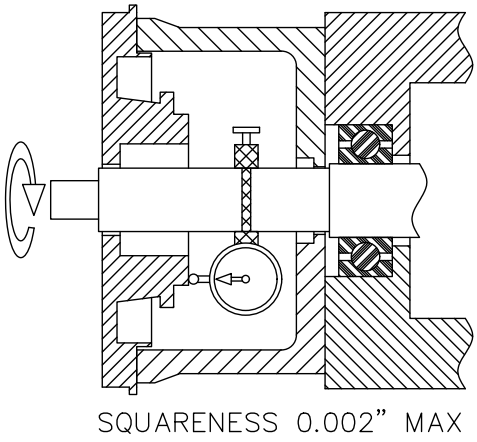


Figure 6-4: Measuring SB Squareness

Mechanical seals must not run dry or operate in dirty liquids. Connect flush, quench, barrier/buffer or cooling fluids as required.

6.6.3 Type 1 Mechanical Seal

Pumps are shipped with type 1 mechanical seals installed in the pump. Type 1 seals are set and ready for operation.

Installing a type 1 mechanical seal requires a reference dimension from the seal manufacture. This reference dimension is usually from the shoulder of the sleeve or solid shaft to the nearest face of the set collar of the seal.

To install the seal, follow the general guidelines below for the 2996 pump alongside the seal manufacturer's instructions which will have the reference dimensions needed to locate the set collar.

1. Check the runout, end paly and stuffing box squareness as shown in Figure 6-3, Figure 6-2 and Figure 6-4.
2. Take the seal out of the packaging and check for damage of the seal and seal faces.
3. Install stationary seal face into the seal gland. Make sure the highly polished seal face is faced outward. Lubricate the stationary O-ring with the recommended lubricant. When pressing into the gland, take care as not to cut the O-ring and ensure stationary face is set square in gland.
4. If not already, remove the stuffing box from the bearing frame. Slide the gland and stationary face over the IB end of the shaft.
5. Lubricate the bellows of the seal with recommended lubricant and carefully slide the rotating seal face and member over the IB end of the shaft. Install the spring over the rotating element of the seal.
6. Position the set collar in the position determined by the reference dimension provided by the seal manufacturer. Tighten the set screws in the set collar to secure the set collar to the shaft or shaft sleeve.
7. Slide the spring and rotating element back to the set collar. Ensure everything is in alignment and spring is set in parallel with the shaft.
8. Install the stuffing box onto the bearing frame. Bring the gland, gland gasket and stationary seal face to the box cover and torque the mechanical seal nuts to the proper torque per the seal manufacturer.
9. Rotate the shaft by hand and listen for any rubbing. If no rubbing the seal is ready for operation.

7 OPERATION

7.1 CHECKING ROTATION

The pump can only operate clockwise rotation when viewed from the motor. If the pump has been accidentally operated in a counter-clockwise rotation remove the pump from the casing and ensure damage has not occurred. (As a general note, the pump will produce about half the expected head at an unknown flow if the pump is rotating counter-clockwise.)

⚠ DANGER

Lock out power to avoid personal injury or death.

1. Lockout power to drive.
2. Remove the pump from the motor.
3. Unlock power to motor.
4. Clear personnel from immediate area, jog motor just enough to determine direction of rotation.
5. If the motor is rotating in the wrong direction the electrical wiring will need to be adjusted by qualified personnel. Then repeat Step 4 and 5.
6. Once rotation is in the desired direction, lockout motor and reattach pump to motor.
7. Check clearances connect piping to pump and check alignments.
8. Unlock motor.

7.2 FIRST RUN CHECK

Several items need to be checked before you put your pump into service. Each of the following items needs to be addressed to make certain that your equipment is correctly installed.

1. Ensure all plugs, seals or packing is installed correctly.
2. Impeller clearance is set for the application. Refer to Section 7.4 on page 18
3. Proper alignment of pump.
4. All electrical connections.
5. All instruments and gauges should be in working order.
6. Correct pump rotation is checked.
7. Open the suction valve and crack open the discharge valve slightly. There must be some resistance when starting and evacuate any air in the line.

⚠ WARNING

Do not run pump below minimum flow or closed suction. Explosive hazard due to vaporization.

⚠ CAUTION

Avoid operating against closed valves or wide-open discharge valve. This can damage driving components and cause injury.

NOTICE

Do not operate pump dry. Dry operation can cause premature damage to pump internals.

7.2.1 Start Up

1. Crack open the discharge valve to allow flow, yet still give the pump resistance.
2. Before operating the pump, it must be filled with liquid. If in a flooded suction, opening the suction valve will fill the pump piping. The pump can also be primed by removing the discharge piping and filling the pump with the pumped liquid or water. (Only use water if it will not contaminate the pumping liquid.).
3. Ensure the motor rotation is clockwise when viewed from the top of the motor looking towards the pump.
4. Ensure all plugs, gauges, seals are installed and any seal clips are removed.
5. Start the pump.

⚠ CAUTION

Immediately monitor flow and pressure gauges. STOP pump if not primed.

7.2.2 Shut Down

1. If possible, flush the pump with clean water. (Only use water if it will not contaminate the pumping liquid.)
2. Slowly close the discharge valve to minimum flow of the pump.
3. Shut down the motor.
4. Close both the discharge and suction valves after pump as come to a complete stop.
5. Lockout power to the motor.

7.3 Lubrication

NOTICE

Grease lubricated pumps are packed with Mobil Grease XHP222 at the factory

NOTICE

Grease lubricated pumps are intended to use grease only. Do not add oil to the bearing housing

⚠ CAUTION

Oil lubricated pumps are shipped with NO oil in the bearing frame.

There are two types of lubrication for the 2996, grease lubrication (standard) or oil mist lubrication (optional). Grease lubricated pumps are greased lubricated at the factory whereas oil mist lubrication pumps do not get shipped with oil. Regrease intervals are needed to keep pump in operation.

7.3.1 Grease

Acceptable greases are petroleum base or synthetic meeting NLGL grade 2. Grease is only recommended when bearing temperature is between -5°F and 230°F. Temperature range of the process fluid is -60°F to 350°F, grease is not recommended outside of this range. Bearing temperature is generally 20°F higher than bearing housing surface temperature.

Table 7-1: Acceptable Greases

Acceptable Greases:	NLGI Grade 2
Citgo	Mystic EP2
Keystone	81EP2
Mobil	Mobil Grease XHP222
Mobil Synthetic	SCH 100
Exxon	Unirex N2
Sunoco	Multipurpose EP
SKF	LGMT 2

7.3.1.1 Lubrication Frequency

Lubrication frequency depends on environment and service factors. Each operator of the pump is responsible for determining these factors as it is impractical to identify all operating situations. Table 7-2 below is a general recommendation of lubrication frequency.

Table 7-2: Lubrication Frequency

Operation Conditions	Lubrication Frequency
Little operation. About 10 hours per week. Air is free of dust and chemicals	1 Year
8 hour operation per 5 day week. Air is free of dust and harmful chemicals	6 Months
Intense operation. 24 hour service with limited dust and/or chemicals. Outdoor operation	1 Month

7.3.1.2 Lubrication Amount

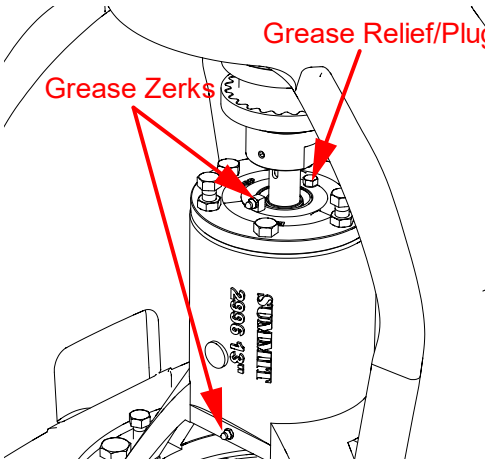


Figure 7-1: Grease Fittings

STO and MTO 2996 grease lubricated pumps have a grease relief fitting (113) for both inboard and outboard bearings.

Before adding grease, clean the grease zerk (193, 193A) fittings from all dust and debris, If this is not done, contaminates will be injected strait into the bearing. Add the acceptable grease type through the grease zerk (193, 193A) until grease emerges from the respected relief fitting (113). *Note: there is a grease relief/plug for each bearing.*

If the relief fitting (113) is a plug, remove the plug before adding grease. Replace plug (113) after grease emerges from the plug hole due to adding grease.

7.3.1.3 Bearing Shields

Greaseable bearings are shielded on one side to contain grease. These bearings shall be installed with shields towards the center of the shaft (122). Sheild will be away from impeller (101) for the IB bearing (168) and towards impeller for OB bearing (112).

⚠ CAUTION

DO NOT add grease to greased for life bearings.

NOTICE

After regrease bearing temperature will run higher until excess grease is purged from bearing.

7.3.2 Oil Mist

Oil mist lubrication is an option for the 2996 pump model. Ensure to follow oil mist system manufacturer's instructions for operation and installation. Monitor bearing temperature as overheating will reduce bearing life.

Oil mist lubrication must be used where environment or process does not allow for grease lubrication. For example, if bearing temperature is greater than 230°F oil mist system must be used.

Connect all oil mist auxiliary lines to inlet, vent and drain. See Figure 7-2 for these locations. Use acceptable oils as stated with oil mist system manufacturer.

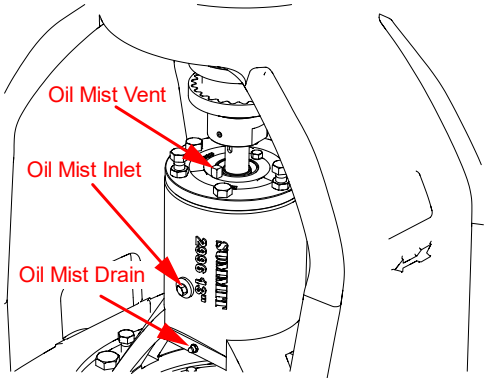


Figure 7-2: Oil Mist Auxiliary Ports

Table 7-3: 2996 Impeller Clearances

Liquid Temperature (°F)	STO (inches)	MTO (inches)
-20 to 200	0.005	0.008
201 to 250	0.006	0.009
251 to 300	0.007	0.010
301 to 350	0.009	0.012
351 to 400	0.010	0.013
401 to 450	0.011	0.014
451 to 500	0.012	0.015

7.4 Impeller Clearance

Setting the impeller clearance must be set before operation of pump. The impeller clearance directly affects the efficiency of the pump which are set referencing the front of the impeller and casing.

Recommended impeller clearances are shown in Table 7-3. It is not recommended to go more than 0.005 inches higher than these values or significant performance loss will occur.

NOTICE
Check impeller clearance before pump operation.

7.4.1 Dial Gauge Method

1. Ensure motor is locked out and pump is isolated from the piping (i.e. suction and discharge valves are closed). Remove the coupling guard and coupling.
2. If mechanically sealed with cartridge seal, the seal clips must be in place.
3. Loosen jam nuts (423) and loosen bolts (370D) a few turns.
4. Tighten bolts (370C) evenly drawing the bearing housing (134) towards the bearing frame (228). After each turn of the bolts (370C), spin the shaft (122) by hand until the impeller (101) has a slight but noticeable drag against the casing (100).

5. Set the dial indicator against the end of the shaft to measure axial movement. Reference the dial to zero.
6. Loosen the bolts (370C) about one turn. Thread the jack bolts (370D) into the bearing housing (134) until all three bolts lightly and evenly touch the bearing frame (228).
7. Evenly tighten bolts (370C) one-sixth of a turn at a time until the desired impeller clearance is shown on the dial indicator.
8. Evenly tighten jack bolts (370D) keeping reading on dial indicator at desired impeller clearance setting. Tighten down jack nuts (423) and check dial indicator reading.
9. Ensure shaft rotates freely without rubbing. Replace coupling and coupling guard.

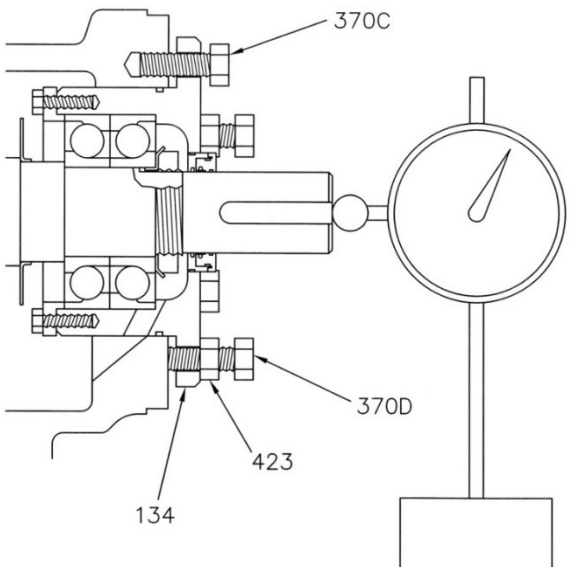
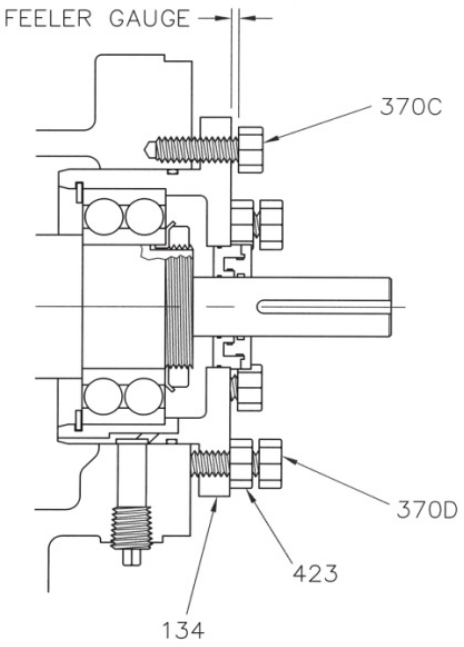


Figure 7-3: Dial Indicator Position

7.4.2 Feeler Gauge Method



1. Ensure motor is locked out and pump is isolated from the piping (i.e. suction and discharge valves are closed). Remove the coupling guard and coupling.
2. Loosen jam nuts (423) and loosen bolts (370D) a few turns.
3. Tighten bolts (370C) evenly drawing the bearing housing (134) towards the bearing frame (228). After each turn of the bolts (370C), spin the shaft (122) by hand until the impeller (101) has a slight but noticeable drag against the casing (100).
4. Using a feeler gauge, set the gap between the 3 bolts (370C) and the bearing housing (134). The thickness of the feeler gauge should be the value in Table 7-3
5. Evenly tighten the jack bolts (370D) until the bearing housing (134) contacts the bolt (370C).
6. Tighten the jack nuts (423) evenly. Rotate the shaft to make sure the assembly turns freely. Replace coupling and coupling guard.

8 MAINTENANCE TIMETABLE

Routine maintenance will increase the life of the pump and induce fewer repairs. The below are suggestions for routine maintenance. Actual routine maintenance schedules should be determined by the end user based upon environmental, service and operation conditions.

8.1 DAILY MAINTENANCE

1. Check the lip seals (332A, 333A), casing gasket (351), the seal area of the pump and piping for damage or leakage.
2. Verify expected flow, head and power consumption are achieved.
3. Check noise levels, fluid and bearing frame (19) temperatures.
4. Monitor vibrations and noise levels

8.2 SIX MONTH MAINTENANCE

1. Daily maintenance and the following.
2. Based upon lubrication schedule and service intensity lubricate bearings.
3. Inspect and/or clean suction and discharge spools for debris and wear.
4. Check pump/piping supports. Tighten if needed, report and resolve issue.
5. Check and lubricate packing if pump has not been in service. Rotate shaft by hand to defer false brinelling of the bearings.

8.3 YEARLY MAINTENANCE

1. All the above and the following:
2. Check and compare pump performance with published performance curve and previous data recordings of the pump. These inspections can range from once a year, to once every three to five years.

9 TROUBLESHOOTING

9.1 PUMP PROBLEMS

Pump turns, no flow.	1, 2, 3, 4, 5, 8, 10, 11, 12, 13, 14, 16, 23, 28
Pump flow rate below expected capacity.	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 16, 17, 18, 22, 23, 26, 28, 32, 34, 35
Pump will not produce rated pressure.	1, 2, 3, 4, 5, 7, 8, 9, 10, 11, 13, 14, 15, 16, 17, 18, 22, 23, 26, 28, 31, 32, 34, 35
Pump develops too much pressure.	6, 8, 9, 12, 28, 31, 35
Stuffing box is leaking excessively	2, 7, 9, 18, 20, 21, 23, 24, 25, 26, 30, 33
Motor overloads or excessive amperage	5, 6, 7, 18, 19, 20, 21, 23, 25, 27, 29, 30, 31, 33, 35
Pump is very noisy/excessive vibration.	1, 2, 3, 4, 5, 6, 7, 10, 11, 13, 14, 15, 16, 17, 18, 19, 20, 21, 23, 25, 26, 29, 32, 34
Pump runs hot.	2, 4, 6, 11, 14, 15, 16, 18, 19, 20, 21, 23, 25, 26, 29, 30, 31, 33, 34
Pump seals have short life.	1, 2, 3, 4, 6, 7, 9, 10, 11, 13, 14, 16, 18, 19, 20, 21, 23, 24, 25, 26, 30, 31, 33
Excessive internal wear.	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 23, 24, 25, 26, 29, 30, 31, 32, 33, 34
Pump does not reach maximum flow on curve	1, 2, 3, 4, 5, 6, 8, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 22, 23, 27, 28, 32, 34, 35
Pump shut off head does not match curve	2, 3, 5, 6, 7, 9, 10, 14, 15, 18, 19, 23, 25, 26, 27, 28, 35

9.2 PROBABLE CAUSE AND REMEDY.

NPSHA not sufficient.	1
Pump has run dry.	2
Air leaking into the pump.	3
Liquid temperature higher than stated.	4
Viscosity is higher than expected.	5
Pump running too fast for application.	6
Abrasives in liquid.	7
Losses in system are greater than calculated	8
Suction or differential pressure too high.	9
Suction valve not open.	10
Suction valve partially open.	11
Discharge valve not open or partially open.	12
Clogged strainer.	13
Supply vessel empty.	14
Pump rotation wrong.	15
Minimum submergence not met	16
Velocity in suction pipe too high	17
Internal parts are worn	18
Internal part rubbing	19
Improper seal installed.	20
Inadequate lubrication.	21
Velocity in suction is too low for solids	22
Suction lift is too great and/or pump is not primed	23
Material compatibility.	24
Drive misalignment	25
Pump/pipe supports loose	26
Drive not sized for horsepower required.	27
Gauges are not located correctly	28
Low or insufficient bearing lubricant	29
Stuffing box gland is too tight	30
Liquid SG is heavier than specified	31
Suction piping does not have straight unobstructed pipe before pump	32
Stuffing Box is packed incorrectly	33
Entrance velocity in suction is too high for submergence	34
Impeller diameter different than expected	35

10 EXPLODED VIEW

Use below figure and table with respect to identifying item numbers in this IOM manual.

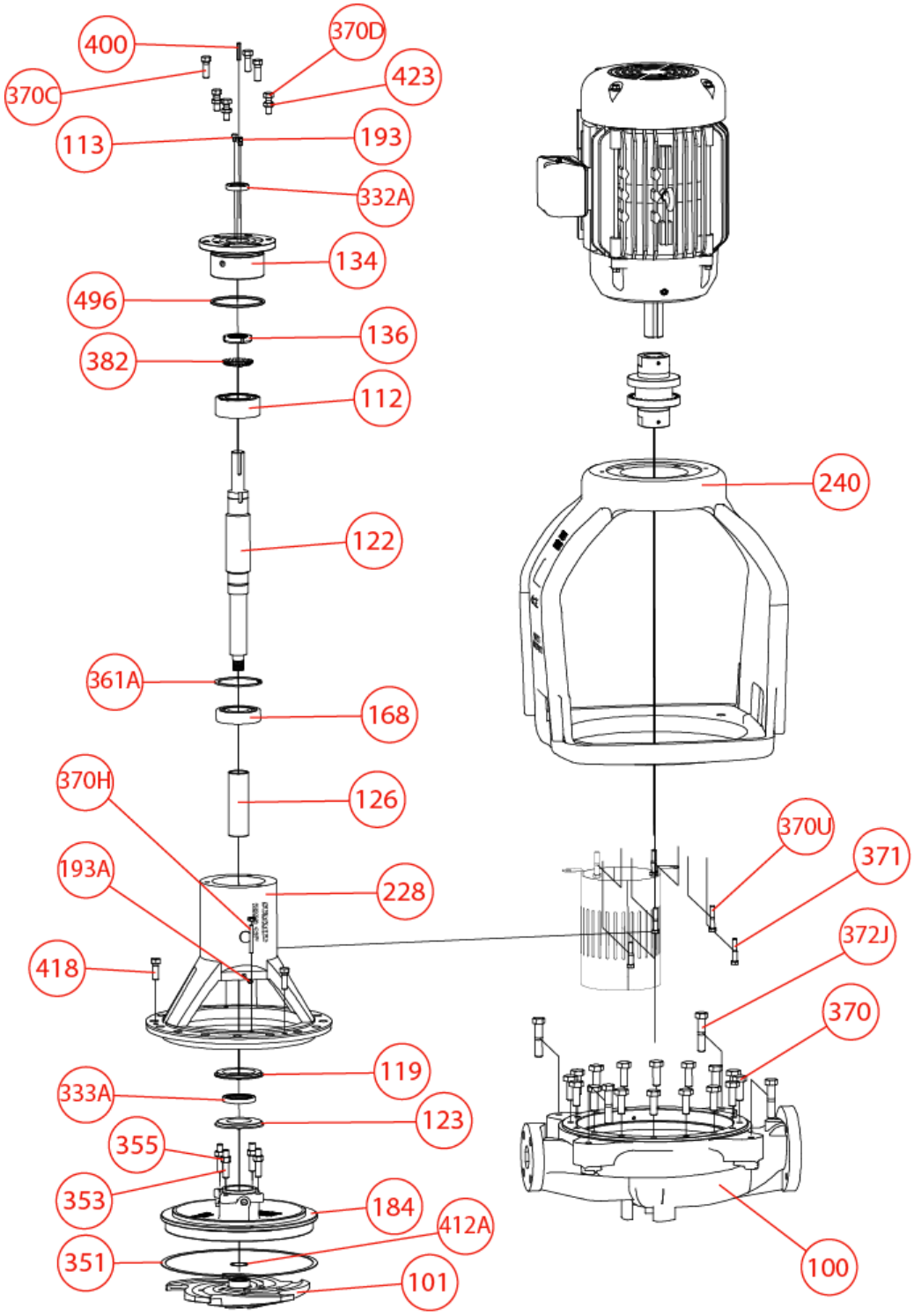


Figure 10-1: 2996 Exploded View

Table 10-1: 2996 Itemized Parts

MODEL 2996 IN-LINE PROCESS PUMP			
ITEM	**DESCRIPTION**	**ITEM**	**DESCRIPTION**
100	CASING	333A	LIP SEAL IB
101	IMPELLER	351	CASING GASKET
105	*LANTERN RING	353	STUD, GLAND
106	*PACKING	355	HEX NUT, GLAND
112	BEARING OB	360Q	*GASKET, MECH SEAL
113	GREASE VENT	361A	RETAINING RING
119	END COVER BEARING	370	HEX SCREW, CASING
122	SHAFT	370C	HEX SCREW, BEARING HOUSING
123	DEFLECTOR	370D	HEX BOLT, BEARING HOUSING JACK
126	SLEEVE	370H	STUD/NUT, SB TO BRG FRAME
134	BEARING HOUSING	370U	HEX SCREW, SUPPORT TO MOTOR
136	BEARING LOCKNUT	371	HEX SCREW, MOTOR JACK
168	BEARING IB	372J	HEX SCREW, SUPPORT TO CASING
184	STUFFING BOX	382	BEARING LOCKWASHER
193	GREASE FITTING	383	*MECH SEAL
193A	GREASE FITTING	400	KEY, COUPLING
210	*GLAND, PACKING	412A	O-RING, IMPELLER
228	BEARING FRAME	423	HEX NUT, 370D
240	MOTOR SUPPORT	418	HEX SCREW, CASING JACK
250	*MECH SEAL GLAND	496	O-RING, BRG HOUSING
332A	LIP SEAL OB		

* NOT DEPICTED

Table 10-2: Recommended Spare Parts

MODEL 2996 RECOMMENDED SPARE PARTS	
ITEM	**DESCRIPTION**
106	PACKING
112	BEARING OB
122	SHAFT
126	SLEEVE
136	BEARING LOCKNUT
168	BEARING IB
210	GLAND, PACKING
250	MECH SEAL GLAND
351	CASING GASKET
360Q	GASKET, MECH SEAL
382	BEARING LOCKWASHER
383	MECH SEAL
496	O-RING, BRG HOUSING

11 DISASSEMBLY MODEL 2996

This section will cover sizes: STO and MTO. It must be noted that although there are slight differences within these sizes, the disassembly and assembly procedures follow the same progression. Use the following steps as a general guideline, as it is impractical to cover every situation.

When item numbers are called out in this manual, they will be in parentheses following the description of the part. Example: Casing (100).

If making a service repair or a quick teardown be sure to have new gaskets and commonly worn parts onsite and ready for replacement upon reassembly.

Notes:

- The 2996 is designed to remove the pullout assembly without removal of the motor or casing (100) from the in-line installment.
- If a 2196 bearing frame assembly is used in the 2996 pump, steps concerning the frame adaptor and shaft alignment will be slightly different. Follow the 2196 manual assembly and disassembly procedures when handling the frame adaptor and shaft alignment.

⚠ DANGER

Lock out power to avoid personal injury or death when working on pump.

⚠ DANGER

Properly vent any pressure in pump, fittings and connecting lines.

⚠ WARNING

Understand material being pumped. Obtain MSDS information for product. Take all necessary precautions.

⚠ WARNING

Wear eye protection and proper personal protective equipment.

NOTICE

Secure pump before disassembly to avoid damage. Pump's center of gravity changes when removing parts.

11.1 REMOVE PULLOUT ASSEMBLY

1. Disconnect and lockout power to driver. Disconnect the shaft coupling by removing the set screw in the driver side of the coupling. Slide the driver side hub up on the driver shaft and remove the coupling sleeve. Scribe pump shaft (122) at coupling hub for relocating upon assembly.

2. Close the suction and discharge valves. Drain fluid from piping and casing (100).

3. Remove any seal flush lines either from the casing (100) or from external sources.

4. Remove casing bolts (370) from casing (100). Slowly and evenly tighten jacking bolts (418) to lift pullout assembly from the casing (100). Being carful not to damage casing gasket (351) lift pullout assembly from the motor support (240) and casing (100).

⚠ CAUTION

Use proper lifting equipment when removing heavy parts.

11.2 PULLOUT ASSEMBLY

5. Secure pullout assembly in a large clamp or vise to assist with removing the impeller (101). Hold the coupling end of the shaft (122) in place using a coupling wrench to unthread the impeller (101) from the shaft (122). Impeller (101) is right-hand threaded. When removing the impeller (101), take care as not to damage the O-ring (412A) that seals the impeller (101) to the shaft (122) or sleeve (126).

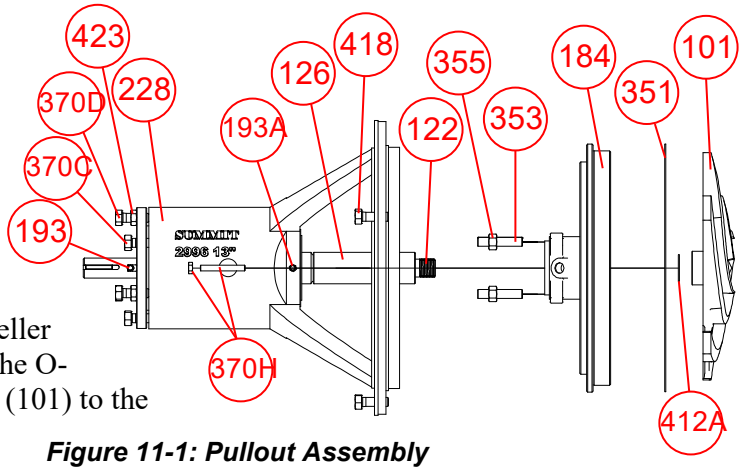


Figure 11-1: Pullout Assembly

6. Inspect the impeller (101) for damage. Replace if needed.

11.2.1 Packed Pumps

a. Loosen and remove the gland nuts (355). Slide the packing gland (210 – not shown) towards the inboard bearing (168).

b. Remove the studs and nuts (370H) for the stuffing box cover (184). The packing (106 – not shown) and stuffing box (184) can be slid off the end of the shaft (122). Take care as not to scratch or dent any sealing areas on the shaft (122), sleeve (126), stuffing box (184) or the threads on the end of the shaft (122).

c. Remove packing (106- not shown) from the stuffing box (184) and slide the packing glad (210 - not shown) and sleeve (126), if present, off the shaft (122).

11.2.2 Cartridge Mechanical Seals

a. Loosen and remove the gland nuts (355). Slide the mechanical seal (383- not shown) towards the inboard bearing (168). Remove the studs and nuts (370H) for the stuffing box cover (184). The stuffing box (184) can be slid off the end of the shaft (122). Take care as not to scratch or dent where any sealing areas on the shaft (122), sleeve (126), stuffing box (184) or the threads on the end of the shaft (122).

b. Slide the mechanical seal (383 - not shown) and sleeve (126), if present, off the shaft (122).

11.2.3 Component Mechanical Seal

a. Loosen and remove the gland nuts (355). Slide the mechanical seal gland (360Q - not shown) towards the inboard bearing (168). Remove the studs and nuts (370H) for the stuffing box cover (184). The stuffing box (184) can be slid off the end of the shaft (122). Take care as not to scratch or dent where any sealing areas on the shaft (122), sleeve (126), stuffing box (184), mechanical seal (383 - not shown) or the threads on the end of the shaft (122).

b. Replacing the mechanical seal (383 - not shown) is recommended. Loosen the set screws on the rotating member. These set screws lock the rotating member to the shaft (122) or sleeve (126). Slide the sleeve (126), mechanical seal (383 - not shown) and mechanical seal gland (360Q- not shown) off the end of the shaft (122).

NOTICE
Push stationary element out by hand. DO NOT use hammer

NOTICE
It is recommended that seals be replaced if removed to ensure best sealing possible.

7. Inspect all sealing items for wear, scratches or damage. It is recommended to replace all sealing parts upon downtime or repair specifically, packing (106 – not shown), component mechanical seals (383 – not shown), sleeve (126) and shaft (122).

8. Slide the deflector (123) off the end of the shaft (122). It may be difficult at first to move the deflector (123), use two flat screwdrivers to initially slide the deflector (123) away from the bearing frame (228). Take extreme care as not to damage the bearing frame (228), lip seal (333A) or bearing end cover (119).

9. Remove the shaft kit assembly from the bearing frame (228). Begin by unthreading bolts (370C) from the bearing frame (228). Loosen the jam nuts (423) and slide the bearing housing (134) using the jacking bolts (370D). Once the O-ring (496) is visible the shaft kit assembly should be able to be removed out by hand.

10. Unclip the snap ring (361A) from the bearing housing (134) and slide the bearing housing (134) off the outboard bearing (112).

11. It is recommended to replace lip seals. Remove lip seal OB (332A) from bearing housing (134). Remove the lip seal IB (333A) from the bearing frame (228). The bearing end cover (11) may come out with removal of lip seal IB (333A). Take care as not to damage machined surfaces. *This step is not necessary if keeping the same seals upon reassembly.*

12. If removing bearings, bend up the locking tab on the lock washer (382) locking it to the locknut (136). Unthread the locknut (136) from the shaft (122).

13. Spin ball bearings and replace if noisy, loose or worn. Do not unwrap new bearings until they are being installed on the shaft. Avoid reusing bearings that have been removed from shaft (122).

14. Using a hydraulic press, support the shaft and bearing assembly from the inner race of the bearing. Setup the hydraulic ram on the end of the shaft (122) and begin to press the shaft (122) though the bearing. Bearings will get pressed off one at a time. Refer to Figure 11-2.

Check the shaft (122) runout supporting the shaft on bearing locations. Check runout where coupling hub is mounted and seal location on shaft (122). Replace if shaft is bent or has scratches in critical areas.

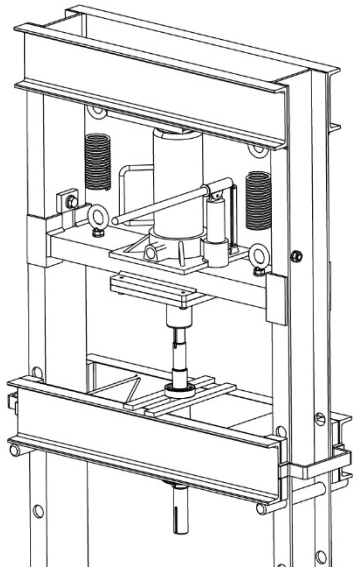


Figure 11-2: Setup for Removing Bearings

⚠ CAUTION

Wear proper EYE and FACE projection when using hydraulic press.

11.3 DRIVE COMPONENTS

1. Remove coupling hub from motor shaft. Remove bolts (370U) which secure motor to motor support (240).

2. Use jacking bolts (371) to break free motor from motor support (240). Remove motor using proper lifting techniques.

3. Loosen and remove bolts (372J) for the motor support (240) and casing (100). Lift the motor support (240) from the casing (100) using proper lifting techniques. Lift evenly as not to damage casing (100) or piping.

11.4 CASING

1. Unbolt the casing (100) from piping and any pump supports that may have been installed. Remove casing (100) from in-line position. Inspect for any damage or wear on all machined surfaces.

12 ASSEMBLY MODEL 2996

This section will cover sizes: STO and MTO. It must be noted that although there are slight differences within these sizes, the disassembly and assembly procedures follow the same progression. Use the following steps as a general guideline, as it is impractical to cover every situation.

When item numbers are called out in this manual, they will be in parentheses following the description of the part. Example: Casing (100).

If making a service repair or a quick teardown be sure to have new gaskets and commonly worn parts onsite and ready for replacement upon reassembly.

Notes:

- The 2996 is designed to remove the pullout assembly without removal of the motor or casing (100) from the in-line installment.
- If a 2196 bearing frame assembly is used in the 2996 pump, steps concerning the frame adaptor and shaft alignment will be slightly different. Follow the 2196 manual assembly and disassembly procedures when handling the frame adaptor and shaft alignment.

⚠ DANGER

Lock out power to avoid personal injury or death.

⚠ DANGER

Mechanically disconnect pump from driving equipment

⚠ WARNING

Wear eye protection and proper personal protective equipment.

NOTICE

Secure pump before assembly to avoid damage. Pump's center of gravity changes when adding parts.

Figure 12-1 shows the assembled 2996 pump. This general layout will be the same for both the STO and MTO pump frame sizes. Use this as reference during assembly.

Assembly of the 2996 pump has multiple ways to assemble the pump. This assembly procedure will first place the casing (100) in-line with process piping, installation of the motor support (240) and motor with the install of the pullout assembly being the final assembly item.

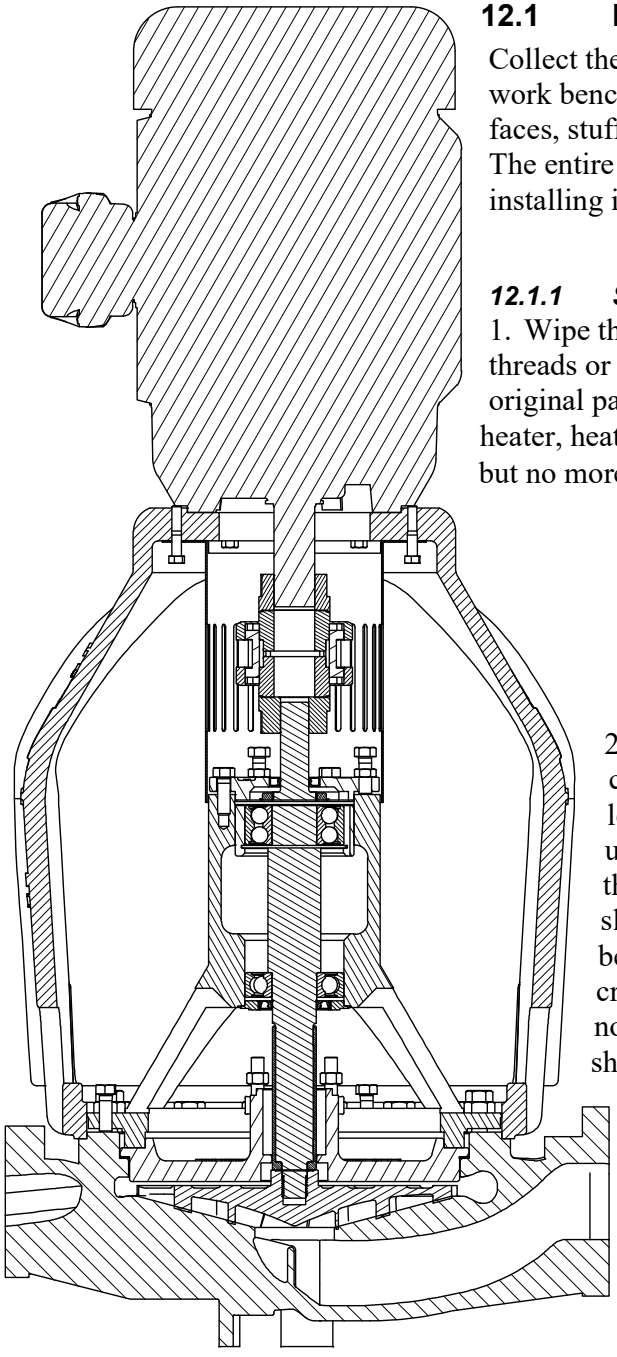


Figure 12-1: Assembled 2996 Cutaway

12.1 PULLOUT ASSEMBLY

Collect the pullout assembly parts together and build on a clean work bench or station. It is critical to keep mechanical seal faces, stuffing box cover (184) and bearings free from debris. The entire pullout assembly should be assembled before installing into the motor support (240) and casing (100).

12.1.1 Shaft Kit Assembly

1. Wipe the shaft (122) clean, ensure there is no debris in the threads or bearing seats. Remove OB bearing (112) from original packaging. Using a demagnetizing induction bearing heater, heat bearing (112) 160°F higher than ambient temperature but no more than 240°F.

⚠ WARNING

Use INSULATED GLOVES when using bearing heater.

2. Align shaft (122) in vertical position with coupling end up. Orient OB bearing (112) with lettering on outer face of the bearing (122) showing upward or towards the end of the shaft (122). Square the bearing (112) over coupling end of shaft (122) and slide the bearing down to the shaft shoulder where bearing (112) rests. Check to see if bearing (112) is set crooked, if so remove quickly and reheat bearing. Do not hit bearing (112) with a hammer to remove from shaft (122). Use a hydraulic press or flip shaft (122) and drop coupling end on a soft piece of wood to let bearing (112) fall off. Take extreme care not to damage coupling end or bearing seat of shaft (122).

3. Let bearing (112) cool-to-touch and install bearing lock washer (382) and bearing locknut (136) onto shaft (122). Torque locknut to value in Table 13-3 on page 38. It is best to clamp the shaft (122) in the area between the bearings (112, 168) on the largest diameter of the shaft (122) when torquing the locknut (136).

NOTICE

NEVER use impact force to install bearings

4. Install inboard bearing (168) using the same method as the outboard bearing (112). Heat bearing (168) 160°F higher than ambient temperature but no more than 240°F. Orient bearing (168) so that the bearing number on the outer diameter is facing towards the end of the shaft (122). Slide bearing (168) over the impeller-end of the shaft (122) until it sets squarely on shaft (122) shoulders for bearing (168).

5. If pump is grease lubricated, bearing housing (134) should have a grease zerk (193) and a vent (113) installed. If grease lubricated and grease zerk (193) and vent (113) are not present, drill and tap the bearing housing (134) before installing any seals, bearings or O-rings. Refer to Figure 7-1 on page 17 for grease fitting locations. Be aware if bearing are greased for life, do not regrease pump.

NOTICE

Refer to drill and tap charts for correct drill and tap sizes.

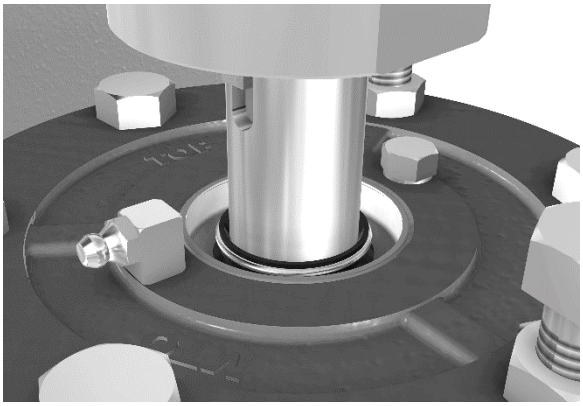


Figure 12-2: Lip Seal Orientation

6. Apply a light coating of bearing grease to O-ring (496). Install new O-ring (496) onto the bearing housing (134). Take care not to damage O-ring (496) on sharp edges.

7. Install lip seal (332A) into bearing housing (134). Lip seal (332A) should have lip facing outwards or the spring should be visible when installed. See Figure 12-2. Apply a light coating of bearing grease on the lip of the lip seal (332A)

8. Apply a thin layer of bearing grease to the outer diameter of bearing (112) and inner diameter of bearing housing (134). Slide bearing housing (134) over the shaft (122) and outboard bearing (112). Take extreme caution with the lip seal (332A) as it is very easy to pop out spring or damage lip seal (332A) when installing the bearing housing (134).

9. Install retaining ring (361A) into groove in bearing housing (134). Doing this locks the position of the bearing housing (134) with OB bearing (112). Retaining ring (361A) will have a flat side and a tapered side, ensure the flat side is face to face with the OB bearing (112) outer diameter.

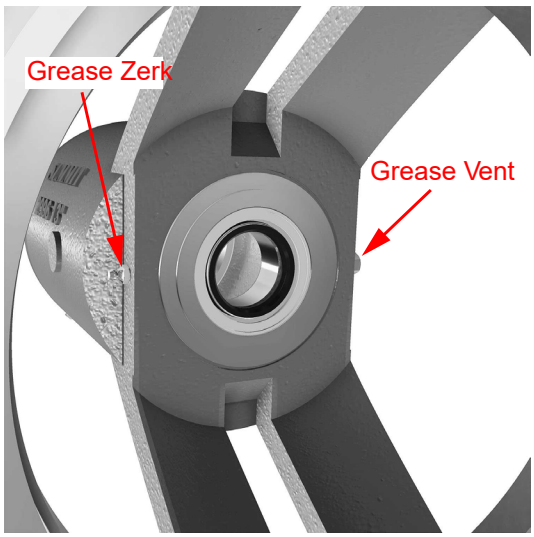


Figure 12-3: IB Lip Seal & Grease Fittings

10. If equipped, install the sleeve (126) over the impeller-end of the shaft (122).

12.1.2 Power End Assembly

11. Grease lubricated pumps should have the grease zerk (193A) and vent (113) installed. If not drill and tap bearing frame (228) for these fittings before installing any seals, bearings or end covers. Be aware if bearing are greased for life, do not regrease pump.

NOTICE
Refer to drill and tap charts for correct drill and tap sizes.

12. Clean bearing frame (228) with a clean rag, remove all debris. Install the bearing end cover (119) into the bearing frame (228) by use of hydraulic press or a soft mallet.

13. Install the inboard lip seal (333A) into the bearing end cover (119). The orientation of the lip should face towards the impeller-side, the spring should be visible once installed. See Figure 12-3. Apply a light coating of bearing grease to the lip of the lip seal (333A).

14. Apply a thin film of bearing grease on the outer diameter of the bearing (168), O-ring (496) and inner diameter of the bearing seats in the bearing frame (228).

15. Install the shaft kit into the bearing frame (228). Take extreme care as not to damage lip seal (333A) or dislodge the spring.

16. Install deflector (123) over the impeller-end of the shaft (122), deflector (123) should be a tight fit with the shaft (122) and should not rest on the sleeve (126). Deflector (123) is tapered on the outer diameter; the larger diameter of the taper should be closest to the impeller (101).

    If sleeve (126) was removed for shaft kit installation, reinstall the sleeve (126) onto the shaft (122).

17. Thread in bolts (370C) (370D). At this point do not tighten the bolts (370C) (370D); leave bolts loose to adjust impeller clearance in later steps.

12.1.3 Installing Seals

NOTICE
ALWAYS refer to seal manufacturer's installation and operations manual

The type of seal being installed will affect the order of installation of the stuffing box (184). If sealing with packing, the stuffing box (184) can be installed first.

If installing a cartridge seal, lubricate seal O-ring with seal manufacturer supplied lubricant and slide onto shaft (122) or sleeve (126). Then install stuffing box (184)

Installing a component seal follow seal manufacturer's instructions and Section 6.6.3 beginning on page 12.

To install the stuffing box (184) slide the box bore over the shaft until the box mates with the bearing frame (228). Algin the holes for the stud/nut (370H), thread in the studs (370H) until tight in stuffing box (184). Thread on nuts (370H) and torque to value corresponding value in Table 13-2 on page 37.

For detailed installation of the pump seal refer to Section 6.6 beginning on page 11.

Tighten gland studs (353) and nuts (355) to recommended torque by seal manufacture. Do not torque studs (353) and nuts (355) for packed pump applications.

12.1.4 Wet-end

18. Ensure shaft (122) shoulder or sleeve (126) shoulder is protruding through the stuffing box (184) such that when impeller (101) is treaded on it will not touch the stuffing box (184). See Figure 12-4 for protrusion reference.
    If shaft should is not protruding, adjust bolts (370C, 370D) until shoulder emerges from stuffing box (184) bore.

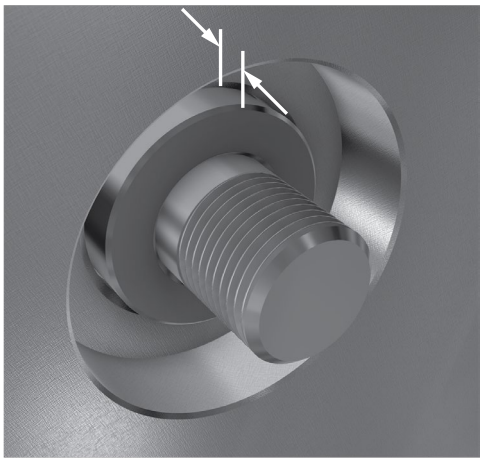


Figure 12-4: Shaft/sleeve protruding for impeller

19. Install impeller O-ring (412A) into impeller (101) groove. Thread the impeller (101) on the shaft (122) until it mates with the shaft (122) or sleeve (126) shoulder.
20. Use an impeller wrench or coupling wrench to tighten the impeller (101) to the shaft (122). Pump rotation is clockwise, as viewed from the driver, which will keep impeller (101) from unthreading while in use.
21. Adjust the clearance between the stuffing box (184) and backside of impeller (101) to approximately 0.020 inches. This will keep the impeller (101) from hitting the casing (100) when installing.
22. Install the casing (100) into process piping. Support casing (100) with a hoist or jack stands while aligning casing (100) to piping. Use piping supports and/or pump baseplate to secure casing (100) when flange bolts are installed and torqued.
23. Install casing gasket (351) into casing (100).

12.1.5 Complete Pump

⚠ CAUTION

Use proper lifting equipment when installing heavy parts.

24. Lower pull-out assembly into casing (100). Ensure groove in stuffing box (184) is aligned with drain hole in casing (100). When lowering ensure casing gasket (351) does not get pinched or damaged by stuffing box (184).

25. Thread in casing bolts (370) until finger tight. Follow shaft alignment procedure in Section 6.5 starting on page 10. If fine tune shaft alignment is not desired torque casing bolts (370) in a proper tightening pattern. Use Table 13-1 on page 37 for torque values.

26. Lower motor support (240) over the power end assembly and onto the casing (100). Use bolts (372J) to secure to casing (100).

27. Lower motor onto motor support (240) and secure using bolts (370U). Follow shaft alignment procedure in Section 6.5 starting on page 10.

28. Set the impeller clearance. Impeller clearance procedure is described in Section 7.4 on page 18. If pump has a cartridge seal installed, set the mechanical seal (383) after the impeller clearance is set. Ensure pump shaft (122) spins freely with no rubbing.

29. Install coupling key (400), coupling, coupling guard, motor jacking bolts (371) and casing jacking bolts (418).

30. Connect motor wiring per motor manufacturer's installation manual. Energize motor and follow start up procedure for pump operation.

⚠ WARNING

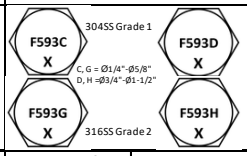
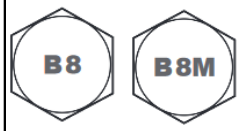
Install all shaft and seal guards before energizing motor

13 APPENDIX E – Reference Tables

13.1 TORQUE GUIDELINES

13.1.1 Casing Bolt (370) Torques

Table 13-1: Casing Bolt Recommended Torque Values

2996 Casing Bolt Torques - Dry										
Flange Rating			**150 LB CASING**				**300 LB CASING OR HIGH TEMPERATURE APPLICATIONS**			
Casing Material			**Ductiile Iron, WCB**		**316SS, CD4MCu, A20**		**Ductile Iron, WCB**		**316SS, CD4MCu, A20**	
Bolt Specification			ASTM A307 Grade B (CARBON) HEAVY HEX HEAD BOLTS		(304SS) F593 Grade 1 OR (316SS) F593 Grade 2		ASTM A193 Grade B7 (CARBON)		ASTM A193 Grade B8/B8M (304SS/316SS) Class 2	
Head Markings										
Pump Size	**Bolt Size**	**Length**	**Torque to ft-lb**	**Fastener PN**	**Torque to ft-lb**	**Fastener PN**	**Torque to ft-lb**	**Fastener PN**	**Torque to ft-lb**	**Fastener PN**
6" STO	**5/8"-11**	**1-1/2"**	59	AI019Z	107	G0309	173	AN309ZP	120	AP3092
8" STO	**1/2"-13**	**1-1/4"**	30	AI008Z	54	G0207	87	AN207Z	60	AP2072
MTO	**5/8"-11**	**1-1/2"**	59	AI019Z	107	G0309	173	AN309ZP	120	AP3092

13.1.2 General Fastener Torque Values

Table 13-2: General Fastener Recommended Torque Values

Fastener Size	**ASTM A307 Grade A (Carbon Steel) or ASTM F593 (304SS or 316SS)**
	Recommended Torque
#10-24	25 inlb
1/4"-20	50 inlb
5/16"-18	70 inlb
3/8"-16	12 ftlb
7/16"-14	18 ftlb
1/2"-13	30 ftlb
5/8"-11	58 ftlb
3/4"-10	94 ftlb
7/8"-9	152 ftlb
1"-8	228 ftlb

Table 13-3: 2996 bearing locknut (136) torques

Bearing Locknut (136) Torques		
Frame Size	**Locknut Size**	**Torque (lbft)**
STO	N-06	19
MTO	N-09	50

13.2 Construction Details

Table 13-4: General Construction Details

2996 Construction Details (All dimensions in inches and (mm)			
		STO	**MTO**
Shaft	Diameter at Impeller	0.75 (19)	1 (25)
	Diameter in Stuffing Box		
	Solid Shaft construction	1.375 (35)	1.75 (45)
	Sleeved Shaft - OD of shaft under sleeve	1.125 (29)	1.5 (38)
	Diameter between Bearings	1.5 (38)	2.125 (54)
	Diameter at Coupling	0.875 (22)	1.125 (29)
	Overhang	6.125 (156)	8.375 (213)
	Maximum Shaft Deflection	0.002 (0.05)	
	Shaft Deflection Index (L^3/D^4)		
	Solid Shaft	64	63
	Sleeved Shaft	143	116
Sleeve	OD at Stuffing Box/Seal Chamber	1.375 (35)	1.75 (45)
Bearings	Radial Bearing (168)	SKF 6207	SKF 6309
	Thrust Bearing (112)	SKF 3306 A/C3	SKF 3309 A/C3
	Bearing Span	4.125 (105)	6.75 (171)
Stuffing Box	Bore	2 (51)	2.5 (64)
	Depth	2.125 (54)	2.625 (67)
	Packing Size	5/16" x 5/16" (8x8)	3/8" x 3/8" (10x10)
	Number of Rings	5	5
	Width of Lantern Ring	7/16" (11)	5/8" (16)
	End of box to Nearest Obstruction	2-3/16" (55)	3 (76)

Table 13-5: Bearing Fits

Bearing Fits & Tolerances All dimensions in inches and (mm)		
According to ABEC I Standards		
	STO	**MTO**
Shaft O. D. Inboard	1.3785 (35.013) 1.3781 (35.002)	1.7722 (45.013) 1.7718 (45.002)
Clearance	0.0010 (0.025) tight 0.0001 (0.002) tight	0.0010 (0.025) tight 0.0001 (0.002) tight
Bearing I. D. Inboard	1.3780 (35.000) 1.3775 (34.988)	1.7717 (45.000) 1.7712 (44.988)
Frame I. D. Inboard	2.8346 (72.000) 2.8353 (72.019)	3.9370 (100.000) 3.9379 (100.022)
Clearance	0.0012 (0.032) loose 0.0000 (0.000) loose	0.0015 (0.037) loose 0.0000 (0.000) loose
Bearing O. D. Inboard	2.8346 (72.000) 2.8341 (71.987)	3.9370 (100.000) 3.9364 (99.985)
Shaft O. D. Outboard	1.1815 (30.011) 1.1812 (30.002)	1.7722 (45.013) 1.7718 (45.002)
Clearance	0.0008 (0.021) tight 0.0001 (0.002) tight	0.0010 (0.025) tight 0.0001 (0.002) tight
Bearing I. D. Outboard	1.1811 (30.000) 1.1807 (29.990)	1.7717 (45.000) 1.7712 (44.988)
Housing I. D. Outboard	2.8346 (72.000) 2.8353 (72.019)	3.9370 (100.000) 3.9379 (100.022)
Clearance	0.0012 (0.032) loose 0.0000 (0.000) loose	0.0015 (0.037) loose 0.0000 (0.000) loose
Bearing O. D. Outboard	2.8346 (72.000) 2.8341 (71.987)	3.9370 (100.000) 3.9364 (99.985)

13.2.1 Tolerances

Table 13-6: Shaft Runout

Shaft Runout Tolerances All dimensions in inches and (mm)	
At Stuffing Box	At Coupling
.002 (.051)	.001 (.026)

Table 13-7: Shaft End Play

Shaft End Play All dimensions in inches and (mm)		
	STO	**MTO**
Double Row	.0011/.0019 (.028/.047)	.0013/.0021 (.033/.054)
Duplex	.0007/.0010 (.018/.026)	.0009/.0012 (.022/.030)

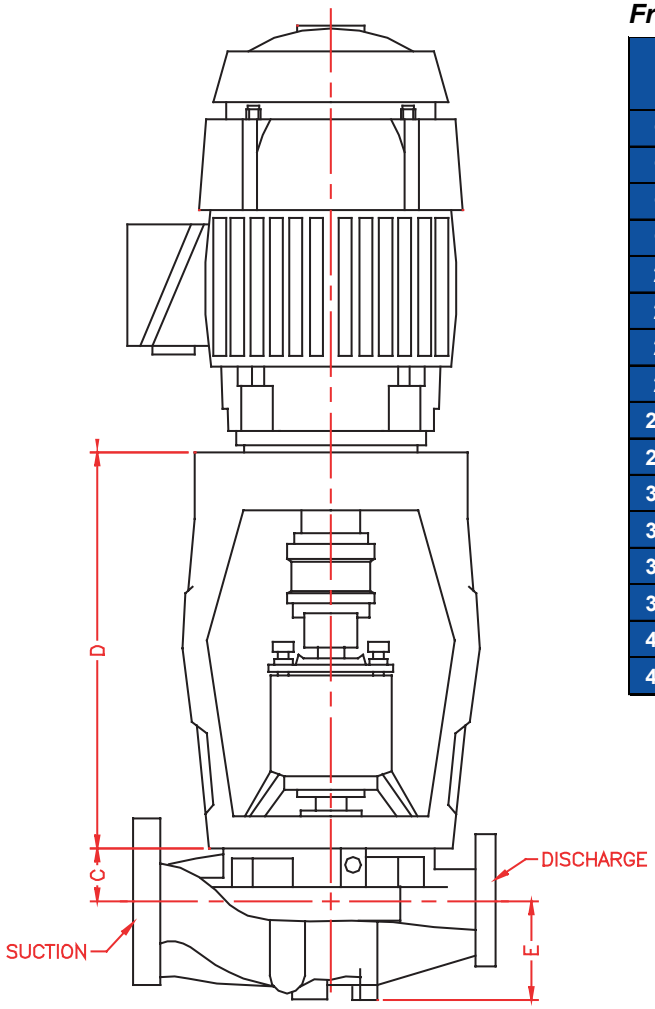
13.2.2 Limits and Capacities

Table 13-8: 2996 Limits and Capacities

2996 Limits and Capacities														
Pump Size		STO					MTO							
		1.5x2-6	1.5x3-6	2x3-6	1.5x2-8	1.5x3-8	1.5x2-10	1.5x3-10	2x3-10	3x4-10	1.5x3-13	2x3-13	3x4-13	4x6-13
ANSI Dimension Designation		2015/15	3015/15	3020/17	2015/17	3015/19	2015/19	3015/19	3020/20	4030/25	3015/24	3020/24	4030/28	6040/30
Power Limit (HP/100RPM)		1.1					3.4							
Maximum Speed	RPM	3600												1800
Minimum Flow - % BEP	at 3500 RPM	15	15	20	20	20	25	30	30	30	30	40	40	N/A
	at 1750 RPM	10	10	10	10	10	10	15	15	15	15	15	40	40
Max Solids Diameter	(in)	0.344	0.538	0.375	0.344	0.438	0.438	0.219	0.375	0.625	0.219	0.375	0.625	1.000
	(mm)	8.7	13.7	9.5	8.7	11.1	11.1	5.6	9.5	15.9	5.6	9.5	15.9	25.4
Casing Thickness Minimum	(in)	0.375					0.500					0.563	0.625	
	(mm)	9.5					12.7					14.3	15.9	
Casing Corrosion Allowance	(in)	0.125												
	(mm)	3.2												
Maximum Allowable Working Pressure (MAWP)	PSIG	See Summit Pump's "Pressure Rating vs Temperature" chart for 150lb and 300lb flanges.												
Test Pressure	PSIG	1.5 x MAWP at 100°F												
Maximum Liquid Temp - Standard Pump		250°F												
Maximum Liquid Temp - Jacket Cooling		350°F												
Maximum Liquid Temp - Jacket Cooling with Oil Mist		500°F												
Impeller Balance Grade		ISO 1940-10 Grade 6.3												
Shaft Rotation (Viewed from Driver)		Clockwise (Right Hand Rotation)												

14 APPENDIX F –DIMENSIONS

14.1 General Pump



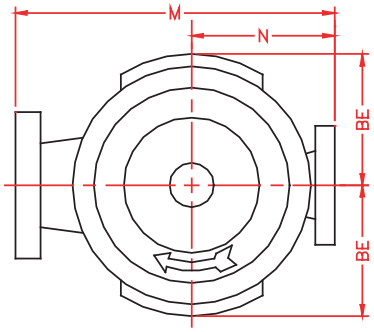


Figure 14-1: General Pump Dimensions

Table 14-1: 2996 Dimensions per Motor Frame

	D			
	STO 6"	STO 8"	MTO 10"	MTO 13"
143TC	17.5	N/A	N/A	
145TC	17.5	N/A	N/A	
182TC	19.25	19.9	25	
184TC	19.25	19.9	25	
213TC	19.25	19.9	25	
215TC	19.25	19.9	25	
254TC	19.25	19.9	25	
256TC	19.25	19.9	25	
284TSC	19.25	19.9	25	
286TSC	19.25	19.9	25	
324TSC	N/A	N/A	27	
326TSC	N/A	N/A	27	
364TSC	N/A	N/A	27	
365TSC	N/A	N/A	27	
404TSC	N/A	N/A	27	
405TSC	N/A	N/A	27	

Table 14-2: 2996 Dimensions

Pump Frame	Pump Size	Discharge (in)	Suction (in)	C inch (MM)	E inch (MM)	M inch (MM)	N inch (MM)	BE inch (MM)	Pump Weight (Less Motor) LBS (KGS)
STO	1.5X2-6	1 1/2	2	2 1/8 (54)	4 1/2 (114)	15 (381)	6 3/4 (171)	6 1/2 (165)	190 (86)
	2X3-6	2	3	2 3/16 (56)	4 7/8 (1118)	17 (432)	7 1/2 (191)	6 1/2 (165)	205 (93)
	1.5X3-8	1 1/2	3	1 11/16 (43)	5 1/4 (133)	19 (483)	8 3/8 (213)	6 5/8 (168))	210 (95)
MTO	1.5X3-10	1 1/2	3	2 3/8 (60)	5 (127)	18 7/8 (479)	9 3/16 (233)	10 (254)	380 (173)
	2X3-10	2	3	2 1/2 (64)	5 1/4 (133)	20 (508)	9 1/2 (241)	10 (254)	390 (177)
	3X4-10	3	4	2 5/8 (67)	6 (152)	25 (635)	11 1/2 (292)	10 (254)	430 (195)
	1.5X3-13	1 1/2	3	2 3/8 (60)	5 5/8 (143)	24 (610)	11 1/2 (292)	10 (254)	460 (209)
	2X3-13	2	3	2 1/2 (64)	5 3/4 (146)	24 (610)	11 1/2 (292)	10 (254)	490 (223)
	3X4-13	3	4	2 5/8 (67)	6 7/8 (175)	28 (711)	13 (330)	10 (254)	520 (236)
	4X6-13	4	6	2 3/4 (70)	8 1/2 (216)	30 (762)	14 (356)	10 (254)	610 (277)

14.2 Stuffing Box

14.2.1 Standard Bore

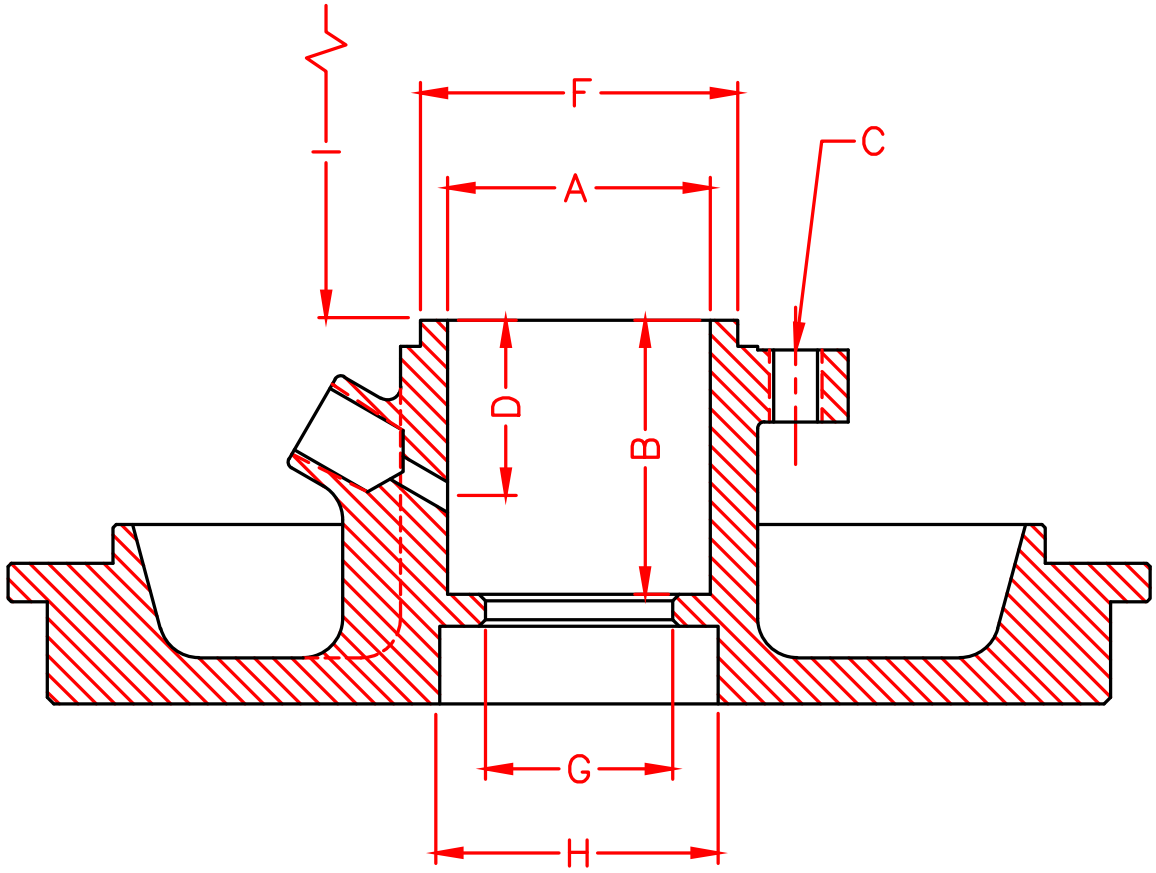


Figure 14-2: Standard Bore Stuffing Box Dimensions

Table 14-3: Standard Bore Stuffing Box Dimensions

STANDARD BORE DIMENSIONS										
PUMP FRAME	A	B	C		D	E	F	G	H	I
			B.C.	TAP						OBSTRUCTION
STO	2.00	2.13	3.25	3/8-16 UNC	0.97	1/4-18 NPT	2.39	1.40	-	2.18
MTO	2.50	2.61	4.13	1/2-13 UNC	1.56	3/8-18 NPT	3.02	1.78	2.65	3.00
LTO	2.88	2.63	4.50	1/2-13 UNC	1.56	3/8-18 NPT	3.52	2.15	2.63	3.00
XLO	3.38	3.00	5.38	5/8-11 UNC	1.75	3/8-18 NPT	4.37	2.53	3.38	2.90
XLO-17	3.63	3.00	5.38	5/8-11 UNC	1.63	1/4-18 NPT	4.38	2.78	3.50	2.90

14.2.2 Large Bore

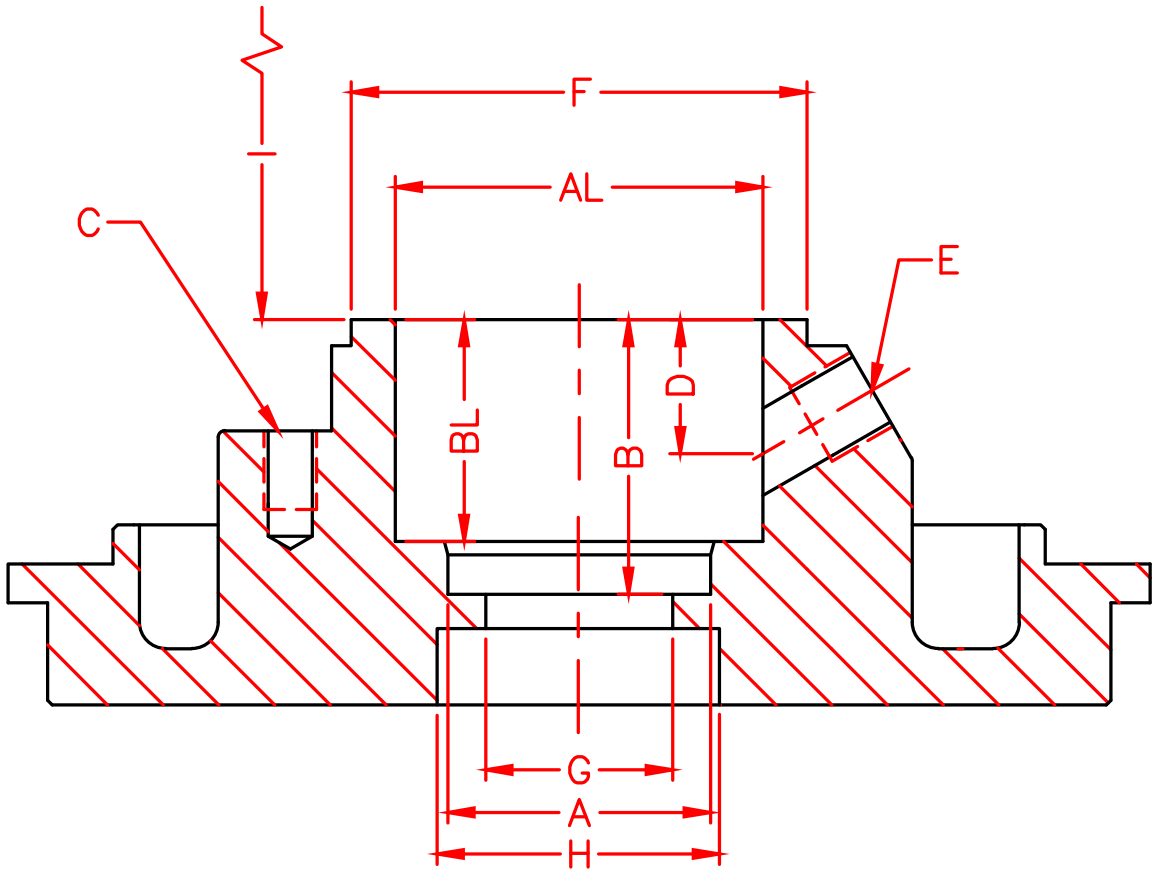


Figure 14-3: Large Bore Stuffing Box

Table 14-4: Large Bore Dimensions

LARGE BORE DIMENSIONS												
PUMP FRAME	A	AL	B	BL	C		D	E	F	G	H	I
					B.C.	TAP						OBSTRUCTION
STO	2.00	2.86	2.13	1.69	4.50	3/8-16 UNC	0.88	1/4-18 NPT	3.60	1.40	N/A	2.18
MTO	2.50	3.50	2.61	2.12	5.50	1/2-13 UNC	1.28	1/2-14 NPT	4.34	1.78	2.69	3.00
LTO	2.88	3.88	2.63	2.06	6.00	5/8-11 UNC	1.38	3/8-18 NPT	4.71	2.16	2.77	3.00
XLO	3.38	4.75	3.00	2.50	6.75	5/8-11 UNC	1.38	3/8-18 NPT	5.45	2.53	3.38	2.90
XLO-17	3.63	4.75	3.00	2.45	6.75	5/8-11 UNC	1.41	3/8-18 NPT	5.45	2.75	3.50	2.90

14.2.3 Taper Bore

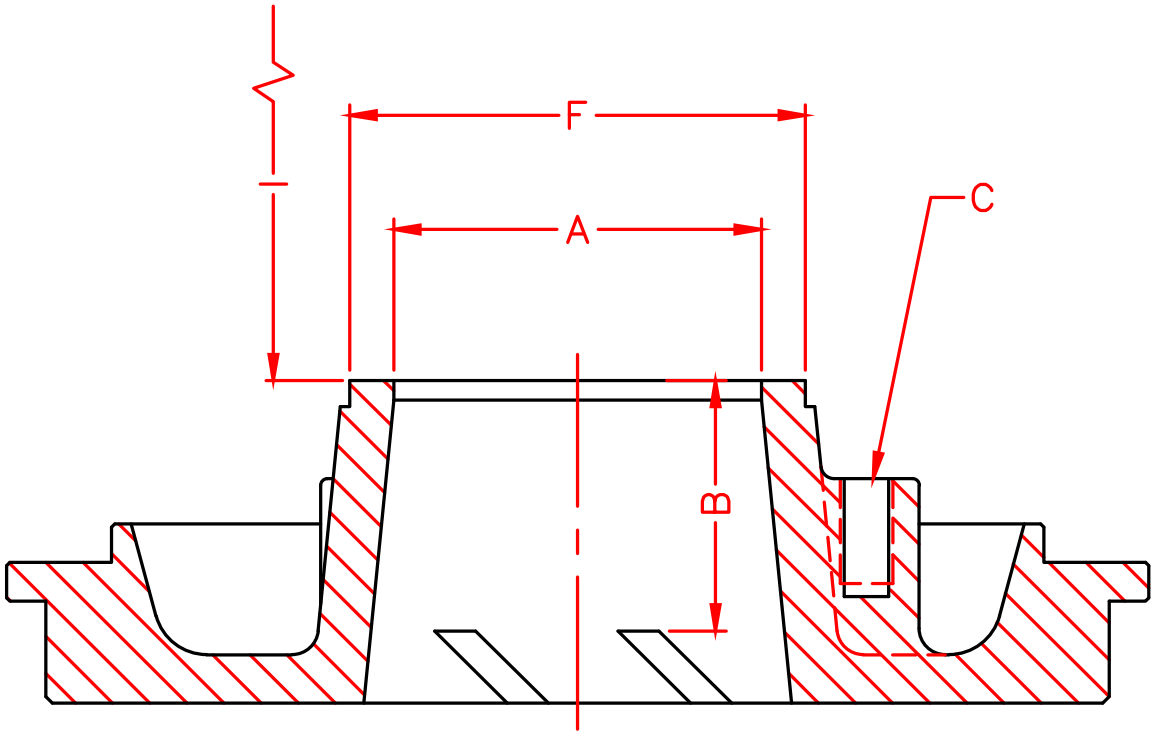


Figure 14-4: Taper Bore Stuffing Box

Table 14-5: Taper Bore Dimensions

TAPER BORE DIMENSIONS						
PUMP FRAME	A	B	C		F	I
			B.C.	TAP		OBSTRUCTION
STO	2.88	1.75	4.50	3/8-16 UNC	3.60	2.18
MTO	3.50	2.23	5.50	1/2-13 UNC	4.34	3.00
LTO	3.88	2.21	6.00	5/8-11 UNC	4.71	3.00
XLO	4.75	2.02	6.75	5/8-11 UNC	5.45	2.90
XLO-17	4.75	2.02	6.75	5/8-11 UNC	5.45	2.90

15 PUMP INFORMATION

Purchase Date: _____

Purchase Order#: _____

Serial Number: _____

Equipment Number: _____

PO Box 12145 Green Bay, WI 54307
www.summitpump.com

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