

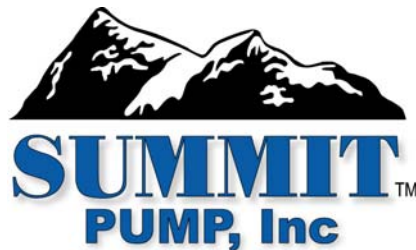
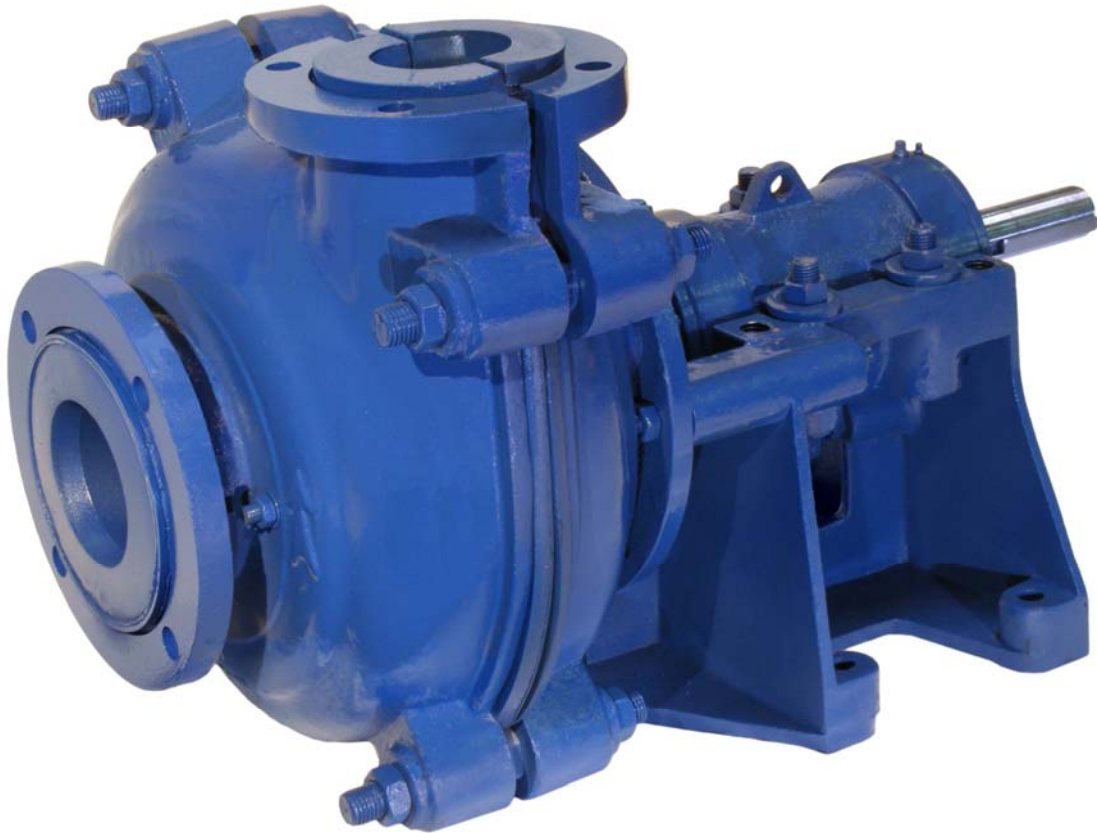
# **SUMMIT PUMP**

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## **Model SP**

Single Stage, Horizontal Slurry Pump,

## **Installation, Operation, and Maintenance Manual**





## **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.

## **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.

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## 1. INTRODUCTION

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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 a vertical case centrifugal pump with enclosed or open impeller impeller. It is designed for general slurry service.

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

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

### 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:

<b>WARNING!</b>
Failure to comply with the warnings in this manual could result in personal injury or death.

<b>CAUTION!</b>
Failure to comply with the cautions in this manual could result in destruction of, or damage to equipment.

<b>NOTE:</b> <i>Identifies a condition or procedure which is essential to proper equipment operation.</i>
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## **PUMP SAFETY WARNINGS**

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

### **WARNING!**

Do not apply heat to the impeller inlet eye or hub to remove impeller. The impeller may fracture resulting in damage to equipment or personal injury.

### **WARNING!**

Do not operate pump with very low flow rate or no flow rate. Overheating of the pump and vaporization of pumping fluids may generate extreme pressures. This may result in damage to equipment or personal injury.

### **WARNING!**

Observe drive rotation prior to installing couplings or drive belts. Failure to do so may result in damage to equipment or personal injury.

### **CAUTION!**

Treat Summit SP pumps as both a pressure vessel and rotating machinery. Follow all safety instructions for both types of equipment at all times.

### **CAUTION!**

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

### **CAUTION!**

Follow all auxiliary equipment (motors, drives, couplings ect) manufactures manuals, instructions or procedures during installation, operation and maintenance of the pump.

## 2. RECEIPT AND STORAGE

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### 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 distributor.

### STORING THE PUMP

#### TEMPORARY

Temporary storage is less than six months. Store pump in a clean, dry place, free from extreme swings in temperature and humidity. Rotate the shaft once a week to avoid bearing damage.

#### LONG TERM

Long Term Storage is more than six months. Follow temporary storage guidelines and consult with factory for detailed long term guidelines.

### HANDLING

Pump unit boxes and crates may be unloaded using a forklift or slings depending on size and package construction.

#### WARNING!

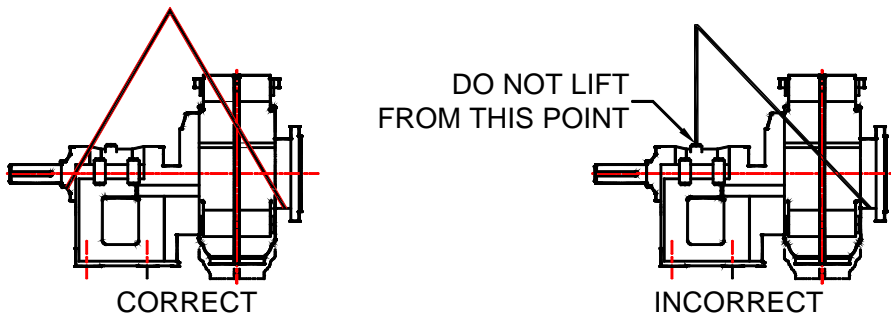
Pumps and assemblies are heavy, improper handling can result in serious injury.

### LIFTING

To avoid damage to pump and/or motor unit should be lifted using a nylon sling, chain or wire rope. The slings should be placed so lift is equally supported at four or more points. To avoid damage, See figure below to guide placement of slings.

#### CAUTION!

Be sure all components are securely fastened to baseplate before lifting.





### 3. INSTALLATION

#### LOCATION

The pump should be located as close as practical to the supply of liquid. Other location considerations are easy access for inspection and maintenance and ample overhead space for lifting with crane or hoist.

The final location consideration is to assure that maximum NPSHa is available at the suction flange. NPSHa must always be greater than NPSHr.

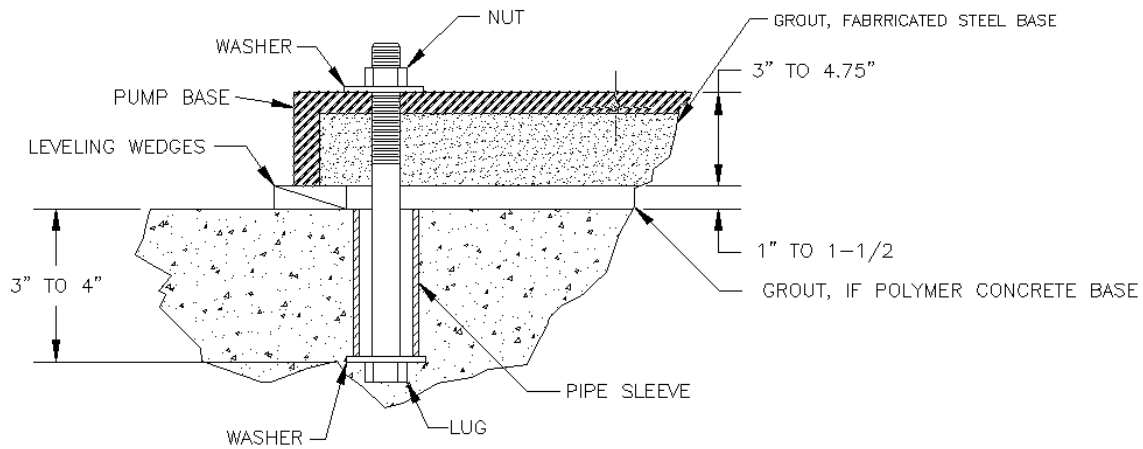
#### FOUNDATION

##### CONCRETE SUB-BASE

The concrete sub foundation performs a number of functions. It must support the weight of the entire pump assembly, maintain the alignment of all system components, and absorb the loads, forces and vibrations that are developed under normal operating conditions. The concrete material used must be top quality and conform to local building codes as well as the contractor's strength requirements. Reinforcing bars and mesh should be used as required. The mounting surface of the concrete foundation must be flat and level beneath the footprint of the sub-base, or the pump could be installed out of square. This could create problems aligning the piping, place extra loads on the couplings and bearings, and alter the operating levels of lubricants or hydraulic fluids in the system. It is recommended that the top surface of the slab be held flat and level to Ff50/F150 according to American Concrete Institute (#117) and the Canadian Standards Association (#A23.1) which is approximately 1/8" per 10 foot.

The mass weight of the sub foundation should be 3-5 times the mass weight of pump, motor and baseplate. Dimensionally, it should be 3" to 6" longer and wider than the polymer concrete or fabricated steel baseplate. Anchor bolts are installed in pipe sleeves. The pipe diameter is 2.5 times larger than the anchor bolt diameter. This sleeve/bolt assembly is embedded in the base when poured.

Anchor bolt sizes: 1"-8UNC. Length is 7.5 to 10" depending on base thickness and overall size.

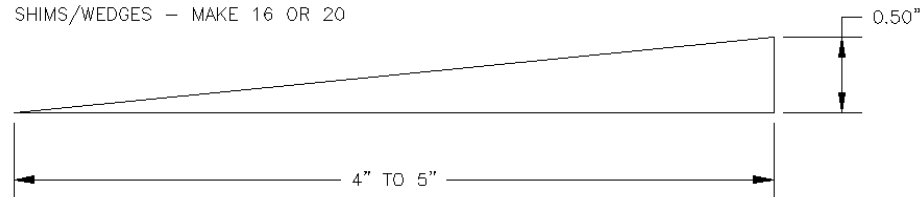


## BASEPLATE GROUTING

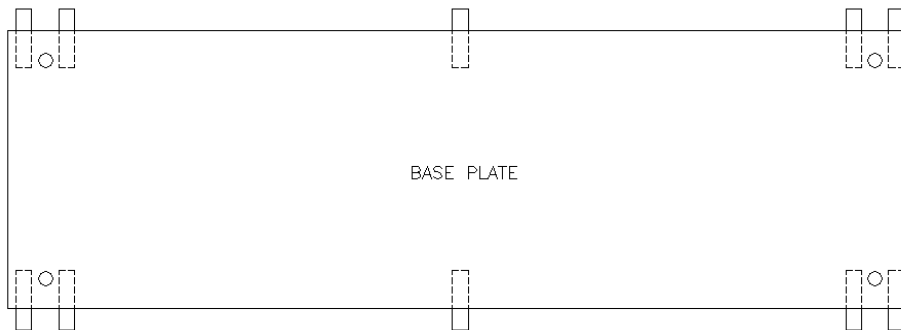
1. This grouting instruction assumes a concrete sub base has been put in place to accept the baseplate. The sub base should be clean of dirt, oil and any other debris.
2. Shims/wedges should be put in place on the sub base, as shown below. Shims/wedges should be wood, as shown.

### SHIMS/WEDGES(wood)

SHIMS/WEDGES - MAKE 16 OR 20



3. Locations are shown in figure below. Use 2 to 3 per stack to obtain desired gap between baseplate and sub-base. Normal gap is 1" to 1-1/2".



SHIM PLACEMENT

4. Carefully lower baseplate with pump and motor onto sub base over anchor bolts.
5. Level baseplate to 0.125" over length and 0.088" in over width.
6. When leveling is complete, tighten anchor bolts uniformly hand tight.
7. Build a plywood form around baseplate supported on the sub base. It should be 3" high and 1" to 1.5" larger than the baseplate. Its size should be large enough to include the shims or wedges that are left in place.
8. Use a high quality non-shrinking epoxy grout, following manufacturer's mixing and installation instructions.
9. When grout has cured, per grout manufacturer's recommended cure time, tighten anchor bolt till secure.
10. When grouting is complete, check coupling alignment and re-align as necessary.

## **PIPING CONNECTION – SUCTION / DISCHARGE**

Connect piping in a manner that is as short and direct as possible. Independent pipe supports and anchors must be used in all installations. Never support piping with pump flanges.

### **SUCTION PIPING**

Never use suction piping smaller than the suction flange size. Use pipe one to two sizes larger than the pump suction with an eccentric reducer at the pump suction flange. Install reducer flat side on top if the suction side incurs a lift. Place the flat side on the bottom if the suction side is flooded.

Elbows at the pump suction should be avoided. If used, the vertical position is the only acceptable position. Horizontal positioning where the elbow plane is parallel to the pump shaft will result in excessive axial loads on the pump shaft and could lead to breakage.

If a horizontal elbow is used, it must be at least ten (10) suction pipe diameters from the suction flange.

Shut off valves should be located as close as possible to the suction source, not at the pump.

#### **CAUTION!**

Do not throttle the pump using the suction valve. This valve is for pump isolation during maintenance.

#### **CAUTION!**

Use valves specifically designed for slurry liquids. Failure to do so could cause damage to the pump.

Suction piping should be sized to ensure a flow velocity of Four (4) to Seven (7) feet per second.

### **DISCHARGE PIPING**

For a short run, use the same diameter pipe as the discharge flange pipe diameter. For a long run, the discharge pipe should be one (1) to two (2) sizes larger than the discharge flange diameter. If the larger size discharge pipe is used, install the pipe increaser directly onto the pump discharge flange. A check valve (first) and isolation valve should be installed in the discharge line. (The check valve prevents back flow during pump shutdowns. The isolation valve is for pump isolation during maintenance.) If an increaser is used, mount it directly on the pump discharge flange with the check and isolation valve directly downstream.

## ALIGNMENT

<b>CAUTION</b>
Careful alignment is an extremely important consideration to ensure long pump life.

The pump and driver were aligned at the factory, however that alignment will have been disturbed during transportation and handling. Alignment must be rechecked. If necessary, align the motor to the pump, not the pump to the motor. Check both parallel and angular alignment. Final alignment should be within 0.005" in all planes at operating temperature.

If pump is belt driven, refer to belt manufacturer for correct alignment procedures.

Alignment checking needs to be done several times prior to pump start up. Those alignment recommendations are as follow:

<b>WARNING!</b>
Lock out Power to avoid personal injury.

1. Prior to grouting, to remedy misalignment caused by transportation
2. After grouting, to correct any changes that occurred during grouting.
3. After piping is connected to ensure possible pipe strains have changed alignment.
4. Hot alignment, after the pump has reached operating temperature, if the pump is used in high temperature service.

Alignment is accomplished by adding or removing shims under the motor feet and moving the motor as required.

## 4. OPERATION

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### CHECKING ROTATION

<b>CAUTION!</b>
Lock out power to avoid personal injury.

<b>WARNING!</b>
Operating the pump in the opposite direction may cause damage to casing and impeller

1. Lockout power to drive.
2. Remove coupling guard.
3. Remove coupling grid/sleeve element so that the motor half of coupling can spin free from the pump half.
4. Unlock power to motor.
5. Clear personnel from immediate area, jog motor just enough to determine direction of rotation. Rotation must be same as arrow on pump.
6. If same, lock out pump, reassemble coupling grid/sleeve to connect pump half.
7. If direction is wrong, change electrical wiring connection and repeat Step 4, 5 and 6.
8. Install coupling guard
9. Unlock motor, pump is ready to run.

### LUBRICATION

Summit SP pumps are grease lubricated. The pump has been pre-greased at the factory for 2000 hours operation. Regreasing should occur at 2000 hours or at three month intervals.

Acceptable greases are shown in the table below:

**Table 5**

Acceptable Greases	
Citgo	Mystic EP2
Keystone	81EP2
Mobil	Mobil Grease XHP222
Mobil Synthetic	SCH 100

■ TO REGREASE LUBRICATED BEARINGS

1. Wipe dirt and foreign matter from the Grease Zerk(2.11) on top of the Bearing Cover(2.5).
2. Remove grease Pipe Plugs(2.13).
3. Fill grease through fittings until there is grease coming out of the relief hole.
4. Reinstall Pipe Plugs(2.13).

**SEALING**

**WARNING!**

Lock out power to avoid personal injury

**PACKING**

1. The packing should be as loose as possible without an air leak, when the pump is started. As the pump runs in, gradually tighten the gland bolts evenly. Recommend adjusting the packing nuts no more than one flat every 25 minutes. There must be some leakage. The leakage should be reduced to 40 – 60 drops per minute. Normally this will take 50 – 60 minutes for packing to seal.

**MECHANICAL SEALS**

1. Check all fasteners to be sure they are tight.
2. Turn shaft by hand to ensure no binding exists.
3. Check seal, flush lines for leaks, if shut off valves exist, turn on.

**PRIMING**

A centrifugal pump should never be operated unless first filled with liquid and ALL of the air vented out. The pump must NOT be operating to prime it.

1. Lock out power to the pump drive,
2. Remove coupling guard.
3. Slowly rotate the pump several turns by hand when priming. An operating pump cannot be vented as the water will exit, but not the air.
4. Re-install the coupling guard.
5. Restore power to the pump.

The pump must be fully primed and suction pipe full of liquid before the pump is started.

**CAUTION!**

Do not operate the pump dry, rotating parts may seize, damaging pump.

## START UP

### ■ TO START UP THE PUMP

1. Lockout power to the pump drive.
2. Remove the coupling guard.
3. Rotate the pump by hand; making sure that the rotating element is spinning freely.
4. Re-install the coupling guard and restore power to the pump.
5. Be sure the suction valve is open.
6. Partially close the discharge valve.

### CAUTION!

Do not operate the pump with the discharge valve closed for an extended period of time.

7. Unlock power to the pump driver.
8. Slowly open the discharge valve as soon as the motor reaches operating speed.
9. Check stuffing box leakage and adjust, if necessary, to achieve leakage of 40-65 drops per minute.
10. Adjust the discharge valve as needed while checking piping for leaks.
11. Check mechanical operation of the pump and motor.

### WARNING!

Do not operate the pump without the proper guard. See ANSI/ASME B15.1-1996.

## SHUT DOWN

### ■ TO SHUT DOWN THE PUMP

1. Gradually close the discharge valve and turn off the power to the motor.
2. Lock out power to the pump driver.

## **APPENDIX A – MAINTENANCE TIMETABLE**

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### **DAILY MAINTENANCE**

1. Check bearing temperature. Use an instrument such as a thermometer, surface pyrometer or Infrared thermometer. Do not use your hand. Temperature must be below 180° F.
2. Check suction and discharge pressures.
3. Check shaft packing for excessive leakage.

### **THREE MONTH MAINTENANCE**

1. Grease bearings per instructions in Section 4, Page 9.
2. Check grease that comes out relief plug. If white it indicates water contamination. Remove contaminated grease, replace with new grease.

### **SIX MONTH MAINTENANCE**

1. Check packing and replace, if necessary. Be sure lantern ring is centered in the stuffing box and seal water piping is in good condition.
2. Take vibration readings and compare to previous readings.
3. Check shaft sleeve, if grooved/worn; replace. (If not replaced when worn, packing life will be reduced.)

### **YEARLY MAINTENANCE**

1. Depending on the fluid pumped and pump operating hours during the year, check pump performance and vibration inspection records. If necessary remove the Front Plate(31) and Liner(30) then inspect Casing halves, Impeller and Liners. These inspections can range from once a year, to once every three to five years.



## APPENDIX B – MAINTENANCE AND REPAIR

---

### WARNING!

WEAR EYE PROTECTION. Failure to do so can result in serious personal injury.

### WARNING!

Pump parts are heavy. Use proper lifting methods to avoid personal injury.

### ASSEMBLY PROCEDURES

(See APPENDIX D for Cross-Section)

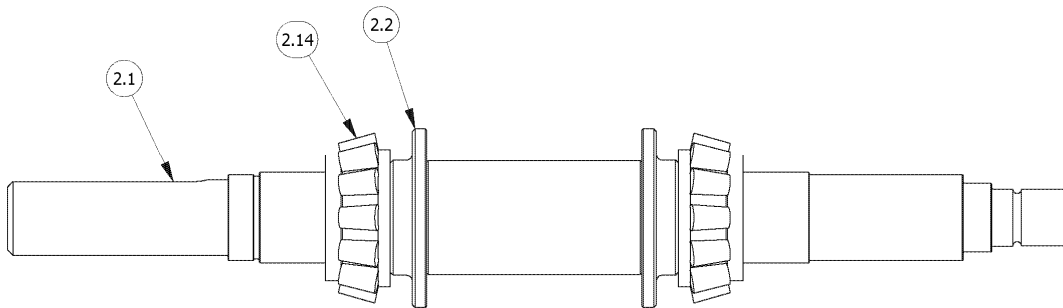


Fig 1.

1. Lightly grease or oil the bearing shoulders on Shaft(2.1). (See Fig 1)
2. Slide on a Grease Retainer(2.2) up to Shaft(2.1) shoulder. (See Fig 1)
3. Using induction heater preheat, bearing cone of Bearing(2.14) to 210°F.
4. Place cone of Bearing(2.14) positioned so the smaller diameter is positioned outward from the center of Shaft(2.1) and install the Bearing Cone up to Grease Retainer(2.2). (See Fig 1)
5. Install second Grease Retainer(2.2) and Bearing Cone(2.14) in opposite direction and on opposite end of Shaft(2.1) repeating steps 2-4.

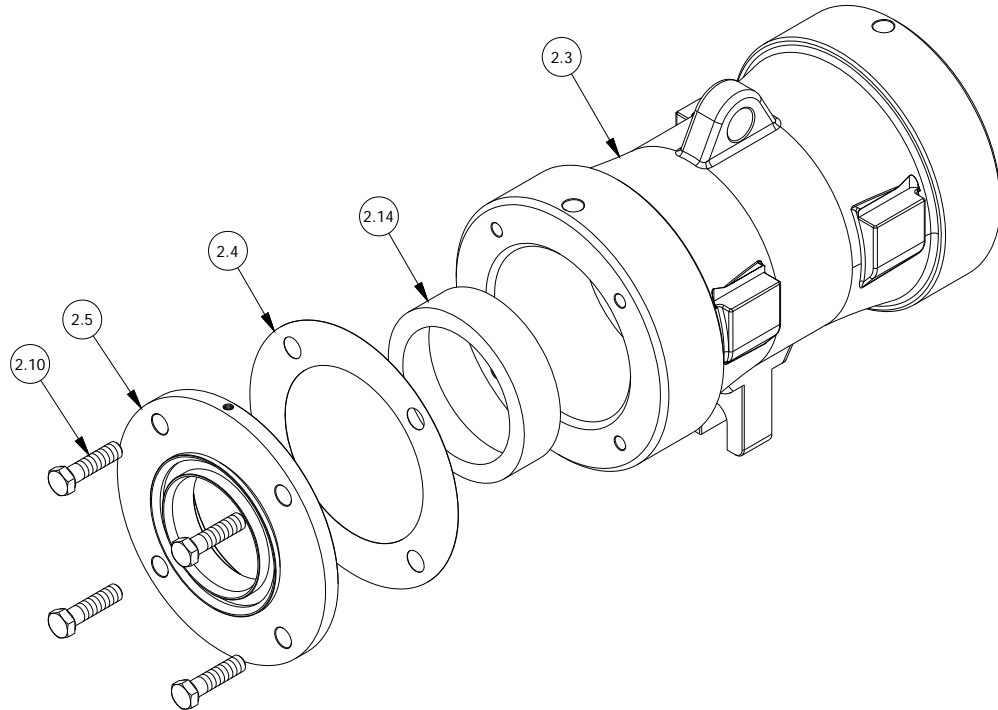


Fig 2.

6. Lightly grease or oil the inside bores of the Bearing Housing(2.3)
7. Insert Bearing Cup of Bearing(2.14) with the small I.D. facing towards the outside of the Bearing Housing(2.3). Using a rubber mallet tap Bearing Cup into Bearing Housing(2.3) till the Bearing Cup has been installed just past the lip of the Bearing Housing(2.3) (See Fig 2.)
8. Place a 0.018”-0.020” Shim(2.4) onto Bearing Cover(2.5) and place assembled components into position on Bearing Housing (2.3).(See Fig 2.)
9. Insert Hex Bolt(2.10) into assembled components and evenly tighten screws in a crisscross pattern until Bearing Cover(2.5) is seated against Bearing Housing(2.3) this will place the Bearing Cup into correct position. (See APPENDIX C for cross-section)
10. Grease both Bearings(2.14) by hand, using grease specified in Table 5. Fill in gaps between roller, roller cage, cone, and grease retainer.
11. Insert Shaft(2.1) assembly into Bearing Housing(2.3) threaded end first.
12. Place remaining Bearing Cup with small diameter facing out into housing and tap it down using a rubber mallet until the Bearing Cup has been installed just past the lip of the Bearing Housing(2.3).
13. Put Bearing Cover(2.5) with a 0.018”-0.020” Shim(2.4) on Bearing Housing(2.3)
14. Insert Hex Bolt(2.10) into assembled components and evenly tighten screws in a crisscross pattern while rotating the shaft until shaft is hard to rotate and there is no end play. This means the Bearing Cup is seated properly.
15. Grease Piston Rings(2.8) and install on each Bearing Labyrinth(2.6) with gaps directly opposite of each other. (See Fig 3.)

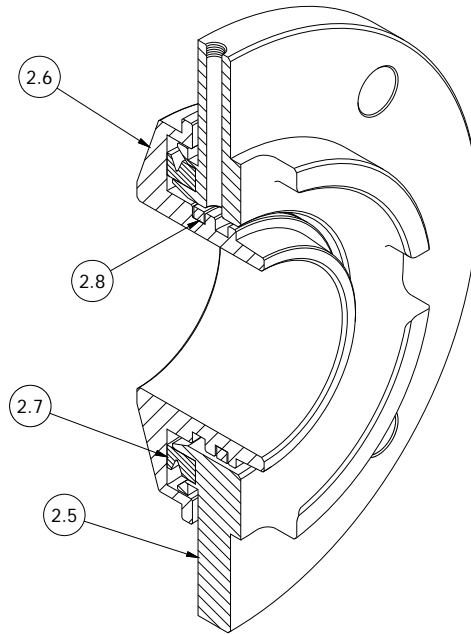


Fig 3.

16. Fit V-Ring Seal(2.7) into notch in Bearing Cover(2.5). (See Fig. 3)
17. Fit Labyrinth Assembly onto shaft sliding up snugly to Bearing Cover(2.5)
18. Install Lock Nut(2.9) onto Shaft(2.1) tighten using spanner wrench.
19. Install Grease Nipple(2.11) into Bearing Cover(2.5) and Square Head Plugs(2.13) into Bearing Housing (2.3)
20. Rotate Shaft(2.1) and pump grease into Bearing Cover(2.5) using Grease Nipple(2.11) to fill Labyrinth assembly.

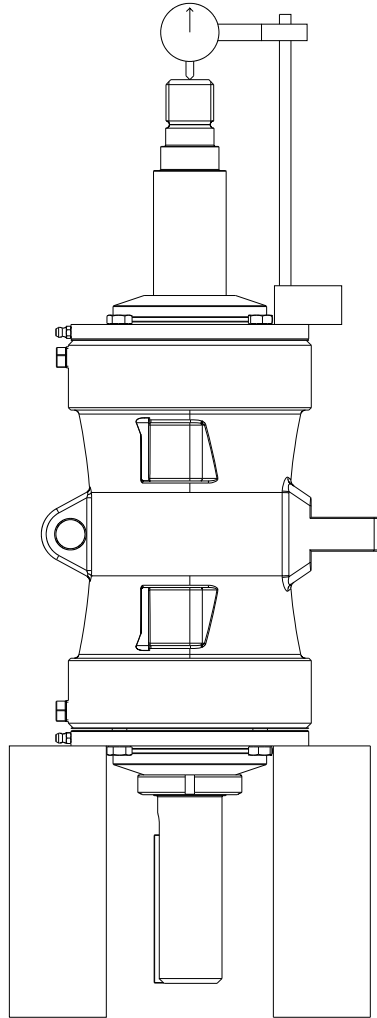


Fig. 4

21. To check Bearing Assembly(2) end play place assembly on blocks with keyed end down. (See Fig. 4) be sure to secure Bearing Assembly(2) from tipping.

**WARNING!**

Secure Bearing Assembly(2) when checking end play to avoid personal injury.

22. Secure dial indicator to the Bearing Assembly(2) so that the axial movement between the housing and the end of the shaft can be measured.
23. Lift shaft up and down to observe the maximum and minimum readings on the dial indicator repeating several times to ensure proper reading. Record the reading to check with the values in Table 6.

**Table 6**

Bearing Assembly End Play		
N005	.0020" - .0045"	(.050 - .110mm)
P005, CC005	.0030" - .0062"	(.074 - .159mm)
Q005, DD005	.0040" - .0065"	(.102 - .165mm)
R005, RS005, EE005	.0032" - .0060"	(.081 - .152mm)
S005, SH005, FF005	.0024" - .0070"	(.061 - .178mm)
T005, TH005, GG005	.0065" - .0090"	(.165 - .229mm)
U005	.0075" - .0122"	(.191 - .312mm)

24. Insert Heavy Hex Bolt(3) into Base(1) from exterior screw on one nut and tighten. Next screw on one Nut(4) the two Washers(5) and the last Nut(4) leaving them loose and as far apart as possible.
25. Grease the machined surfaces on Base(1) where Bearing Assembly(2) will sit.
26. Lower Bearing Assembly(2) onto Base(1) lining up machine surfaces of the Bearing Housing(2.3) with the holes in the Base(1). Be sure that the Bearing Housing(2.3) adjustment lug fits in between the two washer(5) on the Heavy Hex Bolt(3) adjuster.
27. Insert the clamp bolt Heavy Hex Bolt(6) and Plain Washer(7) into Base(1) and install Plain Washer(7) and Nut(4) from top. Fully tighten "ALPHA" side bolts leaving "BETA" side bolts finger tight. (See Fig 5.)

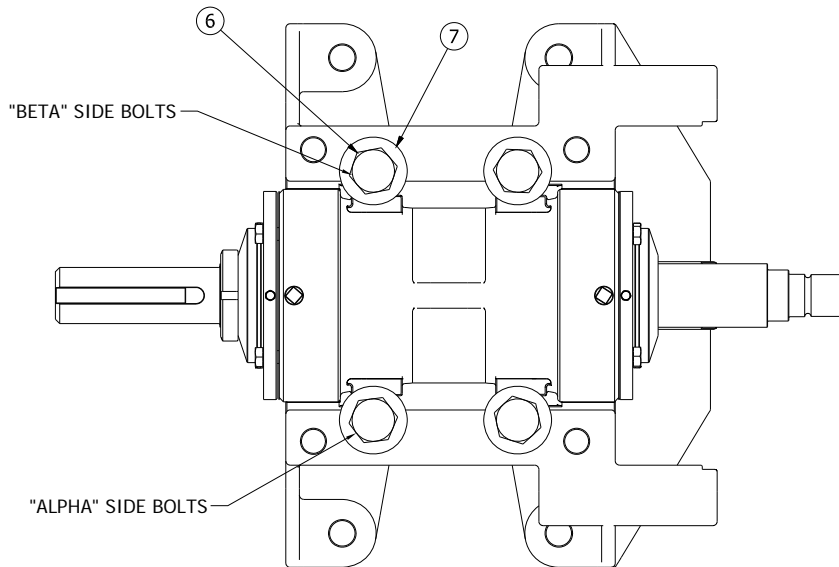


Fig 5.

28. Grease Shaft(2.1) on impeller end to help in installing shaft components and prevent rusting.
29. Mount the Cover Plate(9) to Base(1) with three Case-Frame Bolt(10) and Hex Nut(11). Be sure that the shoulder of the Cover Plate is fit into the recess in the Base.
30. Torque the Case-Frame Bolt(10) Hex Nut(11) to the values on Table 7,

**Table 7**

<b>Case-Frame Bolt Torque</b>	
Size	Torque Ft Lb/Nm
1/2	40 / 54
5/8	80 / 109
3/4	130 / 176
1	190 / 258
1 1/4	380 / 516
1 3/4	750 / 1017

31. Install Case Bolt(12) and onto Cover Plate(9) and fully tighten nuts to ease in assembly.
32. Put the Stuffing Box(13) on flat surface with the gland side facing upward.
33. Insert the Lantern Restrictor(14) with the small end down fitting in the center of the Stuffing Box.
34. Place the Shaft Sleeve(15) through the center of the Lantern Restrictor(14).
35. Insert the Packing(19) into the Stuffing Box(13) fitting the Packing(19) with the joints staggered from one to the next.
36. Join the Gland(20) halves together with the Clamp Bolts(21) tightening them completely.
37. Install the assembled Gland(20) onto the Stuffing Box(13) with the flat side facing away from the Stuffing Box(13) compressing the Packing(19) into the Stuffing Box(13).
38. Install the Gland Bolt(23) to the assembly of the Stuffing Box(13) and Gland(20).
39. Place the Shaft Sleeve O-Ring(16) onto the Shaft(2.1) sliding it up to the Bearing Labyrinth(2.6).
40. Install the assembled Stuffing Box(13) onto Frame Plate(31). Be sure to install the Stuffing Box with the flush port facing upward.
41. Place the second Shaft Sleeve O-Ring(16) onto the Shaft(2.1) and push it into the recess in the Shaft Sleeve(15).
42. Insert the Shaft Spacer(17) onto Shaft(2.1) and press up tightly against the Shaft Sleeve(15).
43. Coat the shaft thread with anti-seize lubricant.
44. Place the Rear Cover Plate Gasket(26) onto the Stuffing Box(13) and Seal Ring(28) onto the Cover Plate(9). If Cover Plate Gasket(26) or Seal Ring(28) will not stay in place rubber cement can be used to hold them in place.
45. Install the Rear Liner Plate(27) then screw on Impeller(29).
46. Fit Liner(30) over impeller and mount against the Rear Liner Plate(27).
47. Install Frame Plate(31) onto Case Bolt(12) tighten nuts to value on Table 7 being sure to tighten evenly in a criss-cross pattern. Pump is now ready for impeller adjustment.

## APPENDIX C – IMPELLER CLEARANCE ADJUSTMENT

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### WARNING!

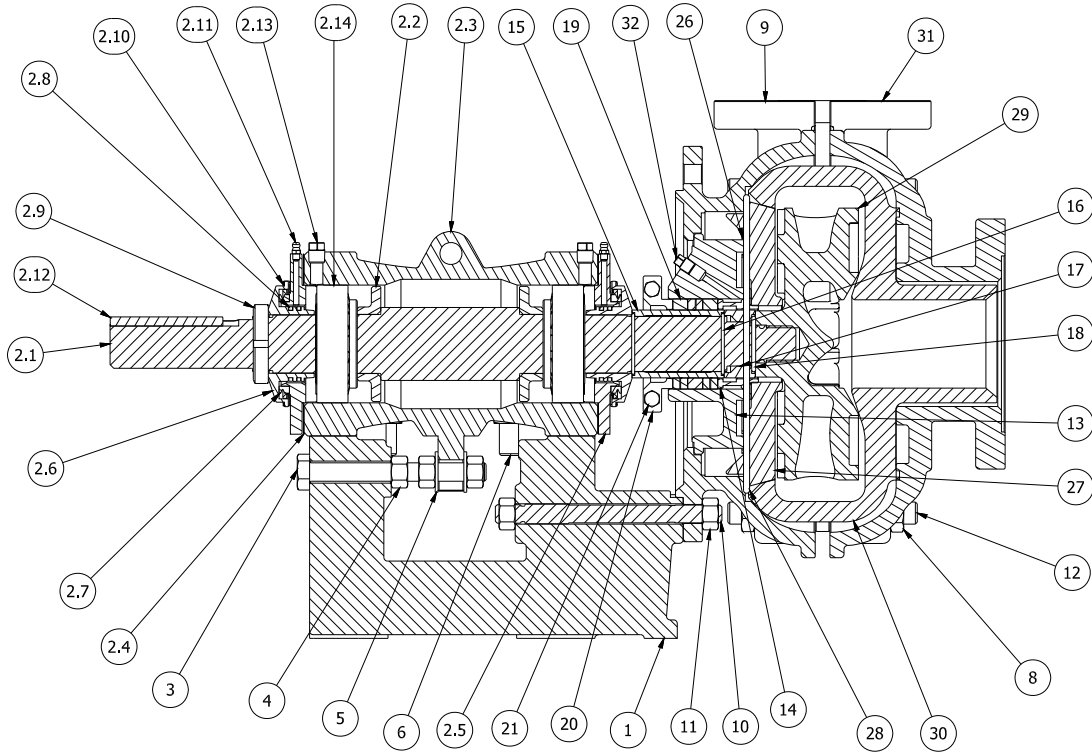
WEAR EYE PROTECTION. Failure to do so can result in serious personal injury.

1. Loosen Clamp Bolt(6) on Beta side only.(See Fig. 5)
2. Turn the shaft clockwise by hand and push the Bearing Assembly(2) forward toward the Frame Plate(31) by tightening the rear nut on the Adjustment Bolt(3) until the impeller starts rubbing on the Liner (30)
3. Loosen the rear hex nut on the Adjustment Bolt(3) 1/3 turn then move bearing assembly back with the front nut on the Adjustment Bolt(3) until the housing is secure against the rear nut.
4. Tighten Clamp Bolt(6) on the Beta side (See Fig. 5) bolts on Alpha side were secured previously.
5. Secure both Adjustment Bolt(3) Hex Nuts against the Adjustment Lug on the Bearing Assembly(2)
6. Turn the shaft and if impeller rubs against Liner(30) repeat Steps 1-6 until the impeller no longer rubs.

### CAUTION!

When pumping fluid that will cause expansion of impeller or liner, increase impeller clearance to prevent damage to the pump.

**APPENDIX D – PUMP CROSS SECTION AND PARTS LIST**  
 (Parts Will Vary by Model)



**SUMMIT MODEL SP PARTS LIST**

ITEM	DESCRIPTION	ITEM	DESCRIPTION
1	Pump Base	14	Lantern Restrictor
2	Bearing Assembly (Encumspasis 2.1-2.14)	15	Seal Sleeve
2.1	Shaft	16	Sleeve O-Ring
2.2	Grease Retainer	17	Shaft Spacer
2.3	Bearing Housing	18	Impeller O-Ring
2.4	Shim	19	Packing
2.5	Bearing Cover	20	Split Packing Cover (Gland)
2.6	Bearing Labyrinth	21	Split Packing Gland Bolt
2.7	V-Ring Seal	22	Split Packing Gland Nut (Not Shown)
2.8	Piston Ring	23	Square Head Bolt Split Packing Gland to Box cover (Not Shown)
2.9	Slotted Round Nuts	24	Washer Split Packing Gland to Box cover (Not Shown)
2.10	Hex Bolt	25	Nut Split Packing Gland to Box cover (Not Shown)
2.11	Grease Zerk	26	Rear Cover Plate Gasket
2.12	Key	27	Rear Liner Plate
2.13	Pipe Plug	28	Seal Ring
2.14	Taper Roller Bearings	29	Impeller
3	Adjustment Bolt	30	Liner
4	Adjustment Nut	31	Frame Plate (Front Case Half)
5	Adjustment Bolt Washer	32	Pipe Plug, Box Cover
6	Clamp Bolt	33	Front Liner Gasket (Not Shown)
7	Clamp Washer (Not Shown)	34	Throte Bushing (SUCTION LINER) (Not Shown)
8	Case Bolt Nut	35	Suction Gasket (Not Shown)
9	Cover Plate (Rear Case Half)	36	Discharge Gasket (Not Shown)
10	Case-Frame Bolt	37	Water Seal Ring (Not Shown)
11	Case-Frame Bolt	38	Front Water Seal Ring (Not Shown)
12	Case Bolt	39	Packing Gasket (Not Shown)
13	Stuffing Box	40	Oil O-Ring (Not Shown)



**APPENDIX E – TROUBLESHOOTING**

**PUMP PROBLEMS**

Discharge failure	1,2,3,4,6,11,12,13,14,16,17,22,23,29,30,37
Reduced discharge delivery	2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,22,23,29,30,37
Insufficient pressure	5,14,15,16,17,20,22,23,29,30,37
Pump loses prime	2,3,5,6,7,8,11,12,13,22,23,37
Excessive horsepower required	15,16,17,18,19,20,24,26,27,32,33,36
Leakage from stuffing box	24,26,31,32,33,34,35,38,45,46
Packing has short life	24,26,28,31,32,34,35,36,38,45,46
Vibration and noise from pump	2,3,4,9,10,11,21,23,24,25,26,27,28,29,34,35,37,39,40,41,42,43,44
Short life of bearings	24,26,27,28,34,35,40,41,42,43,44
Overheating or seizure of pump	1,4,21,24,27,28,34,35,39,40,41,42
Hopper overflows	1,5,11,12,13,14,16,17,19,22,23,30,37

**PROBABLE CAUSE AND REMEDY.**

<b>INTAKE</b>	The pump is not primed.	1
	The pump or intake is not completely filled with liquid.	2
	The suction lift is too high.	3
	There is insufficient margin between the intake pressure and vapor pressure.	4
	There is an excessive amount of air or gas in the liquid.	5
	There are air pockets in the line.	6
	Air is leaking into the intake line.	7
	There is air leaking into the pump through the stuffing box.	8
	The foot valve is too small.	9
	The foot valve is partially clogged.	10
	The intake pipe is insufficiently submerged.	11
	The intake is blocked.	12
	The intake diameter is too small or the length of the intake pipe is too long.	13
<b>SYSTEM FAULTS</b>	The speed is too low.	14
	The speed is too high.	15
	The pump is rotating in the wrong direction.	16
	The total head of the system is higher than designed head.	17
	The total head of the system is lower than designed head.	18
	The specific gravity of the liquid is different than the design.	19
	The liquid viscosity differs from design of the pump.	20
	Operating at low capacity.	21
	Entrained air in the pump. The pump hopper requires baffles.	22
	Incorrectly installed pipe line or gaskets partly blocking pipe.	23
<b>MECHANICAL FAULT</b>	The pump is misaligned.	24
	The foundation is not rigid.	25
	The shaft is bent.	26
	The rotating parts rubbing together.	27
	The bearings are worn.	28
	The impeller is damaged or worn.	29
	The casing gasket is leaking permitting internal leaking.	30
	The shaft sleeve is worn or scored at the packing.	31
	The packing is improperly installed.	32
	The packing is incorrect for the operating conditions.	33
	The shaft is running off center due to bearing ware or misalignment.	34
	The impeller is out of balance resulting in vibrations.	35
	The gland is too tight resulting in no flow of liquid to lubricate the packing.	36
	There is foreign matter in the impeller.	37
	There is dirt or grit in the sealing liquid leading to scoring of the shaft sleeve.	38
	Excessive thrust caused by mechanical failier inside the pump.	39
	There is an excessive amount of lubrication in the bearing housing causing high temperature.	40
	There is a lack of lubrication.	41
	The bearings are installed improperly.	42
	There is dirt getting into the bearings.	43
	There is water in the bearing housing rusting the bearings.	44
	The expeller is worn or blocked.	45
	There is excessive clearance at the bottom of the stuffing box, forcing the packing into the pump.	46

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