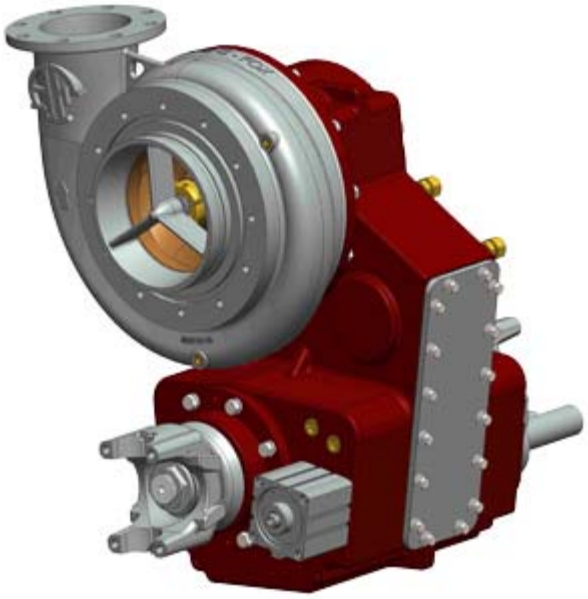
AF2000-SS PUMP MANUAL

Operation, Maintenance & Repair



HME, Incorporated ● 1950 Byron Center Avenue ● Wyoming, Michigan 49519
616-534-1463 ● www.firetrucks.com

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HME will not assume responsibility for product failure due to improper maintenance or operation.

HME is responsible only within the limits stated in the product warranty.

Information contained in this manual is subject to change without notice.

SAFETY

IMPORTANT!

FOLLOW THE SAFETY GUIDELINES LAID OUT IN THIS MANUAL AND ADHERE TO ALL WARNING, DANGER, CAUTION AND IMPORTANT NOTES.

ALL DOCUMENTATION MUST BE READ, UNDERSTOOD AND STRICTLY FOLLOWED BY ALL INSTALLERS, MAINTENANCE PERSONNEL, AND OPERATORS.

WHEN CREATING DEPARTMENTAL SOPS INCORPORATE THE WARNING AND CAUTION INFORMATION.

DEFINITIONS

DANGER! - ***IMMEDIATE HAZARD, WHICH WILL RESULT IN SEVERE PERSONAL INJURY OR DEATH IF THE WARNING IS IGNORED.***

WARNING! - ***HAZARDS OR UNSAFE PRACTICES, WHICH COULD RESULT IN SEVERE PERSONAL INJURY OR DEATH IF THE WARNING IS IGNORED.***

CAUTION! - ***HAZARDS OR UNSAFE PRACTICES WHICH COULD RESULT IN MINOR OR MODERATE PERSONAL INJURY IF THE WARNING IS IGNORED.***

IMPORTANT! - ***THIS ACTION COULD RESULT IN DAMAGE TO THE APPARATUS OR OTHER PROPERTY.***

IMPORTANT!

THE PROCEDURES IN THIS MANUAL ARE FOR GENERAL INFORMATION AND DO NOT REPLACE THE PROCEDURES, POLICIES, OR GUIDELINES ESTABLISHED BY THE AUTHORITY HAVING JURISDICTION, NOR DO THEY REPLACE THE RECOMMENDATIONS AND PROCEDURES PROVIDED IN THE APPARATUS MANUAL.

REFER TO THE PROCEDURES PROVIDED BY THE AUTHORITY HAVING JURISDICTION ON SETTING WHEEL CHOCKS, LAYING OUT AND CONNECTING OF HOSES AND SETTING VALVES AND DRAINS.

ALL FASTENERS ON THE PUMP AND GEARBOX ASSEMBLY ARE SELECTED FOR THE APPLICATION. DO NOT REPLACE FASTENERS WITH ANYTHING OTHER THAN HME PART NUMBERS PROVIDED. REPLACING WITH AN ALTERNATIVE POSES A SERIOUS SAFETY RISK.

ALL FASTENERS MUST BE INSTALLED WITH A LOCKING ANAEROBIC ADHESIVE/SEALANT, SUCH AS LOCTITE #243 OR EQUIVALENT.

WARNING!

THE PUMP AND GEARBOX ASSEMBLY IS HEAVY AND BULKY.

BE CERTAIN TO USE PROPER LIFTING AND SUPPORT DEVICES CAPABLE OF HANDLING THE LOAD WHEN REMOVING OR INSTALLING THE PUMP AND GEARBOX ASSEMBLY.

WARNING!

MODIFICATIONS MADE TO THE PUMP AND GEARBOX ASSEMBLY WITHOUT PRIOR WRITTEN PERMISSION MAY RESULT IN PRODUCT DAMAGE OR INJURY.

WARNING!

BE SURE TO WEAR SAFETY GLASSES WHEN REMOVING AND/OR INSTALLING PRESS FIT PARTS. WEAR HEAT-RESISTANT GLOVES WHEN HANDLING PARTS THAT REQUIRE HEATING FOR INSTALLATION AND/OR REMOVAL. FAILURE TO COMPLY MAY RESULT IN SERIOUS INJURY.

WARNING!

- Rotating drive line parts can cause injury. Be careful that no part of your body is in an area of rotating parts.

- Everyone should be clear of the apparatus before shifting to the PUMP position. The parking brake must be set and the wheels should be chocked to prevent any movement of the apparatus.
- Make sure proper personal protective equipment is used when installing, operating or servicing the pump or apparatus.

WARNING!

DO NOT OVERHEAT PARTS CONSTRUCTED OF BRONZE (E.G. IMPELLER). OVERHEATING WILL WEAKEN THE PART AND IT WILL NEED TO BE REPLACED.

WARNING!

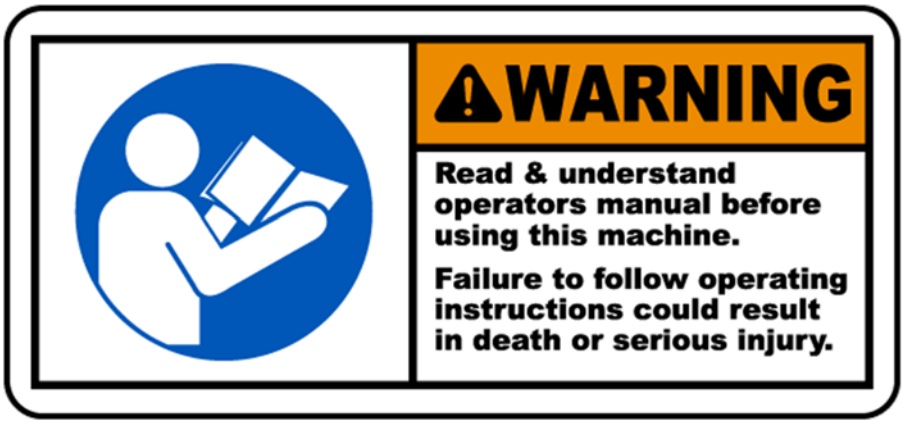
- **DO NOT** operate the pump system at pressures higher than the maximum rated pressure.
- Relieve all pump system pressure, then drain all water from the pump system before servicing any of its component parts.
- Use only pipe, hose and fittings, which are rated at or above the maximum pressure rating at which the water pump system operates.
- If a pump is operated without water for extended periods, or without discharging water, it could overheat. This can damage the mechanical seal, impeller, wear rings or the drive components.
- **DO NOT** advance the throttle unless the **OK TO PUMP** indicator is **ON**.
- **DO NOT** leave the cab, after selecting the **PUMP** mode, until all the **GREEN** pump indicators in the cab and panel are ON.
- **DO NOT** attempt emergency manual shift procedures while the engine is running.
- **DO NOT** attempt to shift the pump from, pump to road or road to pump, while the apparatus transmission is in gear. Always shift the transmission to neutral and verify the speedometer is at zero before shifting the pump.

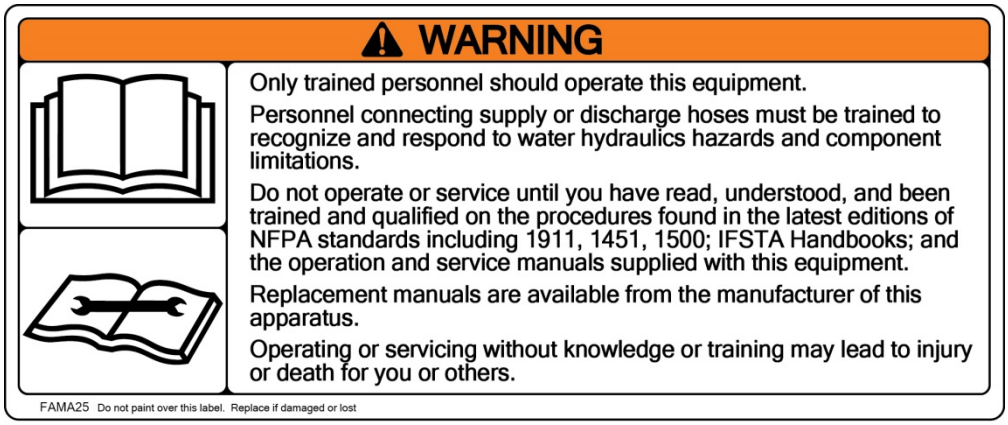
- **DO NOT** reduce the pressure on the intake gauge below zero. Serious damage to the water main could result.

Use only U.S. SEALUBE Rubber Lubricant Emulsion (or equal) on the rubber mechanical seal parts to ease installation. If U.S. Sealube is not available use a solution of liquid dish soap in water as lubricant.

DO NOT use other lubricant types as damage to the mechanical seal and seat could occur. Never use grease or oil as an installation lubricant. Oil used to lubricate the elastomer bellows/cup gasket will significantly reduce the friction drive or anti-rotation capability of the component.

- **DO NOT** touch the mechanical seal seat or rotating surface with your hands, the oil on your hands will cause the seal to fail. Handle the seal with care; it is manufactured to precise tolerances. The seal faces are of special importance and should be kept perfectly clean at all times.





TO THE OPERATOR

The Ahrens-Fox® Stainless Steel Centrifugal Pump introduces a new level of corrosion resistant durability and performance, in a wide range of models offering NFPA certified ratings from 1000-GPM to 2250-GPM.

Engineered to deliver the best-in-class torque ratings in the industry today, with quieter, more efficient operation, and designed for easier service, Ahrens-Fox® Stainless Steel Centrifugal Pumps deliver extended life and low cost operation.

STAINLESS STEEL DESIGN DURABILITY

Every Ahrens-Fox® Stainless Steel Centrifugal Pump features a corrosion resistant stainless steel volute case to extend service life and performance, while reducing the need for anode maintenance typical in lower quality iron case designs. The stainless volute case is nearly three-times more resistant to damage from cavitation and six times more resistant to wear or damage from pumping abrasive materials. Effective TRV for thermally protected operations.

Additional corrosion resistance is provided by a high-grade stainless steel pump shaft and a sea-water resistant, CAD-CAM bronze impeller. The durability of materials and advanced design extends the pump's effective service life while enhancing performance.

BUILT TOUGH FOR BEST-IN-CLASS PERFORMANCE

The advanced engineering and robust construction of the Ahrens-Fox® Stainless Steel Centrifugal Pump delivers best-in-class performance with the best-in-class torque rating in the industry today. The improved design features helical drive train gearing for quieter operation, double taper roller bearings support the shafts for a transfer-case rating of 20,000 lb-ft of torque.

Stronger, tougher and easier to service than competitive pump construction designs, the Ahrens-Fox® Stainless Steel Centrifugal Pumps features piloted, eight-bolt bearing support covers. A vertically spilt case offers easy access and service, maintenance free, self-adjusting mechanical seals and easy-to-replace wear rings.

PUMPING POWER TO SPARE

While all model rating are all third-party certified, the 2250-GPM Ahrens-Fox® Stainless Steel Centrifugal Pump model has the capability to produce over 3000-GPM from a hydrant with sufficient engine horsepower. The big bore configuration of the pump develops high-intake performance in drafting operations. An automatic air venturi primer system keeps the pump operating smoothly while offering quiet and effective operation. A computer designed and optimized water cut supports high efficiency water flow.

HME AHRENS-FOX SINGLE SOURCE FIRE APPARATUS ENGINEERING AND MANUFACTURING

The Ahrens-Fox® Stainless Steel Centrifugal Pump is another product of HME's dedication to total vertical integration of engineering and manufacturing complete fire apparatus under one roof. From custom chassis, cab, body, aerial ladders, pump modules, foam systems and stainless steel centrifugal pumps, HME Ahrens-Fox is leading the way in creating the finest fire apparatus available today.

The Ahrens-Fox tag is not just a name but a badge, a symbol of honor of the technological leadership in the fire service. Placed upon HME's premier products and new technology the Ahrens-Fox badge is a certificate to the end user that the latest in technology is employed in the design of the apparatus. Advancements, features and patented technology to assist the fire service to perform swift, effectively and efficiently. The DNA of HME's technological innovation continues to serve as the driving force of HME's leadership of the fire service.

PRINCIPLE OF OPERATION

CENTRIFUGAL FORCE

HME pump products are a centrifugal design that operates on the principle of centrifugal force created by a rotating impeller.

Inside a centrifugal pump both low and high pressure areas are created, mostly due to the action of the pump's spinning impeller. Low pressure is created at the water inlet causing water to get drawn into the plumbing for discharge.

The same thing happens inside a centrifugal pump due to internal water movement. The spinning impeller moves water from inlet to discharge. As water is discharged, a void, or vacuum, is created inside the pump, causing water at the inlet to get sucked inside at low pressure.

As water moves inside the housing, it comes into contact with the rotating impeller itself. This impeller is comprised of multiple spiral curved blades, made to maximize efficient movement of water. They use the power of centrifugal force to create a high pressure environment, and water is channeled in the volute at high speed towards the pump's outlet, where it is then discharged.

The velocity at which the water travels from the center is directly relates to the diameter of the impeller and the speed of rotation. The velocity of the water is converted to pressure that rises to a level based on the speed of rotation.

There are three interrelated factors that produce the performance of a centrifugal pump:

- **SPEED (RPM):** If the speed of rotation increases with the flow held constant, fluid pressure increases.

- **PRESSURE:** Measured in pounds per square inch (PSI) or Bar. If the pressure changes the speed is held constant, the flow, measured in gallons or liters per minute (GPM/LPM), will change inversely, i.e. if pressure increases, flow decreases.

- **FLOW:** If the pressure is held constant, the flow will increase with an increase in the speed of rotation.

A centrifugal pump has the ability to utilize any positive suction inlet pressure, reducing the amount of work done by the pump. The potential flow can be greater than the pump rating.

BASIC OPERATION

WARNING!

ALL PROCEDURES IN THIS SECTION MAY NOT APPLY TO YOUR SPECIFIC OPERATING REQUIREMENTS. ONLY REFER TO THOSE SECTIONS WHICH APPLY TO YOUR OPERATING REQUIREMENTS.

THESE PROCEDURES DO NOT REPLACE THE PROCEDURES, POLICIES OR GUIDELINES SET DOWN BY THE AUTHORITY HAVING JURISDICTION, NOR DO THEY REPLACE THE RECOMMENDATIONS AND PROCEDURES PROVIDED IN THE APPARATUS MANUAL.

ALWAYS REFER TO THE PROCEDURES PROVIDED BY THE AUTHORITY HAVING JURISDICTION FOR OPERATING PROCEDURES, SETTING WHEEL CHOCKS, LAYING OUT AND CONNECTION OF HOSES, SETTING VALVES AND DRAINS.

NEVER ATTEMPT TO SHIFT THE PUMP TRANSMISSION WHILE THE TRUCK TRANSMISSION IS IN GEAR. ALWAYS PLACE THE TRANSMISSION TO NEUTRAL AND VERIFY THE SPEEDOMETER IS AT ZERO (0) BEFORE MAKING A PUMP TRANSMISSION SHIFT.

PUMPING OPERATIONS

PUMPING FROM DRAFT

Draft Limiting Factors

• When pumping from draft, water temperature will have a limiting effect on lift, water temperatures above 95°F (35°C) cause a noticeable decrease in lift when drafting.
• Barometric pressures below 29" Hg. can limit lift when drafting.
• High elevations, over 2000 ft., can affect maximum flow and lift available from the pump
• High elevations, over 8000 ft., can affect available engine power (turbocharged engine which can affect pump output). (2000 ft. on naturally aspirated engine).
• Longer than 20 ft. of suction hose lengths and some hose strainer styles can also affect maximum flow and lift available from the pump.
• As the vertical lift increases to above 6 ft. (1.8 m) on 2000 GPM pumps 8 ft. (2.5m) on 1750 GPM pumps or 10 ft. ((3m) on 1500 GPM or less pumps capacity will be reduced.

1. Position the apparatus as close to the water source as practical. The pump can draw 100% of its rated capacity with a 10 ft. (3m) (1250 or 1500 GPM, 5000 or 6000 LPM), 8 ft.(2.5m) (1750 GPM, 7000 LPM), 6 ft. (1.8m) (2000 GPM, 8000 LPM) vertical lift and one (1) (1250 and 1500 GPM), two (2) (1750 GPM) sets of 20 feet (6 meters) of suction hose.
2. As the vertical lift increases to above the factory standard (10', 8' or 6'), pump capacity is reduced.
3. Bring the apparatus to a complete stop, apply the parking brake, and shift the apparatus transmission to the **NEUTRAL** position. Make sure the apparatus is completely stopped before exiting the cab. Set all wheel chocks.
4. Connect suction hoses and strainers. Make sure strainers are at least 2 ft. under the water surface and also at least 2 ft. from the bottom of the water source.
5. Make sure the apparatus is at a complete stop before you attempt to shift from **ROAD** to **PUMP**.
6. Engage the in-cab pump shift control valve to the **PUMP** position. The **GREEN** shift warning lights illuminate, indicating a complete shift.

CAUTION!

DO NOT LEAVE THE CAB OR ATTEMPT TO PUMP UNTIL ALL THE GREEN PUMP LIGHTS IN THE CAB ARE ON. DO NOT OPEN THE THROTTLE UNLESS THE GREEN INDICATOR LIGHT ON THE OPERATOR PANEL IS ON.

7. Exit the driving compartment only after all the above steps are completed and you are sure that the appropriate lights in the cab and panel are **ON**.
8. Verify that the pump operator's panel **GREEN** shift indicator **OK TO PUMP** light illuminates and that all hose connections are complete.

9. Place the apparatus transmission in the proper pump operating range or gear. For most pumpers this is direct drive (1:1) ratio. The speedometer should register after the shift has been completed. If the shift does not complete, shift the transmission back to **NEUTRAL (N)** and repeat the entire procedures. In this case, the speedometer will not register after shifting to the pump position. See the chassis manual for details.
10. Activate the priming system.
11. Running the engine at speeds higher than 1,200 RPM during priming is not recommended. It does not improve the priming operation and can cause damage to the pump.

CAUTION!

IF THE DISCHARGE GAUGE READING DOES NOT INCREASE, THE INTAKE GAUGE READING DOES NOT FALL BELOW ZERO, OR THE PRIMING SYSTEM DOES NOT DISCHARGE WATER TO THE GROUND WITHIN 60 SECONDS, STOP THE PUMP AND CHECK FOR AIR LEAKS OR OTHER POSSIBLE PROBLEMS.

12. Watch the intake and discharge master gauges. When the pump is primed, the intake reading falls below zero (0), and the discharge pressure starts to increase. You may also hear water splashing on the ground, indicating the pump is primed.
13. Gradually open the discharge valve until water flows at a steady stream. Then open the other discharge valves as needed
14. Gradually open the engine throttle until the desired pressure and flow is achieved.

CAUTION!

DO NOT CAUSE A WHIRLPOOL AT THE SUCTION STRAINER. THIS ALLOWS AIR INTO THE PUMP CAUSING ROUGH OPERATION AND PULSATION. REPOSITION THE STRAINER OR REDUCE FLOW.

15. As the throttle is opened, the pressure gauge reading increases with the engine speed. If the engine speed increases without an increase in pressure, the pump can be cavitating.
16. If the pump is cavitating, warn personnel that the flow is being **REDUCED**. Close the throttle slowly until you operate without cavitation.

The following can also lead to cavitation:

Flowing more than the conditions or hose set up will allow.
Air enters with the water (leaks in hose, pump or plumbing, air can also enter from the water source due to the way water has been returned to the source)
Hot water (over 95 deg. F, 40 deg. C)
Low barometer pressure
High elevation (over 2000 ft. (600m))
High lift (over 10' (3m), 8' (2.5m) or 6' (1.8m))

Long suction hose lays (over 20 ft. (6m))
Restrictive suction hose strainer
Blocked suction strainer
Wrong size or quantity of suction hoses
Addition of suction inlet control valves

17. When a pump shutdown is desired while pumping from draft, reduce the engine speed to **IDLE** and close the discharge valves.
18. To resume pumping, open the throttle and discharge valves. If the pump over-heats from continued churning without water flow, open the discharge valves periodically to release hot water.
19. To avoid pump overheating, if not equipped with the thermal relief valve, open the pump auxiliary cooling system valve, or slightly open the tank fill line. Or also open a discharge valve. Direct water away from work area and personnel.
20. After completion of pumping procedures, gradually reduce the engine **RPM** to **IDLE** speed.

Pumping From a Hydrant, General Operation

1. Position the apparatus for the best hydrant hookup and discharge hose layout.
2. Bring the apparatus to a complete stop, apply the parking brake, and then shift the truck transmission into **NEUTRAL**. Make sure the apparatus is completely stopped before exiting the cab. The apparatus **MUST** be stopped before attempting to shift from road to pump.
3. Connect suction hose to hydrant and apparatus.
4. Open the hydrant. Bleed off the air from the suction hose.
5. Open the suction valve to allow water flow into the pump (if applicable).
6. Open the appropriate valve to expel air or prime the pump if so equipped.
7. Move the in-cab shift control from **ROAD** to **PUMP** Position. The Green **PUMP ENGAGED** indicator light on the panel control and **IN CAB** will light.
8. Place the transmission in the proper pump operating range or gear. For most apparatus, this is direct drive (1:1) ratio. On many apparatus the speedometer should register after the shift has been completed.
9. If the shift does not complete, shift the transmission back to **NEUTRAL** and repeat the entire procedure.
10. Some vehicles drive the speedometer from the front wheel of the chassis. In this case, the speedometer will not register after shifting to the **PUMP** position. See the chassis manual for details.
11. Exit the driving compartment only after all the preceding steps are completed and you are sure the appropriate lights in the cab and panel are **ON**.

CAUTION!

DO NOT LEAVE THE CAB OR ATTEMPT TO PUMP UNTIL ALL THE GREEN PUMP LIGHTS IN THE CAB ARE ON.

CAUTION!

DO NOT OPEN THE THROTTLE UNLESS THE GREEN INDICATOR LIGHT ON THE OPERATOR PANEL IS ON.

12. Verify that the pump operator's panel **GREEN** shift indicator **OK TO PUMP** light illuminates and that all hose connections are complete.
13. Gradually open the engine throttle until the master discharge gauge indicated the desired pressure.

CAUTION!

DO NOT REDUCE THE PRESSURE ON THE INTAKE GAUGE BELOW DEPARTMENT LIMITS. SERIOUS DAMAGE TO THE WATER MAIN COULD RESULT.

14. If the master intake gauge shows a vacuum before the desired discharge pressure or flow is achieved, you are receiving all the water that the suction piping (hydrant) can supply.
15. If you need to increase pressure when this occurs, pump flow must be reduced or the water supply improved.
16. To increase pressure, reduce the pump flow. However, the master intake gauge reading must be maintained at 5 PSI.
17. As the throttle (engine speed) is increased, the pressure gauge reading increases.
18. Close the throttle slowly until the pressure begins to stabilize and track with engine speed. If this does not correct the problem, you may be pumping more capacity than is available from the supply. Also check the inlet strainers for possible blockage.
19. Open the discharge valves.

IMPORTANT!

IF THE PUMP OVERHEATS AND IS NOT EQUIPPED WITH A THERMO RELIEF VALVE, OPEN THE VALVE TO THE PUMP AUXILIARY COOLING SYSTEM OR SLIGHTLY OPEN THE TANK FILL LINE, OR SLIGHTLY OPEN A DISCHARGE VALVE, TO CIRCULATE WATER

20. When pumping operations are completed, gradually reduce the pump pressure until the engine returns to **IDLE** speed.

PUMPING FROM APPARATUS WATER TANK

1. Position the apparatus for the best future access to water source hookup and discharge hose layout.
2. Bring the apparatus to a complete stop, apply the parking brake, and shift the transmission to the **NEUTRAL** position. Make sure the apparatus is at a complete stop before exiting the cab. Set all wheel chocks.
3. Open the tank suction valve.
4. Make sure the apparatus is at a complete stop before you attempt to shift from **ROAD** to **PUMP**.
5. Move the in-cab pump shift control valve to the **PUMP** position. The shift warning lights illuminate, indicating a complete shift.
6. Exit the driving compartment only after all the above steps are completed and you are sure that the shift completed lights in the cab and panel are **ON**.
7. Verify that the pump operator panel shift indicator **OK TO PUMP** green light is **ON** and that all hose connections are complete.

CAUTION!

DO NOT LEAVE THE CAB OR ATTEMPT TO PUMP UNTIL ALL THE GREEN PUMP LIGHTS IN THE CAB AND PUMP OPERATING PANEL ARE ON. DO NOT OPEN THROTTLE UNLESS ALL GREEN PUMP INDICATOR LIGHTS ON THE OPERATORS PANEL ARE ILLUMINATED.

8. Check the master discharge gauge to see if priming is necessary. Start the priming system.

CAUTION!

IF DISCHARGE GAUGE READING DOES NOT INCREASE, THE INTAKE GAUGE READING DOES NOT FALL BELOW ZERO, OR THE PRIMING SYSTEM DOES NOT DISCHARGE WATER TO THE GROUND WITHIN 60 SECONDS, STOP THE PUMP AND CHECK FOR AIR LEAKS OR POSSIBLE PROBLEMS.

9. Gradually open the engine throttle until the desired pressure or flow is achieved.
10. As the throttle is opened, the pressure gauge reading increases with the engine speed. If the engine speed increases without an increase in pressure, the pump may be cavitating.

WARNING!

DO NOT OPEN THROTTLE UNTIL ALL GREEN PUMP LIGHTS ARE ON.

11. Gradually open the discharge valve until the water emerges as a steady stream. Then open the other discharge valves to the desired setting.
12. To avoid pump overheating, if not equipped with the thermal relief valve, open the pump auxiliary cooling system valve, or slightly open the tank fill line. Or slightly open the tank fill line.
13. After completion of pumping procedures, gradually reduce the engine RPM until it is at an **IDLE** speed.

PUMPING IN RELAY

Relay pumping is the movement of water through a number of apparatus, from suction to discharge. Relay operations are necessary when the water source is too far away from the fire to be pumped by one apparatus. The number of apparatus is determined by how far the water source is from the fire, size of supply and discharge hose, and flow and final pressure required.

In some cases, when you are on the receiving end of a relay, it may help to set the suction dump very low. This limits the incoming pump pressure by dumping water on the ground before the discharge hose lines are connected and are flowing water. Then, as the incoming water is used, the relief valve control can be increased to the desired operating pressure. This technique also helps to purge air from the incoming hose and the pump before it gets to a dangerously high pressure. Use this procedure after the hose is positioned, the apparatus are in position and the pumps are engaged.

Relay Procedures

Note: When feeding through a pump, the pump must be in pump gear in order to lubricate the pump, and the gears.

1. Open two discharge gates on all pumps, except on the pump at the source, to expel air from the hose lines and pumps.
2. On each pump, attach the hose lines to one of the discharges and leave the other discharge uncapped.

Note: Uncapping the second discharge gate is not necessary if a relay valve is installed. The valve, connected to the intake side of the pump, automatically opens and dumps water on the ground if too high a pressure is supplied, protecting the pump.

Note: If no valve is present, you must watch the intake gauge for a high-pressure reading. If necessary, open the gate controlling the uncapped discharge to dump excess water on the ground and reduce pressure.

3. Supply the pump at the water source with water; prime if necessary.
4. The discharge pressure must not exceed the safe operating pressure of the supply hose.

IMPORTANT!

FOR SUPPLY HOSE AND PRESSURE SETTING INFORMATION, SEE NFPA STANDARDS 1962 AND INFORMATION SUPPLIED BY THE HOSE MANUFACTURER

5. When the water reaches the second pump, close the uncapped discharge gate. Repeat this step for all pumps until the water reaches the fire ground.
6. Adjust the throttle on the pump at the water source for the required operating pressure. Watch the gauges to avoid cavitation.
7. Adjust the discharge pressure or flow at the fire scene to supply the lines being used.
8. Observe the gauges carefully, and adjust the pressure or flow as needed.
9. Shutdown starts from the fire ground pump and works toward the water source. Gradually reduce pressure at the fire ground pump until you can disengage the pump.
10. Follow this procedure for every pump in the relay until the pump at the water source is shut down.

IMPORTANT!

AHJ (AUTHORITY HAVING JURISDICTION) TRAINING PROCEDURES MAY VARY FROM ABOVE. ALWAYS FOLLOW AHJ TRAINING PROCEDURES.

SERIES PUMPING

Series pumping operations are used when higher pressures are required than a single apparatus is capable of supplying. This can occur when the apparatus is supplying high-rise sprinkler or standpipe systems or long hose layouts.

CAUTION!

WHEN SUPPLYING HOSE LINES IN A SERIES PUMPING OPERATION IT IS POSSIBLE TO SUPPLY GREATER PRESSURE THAN THE HOSE CAN WITHSTAND. PRESSURE SUPPLIED TO THE HOSE SHOULD NOT EXCEED THE PRESSURE AT WHICH THE HOSE IS ANNUALLY TESTED BY THE AHJ.

CONSULT NFPA 1962, "STANDARD FOR THE CARE, USE AND SERVICE TESTING OF FIRE HOSE INCLUDING COUPLINGS AND NOZZLES," FOR THE TEST PRESSURES RECOMMENDED FOR THE TYPE OF FIRE HOSE USED BY YOUR AHJ.

In series pumping, the pumper directly attached to the water supply source pumps water through its discharge outlet(s) into the intake(s) of the second apparatus. This enables the second apparatus to discharge water at a much higher pressure than a single apparatus could have supplied.

Series Pumping

1. Connect the first apparatus to the hydrant connection. Open the hydrant until the pump is charged.
2. Position the second apparatus "discharge-to-intake" with the first apparatus.
3. Open a discharge to flow water.
4. Adjust the throttle on the first apparatus until the intake gauge reads approximately 5 PSI (.35 Bar).
5. Connect the second apparatus to the unused intake of the first apparatus
6. Both apparatus pump water to the fire.

AHJ (AUTHORITY HAVING JURISDICTION) TRAINING PROCEDURES MAY VARY FROM ABOVE. ALWAYS FOLLOW AHJ SOPS.

Pump-to-Road Shift Procedures

1. Verify that the operator's hand throttle or governor control is at IDLE speed.
2. Shift the truck transmission into the **NEUTRAL** and wait about four (4) seconds. Check to make sure the speedometer reads **ZERO**
3. Set the pump to the **ROAD** position. The in-cab and panel pump indicator lights go out as the pump transmission shifts into the **ROAD** position.

IMPORTANT!

REFER TO THE AHJ PROCEDURES FOR REMOVING WHEEL CHOCKS, AND THE LAYOUT AND CONNECTION OF SUCTION AND DISCHARGE HOSES.

Manual Override Pump Shift Procedures

Before implementing manual override shift procedures, repeat the recommended shift procedures. If the shift fails, proceed as follows:

1. Bring the apparatus to a complete stop.
2. Apply the parking brake, and chock the wheels.
3. Shift the transmission to the **NEUTRAL**.
4. For **PUMP** or **ROAD** position, place the in-cab shift control in the **NEUTRAL** position.
5. Shut down the engine.

WARNING!

DO NOT ATTEMPT EMERGENCY SHIFT PROCEDURES WHILE THE ENGINE IS RUNNING.

6. Attempt manual override procedure at the shift cylinder on the pump gearbox as follows:
    a. The shift shaft is designed to accept a drift punch.

b. Insert the punch into the hole provided, then pull or push the shaft manually.
c. Push the shaft toward the front of the apparatus for **PUMP** position or push to the rear of the vehicle shaft for **ROAD** position
d. If the shift stroke cannot be completed manually, turn the drive shaft slightly by hand to realign the internal gears and repeat the manual shift.

7. When gearbox shift is complete, make sure all personnel are clear of the under-side of that apparatus and start the engine and proceed with the required operation.

Post Pumping Operation Procedures

1. Return the engine to **IDLE**, and then slowly close all valves.
2. Place the transmission in **NEUTRAL**, and then slowly shift to **ROAD** to disengage the pump. Shut down engine.
3. Disconnect Hoses and remove fittings, adapters or valves not normally attached during road operations. Repack equipment and hose on apparatus.
4. Drain the pump. Open the discharge valves, remove suction tube caps, and discharge valve caps. Open the pump body's drain valves.
5. If sea water, dirty water, alkaline water or foam solution has been used, **FLUSH THE PUMP WITH CLEAN WATER.**
6. Remove the wheel chocks only when preparing to leave the site.

PREVENTATIVE MAINTENANCE

OVERVIEW

The following procedures are for normal use and conditions. Extreme conditions or heavy usage may indicate the need for increased maintenance. This manual will identify some extreme conditions and the additional steps needed to ensure pump life and continuing dependability. Always follow AHJ maintenance and test procedures.

POST OPERATION

1. Inspect the suction hose and rubber washers. Remove foreign matter from under gaskets. Replace worn, damaged, or dry gaskets.
2. Verify that all discharge, intake and drain valves are operational and closed.
3. Tighten suction caps.
4. Make sure the gearbox oil reservoir is full to correct level with the correct type of oil.
5. Report to AHJ any irregularities observed during operations or at post operation inspection.

EXTREME CONDITIONS

Extreme conditions occur when operating in freezing weather or as a result of pumping from a water source that contains material that is harmful if not flushed out.

During Freezing Weather

In freezing weather, drain the pump as follows:

1. Open all discharge and suction valves, remove suction tube caps, and discharge valve caps.
2. Open pump body drain cocks and/or multiple drain valve.
3. After the pump is completely drained, replace all caps and close all valves.

Pumping Salt Water, Contaminated Water, or Foam Solution

1. Flush the pump and suction hoses using fresh, clean water.
2. After pumping foam, flush as above until all foam residues are flushed from the system.
3. Drain the gearbox cooler, if applicable.

WEEKLY

Weekly maintenance consists of the following:

- Test the relief valve or governor system
- Test the priming system
- Test the pump shift warning indicator lights
- Perform valve maintenance
- Check and clean the intake strainers
- Check pump driving engine per manufacture's recommendations
- Verify all gauges are in working order
- Operate pump and all valve controls

Report to AHJ any irregularities observed during preventive maintenance inspection.

Relief Valve or Governor Test

If your apparatus is equipped with an electronic governor or relief valve system, follow the manufacturer's instructions for weekly preventive maintenance.

Priming System Test

1. Tighten all pump caps, and close all pump valves.
2. Activate primer control while you watch for a below-zero reading on the master intake gauge.
3. Continue operation for three (3) to five (5) seconds after the primer starts flushing water through the pump to clear any possible dirt or slug buildup.
4. Verify that the master intake gauge readings hold for approximately five (5) minutes after you release the primer control. A drop of 10" Hg. in this 5 minute period is anticipated per NFPA 1901.
5. If air leaks are heard or the gauge bounces back to or above zero (0), the pump or valves require service.

Pump Shift Warning Lights

1. Switch to non-pumping operations and verify the warning indicators are OFF.
2. Verify that the warning indicators in the cab and on the pump control panel function properly.

CAUTION!

MAKE SURE EVERYONE IS CLEAR OF THE APPARATUS BEFORE SHIFTING TO THE PUMP POSITION. VERIFY THE PARKING BRAKE IS SET AND THE WHEELS ARE CHOCKED TO PREVENT ANY MOVEMENT OF THE APPARATUS.

3. Repair or replace any malfunctioning indicators.

Valve Maintenance

Refer to the separate valve manuals for proper valve maintenance procedures. Lubricate all moving parts of the suction, discharge, hose drain, and multi-drain valves and valve linkage with a good grade of grease.

Intake Strainers

- Check and clean any debris from the intake.
- Flush the pump, if required, using AHJ procedures.
- Repair or replace any damaged strainers.

Verify All Gauges are in Working Order

Any gauge that is repeated in the cab or another panel, must agree with the gauge on the operator's panel. Gauges not reading within 10% of the calibrated test gauge must be removed from service and re-calibrated.

Operate Pump Controls

Operate the pump drive controls to verify the pump engages. Verify the indicator lights work properly.

Inspect Water and Foam Tanks

Inspect water and foam tanks for proper level and gauge readings. If any debris is present, flush the tanks to protect the pump from wear caused by dirty water or foam concentrate.

Check Drive Engine

See engine manufacturer's manual for wear and proper operation.

MONTHLY

Monthly maintenance includes the weekly maintenance procedures plus:

- Valve, control and linkage lubrication
- Check Gearbox lubrication level
- Checking the pump and drive line bolts
- Perform a dry vacuum test
- Lubricate suction threads

Report to AHJ (Authority Having Jurisdiction) any irregularities observed during preventive maintenance inspection.

Gearbox Lubrication

Incorrect oil types or amounts of oil result in unnecessary high oil temperature and possible wear or damage. Change the oil every 12 months, depending on pump usage. Lubricant required is Citgo Synthetic 80W-140.

1. Gearcase oil capacity for midship applications is 11 quarts.
2. The oil level should be up to the middle of the sight glass (see page 66).
3. Have clean disposable shop rags and oil dry handy and a suitable container to collect the fluid.
4. If the oil appears "milky" a water leak is indicated. Remove the drain plug and drain the oil into a suitable container. Also examine the oil for metal flakes or other contamination.
5. Either condition indicates maintenance is required. Report to AHJ any irregularities observed during oil inspection

Pump, Drive Line and Flange Bolts

Check all pump, drive line and flange bolts to ensure:

- No bolts are missing

- All bolts are tight. Use a torque wrench and torque bolts to the drive train manufacturer's recommended specifications.
- Bolts used are "Grade 5" minimum for mounting and "Grade 8" minimum for the drive line.

Priming System Test (Dry Vacuum Test)

(Refer to NFPA 1901 or NFPA 1911)

1. Close all valves and drains. Cap all suction openings and the outlet of the suction side relief valve (if so equipped).
2. Connect a test vacuum gauge or manometer to the intake test gauge connection on the pump panel.
3. Engage the priming pump until the gauge indicates 22" Hg.
4. Compare the readings of the test gauge and the apparatus gauge. Note any difference.
5. **STOP** the priming pump and observe the gauge. If the vacuum falls more than 10" Hg. In five (5) minutes it is an indication of at least one air leak.
6. Vacuum leaks may often be detected by ear if the engine is turned **OFF**. Correct leaks immediately before returning the pump to service.
7. Test the suction hose as follows:
    - Attach the suction hose to the pump.
    - Place the suction tube cap on the end of the hose in place of a strainer.
    - Close all valves and drains. Cap all suction openings and the outlet of the suction side relief valve (if so equipped).
    - Connect a test vacuum gauge or manometer to the intake test gauge connection on the pump panel.
    - Engage the priming pump until the gauge indicates at least 22" Hg.
    - If the vacuum falls more than 10" in 5 minutes, at least one air leak exists.
    - Verify the test gauge and the apparatus gauge display the same readings. Repair or replace and gauges that do not display the correct pressure.

IMPORTANT!

IF LEAKS CANNOT BE DETECTED BY FOLLOWING THE PROCEDURE, IT IS ADVISABLE TO TEST THE PUMP HYDROSTATICALLY.

TO TEST:

- Open all valves
- Place caps on all valves
- Connect a positive pressure source (typically 250 PSI / 17 BAR)
- Bleed air out of the highest point on the pump system as you pressurize the pump, close outlet after water is observed exiting this point. Continue pressurizing until you reach 250 psi
- Inspect the pump for leaks

ANNUAL

Annual maintenance consists of post-operation, weekly, and monthly maintenance plus the following tasks:

- Replacing the pump gearbox oil
- Relief valve or governor system, check and repair
- Checking individual drain lines from the pump to the multi-drain to ensure proper drainage and protection from freezing.
- Disassembly of priming pump to clean – if applicable
- Yearly pump test to check performance levels, including Tank-to-Pump Flow Rate. (Also see NFPA 1911 standard for more details.)
- Lubricating the power shift cylinder, and shift control valve with air cylinder oil.
- Check gauge calibration
- Report to AHJ any irregularities observed during preventive maintenance inspection, servicing or testing.

Replace Gearbox Oil

1. Remove the drain plug and drain the gearbox oil into an approved container.
2. Have clean disposable shop rags and oil dry handy.
3. Examine the oil for contamination (water turns the oil a milky color or settles to the bottom)
4. Properly dispose of the used oil
5. Inspect the magnetic drain plug. If metal filings are present, visually inspect and clean
6. Remove the oil fill plug and install the magnetic drain plug, using suitable thread sealant.
7. Fill the gearbox with 11 quarts Citgo Synthetic 80W-140 gear oil. Which will be the middle of the oil level sight glass.

Check Drain Lines to Multi-Drain

Drains are supplied on the pump and piping at the lowest points where water could collect and freeze.

Sometimes drain lines are piped together to a multi-drain to allow the entire system to be drained by one valve.

It is important to inspect each drain line to ensure the entire system is draining when the valve(s) are operated. Inspect each connection and verify the individual lines are free of debris. Repair and/or replace any lines that are damaged, kinked, or corroded.

Performance Testing Overview

The yearly standard performance test consists of checking the apparatus, (according to rating) at three capacities and comparing the results to when the pump was first placed in service. This provides some comparison of performance deterioration, if any.

Note: Refer to NFPA 1911 for additional testing information.

A pump must be able to pump FULL rated capacity at 150 PSI (10 Bar), 70% capacity at 200 PSI (14 Bar) and 50% capacity at 250 PSI (17 Bar).

	GPM/LPM	GPM/LPM	GPM/LPM	GPM/LPM	GPM/LPM	GPM/LPM
Capacity	Pressure (PSI) (BAR)	1250 (5000)	1500 (6000)	1750 (7000)	2000 (8000)	2250 (9000)
100%	150 (10)	1250 (5000)	1500 (6000)	1750 (7000)	2000 (8000)	2250 (9000)
70%	200 (14)	875 (3500)	1050 (4200)	1225 (4900)	1400 (5600)	1575 (6300)
50%	250 (17)	625 (2500)	750 (3000)	875 (3500)	1000 (400)	1125 (450)

Annual Pump Test Results in PSIG (Bar)			
	Capacity at 150 PSI (10 BAR)	Capacity at 200 PSI (14 BAR)	Capacity at 250 PSI (17 BAR)
Category			
Hose Layout			
Nozzle Size			
Nozzle Pressure, PSI (BAR)			
Flow GPM (LPM)			
Current Engine Speed, RPM			
Engine Speed from Original Test Documents			
Lift and Suction Hose Size and Number			
Pump Master Discharge Pressure, PSI (BAR)			
Pump Master Intake Vacuum Reading in HG (BAR)			

Tank-to-Pump Flow Rate Test

Note: This procedure is provided as a reference only. It does not supersede any AHJ procedures.

1. Fill the water tank until it overflows.
2. Close the tank fill line; bypass the cooling line, and all the pump intakes.
3. Attach sufficient hose lines and nozzles to pump the required discharge rate.
4. With the pump in gear, open the discharge and begin pumping water.
5. Increase the engine throttle until the maximum consistent pressure is obtained on the master discharge gauge.
6. Close the discharge valve without changing the throttle setting. Refill the tank. The bypass valve may be opened to prevent pump overheating.
7. Reopen the discharge valve and check the flow through the nozzle using a Pitot tube or flow meter. Adjust the engine throttle to bring the pressure to the amount previously determined.
8. Compare the flow rate measured to the NFPA minimum. The minimum flow rate should be continuously discharged until 80% of the tank is discharged.

Performance Testing Equipment and Materials

Current Equipment Pump Rating	Max Lift	Normal Suction Hose Size	Suction Hose Length	Qty. of Suction Hose Sets
1250 & 1500 GPM (5000 & 6000 LPM)	10 ft. (3M)	6 in. (150 mm)	20 ft. (6m)	One (1)
1750 GPM (7000 LPM)	8 ft. (2.5M)	6 in. (150 mm)	20 ft. (6m)	Two (2)
2000 GPM (8000 LPM)	6 ft. (1.5M)	6 in. (150 mm)	20 ft. (6m)	Two (2)
2250 GPM (9000 LPM)	6 ft. (1.5M)	6 in. (150 mm)	20 ft. (6m)	Two (2)

- Use smooth bore test nozzles of accurate size with the Pitot gauge. The volume pumped is then determined by reference to discharge tables for smooth nozzles. Preferably, nozzles will be used on a Siamese deluge gun for greatest accuracy. A stream straightener, just upstream of the nozzle is required.
- Refer to AHJ procedures for pump testing procedures and practices as well as applicable NFPA 1911 standards.
- For Pitot Gauge accuracy, the nozzle pressures should be between 60 and 100 PSIG (4 and 7 Bar).
- The amount of discharge hose required for the service tests is dependent on the flow requirements and capacity test point. Provide adequate hose to discharge the rated capacity with a flow velocity 16 to 32 ft./sec.
- NFPA standards specify both GPM and pressure, it is necessary to restrict the flow somewhat to build up the pump pressure. In normal pumping, this restriction would be caused by the friction loss in the lines and gating the discharge valves to obtain pressure.

Worn Clearance Rings and Impeller Hubs

Do not assume that clearance ring wear is at fault, until all other possible causes of low performance have been explored.

Other Possible Causes

- Test Gauges not certified
- Wrong suction hose, size and length
- Restrictive suction hose strainer
- High lift
- High water temperature
- Air leaks or air pockets or suction hose or suction manifold
- High altitude
- Insufficient restriction on pump discharge
- Wrong pitot size or uncertified test tips (stacked tips do not work)
- Using a restrictive or turbulent monitor
- Insufficient quantity of water at test site

Clearance rings limit the internal bypass of water from the discharge side of the pump back to suction.

The radial clearance between the impeller hub and the clearance rings is only a 6 to 20 thousandths of an inch when new. In clear water, the clearance rings continue to effectively seal for many years of operation. In dirty or sandy water, the impeller hub and clearance rings wear faster. The more wear, the greater the bypass and lower pump performance. It should not be necessary to replace clearance rings until a loss in pump performance is noticed during the annual test. Sometimes, replacement of the clearance rings reduces the bypass and restores the pump to near original performance.

A complete restoration can require that the impeller also be replaced.

Troubleshooting

Pump Will Not Engage

- Manual transmission: Check clutch disengagement. Drive shaft must come to a complete **STOP** before attempting pump shift.
- Automatic transmission: Automatic transmission not in **NEUTRAL.**
- Repeat recommended shift procedures with transmission in **NEUTRAL** position.
- Insufficient air supply in shift system. Check system for loss of air and possible air leaks, locate and repair leak(s). Leakage, if external, may be detected audibly. Internal leakage is more difficult to detect and will require disassembly.
- Use manual override if necessary

CAUTION!

DO NOT LEAVE THE CAB OR ATTEMPT TO PUMP UNTIL ALL THE GREEN PUMP LIGHTS IN THE CAB AND PANEL ARE ILLUMINATED

Pump Loses Prime or Will Not Prime

Electric priming systems

Primer must be operated weekly to prevent sticking or gumming up. When using the primer always operate until water exits the primer pump. This cleans the primer pump of dust and debris.

- NO engine speed is required to operate the electric primer. However, 1,000 engine RPM maintains the electrical system while providing enough speed for initial pumping operations. Inoperative priming system or possible clogged priming pump. Using lubricant on the vanes and vane slots during disassembly and cleaning eventually causes a gummy residue to develop, rendering the system inoperative. **DO NOT** lubricate vanes or vane slots.
- Check the priming system by performing a "Dry Vacuum Test" per NFPA standards. If the pump holds vacuum but primer pulls less than 22" Hg (.75 BAR), it could indicate excessive wear in the primer.
- Repair and/or replace accordingly.

Air Primer Systems

- Insufficient air supply
- Plugged air line
- Dirt in venturi(s)

Pump loses Prime

- Check all drains, intake and discharge valves and caps, make sure they are closed.
- Re-prime the pump. Check for pump system leaks by performing a Dry Vacuum Test per NFPA standards or by hydrostatically testing the system to 250 psi, fix leaks.

- In some severe cases, an extremely worn impeller and wear rings can be the problem, retest the pump per NFPA 1911.

Suction lifts too high

DO NOT attempt lifts exceeding 23 feet (7 meters) except at low elevation.

Blocked suction strainer

- Remove obstruction from suction hose strainer.
- Thoroughly clean strainer screen.

Suction connections

- Clean and tighten all suction connections.
- Check suction hose and hose gaskets for possible defects - repair and/or replace accordingly.
- Check hose assembly by attaching hose to pump and cap the other hose end of the hose and perform a Dry Vacuum Test.

Air trapped in suction line

- Do not place any part of the suction hose higher than the suction intake.
- Suction hose should be laid out with continuous decline to fluid supply.
- If air trap in hose is unavoidable, repeated priming may be needed to eliminate air pockets in suction hose.

Insufficient priming

Proper priming procedures should be followed.

- Do not release the primer control before assuring a complete prime.
- Open the discharge valve slowly at completion of prime to ensure complete prime.

NOTICE!

DO NOT RUN THE PRIMER OVER 60 SECONDS. IF PRIME IS NOT ACHIEVED WITHIN 60 SECONDS, STOP AND LOOK FOR CAUSES

Pump pressure too low when nozzle is opened

- Prime pump again and adjust for a higher pump pressure while opening the discharge valve slowly.

Air leaks

Attempt to locate and correct air leaks using the following procedures:

- Perform “Dry Vacuum Test” on pump per NFPA standards with 22” (.74 BAR) minimum vacuum required with loss not to exceed 10” Hg. (.37 BAR) in five (5) minutes.
- If a minimum of 22” Hg.(.74 BAR) cannot be achieved, the priming device or system may be malfunctioning, or the leak is too great for the primer to overcome (such as an open

valve). The loss of vacuum indicates leakage and could prevent priming or cause loss of prime.
- After priming shut **OFF** the engine. Audible detection of a leak is often possible.
- Connect the pump suction to a hydrant or the discharge of another pumper to pressurize the pump with water. Look for visible leakage and correct. A pressure of 100 PSI (6.9 Bar) should be sufficient. **DO NOT** exceed pressure limitations of pump, accessories or piping connections.
- The suction side relief valve can leak. Plug the valve outlet connection and retest.

Insufficient Pump Capacity

Insufficient engine power

- Engine power check and tune up may be required for peak engine and pump performance.
- Recheck pumping procedure for recommended transmission gear or range. Use hand held speed counter reading off the input drive shaft to check actual speed against possible clutch or transmission slippage or inaccurate tachometer.

Relief valve improperly set - if so equipped.

- If relief valve pressure is set too low it allows the valve to open, bypassing water.
- Reset the relief valve pressure accordingly.
- Relief valve may be malfunctioning and staying open, bypassing water.
- Repair relief valve.

Suction hose diameter is too small for the volume being discharged

- Use larger suction hose.
- Shorten total length by removing one length at a time.
- Reduce volume of discharge.

Restriction in suction line at strainer

- Remove any debris restricting entrance of water at the strainer.
- Preventive Maintenance, heading “Intake Strainers”
- “Air Leaks” under drafting conditions

Partial collapse of the lining in the suction hose

- Damage to the outer lining may allow air between the outer and inner linings causing a partial collapse.
- Replace hose and retest.

Engine governor set incorrectly.

- If the engine governor is set too **LOW** (pressure), when on automatic, engine speed decelerates before the desired pressure is achieved.
- Reset governor per manufacturer’s procedures.

Truck transmission in wrong gear or clutch is slipping

- Recheck the pumping procedures for the recommended transmission or gear range.
- Use a speed counter on the main drive shaft, forward of pump to check speed against possible clutch or transmission slippage or inaccurate tachometer.
- Check truck manual for proper speed counter ratio.
- Drafting from a lift over 6, 8 or 10 ft. (1.8, 2.5, 3 m) or higher than 2000 ft.(600 m) elevation or when the water source temperature is higher than 95 deg. F (40 deg. C).

These conditions will also reduce the pump's performance

- Items are lodged in the impeller - Use a scope thru the suction inlet and visually inspect the eye of the impeller for possible items lodged in the impeller.
- Back flushing the pump may dislodge the item.

Worn clearance rings and impeller wear hubs. Exhaust all other possible causes before investigating this cause. This will require pump disassembly to measure the radial clearance between the ID of the clearance rings and the OD of the impeller hubs. If the difference is greater than 40 thousands, performance will be affected.

Engine Speeds Too High for Required Capacity or Pressure

- Truck transmission in wrong gear or range.
- Check the pumping procedures for the recommended transmission or gear range

Lift too high, suction hose too small or too long

- Higher than normal lift, 6, 8, or 10 ft. (1.8, 2.5, 3 m), can cause higher engine speeds, high vacuum and rough operation.
- Use larger suction hose or more suction hose sets.
- Move the pump closer to the water source as needed.

Cavitation (Pump beginning to cavitate)

Discharging more water than the pump is taking in

- Increase the flow into the pump with more and/or larger intake lines.
- Gate the discharge valves to reduce flow and maintain pressure.

Air leak

- Verify that the air bleeder on the suction tube is NOT open.
- Locate and eliminate all air leaks during maintenance.

Drafting too high

- Verify lift hose, hose friction, water temperature and other lift limiting factors are reduced or eliminated.
- Locate the pump closer to the water source.

Water temperature too high

- Reduce volume discharge by lowering the RPM or gating the discharge valves.

- Locate a source of cooler water.

Discharging more water than the pump was designed to flow

- Verify pump capacity rating and discharge output that is being created. Incorrect test equipment or inaccuracy in flow reading procedures can cause the pump to cavitate.

Water/Moisture in Pump Gearbox

Leak coming from above the pump

- Check all piping connections and tank overflow for possible spillage falling directly onto the pump gearbox.
- Repair accordingly.

Operating or a driving condition that submerges the gearbox in water

- Visually inspect the unit for external signs of water leakage.
- Was the unit submerged in water? Does your unit include an air vent / breather where water can enter if submerged? If so, change oil.

Normal condensation

- Depending on area / region where unit is operated, normal condensation can develop over time.
- Periodic inspection and possibly more frequent oil changes are needed.

WARNING!

BEFORE WORKING ON THE PUMP, DISCONNECT SUCTION AND DISCHARGE PIPING AS NEEDED AND DRAIN THE PUMP.

THE PUMP, GEARBOX AND ASSOCIATED ACCESSORIES CAN BE HEAVY AND BULKY. BE CERTAIN TO USE PROPER LIFTING DEVICES CAPABLE OF HANDLING THE LOAD WHEN REMOVING OR INSTALLING THESE COMPONENTS BE SURE TO WEAR SAFETY EQUIPMENT WHEN REMOVING OR INSTALLING PRESS FITTED PARTS. FAILURE TO COMPLY MAY RESULT IN SERIOUS EYE INJURY.

ALL FASTENERS ON THE PUMP AND GEARBOX ASSEMBLIES ARE SELECTED FOR THEIR APPLICATION. IT IS NOT RECOMMEND REPLACING FASTENERS WITH ANY THING OTHER THAN THE PART PROVIDED. REPLACING WITH A WEAKER ALTERNATIVE POSES A SERIOUS SAFETY RISK.

ALL FASTENERS MUST BE INSTALLED WITH A LOCKING ANAEROBIC ADHESIVE SEALANT, SUCH AS LOCTITE® #243.

HAVE CLEAN DISPOSABLE SHOP RAGS AND OIL DRY HANDY.

Tools Required

Lifting hoist, chains, choker and lifting eye bolts
Floor or transmission jack
Ball peen hammer, Dead Blow Hammer
Center punch, Drift punches
Allen wrenches
Strap wrench
Snap ring pliers
Hooks to pull mechanical seal/seat out
Gasket scraper
Pry bars
Hard wood block
Ratchets, sockets, and wrenches for assembly and disassembly, 3/8" to 1-1/8"
Large sockets, 6 point, 2-1/4" (drive line) and 2-1/2" (impeller)
Torque wrench capable 40, 150 and 300
Pan (to collect drip oil), Disposable rags, Oil dry
Wedges
Bearing puller

Leaking oil seal or mechanical seal

- Inspect the oil seals and replace as needed. If the oil seal checks OK, the mechanical seal may be leaking.
- There must be NO leaks at the mechanical seal.
- Hydrostatic test the system to determine leakage.

Bolt Torque Chart

Thread	Grade 5 (1)		Grade 8 (2)	
	Dry (3) lb-ft	Lubed (4) lb-ft	Dry (3) lb-ft	Lubed (4) lb-ft
1/4-20	8	6.3	12	9
5/16-18	17	13	25	18
3/8-16	30	23	45	35
7/16-14	50	35	70	55
1/2-13	70	55	110	80

1. Minimum tensile strength for Grade 5 bolts is 120ksi. Proof load is 85ksi
2. Minimum tensile strength for Grade 8 bolts is 150ksi. Proof load is 120ksi
3. Dry K value assumed to be K=0.20
4. Lubricated K value assumed to be K=0.15
5. Tightening torque values are calculated using the industry standard formula. *T=KDP*, where *T*=tightening torque (in-lbs), *K*=friction coefficient, *D*=nominal bolt diameter (in), and *P*=bolt clamp load. Values are then converted into lb-ft.

PUMP MAJOR REPAIR

This section describes the removal, inspection, and reinstallation of the pump and gearbox. Follow the disassembly instructions in the order they appear, during the process, at any point, following the instructions in the reverse can reassemble the unit.

A trained and qualified service technician, with sufficient knowledge, experience and the proper tools, should perform service.

When new parts are required, only use Ahrens-Fox approved parts.

GENERAL REPAIR GUIDELINE

IMPORTANT!

READ ALL INSTRUCTIONS THOROUGHLY BEFORE BEGINNING ANY SERVICE REPAIR.

1. Place apparatus out of service in accordance with AHJ's SOP.
2. Park the apparatus on a level surface. Set the parking brake and chock the front and rear wheels in accordance with AHJ's SOP.
3. Mark, tag or photograph the orientation of all mechanical and electrical components and connections to the pump and/or gearbox before disassembly.
4. Plan the best method for servicing whether in the apparatus or removal from the top or bottom of the apparatus, and which manifolds, valve panels or structures will need to be removed.

CLEANING AND INSPECTION GUIDELINES

1. Inspect all components (bearings, seals, gears, etc.) for excessive or abnormal wear including pitting, scoring/scratches, cracks splits, etc.

IMPORTANT!

WHEN REASSEMBLING, ALL COMPONENTS MUST BE CLEAN AND FREE OF DEBRIS.

2. Replace O-rings, oil seals, and gaskets whenever they are removed.
3. Clean all gasket material from mating surfaces before installing a new gasket. Be careful not to score the machined surfaces.
4. Install new gaskets and apply a light coat of grease to the gasket to hold it in place. Where applicable trim gaskets to match the contour of the matching part(s).
5. Lightly oil or grease the shaft, O-ring seals and lip seals with a coating of general purpose grease before reinstalling, especially when pressed in. Use only the special lubricant listed in this manual when installing a mechanical seal or its stationary seat.
6. Never reuse a mechanical seal.

7. See “Lube and Sealant Specifications” for recommendations.
8. Replace any hardware that shows signs of excessive wear.
9. Clean bearings and other components using only recommended solvents.

IMPORTANT!

WHEN REPLACING TAPERED BEARINGS, DO NOT INTERCHANGE BEARING MANUFACTURER’S COMPONENTS. THE BEARING RACE, CONE SPACERS AND SNAP RINGS MUST ALWAYS BE REPLACED IN MATCHING SETS AS SUPPLIED BY THE MANUFACTURER

REMOVING THE COMPLETE PUMP ASSEMBLY

1. First, review all instruction and data in this manual and the information on the pump installation drawing.
2. Drain oil from the gearbox.
3. Remove control linkage, panels, structure and valves as needed to gain access to pump.
4. Disconnect drive shafts, air lines, electrical wiring and cooling lines, as necessary, from the gearbox, label as needed.
5. Disconnect drain lines, gauge lines, suction and discharge manifolds form the pump volute.
6. Install eyebolts into the lifting holes on the pump volute and gear box top or use a heavy duty transmission jack.

CAUTION!

ALWAYS USE PROPER LIFTING AND SUPPORT EQUIPMENT (JACKS, HOISTS, STRAPS, ETC.) WHEN SERVICING THE UNIT. CARE MUST BE TAKEN WHEN USING CHAINS TO PROTECT FINISHED SURFACES FROM SCRATCHES.

7. With the pump assembly properly supported and balanced, disconnect the mounting brackets that secure the assembly to the apparatus chassis frame.
8. Carefully remove the assembly from the apparatus and place on a clean work area. Secure into a suitable and stable holding device. Care must be taken not to damage any machined surfaces.

INSTALLING THE ASSEMBLY INTO THE APPARATUS

1. Review manual and installation drawings.
2. Install the pump and gearbox assembly into the apparatus before filling with oil. Attach proper supporting devices and stabilize the assembly before moving to the apparatus.
3. Place the pump assembly into the correct location in the apparatus.

Apply Loctite and secure the pump assembly to chassis frame. Torque the fasteners to proper values in accordance with manufacturer’s recommendations.

4. Remove the lifting device and lifting eyebolts.
5. Connect the drive shaft to the gearbox. Apply a coating of Loctite #243 to the fasteners and torque to the manufacturer's specifications.
6. Connect all components to the gearbox.
7. Fill the gearbox to the proper oil level.
8. Attach suction and discharge manifolds, with new gaskets, gauge lines and drain lines.
9. Reassemble and connect all components removed to gain access to the pump assembly.
10. Reinstall apparatus frame work and body panels previously removed.
11. Test the pump per your AHJ's requirements.
12. Recheck and top-off oil levels and return the apparatus to operation.

REMOVING THE GEARBOX AND IMPELLER ASSEMBLY

CAUTION!

ALWAYS USE PROPER LIFTING AND SUPPORT EQUIPMENT (JACKS, HOISTS, STRAPS, ETC.)

1. Drain gearbox oil.
2. Disconnect shift switch wire connections, shift cylinder air lines and front and rear drive shafts.
3. Remove nuts and bolts holding the volute to the gearbox.
1. **NOTE:** Care must be used when pulling pump out of the volute to not damage the impeller.
4. Remove the gearbox from the apparatus. Move the assembly to a clean work area and clamp into a suitable and stable holding device.
5. Place a temporary cover over the exposed pump assembly to prevent dirt and debris contamination.

Gearbox and Impeller Assembly Installation

1. Install O-ring on volute.

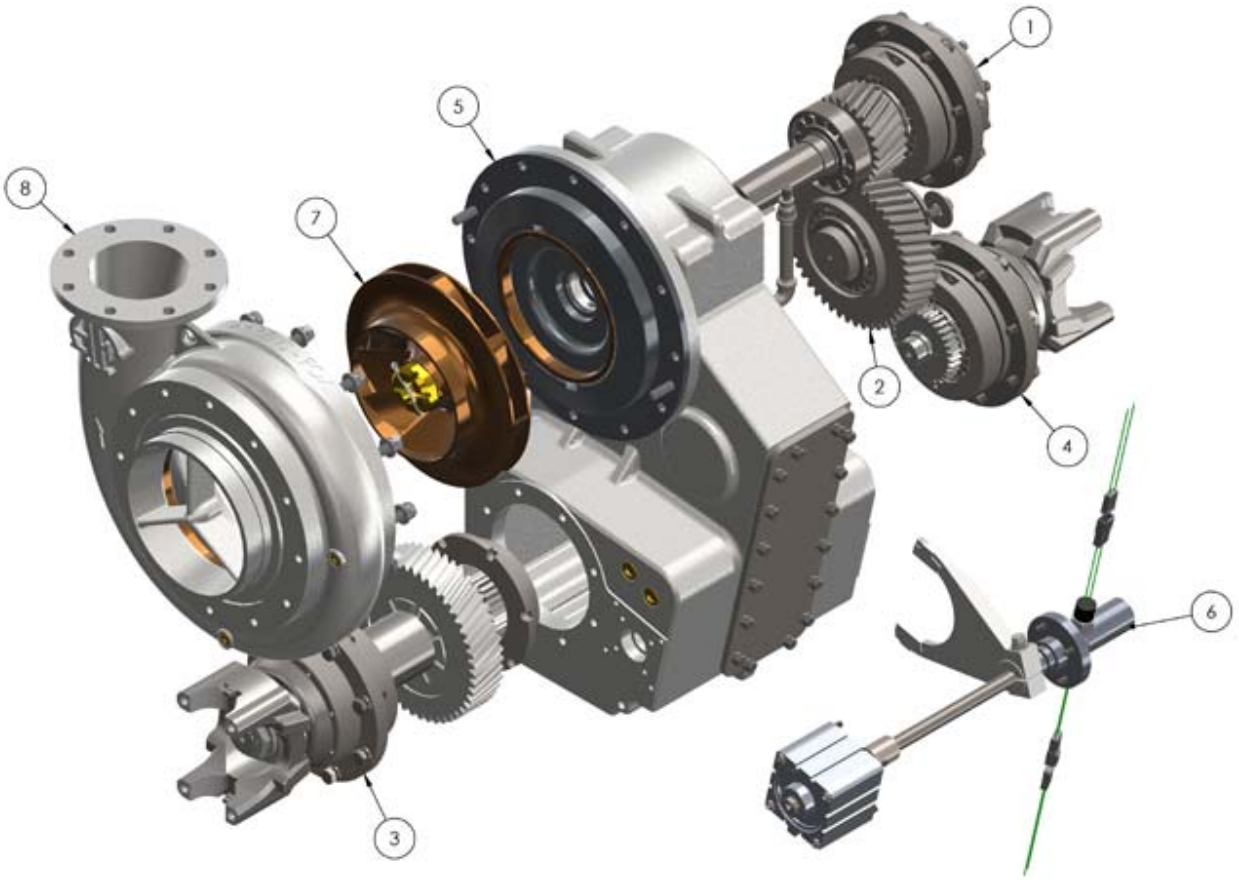
2. Lift and slide in gearbox into place around the rear bearing housing. Apply Loctite #243 and insert two or three screws through the rear bearing housing. Tighten screws hand tight. Insert and tighten nuts and bolts holding volute to inboard head. Apply Loctite #243 and insert screws. Tighten screws hand tight.
3. Apply Loctite #243 and insert the remaining screws through the rear bearing housing and gearbox cover and gaskets. Tighten all screws in a crisscross fashion to ensure a uniform seal, then torque.
4. Reinstall mounting brackets
5. Connect drive shafts, cooling lines, air hoses, and electrical connections to gearbox.
6. Fill gearbox with oil.
7. Test the pump for proper operation per your AHJ requirements.
8. Recheck and top off oil levels before returning the apparatus to operation.

BASIC PUMP MODEL

PUMP ASSEMBLY

Major pump sub-assemblies

Item Number	Part Number	Description	Qty	Page
1	63471-1A	Assembly, Impeller Shaft	1	52
2	63471-33A	Assembly, Idler Shaft	1	57
3	63471-39A	Assembly, Drive Shaft	1	61
4	63471-58A	Assembly, Tail Shaft	1	59
5	63471-60A	Assembly, Gear Box	1	53
6	63471-77A	Assembly, Pump Shift	1	56
7	63471-92A	Assembly, Impeller	1	43
8	63471-103A	Assembly, Volute	1	54



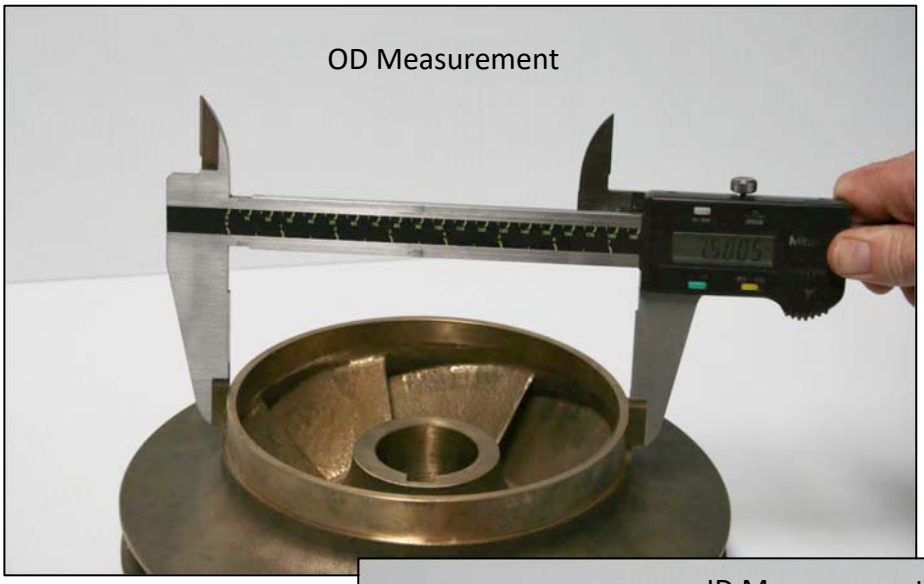
IMPELLER ASSEMBLY

Inspection – Clearance Rings

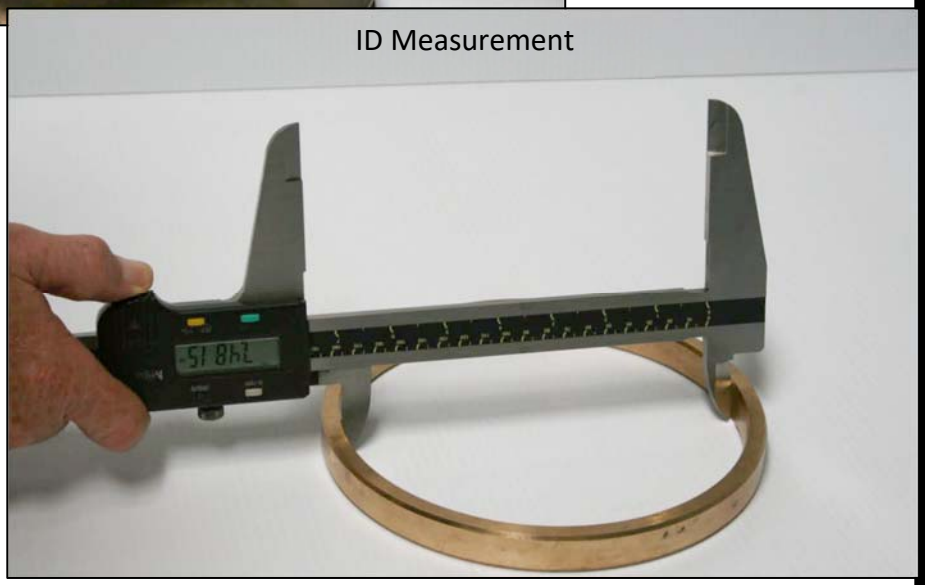
Inspect the front and back of impeller wear ring, ODs, and wear ring IDs in several places for signs of wear. Using a caliper, measure the inside diameter of each ring in several places and OD of wear hubs in several places.

When new, the radial clearance between the impeller wear hub and the clearance rings is between 0.006" (.15mm) to 0.020" (.50mm). Maximum acceptable radial clearance on used pumps is between 0.025" to 0.040" (.6 to 1 mm).

If the gap between the impeller and the clearance ring is greater than 0.040" (.1 mm) radially replace clearance rings. If the Impeller Hub has a diameter of less than 7.488 (190.2 mm) the impeller should also be replaced.



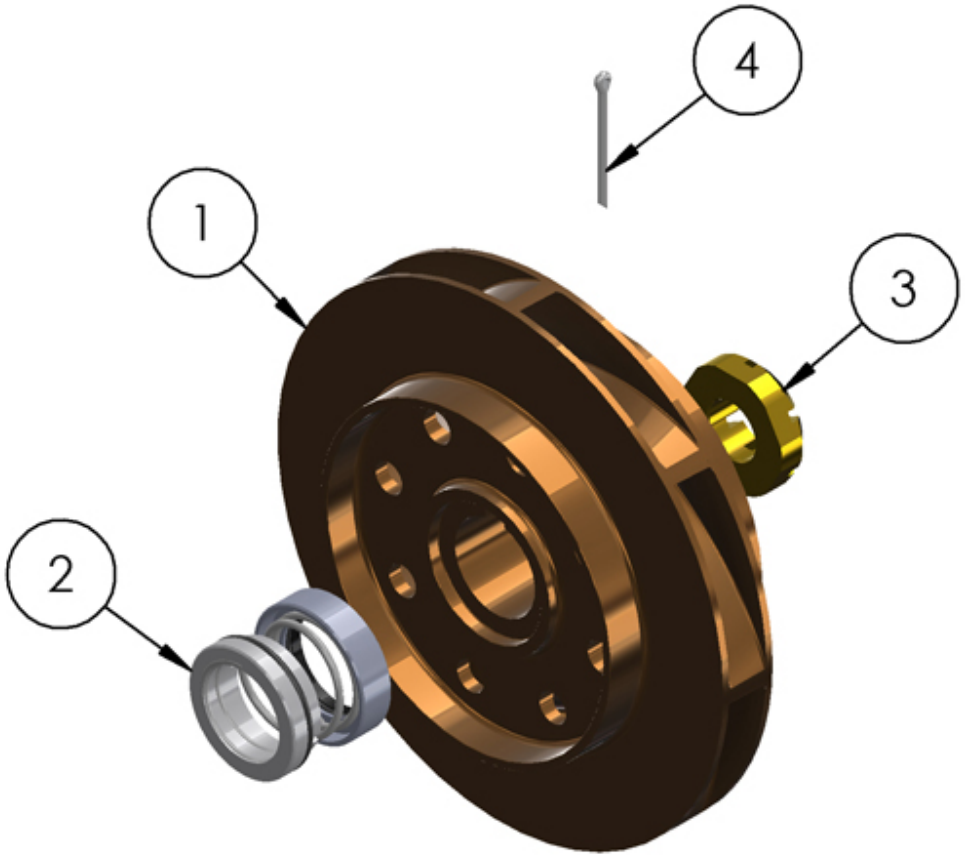
OD Measurement



ID Measurement

IMPELLER ASSEMBLY

Item Number	Part Number	Description	Qty
1	63471-93	Impeller, Bronze	1
2	63471-94A	Mechanical Seal	1
3	63471-101	Nut, Castle – Bronze – 1-3/8”-8TPI	1
4	63471-102	Pin, Cotter – 316 Stainless - 5/32”x3”	1



MECHANICAL SEAL MAINTENANCE

CAUTION!

MECHANICAL SEALS ARE PRECISION DEVICES. EXTREME CARE MUST BE TAKEN TO ENSURE THAT NO DAMAGE OCCURS TO ALL MATING FACES. ENSURE THAT THE FACES ARE ABSOLUTELY CLEAN THROUGHOUT THE ENTIRE INSTALLATION. SOLID FACES MUST BE CLEANED WITH AN APPROPRIATE DEGREASER AND A SOFT CLOTH.

Replacing the Seal

IMPORTANT!

IF WATER LEAKAGE FROM THE DRAIN HOLE IN THE PUMP HEAD IS NOTICED, THE MECHANICAL SEAL MUST BE INSPECTED.

1. Remove the impeller and gearbox assembly,
2. Remove cotter pin and castellated nut from the end of the impeller shaft. Never reuse the cotter pin, always replace it. Cotter pin must be 316 alloy stainless steel.
3. Use two wedges, one on each side of the impeller back shroud at the OD, just under where a vane is located, carefully tap in just enough to add pressure to the impeller. Place a hardwood small block on the end of the impeller shaft and hit it with a hammer. This process usually pops off the impeller. If need be, heat can be applied to the impeller center but care must be taken not to heat the impeller until it turns blue. That is a sign that the bronze has lost its strength permanently.

4. Once the impeller is removed examine the impeller shaft for nicks or burrs, remove if necessary. Pull seal assembly and seat in inboard head out. Two small hooks may be helpful in removing the seal.

No matter how good the mechanical seal looks **DO NOT REUSE IT.**

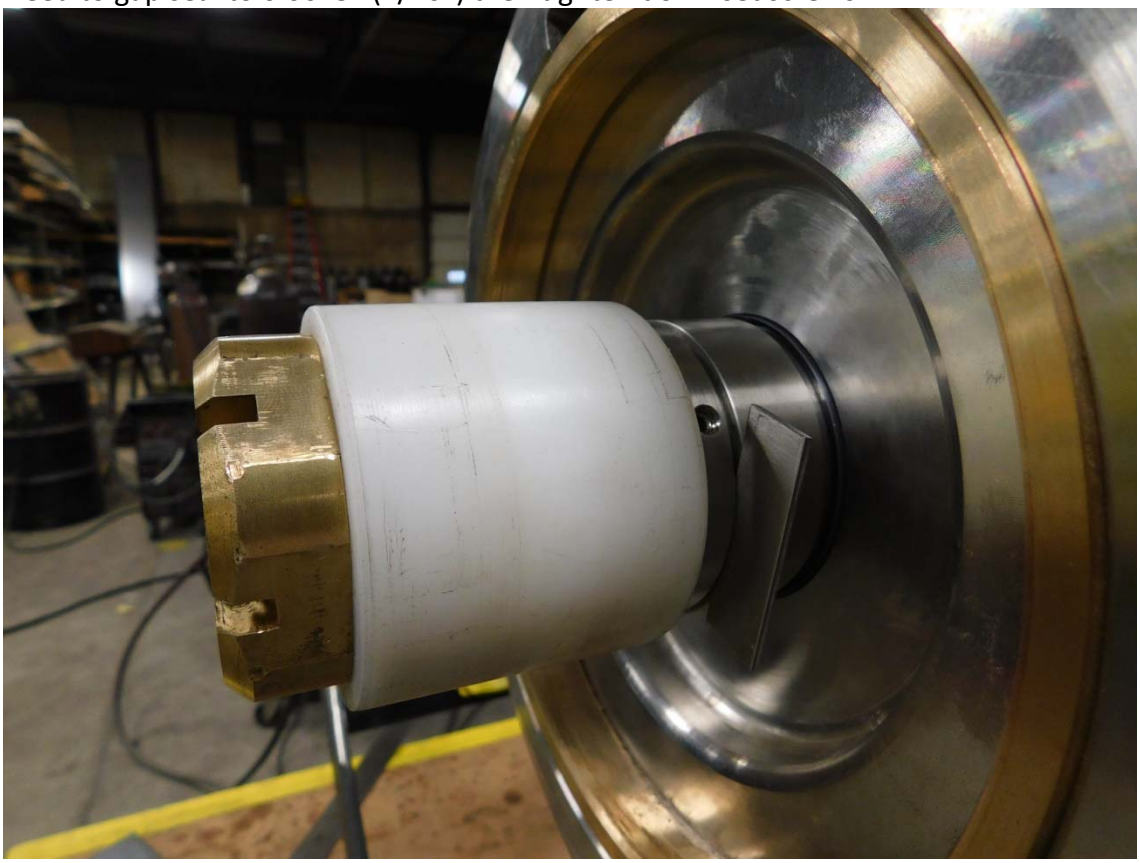
5. Check internal parts for excessive wear, pitting or damage. Repair and/or replace accordingly. This is a good time to inspect clearance rings and impeller hub.
6. Clean the bore of the pump head using alcohol swabs.
7. Ensure that the pump body, mechanical seal housing, impeller bores and all mating surfaces of the mechanical seal assembly are absolutely clean throughout the entire installation process.
8. Make sure the impeller shaft is smooth and free of burrs at the key slots.
9. Clean the pump shaft with alcohol swabs.
10. Apply a generous coating of Molykote (111 compound) to the mechanical seal bellows, the pump shaft and seal cup.

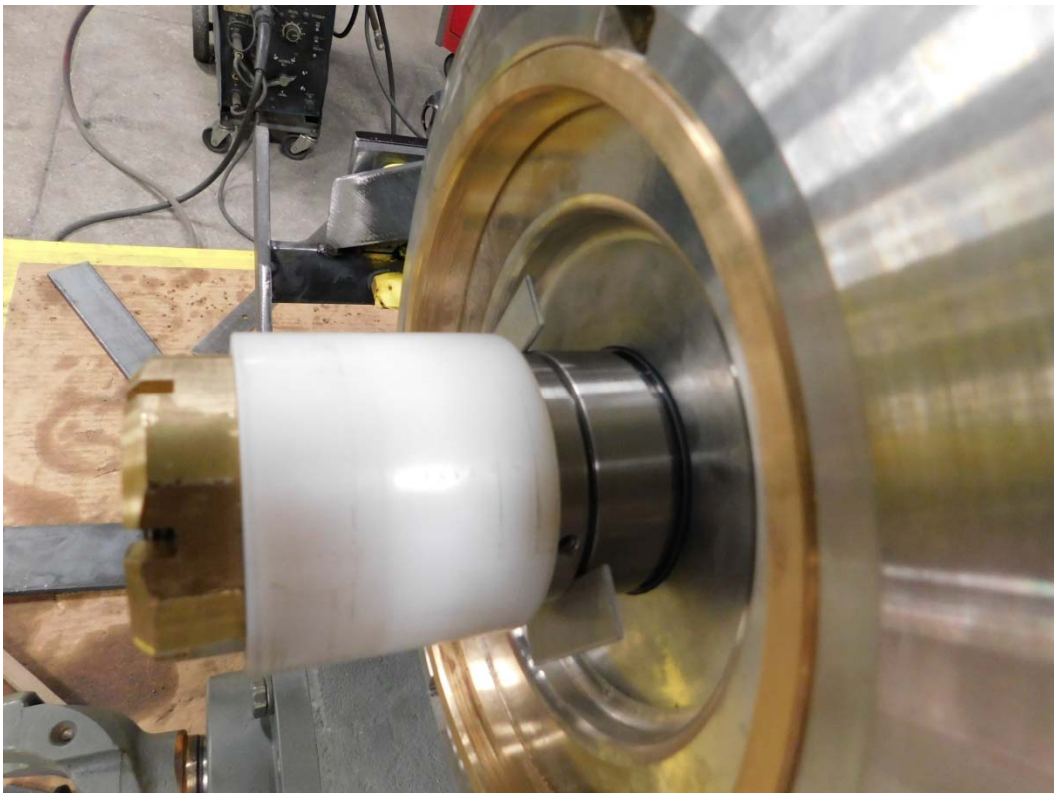
WARNING!

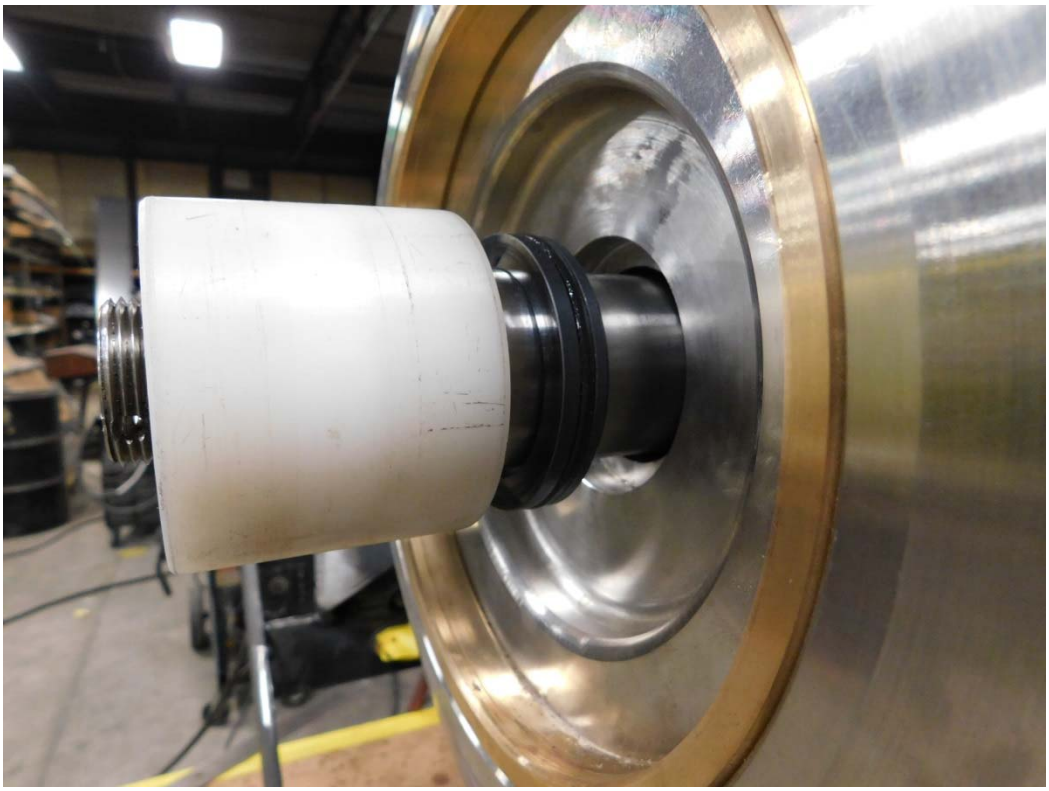
OIL AND GREASE WILL DAMAGE THE MECHANICAL SEAL FACE. DO NOT TOUCH THE FACE OF THE MECHANICAL SEAL. WEAR GLOVES DURING SEAL INSTALLATION. USE ONLY U.S.

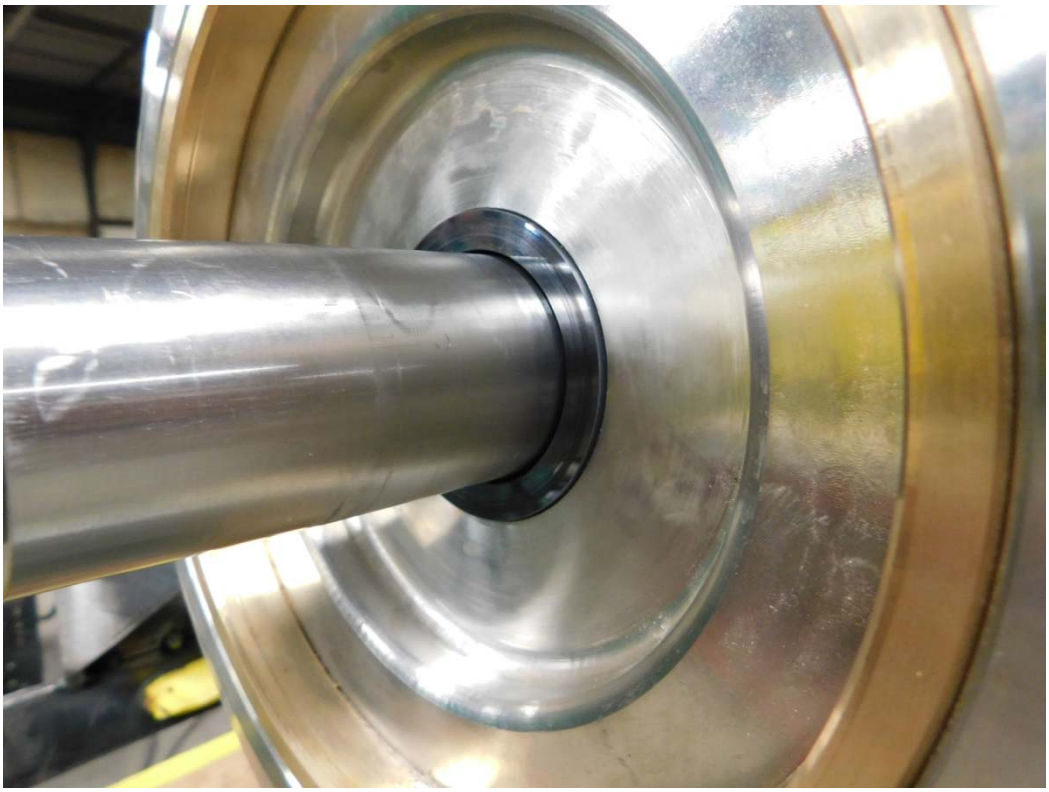
SEALUBE RUBBER LUBRICANT EMULSION (OR EQUAL) ON THE RUBBER MECHANICAL SEAL TO EASE INSTALLATION. USING ANOTHER LUBRICANT CAN DAMAGE THE SEAL AND SEAT. MAKE SURE ALL SHAFT SURFACES AND THE INSIDE OF THE SEALING BOOT ARE WELL LUBRICATED.

11. Without touching the seat face slide the new seat assembly over the pump shaft and into the inboard head bore.
12. Using a soft pusher tube (PVC pipe) and keeping fingers away from ring, push the mechanical seat assembly into the inboard head housing. If binding occurs apply more lubricant. Verify the stationary seat is firmly seated in the housing.
13. Without touching the seal, face slide the new seal assembly over the pump shaft.
14. Using a soft pusher tube (PVC pipe) and keeping fingers away from ring, push the mechanical seal assembly into place. If binding occurs apply more lubricant. Verify the stationary seal is firmly seated in the housing.
15. Need to gap seal to 0.0625” (1/16”) then tighten down set screws.





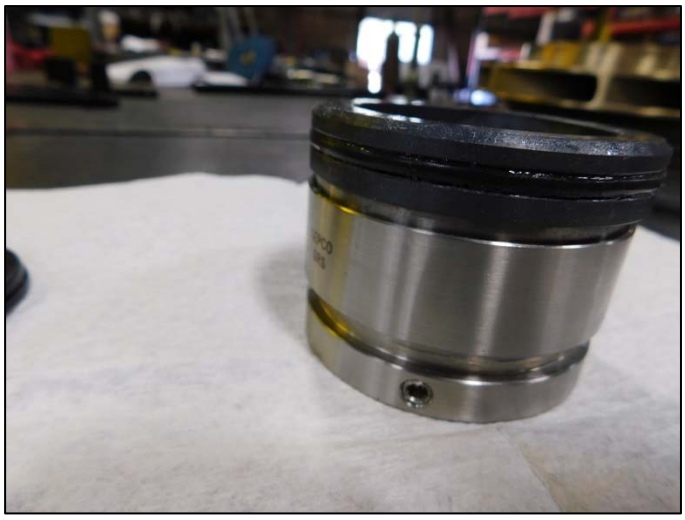




16. Install impeller, torque to spec and install cotter pin.

NOTE: Cotter pin must be 316 stainless steel.

NOTE: Always use a 6 pointed socket on impeller nuts.



Mechanical Seal

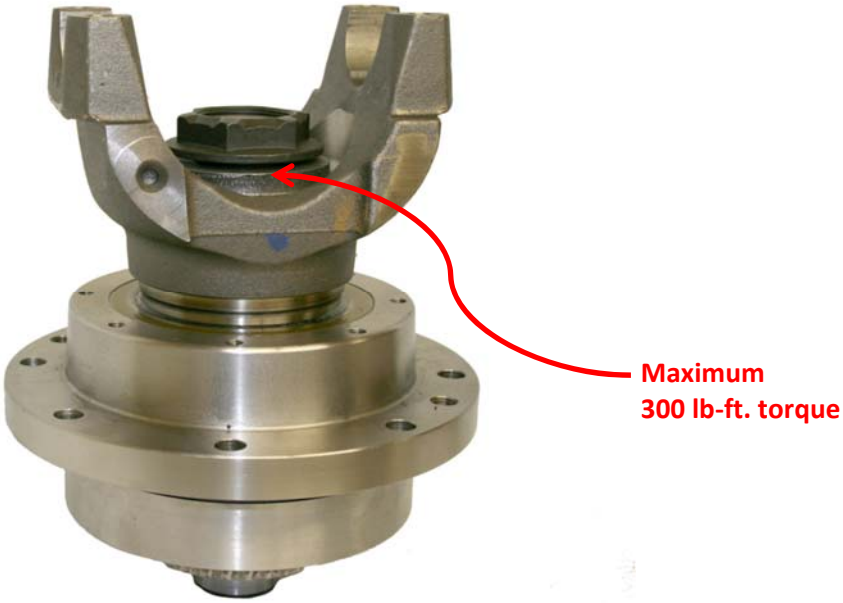
Apply a generous coating of Molykote (111 compound) to the mechanical seal below, the pump shaft and seal cup.

Gearbox Maintenance

Oil seals (Input/Tail Shafts)

Input shaft and tail shaft oil seals are replaced by disconnecting the yoke from the pump and can be accomplished with the unit installed.

1. Remove the nut and washer and carefully slide the yoke from the shaft.
2. Remove the defective oil seal being careful not to score the shaft.
3. Carefully insert a new oil seal into the housing.
4. Carefully slide the yoke onto the shaft and secure using the nut.
5. **Torque nut to a maximum of 300 lb-ft – Torque beyond this limit will result in lower pump drive shaft component failure! Must apply Locktite #243 to yoke nut. Over torquing will result in pump damage.**



Gearbox and Impeller Disassembly

The most efficient method for internal servicing of the gearbox is to remove the gearbox and impeller assembly from the apparatus.

Disassembly of gearbox

1. First, review instructions and data in this manual and the information on the pump parts drawing.
2. Remove gearbox and impeller assembly per instructions elsewhere in this manual.
3. Remove impeller assembly, cotter pin, castellated nut, impeller key, impeller, and mechanical seal.

Carefully inspect all components. Replace as necessary. Clean all parts which are to be reused and all gasket mating surfaces.

NOTE: Check both wear rings and replace if needed.

NOTE: Check impeller wear hubs and replace if needed.

4. Remove and disassemble impeller shaft assembly.
    a. Remove 5/16” bolt, washers, and rear cover plate, and gasket.
    b. Remove 1/2” bolts, washers, from rear top bearing cap and drive impeller shaft assembly out the rear of the pump.

NOTE: Be careful not to damage threads on end of impeller shaft. Check impeller wear hubs and replace if needed.

NOTE: The pusher holes are threaded into the bearing cap to push out the cap from the gear case.

    c. Once assembly is removed from gear case, remove snap rings and pull off bearing, pinion gear, and shims and remove pinon key.
    d. Drive impeller shaft out of bearing cap. Remove oil seal, any shims and bearing set.

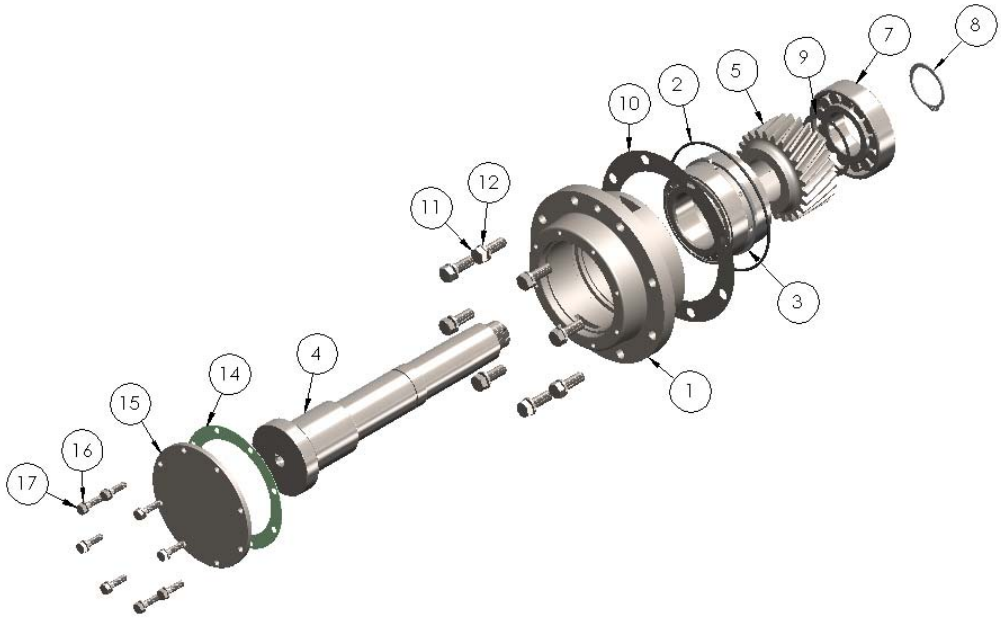
NOTE: There is a snap ring in between the bearing set which fits inside the bore of the bearing cap.

    e. Carefully clean, inspect and replace parts as needed.

5. Gearbox cover disassembly.
    a. Remove oil seal.
    b. Remove sixteen (16) 3/8” bolts and washers, cover plate, and gasket.
    c. Carefully clean, inspect and replace parts as needed.

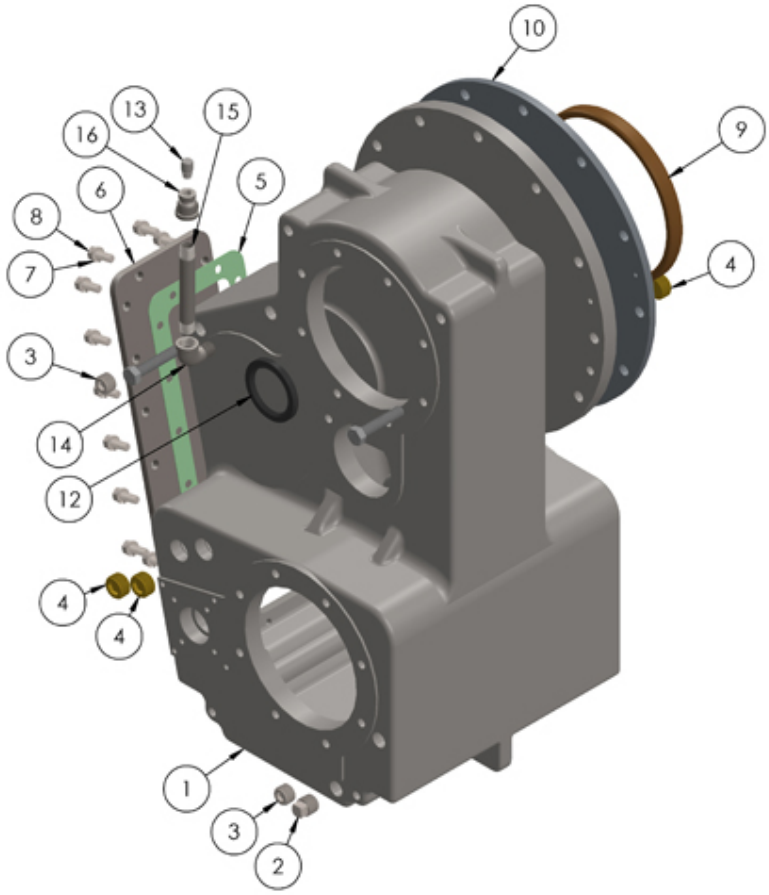
IMPELLER SHAFT ASSEMBLY

Item Number	Part Number	Description	Qty
1	63471-2	Housing, Bearing	1
2	63471-4	O-ring, Housing	1
3	63471-5A	Bearing, Tapered - Matched Set	1
4	63471-15	Shaft, Impeller	1
5	63471-16	Gear, Pump Shaft - 25T	1
6	63471-17	Key, Gear - .5 stainless steel	1
7	63471-18A	Bearing, Pump Shaft	1
8	63471-23	Ring, External Snap	1
9	63471-24	Shim, Shaft	1
10	63471-25	Shim, Bearing Cap	1
11	63471-26	Bolt, Hex Head 1/2-13 x 1-3/4 Long – Grade 8	8
12	63471-27	Washer, Lock – 1/2	8
13	63471-28	Key, Impeller - .5 stainless steel	1
14	63471-29	Gasket, Bearing Cover	1
15	63471-30	Cover, Bearing	1
16	63471-31	Washer, Lock, Bearing Cover - 5/16	6
17	63471-32	Bolt, Hex Head, Bearing Cover - 5/16-18 x 1-1/2 Long – Gr 8	6



GEARBOX ASSEMBLY

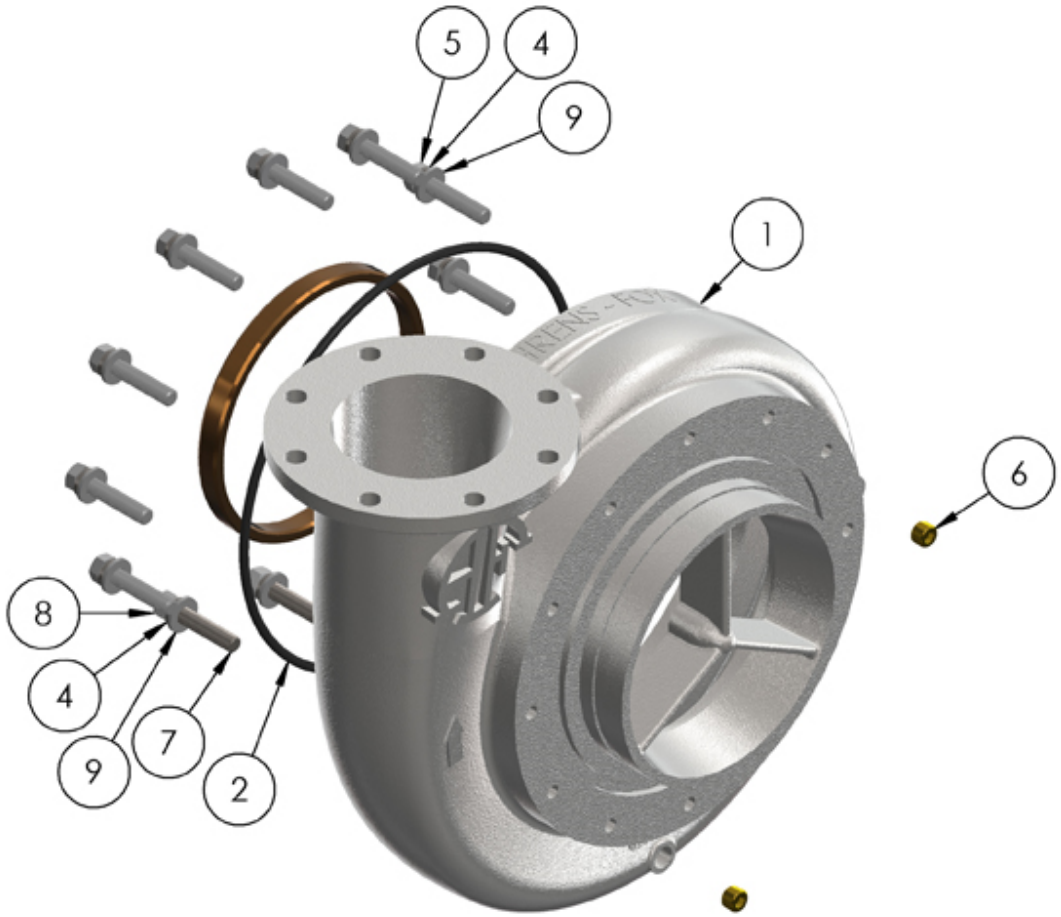
Item Number	Part Number	Description	Qty
1	63471-61	Gearbox, Midship	1
2	63471-62	Plug, 1/2” NPT Magnetic	1
3	63471-63	Plug, 1/2” NPT Brass	2
4	63471-64	Plug, 3/4” NPT Brass	4
5	63471-65	Gasket, Gearcase Cover	1
6	63471-66	Cover, Gearcase	1
7	63471-67	Washer, Lock – 3/8”	16
8	63471-68	Bolt, Hex Head, 3/8”-16x1-1/2” Long	16
9	63471-69	Ring, Clearance – Bronze	1
10	63471-70	Backplate, Volute – 304 Stainless	1
11	63471-71	Bolt, Hex Head – 1/2”-13 x 2-1/2” Long Grade 8	2
12	63471-72	Oil Seal	1
13	63471-73	Vent, Alemite – 1/8” NPTM	1
14	63471-74	Elbow, Street – 90° 1/2”MNPT x 1/2” FNPT	1
15	63471-75	Nipple – 1/2”NPT x 4” Long	1
16	63471-76	Bushing, Reducer – 1/2” FNPT x 1/8” FNPT	1



6. Prep volute (May still be mounted inside apparatus).
    a. Remove O-rings.
    b. Inspect and measure wear ring. Replace if needed.
    c. Carefully clean, inspect and replace parts as needed.

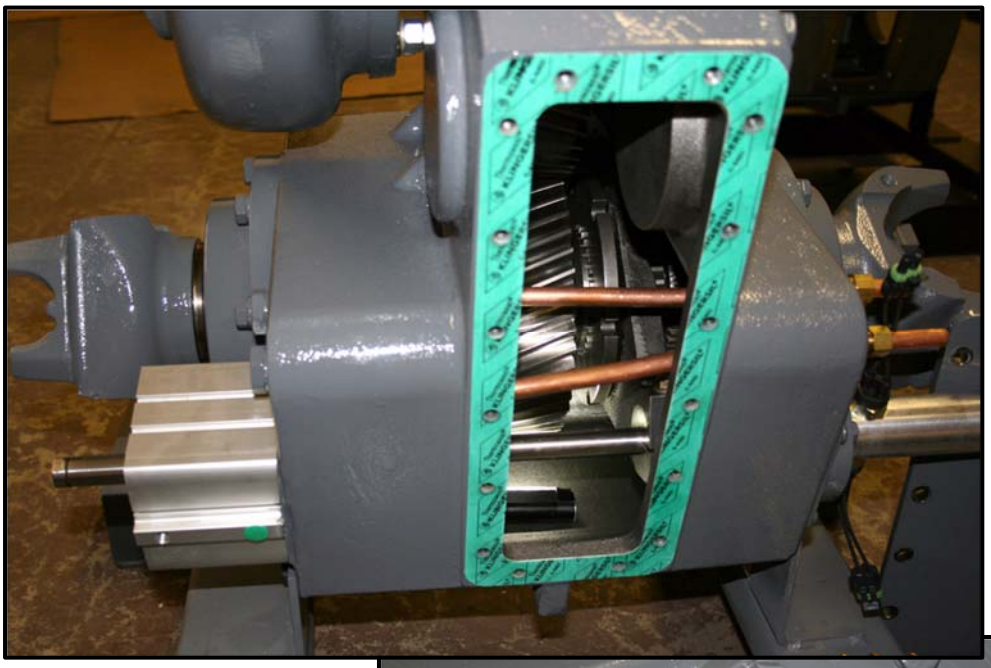
VOLUTE ASSEMBLY

Item Number	Part Number	Description	Qty
1	63471-104	Volute, Stainless	1
2	63471-105	O-Ring	1
3	63471-69	Ring, Clearance – Bronze	1
4	63471-27	Washer, Lock - ½”	12
5	63471-71	Bolt, Hex Head, 1/2-13 x 2.5 Long Grade 8	8
6	63471-106	Plug, Hex Head 3/8NPTM, Brass	4
7	63471-109	Studs, 1/2-13 x 2.5 Long	4
8	63471-110	Nut, Hex Head 1/2-13	4
9	63471-111	Washer, Flat 1/2	12
10	63471-107	Plug, Hex Head 1/2NPTM, Brass	1
11	63471-108	Plug, Hex Head 3/4NPTM, Brass	1



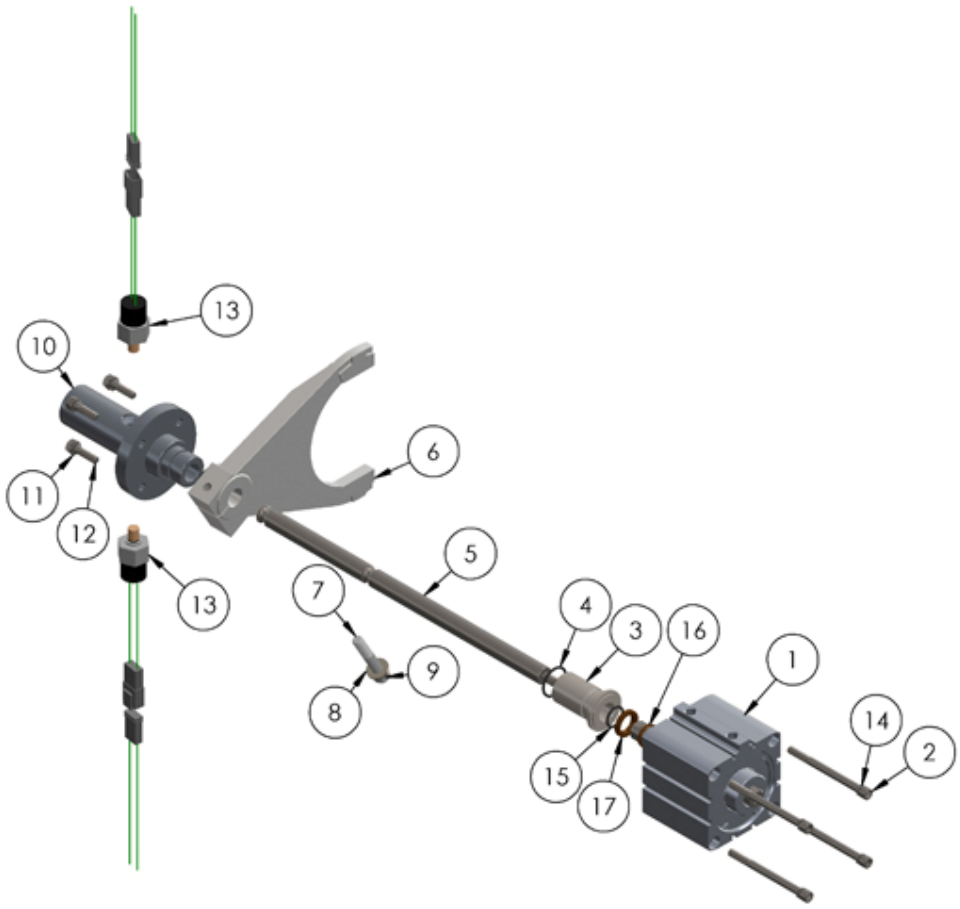
7. Disassembly shift system.
    a. Remove four 5/16” bolts and washers.
    b. Remove two (2) switches, four (4) 5/16” bolts and washers that hold cap onto gearbox and pull off cap. Remove O-ring from cap.
    c. Remove (4) 5/16” bolts and washers that hold cylinder in place. Pull shaft and cylinder sub assembly out of gearbox.
    d. Unscrew cylinder from shift shaft.
    e. Push out shaft cylinder bushing and remove O-ring.
    f. Carefully clean inspect and replace parts as needed.

SHIFTER SYSTEM WITH SIDE GEAR BOX COVER REMOVED



SHIFTER ASSEMBLY

Item Number	Part Number	Description	Qty
1	63471-78A	Cylinder, Air Shift	1
2	63471-81	Screw, Allen Head Cap – 5/16-18 x 4.5 Long Grade 8	4
3	63471-82	Bushing, Shifter Front	1
4	63471-83	O-Ring, Viton	2
5	63471-84	Shaft, Pump Shift	1
6	63471-85	Fork, Shifter	1
7	63471-86	Bolt, Hex Head – 7/16-14 x 2.5 – 1/2 inch thread – Grade 8	1
8	63471-87	Washer, Flat – 7/16	1
9	63471-88	Washer, Spring – 7/16	1
10	63471-89	Cap, Shifter	1
11	63471-31	Washer, Lock – 5/16	4
12	63471-32	Bolt, 5/16-18 x 1.5 Long Grade 8	4
13	63471-90	Switch, Shift	2
14	63471-91	Washer, Lock – 5/16 Stainless	4
15	63471-112	O-Ring	1
16	63471-113	Seal, U Cup – Shift Rod	1
17	63471-114	Seal, U Cup – Shift Rod	1



8. Removal and disassembly of idler shaft assembly
    a. Remove 1/2” bolt and washer that holds idler shaft onto gearbox.
    b. Using a slide hammer, remove shaft, remove O-ring.
        NOTE: Take note of shims and their location.
    c. From side access opening, remove idler gear and drive out bearing set.
        NOTE: There is a snap ring between the bearing inset that fits into bore of idler gear.
    d. Carefully clean inspect and replace parts as needed.

IDLER SHAFT

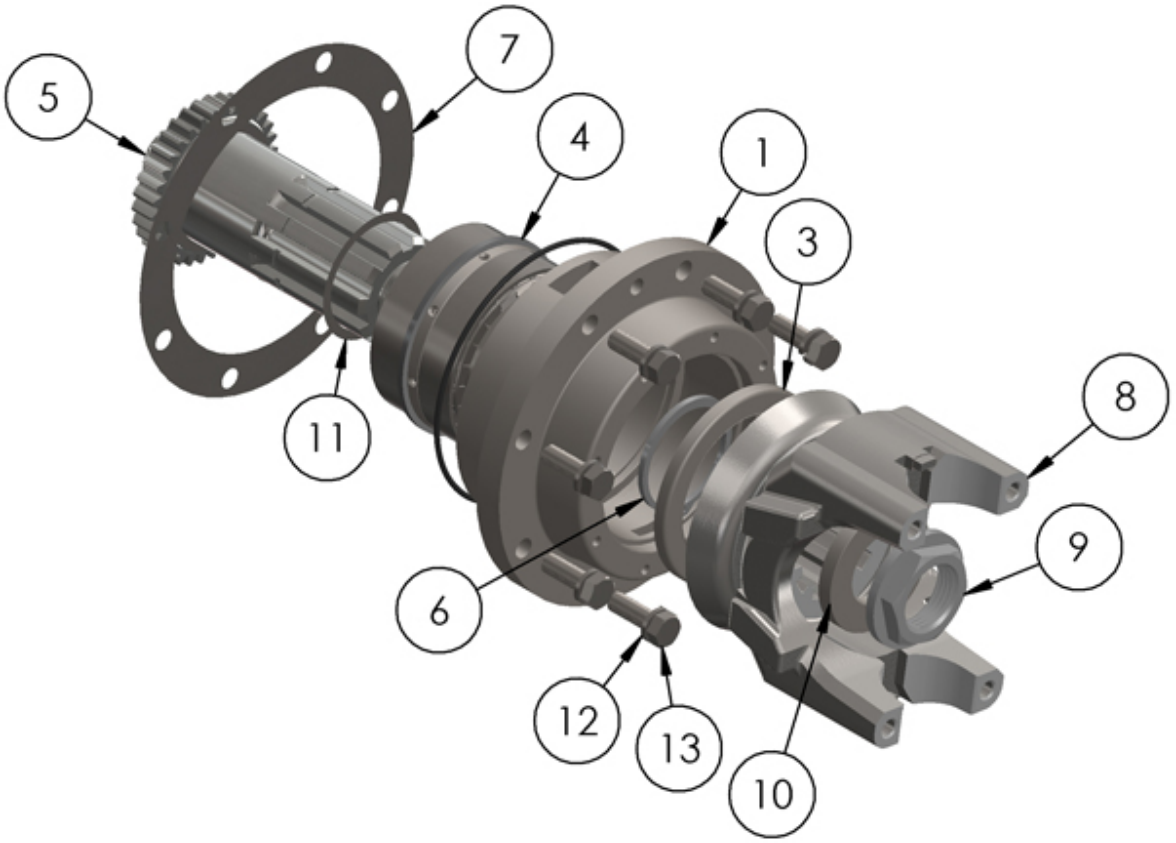
Item Number	Part Number	Description	Qty
1	63471-34	Shaft, Idler	1
2	63471-35	Gear, Idler – 48T	1
3	63471-5A	Bearing, Tapered - Matched Set	1
4	63471-36	O-ring, Viton	1
5	63471-37	Washer, Flat – Idler Shaft	1
6	63471-38	Bolt, Hex Head, 1/2-13 x 1.0” Long, Grade 8	1

9. Removal and disassembly of tail shaft assembly
    a. Remove eight (8) ½" bolts and washers and pull out assembly.
        NOTE: Two pusher holes are threaded into bearing cap to push out cap from gear case.
    b. To disassemble assembly, remove shaft nut and washer. Slide yoke off shaft. Remove oil seal and snap ring.
    c. Drive out shaft and remove bearing set from bearing cap.
        NOTE: There is a snap ring in between the bearing set which fits inside the bore of the bearing cap.
    d. **Note any shims between shaft end and bearing set** and remove O-ring from bearing cap.
    e. Carefully clean, inspect and replace parts as needed.

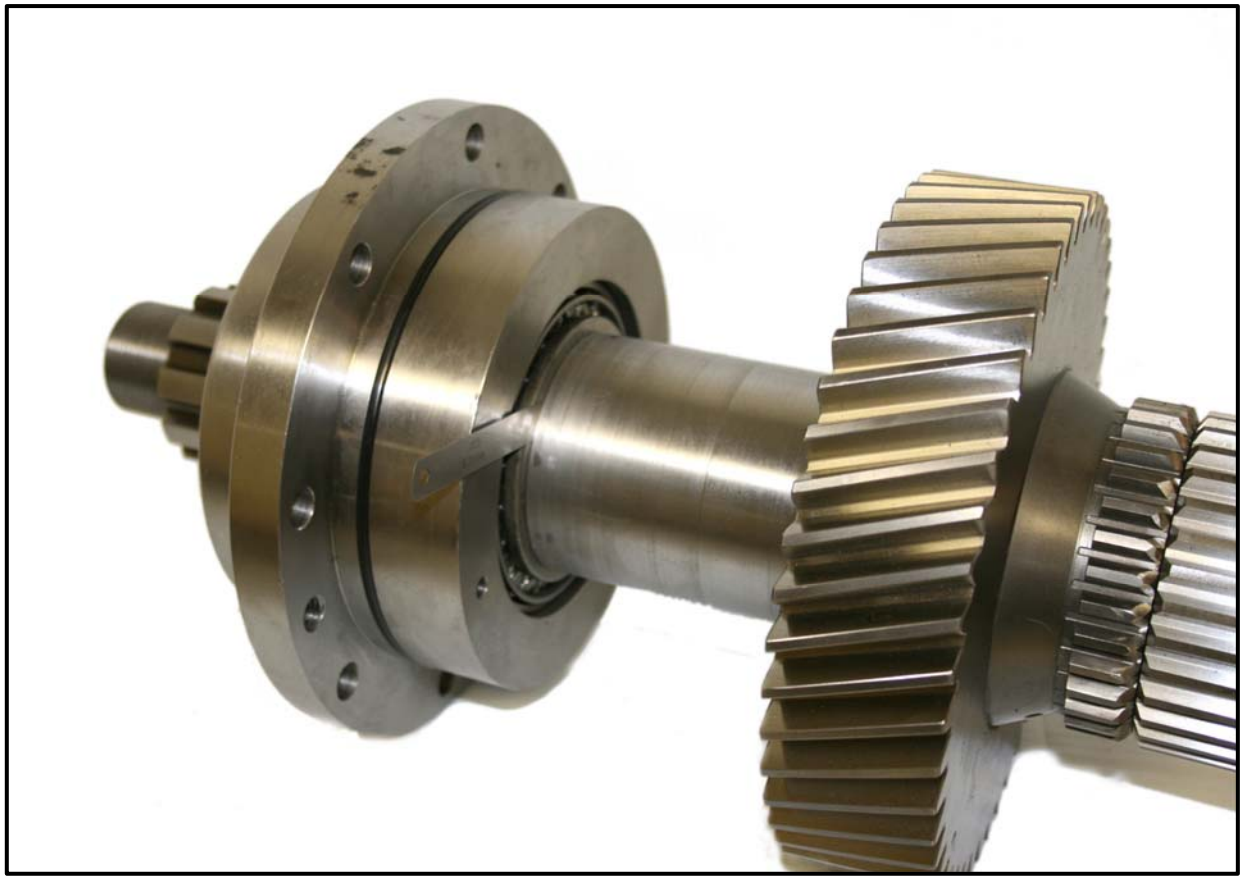
TAIL SHAFT ASSEMBLY

Item Number	Part Number	Description	Qty
1	63471-2	Housing, Bearing	1
2	63471-4	O-ring, Housing	1
3	63471-3	Seal, Oil	1
4	63471-5A	Bearing, Tapered - Matched Set	1
5	63471-59	Shaft, Tail	1
6	63471-41	Ring, Snap External	1
7	63471-25	Shim, Bearing Cap	1
8	76083-126	Yoke, 1710 – Spicer 6-4-6931-1X	**
	62830-7	Yoke, 1760 – Spicer 6.3-4-791-1X	**
	76085-60	Yoke, 1810 – Spicer 6.5-4-3561-1X	**
9	63471-44	Nut, Hex – Yoke – Meritor 1227-D-940	1
10	63471-43	Washer, Flat – Yoke – Meritor 1229- S-1605	1
11	63471-24	Shim, Shaft	1
12	63471-27	Washer, Lock 1/2	8
13	63471-26	Bolt, Hex Head 1/2-13 x 1.75 Long Grade 8	8

** As required depending upon drivetrain



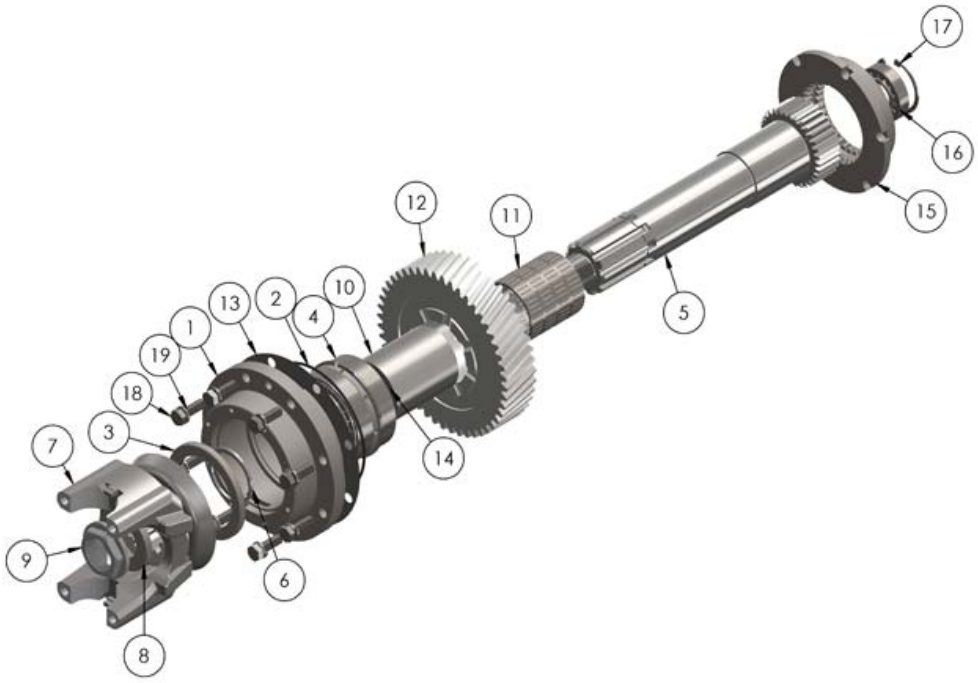
10. Removal and disassembly of drive shaft assembly.
    a. Remove shaft nut and washer. Slide yoke off shaft. Remove oil seal and snap ring.
    b. Remove shift collar from drive shaft from yoke end outward.
    c. Pull out of side access opening drive gear, spacer and shims.
    d. Remove eight (8) 1/2" bolts and washers and pull out cap.
        NOTE: Two pusher holes are threaded in the bearing cap to push off cap from gear case.
        Note any shims behind cap.
    e. Remove bearing set from bearing cap.
        NOTE: There is a snap ring between the bearing set which fits inside the base of the bearing cap.
    f. Remove four (4) needle bearings from drive shaft.
    g. Remove end bearing after removing snap ring.
    h. Carefully clean, inspect and replace parts as needed.



DRIVE SHAFT ASSEMBLY

Item Number	Part Number	Description	Qty
1	63471-2	Housing, Bearing	1
2	63471-4	O-ring, Housing	1
3	63471-3	Seal, Oil	1
4	63471-5A	Bearing, Tapered - Matched Set	1
5	63471-40	Shaft, Drive Input	1
6	63471-41	Ring, Snap External	1
7	76083-126	Yoke, 1710 – Spicer 6-4-6931-1X	**
	62830-7	Yoke, 1760 – Spicer 6.3-4-791-1X	**
	76085-60	Yoke, 1810 – Spicer 6.5-4-3561-1X	**
8	63471-43	Washer, Flat – Yoke – Meritor 1229- S-1605	1
9	63471-44	Nut, Hex – Yoke – Meritor 1227-D-940	1
10	63471-45	Spacer, Main Drive	1
11	63471-46A	Bearing, Needle Roller	4
12	63471-50	Gear, Main Drive	1
13	63471-25	Shim, Bearing Cap	1
14	63471-24	Shim, Shaft	1
15	63471-51	Collar, Shift	1
16	63471-52A	Bearing, Cylindrical Roller	1
17	63471-57	Ring, Retaining, Internal	1
18	63471-26	Bolt, Hex Head 1/2-13 x 1.75 Long Grade 8	8
19	63471-27	Washer, Lock 1/2	8

** As required depending upon drivetrain



Gearbox and Impeller Assembly

1. Install drive shaft assembly

a. Install end bearing onto end of drive shaft and insert snap ring.

b. Slip four (4) needle bearings onto drive shaft. Lubricate bearings with Lubegard 19250 Dr. Tranny Assemblee Goo (Green).

NOTE: The cut down end of the spacer must be installed toward the gear side.

c. Install bearing set into bearing cap. First install bearing set snap ring into cap, then press in outer bearing section, slip spacers into middle of set and press outer bearing section. Lubricate bearings with Lubegard 19250 Dr. Tranny Assemblee Goo (Green).

d. Install O-ring onto bearing cap and lubricate O-ring with proper grease. Install assembly into gear case. Make sure to get gap inserted upright. Install eight (8) 1/2" bolts and washers (use Loctite 243) and torque to 105 lb-ft (143 NM).

e. Lay drive gear and spacer into gear case with shift splines facing rear of gear case and spacer to the front. Slide drive shaft from the rear through.

NOTE: The cut down end of the spacer must be installed toward the gear side.

f. Once shaft is protruding the bearing set, install snap rings.

g. Once snap ring is installed, slide shaft to rear and measure with a feeler gauge the space between the bearing set. Add shims level to the feeler gauge measurement and reinstall snap ring.

h. Add oil seal into cap and slide on yoke. Install washer and nut. Torque to 300 lb-ft (407 NM). **Torque nut to a maximum of 300 lb-ft – Torque beyond this limit will result in lower pump drive shaft component failure!**

i. Slide on shifter collar larger diameter side toward gear side.

63471-5A
Bearing, Tapered
Double Roller,
Matched Set

2. Assemble and install tail shaft assembly

a. Install bearing set onto bearing cap. First install bearing set snap ring into cap, then press outer bearing sector, slide spaces into middle of set and press on outer bearing section. Lubricate bearings with Lubegard 19250 Dr. Tranny Assemblee Goo (Green).

b. Install O-ring onto bearing cap. Lubricate O-ring with proper grease. Install oil seal into cap.

c. Drive tail shaft through cap and bearing set. Install snap ring.

d. Once snap ring is installed, slide shaft to front and measure the space between the bearing set and shaft end with a feeler gauge. Add shims to the assembly equal to the feeler gauge size.

e. Slide yoke onto drive shaft and install washer and nut and torque to 300 lb-ft (407 NM). **Torque nut to a maximum of 300 lb-ft – Torque beyond this limit will result in lower pump drive shaft component failure!**

f. Install O-ring onto bearing cap and lubricate O-ring with proper grease. Install into gear case. Make sure to get cap installed upright. Install eight (8) 1/2" bolts and washers using Loctite 243. Torque to 105 lb-ft (143 NM).

g. Rotate drive shaft and tail shaft assembly in both pumps and road positions. Make sure they turn freely in both positions.

3. Install shift system

a. Install O-ring into front shift bushing and push into front of gear case.

b. Place fork in the correct location on shift collar.

c. Thread shift shaft onto cylinder shaft. Use Loctite 243 on threads and tighten. Slide cylinder/shaft through front shaft bushing and slide through fork hole.

d. Install four (4) bolts and washers through shift cylinder using Loctite 243 and torque bolts to 60 lb-ft (81 NM).

e. Install O-ring onto cap using appropriate O-ring grease. Insert cap into back of gear base and install four (4) bolts and washers using Loctite 243 and torque to 66 lb-ft (89 NM).

f. Align shift fork on shift shaft and insert bolt and washers using Loctite 243 and torque to 157 lb-ft (213 NM).

g. Operate shifter in both road and pump to verify it is functioning correctly.

4. Install impeller shaft assembly

a. Install bearing set into bearing cap. First install bearing set snap plug into cap then press in outer bearing sections, slide spacers onto middle of set and press outer bearing section. Lubricate bearings with Lubegard 19250 Dr. Tranny Assemblee Goo (Green).

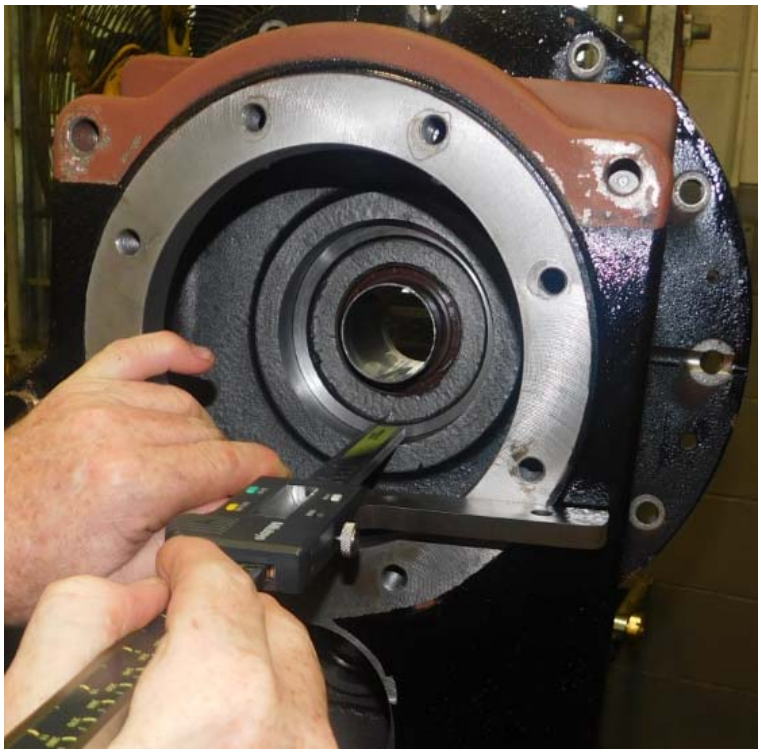
b. Install O-ring onto bearing cap. Lubricate O-ring with proper grease.

c. Press shaft through bearing set. Insert pinon key and slide on pinon and bearing and snap ring. Lubricate bearings with Lubegard 19250 Dr. Tranny Assemblee Goo (Green).

d. Once snap ring is installed, slip shaft to front and measure with a feeler gauge the space between the bearings and pinon gear. Add shims to equal the feeler gauge size.

e. Install oil seal into front area of gear case.

f. Measure the depth of the bearing in case.



g. Mearsure the depth of the bearing on the impeller shaft.

h. The depth of the bearing in the case needs to be .020-.030 shorter than the depth of the bearing on the shaft. If the depth is more than .030 you must add shims to the out bearing housing.

i. Assemble the impeller shaft in the pump.

j. Work the bearing into the case by using the fork tool.

k. Install wear ring into onboard head.

l. Push impeller shaft assembly through gear case. Make sure to get cap inserted upright.
Install eight (8) 1/2” bolts and washers using Loctite 243. Torque to 105 lb-ft (143 NM).

m. Install gasket and rear cover gear using eight (8) washers and bolts using Loctite 243. Torque to 25 lb-ft (34NM).

n. Rotate drive shaft in both road and pump to make sure that they turn free.

5. Install and assemble idle shaft assembly

a. Install bearing set into idler gear. First install bearing set snap ring into gear. Then press on bearing section into gear. Slide spaces into middle of set and press outer bearing section.

b. Insert idler gear and bearing set into gear case through side access opening and place it into its relative location. Lubricate bearings with Lubegard 19250 Dr. Tranny Assemblee Goo (Green).

c. Install O-ring onto idler shaft and push shaft through gear case and gear bearing set.

d. Once shaft is installed, measure the space between the inside of the gear case and bearing with a feeler gauge. Add shims to equal the feeler gauge size.

e. Install bolt and washer with Loctite 243 to hold in idler shaft. Torque to 105 lb-ft. (143 NM).

f. Rotate drive shaft in both road and pump. Make sure they turn free.

6. Install Gear Box Cover Assembly

a. Place gasket using gasket sealer using sixteen (16) 3/8” washers using Loctite 243. Torque to 44 lb-ft (60 NM).

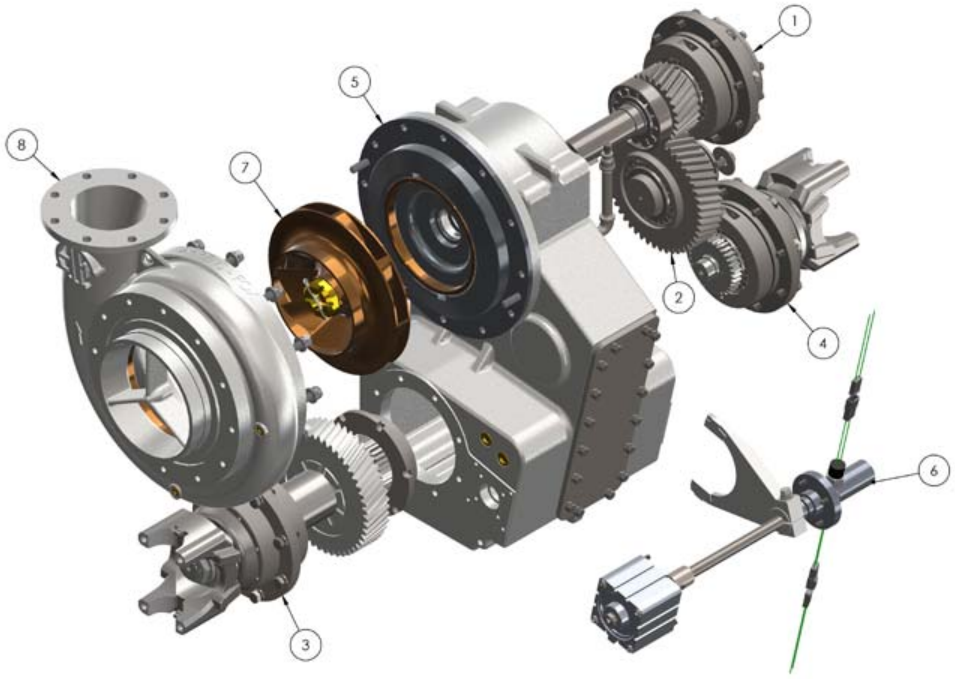
7. Prep Volute (May still be mounted inside apparatus)

a. Install O-rings using O-ring grease.
c. Install wear ring.

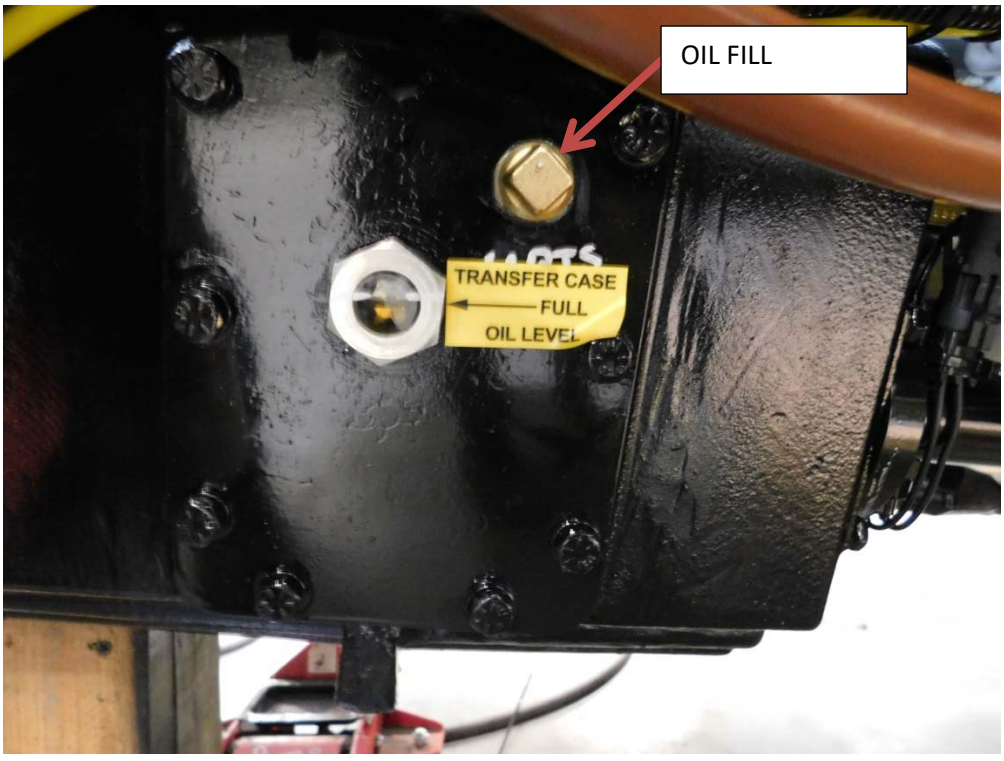
PUMP ASSEMBLY

Drawings of pump sub-assemblies can be found on the pages listed below

Item Number	Part Number	Description	Page
1	63471-1A	Assembly, Impeller Shaft	52
2	63471-33A	Assembly, Idler Shaft	57
3	63471-39A	Assembly, Drive (Input) Shaft	61
4	63471-58A	Assembly, Tail Shaft	59
5	63471-60A	Assembly, Gear Box	53
6	63471-77A	Assembly, Pump Shift	56
7	63471-92A	Assembly, Impeller	43
8	63471-103A	Assembly, Volute	54



PUMP – OIL FILL PLUG and OIL LEVEL SIGHT GLASS



Glossary

Atmospheric Pressure - Pressure caused by the height of air above the earth. Atmospheric pressure is 14.7 pounds per square inch at sea level. Pressure increases below sea level and decreases above sea level. The weather also affects atmospheric pressure. Atmospheric pressure affects a pump's ability to pump from draft.
Higher pressures increase a pumps performance, while lower pressures can cause a noticeable decrease in lift, capability and flow output, pump flow rating, based on NFPA standard in GPM.

Cavitation - Occurs when the pump attempts to deliver more fluid than is being supplied. This causes the formation of bubbles in the pump. The bubbles collapse and the liquid, under pressure rushes in to fill the empty space. This damages the pump and must be corrected immediately.

Centrifugal Force - Force that tends to make rotating bodies move away from the center of rotation.

Centrifugal Pump - A pump that uses a rapidly spinning impeller to create pressure for fluid movement.

Compound Gauge - A compound gauge is graduated to read pressure in "pounds per square inch" and "vacuum in inches of mercury."

Dead Heading - Operating a pump without any discharge. The lack of flow causes temperatures to rise inside the pump.

Dry Prime Test - This is a test outlined in NFPA 1901 and 1911 that provides information on the ability of a priming pump to evacuate air from the main pump. If the vacuum does not hold, it is an indication there is a leak in the system.

Friction Loss - Loss of pressure in hose, fittings, standpipes, and other appliances because of because of the resistance between the fluid and the inside surfaces of the hoses, fittings, piping, and other appliances.

Gauge Pressure - Pressure read from a gauge (PSIG) or BAR.

Governor - Limits pressure changes by controlling engine speed to maintain pump discharge pressure.

Horsepower - A measure of mechanical work.

Impeller - The part of a centrifugal pump that, when rotating, adds energy to fluid. Basically an impeller consists of two disks separated by vanes. The vanes force the fluid to move outward between the disks so that it is thrown outward at high velocity by centrifugal force. The water from the impeller discharges into a passage known as a volute, converting the high velocity of the water into pressure.

Impeller Eye - Point where fluid enters the impeller.

Net Pump Pressure - The difference in pressure between discharge and suction pressure.

Pitot Gauge - Measures velocity head at the discharge of a nozzle and can be converted to flow using a chart.

Positive Pressure - Pressure above atmospheric.

Pressure Gauge - The pressure gauge is usually graduated in pounds per square inch (PSI). It is connected to the pump discharge manifold, thus indicating pump discharge pressure.

Priming - Priming evacuates the air from the main pump and suction hose, thus creating vacuum at the eye of the impeller. This allows atmospheric pressure on the source of the fluid to push the fluid up into the suction hose and pump.

Pump Shift - A midship pump is usually mounted in the truck chassis main drive line. The pump shift moves a sliding ring in the gearbox that transmits power either to the pump or the rear axle. In ROAD position, power is shifted to the rear axle for driving; in PUMP position, the rear axle is disconnected, and power is shifted to the pump shaft.

Relay - Movement of water from an apparatus at a water source to additional apparatus until water reaches the fire ground.

Service Test - Pump test performed to determine if the apparatus can deliver its rated volume and pressure.

Torque - The force that acts to produce rotation.

Vanes - Guides inside an impeller that direct fluid to the volute.

Volute - A gradually increasing discharge waterway. Its function is to collect the water from the impeller and it increases pressure and decreases velocity.

Wear Ring - Prevents discharge fluid from returning to the eye of the impeller.

Measurements and Conversions

One Gallon of Water Weighs ..... 8.33 Pounds
One Gallon..... 231 Cubic Inches
One Cubic Foot..... 7.48 Gallons
One Pound per Square Inch of Head ..... 2.31 Feet of Water
One Inch of Mercury ..... 1.132 Feet of Water
One Pound per Square Inch ..... 2.0178 Inches of Mercury

To Convert To	Multiply By
BAR to PSI	14.504
Feet of Head to Pounds Pressure	0.4331
FT-LB (Torque) to N-m	1.3558
Gallons to Liters	3.785
HP (Horsepower) to KW (Kilowatts)	0.7457
One Pound per Square Inch (PSI) to One BAR	0.0690
Pounds per Square Inch (PSI) to Feet of Head	2.31

Lube and Sealant Specifications

Gear Box Lubrication
Use Citgo Synthetic, 11 quarts 80-W140 or any synthetic oil with an API rating of GL-5 and a viscosity of 75-140.

Grease
Use Lithium-based grease with 1% to 3% Molybdenum Dissolved
Dow Corning BR2-PLUS - Shell Super Duty Grease - Mobile Grease Special

Loctite Sealant
#243 Medium Strength Threadlock
#547 Thread Sealant – Pipe Thread Sealant
#609 Retaining Compound

Mechanical Seal Installation (Pac-Ease equivalent)
U.S. Sealube - Somerset, NJ - www.ussealmfg.com

	P/N	Size
	LUBE-PP 1cc	Pillow Pak
	LUBE-10ML	10 ml tube
63471-118	LUBE-05OZ	½ oz bottle
	LUBE-4OZ	4 oz bottle
	LUBE-8OZ	8 oz bottle

Recommended Cleaners
Safety Kleen®

Bearing Lubricant
Lubegard 19250 Dr. Tanny Assemblee Goo (Green)

IMPORTANT!

THE USE AND DISPOSAL OF SOLVENTS / CLEANERS / OIL / LUBRICANTS MUST BE IN ACCORDANCE WITH LOCAL ENVIRONMENTAL REGULATIONS.

PARTS KITS

Item Number	Part Number	Description	Qty
1	63471-1K	Shift Cylinder Replacement Kit includes: 63471-78A Cylinder 63471-83 O-Ring 63471-112 O-Ring 63471-113 Seal, U Cup Shift Rod 63471-114 Seal, U Cup Shift Rod	 1 1 1 1 1
2	63471-2K	Driveline Oil Seal Kit includes: 63471-3 Seal, Oil	 3
3	63471-3K	O-Ring Kit includes: 63471-4 O-Ring, Bearing Cap 63471-36 O-Ring, Idler Shaft 63471-105 O-Ring, Volute to Back Plate	 3 1 1
4	63471-4K	Gasket Kit includes: 63471-65 Gasket, Access Cover	 1
5	63471-5K	Clearance Ring Kit includes: 63471-69 Ring, Clearance 63471-102 Pin, Cotter - Impeller Nut 63471-118 Lube, Mechanical Seal Installation (1/2oz bottle)	 2 1 1
6	63471-6K	Impeller Kit Includes: 63471-69 Ring, Clearance 63471-102 Pin, Cotter - Impeller Nut 63471-93 Impeller, Bronze 63471-28 Key, Impeller 63471-105 O-Ring, Volute to Back Plate 63471-118 Lube, Mechanical Seal Installation (1/2oz bottle)	 2 1 1 1 1 1
7	63471-7K	Mechanical Seal Kit includes: 63471-94A Seal, Mechanical 63471-105 O-Ring, Volute to Back Plate 63471-102 Pin, Cotter - Impeller Nut 63471-118 Lube, Mechanical Seal Installation (1/2oz bottle)	 1 1 1 1
8	63471-8K	Bearing Kit includes: 63471-5A Bearing, Double Taper Roller Matched Kit 63471-18A Bearing, Pump Shaft 63471-46A Bearing, Needle Roller 63471-52A Bearing, Cylindrical Roller	 4 1 4 1

PUMP POST OPERATION INSPECTION

Review Date: _____ /_____ /_____ Time: _____

Reviewed By: _____

✓ = Okay 0 = Repairs Needed

STATUS	ITEM	CORRECTIVE ACTION	DATE REPAIR COMPLETED
	Inspect the suction hose and rubber washers. Remove foreign matter from under gaskets. Replace worn, damaged, or dry gaskets		
	Verify that all discharge, intake and drain valves are operational and closed		
	Tighten suction caps		
	Make sure the gearbox oil reservoir is full to correct level with the correct type of oil		

IMPORTANT: Report to AHJ any irregularities observed during preventive maintenance inspection.

REMARKS:

PUMP WEEKLY INSPECTION

Review Date: _____ /_____ /_____ Time: _____

Reviewed By: _____

✓ = Okay 0 = Repairs Needed

STATUS	ITEM	CORRECTIVE ACTION	DATE REPAIR COMPLETED
	Test the relief valve or governor system		
	Test the priming system		
	Test the pump shift & pump shift warning indicator lights		
	Perform valve maintenance		
	Check and clean the intake strainers		
	Check pump driving engine per manufacturer's recommendations		
	Verify all gauges are in working order		
	Operate pump and all valve controls		

IMPORTANT: Report to AHJ any irregularities observed during preventive maintenance inspection.

REMARKS:

PUMP MONTHLY INSPECTION

Review Date: _____ /_____ /_____ Time: _____

Reviewed By: _____

✓ = Okay 0 = Repairs Needed

STATUS	ITEM	CORRECTIVE ACTION	DATE REPAIR COMPLETED
	Test the relief valve or governor system		
	Test the priming system		
	Test the pump shift & pump shift warning indicator lights		
	Perform valve maintenance		
	Check and clean the intake strainers		
	Check pump driving engine per manufacturer's recommendations		
	Verify all gauges are in working order		
	Operate pump and all valve controls		
	Valve, control and linkage lubrication		
	Check Gearbox lubrication level		
	Checking the pump and drive line bolts		
	Perform a dry vacuum test		
	Lubricate suction threads		

IMPORTANT: Report to AHJ any irregularities observed during preventive maintenance inspection.

REMARKS:

PUMP ANNUAL INSPECTION

Review Date: _____ /_____ /_____ Time: _____

Reviewed By: _____

✓ = Okay 0 = Repairs Needed

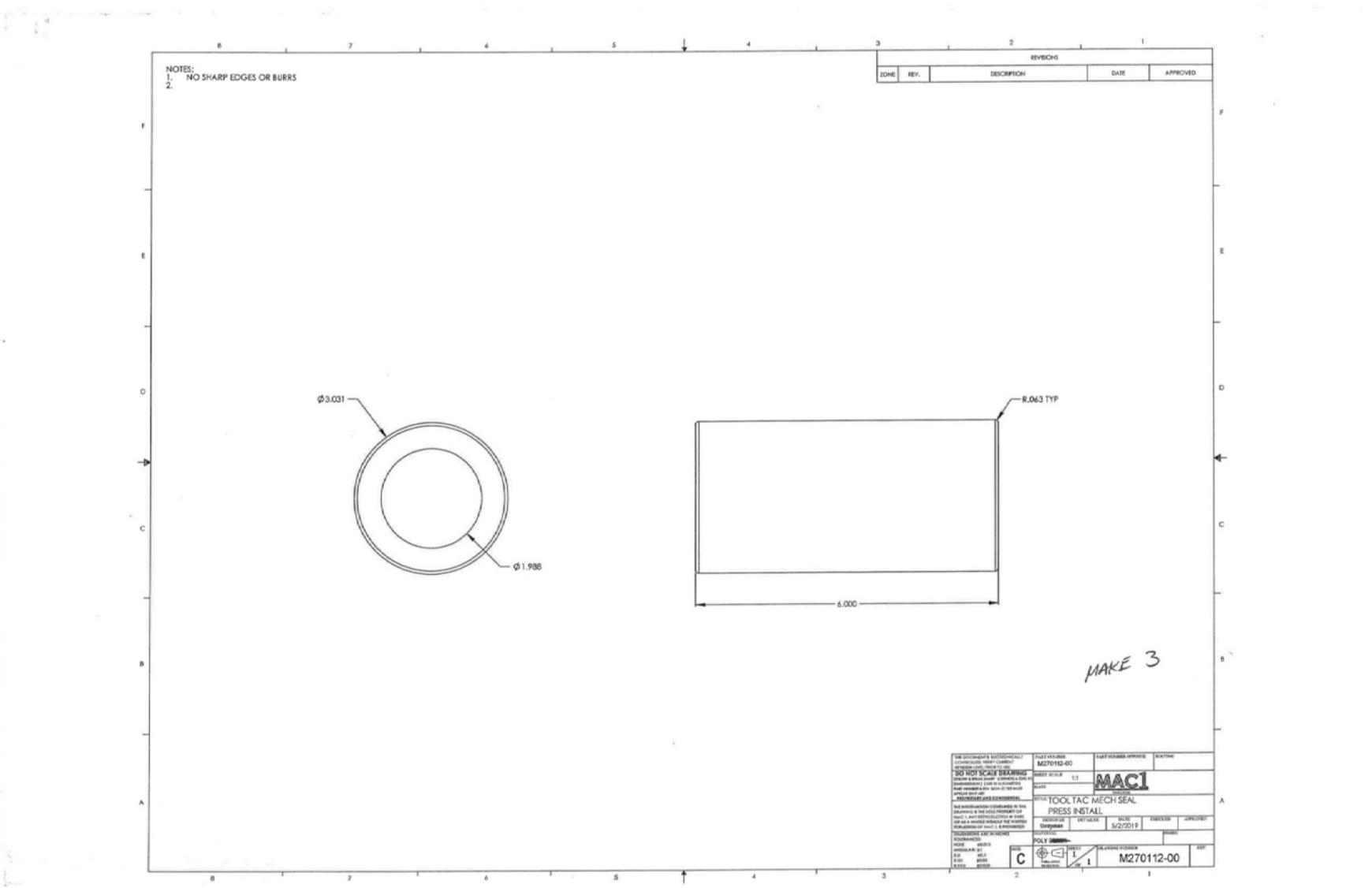
STATUS	ITEM	CORRECTIVE ACTION	DATE REPAIR COMPLETED
	Test the relief valve or governor system		
	Test the priming system		
	Test the pump shift & pump shift warning indicator lights		
	Perform valve maintenance		
	Check and clean the intake strainers		
	Check pump driving engine per manufacturer's recommendations		
	Verify all gauges are in working order		
	Operate pump and all valve controls		
	Valve, control and linkage lubrication		
	Check Gearbox lubrication level		
	Checking the pump and drive line bolts		
	Perform a dry vacuum test		
	Lubricate suction threads		
	Replace the pump gearbox oil		
	Relief valve or governor system, check and repair		
	Checking individual drain lines from the pump to the multi-drain to ensure proper drainage and protection from freezing.		
	Disassembly of priming pump to clean – if applicable		
	Yearly pump test Rate. (see NFPA 1911)		
	Lubricate power shift cylinder, and shift control valve with air cylinder oil.		
	Check gauge calibration		

IMPORTANT: Report to AHJ any irregularities observed during preventive maintenance inspection.

REPAIR TOOLS

The following 9 pages are proposed tools to ease in replacement parts/repairs of the AF2000-SS pump. The drawings are provided for the intended repair personnel to produce for their own use.

See pages 78-86.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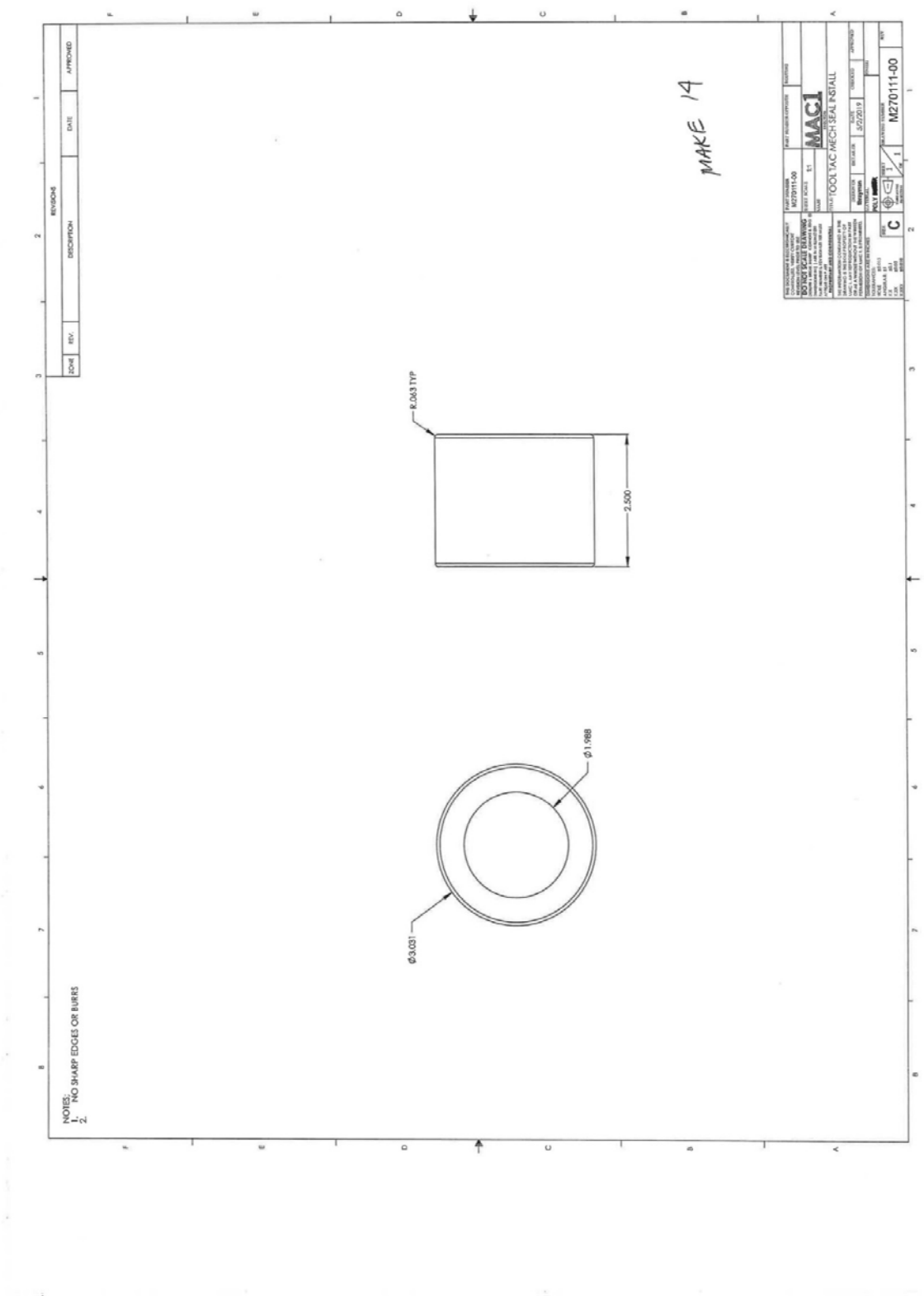
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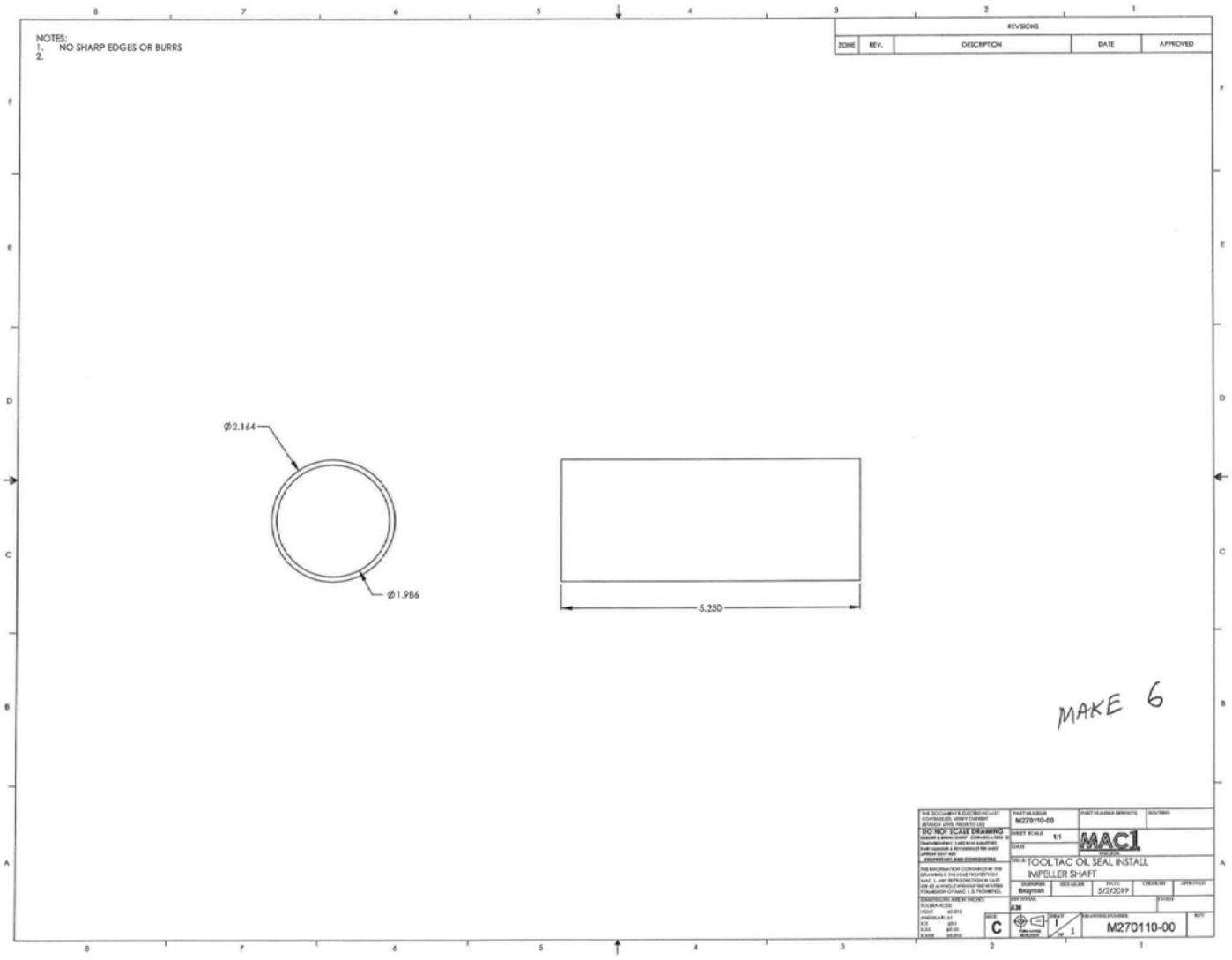
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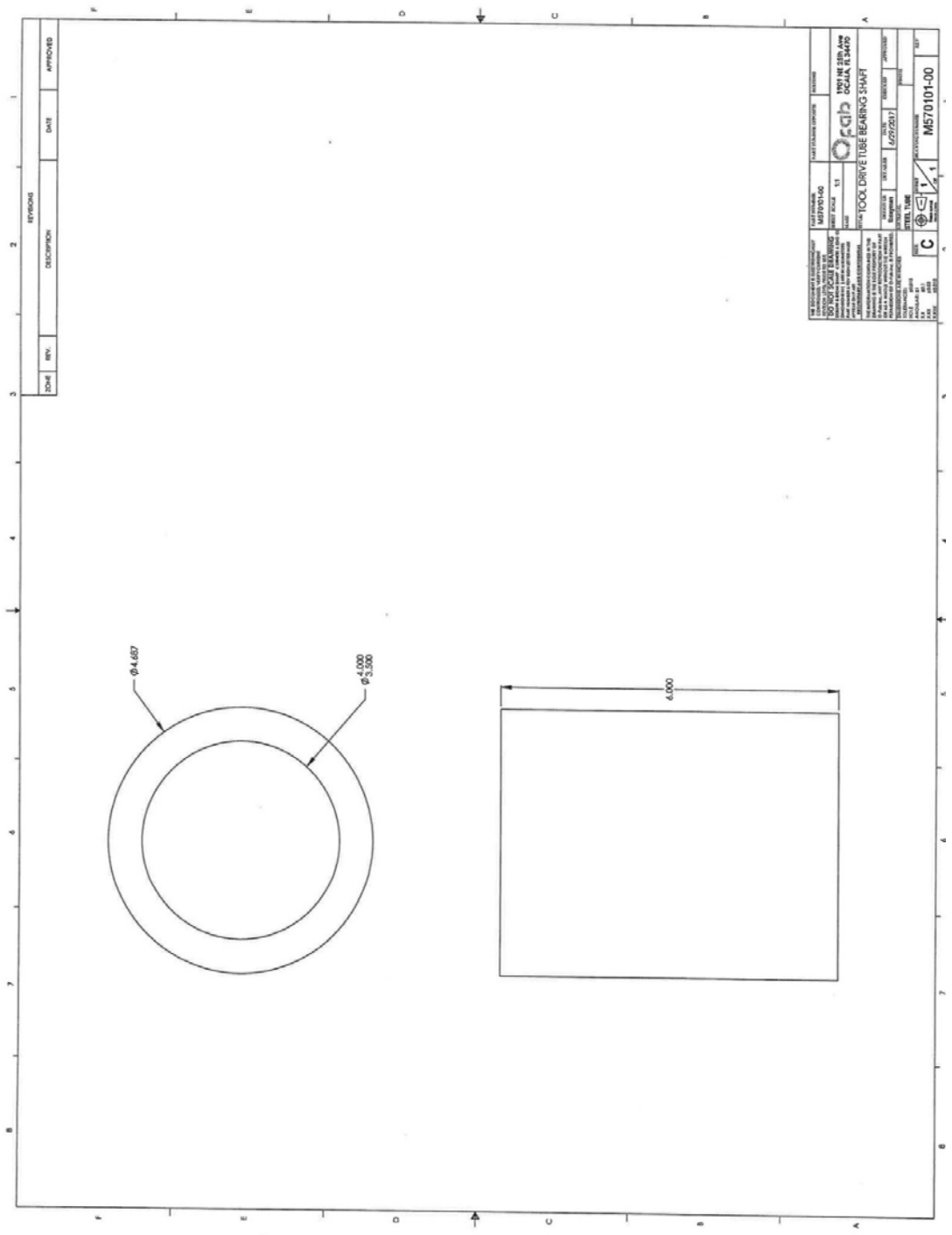
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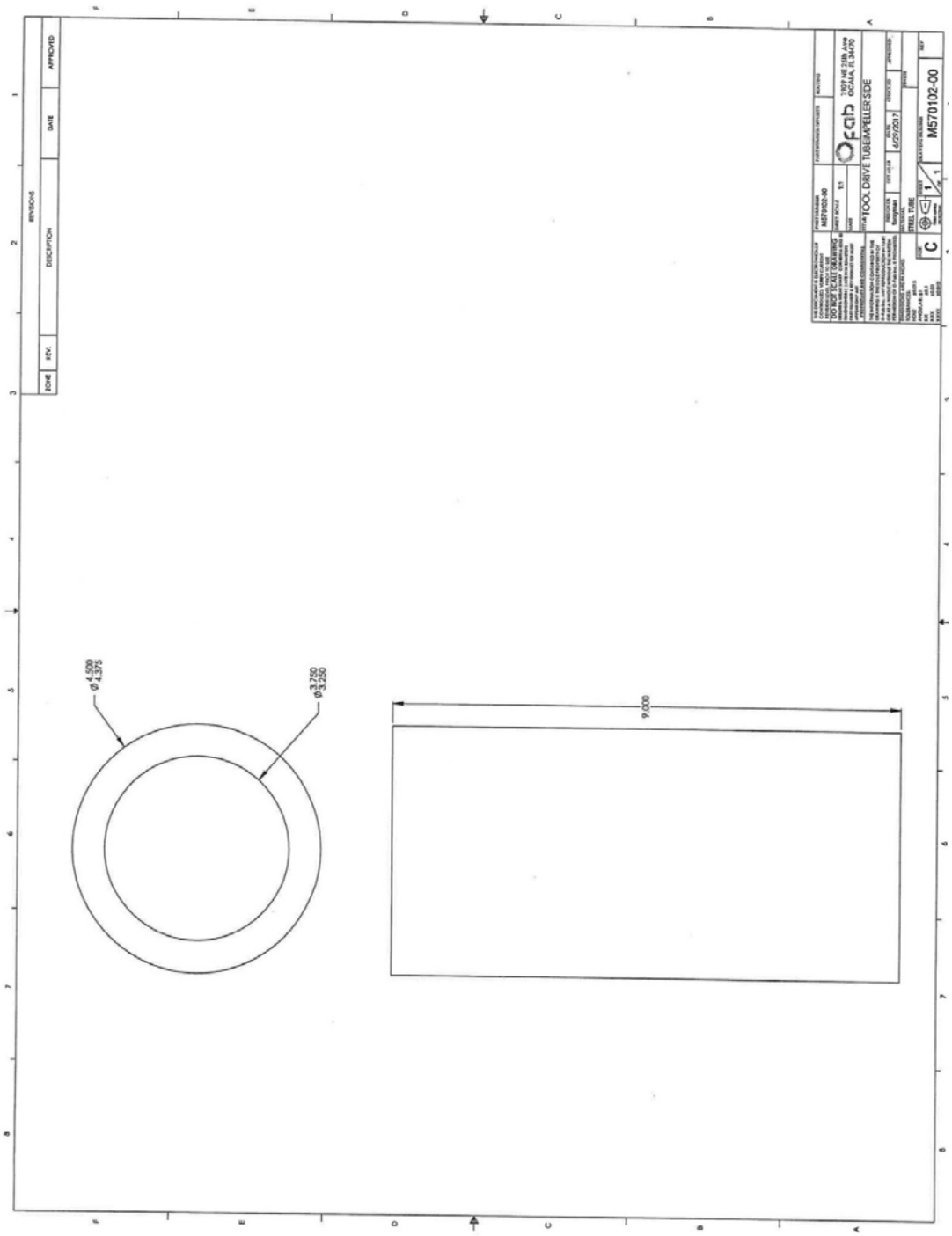
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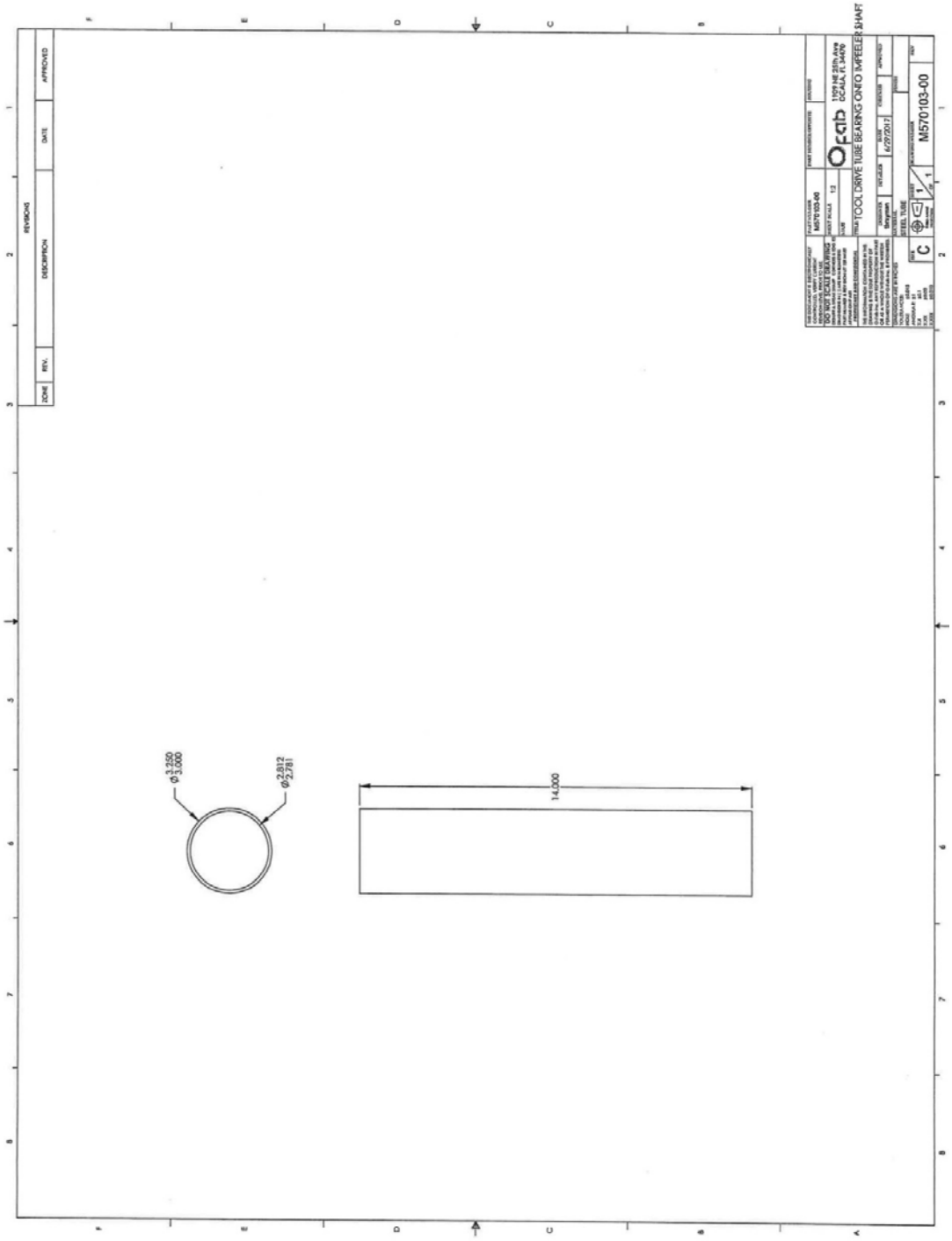
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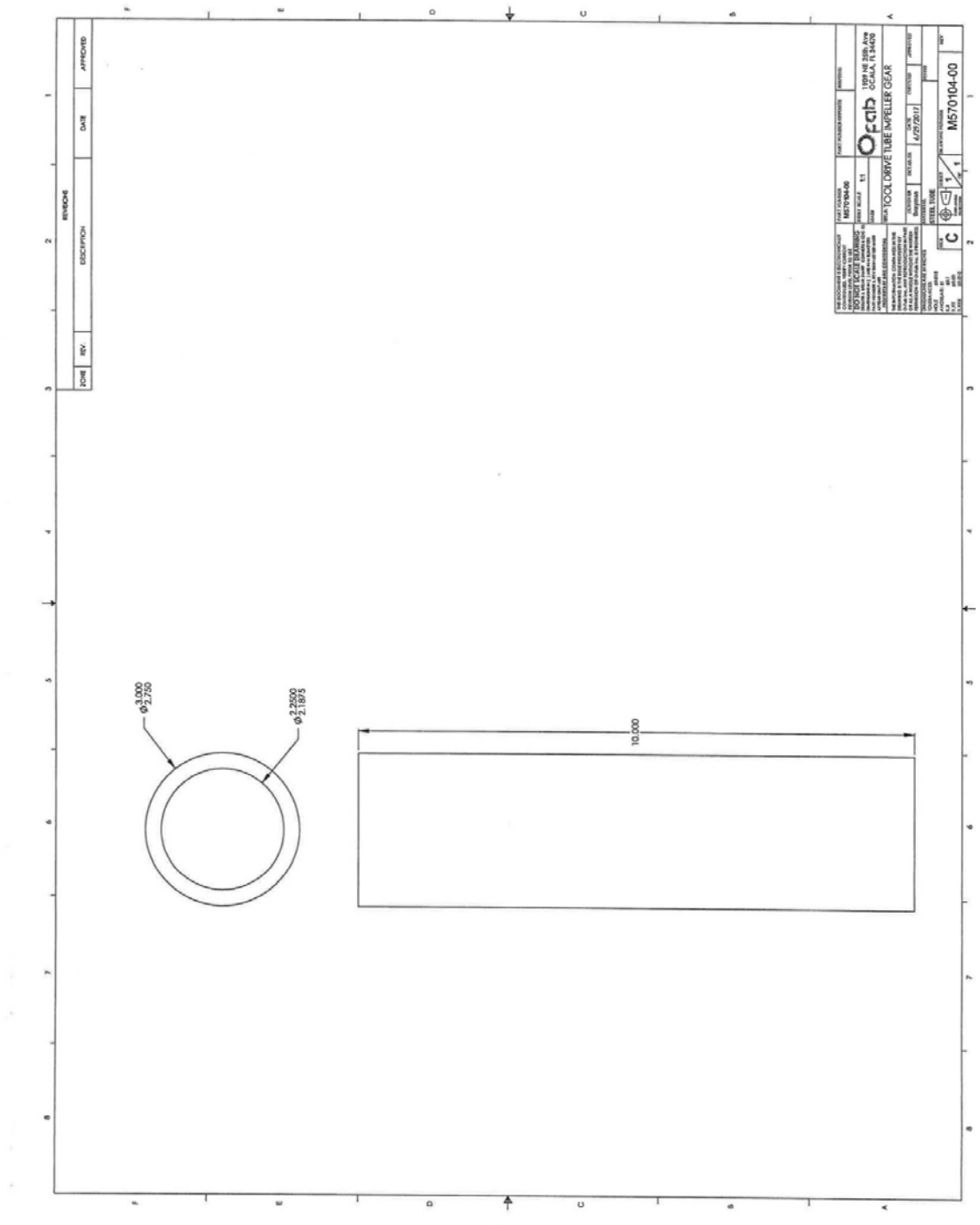
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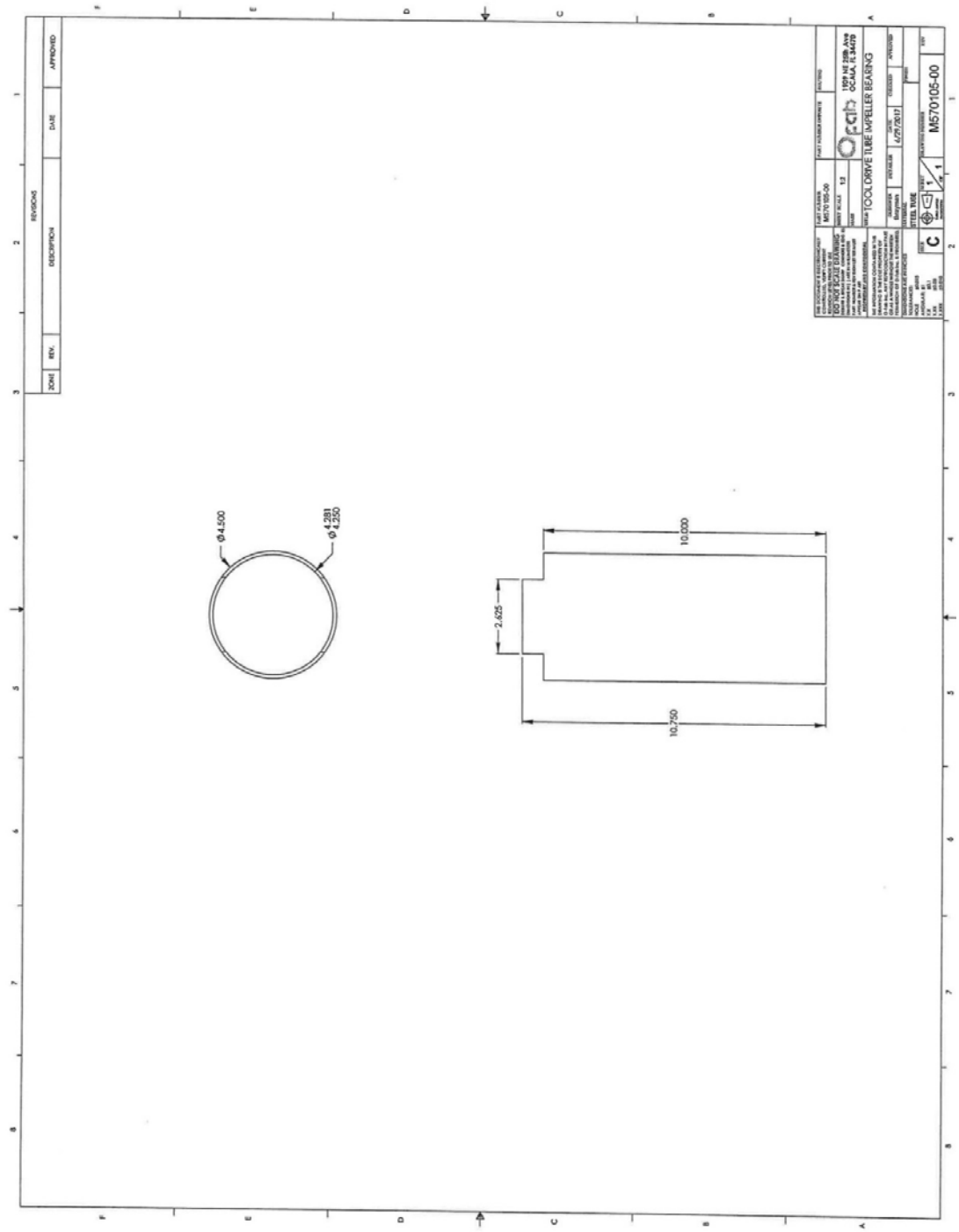
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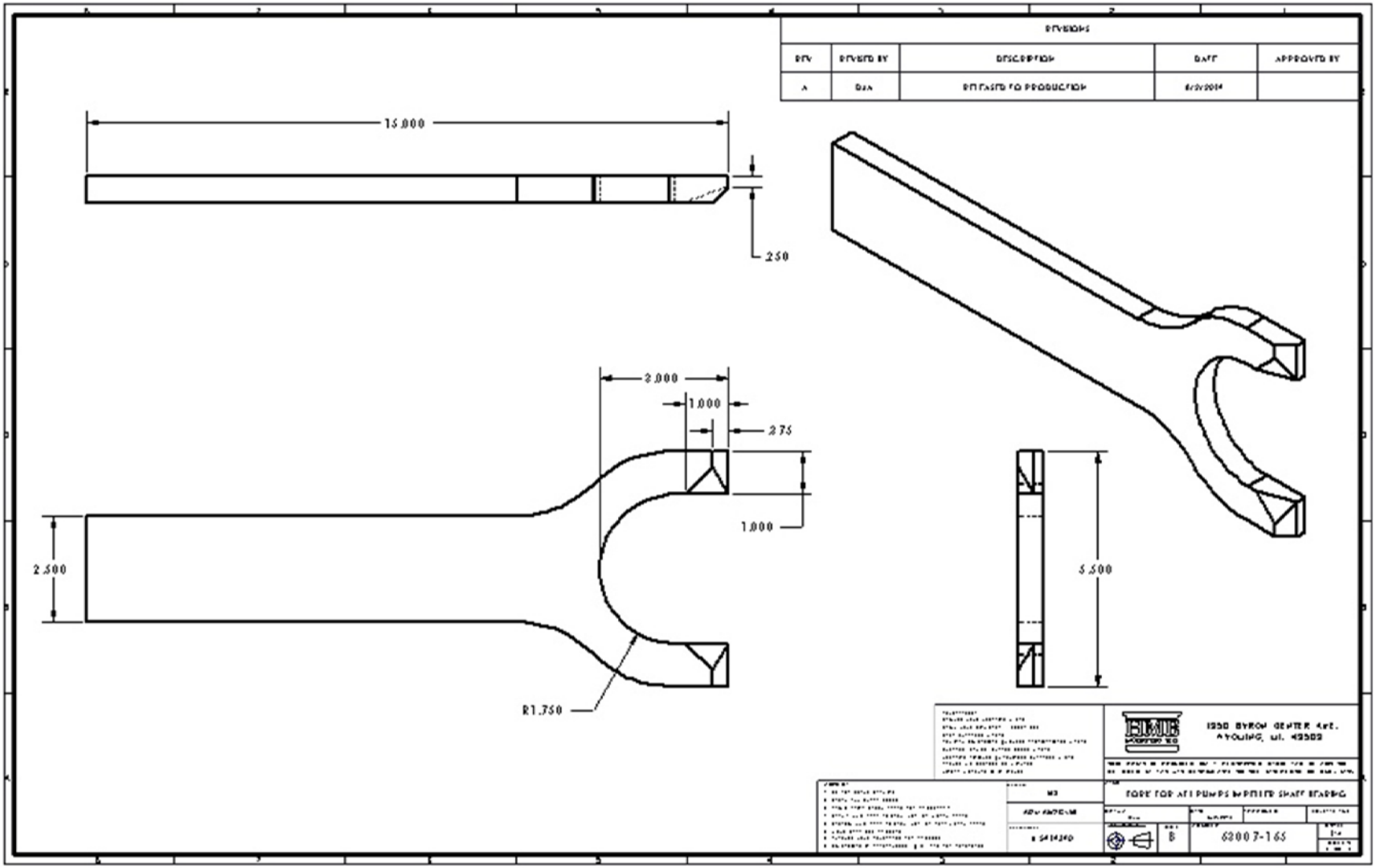
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FORK FOR AF1 PUMPS IMPELLER SHAFT BEARING
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Revisions

January 1, 2019	Draft Created
January 6, 2019	Updated case image and warning images added
March 12, 2019	Added drain plug and sight glass images Replaced exploded views pages 52 & 57
June 10, 2019	Updated oil capacity to 11 quarts Added oil level sight glass image and oil fill image Re-numbered Table of Contents to match page locations
June 14, 2019	Added pages 75-83 with drawings of the repair tools
August 12, 2019	Updated pages 62-64 adding lubricant note for bearings Updated page 69 adding #609 Loctite, and Bearing lubricant Added page 86 Fork tool for bearing
August 19, 2021	Added Damage label and notation of Locktite 243 or equivalent to yoke nut to the instructions page 50.