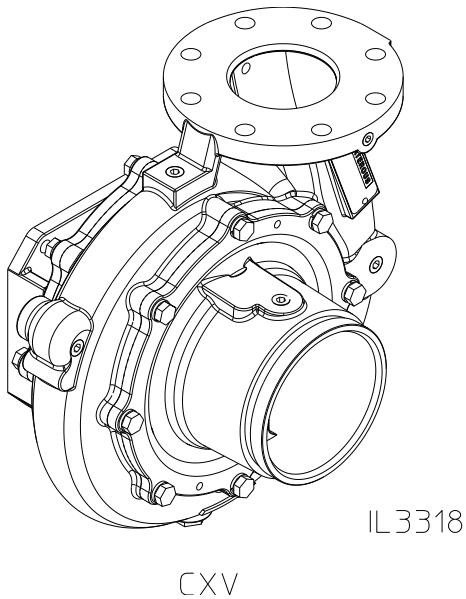


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**Read through the operation instructions carefully before using your Waterous Fire Pump.**

NOTE: Instructions subject to change without notice

F-1031, Section 2109.1 (Rev: 7/14/20)



Read through the safety information and operating instructions carefully before using your Waterous Fire Pump.

## Safety Information

### **WARNING**

Death or serious personal injury might occur if proper operating procedures are not followed. The pump operator, as well as individuals connecting supply or discharge hoses to the apparatus must be familiar with these pump operating instructions as well as other operating instructions and manuals for the apparatus, water hydraulics and component limitation.

### **WARNING**

**Pressure Hazard. May result in personal injury.**  
Prior to connection or removal of hoses, caps or other closures with pump intake or pump discharge connections, relieve pressure by opening drains or bleeder valves. Bleeder valves should also be used while filling a hose connected to an intake with water.

### **WARNING**

**Scalding Water Hazard. May result in serious burns.**  
When operating the pump, be sure to open at least one discharge valve slightly to prevent the pump from overheating. If the pump runs for a few minutes completely closed, it may heat the water enough to scald someone when the valve is opened. Overheating can damage the packing, seals and other pump parts. If the apparatus builder has installed a by-pass system or other provision designed to prevent overheating, opening a discharge valve may be unnecessary.

### **WARNING**

**Unexpected Truck Movement. May result in serious personal injury or death.**

Failure to properly shift transmission in accordance to the transmission operating instructions may result in unexpected truck movement which may result in serious personal injury or death.

### **WARNING**

**Rotating Parts Hazard or Unexpected Truck Movement. May result in serious personal injury or death.**

Stop the engine, set parking brake and chock the wheels before going under the truck to adjust packing or to check packing gland temperature.

### **WARNING**

**Packing Gland and Pump Body Temperature Hazard. May result in serious burns.**

Heat is dissipated through the cross-section of the packing, transferring the heat to the packing gland and pump body.



Read through the safety information and operating instructions carefully before using your Waterous Fire Pump.

## Safety Information



### WARNING

**Hose Testing Hazard. May result in serious personal injury.**

Due to a potential for catastrophic hose failure during service testing of fire hose, it is vital that safety precautions be taken to prevent exposure of anyone to this danger. Fire pumps on fire department apparatus are not designed for and should not be used for service testing of fire hoses. Hose testing machines should be used for service testing of fire hoses.



### WARNING

**Pressure Hazard. May result in serious personal injury.**

If a fire pump on a fire department apparatus is used for service testing of fire hoses, the procedures in NFPA 1962 **MUST be followed** including the use of a fire department gate valve with a ¼-inch (6 mm) hole drilled through the gate installed between the fire apparatus discharge outlet and the hose test layout to prevent a volume surge from the pump in the event a hose bursts during testing.



### WARNING

**Scalding Water Hazard. May result in serious burns.**

If a fire pump on a fire department apparatus is used for service testing of fire hoses, pump discharge water must be circulated through a by-pass system or discharged through a slightly open discharge valve, or some other provision must be used to prevent overheating. If the pump runs for a few minutes without adequate flow through the pump, water may be heated enough to scald someone when a valve is opened.

## Introduction

This instruction contains the information needed for operation and maintenance of CX Series centrifugal pumps. Since there are several types of transmissions available for these pumps, they are covered in separate instructions.

## General Description

The CX series pumps are single stage centrifugal pumps. Depending on the type of transmission used, the pump may be used as a front-mounted pump (driven from the engine crankshaft), power take-off driven, direct-engine driven (bellhousing mounted) or midship mounted. They are available in capacities up to 1250 gpm (4750 l/m).

Model	Intake
CXN	DIN PN10 150
CXR	5 in. or 6 in. NH Thread
CXS	6 in. Victaulic® Tee with a Front Facing 5 in. Victaulic® Connection
CXV	Single 6 in. Victaulic®

**OPERATION LIMITS: Do not operate pump beyond max. pressure (350 psi) or max. speed (5200 rpm). Fail to do that may result in personal injury or premature pump failure.**

## Components

### Body Assembly

This assembly includes the body, head, intake adapter and related parts. The body and adapters are either cast iron or bronze.

### Heater Jacket (CXR Only)

A heater jacket consists of two 1/2" NPT tapped holes in the intake adapter. This allows a piping connection from the engine coolant system to connect to the tapped holes. Engine coolant then flows through a hollowed out area in the intake adapter. The engine coolant helps prevent the water flowing into the pump from freezing.

### Intake Screens

Zinc die cast screens are normally used in the intake fittings, with brass screens available optionally. Although the screens are chemically treated (coated) to inhibit corrosion, the water being pumped may still corrode the screens. Such corrosion is "sacrificial"; that is, it will help prevent corrosion in the rest of the pump the same way the magnesium anodes protect the metal parts of a water heater.

### Anodes

As additional corrosion protection for iron body pumps, Waterous has anodes available to fit any unused opening in the intake fitting. Anodes provide an additional sacrificial surface to the water to supplement the intake screens.

### Flame Plated Impellers

Approximately 75% of the pump wear due to pumping sand, occurs on the impeller hubs. For this reason, the Waterous Company adopted the policy of offering a flame plated impeller as an option. The flame plating process consists of adding tungsten carbide to the surfaces to be protected from wear. This unique process produces extremely hard, well bonded, wear resistant coatings which

### Impeller Shaft Assembly

This assembly consists of a bronze impeller mounted on a stainless steel shaft, wear rings, mechanical seal or packing and related parts. The impeller is balanced and the impeller shaft is supported by ball bearings.

### Mechanical Seal

The mechanical seal consists of a flat, highly polished (lapped), spring-fed carbon ring that is sealed to and rotates with the impeller shaft. It presses against a highly polished (lapped) stainless steel, stationary ring that is sealed in the pump head. This seals the shaft and prevents air from entering and water from leaving. A mechanical seal does not leak or drip water, even when pumping.

## Options

consistently outwear hard chrome plating, tool steel and solid tungsten carbide.

### Overheat Protection Manager (OPM)

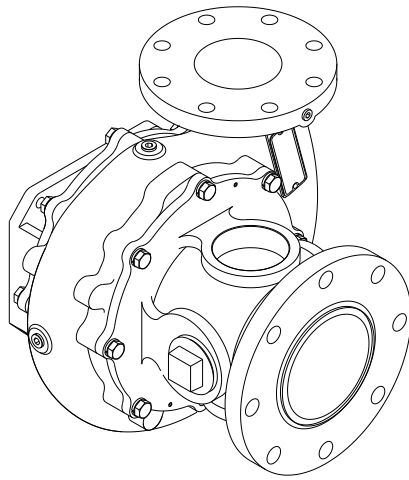
The Overheat Protection Manager (OPM) acts as a safety device by releasing hot water to the ground or back to the water tank from the discharge area of the pump.

### Monarch Intake Valve

The Monarch intake valve is a package including an extra short intake fitting, an intake butterfly valve and an intake nipple with integral relief valve mounting pad, all designed to fit behind the pump panel. The Monarch intake valve also features a provision for a pre-valve relief valve and choice of manual worm gear or pneumatic actuator. For operation and maintenance instructions for the Monarch intake valve, see the following instructions:

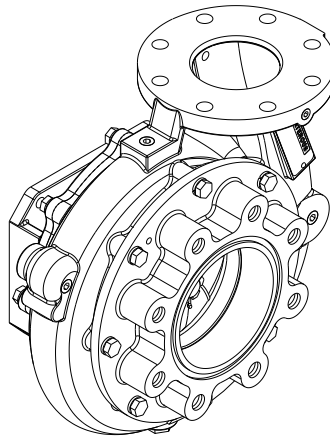
- F-1031, Section 2318, *Operation, Maintenance and Installation Instructions for Butterfly Valves*
- F-1031, Section 2319, *Operation, Maintenance and Installation Instructions for Butterfly Valve Pneumatic Actuator*

**Figure 1. CXN Models 6 in. ANSI Flange & DIN PN10 150 Flange**



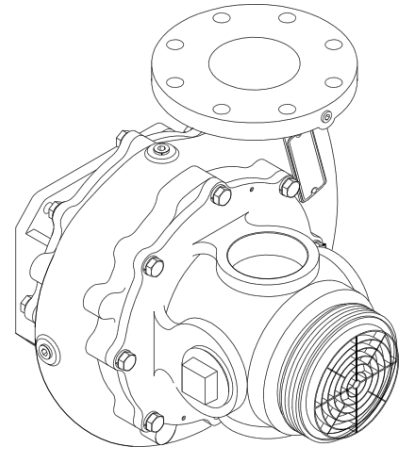
CXN  
6 IN. ANSI FLANGE

IL3318

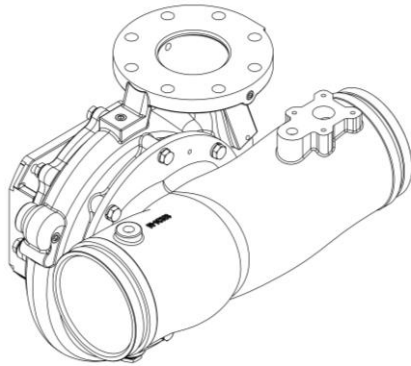


CXN  
DIN PN10 150 FLANGE

**Figure 2. CXR Models**

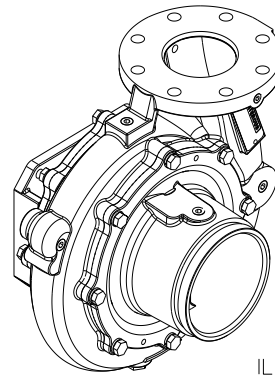


**Figure 3. CXS Models**



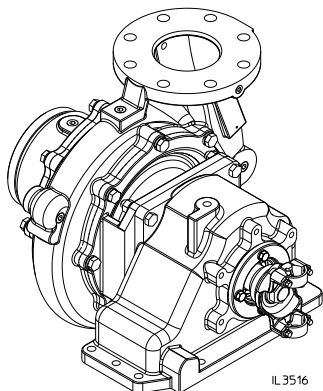
CXS  
IL3318

**Figure 4. CXV Models**



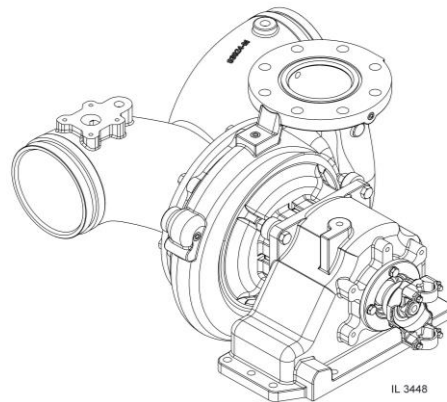
IL3318

**Figure 5. CXD Models**



IL3516

**Figure 6. CXSD Models**



IL3448

# Operating Instructions

## Transmission Operation

Because of the variety of transmissions available for these pumps, the methods of operating them are not explained in this section. For information on Waterous transmissions, refer to transmission operation instructions.

### Pumping from Water Tank

#### **WARNING**

**Pressure Hazard. May result in personal injury.**  
Prior to connection or removal of hoses, caps or other closures with pump intake or pump discharge connections, relieve pressure by opening drains or bleeder valves. Bleeder valves should also be used while filling a hose connected to an intake with water.

#### **WARNING**

**Scalding Water Hazard. May result in serious burns.**  
When operating the pump, be sure to open at least one discharge valve slightly to prevent the pump from overheating. If the pump runs for a few minutes completely closed, it may heat the water enough to scald someone when the valve is opened. Overheating can damage the packing, seals and other pump parts. If the apparatus builder has installed a by-pass system or other provision designed to prevent overheating, opening a discharge valve may be unnecessary.

#### **WARNING**

**Unexpected Truck Movement. May result in serious personal injury or death.**  
Failure to properly shift transmission in accordance to the transmission operating instructions may result in unexpected truck movement which may result in serious personal injury or death.

1. Open valve(s) in piping between water tank and pump intake and at least one discharge valve.
2. Allow about 30 seconds for water to flow into pump.

**NOTE: Priming the pump may be necessary because of air trapped in piping.**

3. Engage pump. If pump is equipped with a Waterous transmission (C10, C20, K, PA, T, Y), follow transmission operation instructions.
4. Open discharge valves and accelerate engine to obtain desired discharge pressure and capacity.

#### **NOTICE**

Do not attempt to pump more water than is available from the water tank. Always make sure the intake pressure compound gage reading stays above zero.

5. Set relief valves or other pressure governing device to desired pressure.

### After Pumping

#### **WARNING**

**Pressure Hazard. May result in personal injury.**  
Prior to connection or removal of hoses, caps or other closures with pump intake or pump discharge connections, relieve pressure by opening drains or bleeder valves. Bleeder valves should also be used while filling a hose connected to an intake with water.

1. Disengage pump. If pump is equipped with a Waterous transmission (C10, C20, K, PA, T, Y), follow transmission operation instructions.
2. If pumping anything but clean water, remove all intake and discharge caps, open all valves and open all drains. Flush entire system with clean, fresh water for several minutes to remove all traces of impurities.
3. If pump is kept full of water when not in use, make sure water is clean and non-corrosive. Make sure the pump is completely full or completely drained - never partially full.

#### **NOTICE**

**Freezing water hazard. May cause damage to the pump.**

If the pump is exposed to freezing temperatures, drain all water from pump, lines and accessories.

4. Close all drains and install intake and discharge caps.
5. If truck is equipped with a priming pump, operate it until fluid is discharged from priming pump discharge pipe. Also check fluid level in priming tank, and refill if necessary.

## Pumping from Hydrant or in Relay

### WARNING

**Pressure Hazard. May result in personal injury.**  
Prior to connection or removal of hoses, caps or other closures with pump intake or pump discharge connections, relieve pressure by opening drains or bleeder valves. Bleeder valves should also be used while filling a hose connected to an intake with water.

### WARNING

**Scalding Water Hazard. May result in serious burns.**  
When operating the pump, be sure to open at least one discharge valve slightly to prevent the pump from overheating. If the pump runs for a few minutes completely closed, it may heat the water enough to scald someone when the valve is opened. Overheating can damage the packing, seals and other pump parts. If the apparatus builder has installed a by-pass system or other provision designed to prevent overheating, opening a discharge valve may be unnecessary.

### WARNING

**Unexpected Truck Movement. May result in serious personal injury or death.**  
Failure to properly shift transmission in accordance to the transmission operating instructions may result in unexpected truck movement which may result in serious personal injury or death.

1. Engage pump. If pump is equipped with a Waterous transmission (C10, C20, K, PA, T, Y), follow transmission operation instructions.
2. Open intake, hydrant and other valves as necessary to allow water to enter the pump.

**NOTE: Bleeder valves should be used while filling a hose connected to an intake with water.**

### NOTICE

If pump has a mechanical seal, limit intake pressure to 100 psi if possible. Although the pump will operate properly with higher intake pressure, such operation will greatly accelerate mechanical seal wear.

3. Open discharge valves and accelerate engine to obtain desired discharge pressure and capacity.
4. Set relief valves or other pressure governing device to desired pressure.

### NOTICE

Do not attempt to pump more water than is available from the water tank. Always make sure the intake pressure compound gage reading stays above zero.

**NOTE: Some fire departments operate at a minimum intake pressure of 10 psi (.7 bar) when pumping from hydrant or in relay to prevent a “soft” intake hose from collapsing.**

### *After Pumping*

### WARNING

**Pressure Hazard. May result in personal injury.**  
Prior to connection or removal of hoses, caps or other closures with pump intake or pump discharge connections, relieve pressure by opening drains or bleeder valves. Bleeder valves should also be used while filling a hose connected to an intake with water.

Disengage pump. If pump is equipped with a Waterous transmission (C10, C20, K, PA, T, Y), follow transmission operation instructions.

2. If pumping anything but clean water, remove all intake and discharge caps, open all valves and open all drains. Flush entire system with clean, fresh water for several minutes to remove all traces of impurities.
3. If pump is kept full of water when not in use, make sure water is clean and non-corrosive. Make sure the pump is completely full or completely drained (never partially full).

### NOTICE

**Freezing water hazard. May cause damage to the pump.**

If the pump is exposed to freezing temperatures, drain all water from pump, lines and accessories.

4. Close all drains and install intake and discharge caps.
5. If truck is equipped with a priming pump, operate it until fluid is discharged from priming pump discharge pipe. Also check fluid level in priming tank, and refill if necessary.

# Pumping from Draft

## WARNING

**Pressure Hazard. May result in personal injury.**  
Prior to connection or removal of hoses, caps or other closures with pump intake or pump discharge connections, relieve pressure by opening drains or bleeder valves. Bleeder valves should also be used while filling a hose connected to an intake with water.

## WARNING

**Scalding Water Hazard. May result in serious burns.**  
When operating the pump, be sure to open at least one discharge valve slightly to prevent the pump from overheating. If the pump runs for a few minutes completely closed, it may heat the water enough to scald someone when the valve is opened. Overheating can damage the packing, seals and other pump parts. If the apparatus builder has installed a by-pass system or other provision designed to prevent overheating, opening a discharge valve may be unnecessary.

## WARNING

**Unexpected Truck Movement. May result in serious personal injury or death.**  
Failure to properly shift transmission in accordance to the transmission operating instructions may result in unexpected truck movement which may result in serious personal injury or death.

### **NOTE: To get full capacity, quick prime and maintain pump efficiency:**

- a) Position vehicle as near as possible to water supply.
- b) Avoid humps and sharp bends in intake hose. Make sure no part of hose is higher than pump inlet. (Air pockets in intake hose may cause loss of prime or erratic pump action, and may reduce pump capacity.)
- c) Make sure all intake connections are tight and discharge valves are closed.
- d) Immerse intake strainer at least two feet below water surface to prevent pump from drawing air. (Whirlpools forming above intake strainer indicate that strainer is too close to surface of water.)
- e) Make sure intake strainer is far enough from bottom to prevent sand, gravel and other foreign matter from being drawn into the pump.

1. Prime the pump (see separate instructions supplied with primer).
2. Engage pump. If pump is equipped with a Waterous transmission (C10, C20, K, PA, T, Y), follow transmission operation instructions.
3. Open discharge valves, and accelerate engine to obtain desired discharge pressure and capacity.
4. Set relief valves or other pressure governing device to desired pressure.

### **After Pumping**

## WARNING

**Pressure Hazard. May result in personal injury.**  
Prior to connection or removal of hoses, caps or other closures with pump intake or pump discharge connections, relieve pressure by opening drains or bleeder valves. Bleeder valves should also be used while filling a hose connected to an intake with water.

1. Disengage pump. If pump is equipped with a Waterous transmission (C10, C20, K, PA, T, Y), follow transmission operation instructions.
2. If pumping anything but clean water, remove all intake and discharge caps, open all valves and open all drains. Flush entire system with clean, fresh water for several minutes to remove all traces of impurities.
3. If pump is kept full of water when not in use, make sure water is clean and non-corrosive. Make sure the pump is completely full or completely drained (never partially full).

## NOTICE

### **Freezing water hazard. May cause damage to the pump.**

If the pump is exposed to freezing temperatures, drain all water from pump, lines and accessories.

4. Close all drains and install intake and discharge caps.
5. If truck is equipped with a priming pump, operate it until fluid is discharged from priming pump discharge pipe. Also check fluid level in priming tank, and refill if necessary.



# Fire Hose Testing



## WARNING

### **Hose Testing Hazard. May result in serious personal injury.**

Due to a potential for catastrophic hose failure during service testing of fire hose, it is vital that safety precautions be taken to prevent exposure of anyone to this danger. Fire pumps on fire department apparatus are not designed for and should not be used for service testing of fire hoses. Hose testing machines should be used for service testing of fire hoses.

NFPA 1962 *Standard for the Inspection, Care, and use of Fire Hose, Couplings, and Nozzles and the Service Testing of Fire Hose* provides requirements and testing procedures for service-testing fire hose at least annually. NFPA 1962 includes procedures for service testing with either a hose testing machine or with a pump on a fire department fire apparatus.



## WARNING

### **Pressure Hazard. May result in serious personal injury.**

If a fire pump on a fire department apparatus is used for service testing of fire hoses, the procedures in NFPA 1962 **MUST be followed** including the use of a fire department gate valve with a ¼-inch (6 mm) hole drilled through the gate installed between the fire apparatus discharge outlet and the hose test layout to prevent a volume surge from the pump in the event a hose bursts during testing.

During fire hose testing with a fire pump on a fire department fire apparatus, the fire pump is required to be operated at high discharge pressure with little or no flow out of the apparatus.



## WARNING

### **Scalding Water Hazard. May result in serious burns.**

If a fire pump on a fire department apparatus is used for service testing of fire hoses, pump discharge water must be circulated through a by-pass system or discharged through a slightly open discharge valve, or some other provision must be used to prevent overheating. If the pump runs for a few minutes without adequate flow through the pump, water may be heated enough to scald someone when a valve is opened.

## NOTICE

If a fire pump on a fire department apparatus is used for service testing of fire hoses, operating the pump at high discharge pressure with little or no flow may result in severe damage to the pump.

# Maintenance

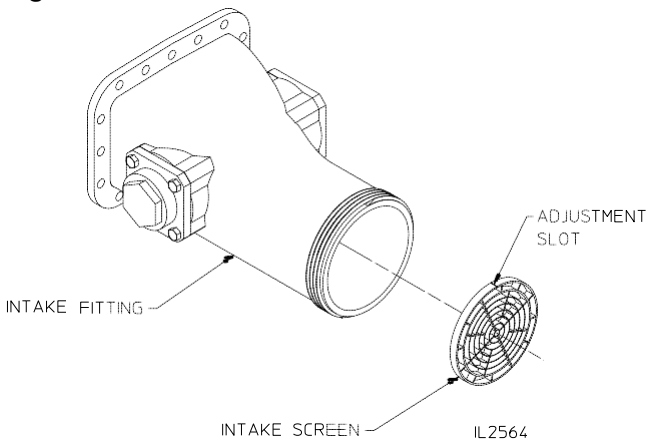
## Corrosion Protection

### Optional Intake Screens

Once per month check to make sure the intake screens are not clogged or damaged. Also check for corrosion, and replace screens if damage is severe. For the screen to adequately control corrosion, there must be a strong electrical contact between the screen and the fitting. Remove any corrosion, debris or paint from the counter bore that will insulate the screen from the intake fitting. If the screen does not fit tightly, adjust the gap of the slot on the outside diameter of the screen to ensure a tight fit.

**NOTE:** These screens are die-cast which results in a slight taper from one side to the other. Install the screen with the thinner cross-section facing out to minimize flow restriction.

**Figure 5. Intake Screens**



### Optional Anodes

Twice per year, remove the anodes and check for erosion of the replaceable elements. Replace the elements if more than half of either of the elements has eroded. Anodes are normally mounted on the pump intake piping, but they may also be installed in the discharge piping if no intake mounting locations were available. Physical mounting of the anode may be via an NPT tap or bolt-on flange as described below.

**NOTE:** The replaceable elements must make contact with water to be effective. Do not paint or use any other coating on the replaceable elements.

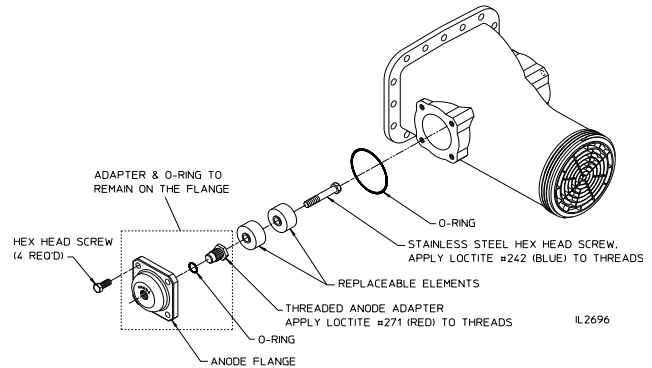
#### Bolt-on Anodes

Unscrew the (4) hex head screws from the pump. If elements require replacement, unscrew the hex head cap screw.

**NOTE:** There is no need to remove the threaded anode adapter from the anode flange for element replacement. The screw was installed using thread sealant so higher force than normal may be necessary to remove.

Replace one or both elements as necessary. Install the hex head screw using Loctite 242 (blue) on the screw threads. Mount the anode assembly back on the fitting.

**Figure 6. Bolt-on Anodes**



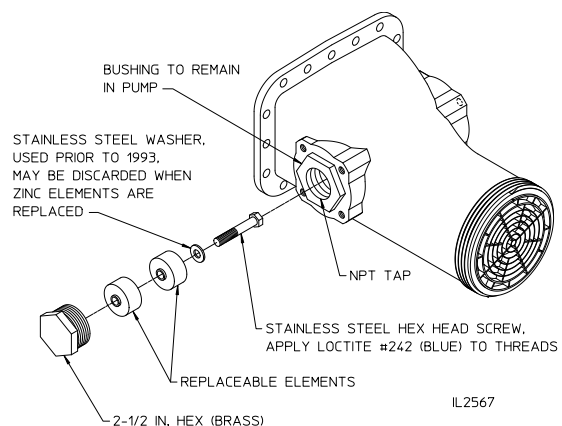
#### Threaded Anodes

**NOTE:** The 2-1/2 in. hex is threaded into a bushing that should remain on the pump. Be sure to restrain the bushing when removing the 2-1/2 in. hex.

Unscrew the 2-1/2 in. hex from the pump. If the elements require replacement, unscrew the hex head cap screw.

**NOTE:** The screw was installed using thread sealant so higher force than normal may be necessary to remove. Replace one or both elements as necessary. Install the hex head screw using Loctite 242 (blue) on the screw threads. Remove any paint or corrosion from the face around the NPT tap on the pump. Apply thread sealant to the threads and screw the 2-1/2 in. hex into the pipe tap until tight.

**Figure 7. Threaded Anodes**



## Mechanical Seal

If a mechanical shaft seal is used, no adjustment is required. When the pump operates, the water being pumped cools and lubricates the shaft seal to prevent it from overheating.

### NOTICE

Prolonged dry pump operation or operating a dry pump at high speeds will reduce the life of the mechanical seal.

## Packing

Waterous uses a braided graphite fiber, with reinforced flexible graphite yarns and high purity graphite filament yarns that appear on the corners as well as throughout the body of the packing. The graphite reinforcement allows the flexible graphite yarns to provide greater tensile strength.

This type of packing reduces the frictional heat created between the shaft and the I.D. of the packing. By dissipating the heat through the cross section of the packing, the heat is transferred to the packing gland and the pump body.

### WARNING

#### Packing Gland and Pump Body Temperature Hazard. May result in serious burns.

Heat is dissipated through the cross-section of the packing, transferring the heat to the packing gland and pump body.

### Packing Removal

### WARNING

#### Truck movement hazard. May cause serious personal injury.

Stop engine, set the parking brake and chock the wheels before going under truck to remove packing.

1. Remove the unbalanced nuts, flat washers and packing gland halves.
2. Engage the pump per appropriate operating instructions. Operate the pump, gradually increasing the discharge pressure until the packing is forced out of the stuffing box. Pressure in excess of 300 psi (20.7 bar) may be required.

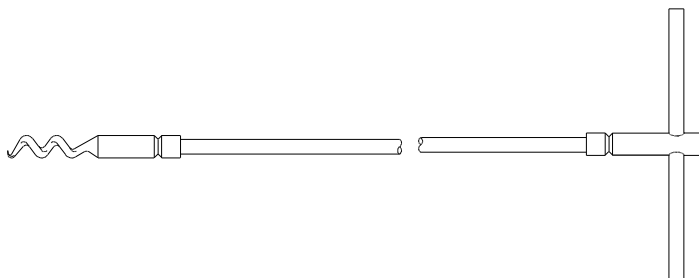
### NOTICE

#### Pump overheating hazard. May cause damage to the pump.

Circulate enough water through the pump to prevent overheating. Do not pressurize the pump over the maximum discharge pressure of the pump.

3. If all the packing is not forced out, it may be necessary to remove the remaining packing by hand, using a pick or similar device. Waterous has a packing removal tool (P/N 5782) available for this purpose, see Figure 8.
4. Replace packing per instructions below.

Figure 8. Packing Removal Tool



IL1931

## Packing Installation

1. Before installing the new packing, be sure that all of the old packing is removed from the stuffing box.
2. Be sure that the stuffing box and the shaft are clean and free of any packing residue.
3. Lightly lubricate the packing ring I.D. and O.D. with mineral oil, automotive grease or engine oil for installation purposes.
4. Make sure the packing is clean.
5. Carefully install one ring of packing. With the aid of packing glands, push the packing into the stuffing box as far as possible. Repeat this operation with each ring, staggering the joints at least 90° apart. Install the packing rings until the top of the last ring is about 1/4 inch from the end of the stuffing box (at least 1/8 inch is required for the packing gland nose entrance into the stuffing box). See Figure 9.

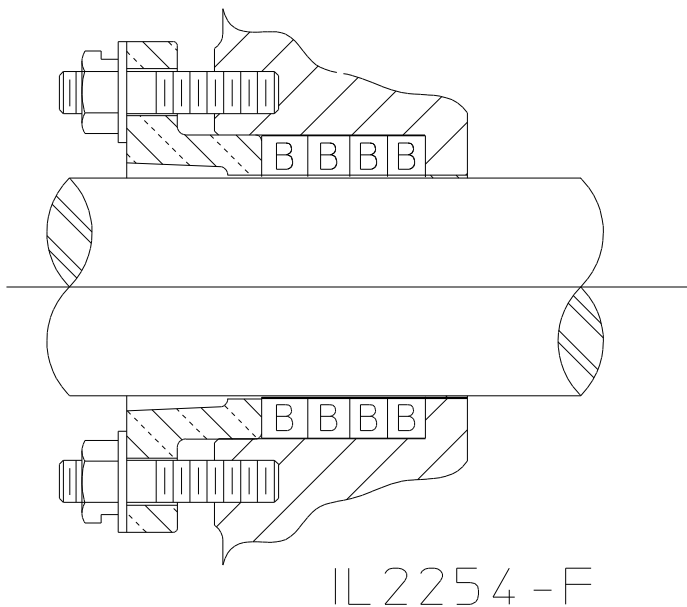
**Note: Be sure that the packing joints are staggered at least 90° apart.**

6. Install packing glands, nuts and washers. Tighten gland nuts one flat beyond finger tight, see Figure 9.

**Note: The milled slot on the nut should face the gland.**

7. Adjust packing as required per instructions on the next page.

**Figure 9. Packing and Gland Installation**



## Packing Adjustment

The pump packing is designed and adjusted to drip slightly during operation. This is to cool and lubricate the packing. It is desirable to adjust the stuffing box to maintain a leakage rate of 10 to 120 drops per minute when operating at a discharge pressure of 150 psi (10.3 bar).

Leakage through the braided flexible graphite (BFG) packing may be at zero or diminish to zero leakage and may not respond to loosening of the packing nuts to restore leakage, see Adjustment Step 3. While the packing gland and stuffing box and pump body may reach high temperatures during this time, the impeller shaft will be protected from heat damage.

### NOTICE

**Pump overheating hazard. May cause damage to the pump.**

Circulate enough water through the pump to prevent overheating.

### WARNING

**Truck movement hazard. May cause serious personal injury.**

Stop engine, set the parking brake and chock the wheels before going under truck to remove packing.

1. Engage pump per appropriate operating instructions. Operate the pump at the capacity pressure shown on the serial plate for ten (10) minutes.

### NOTICE

**Observe the stuffing box drip rate from the side of the truck.**

2. Observe leakage. Normal leakage is 10-120 drops per minute.
3. If drip rate is considered high, stop the engine and tighten the packing gland nuts 1/2 to 1 flat (maximum of 1/6 of a revolution). Make appropriate adjustments starting with 1 flat, when approaching the final adjustment reduce to 1/2 flat. This reduces the possibility of over tightening. **Tighten the gland nuts equally to ensure that the packing gland goes on straight.** Gradually reducing leakage during the first hour of operation will result in a better seal over a longer period of time.

### NOTICE

**Stopping the leakage entirely at this point will cause the packing to overheat.**

4. Operate the pump at the capacity pressure shown on the serial plate for two (2) minutes to let packing run in, then observe the drip rate.



## WARNING

### **Packing Gland and Pump Body Temperature Hazard. May result in serious burns.**

Heat is dissipated through the cross-section of the packing, transferring the heat to the packing gland and pump body.

5. Repeat steps 3 and 4 until the drop rate is acceptable.

**Note: After adjusting the packing, the pump must pass the following vacuum test described below.**

## Vacuum Test

1. Remove all caps except openings without valves. Close all discharge, intake and drain valves and other similar openings. Operate priming device to create a vacuum of about 22 in. Hg/.735 atmosphere in pump, then stop primer and engine.
2. Watch the pressure gauge; if vacuum drops more than 10 in. Hg/.334 atmospheres in five (5) minutes, listen for air leaks around the packing gland, gaskets, valves, etc.
3. Replace gaskets, re-adjust packing, repack or otherwise repair source of trouble.
4. Repeat test.

## Overheat Protection Manager

Check the electrical circuit by pressing the test button located on the panel plate every 100 hours of pump operation or every six months, whichever comes first.

If the light does not flash, the light bulb or flasher may need replacement (provided all wire connections are solid).

## Butterfly Valve (BFV)

Operate valve once a week for optimal performance.