



Direct Drive Pump Maintenance



This manual describes how to rebuild the high-pressure wet end of the direct drive pump. There are also detailed instructions and schedules to help you maximize the life of the pump—with each rebuild—by regularly performing maintenance and inspecting for worn or damaged parts. Each time the pump is rebuilt, all of these procedures must be followed in the exact order detailed here.



All maintenance and electrical work described in this manual should be performed by qualified personnel who follow every safety instruction.

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MAINTENANCE SCHEDULES

Use the maintenance schedules and activities listed below as recommendations for establishing an effective pump maintenance system.

HIGH-PRESSURE WET END MAINTENANCE

NOTE:

The hours listed below are not warranty hours.

Routine Maintenance Schedule

Table 1

WET END MAINTENANCE		RECOMMENDED HOURS	
		P3050	3055V/P4055V
Install Minor Maintenance Kit	PN F300-D0077	500	-
Install MAJOR Maintenance Kit	PN F300-D0076	1000	500
Install Minor Maintenance Kit	PN F300-D0077	1500	-
Install MAJOR Maintenance Kit	PN F300-D0076	-	1000
Install Minor Maintenance Kit	PN F300-D0077	-	-
Install MAJOR Maintenance Kit	PN F300-D0076	-	1500
Install Check Valve Assembly Kit	PN F300-D0082	2000	2000

NOTE:

Repeat above sequence for the corresponding pump after every Check Valve Assembly Kit installation.

Less Frequent Maintenance Schedule

Table 2

WET END MAINTENANCE		RECOMMENDED HOURS	
		P3050	3050V/P4055V
Replace Plunger Assembly Kit	PN F300-D0084	Every 2000	Every 2000
Replace Cylinder Body	PN F300-D0071	Every 4000	Every 3500

Minor Maintenance Detail

Table 3

TASK	DESCRIPTION	PN	
Replace	O-Ring	PN F300-P0610	Kit PN F300- D0077
	O-Ring, Port Adapter	PN F300-P0611	
	O-Ring, Static Seal, Check Valve	PN F300-P0612	
	U-Cup Seal	PN F300-P0614	
	Static Seal, Port Adapter	PN F300-D0060	
	Static Seal, Check Valve	PN F300-D0061	
	Ring Seal, Short	PN F300-D0062	
	Ring Seal, Long	PN F300-D0063	
	Back-Up Ring Assembly, w/Support Ring	PN F300-D0066	
	Seal Assembly	PN F300-D0079	
	Filter Assembly, Manifold	PN F300-D0059	
Inspect	Ball	PN F300-P0616	
	Seat, Check Valve	PN F300-D0057	
	Static Back-Up Ring	PN F300-D0073	
	Check Valve Retainer, Outlet	PN F300-D0058	
	Check Valve Body Assembly, Internal Inlet	PN F300-D0072	
	Inlet Ball Retainer	PN F300-D0075	
	Support Ring, Seal	PN F300-D0065	

Major Maintenance Detail

Table 4

TASK	DESCRIPTION	PN	
Replace	O-Ring	PN F300-P0610	Kit PN F300- D0076
	Ball	PN F300-P0616	
	O-Ring, Port Adapter	PN F300-P0611	
	O-Ring, Static Seal, Check Valve	PN F300-P0612	
	Washer, Flat	PN F300-P0617	
	U-Cup Seal	PN F300-P0614	
	Seat, Check Valve	PN F300-D0057	
	Static Seal, Port Adapter	PN F300-D0060	
	Static Seal, Check Valve	PN F300-D0061	
	Screw, Socket Head Cap, 4-48	PN F300-D0056	
	Ring Seal, Short	PN F300-D0062	
	Ring Seal, Long	PN F300-D0063	
	Check Valve Retainer, Outlet	PN F300-D0058	
	Back-Up Ring Assembly, w/Support Ring	PN F300-D0066	
	Seal Assembly	PN F300-D0079	
Support Ring, Seal	PN F300-D0065		
Filter Assembly, Manifold	PN F300-D0059		
Inspect	Static Back-Up Ring	PN F300-D0073	
	Check Valve Body Assembly, Internal Inlet	PN F300-D0072	
	Inlet Ball Retainer	PN F300-D0075	
	Support Ring, Seal	PN F300-D0065	

Check Valve Assembly Detail

Table 5

TASK	DESCRIPTION	P/N	
Replace	O-Ring	PN F300-P0610	Kit PN F300- D0082
	O-Ring Port Adapter	PN F300-P0611	
	O-Ring, Static Seal, Check Valve	PN F300-P0612	
	U-Cup Seal	PN F300-P0614	
	Filter Assembly, Manifold	PN F300-D0059	
	Static Seal, Port Adapter	PN F300-D0060	
	Static Seal, Check Valve	PN F300-D0061	
	Ring Seal, Short	PN F300-D0062	
	Ring Seal, Long	PN F300-D0063	
	Back-Up Ring Assembly, w/Support Ring	PN F300-D0066	
	Seal Assembly	PN F300-D0079	
	Check Valve Assembly, Internal Inlet	PN F300-D0080	

MAINTENANCE OF THE WET END PUMP ASSEMBLY

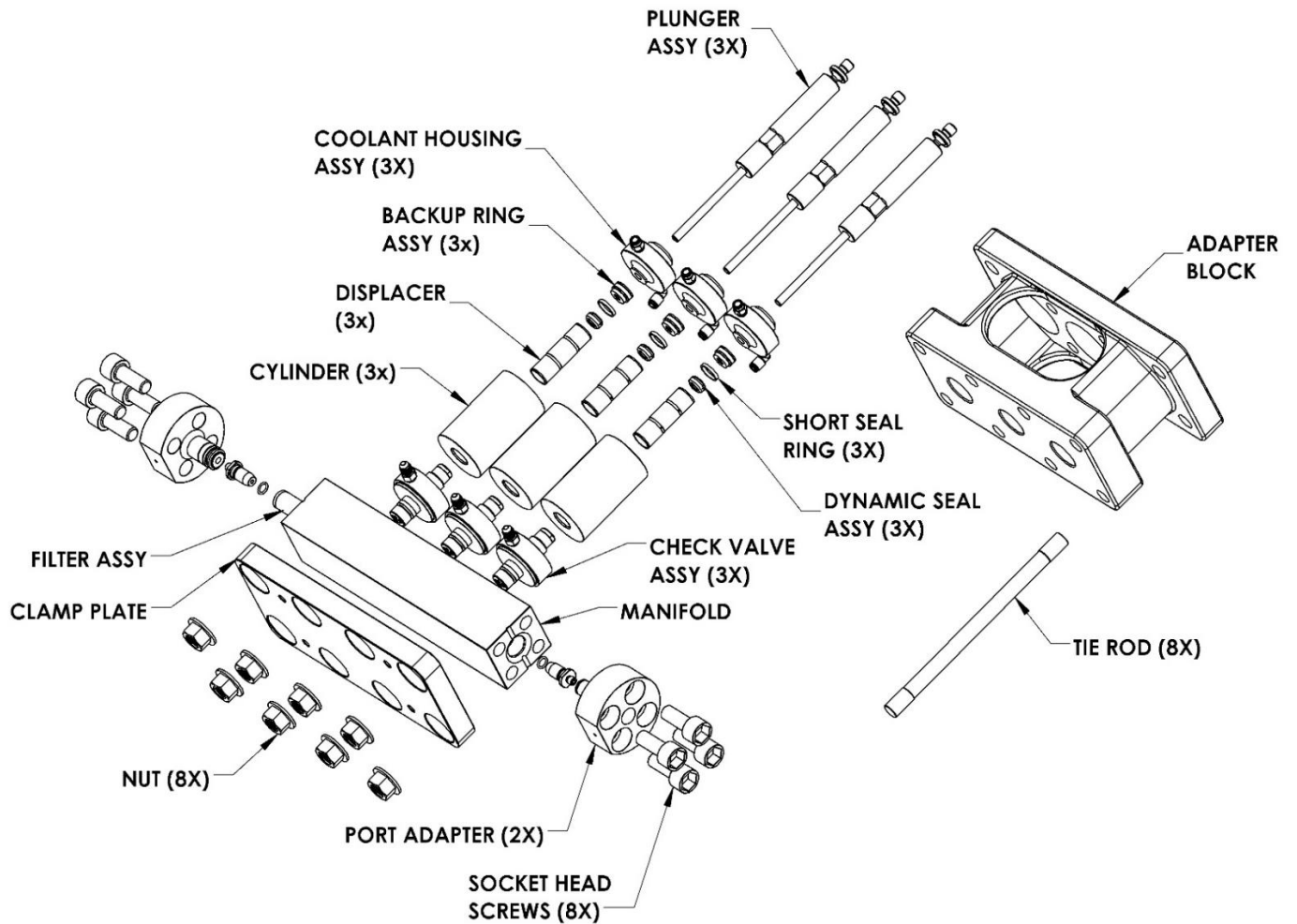


Figure 1 Major Components of Direct Drive Pump Assembly

TOOLS REQUIRED FOR WET END MAINTENANCE

Table 6 - Tools required for each individual component to complete the procedures described in this manual

TOOLS REQUIRED	Wet End Assembly	Backup Ring	Liquid Displacer	Check Valve	Port Adapter	Coolant Housing	Plunger	Dynamic Seal
OPEN-END WRENCHES:								
1/2"	x			x				
5/8"					x			
13/16"	x							
1"	x							
CROW-FOOT WRENCHES:								
5/8"				x				
3/4", 3/8" Drive							x	
SOCKETS:								
15/16" (24 mm); 1/2" Drive		x						
14 mm Allen Head Socket					x			
RATCHET WRENCH:								
1/2"	x							
BREAKER BARS:								
1/2" Drive		x						
3/8" Drive							x	
TORQUE WRENCH(ES):								
Measures up to 175 ft-lb (237 N.m)	x				x			
Measures up to 250 ft-lb (237 N.m)				x			x	
ALLEN WRENCHES:								
3/32"				x				
PLIERS:								
Channel-Lock				x				
Needle-Nose				x				
External Snap-Ring					x			
Internal Snap-Ring						x		
SCREWDRIVERS:								
(2) Large Flat-Blade	x				x			
Small Flat-Blade					x	x		
LUBRICANTS:								
Anti-Seize Lubricant	x			x	x		x	
Lubriplate	x			x	x	x		x
Extreme Pressure Lube	x							
Blue Goop Anti-Galling Compound	x							
SPECIAL TOOLS:								
Check valve removal tool	x		x					
Removal/Installation tool				x				x
0.124" Diameter Anti-Rotation Pin, (1/8" x 2-3/4")				x				
INSPECTION TOOLS:								
Magnifying Glass (Or Microscope)	x	x		x				
1" (2.54 cm) Micrometer		x						
OTHER:								
Arbor Press	x		x					x
Soft-Jawed Vise				x				
Soft-Blow Mallet				x				
Propane Torch			x					
Scale for Weighing Abrasive Flow								x
Ultrasonic Cleaner								x

REMOVING THE HIGH-PRESSURE WET END ASSEMBLY

The high-pressure wet end assembly is made up of the pump parts that are bolted to the crankcase and are involved in providing high-pressure water. (See **Figure 2** on next page.)

When breaking down the assembly, KEEP ALL PARTS TOGETHER in related sets, making note of the origins of each set.

For a list of tools used in maintenance of the pump's wet end assembly, refer to "Tools Required for Wet End Maintenance" section on page 9.



NEVER use a pipe wrench on any high-pressure equipment.

DO NOT disassemble the pump wet end unless a torque wrench capable of 175 ft-lb (235 N.m) is available for reassembly.

To remove the high-pressure wet end assembly:

1. **Turn off** power to the pump at the main AC disconnect. **Place** a "lock-out tag" on the power disconnect to **alert** others that maintenance is in progress.
2. **Use** the 13/16" and 1" open-end wrench to **disconnect** the hard plumbing from the port adapter. (See **Figure 2** on next page.)



Before disconnecting the hard plumbing, ensure that the pump has been shut down and allow the system to depressurize.

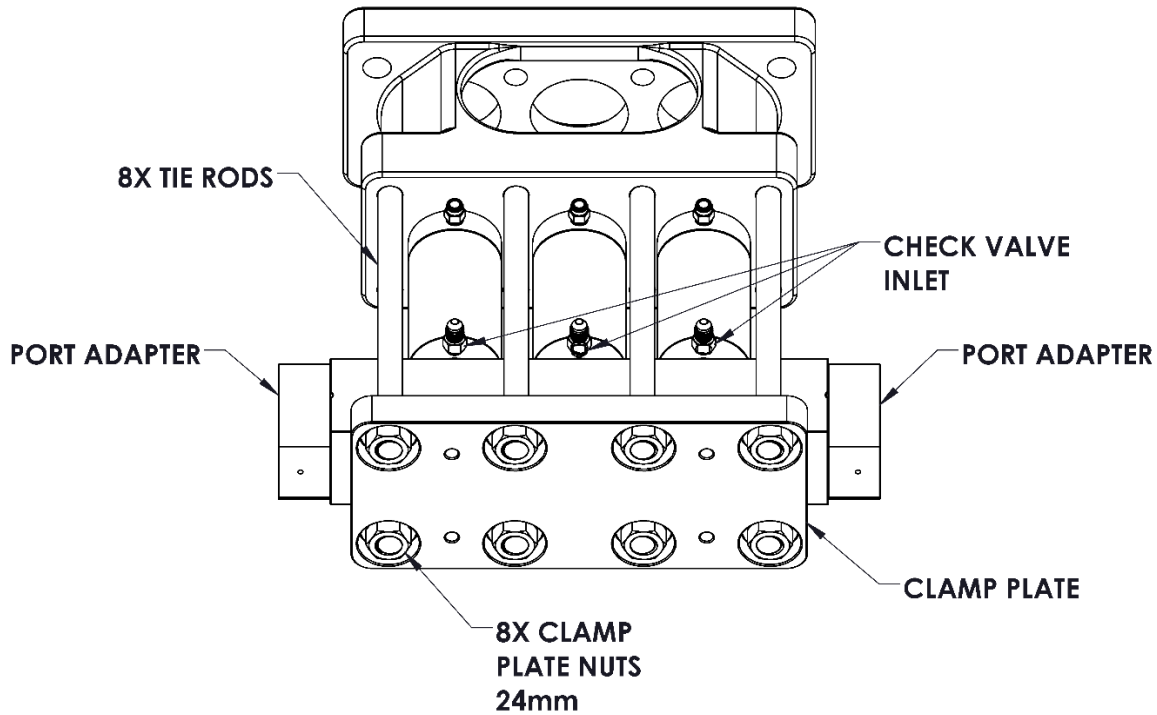


Figure 2 High-Pressure Wet End Assembly

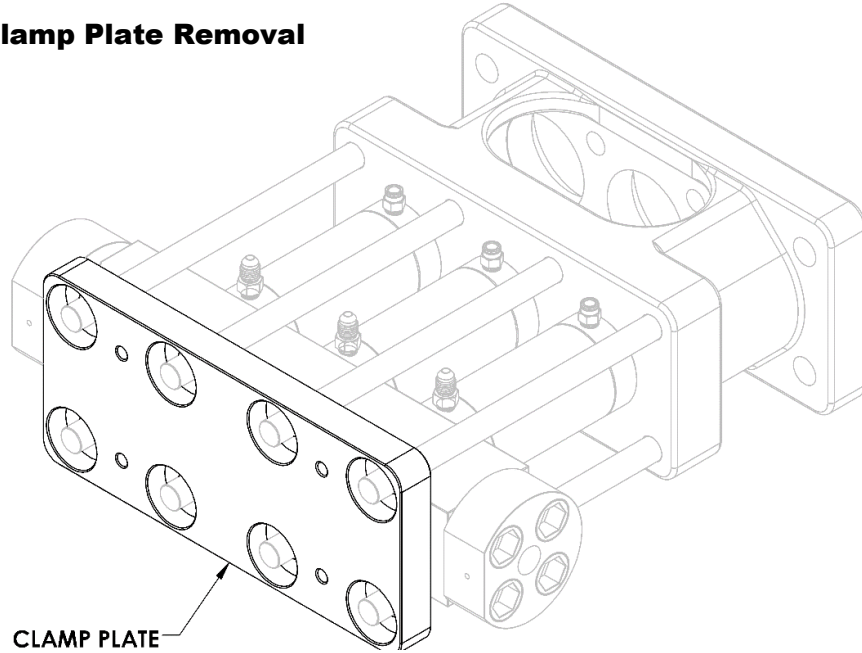
3. Use the 9/16" open-end wrench to **disconnect** the three water hoses from the check valve inlets. **Hold** it with the 1/2" open-end wrench to avoid unscrewing the fitting from the check valve body.
4. **Remove** the eight 24mm nuts from the clamp plate with the 24mm socket (or 15/16" socket) and the 1/2" breaker bar, **ensuring** that you evenly remove the load on the tie rods. **Break loose** the nuts at the ends of the clamp plate, then **use** a crisscrossing pattern when you **break loose** the remaining four nuts (see **Figure 3** below). **Use** the same pattern to **back off** each nut 1/2 turn until you **remove** the load from the tie rods.



Figure 3 Nut-Loosening Sequence for Removing Clamp Plate from High-Pressure Assembly

5. **Remove** the clamp plate and **set it aside** (see **Figure 4** on next page).

Figure 4 Clamp Plate Removal



6. **Slide** the wet end assembly away from the coolant housings. (See **Figure 5 below.**) **Ensure** that the assembly remains level as you **pull it straight back** being careful to **prevent** any binding of the internal plungers. (All components usually remain in the cylinders as the wet end assembly is removed.)

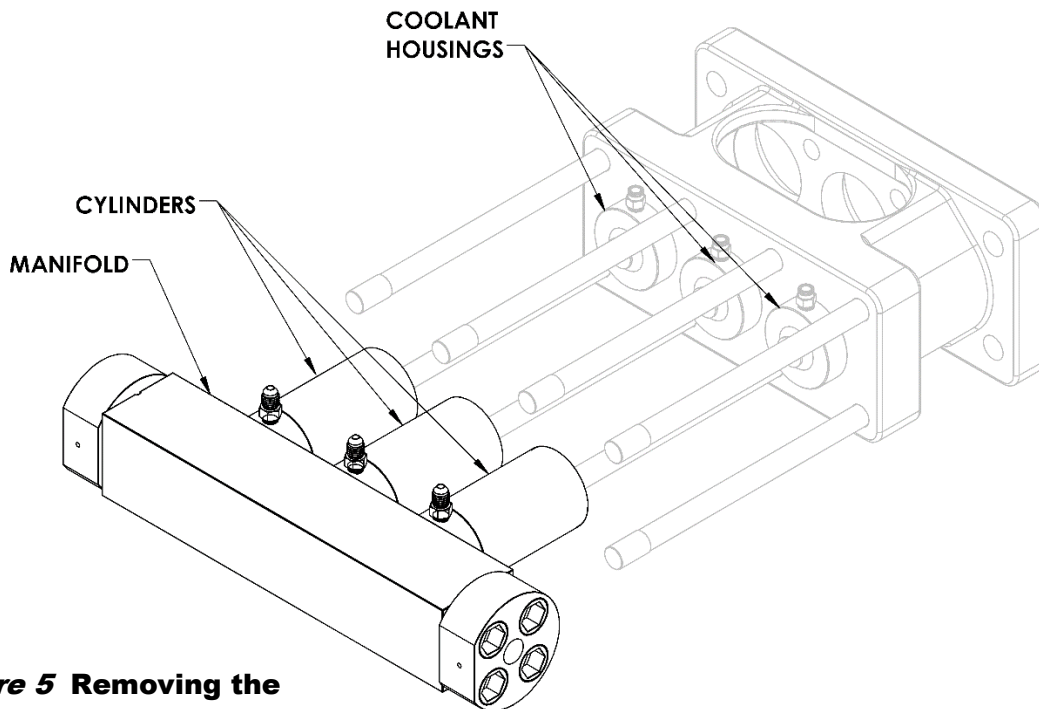


Figure 5 Removing the Wet End Assembly

NOTE:

If a coolant housing sticks to the cylinder and cannot be removed by hand:

1. Disconnect the coolant hoses;
2. Allow the coolant housing to remain attached to the cylinder.

7. **Set** the wet end assembly on a workbench with manifold down and cylinders standing upright.



If one cylinder has problems and the wet end assembly has been removed, all three cylinders must be removed and rebuilt using these procedures for disassembling and reassembling high-pressure wet end.

If the wet end was fully assembled (torque was applied and removed), the ring seals are not reusable and must always be replaced.

DISASSEMBLING THE WET END ASSEMBLY

The following disassembly tools are available to aid in the assembly and disassembly of the wet end assembly's high-pressure seal components:

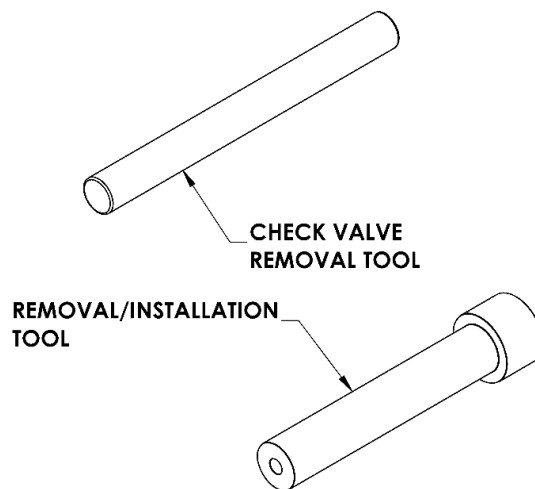


Figure 6 Special Disassembly Tools

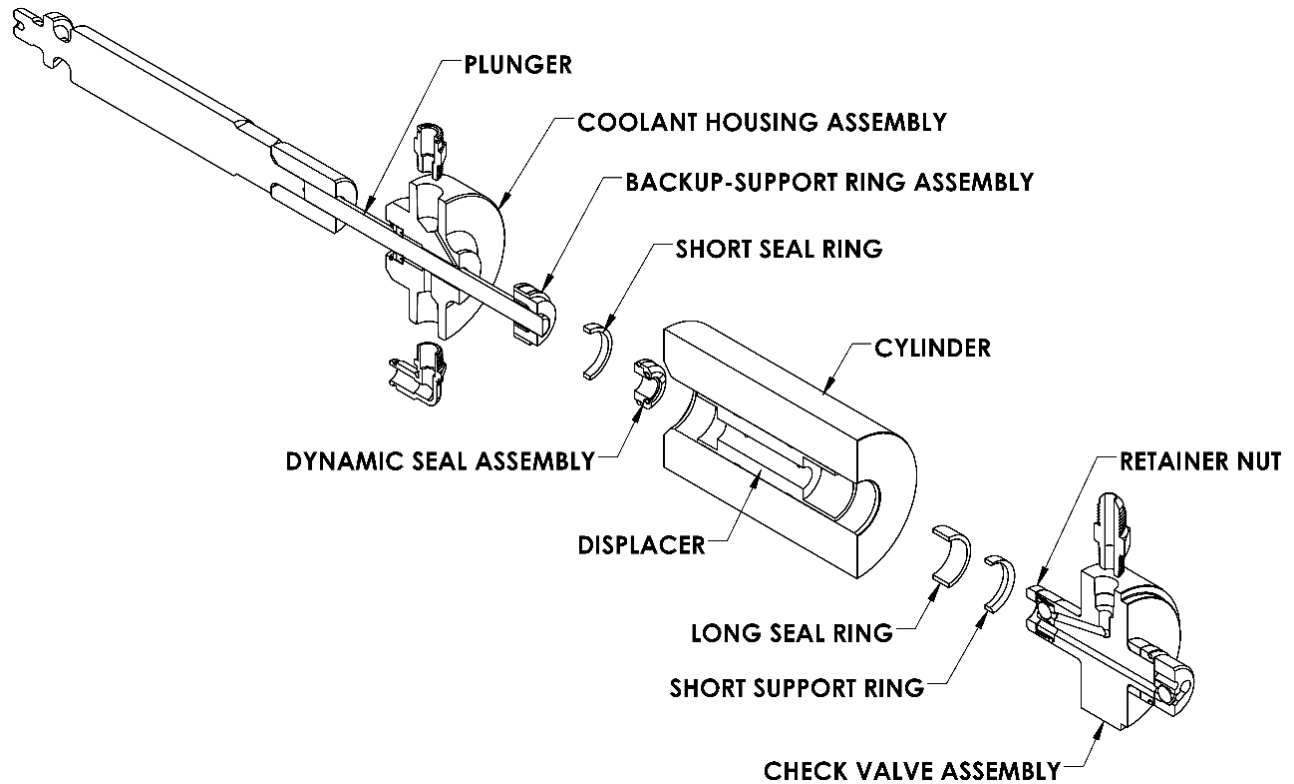


Figure 7 High-Pressure Wet End Assembly Components

NOTE:

Remember to keep all related sets of removed parts organized, noting the origin of each set.

To disassemble the high-pressure wet end assembly:

1. **Remove** the three cylinders and the three check valve assemblies from the manifold by **using** two large flat-head screwdrivers to **lift out** the check valve assembly and the cylinders from the pressure manifold (see **Figure 8** on next page).

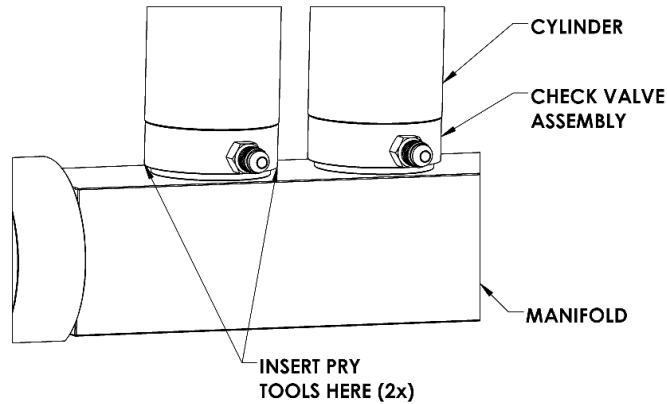


Figure 8 Removing the Cylinder and Check Valve Assembly

NOTE:

If the coolant housing assemblies remained fixed to the cylinders when removing the wet end assembly:

1. Clamp the outer diameter of the coolant housing to the soft jaws of a vise;
2. Strike the side of the cylinder with a soft-blow mallet to remove the coolant housings from the cylinders.

The close tolerance fit of the coolant housing into the cylinder bore extends only into the bore of the cylinder approximately 0.050" and should remove easily.

2. Insert check valve removal tool (see **Figure 9**) through backup-support ring assembly (see **Figure 7**) of the first cylinder until it contacts the check valve retainer nut inside the cylinder.

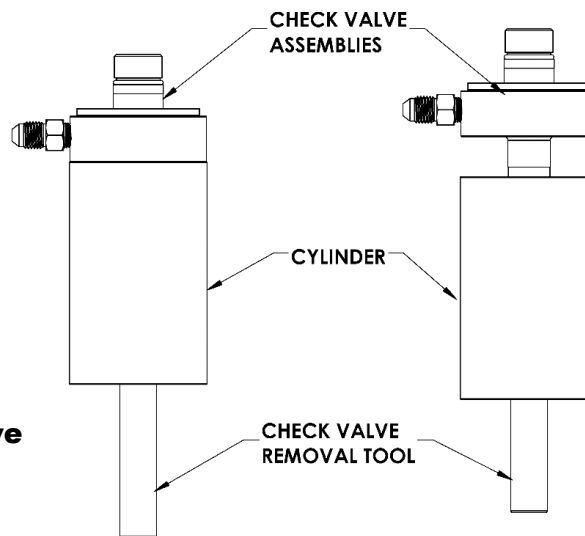


Figure 9 Using the Check Valve Assembly Removal Tool

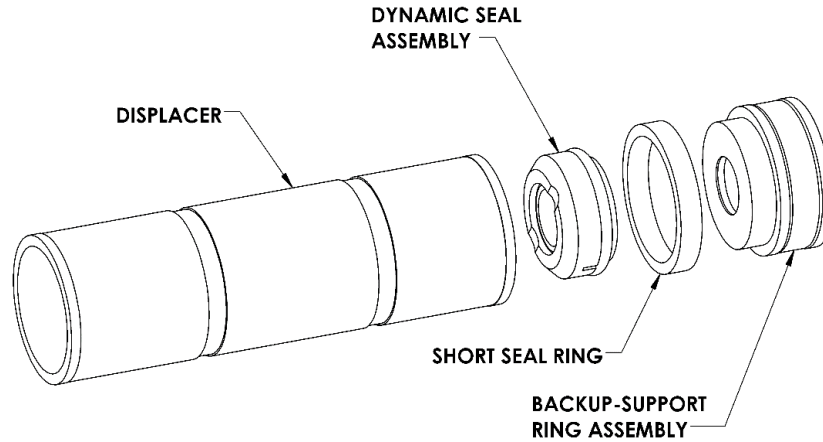


Figure 10 Sealing Assembly Components

3. **Strike** the tool against a surface to **remove** the check valve assembly from the cylinder assembly. **Set aside** check valve assembly until later. Repeat for the two remaining cylinders.
4. **Use** an arbor press and the removal/installation tool to **push out** the sealing assembly components from the cylinder. (See **Figure 10**.) Push the assembly *from* the check valve end *toward* the coolant housing assembly end. Repeat for remaining cylinders.

NOTE:

The long seal ring on the inlet side of the check valve assembly typically remains in the cylinder bore and can be removed by hand.

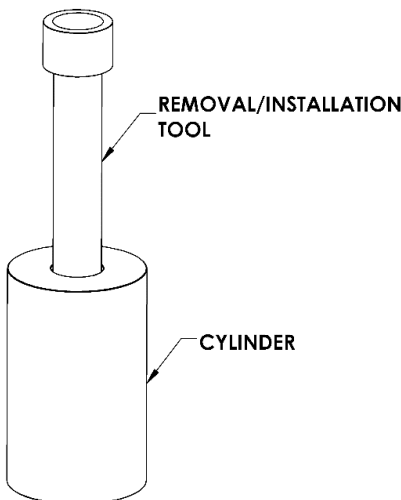


Figure 11 Removing the Sealing Assembly (Using an Arbor Press)

5. **Separate** the backup-support ring assembly (see **Figure 10** on previous page) from the displacer by **placing** the large end of the removal/installation tool (see **Figure 12** below) over the backup-support ring assembly and **breaking loose** the short seal ring from the displacer.

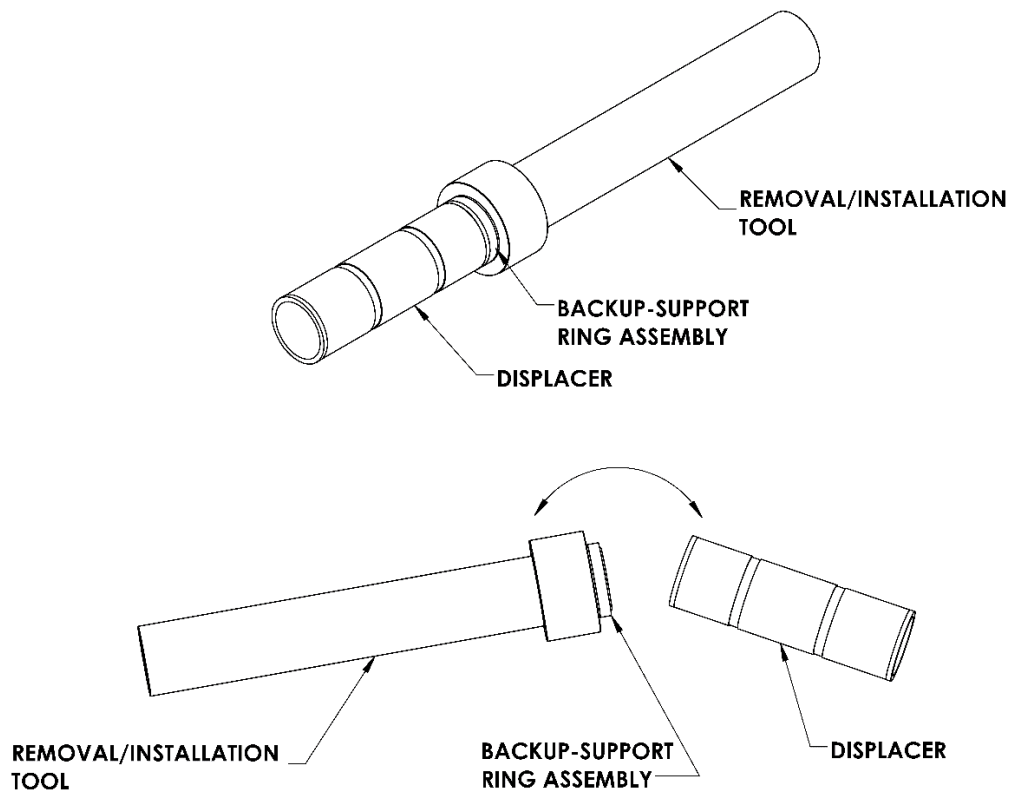


Figure 12 Separating the Backup-Support Ring Assembly from the Displacer

6. The backup-support ring assembly (see **Figure 15** on page 19) is machined together as one assembly. The outer support ring must then be **pressed onto** the inner backup ring. These parts should not be separated. The short seal ring (see **Figure 10** on previous page) should be easily removable by hand. **Remove** the short seal ring from all three backup-ring assemblies.
7. Before removal of the dynamic seal assembly (see **Figure 10** on previous page) from the displacer, **inspect** the dynamic seal for extrusion (see **Figure 13** on next page). Extrusion of seal material around the edges of the bore in the dynamic seal is to be expected. Uneven, missing material and/or from one side of the face of the dynamic seal indicates a failed seal with potential plunger damage caused by the plunger abrading on the bore of the backup ring. If excessive or uneven material is missing or extruded, closely **inspect** the backup-support ring assembly for signs of rubbing.



Figure 13 Dynamic Seal Inspection

8. **Remove** the dynamic seal assembly from inside the end of the displacer. **Remove** large O-ring from outside of dynamic seal. **Separate** components of the dynamic seal assembly by **pushing** the dynamic seal out of the retainer. **Remove** the small O-Ring from inside the retainer.

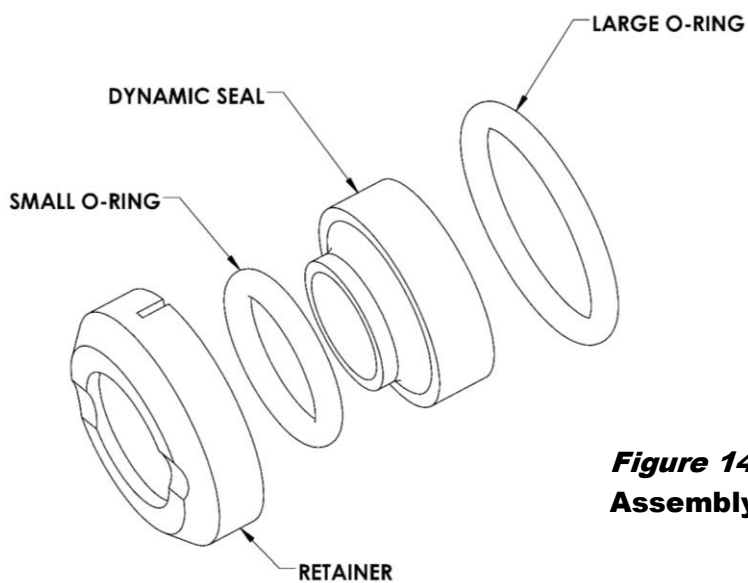


Figure 14 Dynamic Seal Assembly Components

9. Repeat steps 4-8 for the remaining two backup rings and displacer assemblies.
10. Because they are not reusable, **discard** the O-Rings, the plastic dynamic seal of the dynamic seal assembly, and the plastic ring seals. The metal retainer is reused.

INSPECTING THE BACKUP-SUPPORT RING ASSEMBLY

If dynamic seal failure extrusion or an uneven dynamic seal occurred, you should examine the backup-support ring in detail. Determine if plunger rubbing has occurred and whether the associated plunger assembly needs replacement.

To inspect the backup-support ring assembly:

1. **Use** a magnifying glass to **examine** the edges and the interior of the metal lip in the bore of the backup-support ring next to where the dynamic seal was positioned, particularly if you **observe** excessive extrusion of the dynamic seal. The exterior edge of the short lip should be sharp and square with no scratches or gouges. There should be no visible evidence of rubbing on the lip.

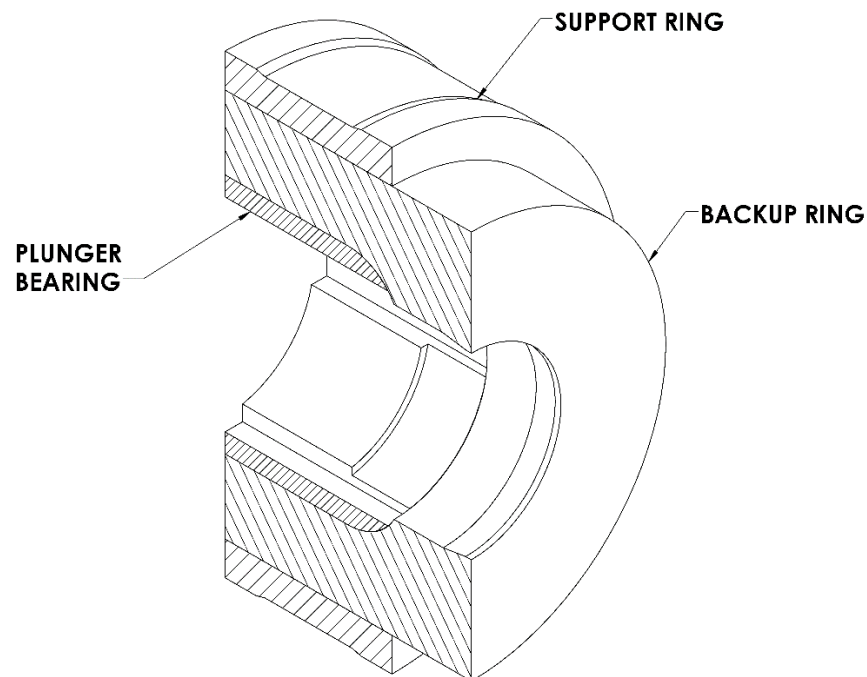
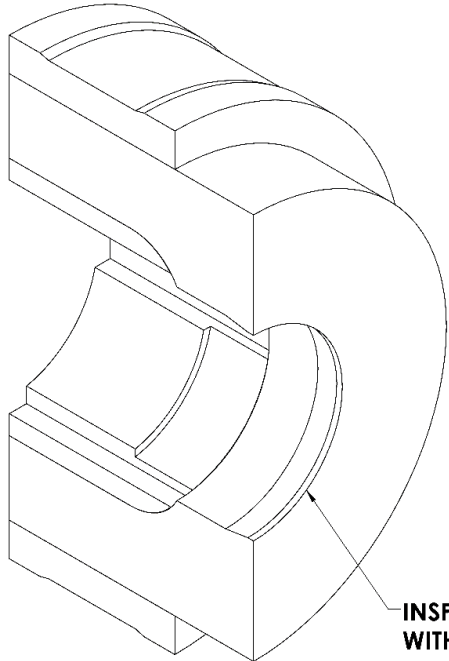


Figure 15 Backup-Support Ring Assembly Components



2. Note that **Figure 16** shows you the lip to inspect and **Figure 17** provides examples of both a damaged and an undamaged backup-support ring. The short lip should appear to be uniform in width all the way around. Any area where the width appears to be wider, darker, or where the machining marks are scraped away indicates a spot where the lip has been rubbed by the plunger.

Figure 16 Backup-Support Ring Inspection

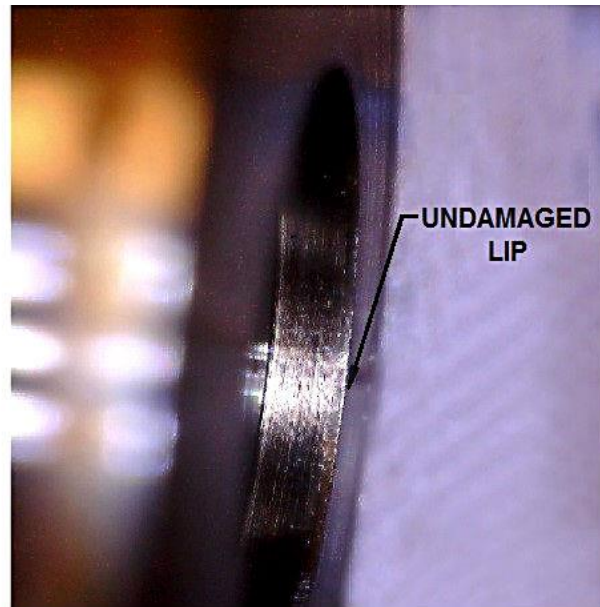
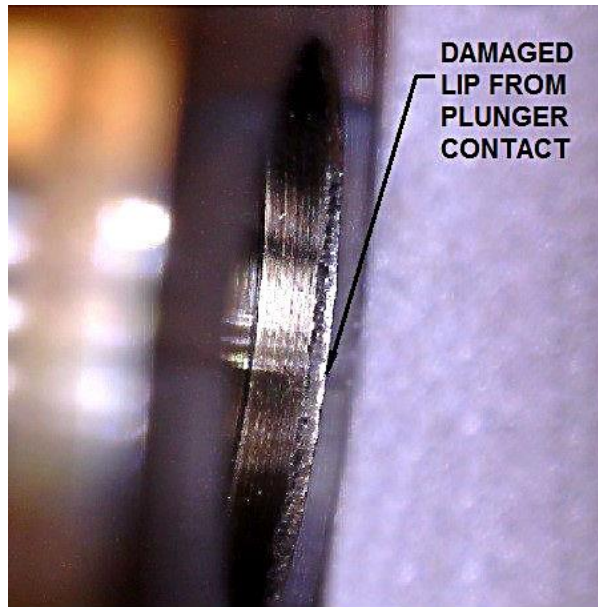


Figure 17 Example of Lip Damage to Backup-Support Ring

NOTE:

If plunger rubbing has occurred, you must replace these pieces:

- Plunger assembly;
- Dynamic seal;
- Backup-support ring assembly.

INSPECTING THE LIQUID DISPLACERS

The small flanges on each end of the liquid displacer should be 0.8115" to 0.8125" (20.61 to 20.64mm) in diameter. If these diameters are undersized, leakage could occur between the coolant housing and the cylinder.

To inspect the liquid displacers:

1. **Clean** the liquid displacers (see **Figure 18 below**) and **use** the micrometer to **measure** the outside diameters of each displacer end.
2. **Replace** any displacer that measures less than 0.9115" (20.61mm) in diameter on either end.
3. **Inspect** the displacer edges on the ends to **determine** if the edges are sharp, free of any missing material, gouges, burrs, or nicks. Score marks from the cylinder bore are normal.



**Do not attempt to smooth score marks with abrasives,
as this makes the diameter undersized.**

THIS DIAMETER SHOULD
MEASURE 0.8115" TO 0.8125"

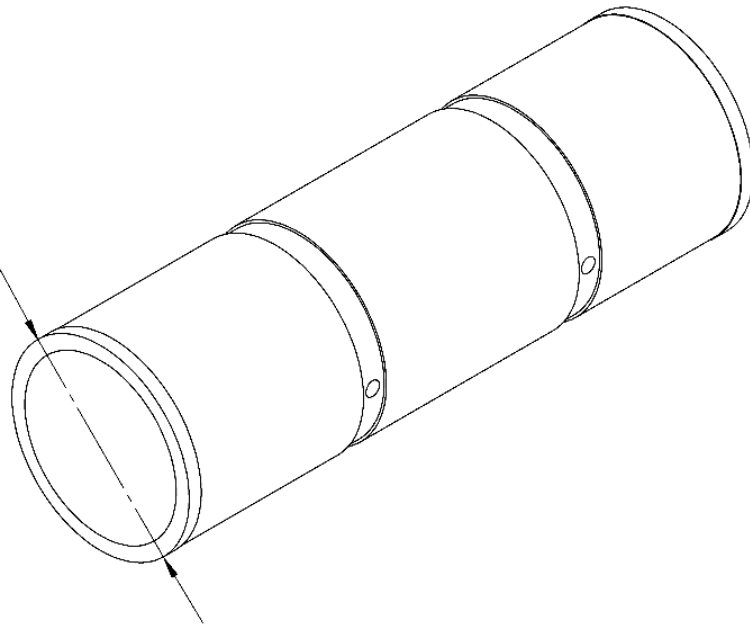


Figure 18 Liquid Displacer Measurements

DISASSEMBLING AND INSPECTING THE CHECK VALVE ASSEMBLY

This section will explain how to inspect the check valve components in a check valve assembly and replace the valve seats.

It is crucial to inspect the mating surface and seats of the check valve body. Use a magnifying glass. Replace worn or damaged seats. Water leaking past check valves can form jets that damage the check valve body.



DO NOT run the direct drive pump if the output pressure drops by more than 4-6 KSI from the original RPM.

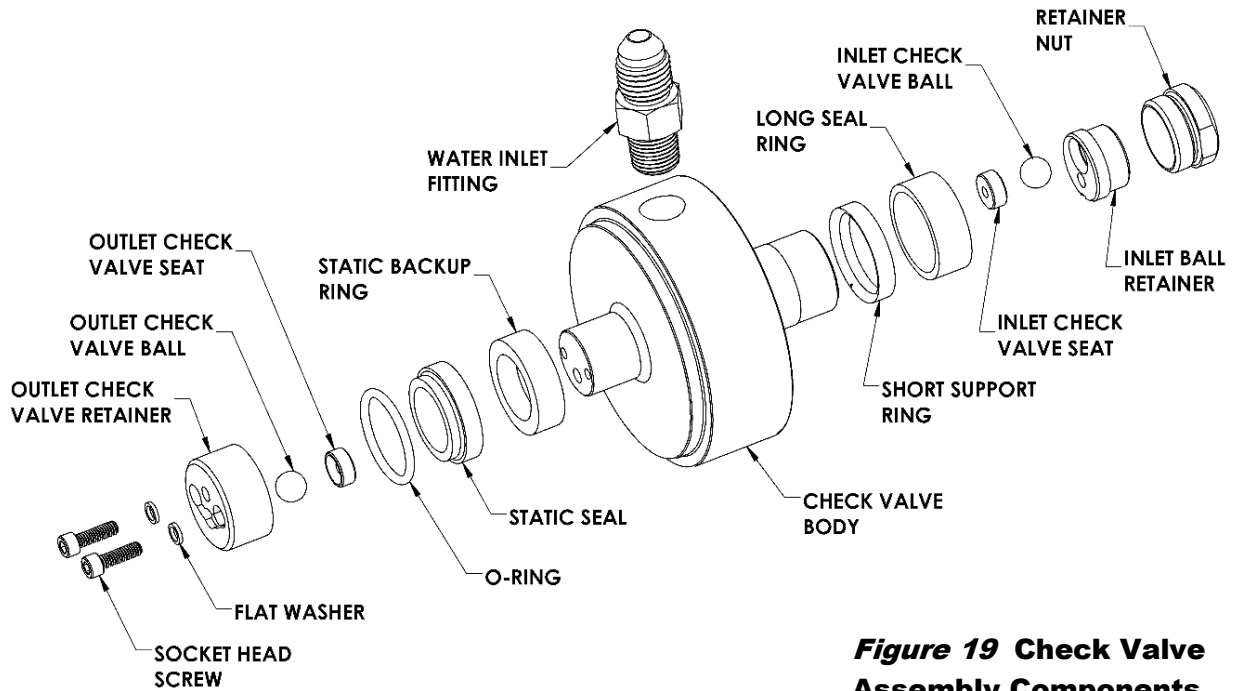
If the check valve seats are worn, continued pump operation can damage the check valve body.

NOTE:

We recommend replacing the check valve seats in all three cylinders at the same time. (Once one check valve seat has worn to the point of replacement, the others will soon also reach the end of their lives.)

To reduce overall downtime, replace the high-pressure seals and the check valve seats whenever the wet end has been disassembled.

Refer to "Tools Required for Wet End Maintenance" on page 9 for a list of tools used in maintenance of the pump's check valve assembly.



To disassemble and inspect the check valve assembly:

1. **Start from** the inlet (cylinder) side to begin disassembly of a check valve assembly. **Clamp** the check valve body into the soft jaws of a vise, and, **using** the 5/8" crowfoot, **remove** the retainer nut (see **Figure 20** below).

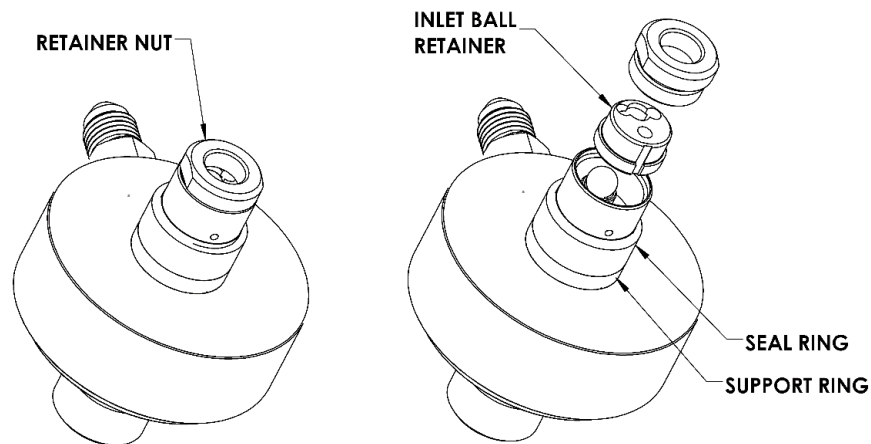


Figure 20 Removing the Retainer Nut from the Check Valve Body

2. **Noting *Figure 19*** on page 23, **remove** the:
 - a. Inlet ball retainer;
 - b. Inlet check valve ball (a pair of needle-nose pliers may help when removing the inlet ball retainer);
 - c. Check valve seat.
3. If the seal ring did not remain in the end of the cylinder (see ***Figure 1*** on page 8), **remove** it from the check valve body stem and **discard** it.
4. **Inspect** the support ring for cracks, chips, or damage, particularly in the area around the center where it contacts the edge of the cylinder. If no damage is found, there is no need to remove it, except at the recommended build intervals. Minor scoring marks are O.K.



Reminder: Never attempt to remove scoring marks by abrasion.

5. **Perform** this 5th step **ONLY IF** the support ring does not pass inspection or has reached its recommended replacement time. A small amount of the short seal ring may have extruded under the short support ring, adhering it to the check valve body stem. To **remove** the short support ring from the check valve body stem (see ***Figure 21*** on next page), **use** a propane torch to **slightly heat** around the diameter of the ring for 20-30 seconds. This softens the plastic between the check valve body stem and the short support ring, allowing you to **remove** it by hand **using** a rag or pair of channel lock pliers.



Once the short support ring has been heated, do not reuse it. The material softens and can no longer support the ring seal compression.

Take care not to scratch the check valve body stem surface with pliers during this process.

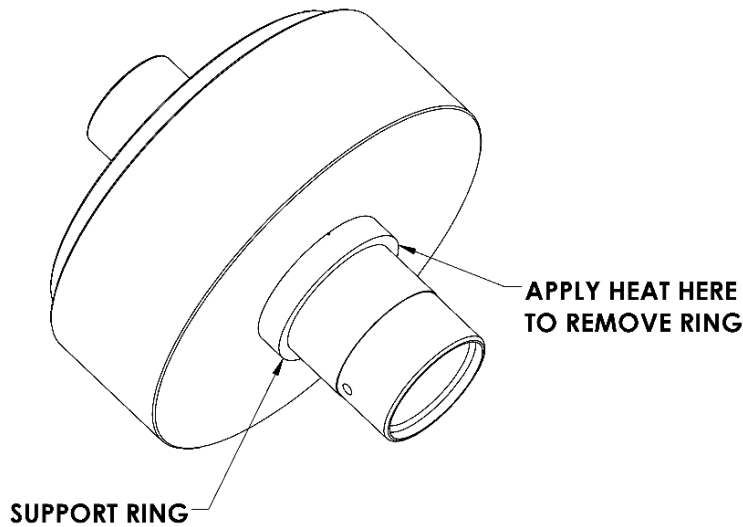


Figure 21 Using a Propane Torch to Remove the Support Ring

6. **Inspect** the outer diameter of the check valve body stem for signs of erosion.
7. **Inspect** for erosion on the surface that was contacting the inlet check valve seat. This may indicate leakage between the flat side of the inlet check valve seat and the check valve body stem, or leakage between the inlet check valve ball and inlet check valve seat.
8. **Inspect** the inlet check valve ball. **Use** a magnifying glass to **look** for chipping or pitting. If chips, pits, or frosted spots are seen on the ball surface, **replace** it.
9. **Inspect** the inlet check valve seat for erosion where it contacts the inlet check valve ball and on the flat sealing surface that contacts the check valve body stem. If you **observe** damage or erosion, **replace** the seats.

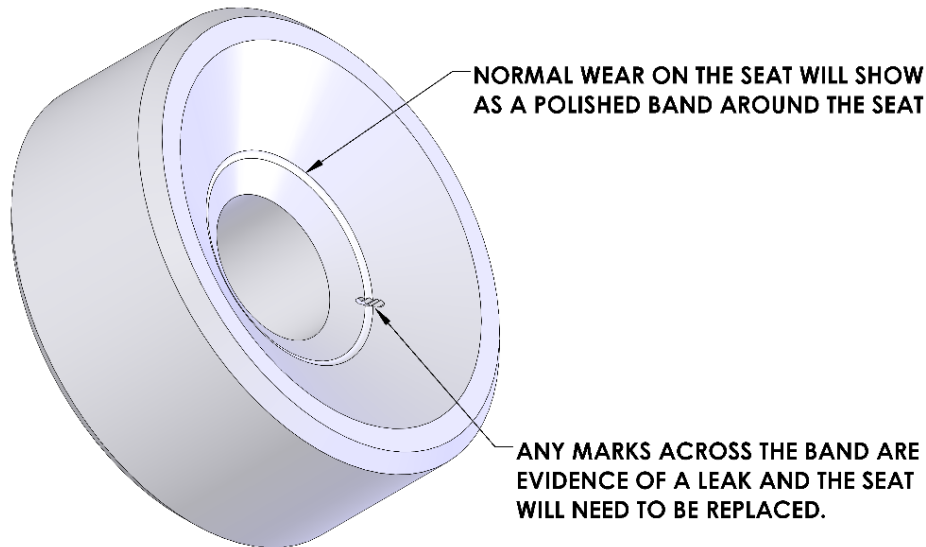


Figure 22 Inspecting the Check Valve Seat for Erosion Marks

1. **Turn over** the check valve body and **use** a 3/32" Allen wrench to **remove** the socket head screws. **Remove** the flat washers and the outlet check valve retainer as well. **Replace** the socket head screws and washers according to the maintenance schedule.
2. **Perform** the same inspection of the outlet check valve ball and the outlet check valve seat. (See steps 7-11 above.)
3. Carefully **inspect** the check valve body stem for signs of erosion on the surface contacting the outlet check valve seat. This may indicate leakage between the flat side of the outlet check valve seat and the check valve body stem, or leakage between the outlet check valve seat and outlet check valve ball.
4. **Remove** and **discard** the O-Ring and static seal. **Inspect** the static backup ring, **ensuring** that the edges are sharp and square with no nicks or gouges. Also, **search** for cracks near the notch and **replace** it whenever damage is apparent.
5. **Clean** the check valve body stem and the radius at its base.
6. If you **observe** leakage between either the manifold and cylinder (*see Figure 1 on page 8*) or check valve body, **use** the magnifying glass to **check** the radius at the base of the check valve body stems for fine cracks.

NOTE:

Be careful not to confuse lines of discoloration with actual cracks.

7. If a pressure loss has occurred without any external leakage yet the high-pressure cylinder is running hot, the check valve body is cracked internally—replace it.
8. Always **discard** any damaged or eroded parts and **replace** them with new ones.
9. Repeat this procedure for the two remaining check valve assemblies.

REASSEMBLING THE CHECK VALVE ASSEMBLY

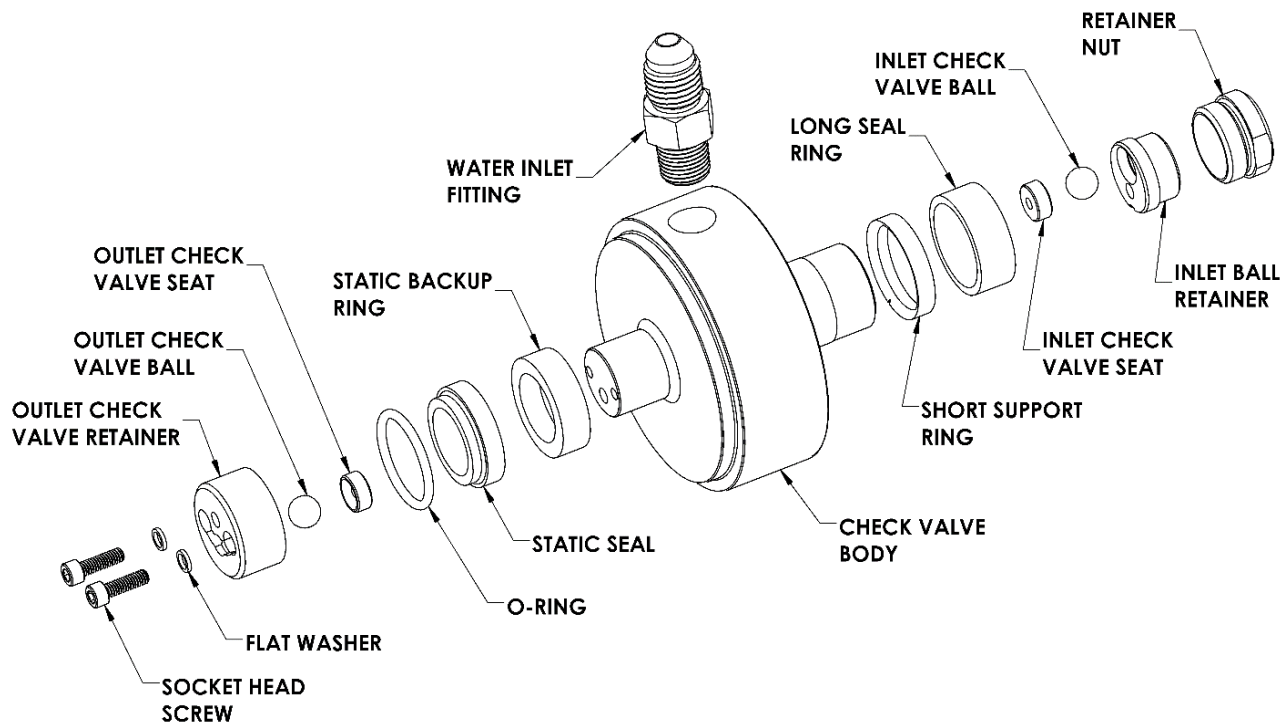


Figure 23 Check Valve Assembly Components

To reassemble the check valve assembly:

1. **Assemble** the outlet side of the check valve assembly first.
2. **Apply** Lubriplate to the O-Ring. **Place** the static backup ring, then the static seal, and then the O-Ring onto the outlet side of the check valve body.

NOTE:

The outlet side of the check valve body has three holes in the end of the stem (see **Figure 24** on this page).

The notch and chamfer on one side of the static backup ring faces toward the check valve body.

3. **Apply** anti-seize lubricant to the threads of the two socket head screws. **Install** the flat washers and the two socket head screws through the outlet check valve retainer (see **Figure 24** below).

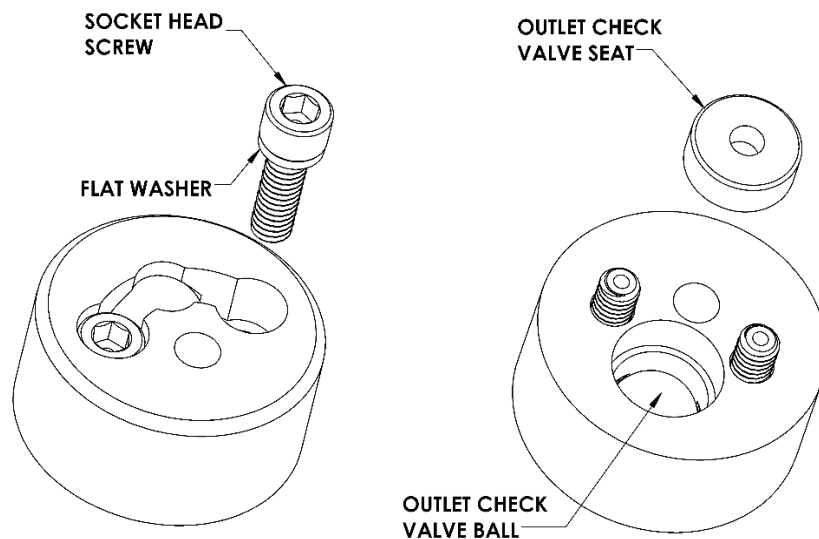


Figure 24 Inserting the Socket Head Screws

4. **Place** the outlet check valve ball followed by the outlet check valve seat in the outlet check valve retainer. **Ensure** that the flat side of the outlet check valve seat faces away from the ball. The outlet check valve seat should be flush, or no more than 0.001" (0.0254mm) above, the surface of the outlet check valve retainer.
5. **Set** the assembled outlet check valve retainer on the outlet end of the check valve body stem with the outlet check valve seat butted up against the end of the stem (see **Figure 25** on next page).

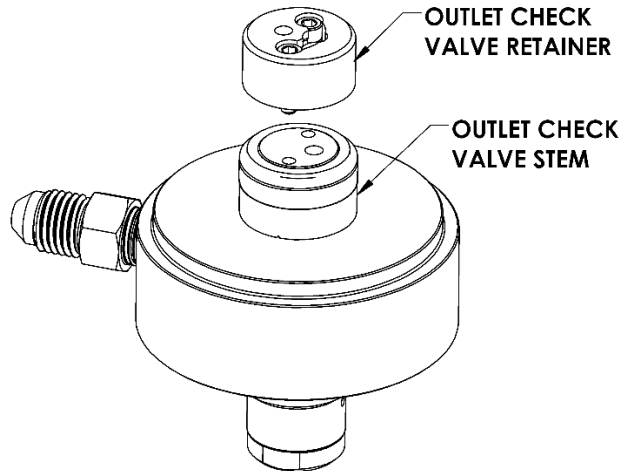


Figure 25 Placing the Outlet Check Valve Retainer on the Check Valve Body Stem



Make sure that the hole through the outlet check valve seat lines up with the hole in the outlet check valve body stem.

The outlet retainer can inadvertently be installed 180° out of its required position. Always be sure that the hole through the outlet check valve seat lines up with the hole in the end of the check valve body stem.

6. **Use** the 3/32" Allen wrench to **tighten** the two socket head screws from 3 to 5 in-lbs (.34 to .57 N.m). (Do not over-tighten.)
7. Repeat steps 1-6 for the remaining check valve body assemblies.
8. **Begin assembling** the inlet side of the check valve body assembly. This is the side with the threaded pocket and the two holes (see **Figure 26** on next page).
9. **Install** the short support ring, with the small notch facing down over the outside of the check valve body stem on the inlet side.

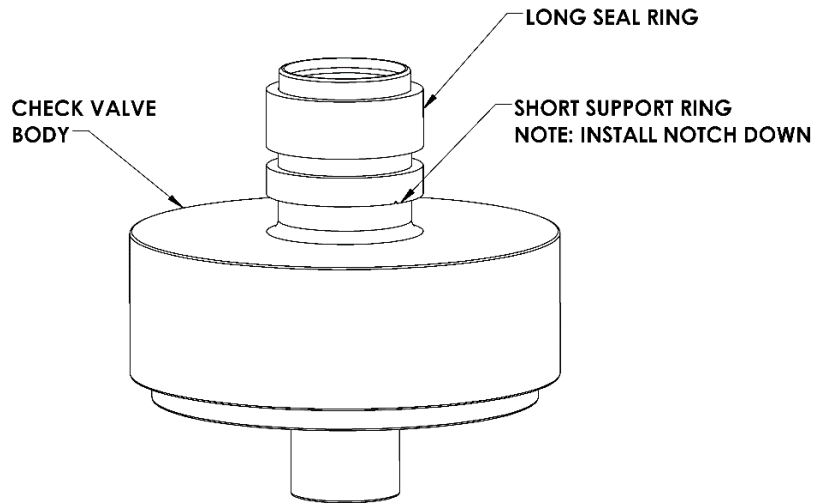


Figure 26 Installing the Short Support Ring

10. **Install** the long seal ring over the outside of the stem (see **Figure 26** above).
11. **Insert** the inlet check valve ball followed by the seat into the inlet ball retainer.

NOTE:

The inlet check valve seat normally protrudes well above the face of the ball retainer.

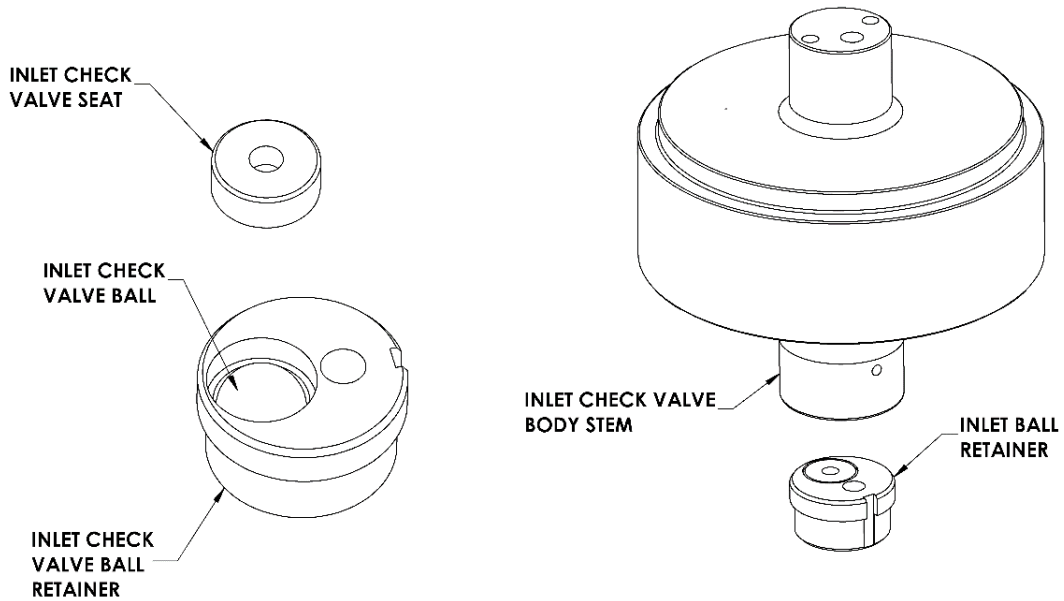


Figure 27 Inserting the Check Valve Ball and Check Valve

Seat into the Inlet Ball Retainer

12. **Hold** the body with its stem facing down so you may **insert** the assembled inlet ball retainer.

NOTE:

An alignment key inside the pocket of the check valve body is designed to fit into a slot machined on the outside of the retainer.

- 1) Make sure to line the alignment key up with this slot.
- 2) Do not turn the assembly over until the retainer is completely inserted into the slot.

When correctly installed, the inlet ball retainer will be nearly flush with the end of the check valve body stem.

13. **Apply** anti-seize compound to the threads of the retainer nut and the bottom face that contacts the retainer (see **Figure 28** below).

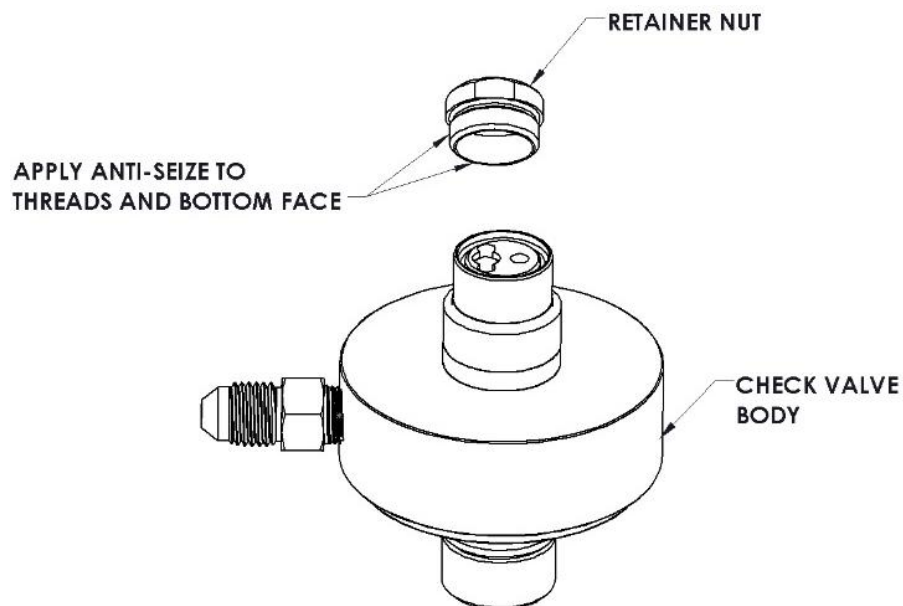


Figure 28 Applying Anti-Seize Compound to Threads and Bottom Face of Retainer Nut

14. **Screw** the retainer nut over the inlet ball retainer and into the threaded inlet check valve body stem. **Tighten** by hand.
15. **Apply** a slight coating of Lubriplate to the 0.124" diameter anti-rotation pin and **insert** it through the outlet port of the check valve retainer and into the check valve body. **Clamp** the outside diameter of the check valve body in the soft jaws of a vise and **use** a 5/8" crowfoot (see **Figure 29 below**) to **torque** the retainer nut to 200 in-lbs (22.6 N.m).

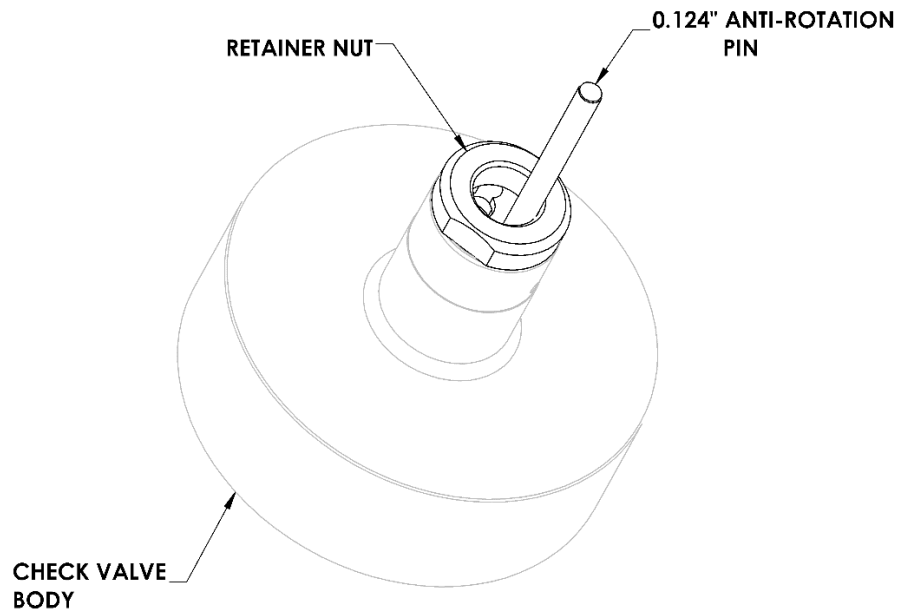


Figure 29 Installing the Inlet Retainer Nut

16. **Remove** the anti-rotation pin.

NOTE:

Removing the anti-rotation pin could require:

1. **Clamping the pin into a vise;**
2. **Pulling on the check valve body.**

17. **Repeat** the above assembly procedures for the remaining check valve assemblies.

REPLACING THE HIGH-PRESSURE PORT ADAPTER SEALS AND FILTER

(See **Figure 30** below.) **Replace** the port adapter high-pressure seals at each pump rebuild, or at any time excessive leakage occurs between the manifold and port adapters. The pump in-line filter provides additional quality assurance for the orifice assembly in the nozzle and dump valve. Also **replace** this filter at every pump rebuild.

Refer to page 9, “Tools Required for Wet End Maintenance,” for a list of tools required for replacement of PAHPS.

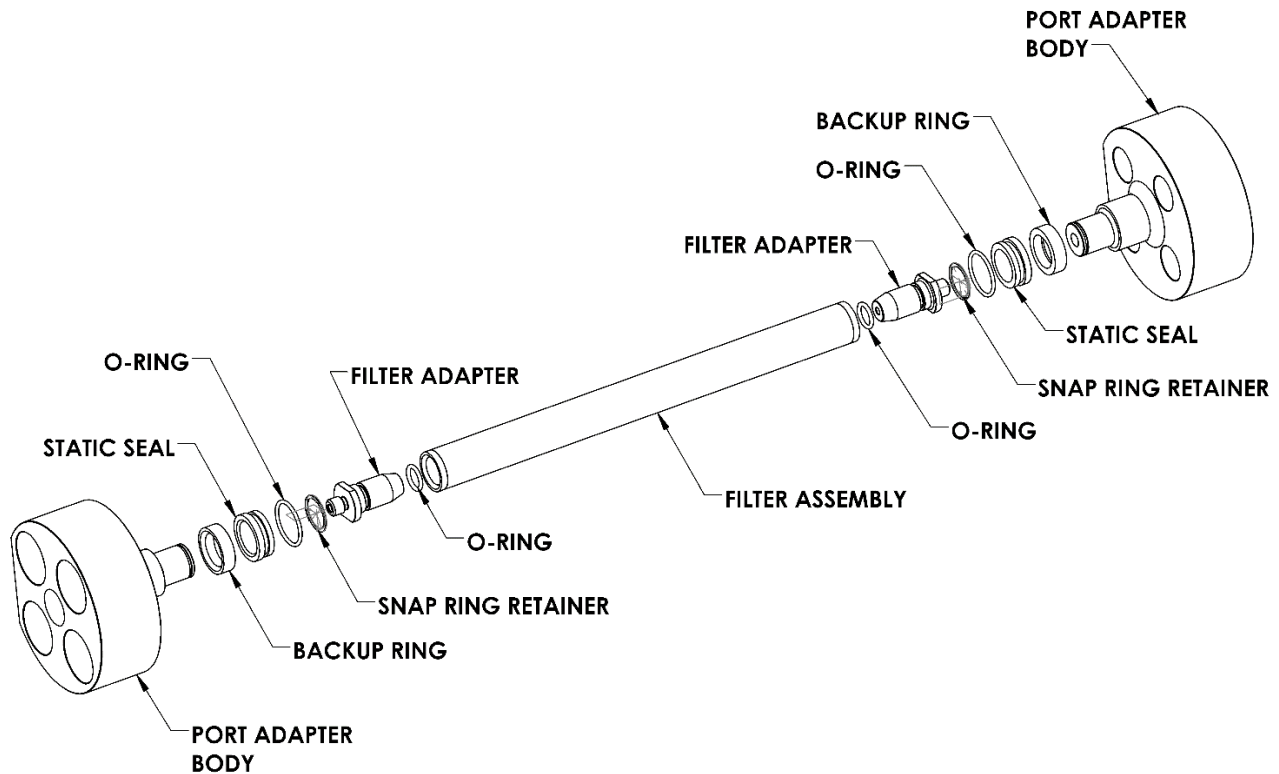


Figure 30 Port Adapter and Filter Assembly Components

To Replace the Port Adapter High-Pressure Seals and Filter:

1. **Set** the manifold body (see **Figure 1** on page 8) into a soft-jawed vise.
2. **Use** a 14mm Allen wrench to **remove** the four socket head screws (see **Figure 1** on page 8) from each of the two port adapters.
3. **Use** a soft-blow mallet to **hit** the port adapter on both sides until a space opens between the manifold and port adapter.
4. **Use** a pair of flat-head screwdrivers to **pry** the port adapter free of the manifold. Repeat to **remove** the second port adapter.



Avoid scoring or scraping the metal components (or inflicting any damage) on the filter.

5. **Remove** filter assembly. **Use** a 5/8" open-ended wrench to **remove** the filter adapters from each port adapter.
6. **Use** snap ring pliers to **remove** the snap ring retainer from the end of the port adapter stem. **Remove** the high-pressure seal, O-ring, and backup ring from the stem of the port adapter body and **discard** the high-pressure seal and O-ring.
7. **Clean** the backup ring and port adapter and **inspect** the edges of the backup ring to **ensure** that the edges are square and sharp. **Examine** the backup ring for cracks near the notch. Replace the backup ring if you see any problems.
8. **Slide** the backup ring onto the stem of the port adapter with the chamfer on the inside of the backup ring facing toward the port adapter body.
9. **Apply** a light coat of Lubriplate to the new O-ring and install it on a new high-pressure seal. **Slide** the high-pressure seal onto the stem of the port adapter body, **ensuring** that the large diameter portion of the high-pressure seal is next to the backup ring.
10. **Install** the snap ring retainer.
11. **Apply** a light coat of Lubriplate to the O-ring and **slide** it onto the O-Ring groove on the filter adapter. **Thread** the filter adapter into the stem of the port adapter body. **Tighten** until snug with a 5/8" open-end wrench.
12. Repeat the above procedures for the remaining port adapter assembly.

13. **Install** the filter assembly onto one of the port adapters by **sliding** it over the end of the filter adapter until the filter adapter rests against the filter adapter shoulder.
14. **Apply** a light coat of Lubriplate to the bores of the manifold.
15. **Orient** the port adapters with flat sides of the body facing away from the cylinders (see **Figure 1** on page 8).

NOTE:

Either port adapter may be installed first.

1. **As the second one is being installed, ensure that it engages properly into the filter assembly without needing to be forced or causing damage.**
2. **You might need to lightly tap the end of the port adapter with a soft-blow mallet to seat it entirely within the manifold.**

16. **Set** the manifold assembly on a flat, steady surface with check valve (see **Figure 1** on page 8) ports facing up. **Apply** anti-seize lube to the threads of the four socket head screws and **tighten** them enough so that they hold the port adapters in place. **Secure** the manifold assembly into a soft-jawed vise. **Use** the 14mm Allen head socket to **torque** each socket head screw to 100 ft-lb (135 N.m).

REASSEMBLY OF THE PUMP WET END ASSEMBLY

NOTE:

This segment outlines procedures for the complete reassembly of the pump wet end. It is necessary to keep all parts very clean.

Generally, all of the high-pressure wet end parts for the direct drive pump are able to be cleaned by wiping them with a clean, lint-free rag and blowing them with compressed air. (Any dirt that is left in the pump could pass through and possibly damage the nozzle.)

Clean all parts and assemble the pump components in the cleanest environment possible.

Whenever the pump wet end has been disassembled:

1. Before you **start up** the pump, ALWAYS **remove** the nozzle assembly from the plumbing to **prevent** debris from damaging or plugging the orifice.
2. **Run** the pump for ten minutes without the nozzle to **clear out** any debris after reassembly.
3. **Inspect** all parts.
4. **Replace** every high-pressure seal.
5. Carefully **clean** each part by wiping it with a lint-free rag.
6. **Blow out** each part with compressed air.



WARNING

Never loosen or tighten any plumbing that is under pressure.

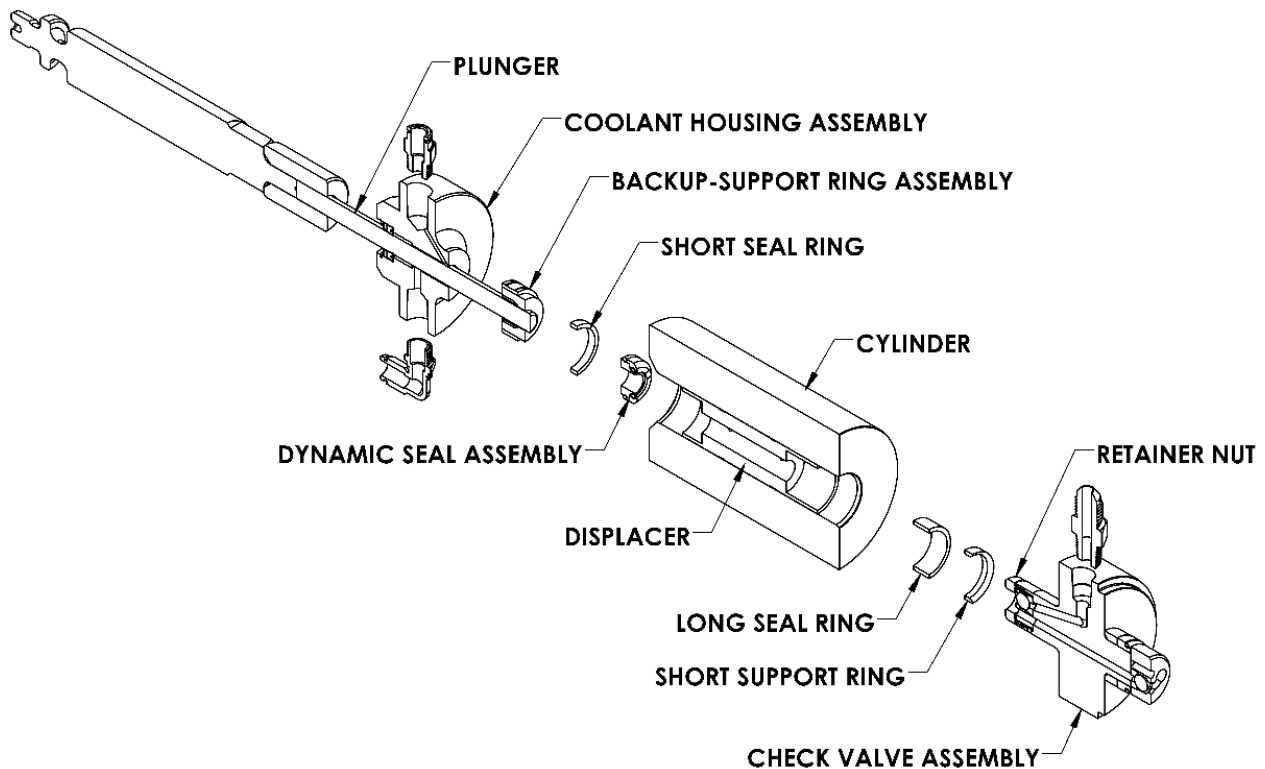


Figure 31 High-Pressure Wet End Assembly Components

To reassemble the high-pressure wet end assembly:

1. **Apply** a light coat of Lubriplate to the interior of the holes on the pressure manifold (see **Figure 1** on page 8) and the check valve body (see **Figure 23** on page 27) outlet side O-ring and static seal.
2. **Install** all three assembled check valve bodies into the pressure manifold.

NOTE:

Check valve bodies can only be installed in one position because of the alignment pins in the pressure manifold.

3. **Place** the displacer over the inlet check valve retainer (see **Figure 32** below) until it connects with the long seal ring (see **Figure 31** on previous page). Repeat this for all of the remaining check valve assemblies.

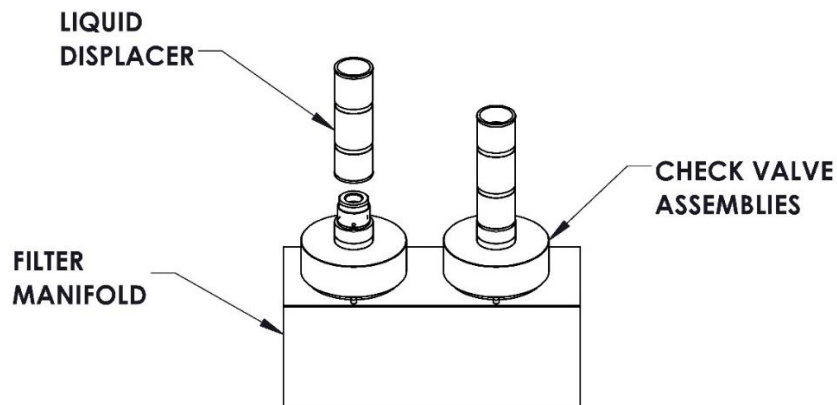


Figure 32 Installing the Liquid Displacer on the Check Valve Assembly



If the incorrect end of the displacer is installed on the check valve assembly, a sizeable gap will appear between the displacer and the seal ring. (See **Figure 33** on next page.)

The end of the displacer must make contact with the seal ring.

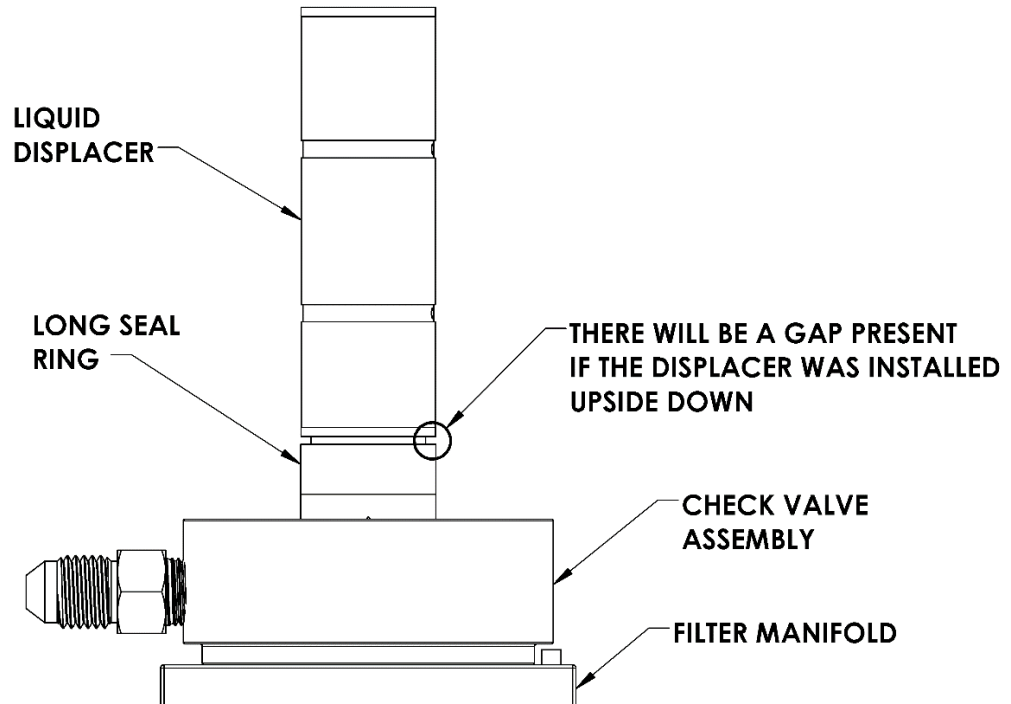


Figure 33 Example of a Displacer in the Incorrect Position

4. **Apply** light coat of Lubriplate just inside bore of the cylinder and on end of the cylinder without the large chamfer (see **Figure 34** on next page). **Install** the cylinder over the displacer, long seal ring, and short support ring until it makes contact with the check valve body.
5. **Verify** that the correct end of the cylinder (end without chamfer) is against the check valve body.



The liquid displacer has a close tolerance fit inside the bore of the cylinders, but:

- The cylinder should slide easily over the displacer if the cylinder is kept square with the displacer;
- The cylinder may need to be firmly pressed over the seal ring;
- If the support ring was not removed during maintenance, the cylinder may not slide over it by hand.
 - If this is the case, place a rag over the open end of the cylinder and tap it into place using a soft-blow mallet.

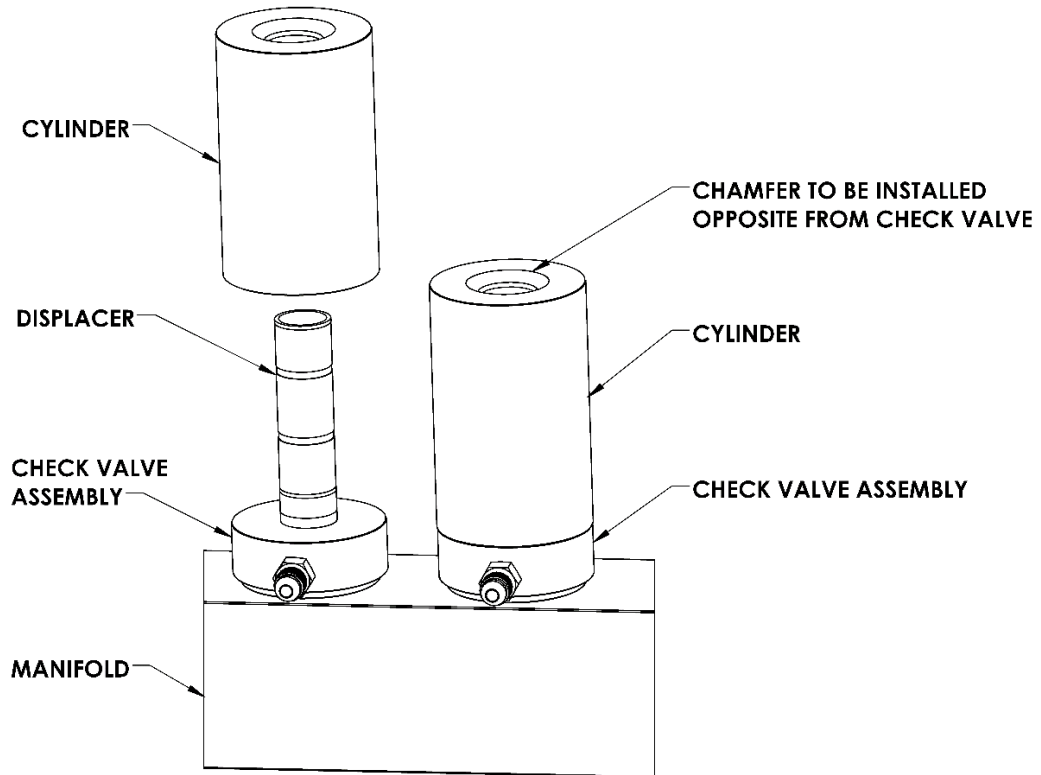


Figure 34 Sliding the Cylinder Over the Displacer

6. Repeat previous steps for the remaining cylinders.
7. **Set aside** the wet end assembly until it is time to reassemble the pump.

REPLACING THE WATER COOLANT HOUSING SEAL

Replace the low-pressure seal in the coolant housing every time the pump is rebuilt.

For a list of tools required to replace the water coolant housing seal, refer to the "Tools Required for Wet End Maintenance" section on page 9.

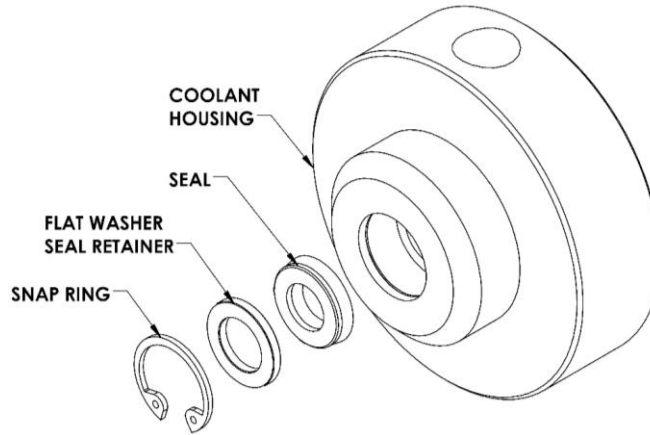


Figure 35 Coolant Housing Assembly Component

To replace the water coolant housing seal:

1. **Remove** the coolant housing assemblies. (See **Figure 36** below.) To do this, **slide** them forward until they clear the end of the plungers. The coolant housing fits snugly to the bore in the adapter block and may be difficult to remove. **Use** both the top and bottom fittings of the coolant housing to **rotate** the assembly while removing it. During removal, **keep it aligned** with the bore.

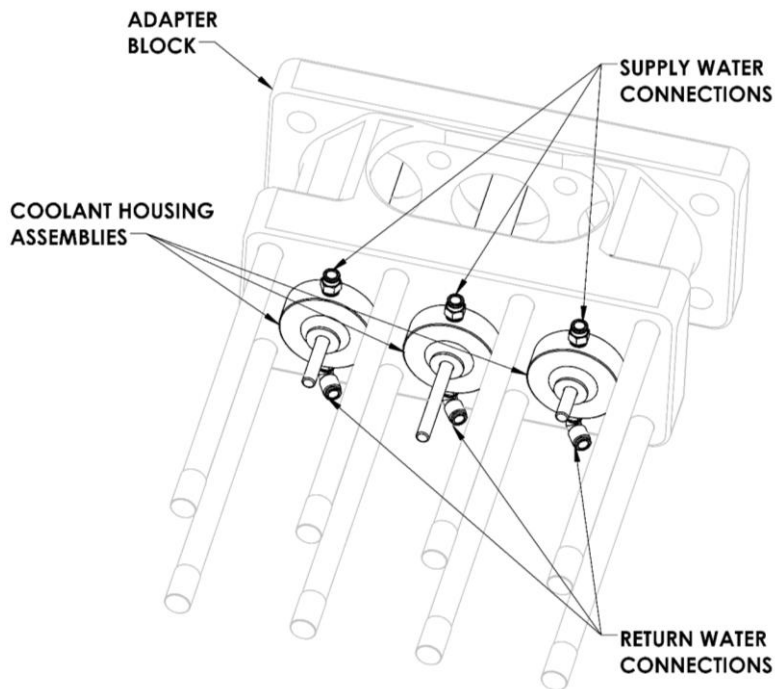


Figure 36 Removing the Coolant Housing Assemblies

2. Once you **remove** the coolant housing, **pull out** the coolant hoses from the push lock fittings by **pulling back on the outer ring of the fitting to release the locking device within the fitting while pulling on the coolant hose.**
3. **Using** a set of internal snap ring pliers, **remove** snap ring. (See **Figure 35** on previous page.) **Use** a small flat-head screwdriver to **lift out** the flat washer seal retainer from housing bore. **Remove** the seal in the same fashion.
4. **Apply** a light coat of Lubriplate to the lip of the new seal and **install** it with the pressure lip (cup) facing into the coolant housing, followed by the flat washer seal retainer and the snap ring.



The snap ring must be fully engaged in the snap ring groove. If it is not fully engaged, it can contact the plunger, damaging its surface.

5. **Set aside** the coolant housing assemblies for later pump assembly.

REMOVING PLUNGER ASSEMBLIES

It is only necessary to remove and inspect the pump plungers if the plunger is rubbing the backup ring. Rubbing can be expected if the dynamic seal shows that the plunger was not aligned, or whether or not the backup ring shows signs of plunger rubbing.



Damaged plungers ALWAYS cause premature dynamic seal failure.

It is not always possible to see plunger damage with the naked eye. Use a magnifying glass to get a more reliable assessment.

Damage is typically caused by the plunger rubbing on the backup-support ring or by the presence of debris in the pump. Whenever a plunger rubs the backup-support ring, metal sticks to the surface of the plunger. Extreme rubbing will produce a rough, discolored area on the surface of the plunger. Refer to "Inspecting the Backup-Support Ring Assembly" section on page 19.

NOTE:

Once plunger rubbing has occurred, these three must be replaced:

- 1) Plunger assembly;
- 2) Backup-support ring;
- 3) Dynamic seal.

If material is missing from the plunger surface, 4) the coolant housing seal must also be replaced (along with the three pieces listed above).

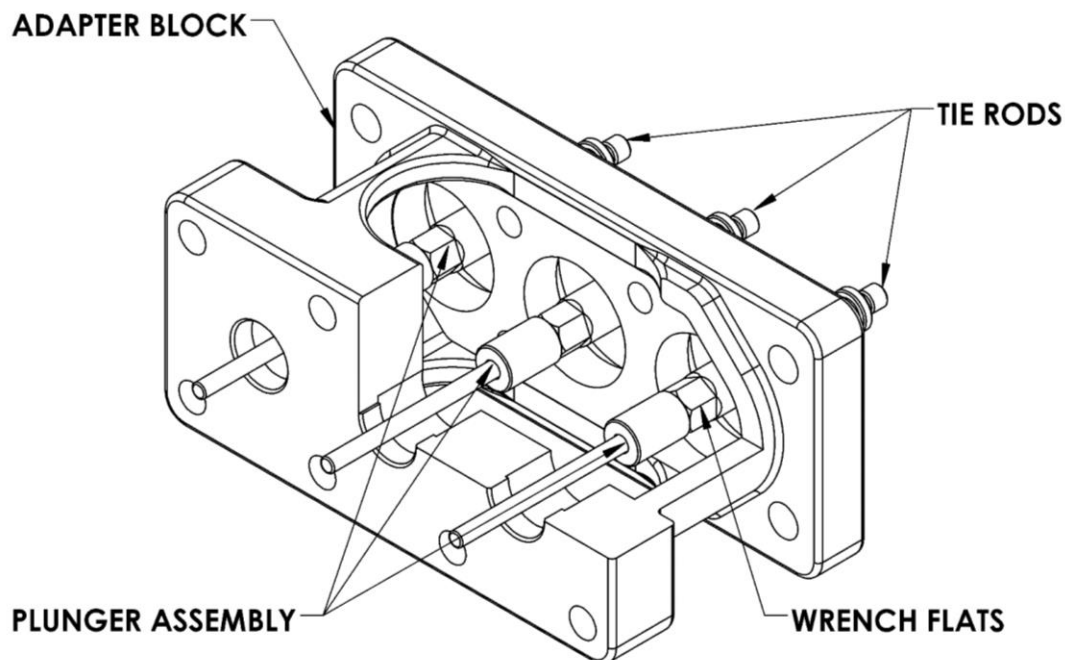


Figure 37 Adapter Block, Tie Rod, and Plunger Assembly

To remove the plunger assemblies:

1. Remove the coolant housings. (See **Figure 36** on page 40.)
2. Access to the wrench flats on the plunger assemblies is through an opening in the top of the adapter block. Remove the metal cover plate (see **Figure 1** on page 8) on the top of the adapter block.

1. **Remove** the access cover plate on the vertical end of the belt guard to **gain access** to the pulley on the pump crankshaft.
2. **Use** the belt pulley to **rotate** the pump crankshaft by hand until the plunger being removed is positioned at bottom dead center. Only two of the plunger assemblies are accessible at a time.



DO NOT LET FINGERS GET CAUGHT between the drive belt and sprockets!!

3. **Use** a 3/4" crowfoot on a 3/8" drive breaker bar with a steady pull to **loosen** the plunger assembly. **DO NOT** jam the wrench or permanently bend the plunger assembly.

REINSTALLING PLUNGER ASSEMBLIES

To reinstall the tie rod and plunger assemblies:

1. **Inspect** and **confirm** the cleanliness of the threads on the plunger assemblies (see **Figure 37** on previous page) and the threads and face of the pistons in the crankcase.
2. **Apply** anti-seize lube to the threads and mounting face of the tie rods.
3. **Install** and **hand-tighten** the plunger assemblies into the crankcase.
4. **Rotate** the pump crankshaft so the plunger is at the bottom, dead center.



To avoid bending the plunger assembly: when being tightened, the plunger must be at bottom dead-center, fully retracted.

5. **Use** the 3/4" crowfoot and torque wrench to **tighten** each assembly to a torque of 225 in-lbs or 19 ft-lb (25 N.m).

ASSEMBLING THE DYNAMIC SEAL ASSEMBLY

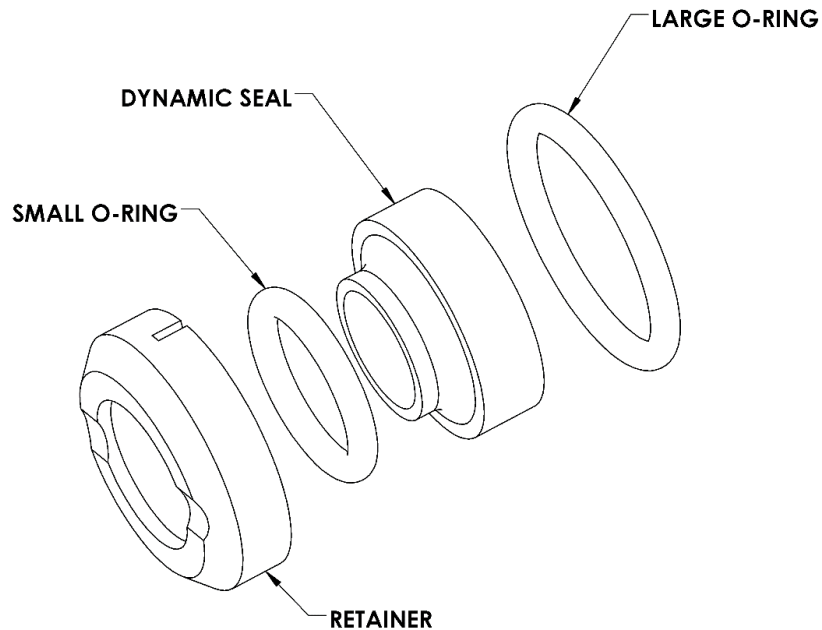


Figure 38 Dynamic Seal Assembly Components

To assemble the dynamic seal assembly:

1. **Set** the small O-ring on the extended lip of the dynamic seal.
2. **Apply** a light coat of Lubriplate to the outside of the small O-ring.
3. **Snap** the metal retainer over the small O-ring onto the dynamic seal (you must **hold** the retainer square and you might need to **exert** some force to **snap** it into place). You may **use** an arbor press to **lightly press** the retainer onto the dynamic seal.
4. **Place** the large O-ring over the outside of the back of the dynamic seal.

REASSEMBLING THE PUMP



WARNING

Once the pump has been reassembled, the crankcase should be turned over by hand to ensure all plungers attain full stroke without touching the check valve retainers.

DO NOT LET FINGERS GET CAUGHT between the drive belt and sprockets!!

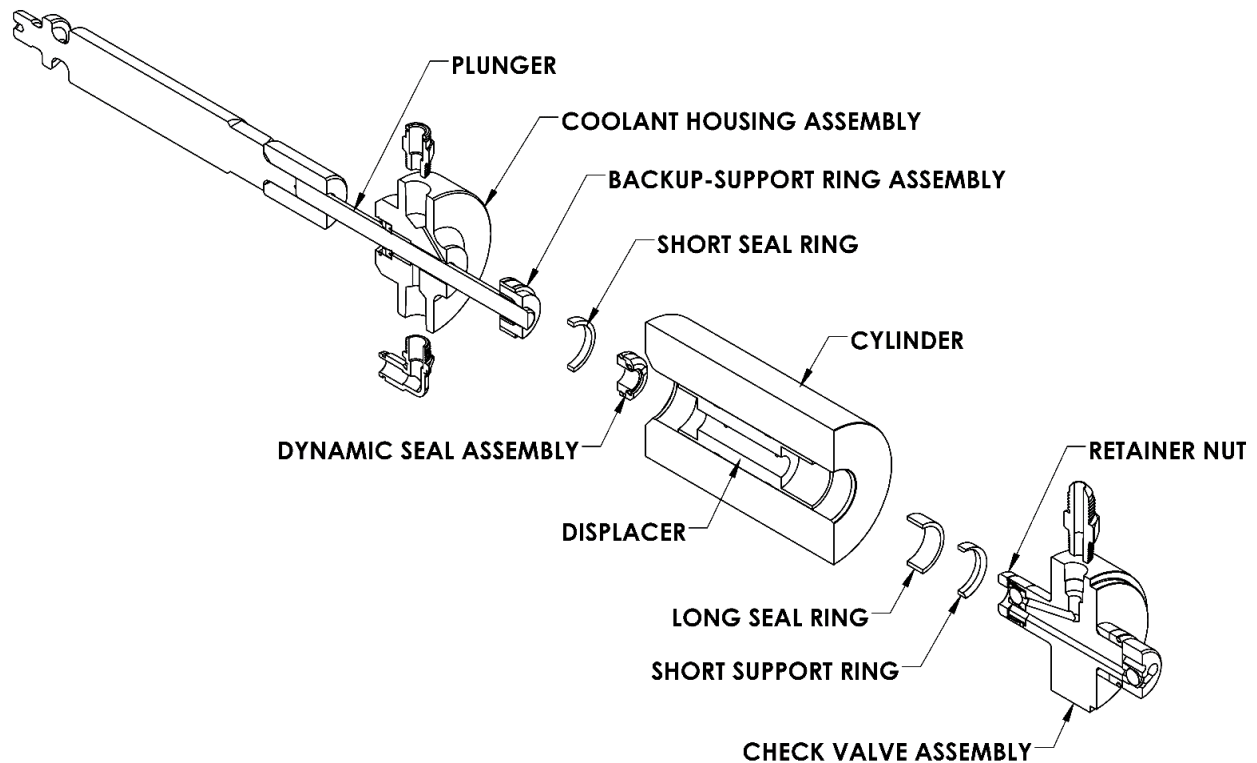


Figure 39 High-Pressure Wet End Assembly

To reassemble the direct drive pump:

1. **Rotate** the pump crankshaft until the center plunger is at the top dead center, maximum extension. The ends of the other two plungers should then be even and extend out far enough for assembly of the wet end without further rotation of the crankshaft.
2. **Apply** a light coat of Blue Goop or an equivalent extreme-pressure lube to the area of the coolant housing assembly that engages into the cylinder bore.
3. **Slide** the coolant housing assembly over the plunger until it is fully engaged into the bore in the adapter block (see **Figure 40** below). **Note** that during this step the plunger is not firmly held and you can **move** it for alignment with the coolant housing assembly.

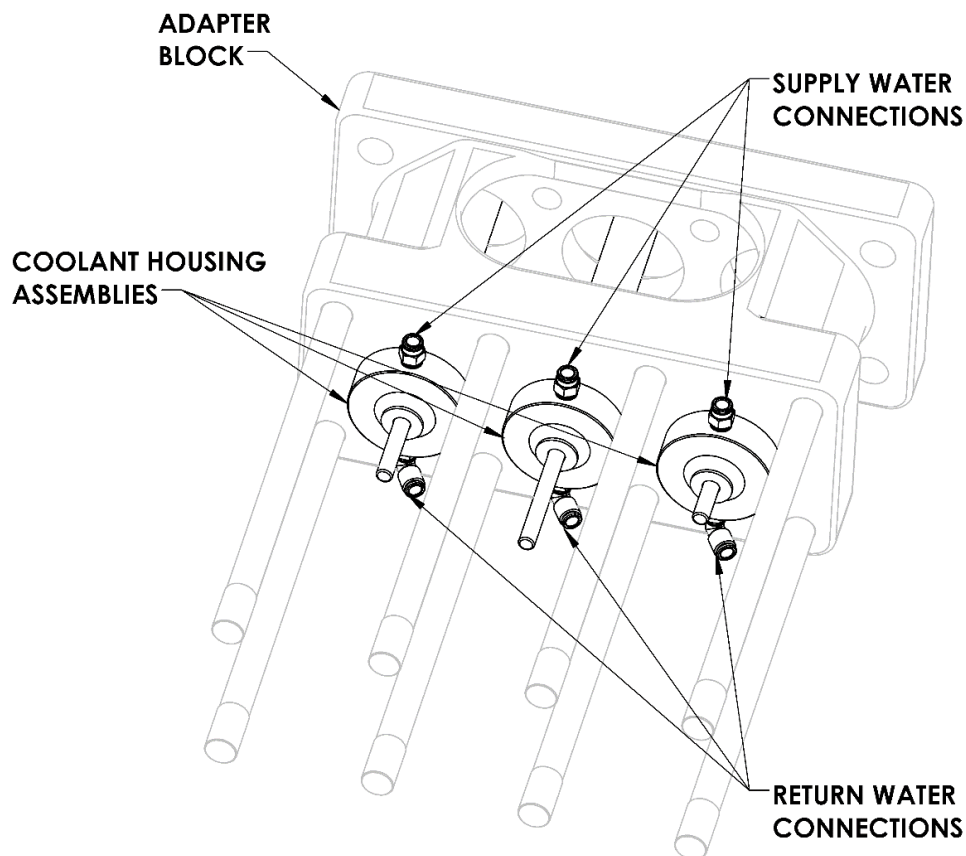


Figure 40 Coolant Housing Assembly Installation and Hose Connections

4. **Trim** off 1/4" from the ends of the low-pressure water supply and return hoses, **making** the ends square and straight-edged. **Insert** them into push lock fittings on coolant housing assemblies.

NOTE:

Hoses from the low-pressure supply manifold block need to be connected to the upper fittings on the coolant housings. The hoses connected to the lower fittings should return water to the water tank.

5. Slide the short seal ring onto the backup-support ring assembly.

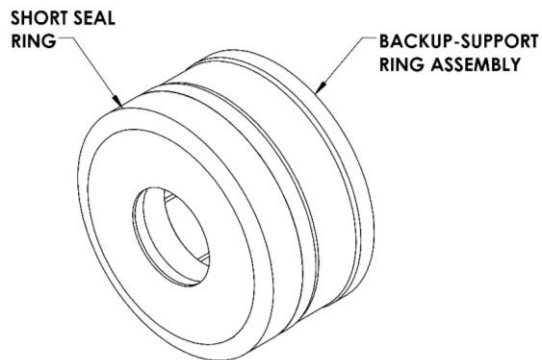


Figure 41 Installing the Short Ring Seal onto the Backup-Support Ring Assembly

6. Slide the backup-support ring assemblies onto the plungers with the black bushing inside the backup-support rings toward the coolant housing assembly. (See **Figure 42** below.) Push the backup-support ring assembly down the plunger until it rests against the coolant housing assembly.

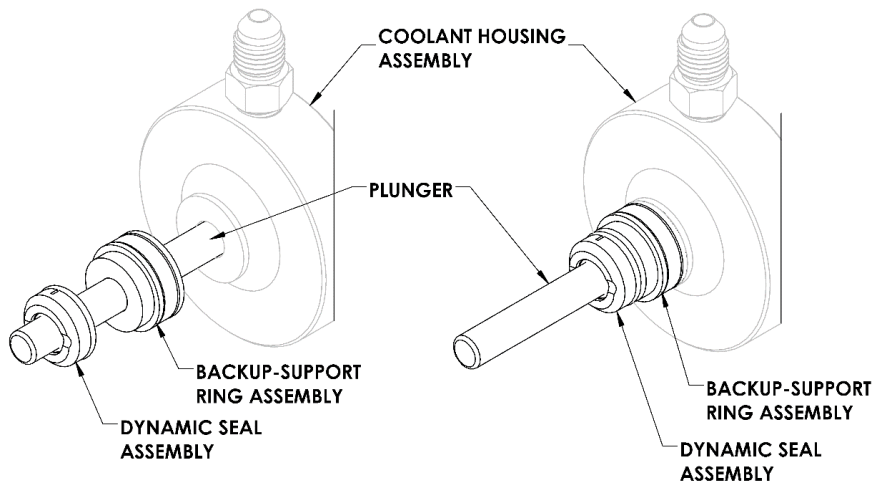


Figure 42 Sliding the Backup-Support Ring Assembly onto the Plungers

1. **Fit** the assembled dynamic seal assembly onto the plunger until it butts against the backup-support ring assembly. **Ensure** that the flat end of the dynamic seal assembly rests against the backup-support ring assembly and that the metal retainer is on the side away from the backup-support ring assembly.

NOTE:

The dynamic seal assembly is an interference fit on the plunger. It can be difficult to engage it. It may be useful to use the removal/installation tool as a pushing device to install the dynamic seal assembly.

2. **Apply** a light coat of Lubriplate to the exterior surface of the outer ring on backup-support ring assemblies.
3. **Take** the wet end assembly that was previously set aside and **slide** it over the plungers—once you've begun do not pull the wet end assembly back as this could cause internal components to move from their original assembled positions. Once the cylinders begin to slide over the short seal rings (see **Figure 43** below), it is possible that they will not go all the way on by hand. The gap that occurs between the end of the cylinders and the coolant housings assemblies will close when you correctly **torque** the wet end assembly.

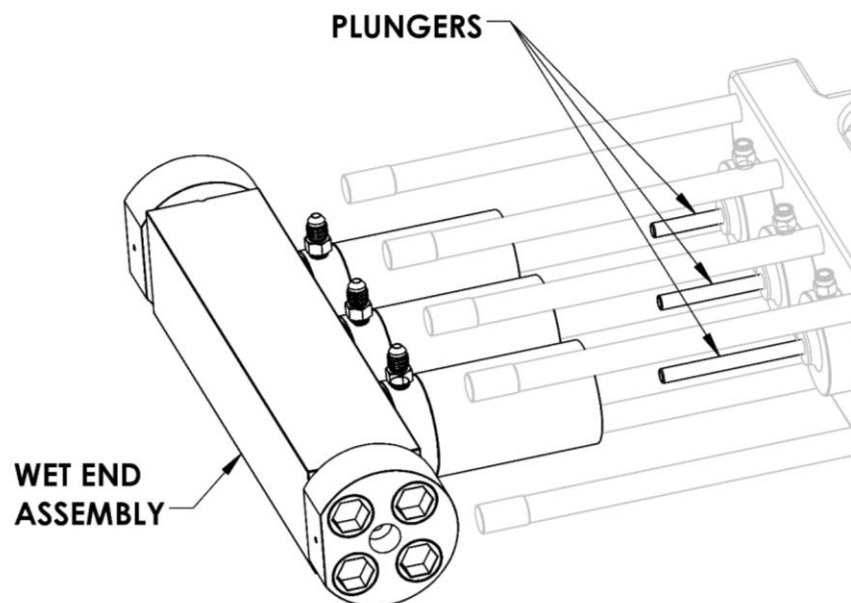


Figure 43 Sliding the Wet End Assembly Over the Plungers

4. **Install** clamp plate and pair of nuts on studs numbered 1 & 2 in **Figure 44** below. **Apply** plentiful amount of anti-seize compound on both the stud threads and the face of the nuts that face the clamp plate.

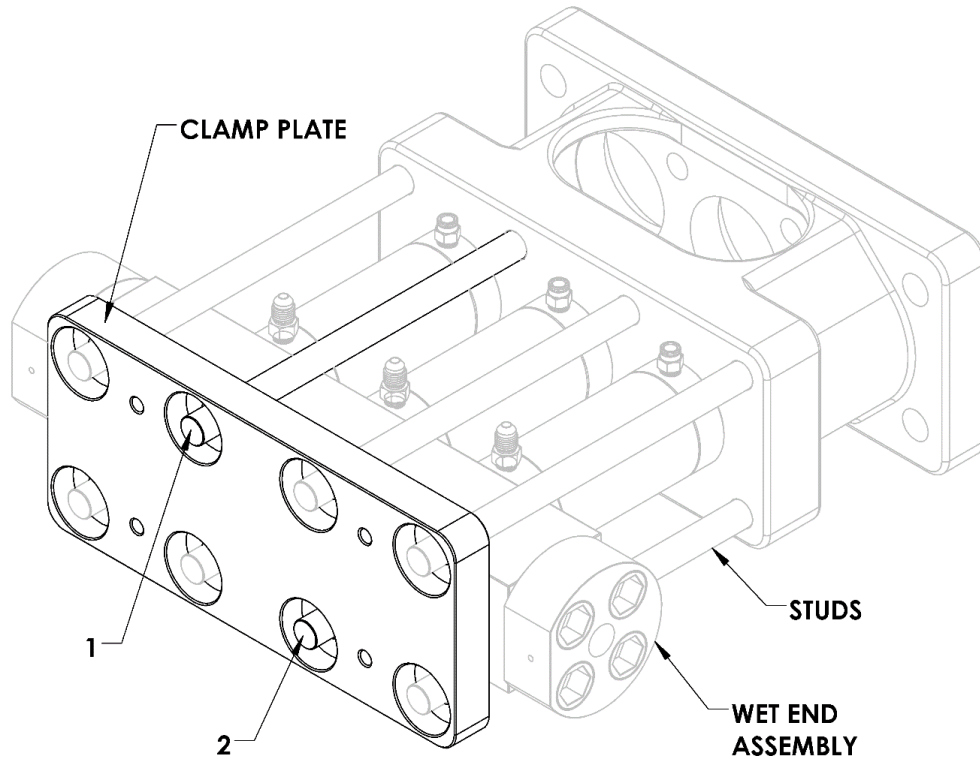


Figure 44 Installing the Clamp Plate



It is **absolutely essential** that enough anti-seize compound be used to lubricate the threads and surface between the nut and clamp plate so that the torque applied properly loads the ring seals and studs.

- To be sure that an evenly distributed load is developed on the clamp plate and cylinders, **torque** each nut one half turn in succession. **Using** the 24mm socket (15/16" socket) and a torque wrench, **tighten** each nut according to the sequence in **Figure 45** below until each nut is torqued to 175 ft-lbs (237 N.m).

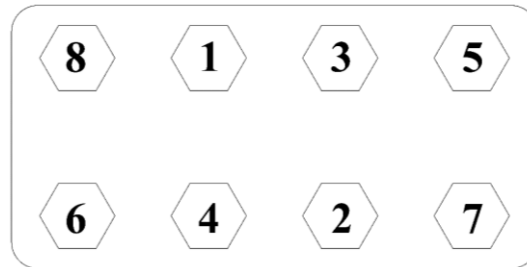


Figure 45 Clamp Plate Torque Sequence for Clamp Plate Nuts



To avoid component **DAMAGE** and to achieve an even loading of the studs and ring seals, be sure all nuts are tightened evenly in the order specified in *Figure 45* above.

- Hand-rotate** the pump crankshaft until each plunger crosses top dead center to **ensure** the plungers clear the inlet retainers and that no binding exists in the wet end assembly that would prevent a smooth rotation.
- Reinstall** the access cover to the belt guard.
- To complete pump assembly, **connect** outlet high-pressure tubing and low-pressure inlet hoses.

* * *

The pump is now ready for routine operation.