OPERATION AND MAINTENANCE MANUAL, Q12 PUMP

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Summary:

This is a manual for an FMC Q12 quintuplex pump. This pump has a 3 inch stroke, five unique pumping chambers, piston type sealing arrangement and an 8000 pound rod load.

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1.0 Important Safety Instructions

WARNING: **Many accidents occur through careless use of mechanical equipment. You can avoid hazards associated with high-pressure equipment by always following the safety precautions listed below.**

- **SHUT DOWN OR DISENGAGE** the pump and all accessory equipment before attempting any type of service. Failure to do this could cause electrical shock or injury from moving pump parts or components under high pressure.
- **BLEED OFF ALL PRESSURE** to the pump and piping before attempting any maintenance to the pump. Failure to do so may spray water or chemicals at high pressure onto service personnel.
- **NEVER OPERATE THE PUMP WITHOUT A PRESSURE RELIEF VALVE**, burst disc, or other type of properly sized overpressure safety device installed.
- **ALWAYS USE A PRESSURE GAGE** when operating the pump. The pressure must never exceed the maximum pressure rating of the pump or damage may occur. This damage may cause leakage or mechanical damage resulting in injury to personnel.
- **INSURE THAT NO VALVES ARE PLACED BETWEEN THE PUMP AND PRESSURE RELIEF VALVE**. If the pump is started with a closed or restricted valve in line before the pressure relief valve, the pump may build up pressure in excess of its rated limits and burst causing injury to personnel.
- **USE SHIELDS OR COVERS AROUND PUMPS** when pumping hot water, chemicals, or other hazardous liquids. This precaution can prevent the exposure of service personnel to these fluids should leakage occur.
- **ALWAYS USE GUARDS** on all belt drives and couplings. Guards can prevent personnel from becoming entangled and injured in rotating parts.
- **USE EXTREME CAUTION WITH SOLVENTS** used to clean or degrease equipment. Most solvents are highly flammable. Observe all safety instructions on packaging.
- Never modify the pump to perform beyond its rated specifications

2.0 Q12 Pump Features

Exceptional design, workmanship, materials, and over 100 years experience building pumps are features go into every FMC pump.

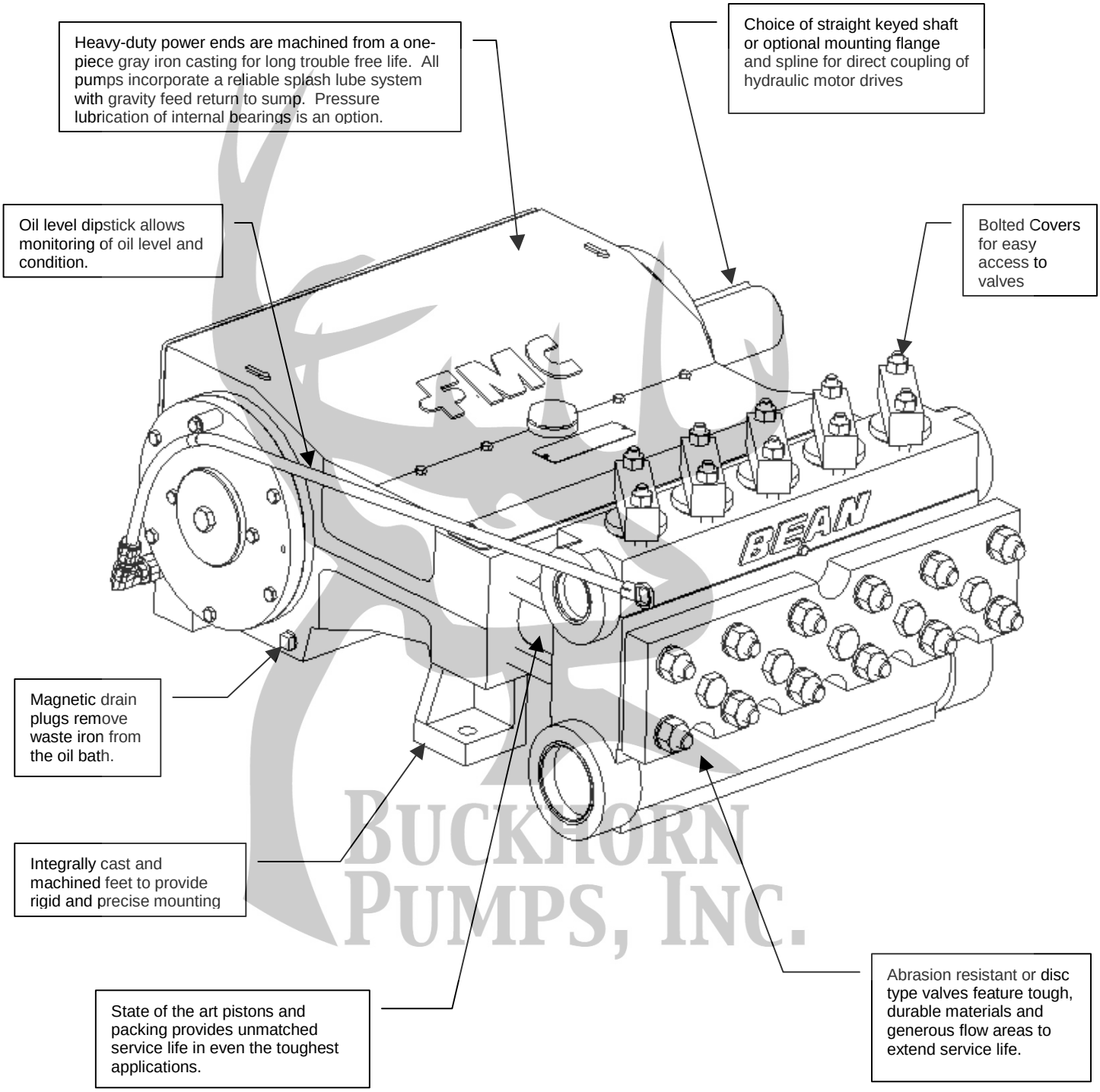

Figure 1: Q12 Features

3.0 Storage Instructions

Proper storage of your FMC pump will insure that it is ready for service when needed. Follow the guidelines below that fit the requirements of your application

FMC pumps come from the factory prepared for storage periods of up to six (6) months in proper environmental conditions. Indoor storage in a dry, temperature-controlled location is always recommended. If pumps are to be stored short term (less than six (6) months) in a severe environment, they should be prepared using the procedures outlined in the "Short Term Storage for Severe Environments" section below. If the pump is to be stored, or is inactive, for periods in excess of six (6) months, it is necessary to prepare the pump as outlined in the "Long Term Storage" section.

3.1 Short Term Storage

If the pump is stored in an indoor, temperature controlled environment for less than six (6) months, no special steps are required to prepare it for storage. As a general rule for pumps in corrosive fluid applications, the fluid end should be drained, flushed with water or other non-corrosive cleanser and blown dry using compressed air whenever idle.

3.2 Short Term Storage for Severe Environments

Drain any fluid from pump, flush the fluid end with water to clean out any of the remaining pumpage and blow dry with compressed air. Spray a fog of preservative oil into the suction and discharge ports of fluid end, and then install pipe plugs in openings. Remove the oil fill cap (or plug) and the power end breather vent. Spray a heavy fog of preservative oil into the oil fill hole until it can be seen coming out of the breather opening. Coat all exposed, unpainted metal surfaces (for example, driveshaft) with preservative oil. Replace the oil fill cap and breather vent, and then cover the entire pump with a weather resistant covering such as a canvas or plastic tarp.

3.3 Long Term Storage

Long-term storage is defined as any period when the pump is in storage or idle in excess of six (6) months. If the pump has been in service, flush the fluid end with water to clean out any of the remaining pumpage, then blow the fluid end dry using compressed air.

Drain all remaining oil from the pump power end. Remove the rear cover to expose the drive components. Spray all internal parts with a rust preservative that is soluble in lubricating oil while rotating the driveshaft several turns by hand to insure complete coverage. Replace the rear cover and add a concentrated internal rust inhibitor per recommendations (see Recommended Lubricant Chart, Section 6.0).

Spray a rust preventative onto all exterior machined surfaces paying careful attention to any unpainted areas like the crankshaft extension and plunger rods. Remove the power end breather cap and store in a dry place. Cap the breather opening with a plug or

other suitable means in order to keep the preservative atmosphere sealed inside the power frame.

Never store the pump on the floor or ground. Always place it on a shelf or pallet that is several inches above ground level. Cover the entire pump with a canvas or plastic tarp. Periodically inspect the unit and rotate the crankshaft by hand several turns during each inspection. Drain and replace the rust inhibitor after every six (6) months of storage.

Before operating the pump, drain the preservative and lubricating oil mixture from the power end. Reinstall the drain plug, breather/filler cap, and any other components that were removed for storage. Once these steps have been completed, follow the normal pump start up procedures outlined in this manual. Note that FMC can factory prepare units for extended storage for a nominal fee if specified at the time of order.

3.4 Precautions During Freezing Weather Conditions

Freezing weather can cause problems for equipment when pumping water based fluids that expand in volume when changing from a liquid to a frozen solid state. For example, when water is left in a pump fluid end and exposed to freezing temperatures, the expansion of the water as it freezes can rupture the fluid cylinder of the pump and cause permanent equipment damage and when operated may result in personal injury.

Whenever the pump is stored or is idle in conditions that are near or below freezing, any water based fluids should be removed from the pump. The best way to do this is to run the pump for 10 to 15 seconds with the suction and discharge lines disconnected or open to atmosphere. This will clear the majority of the fluid from the pumping chamber as well as the suction and discharge manifolds. After the run, blow compressed air through the fluid end to remove all traces of fluid. If possible, remove the pipe plugs and push open the suction valve seat to insure that all fluid is drained from the pumping chamber between the suction and discharge valves.

As an alternative to the previous procedure, a compatible antifreeze solution can be circulated through the fluid end. RV antifreeze, propylene glycol, is recommended for this purpose.

4.0 Installation Guidelines

A proper installation is the key to optimum performance, long service life, and reduced maintenance requirements. Take time to thoroughly plan your installation.

4.1 General Location

It is important to position the pump on a flat, level surface to assist the splash oil lubrication system. Whenever possible, the pump should be mounted in a clean, dry location with sufficient lighting and adequate space for easy inspection and maintenance. Locate the pump as close to the suction source as possible to allow for the shortest and most direct routing of the inlet piping.

4.2 Mounting Pump to Foundation and Power Source

The Q12 pump must be mounted in a horizontal position only. Secure the pump to the mounting surface using the four (4) holes provided in the pump base. Check motor or engine rotation direction to insure that the top of the pump drive shaft rotates towards the pump fluid end when in operation.

For units that are V-belt driven, check the alignment of the sheaves after the unit is installed on its permanent mounting. Tighten belts to the proper tension as recommended by the belt manufacturer. Verify that the sheaves are in line and running parallel to each other with a straight edge or other device. Never operate the pump without the belt guard securely in place.

For direct-coupled or spline driven units, insure that the shafts are centered and parallel when the driver is mounted to the pump. Never operate the pump without a shaft guard securely in place.

4.3 Suction Piping Recommendations

Poor suction piping practices are a very common source of pump problems. To insure proper operation it is very important to follow good design practice in the installation of the suction system before the pump is operated. A small amount of extra time and money invested in the piping system usually provides for better pump performance and longer periods between service requirements. It is difficult to diagnose many pump problems without the aid of a suction pressure gage. For this reason, FMC recommends that a gage always be installed in the suction line directly before it enters the pump.

The suction line from the fluid source to pump should be as short and direct as possible. Use rigid piping, non-collapsible hose or a combination of both as circumstances require in your installation. The suction pipe size should be at least equal to or one size larger than the pump inlet. Long piping runs, low suction heads, or indirect pipe routing may require even greater over-sizing of the suction line for proper operation of the pump. In some cases it may be necessary to install a booster pump in the suction line of the pump to obtain sufficient pressure for the pump to operate successfully. The suction line should be sized for a maximum flow velocity of 3 ft/sec (1 m/sec).

The suction line must be laid out so that there are no high spots in the line where gas or air pockets could collect. These pockets can make the pump difficult to prime and cause rough, erratic operation. A drain valve or plug should be installed at the low point of the suction line to allow for drainage during freezing conditions or for maintenance.

FMC recommends that all piping be supported independently of the pump. By supporting the piping this way, vibrations are reduced and stress on the pump is kept to a minimum. The use of elbows, nipples, unions, or other fittings should be minimized. Make sure that all joints and connections are airtight. Air leaks reduce the capacity of the pump and can result in cavitation, rough operation, and/or loss of prime. To help isolate mechanical and hydraulic vibrations, FMC recommends the use of flexible hose connections between the pump and any rigid piping.

Always insure that calculated system Net Positive Suction Head available, NPSHa, exceeds pump Net Positive Suction Head required, NPSHr, by at least 5 feet, 1.5 meters, of water for proper operation of the pump. NPSH requirements for each pump model are provided on the product data sheets available through FMC or you authorized FMC reseller. FMC does not recommend using the pump in static lift conditions without prior approval.

4.4 Discharge Piping Recommendations

1. Route the discharge piping in as short and direct a route as possible. Use the same pipe size as the outlet of the pump. In installations where the discharge piping is in excess of 50 feet (15 meters), it is suggested to use the next larger size pipe to minimize friction losses downstream of the pump. Always use pipe or hose that is designed for your particular pressure requirements. Inadequate pressure ratings can allow hose or pipe to fail resulting in personal injuries or equipment damage. Normal hose pressure ratings are clearly marked on the outer surface of the hose. Working pressure ratings for steel pipe can be obtained from the manufacturer or from the adjacent chart.

Allowable Working Pressure For Steel Pipe (PSI @ 100F)

Pipe Size (inches)	Pipe Schedule Number				
	40	80	120	160	XX
1/2	2,300	4,100		7,300	12,300
3/4	2,000	3,500		8,500	10,000
1	2,100	3,500		5,700	9,500
1 1/4	1,800	3,000		4,400	7,900
1 1/2	1,700	2,800		4,500	7,200
2	1,500	2,500		4,600	6,300
2 1/2	1,900	2,800		4,200	6,900
3	1,600	2,600		4,100	6,100
3 1/2	1,500	2,400			5,600
4	1,400	2,300	3,350	4,000	5,300
5	1,300	2,090	2,950	3,850	4,780
6	1,210	2,070	2,850	3,760	4,660
8	1,100	1,870	2,840	3,700	3,560

1. Always use a glycerin filled pressure gage in the pump discharge line. A properly functioning gage mounted at the pump (and before any valves) is required to accurately determine the operating pressure of a pump. A gage dampener will lengthen the life of a gage.

2. Insure that all piping is supported independently of the pump to reduce vibrations and strain on the pump itself. The use of elbows, nipples, unions, or other fittings should be kept to an absolute minimum. Avoid short radius 90° elbows; use two long radius 45° elbows instead. To help isolate mechanical and hydraulic vibrations, FMC recommends the use of flexible hose connections between the pump and any rigid piping or the use of pulsation dampeners.

3. A properly adjusted pressure relief valve or rupture disc must be installed directly downstream of the pump to prevent damage or injuries resulting from over pressure or deadhead conditions. The relief valve by-pass line must be as large as the pipe outlet of the relief valve. Never install valves in the by-pass line or between the pump and relief valve. FMC recommends that the by-pass be returned to the suction tank or drain, not back into the pump suction line.

4.5 Multiple Pump Systems

Special consideration must be taken to avoid vibration and pulsation problems when operating multiple reciprocating pumps using common suction and discharge piping headers. It is recommended that the user contact FMC or experienced industry consultants for assistance with the design of the system and pump in these situations.

5.0 How to Start a Pump

Always take special precautions when starting a pump for the first time or after any extended shutdown. Never assume that someone else has properly prepared the pump and system for operation. Always check each component of the system prior to every start-up.

The list that follows is intended to be a general guide for starting a pump in a typical installation. Every installation is different, and each will have different requirements to insure safe and successful operation. It is the responsibility of the operator to determine the correct start-up procedure for each installation.

1. Insure that the drain plugs on the bottom of the pump crankcase have been installed and are tight. Insure that the oil level sight glass has been properly installed.

2. Check the oil level to insure that the pump is properly filled and that the oil has not been contaminated with water or other liquids. FMC pumps are not shipped with oil in the power frame and must be filled with the proper grade of oil prior to start-up. The Q12 pump requires 3 gallons (11.4 liters) of oil. Use the recommended lubricants chart provided in Section 6.0 for assistance in selecting the correct type of oil for your service.

3. Insure that the pressure relief valve and all accessory equipment have been installed and properly adjusted. Verify that all joints are pressure tight.

4. Open the suction line valve to allow fluid to enter pump.

5. Check to insure that power is locked out, and then turn the pump over by hand if possible to insure free, unobstructed operation.

6. Make sure that all guards are in place and secure. Verify that all personnel are in safe positions and that system conditions are acceptable for operation.

7. Start the pump. Whenever possible, use a bypass line for the flow to allow the pump to start in an unloaded condition (no discharge pressure). Slowly close the bypass line to bring the pump into full load conditions. Shut down immediately if the flow becomes unsteady, pressure fluctuates or if unusual sounds or vibrations are noted.

8. A pump will sometimes have a “pounding” noise at startup. This may be due to entrained air in the liquid end. The pounding will be temporary and will end once the air had cleared through the pump. The “pounding” will not harm the pump if duration is less than 5 minutes.

9. The suction line and fittings must have no leaks. Even a small pin-hole leak will allow air into the pump causing poor performance and noisy operation.

6.0 Recommended Lubricants

Few factors can influence the life of a pump more than the power end lubricant. Careful selection of the right type of oil for your particular application will help insure optimum performance from your pump.

The intent of this section is to state the general lubrication requirements for FMC pumps. Several manufacturers' products are listed by name in the table below in order to aid the customer in locating suitable products. The following listing is not exclusive, nor an endorsement of any particular product or manufacturer. Consult FMC for lubrication recommendations for applications that fall outside of the conditions listed below.

Recommended Lubricant Chart

Type of Service	Ambient Temperature	ISO Grade (cSt)	AGMA Number	SAE Weight	SSU Viscosity	Brand Names
General Service	0 - 95º F	100	3	30	550	Texaco Meropa 100 Shell Omala 100 Shell Rotella T SAE 30 Exxon XD-3 30 wt Mobil Trans HD-30
High Ambient Temperatures	95 - 120º F	220	5	50	1165	Texaco Meropa 220 Shell Omala 220 Shell Rotella T SAE 50 Exxon HD-3 50 wt Mobil Trans HD-50
Cold Ambient Temperatures	-30 - 60º F	68	2	20	350	Texaco Meropa 68 Shell Omala 68 Shell Rotella T SAE 20 Exxon HD-3 20 wt Mobil Trans HD-20
Frequent Start-Stop Cycles		150	4	40	775	Texaco Meropa 150
Specialty Items						
Internal Rust Inhibitor						Cortec VCI 329
External Rust Preventative						Texaco Metal Protective Oil L
Packing Lubrication		Rock Drill Oils				Exxon Arox 150 Shell Toreula 150 Mobil Almo 529

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7.0 Preventative Maintenance Chart

Routine maintenance is an essential part of any successful pump installation. Properly maintained FMC pumps are designed to offer years of trouble-free service.

Regular maintenance and inspection will keep your pump operating at peak performance. FMC pumps have been carefully engineered to minimize maintenance requirements and simplify these tasks when they are required. Regular inspections allow operators to become familiar with normal pump operation so they can recognize the signals of potential problems and schedule maintenance. The chart shown below should be used as a guideline only. Many applications will require adjustment of the intervals shown in this chart for severe or unusual operating conditions.

Interval	Component	Service	Remarks
Break In Period	Crankcase Oil	Change	Drain and refill with new oil after first 50 hours of operation. Insure that magnetic drain plugs are cleaned of debris.
	Inlet Strainer	Inspect	Clean if required. The amount of material in the strainer will determine the interval of cleaning.
Daily	Complete Pump	Inspect	General inspection of pump and system to check for proper operation of equipment.
	Piston Seals	Inspect	Check the cylinders for signs of leakage. Replace seals if leakage becomes excessive.
	Pump System	Flush	Required shutdown when pumping fluids that may harden or corrode pump if left inside once stopped.
	Crankcase Oil	Inspect	Insure that oil is at proper level and has not been contaminated by pumpage or condensation.
3 Months/2000 Hours	Crankcase Oil	Change	Drain and refill with new oil. Clean magnetic drain plugs.

8.0 Component Parts List

A typical Q12 pump configuration is shown below for general reference purposes for service procedures outlined in the following sections. Actual pumps supplied by FMC may use different components or configurations. To order service parts or see exact component configurations for your particular pump, refer to the cross section drawing in the literature kit supplied with the pump. Contact your FMC original equipment manufacturer (OEM) or FMC if you do not have this information.

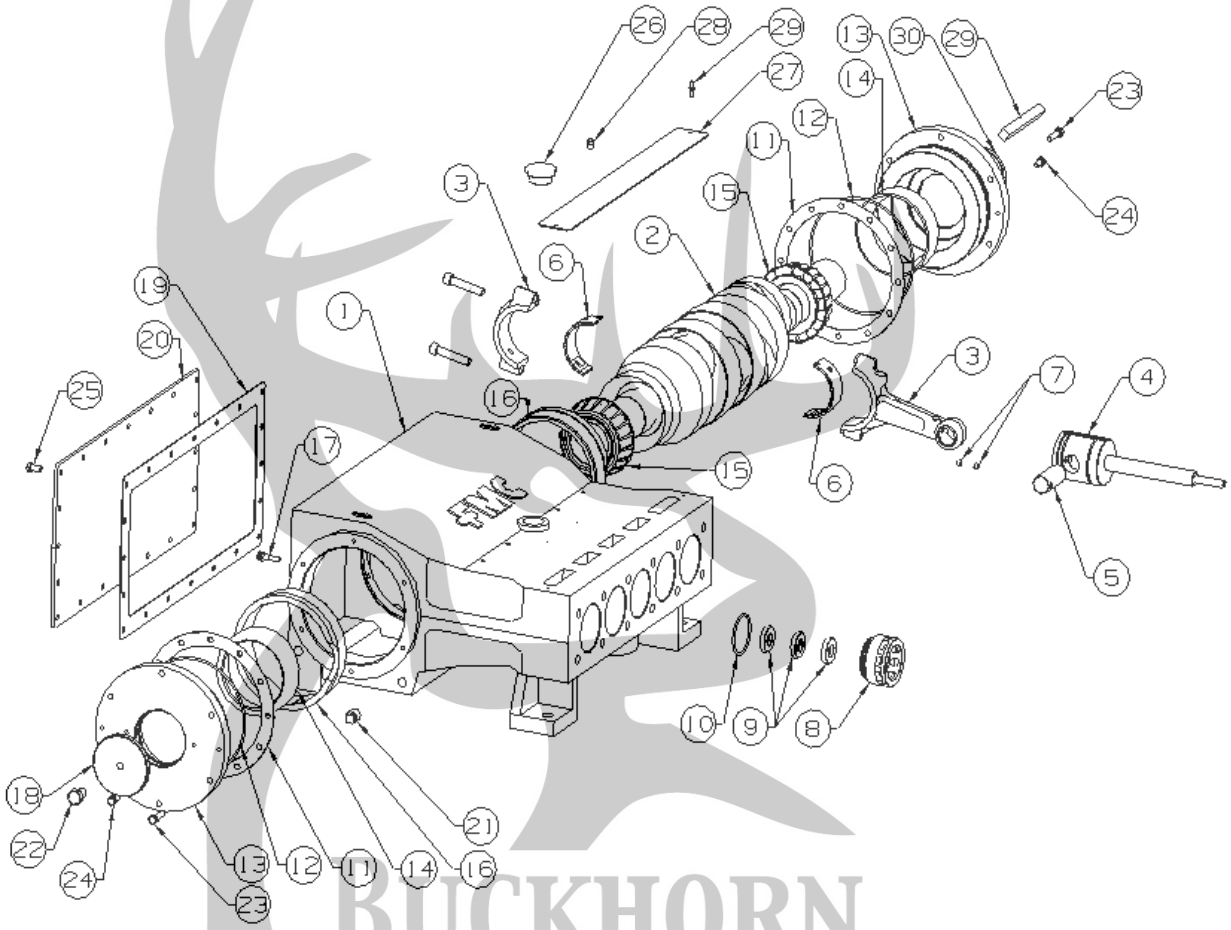

Figure 2: Q12 Power End Components

The figure above shows the typical power end components of a Q12 pump.

Item Number	Description	Quantity Required
1	Power Frame	1
2	Crankshaft	1
3	Connecting Rod Assembly	5
4	Crosshead Assembly	5
5	Wrist Pin	5
6	Rod Bearing	10
7	Set Screw	10
8	Seal Holder	5
9	Oil Seal	15
10	O-Ring (Rod Seal)	5
11	Shim	10
12	O-Ring (Bearing Housing)	2
13	Bearing Housing	2
14	Bearing Cup	2
15	Bearing Cone	2
16	Center Bearing	2
17	Lock Screw (Center Bearing)	2
18	Bearing Housing Plug	1
19	Back Cover Gasket	1
20	Back Cover	1
21	Magnetic Pipe Plug	4
22	Cap Screw (Bearing Housing Plug)	1
23	Cap Screw (Bearing Housing)	12
24	Pipe Plug	4
25	Cap Screw (Back Cover)	22
26	Oil Cap	1
27	Cradle Cover	1
28	Thumb Screw	2
29	Key	1
30	Oil Seal	1

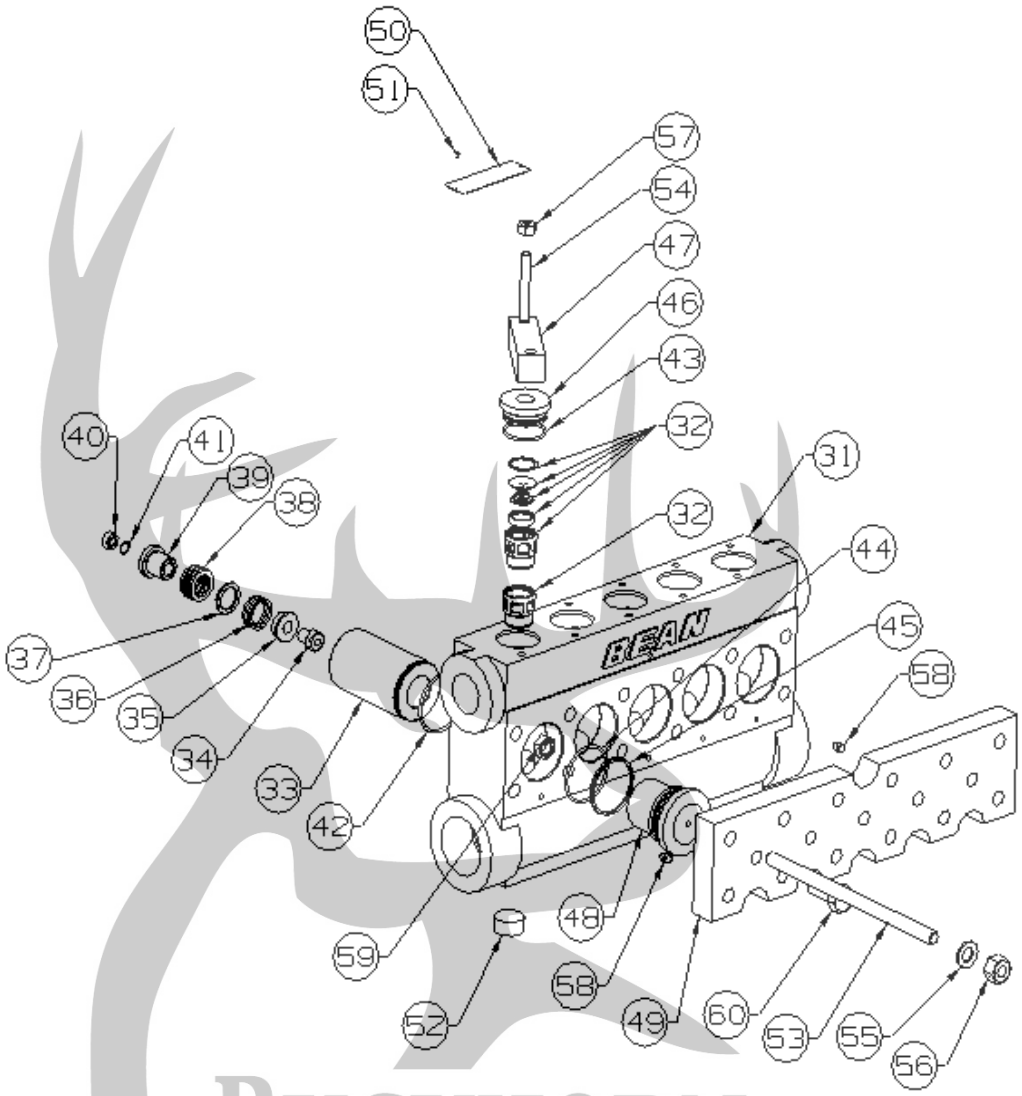

Figure 3: Q12 Fluid End Components

The figure above depicts a typical Q12 pump with a cast fluid cylinder and disc type valves.

The service procedures outlined in this manual are specific to this type of pump; however other configurations and minor design differences may have been supplied with your product. Some procedures many require slight adaptations as a result. A specific parts list should be supplied with each pump. Contact FMC customer service or your OEM for assistance if not supplied.

Item Number	Description	Quantity Required
31	Fluid Cylinder	1
32	Valve Assembly	10
33	Piston Liner	5
34	Packing Nut	5
35	Spring Compressor	5
36	Coil Spring	5
37	Stuffing Box	5
38	Packing	5
39	Packing Holder	5
40	Seal Holder	5
41	O-Ring (Piston)	5
42	O-Ring (Piston Liner)	5
43	O-Ring (Valve Cover)	5
44	O-Ring (Cylinder Cover)	5
45	Backup Ring (Cylinder Box)	5
46	Valve Cover	5
47	Valve Cover Clamp	5
48	Cylinder Cover	5
49	Cylinder Cover Clamp	1
50	Nameplate	1
51	Self-tapping Screws	2
52	Pipe Plug	5
53	Stud (Cylinder Cover Clamp)	12
54	Stud (Valve Cover Clamp)	10
55	Washer (Cylinder Cover Clamp)	12
56	Nut (Cylinder Cover Clamp)	12
57	Nut (Valve Cover Clamp)	10
58	Pipe Plug	6
59	Jam Nut (Fluid Cylinder)	2
60	Cap Screw (Cylinder Cover Clamp)	5

9.0 Service Procedures

FMC pumps are designed to simplify all required maintenance. The pistons, valves, and oil seals are all normal expendable items that will eventually wear out and require replacement. Read and understand each section completely before attempting to service the pump. This section covers all normal service procedures on the fluid end of the pump.

9.1 Replacing Piston Cup Seals(Packing)

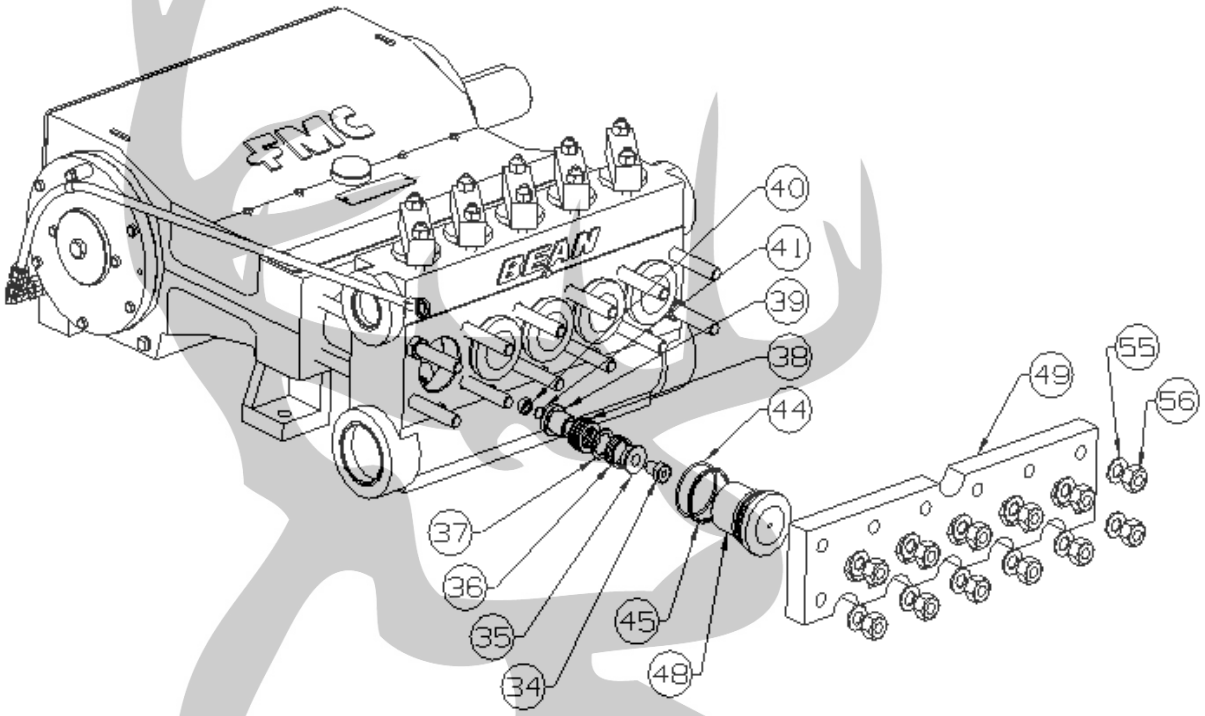

Figure 4: Q12 Seal Arrangement

1. Approximately 2 feet (.6 meters) of clearance is required between the front of the pump fluid cylinder and any obstructions to service the piston seals. If there is insufficient clearance, the pump may have to be removed for routine maintenance.

2. To access the piston seals, the cylinder cover clamp must be removed. Remove the twelve (55) diagonal nuts that hold the cylinder cover clamp in place, then remove the cylinder covers. ***Do not*** remove the two jam nuts (59) on the opposite corners of the fluid chamber. They will keep the fluid cylinder securely mounted on the pump during this repair procedure.

3. Using a socket wrench with a long extension, remove the packing nut (34) from the piston assembly. This nut secures the piston assembly to the crosshead rod.

4. Once the packing nut has been removed, remove the spring compressor (35) and coil spring (36) from the bore.

5. Rotate the crankshaft to pull the crosshead rod away from the piston. Remove the packing (38), packing holder (39), seal holder (40) and O-Ring (41) from the bore.

6. Inspect all parts for damage or unusual wear. Insure that the interior surface of the piston liner is smooth and free of cracks and grooves. New piston seals will fail prematurely if installed in liners with damaged bores. FMC Technologies recommends that all 5 piston seals be replaced, not just those that show signs of leakage, whenever this type of service is performed. This will insure maximum operational time between service intervals.

7. Reverse the previous steps to rebuild the pump. FMC Technologies recommends that all seals or gaskets that are disturbed during service procedures be replaced. This includes the seal holder O-Ring that is located on the crosshead rod directly behind the piston assembly.

8. Insure that all fasteners are tightened to the values specified in the Fastener Torque Requirements in Section 10.0.

9.2 Fluid Cylinder and Liner Removal

1. If the liners (33) or cylinder O-Rings (42) have been damaged, it is necessary to remove the fluid cylinder (31) for repair. The fluid cylinder must also be removed to service the piston rod oil seals (8 & 9).

2. Remove the cylinder cover clamp (49) and covers (48) as described in the previous section. Remove the jam nuts (59) if they are still in place at this time.

3. Tap the fluid cylinder to loosen it from the liners, then slide it off of the attaching studs (53). If pistons have already been removed, take care to insure that the piston liners do not fall off the front of the power end and become damaged

4. The packing nut (34) must be removed to allow removal of the piston assembly. If the pistons have not been removed, remove the packing nut, and lift the liners (33) out of the pump.

5. Inspect all parts for signs of wear or damage. Replace if required.

6. Always replace the liner O-Rings (42) when the piston liners have been moved or replaced.

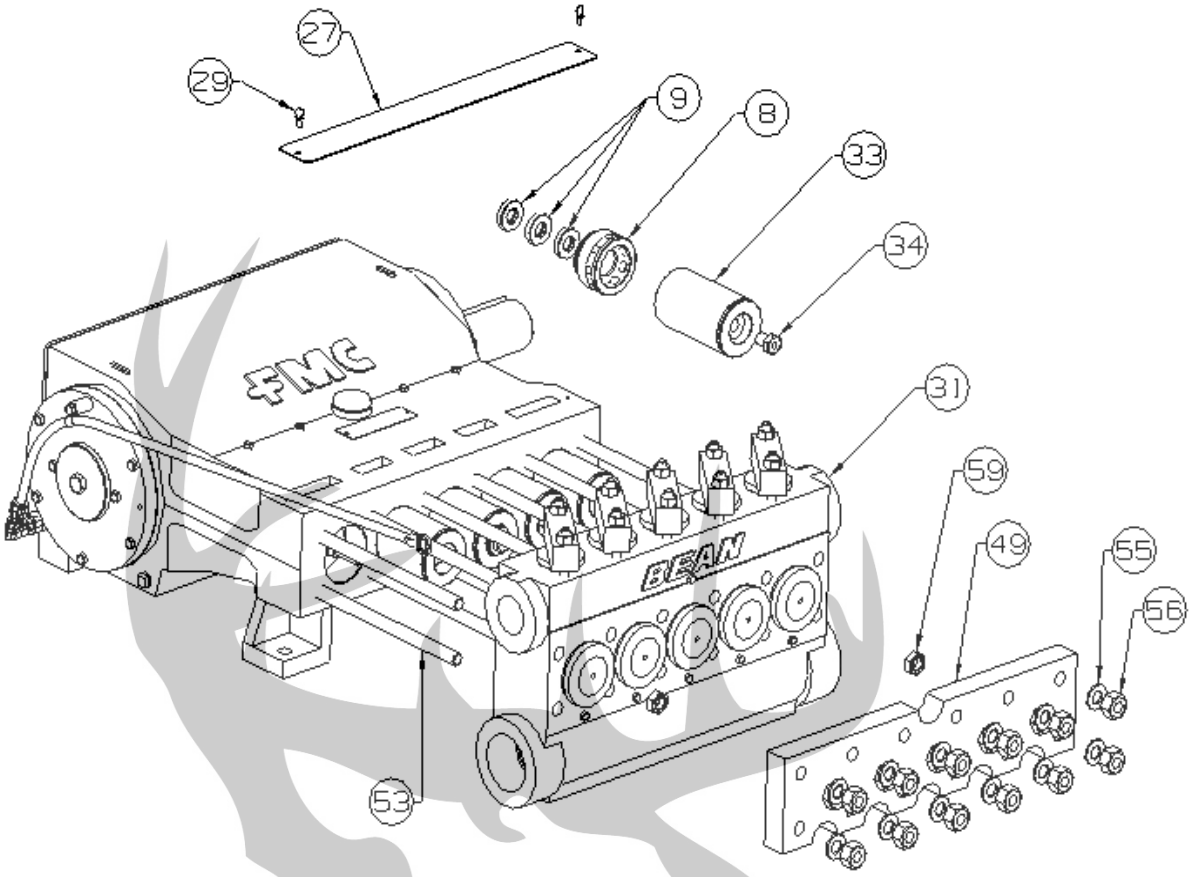

Figure 5: Q12 Oil Seal and Cylinder Replacement

9.3 Replacing Piston Rod Oil Seals

1. The piston rod oil seals retain oil in the power frame and prevent dirt, water, or other contaminants from entering the power frame by way of the piston rods. The fluid cylinder and liners must be removed first as outlined in the previous sections to provide access to the seals.

2. With the liner removed, pull the seal holder (8) out of the pump frame and slide off the piston rod. It may be necessary to insert a screwdriver or other pointed tool into one of the holes in the seal carrier to help pry away from the frame.

3. Remove the old oil seals (9) from the holder

4. To rebuild, insert new seals in the holder. Take care to insure they are oriented with the lips facing the power end. Never attempt to reuse seals that have been removed from the pump.

5. Wrap tape or other material over the exposed piston rod threads to protect the new seal lips from damage. Slide the seal holder over the protected threads and into the pump frame. Care must be taken to insure the seal lips are not folded or damaged when passing over the ends of the piston rod.

6. Remove protective covering from piston rod threads, then rebuild fluid end as outlined in the previous sections. Torque all fasteners as outlined in the Fastener Torque Requirements section of this manual in Section 10.0.

9.4 Replacing Suction and Discharge Valves

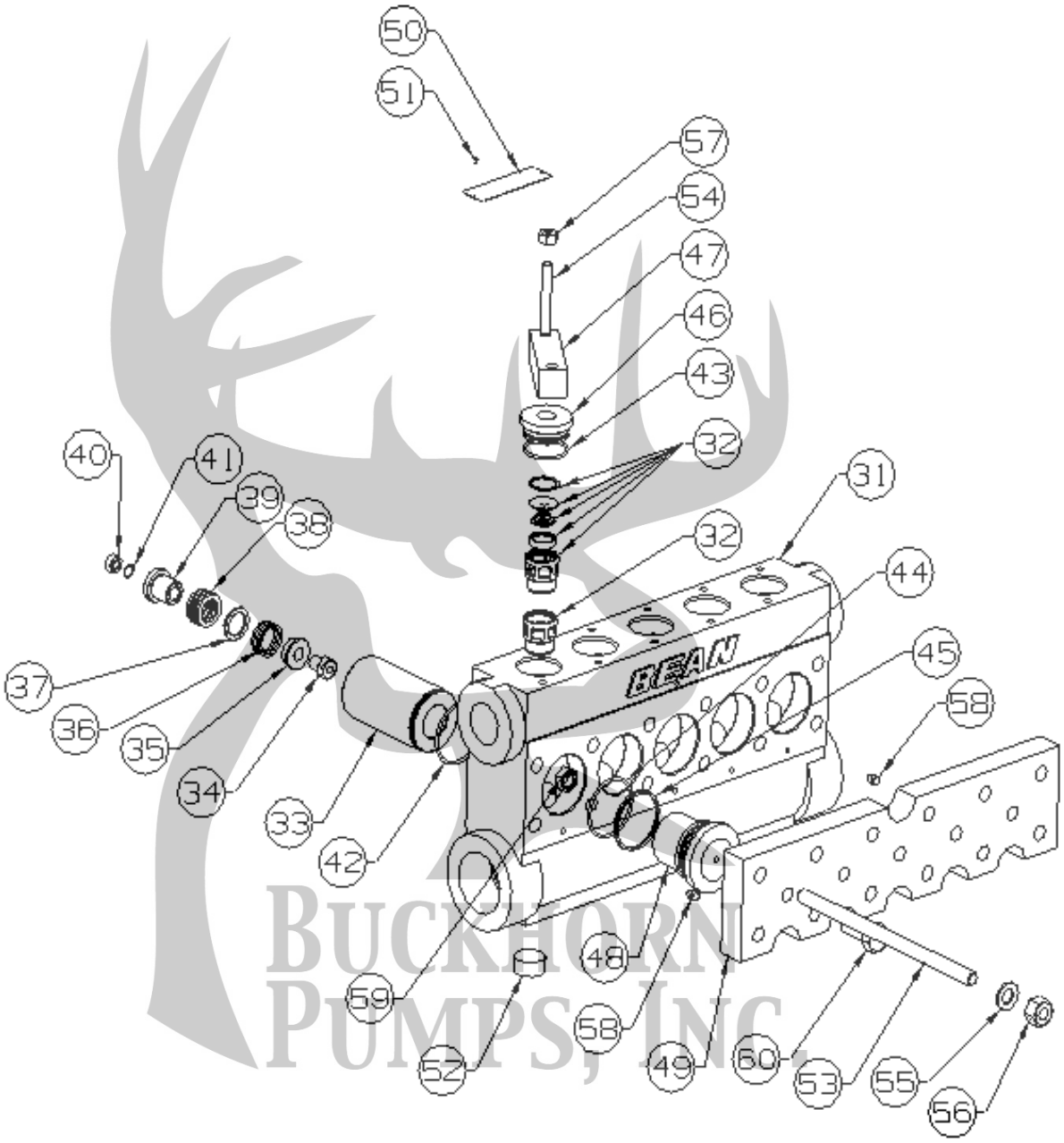

Figure 6: Q12 Valve Removal

1. A minimum of approximately 2 feet (.6 meters) of clearance is required above, below, and in front of the pump fluid cylinder to allow valve servicing without removal of the fluid end. If sufficient clearance is not available, the fluid cylinder must be removed as outlined in previous sections and taken to a workshop for valve servicing.

2. Remove the five drain plugs (52) from the bottom of the fluid cylinder (31).

3. Remove the five valve covers (46) from the top of the fluid cylinder.

4. The cylinder covers (48) must be removed to allow removal of the suction valve assemblies. Remove the covers as outline above.

5. Use a 1-3/8" diameter x 18" long rod and a hammer to drive the suction, lower, valve assemblies (32) from their seats and remove them through the cylinder bores. Insure that the rod makes contact with the bottom of the valve seat, not the valve body.

6. Use the same procedure to remove the discharge, upper, valve assemblies (32) and remove them through the discharge valve cover opening.

7. FMC Technologies recommends that complete sets of new suction and discharge valves be installed whenever valve service is required. Replacing only valve assemblies that have visible signs of wear will reduce the operating time between service intervals. FMC recommends replacing complete valve assemblies, never individual valve parts.

8. Before new valves are installed the valve seats and valve bores in the fluid end must be clean and dry. Do not lubricate these surfaces! Valve assemblies are secured using a self-locking taper and must make metal-to-metal contact to be effective. Failure to have clean mating surfaces will cause premature valve failure or damage the pump.

9. Lower the suction valves into the cover port of the fluid cylinder. Lift the valve one inch (25 mm) above the surface and drop. If the seat drops straight it will seize in the taper and cannot be pulled up by hand.

10. Use the small end of the FMC valve tool to drive the valve assemblies into the seats using two firm blows with a ball peen hammer or mallet. Insure that the tool is mated to the top of the valve body, not the valve cage. Contact with the valve cage may damage the valve assembly.

11. Use the same procedure to install the discharge valve assemblies.

12. Replace the cylinder covers, cover clamp, valve covers, and inlet drain plugs. Replace any O-Rings or gaskets that have been moved during this procedure. Tighten all fasteners as indicated in the Fastener Torque Requirements section of this manual in Section 10.0.

9.5 Servicing the Power End

1. Remove drain plug (21) from bottom of pump and allow all oil to drain from power frame sump. See Figure 7.

2. Disconnect the driver from the pump and insure that suction and discharge lines are disconnected or blocked and have no pressure applied. Removal of the fluid cylinder simplifies most power end service procedures.

3. Remove the rear cover bolts (25) and the rear cover from the pump frame.

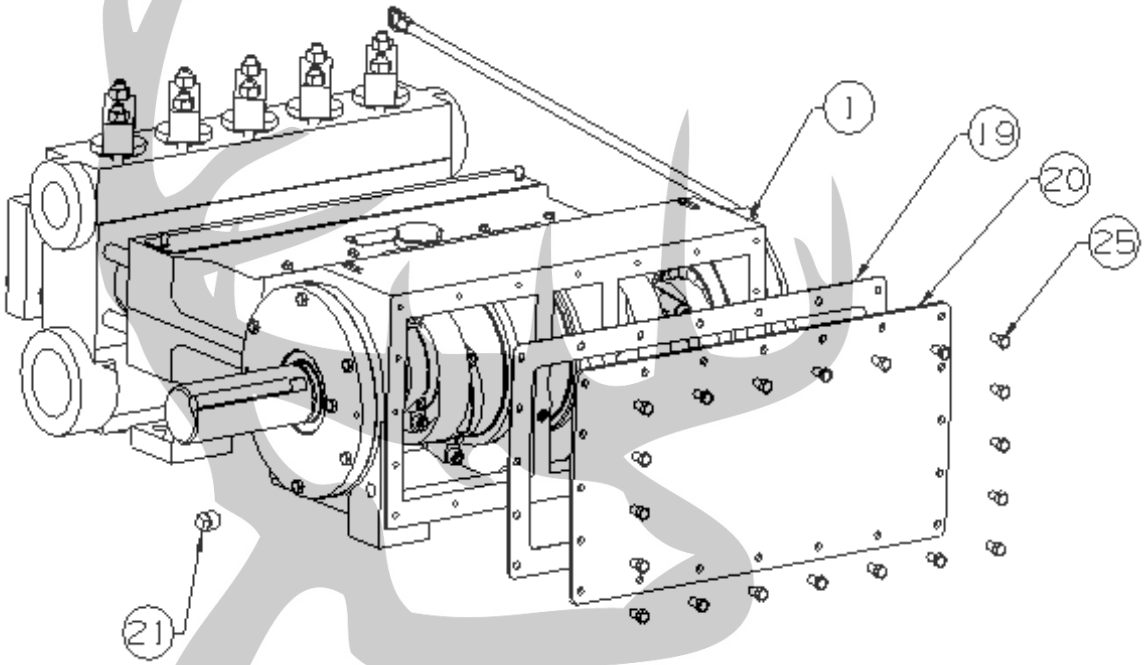

Figure 7: Q12 Power End Assembly

4. Remove the connecting rod caps by unscrewing the two cap screws that hold each of the caps in place. See Figure 8.

5. Connecting rods and caps (3) are matched sets and must be reassembled with their original mate, in the same orientation, and at the same crankshaft location. Note the numbered codes stamped on each of the connecting rod assemblies.

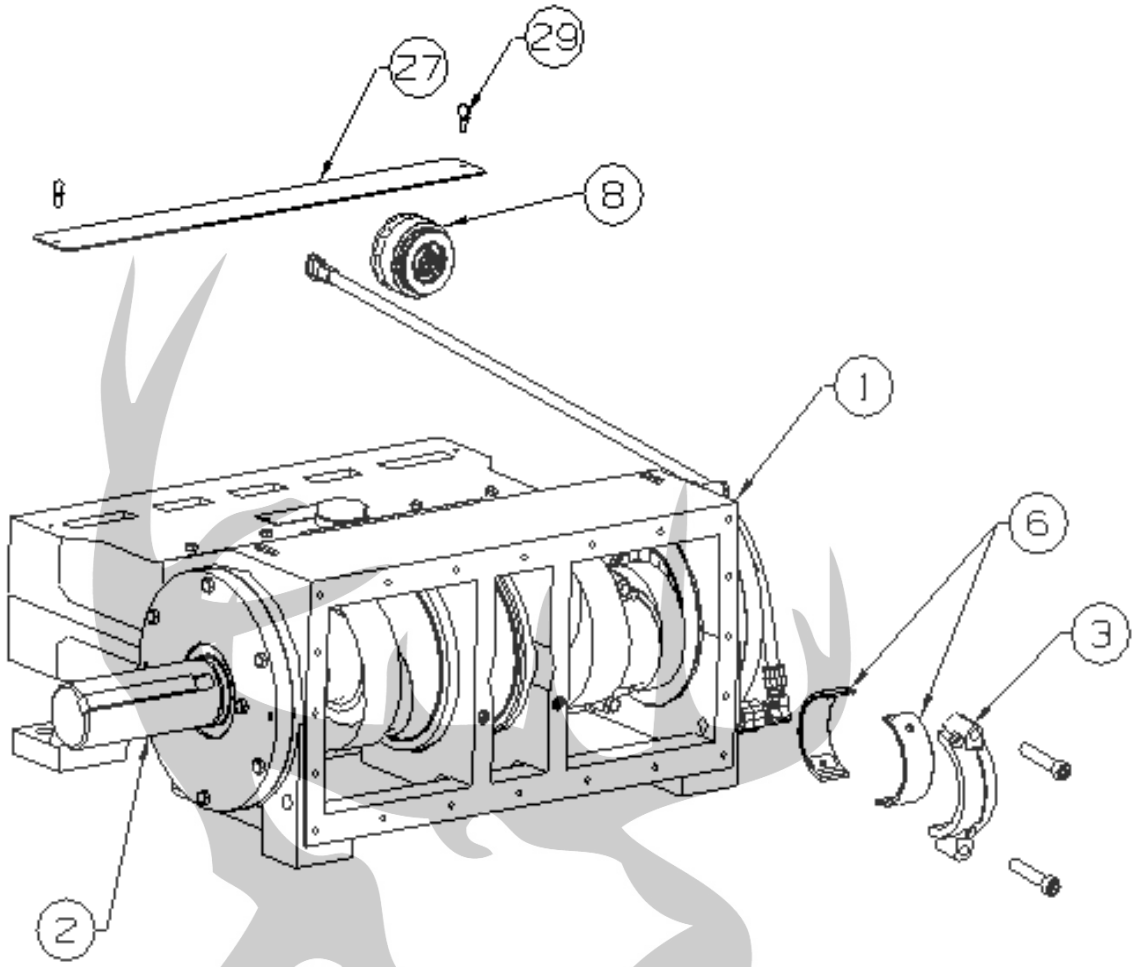

Figure 8: Q12 Connecting Rod Caps

6. Push the connecting rods (3) and crosshead assemblies (4) as far forward into the power frame as possible to provide clearance for the crankshaft. Connecting rod bolts must be removed completely to provide additional clearance when removing the crankshaft.

7. Remove the left and right side bearing housings (13). See Figure 9. It may be necessary to tap on the housing with a rubber mallet to free it from the pump frame.

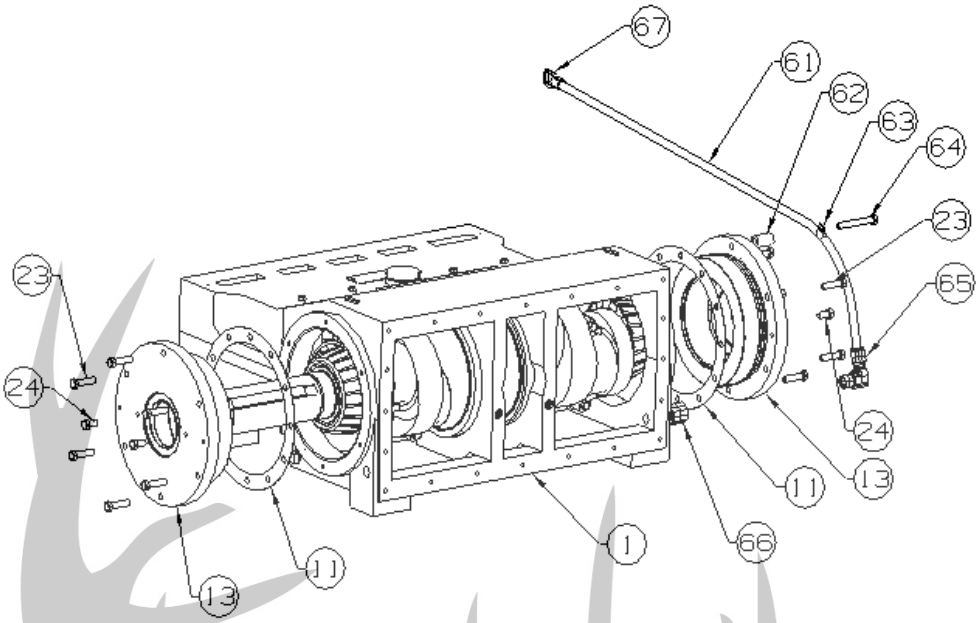

Figure 9: Q12 Bearing Housings

8. Work crankshaft through bearing housing opening in pump frame to remove. The throws must be rotated as the crank is removed to clear the connecting rods. The crankshaft should be handled very carefully to insure the critical bearing surfaces are not scratched or damaged.

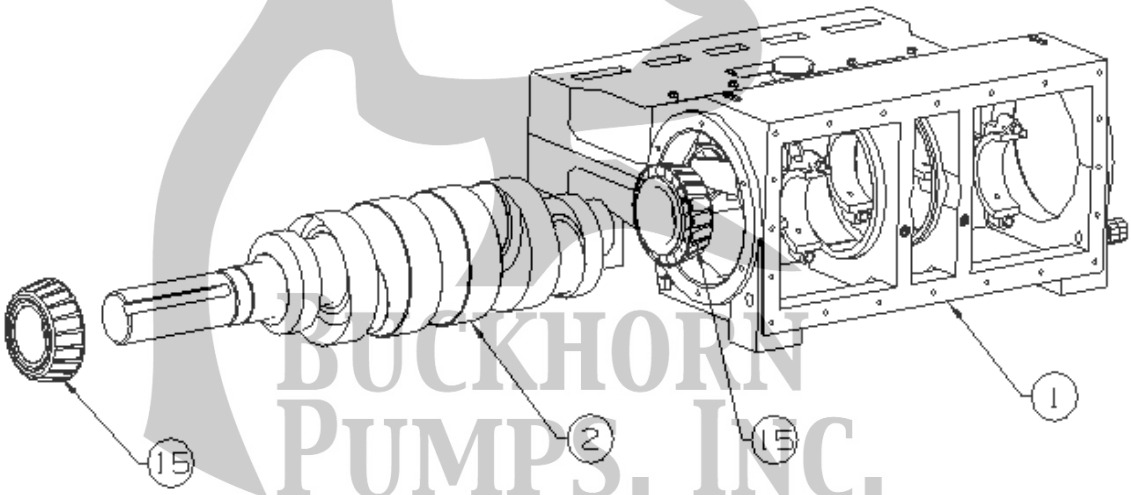

Figure 10: Q12 Crank Bearings

9. Pull connecting rod and crosshead assemblies from the pump frame. Take care to insure they are reassembled into the same bore from which they were removed.

10. Remove the center bearing lock screws (17). Slide the center bearings (16) from the power frame. See Figure 11.

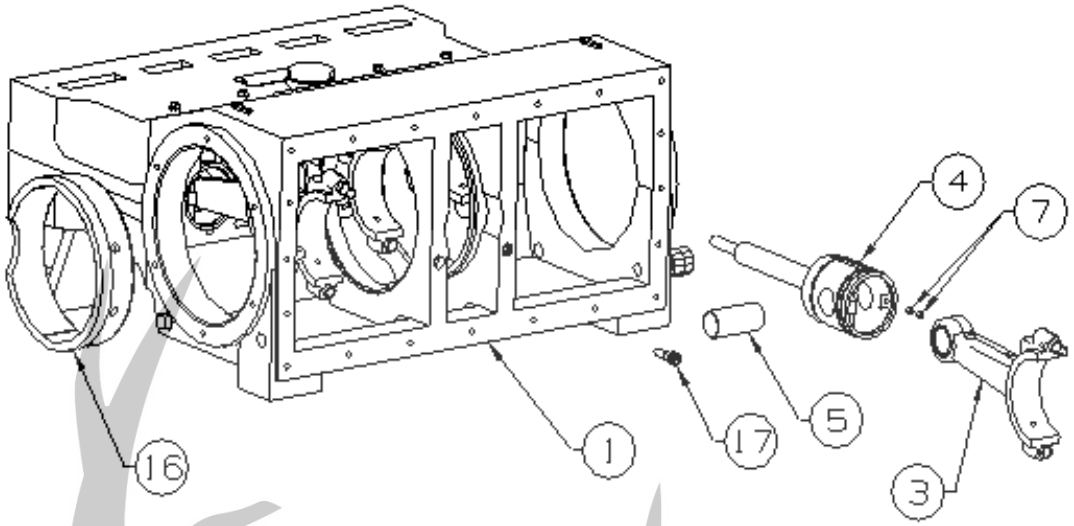

Figure 11: Q12 Connecting Rods and Crossheads

11. Remove crankshaft oil seal (9) from its bearing housing (13) using a screwdriver or similar object and discard.

12. If required, remove crankshaft bearing cup (14) and cones (15) using an automotive type bearing puller.

13. Inspect all components for signs of wear or damage and replace if required. Carefully check the crankshaft bearing surfaces for pits, scratches or other signs of wear.

14. Thoroughly clean all parts with solvent and apply a thin coat of oil before reassembly.

15. Tapered roller bearings cones (15) must be heated to aid in assembly to the shaft. Always observe proper safety procedures and use heat resistant tools and gloves when handling hot parts. There are a number of recommended methods for heating bearings. Electric ovens or electrically heated oil baths may be used, but only when accompanied by proper thermostatic control.

16. To replace the crankshaft tapered roller bearings, first heat cones to a maximum of 300℉ and slide down the shaft until it is full seat ed against shoulder. The hot cone may pull away from the cold shoulder unless it is held in position until it is cool enough to grab the shaft. Use a feeler gauge to insure the cone is fully seated against the shoulder after parts have cooled. There should be a maximum .001 inches of clearance between the cones and the shoulder on the crank.

17. Use a press to seat the new cups (14) in the bearing housing. Never install new bearing cones in old bearing cups.

18. Install the center bearings (16) in the power frame. Install the lock screws (17) to hold the bearings in position.

19. Reassemble the crosshead assemblies and connecting rods. Install new bearings (6). Insure that wrist pin bushing set screws (7) are in place if they were removed for repair or inspection of the wrist pin bushing.

20. Replace crosshead assemblies and push fully forward in power frame to provide maximum clearance for the crankshaft. Insure crosshead assemblies are replaced in same orientation and in same cylinder bore they were originally. The connecting rod oil cup pocket must be in the up position.

21. Install crankshaft in pump. Take care not to scratch bearing surfaces.

22. Replace rod bearings and connecting rod caps. Insure that rod caps are assembled with mating connecting rod.

23. Replace shims and bearing housings. As a start point, install same number of shims that the pump originally had prior to service.

24. Dial indicators and shims must be used to properly adjust the endplay of the tapered roller bearings used on the crankshaft. Improper bearing adjustment may result in excessive temperature, noise, and reduced bearing life. FMC Technologies recommends between .002”-.005” of endplay when assembled. Final adjustment must be made using a dial indicator.

    a) Insure the connecting rods are loose to allow free crankshaft movement.

    b) Mount indicator base on back of pump frame and the indicator tip on the shoulder of the crankshaft.

    c) Move the crankshaft to one side of the housing using light taps from a rubber mallet or a pry bar.

    d) Set dial indicator to zero.

    e) Force the crankshaft back over to the opposite side and read bearing endplay as total indicator movement. Remove or add shims as necessary to achieve proper endplay. Distribute shims on both ends of the shaft.

25. With the piston seals not installed the pump shaft should turn freely by hand.

26. Complete reassembly of pump. Torque all fasteners as outlined in the Fastener Torque Requirements section of this manual. See Section 10.0.

10.0 Fastener Torque Requirements

No pump service procedure is complete without insuring that the fasteners have been properly torqued. Failure to properly tighten the pump bolting could cause the pump to leak or even allow the bolts to fail. Always use a calibrated torque wrench during the installation of all critical fasteners listed below. Values are in FT-LBS and Newton meters (N-m). Typical sizes are shown; other sizes may be used depending on application.

Power End (Refer to Figures 5, 7, 8, 9 & 11 for item locations)

Item				*Typical*	*Torque*	
Number	*Description*	*Size*		*Material*	*Ft-lbs*	*N-m*
(25)	Back Cover Bolts	3/8	-16-UNC	GR-5	20	27
(23)	Bearing Housing Bolts	3/8	-16-UNC	GR-5	20	27
	Connecting Rod Bolts	1/2	-13-UNC	Alloy	40	54
(7)	Cross Head Set Screw	5/16	-18-UNC	Alloy	15	20
(29)	Cradle Cover Wing Nut	1/4	-20-UNC	GR-2	10	13

Fluid End (Refer to Figure 6 for item location)

Item				*Typical*	*Torque*	
Number	*Description*	*Size*		*Material*	*Ft-lbs*	*N-m*
(34)	Packing Nut	1/2	-10-UNC	Alloy	40	54
(57)	Valve Cover Clamp Nut	1/2	-13-UNC	Alloy	40	54
(56 & 59)	Cylinder Cover Clamp Nut	3/4	-10-UNC	Alloy	200	270

11.0 Trouble-Shooting Pumps

This chart is designed to aid in the solution of pump and pump system problems. Once the problem has been identified, work through the possible causes and solutions until the problem has been corrected.

No flow from pump

- Tank is empty
- Suction valve is closed
- Inlet strainer is clogged with debris
- Crankshaft is not turning

Insufficient pressure from pump ONLY

- Pump speed is too slow
- Relief valve improperly adjusted and by-passing fluid
- Oversize or worn nozzle on equipment
- Worn pump valves
- Excessive leakage from pump seals

Insufficient flow from pump ONLY

- Pump speed is too slow
- Relief valve improperly adjusted and by-passing fluid
- Worn pump valves
- Excessive leakage from pump seals

Insufficient flow OR pressure AND rough operation

- Valve problem:
  - Valve is stuck in the open or closed position
  - Valve assembly is damaged or unseated
  - Valve seat is washed out
- All pump cylinders not primed

- Inlet strainer is clogged with debris
- Excessive gas in liquid due to:
  - Air leaks in suction line or fittings
  - High spots in suction line that allow formation of gas pockets
  - Vortex in tank near inlet pipe opening
- Pump is cavitating due to:
  - Insufficient Net Positive Suction Head available (NPSHa) (tank head or charge pressure)
  - Fluid viscosity is too high
  - Inlet line is too long and/or too small diameter

Pump runs rough, knocks, or vibrates ONLY

- Loose piston assembly
- Valve assembly is damaged or has unseated
- Pump is cavitating due to:
  - Insufficient NPSHa (tank head or charge pressure)
  - Fluid viscosity is too high
  - Inlet line is too long and/or too small diameter
- Worn or damaged power frame components
- Pump is sucking air across worn piston seals during suction stroke (usually only observed on pumps that due not have a booster pump)

Suction pressure fluctuates rapidly

- Pump is cavitating
- Air is entering into the suction piping

Fluid leaking from pump

- Piston seals are wearing and about to fail
- Fluid cylinder bolts are not properly tightened
- Fluid cylinder O-Rings (or gaskets) are damaged

- Piston assembly O-Rings are damaged

Short piston seal life

- High abrasive particle content in fluid
- Wrong style or type of piston for service
- Piston liner is damaged
- Pump is cavitating (cylinders may run hot)
- Piston assembly O-Ring is damaged
- Poor quality water used (sources like lakes, streams, or fire hydrant that has not been purged)
- Pump is allowed to run dry for extended periods of time
- Liner wash system not properly maintained (if equipped)

Short valve life

- High abrasive particle content in fluid
- Valve assemblies only partially rebuilt during previous service
- Valve assemblies damaged due to improper installation techniques
- Poor quality water used (sources like lakes, streams, or fire hydrant that has not been purged)
- Pump is cavitating

Cracked fluid cylinder

- Discharge pressure too high
- Pump exposed to freezing conditions without properly draining
- Hydraulic shock resulting from cavitation or entrained air
- Discharge valve is stuck shut
- Material or manufacturing defect

Crankshaft jerks or starts and stops rotation

- V-belts are loose and slipping (if equipped)
- Hydraulic system relief valve is chattering (if equipped):

- Pump operating at excessively high discharge pressure
- Discharge line is blocked or partially obstructed

Power end overheats (in excess of 180° F)

- Discharge pressure too high
- Low oil level
- Improper oil viscosity, see Section 6.0 for proper selection of lubricants
- Contaminated power end oil
- Pump speed is too fast
- Pump is running backwards
- Couplings are misaligned
- V-belt drive tension is too tight
- Pump located too close to heat source
- Worn or damaged power frame bearings

Broken crankshaft or connecting rod

- Pump exposed to freezing conditions without proper draining
- Discharge pressure too high
- Suction pressure too high
- Hydraulic shock due to cavitation
- Material or manufacturing defect

Broken Fluid End Bolts

- Bolt or nut not properly torqued
- Discharge pressure too high
- Excessive piping loads on fluid end

Power end oil is contaminated

- Pump has been operated with failed piston seal for extended periods of time
- Use of high-pressure wash wand to clean near breather or oil seal areas

- Crosshead extension oil seals are damaged or improperly installed
- Excessive capacity in liner wash system
- Improperly adjusted liner wash nozzle

12.0 Ordering Parts

Service parts are available through FMC's worldwide network of distributors, or from the original equipment supplier that pump is used on. If unsure where to purchase parts, contact FMC customer service for the location of an authorized parts retailer in your area. Always insist on genuine FMC replacement parts.

Use the assembly drawing and bill of material included in addition to this manual to determine the components and corresponding part numbers required to service the pump. Make sure that the part number on the drawing or bill of material matches the part number of the pump requiring parts. When ordering parts, always reference the part number and serial number of the pump with the order. These numbers can be found stamped on the metal nameplate affixed to the power end of every pump. By referencing these numbers you can insure that the components you receive work as intended with your pump.

Be sure to inquire about any special service tools or complete maintenance kits.

13.0 Glossary of Commonly Used Terms

CAPACITY	The total volume throughput per unit of time at suction conditions. It includes both liquid and any dissolved or entrained gases. For all practical purposes this can be considered the volume flow rate in the suction pipe. The standard units of pump capacity are U.S. gallons per minute (GPM) or International cubic meters/hour.
CAVITATION	The state where fluid pressure drops below vapor pressure, causing the liquid to begin to change from a liquid to a gas and boil. Usually occurs in the chamber between the suction and discharge valves during the suction stroke, and often sounds like a mechanical knock. Cavitation results in the formation of gas bubbles, or cavities, in the fluid that cause vibration and metal damage when they are collapsed by the increased fluid pressure on the discharge stroke.
DAMPENER	A device that reduces pressure pulsations in the suction or discharge piping. May be referred to as a suction stabilizer, accumulator, or surge suppressor.
DISPLACEMENT	The volume swept by all pistons or plungers per unit time. This term is typically expressed as gallons or liters per revolution.
POWER END	The portion of the pump that converts supplied rotary motion into linear motion used by the Fluid End to move the pumpage.
EFFICIENCY	Mechanical efficiency is the ratio, expressed as a percentage, of pump power output to the pump power input. The mechanical efficiency of reciprocating piston pumps is high, typically in excess of 85%. Volumetric efficiency is the ratio of actual pump capacity to theoretical displacement
FLOODED SUCTION	Implies that the level of liquid in the suction vessel is above the centerline of the suction port of the pump.
FLUID END	The portion of the pump that converts the linear motion supplied by the power end into fluid flow at pressure. May also be called Liquid End.

N P S H A	An abbreviation that stands for Net Positive Suction Head Available. NPSHA is the total suction pressure, including allowance for acceleration head, available from the system at the pump suction connection, minus the vapor pressure of the liquid at actual pumping temperature. NPSHA for a reciprocating pump is normally expressed in units of feet or meters of water.
N P S H R	An abbreviation that stands for “Net Positive Suction Head Required”. This is the minimum total inlet pressure required by the pump for proper operation. This value is a function of pump design and speed and is determined by the pump manufacturer through a specific NPSHR test.
P I S T O N	A type of power pump that uses a cylindrical seal (piston) mounted on a holder to drive fluid through the valves. The piston seal reciprocates within a stationary cylinder.
P L U N G E R	A type of power pump that uses a cylindrical plunger to drive fluid through the valves. The plunger reciprocates through a stationary set of seals known as packing.
P O W E R P U M P	A reciprocating pump that drives the pumping element(s) using a slider crank mechanism. Power pumps are piston, plunger, or diaphragm type. All require a driver with a rotating shaft, such as a motor or engine, as a power source.
P O W E R F R A M E	The major portion of a power pump that encloses and supports all other components of the power (or drive) end.
S T R O K E L E N G T H	The length of one complete, unidirectional motion of the piston or plunger. Stroke length is usually expressed in inches and is 3 inches for the Q12 pump.
V A L V E	A component that allows unidirectional flow of liquid. FMC pumps have a series of two valves, one suction and one discharge, per pumping cylinder.

14.0 Reference Information

Use the following section to record key information about your specific pump model. Information such as part and serial numbers will be needed when ordering service parts. This data may be found stamped on the metal nameplate located on the pump power frame. This area may also be used to make notations about special parts, procedures, phone numbers, or other important information related to your pump.

Pump Model

Part Number

Serial Number

Rated Pressure

Rated Capacity

Rated Speed

Notes: