OPERATION AND MAINTENANCE MANUAL, D04 DUPLEX PUMPS

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Summary:

This is a manual for FMC D04 duplex plunger pumps. This pump has a 1 inch stroke length and a continuous duty power rating of 2.7 horsepower (2.0 kilowatts). Refer to part number P537864 for printing information.

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1.0 Important Safety Instructions

WARNING: Many accidents occur every year 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. Always adhere to “Lock Out” and “Tag Out” procedures. For mobile equipment, be sure engines and hydraulics cannot be accidentally started.
- **BLEED OFF ALL PRESSURE** to the pump and piping before performing any maintenance on the pump. Failure to do so may spray water or chemicals at high pressure or high temperature onto service personnel.
- **NEVER OPERATE THE PUMP WITHOUT A PRESSURE RELIEF VALVE**, rupture disc, or other type of properly sized over pressure 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 can cause leakage or structural 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 exceed the rated or design pressure limits and rupture 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, couplings, and shafts. Guards can prevent personnel from becoming entangled and injured by rotating and reciprocating parts.
- **USE EXTREME CAUTION WITH SOLVENTS** used to clean or degrease equipment. Most solvents are highly flammable and toxic. Observe all safety instructions on packaging.
- **FOLLOW NORMAL ENVIRONMENTAL GUIDELINES WHEN** fluids, lubricants, or solvents are disposed of or spilled.
- **NEVER MODIFY THE PUMP** to perform beyond its rated specifications without proper authorization in writing from FMC.

2.0 D04 Pump Features

Exceptional design, workmanship, materials, and over 100 years of pump building experience are features you'll find built into every FMC pump.

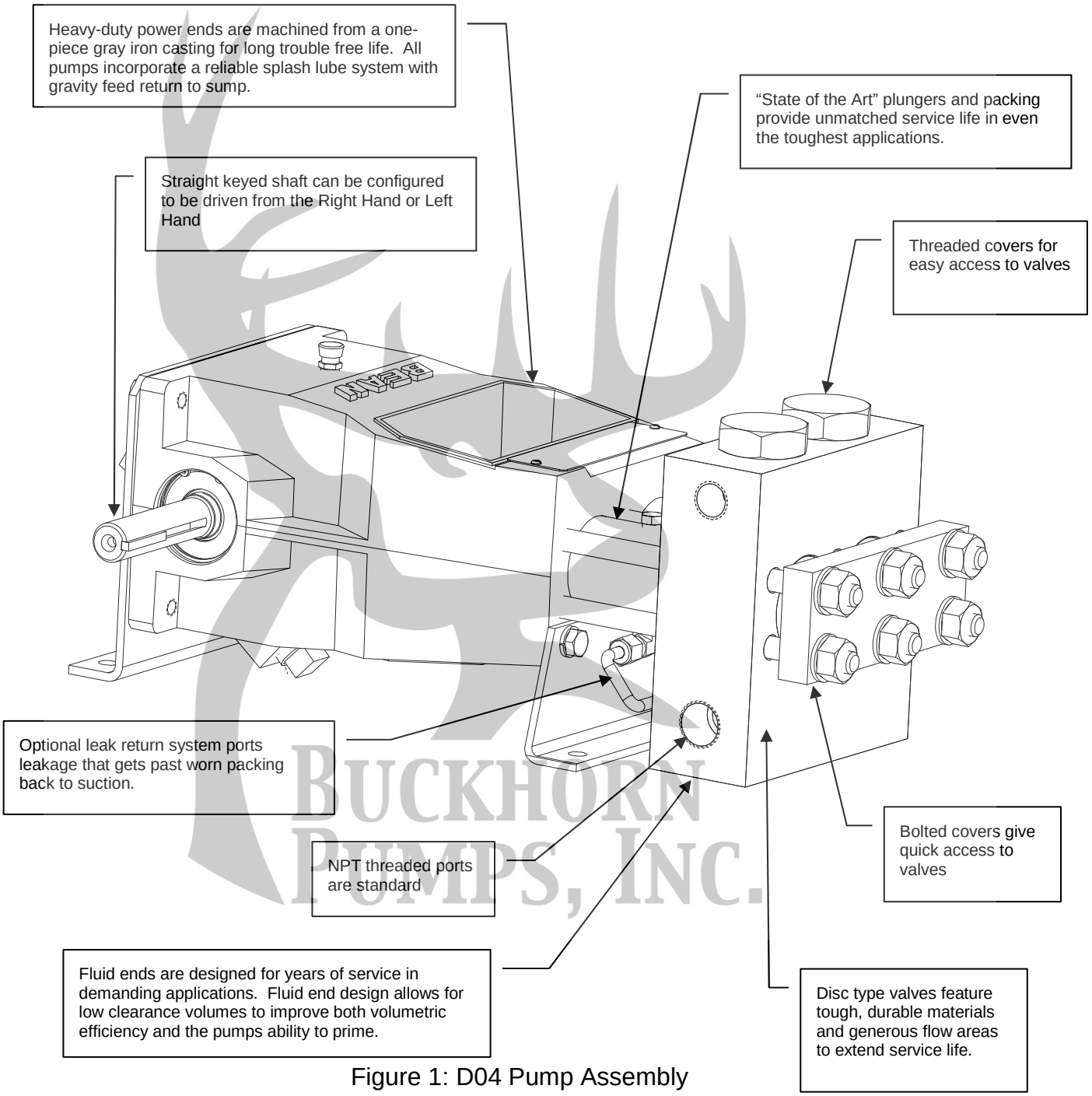

Figure 1: D04 Pump Assembly

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 **without crankcase oil** and are 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 3.2 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 3.3. Remember that any fluid that poses an environmental hazard or is toxic must be handled and disposed of properly.

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 compressed air used to blow dry whenever idle.

3.2 Short Term Storage for Severe Environments

If the pump has been in service, drain any fluid from pump fluid end, flush the fluid end with water to clean out any of the remaining pumpage and blow dry with compressed air. Pour 1/4 to 1/2 cup of internal rust inhibitor oil described in Table 2 (see Recommended Lubricant Chart, Section 6.0), into the suction and discharge ports of fluid end, and then install pipe plugs in openings. Drain the power end (crankcase) oil and remove the oil fill cap (or plug). Pour ½ to 1 cup of internal rust inhibitor oil described in Table 2, into the oil fill hole and then install the filler cap.

Coat all exposed, unpainted metal surfaces (for example, Driveshaft) with preservative oil. Replace the oil fill cap, 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, drain any fluid from the pump fluid end, flush the fluid end with water to clean out any of the remaining pumpage, and blow dry using compressed air. Pour 1/4 to 1/2 cup of internal rust inhibitor oil described in Table 2, into the suction and discharge ports of fluid end, and then install pipe plugs in openings.

Drain the 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 ½ to 1 cup of internal rust inhibitor described in Table 2.

Spray a rust preventative onto all exterior machined surfaces paying attention to any unpainted areas like the crankshaft extension. Remove the lube vent and cap the opening with a plug or other suitable means in order to keep the preservative atmosphere sealed inside the power end.

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. Every two months inspect the unit. Rotate the crankshaft by hand at least 4 turns during each inspection. Drain and replace the rust inhibitor after every six (6) months of storage.

3.4 Returning a Stored Pump to Operation

Before operating a pump that has been prepared for storage, drain the preservative and lubricating oil mixture from the power end (crankcase). Reinstall the rear cover, 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: FMC can factory prepare units for long term storage for a nominal fee if specified at the time of order.

3.5 Precautions during Freezing Weather

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. 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 equipment damage. Injury may result when starting equipment that has been damaged.

Whenever the pump is stored or 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 a few 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 plugs from the bottom of the fluid cylinder and lift up the suction valve seats 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. Remember that any fluid that poses an environmental hazard or is toxic must be handled and disposed of properly.

4.0 Installation Guidelines

A proper installation is essential to optimal performance, long service life, and reduced maintenance requirements. Take time to thoroughly plan all aspects of your installation.

4.1 General Location

It is important to position the pump on as flat and level a surface as possible to assist the splash oil lubrication system. Park mobile equipment, such as sewer cleaner trucks or drilling machines, on as level a surface as possible. 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 D04 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 crank shaft rotates toward 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 parallel to each other with a straight edge. **CAUTION:** Never operate the pump without the belt guard securely installed.

For direct-coupled or spline-driven units, insure that the shafts are centered and parallel when the driver is mounted to the pump. Follow the coupling manufacturer instructions for installation procedures and tolerances. **CAUTION:** Never operate the pump without a shaft guard securely installed.

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 additional planning and investment 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 the 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 oversizing of the suction line for proper

operation of the pump. A suction pulsation dampener is recommended to reduce the effects of acceleration head to help when suction conditions are not optimal. 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 must be configured so there are no high spots in the line where air pockets can collect. These pockets may 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 draining before 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 pipe couplings or 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 your authorized FMC reseller. FMC does not recommend using the pump in static lift conditions without prior factory 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.

Allowable Working Pressure For Steel Pipe (PSI @ 100F)					
Pipe	Pipe Schedule Number				
Size (inches)	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

14.5 psi = 1 Bar

Table 1: Pipe Pressure Chart

CAUTION: 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 equipment damage and possibly personal injury. 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 chart shown in Table 1.

2. **Always use a 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 and to conduct troubleshooting.

3. Insure that all piping is supported independently of the pump to reduce vibrations and strain on the pump. Pulsation dampeners on the discharge are recommended to reduce pressure pulsation and resulting vibration. 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 pipe couplings or hose connections between the pump and any rigid piping or the use of pulsation dampeners.

4. 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 discharge line must be as large as the pipe outlet of the relief valve. Never install valves in the relief valve discharge line or between the pump and relief valve. FMC recommends that the discharge be returned to the tank or drain, not back into the pump suction line.

5. It is recommended that a start-up bypass line and valve be installed to allow flow to bypass the relief valve. This allows the pump to start in an unloaded condition (no discharge pressure).

4.5 Multiple Pump Systems

Special consideration must be taken to avoid vibration, pulsation, or uneven flow distribution 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 installation in these situations.

5.0 How to Start a Pump

CAUTION: 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 checklist 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 plug(s) on the bottom of the pump crankcase have been installed and are tight. Insure that the oil level sight glass, if equipped, has been properly installed.

2. Check the oil level to insure that the pump is properly filled with non-detergent motor oil or a synthetic oil as described in Table 2 and that the oil has not been contaminated with water or other contaminants. NOTE: FMC pumps are shipped with no oil in the power frame and must be filled to the proper level with the proper grade of oil prior to start-up. The D04 requires 1 quart (.95 liters) of oil.

3. Check plunger and plunger rods to insure that they are free from abrasive particles or debris. Apply 10 to 20 drops of glycerin, or mineral oil on each plunger and plunger rod to lubricate the packing and seals.

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

5. Open the suction line valve to allow fluid to enter pump. Prime the fluid cylinder if necessary on the initial start up or after the system piping has been drained. The valve covers may have to be cracked open to assist with priming. **CAUTION: Do not loosen the valve covers with volatile or hazardous fluids.**

6. Check to insure that power is locked out and tagged out. Turn the pump over by hand if possible to insure free, unobstructed operation.

7. 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.

8. The pump is now ready to start. NOTICE: Whenever possible, use a bypass in the discharge line to allow the pump to start in the unloaded condition (no discharge and 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.

9. Take temperature readings of the power end and stuffing boxes. Do not exceed 170℉ (77℃) on power end.

6.0 Lubrication of Power End

6.1 Recommended Lubricants

Few factors can influence the life of a pump more than the power end lubricant (oil). Careful selection of the right type of oil for each particular application will help insure optimal performance from an FMC pump.

The intent of this section is to state the general lubrication requirements for FMC pumps. Several products are listed by manufacturer name in the table below in order to aid the customer in locating suitable lubricants. 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 in Table 2 below.

NOTE: Lubricant temperatures should not exceed 170°F (77°C) for continuous duty or 180°F (82°C) for intermittent duty applications. C rankcase temperatures that exceed these limits will cause the lubricant to prematurely "break down". The result will be poor lubrication and failure of power end components.

6.2 Oil Changes

- Oil changes must be carried out after first 50 hours of operation, and subsequently after every 4000 hours or at least every 6 months. These intervals may be modified depending on actual operating conditions.
- Oil should be changed when hot to prevent build up of sludge deposits.
- It is advisable to check oil level daily. If more than 10% of the total capacity has to be added, check for oil leaks.
- Do not mix oils of different types, even if produced by the same manufacturer.
- Never mix mineral and synthetic oils.
- To avoid the risk of scalding or burns, pay attention to oil and power end temperature during an oil change.
- Follow environmental guidelines when changing and disposing of lubricants.

RECOMMENDED LUBRICANT CHART - L06 THROUGH L12								
		Motor Oil Lubricant				Synthetic Lubricant *		
Type of Service	Ambient Temp	SAE Grade	ISO Viscosity (cSt@40 C)	SSU Viscosity	Manufacturer Brand Name	SAE Grade	ISO Viscosity (cSt@40 C)	Manufacturer Brand Name
General Service	0 F to 100 F (-18 C to 38 C)	30	100	550	Texaco® Meropa 100 Shell® Omala 100 Shell® Rotella T SAE 30 Exxon® XD-3 30 wt Mobil® Trans HD-30	5W-40 NA	90.0@40 15.0@100 99.1@40 13.9@100	Shell® Rotella T Synthetic SAE 5W-40 Mobil® SCH 627
High Ambient Temperature Service	100 F to 130 F (38 C to 54 C)	50	220	1165	Texaco® Meropa 68 Shell® Omala 220 Shell® Rotella T SAE 50 Exxon® HD-3 50 wt Mobil® Trans HD-50	5W-40 NA	90.0@40 15.0@100 217@40 29.9@100	Shell® Rotella T Synthetic SAE 5W-40 Mobil® SCH 630
Cold Ambient Temperature Service	0 F to -30 F (-18 C to -34 C)	20	68	350	Texaco® Meropa 68 Shell® Omala 68 Shell® Rotella T SAE 20 Exxon® HD-3 20 wt Mobil® Trans HD-20	5W-40 10W-30 NA	90.0@40 15.0@100 12.0@100 69.9@40 10.9@100	Shell® Rotella T Synthetic SAE 5W-40 BP® Vanellus E8 ULTRA 5W-30 Mobil® SCH 626
Frequent Start-Stop Operation		40	150	775	Texaco Meropa® 150			
SPECIALTY ITEMS								
Internal Rust Inhibitor					Cortec® VCI 329			
External Rust Preventative					Texaco® Metal Protective Oil L			

*Synthetic lubricants are suggested for high or low temperature service.

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Table 2: Lubricant Recommendations

7.0 Inspection and 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 maintenance chart in Table 3 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 the magnetic drain plugs are cleaned to remove 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.
	Packing	Inspect	Check the stuffing box area of the pump for signs of leakage. Replace packing if leakage becomes excessive.
	Pump System	Flush	Required for shutdown when pumping fluids that may harden or corrode the pump if left inside once stopped.
	Crankcase Oil	Inspect	Insure that the oil is at proper level and has not been contaminated by pumpage or condensation.
6 Months/ 4,000 hours	Crankcase Oil	Change	Drain and refill with new oil. Clean magnetic drain plugs.
	Fluid Cylinder Nuts	Inspect	Check the fluid cylinder nuts with a torque wrench to insure they are within specification.
	Connecting Rod Bolts	Inspect	Check the connecting rod bolts with a torque wrench to insure they are within specification. This should be done in conjunction with oil change.

Table 3: Maintenance Chart

8.0 Estimated Life of Wearing Components

The information given here is an estimate of the average wear life of listed components in clean liquid service. It is not a guarantee of life for any given application, but is intended to facilitate maintenance schedules and stocking of spares. The maintenance of the power end lubrication system will influence the life of the power end components. The speed of operation and percent of maximum allowable load will influence the life of both power end and fluid end parts. The temperature, abrasiveness, and lubricity of the liquid affect the life of fluid end expendables.

POWER END COMPONENT	ESTIMATED LIFE (Hours)
End Bearings (Ball)	40,000
Wrist Pin Bushings	20,000
Power End Cover Gasket	10,000
Connecting Rod Bearings	10,000
Oil Seal on Crankshaft	10,000
Oil Seal on Plunger (Pony) Rod	5,000

FLUID END COMPONENT	ESTIMATED LIFE (Hours)
Fluid Cylinder	16,000
Plungers	8,000
Valve Assembly	8,000
O-Ring Seals	10,000
Packing	4,000
Packing Adapter Rings	8,000

9.0 Component Parts List

A typical pump configuration is shown below for general reference purposes. This will aid in identifying components for service procedures outlined in the following sections. Each pump may have a slightly different appearance.

To order service parts or see exact component configurations for your particular pump, refer to the cross-section parts drawing in the literature kit supplied with the pump. Contact your local FMC pump distributor or FMC if you do not have this information.

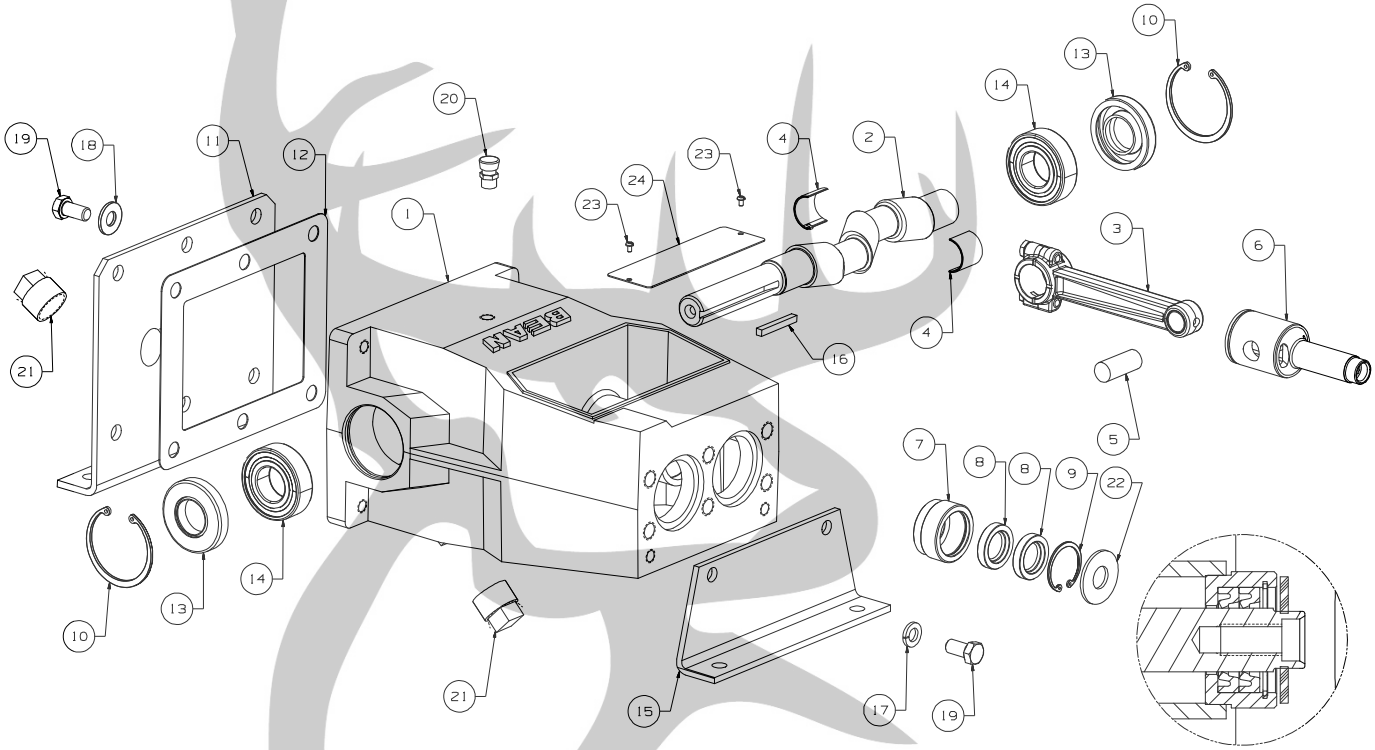


Figure 2: Power End Components

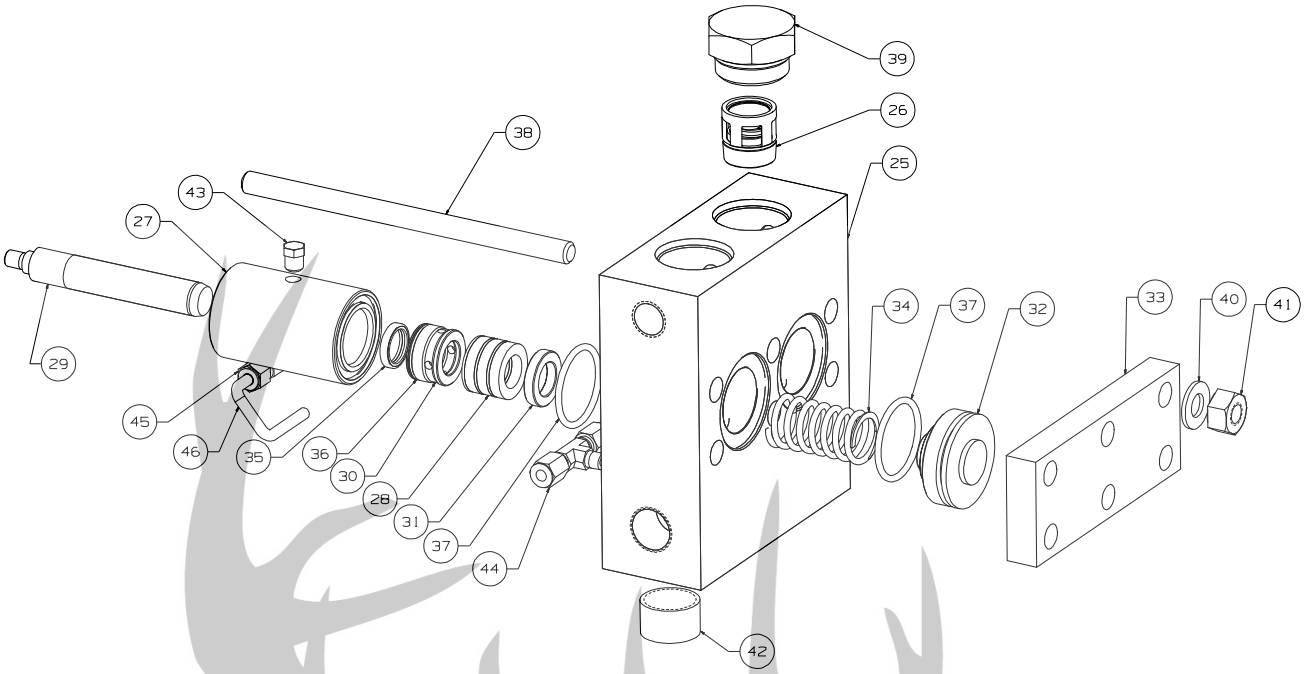


Figure 3: Fluid End Components

The service procedures outlined in this manual are intended to describe the more popular type of pump. Other configurations and minor design differences may exist with alternate pumps. Some procedures many require slight adaptations as a result.

Item No.	Component Description	Quantity
1	Power Frame	1
2	Crankshaft	1
3	Connecting Rod Assembly	2
4	Rod Bearing (half shell)	4
5	Wrist Pin	2
6	Crosshead / Plunger Rod	2
7	Seal Holder	2
8	Oil Seal, Plunger Rod	4
9	Retaining Ring	2
10	Bearing Retaining Ring	2
11	Rear Foot (Back Cover)	1
12	Gasket, Back Cover	1
13	Oil Seal, Rotating	2
14	Ball Bearing	2
15	Front Foot	1
16	Key	1
17	Lock Washer	2
18	Washer, Belleville	6
19	Cap Screw, Back Cover	8
20	Lube Vent	1
21	Pipe Plug, Power End	2
22	Deflector Shield	2
23	Tapping Screw	2
24	Nameplate	1
25	Fluid Cylinder (Chamber)	1
26	Valve Assembly	4
27	Stuffing Box	2
28	Packing	2
29	Plunger	2
30	Seal Carrier	2
31	Throat Bushing	2
32	Cylinder Cover	2
33	Cylinder Cover Clamp	1
34	Packing Spring	2
35	T-Seal	2
36	O-Ring, Packing	2
37	O-Ring Valve Chamber	4
38	Stud, Fluid Chamber	6
39	Valve (Discharge) Cover	2
40	Flat Washer	6
41	Hex Nut	6
42	Pipe Plug, Drain	2
43	Plug, Stuffing Box	2
44	Tee, Leak Return	1
45	Elbow, Leak Return	2
46	Tubing, Leak Return	-

10.0 Service Procedures

FMC pumps are designed to simplify all required maintenance. The following sections illustrate step-by-step instructions for performing most common service procedures of a pump. Read each section before starting service work on the pump.

Refer to Figures 2 and 3 for location of components.

It is recommended that a sufficient quantity of clean water be pumped through the fluid end before starting any service procedures that involve fluid end components. This will remove a significant portion of contaminants left in the fluid cylinder by the normal pumpage and improve the ability to work with parts or see potential problems.

WARNING: Many accidents occur every year through careless use or service of mechanical equipment. You can avoid hazards associated with high-pressure equipment by always following the safety precautions listed in Section 1.0.

10.1 Removing Fluid Cylinder / Replacing Packing, Plungers and Plunger Rod Seals

1. Bleed off all pressure inside pump fluid end before starting any service work. Shut the valve on the inlet piping, if provided, to prevent flow of liquid from the source into the pump during service. **CAUTION: CHECK TO INSURE THAT THE POWER IS LOCKED OUT AND TAGGED OUT (MOTOR OR ENGINE CANNOT BE STARTED).**

2. If equipped, remove leak return tubing (46) from under stuffing boxes (27).

3. Remove six fluid cylinder/clamp nuts (41), cylinder cover clamp (33), two cylinder covers (32) and two cylinder cover o-rings (37).

4. Slide out two packing springs (34) from the fluid cylinder (25). Then, rock the fluid cylinder to loosen from the stuffing boxes and carefully lift fluid cylinder off the fluid cylinder studs (38).

5. Now the stuffing boxes (27) can be slid off the plungers and taken to a work bench or other suitably clean area for repacking.

6. Remove packing (28) and junk rings by tapping out with a brass bar or by bumping the stuffing box on the table. Observe the type and orientation of packing components during removal. V-ring orientation, if V packing is installed, is critical to proper operation. The lips of the “V” must face the fluid cylinder (25). Braided packing requires that the cuts in the rope are staggered at least 120° apart at installation.

7. Clean the stuffing box bore (27), throat bushings (31) and seal carriers (30) with 60 grit emery cloth and solvent. Clean plungers (29) with steel wool or solvent and a soft cloth. Clean other parts such as springs as required with a wire brush.

8. If the plunger or plunger rod seals need to be replaced, first unscrew plunger from plunger rod (6). Be certain to use a wrench to support the plunger rod while loosening and tightening the plunger to avoid putting unnecessary stress on the connecting rod and bearings.

   a) Remove deflector shield (22), plunger rod seal retaining ring (9) and plunger rod seals (8).

   b) Install two new seals with sealing lips facing the inside of the power end and reinstall retaining ring. See Figure 2.

   c) Slip deflector shield back onto plunger rod.

   d) Make sure both end surfaces of plunger and plunger rod are clean and dry. Apply Loctite 290 to threads of plunger and screw into plunger rod.

9. Inspect all parts for damage or unusual wear. Insure that plungers (29) and stuffing boxes (27) are smooth and free of cracks, scores or grooves. New packing will fail prematurely if used with plungers that have damaged or rough surfaces (exceeding 16 Ra finish). Replace junk rings (30, 31) if they show signs of excessive wear. FMC strongly recommends that both packing sets be replaced, not just those that show signs of leakage, whenever this type of service is performed. This will maximize operational time between service intervals.

10. Install new packing in stuffing box paying special attention to reinstall in the same order they were removed.

11. Apply a light oil to the plungers and packing then slide stuffing box assembly back over plunger. Coat the base of the stuffing box with a grease-based or nickel-based anti-seize compound before seating in power frame to avoid rusting in place.

12. Reverse the previous steps to rebuild the pump after damaged components have been replaced. FMC suggests that all seals that are disturbed during a service procedure be replaced. This includes the valve chamber o-rings (37).

    TIP: Lightly grease o-rings (37) on stuffing box and cylinder covers to help insure o-rings stay in place during reassembly.

13. Tighten all fasteners to the values specified in Fastener Torque Requirements, Section 11.0 of this manual. When tightening fluid cylinder/clamp nuts (41), use crisscross tightening in three stages of torque. Begin at approximately 25% of the final torque value, then 50% and finish at full torque value. CAUTION: Insure the stuffing box and cylinder cover are properly piloted in the fluid cylinder.

10.2 Servicing Valves

10.2.1 Introduction

The disc type valve used in the D04 pump is shown in Figure 4. The standard construction of stainless steel seat, disc, and stop are a cost effective design with excellent performance and ample life. These valve assemblies come pre-assembled from the factory and should not need to be disassembled.

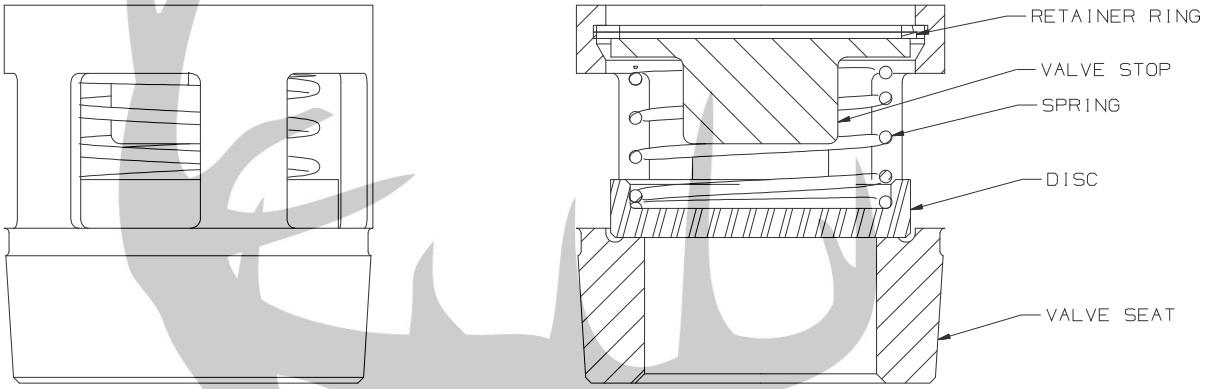


Figure 4: Disc Valve Assembly

When a worn or malfunctioning valve is detected, it must be replaced. With disc valves, the most difficult task associated with replacing a valve is the removal of the seat from the fluid cylinder. The seats are held into the fluid cylinder with a matching locking taper. Removal is particularly difficult if the discharge pressure of the pump was over 3,000 psi or corrosive fluid was pumped.

10.2.2 Valve Servicing Tools

The Ball Knock Out tool (P534695) is used in the removal and installation of valves.

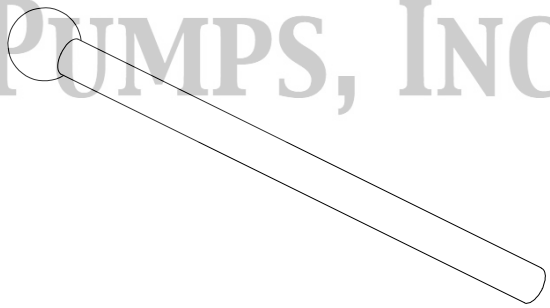


Figure 5: Ball Knock Out Tools

Valve Installation tool (P534696) is used in conjunction with the Ball Knock Out tool and placed on top of the valve during installation.

10.2.3 Removal of Disc Valves

1. Bleed off all pressure inside pump fluid end before starting any service work. Shut the valve on the inlet piping, if provided, to prevent flow of liquid from the source into the pump during service. **CAUTION: CHECK TO INSURE THAT THE POWER IS LOCKED OUT AND TAGGED OUT (MOTOR OR ENGINE CANNOT BE STARTED).**

2. If equipped, remove leak return tubing (46) from under stuffing boxes (27).

3. Remove the two suction plugs (42) and two valve covers (39) from the fluid cylinder (24).

4. Remove six fluid cylinder/clamp nuts (41), cylinder cover clamp (33), two cylinder covers (32) and two cylinder cover o-rings (37).

5. Slide out two packing springs (34) from the fluid cylinder (25). Then, rock the fluid cylinder to loosen from the stuffing boxes and carefully lift fluid cylinder off the fluid cylinder studs (38) and place upside down on a firm work surface.

6. The suction valve is removed first by placing the Ball Knock Out tool (P534695) through suction plug opening until it contacts the bottom of the valve seat.

7. Strike tool sharply with a hammer to loosen the valve. The suction valve can be removed through the cylinder cover opening.

8. Now the discharge valve can be removed in the same manner through the valve cover opening.

10.2.4 Installation of Disc Valves

The suction valves must be installed before the discharge valves can be installed. The following reassembly procedure is applicable for both.

1. Select a new valve assembly and check to insure the taper on the valve is clean and dry.

2. Carefully clean the taper in the fluid cylinder and on the valve seat with a cleaning solution and a clean cloth. Small scratches can be removed with steel wool or 100 grit emery paper. Remove all dirt, grease, oil, water, or any other contaminants from the surfaces. Do not oil the seats or the seating surfaces in the fluid cylinder. Confirm that they are dry before installation.

3. Position the valve assembly directly over the mating taper in the fluid cylinder.

4. Let the valve seat drop into the taper. Check to see that the seat is sitting in the taper properly and not cocked to one side. If the seat drops straight, it will seize on the taper. When correctly seated, it cannot be pulled up by hand.

5. Place installation tool (P534696) on the top surface of the valve assembly. Using the Ball Knock Out tool (P534695), strike with a hammer three times to seat the valve.

6. Repeat steps 1 through 5 for the discharge valve.

7. After the valves have been replaced, inspect o-ring for each valve cover (39) as well as valve chamber o-ring (37). FMC recommends that these o-rings be replaced if nicked or extruded.

   TIP: Lightly grease o-rings (37) on stuffing box and cylinder covers to help insure o-rings stay in place during reassembly.

8. Reverse the steps to rebuild the pump after damaged components have been replaced.

9. Tighten all fasteners to the values specified in Fastener Torque Requirements, Section 11.0 of this manual. When tightening fluid cylinder/clamp nuts (41), use crisscross tightening in three stages of torque. Begin at approximately 25% of the final torque value, then 50% and finish at full torque value. CAUTION: Insure the stuffing box and cylinder cover are properly piloted in the fluid cylinder.

10.3 Power End Maintenance

WARNING: Disconnect the driver from the pump and insure that suction and discharge lines are disconnected or blocked and have no pressure applied.

1. Remove bottom drain pipe plug (21) to allow all oil to drain from power frame (1).

2. Remove all rear cover cap screws (19) and washers (18). Remove the back cover/rear foot (11) and back cover gasket (12) from the power frame.

3. Remove the end cap of each connecting rod (3) by unscrewing the two cap srews that hold each cap to the connecting rod body. The cap can be removed from the body by tapping with a rubber mallet on the cap screws to remove them and then tapping on the end cap to loosen it. Take care to not damage the threads on the cap screws.

4. Slide the two rod bearing halves (4) from each connecting rod (3). Note that these parts sometimes adhere to the pins (journals) on the crankshaft (2).

5. NOTE: Connecting rods and caps are matched sets and must always be reassembled with their original mate and in the same orientation. Note the numbered codes stamped on each half of the connecting rod assemblies and

make certain they are installed as matched set and in the same orientation when re-assembling the pump.

6. Push the connecting rod (3) and crosshead assemblies (6) as far forward into the power frame as possible to provide clearance for the crankshaft.

7. Use snap ring pliers to remove the bearing retainer snap ring (10) from each side of the pump.

8. Using a hammer and wood block or rubber mallet, drive the crankshaft and bearings out either side of the power frame.

9. Remove bearings from crankshaft using a press. Be sure to provide suitable support for the back side of the bearings during this step.

10. If damaged, remove the crankshaft oil seal (13) using a screwdriver or similar object and discard the old seal.

11. If desired, pull the connecting rod/crosshead assemblies from the power frame. Mark each connecting rod and crosshead assembly to insure they are reassembled into the same bore from which they were removed. Note: Plungers must also be removed per instructions above to perform this step.

12. Slide the wrist pin (5) out of the crosshead (6) if crosshead or connecting rod (3) requires service. Keep components matched together.

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. The connecting rod bearings should be inspected for deep scratches or the top metal surface worn away.

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

15. Reassemble the crosshead assemblies and connecting rods.

16. Push the crosshead/connecting rod assemblies fully forward in power frame to provide maximum clearance for the crankshaft. Insure crosshead assemblies are replaced in the same orientation and in the same cylinder bore they were originally.

17. Install new bearings on crankshaft using a press.

18. Install crankshaft in the power frame. Take care not to scratch bearing surfaces of the crankshaft.

19. Place the oil seals (13) over the ends of the crankshaft with the lip of the seals facing the inside of the power frame.

20. Seat the snap rings (10) in the grooves of the power frame against the oil seals and tap the crankshaft to allow a SLIGHT endplay in the crankshaft.

21. Replace the rod bearings (4) in the connecting rod and connecting rod caps. Insure that rod caps are properly assembled with their mating connecting rod.

22. Torque the fasteners holding the end caps to the mating rod per the values given in Fastener Torque Requirements, Section 11.0 of this manual. Use back and forth pattern tightening with a torque wrench. After the cap screws are torqued, a light strike to the cap with a rubber hammer will help properly seat the rod bearings.

23. Turn the crankshaft at least two revolutions to insure the connecting rods are loose and that there is no binding in the rod bearings; the wrist pin joints are free; and the crossheads move freely in the power frame.

24. Complete reassembly of pump.

25. Torque all fasteners as outlined in Fastener Torque Requirements, Section 11.0 of this manual.

11.0 Fastener Torque Requirements

NOTICE: No pump service procedure is complete without insuring that the fasteners have been properly torqued. Failure to properly tighten the pump bolts could cause the pump to leak or possibly allow the pump to fail. Always use a calibrated torque wrench during the installation of all critical fasteners listed in Table 4 below. Values are in foot-pounds (Ft-lb) and Newton meters (N-m). Typical sizes are shown in Table 4 below.

Item No.	Component Description	Size	Ft-lb	N-m
3	Connecting Rod Bolts	1/4	7	10
19	Back Cover Bolts	3/8	25	34
41	Cylinder Attach/Clamp Nut (Xylan coated)	1/2	40	54
41	Cylinder Attach/Clamp Nut (plain steel or stainless steel)	1/2	60	81

Table 4: Fastener Torque Requirements

Refer to Figure 2 and Figure 3 for item numbers.

12.0 Critical Clearances

When maintenance requiring disassembly of the power end is performed, the following clearances should be checked to see if they are within factory specification or within maximum allowable limits. Additional clearance is allowed for component wear. This additional clearance is a maximum of .002 inches of total diametral wear that can be added to the clearance values in Table 5. For radial clearance, use ½ of the total diametral value.

All dimensions are shown in Inches.

DESCRIPTION	D04
CrankshaftThrow Diameter (Stroke)	1.00
Crankshaft Pin or Journal (OD)	.8715/.8725
Connecting Rod / Crank Clearance (Max. Total)	0.004
Crosshead Diameter (OD)	1.498/1.500
Crosshead Cylinder Bore (ID)	1.501/1.504
Crosshead to Bore Clearance (Max. Total)	0.006
Wrist Pin Bushing Bore (ID)	.560/.562
Wrist Pin to Bore Clearance (Max. Total)	0.0035

NOTE: Clearances shown are total diametral values: For radial clearance use ½ the value shown.

Table 5: Clearance Chart

Metric Conversion: 1 inch = 25.4 mm

1 mm = 0.03937 inches

13.0 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.

SYMPTOM	POSSIBLE CAUSE	REMEDY
No flow from pump	-No liquid in reservoir (tank) -Inlet line valve closed -Inlet strainer is totally clogged with debris -Crankshaft is not turning	-Insure lines are connected and fill tank -Insure lines are connected and open valve -Clean or replace strainer -Check for power to drive and drive connections
Insufficient pressure from pump (ONLY)	-Pump speed is too low -Relief valve improperly adjusted or worn -Insufficient system resistance (worn nozzle) -Worn pump valves -Excessive leakage from pump seals	-Check belt tightness or power to motor -Check relief valve and adjust setting -Properly service system -Inspect check valves and repair or replace -Adjust or replace packing or damaged parts
Insufficient flow from pump (ONLY)	-Pump speed is too low -Relief valve improperly adjusted or worn -Worn pump valves -Excessive leakage from pump packing -Plunger worn -Valve seat washed out in fluid cylinder	-Check belt tightness or power to motor -Check relief valve and adjust setting -Inspect pump valves and repair or replace -Adjust or replace packing or damaged parts -Replace plunger -Repair or replace fluid cylinder
Insufficient flow or pressure AND rough operation (pump pounds or vibrates)	-All pump cylinders not primed -By-pass or relief is piped back to suction -Inlet line too long or too small in diameter -Insufficient NPSHA -Air leaks in suction line or fittings -Vortex in tank near inlet pipe opening -Air entering booster pump -Pump valve stuck open or closed -Valve assembly damaged or unseated -Valve seat washed out in fluid cylinder -Gas pocket formation from high spots in suction -Air leaking through packing or stuffing box o-ring	-Prime all chambers -Pipe back to reservoir (tank) -Increase suction pipe size -Provide more NPSH -Correct installation to stop leaks -Increase submergence or baffle to stop vortex -Correct installation of booster pump -Clean and deburr valve -Properly seat or repair valve -Repair or replace fluid cylinder -Correct suction line installation -Replace worm or failed packing or o-ring

Pump runs rough, knocks, or vibrates (ONLY)	-Broken or weak valve spring -Valve damaged or unseated -Loose plunger, piston, or rod -Low oil level in power end -Excessive connecting rod bearing clearance -Worn wrist pin or bearing -Pump running backward -Loose sheaves or bushings (v-belt drive) -Insufficient NPSHA -Excessive acceleration head in suction line -Pulsation dampener improperly charged -Inlet line too long or too small in diameter	-Replace valve spring -Repair/replace valve or re-seat -Tighten loose components -Fill to proper level -Check cap torque or replace bearings -Replace worn components -Correct rotation -Tighten loose components -Provide more NPSH -Install suction stabilizer -Charge to proper pressure -Increase suction pipe size
Rapid suction pressure fluctuation	-Pump cavitation -Air is entering suction line	-Increase suction size or NPSH -Correct installation to stop leaks
Piping vibration	-Same as Pump runs rough above -Excessive pressure variation in discharge -Piping inadequately supported -Excessive short-radius elbows or tees	-See above -Install discharge pulsation dampener -Install supports at proper locations -Correct installation to minimize turns and short-radius fittings
Pump requires excessive power	-Discharge pressure too high -Plungers or pistons too large -Speed too high -Misaligned coupling -Belts too tight -Power end bearings too tight -Low motor voltage	-Reduce system back-pressure or relief valve -Install smaller plungers to reduce flow -Reduce speed -Correct alignment -Correctly adjust belt tension -Increase end-play -Supply correct voltage
Power end overheats (over 180°F) and/or reduced power component end life	-Discharge and/or suction pressure too high -Oil level too high or too low -Contaminated power end oil -Incorrect oil viscosity or grade -Misaligned coupling -Belts too tight -Pump running backward -Pump located too close to heat source -Worn or damaged power end bearings	-Reduce pressure or reduce plunger size -Adjust to correct oil level -Refill with clean oil & eliminate contamination -Fill with correct oil -Correct alignment -Correctly adjust belt tension -Correct rotation -Remove heat source or insulate power end -Replace damaged bearings
Crankshaft jerks or starts and stops rotation	-Drive belts loose and slipping (if equipped) -System relief valve pressure set too high -Discharge line blocked or partially blocked	-Correctly adjust belt tension -Reduce relief valve pressure setting -Clear obstructions from piping system
Fluid leaking from pump	-Packing is worn -Fluid cylinder bolts not properly tightened -Fluid cylinder o-rings (or gaskets) damaged	-Replace packing -Properly tighten and torque bolts -Replace damaged o-rings or gaskets

Reduced packing life	-Highly abrasive particles in fluid -Incorrect packing for fluid type -Inadequate packing lubrication -Pump was run dry for extended time -Plunger misaligned to stuffing box -Worn plunger -Too much packing in box -Broken or weak spring	-Install strainer or filter -Change to correct packing -Correct problem and replace packing -Correct problem and replace packing -Correct alignment -Replace plunger -Correct installation problem -Replace spring
Reduced valve life	-Highly abrasive particles in fluid -Cavitation damage -Air leaking into suction line or stuffing box -Suction inlet insufficiently submerged -Relief valve or bypass piped to suction -Valve damaged by improper installation	-Install strainer or filter -Correct problem and replace damaged valves -Correct problem and replace damaged valves -Increase submergence or baffle to stop vortex -Pipe back to reservoir (tank) -Replace damaged components
Cracked fluid cylinder or broken fluid end bolts	-Discharge pressure too high -Hydraulic shock (cavitation or entrained air) -Discharge valve stuck closed -Fluid freezing in fluid cylinder -Material or manufacturing defect -Bolt or nut not properly torqued -excessive piping loads on fluid end	-Reduce system back pressure or relief valve -Correct piping system problem -Replace damaged components -Change procedure to drain fluid when cold -Replace defective component -Replace fluid cylinder and properly torque -Add supports to piping
Broken crankshaft or connecting rod	-Discharge pressure too high -Suction pressure too high -Fluid freezing in fluid end -Hydraulic shock due to cavitation -Material or manufacturing defect	-Reduce system back pressure or relief valve -Reduce suction pressure or plunger diameter -Change procedure to drain fluid when cold -Correct piping system problems -Replace defective components
Power end oil is contaminated	-Extended operation with failed packing -Hi-press wash wand near breather or seals -Deflector shields are missing or damaged -Crosshead extension seals damaged	-Replace packing and improve monitoring -Provide shields to protect breather and seals -Repair or replace deflector shields -Replace oil seals

14.0 Ordering Parts

Service parts are available through FMC's worldwide network of distributors or from the original supplier for the equipment that the pump is a component of. 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 with 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 name tag 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.

15.0 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 unit of pump capacity is U.S. gallons per minute (GPM) and metric cubic meters per hour (m3/hr).
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 damage to components when they collapse.
DAMPENER	A device that reduces pressure pulsations in the suction or discharge piping. This 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 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.
MECHANICAL EFFICIENCY	Mechanical efficiency (ME) is the ratio, expressed as a percentage, of pump power output to the pump power input. The mechanical efficiency of reciprocating pumps is very high, typically 85% to 90%.
VOLUMETRIC EFFICIENCY	Volumetric efficiency (VE) is the ratio of actual pump capacity output to theoretical displacement. The volumetric efficiency is affected by the fluid being pumped and the discharge pressure.

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. This may also be called the Liquid End. It is called a valve chamber in old literature.
NPSHa	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 of water.
NPSHr	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 NPSH test. NPSHa should exceed NPSHr by at least 5 feet.
PISTON	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.
PLUNGER	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.
POWER PUMP	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.
POWER FRAME	The major portion of a power pump that encloses and supports all other components of the power (or drive) end. It is called a pump case in old literature.

STROKE LENGTH	The length of one complete, unidirectional motion of the piston or plunger. Stroke length is usually expressed in inches.
PUMP VALVE	A check valve that allows flow of liquid in one direction. FMC pumps have a series of two valves, one suction (inlet) and one discharge, per pumping cylinder.

16.0 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:

17.0 MAINTENANCE LOG

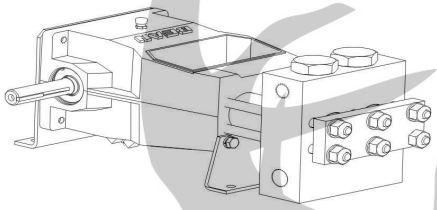
DATE	SERVICED BY	SERVICE PERFORMED	REMARKS

Innovative Technologies, Creative Solutions

FMC EnergySystems
FMC Fluid Control

Model D04

2.7 BHP Continuous Duty Rated (3.2 BHP Intermittent)



Standard Fluid End Materials Available:

Carbon Steel
Other alloys per request

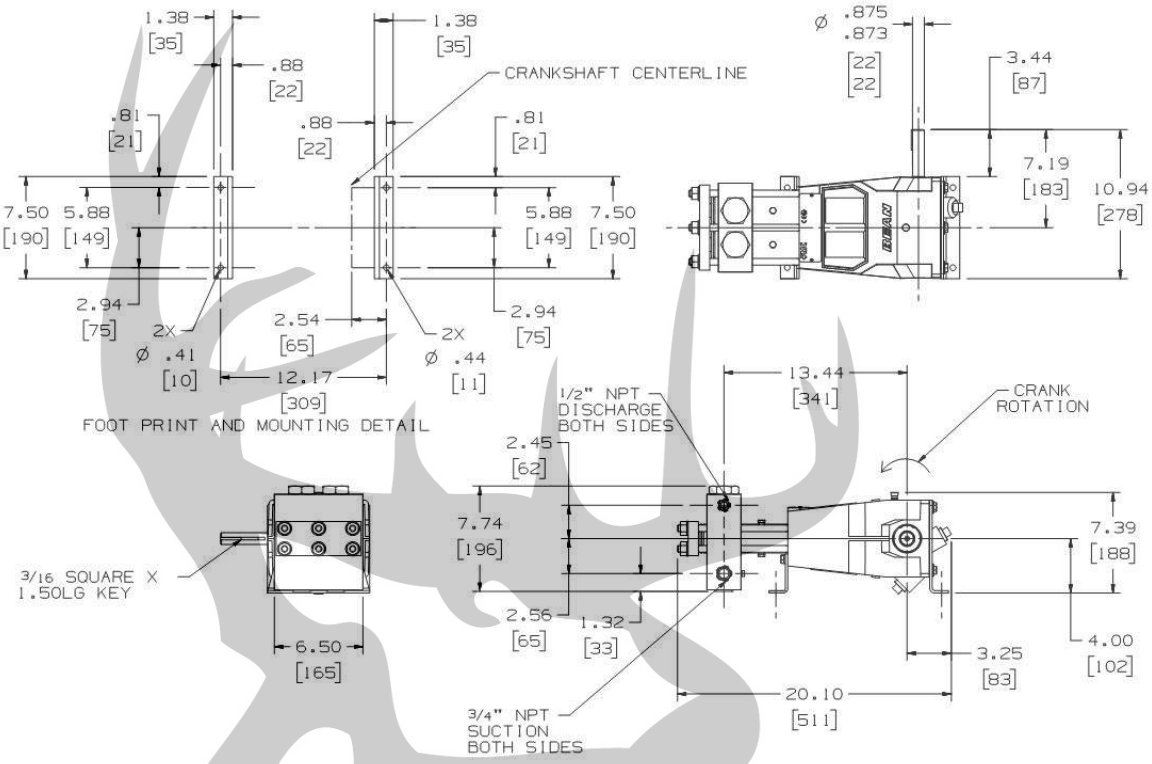
Specifications

Pump Model.....D04
Configuration.....Horizontal Duplex Plunger
Stroke Length.....1.0 Inches
Frame Load Rating.....950 lbs
Pump Weight.....75 lbs
Intermittent Duty Speed Rating.....600 RPM
Continuous Duty Speed Rating.....500 RPM
Minimum Speed.....100 RPM
Mechanical Efficiency.....90%
Lubrication System .....Splash, Gravity Return
Oil Capacity.....1.0 Quart
Maximum Fluid Temperature.....250°F
Minimum Fluid Temperature..... –20°F

Pump Model	Plunger Diameter (IN)	Displacement (GAL/REV)	Maximum Pressure (PSI)	Pump Capacity (GPM) @ Input Speed (RPM) 100 RPM	250 RPM	400 RPM	500 RPM	*600 RPM*
D0404	.500	.0017	2,150	.17	.42	.68	.85	*1.02*
D0406	.750	.0038	2,150	.38	.96	1.53	1.91	*2.29*
D0408	1.000	.0068	1,210	.68	1.70	2.72	3.40	*4.08*

Innovative Technologies, Creative Solutions

FMC EnergySystems
FMC Fluid Control



Notes

1. Consult FMC for any application where inlet pressures will exceed 10% of rated discharge pressure.
2. Horsepower based on 90% mechanical efficiency. Actual application horsepower requirements can be calculated using the equation:
   BHP = (GPM X PSI) ÷ 1543
3. Pump capacities shown are based on 100% volumetric efficiency.
4. Dimensions shown are for general sizing purposes and should not be used for construction.
5. FMC reserves the right to modify this information without prior notice.

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