

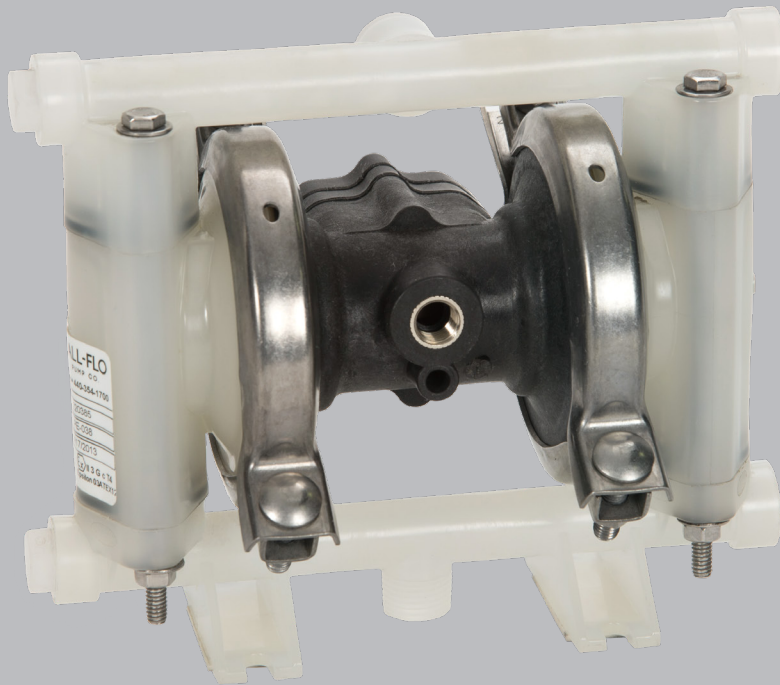
IOM

INSTALLATION OPERATION
& MAINTENANCE

C038

PLASTIC 3/8 INCH

AIR-OPERATED DOUBLE-DIAPHRAGM PUMP



CE


PSG
a DOVER company

 ALL-FLO

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CAUTIONS — READ FIRST!

READ THESE WARNINGS AND SAFETY PRECAUTIONS PRIOR TO INSTALLATION OR OPERATION. FAILURE TO COMPLY WITH THESE INSTRUCTIONS COULD RESULT IN PERSONAL INJURY AND OR PROPERTY DAMAGE. RETAIN THESE INSTRUCTIONS FOR FUTURE REFERENCE.

CAUTION Always wear safety glasses when operating a pump to avoid eye injury. If diaphragm rupture occurs, material being pumped may be forced out of the air exhaust.

CAUTION Do not connect a compressed air source to the exhaust port of the pump.

CAUTION Do not lubricate air supply.

CAUTION Do not exceed 120 psig (8.3 bar) air-inlet pressure.

CAUTION Do not exceed 10 psig (0.7 bar) or 23 ft-H₂O suction pressure.

CAUTION The temperature of the process fluid and air input must be no more than the maximum temperature allowed for the appropriate non-metallic material. See the list of temperatures below for each material's maximum recommended temperature:

Buna-N (Nitrile):	10°F to 180°F (-12°C to 82°C)
Geolast®:	10°F to 180°F (-12°C to 82°C)
EPDM:	-40°F to 280°F (-40°C to 138°C)
FKM:	-40°F to 350°F (-40°C to 177°C)
Hytrel®:	-20°F to 220°F (-29°C to 104°C)
Nylon:	0°F to 200°F (-18°C to 93°C)
PTFE:	40°F to 220°F (4°C to 104°C)
Polyethylene:	32°F to 158°F (0°C to 70°C)
Polypropylene:	32°F to 180°F (0°C to 82°C)
Polyurethane:	10°F to 150°F (-12°C to 66°C)
PVDF:	0°F to 250°F (-18°C to 121°C)
Santoprene®:	-40°F to 225°F (-40°C to 107°C)
Urethane:	-65°F to 220°F (-54°C to 104°C)

Temperature limits are solely based upon mechanical stress and certain chemicals will reduce the maximum operating temperature. The allowable temperature range for the process fluid is determined by the materials in contact with the fluid being pumped. Consult a chemical resistance guide for chemical compatibility and a more precise safe temperature limit. Always use minimum air pressure when pumping at elevated temperatures.

CAUTION It is the end user's responsibility to maintain the process fluid's temperature during use.

CAUTION Ensure all wetted components are chemically compatible with the process fluid and the cleaning fluid.

WARNING = Hazards or unsafe practices which could result in severe personal injury, death or substantial property damage

CAUTION = Hazards or unsafe practices which could result in minor personal injury, product or property damage.

WARNING Prior to servicing the pump, ensure that the air and fluid lines are closed and disconnected. While wearing personal protective equipment, flush, drain and process liquid from the pump in a safe manner.

WARNING Maintenance must not be performed when a hazardous atmosphere is present.

CAUTION The equipment must be inspected for visible damage prior to use.

CAUTION Ensure pump is thoroughly cleaned and flushed prior to installation into a process line.

CAUTION Blow out all compressed air lines in order to remove any debris, prior to pump installation. Ensure that the muffler is properly installed prior to pump operation.

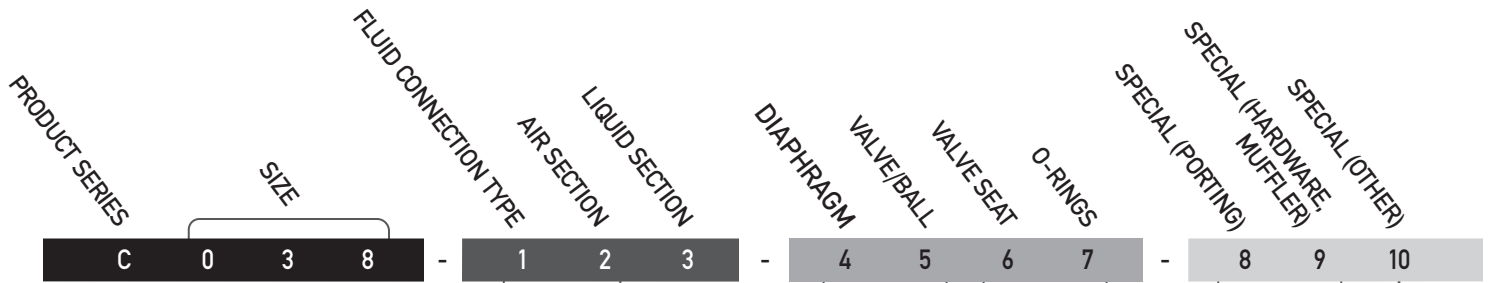
CAUTION Ensure air exhaust is piped to atmosphere prior to a submerged installation.

CAUTION Ensure all hardware is set to correct torque values prior to operation.

WARNING Pump, valves and all containers must be properly grounded prior to handling flammable fluids and/or whenever static electricity is a hazard.

WARNING This product can expose you to chemicals including Nickel, Chromium, Cadmium, or Cobalt, which are known to the State of California to cause cancer and/or birth defects or other reproductive harm. For more information, go to www.P65Warnings.ca.gov.

MODEL DESIGNATION MATRIX-CLAMPED PLASTIC



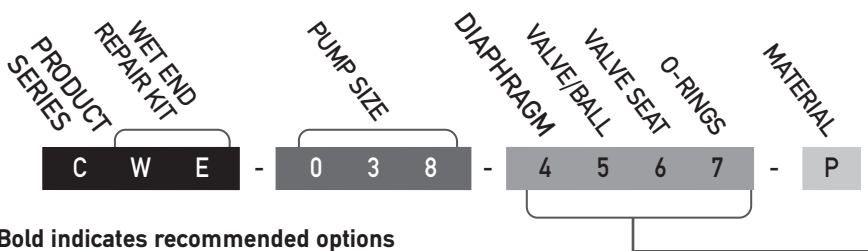
- 1 FLUID CONNECTION TYPE**
 S = NPS (NPT/BSP)
 2 = Dual Suction / Dual Discharge NPT & BSP Compatible
 4 = Dual Suction / Single Discharge NPT & BSP Compatible
 6 = Single Suction / Dual Discharge NPT & BSP Compatible
- 2 AIR SECTION**
 Q = Polypropylene Intermediate-Mechanical Shift
- 3 LIQUID SECTION**
 K = PVDF
 P = Polypropylene
 Y = Conductive Nylon
- 4 DIAPHRAGMS**
 G = Geolast®
 S = Santoprene®
 T = PTFE
- 5 VALVE/BALL**
 G = Geolast®
 S = Santoprene®
 T = PTFE
 V = FKM
 3 = Stainless Steel

- 6 VALVE SEAT**
 K = PVDF
 P = Polypropylene
 3 = Stainless Steel
- 7 O-RINGS**
 E = EPDM
 N = Buna-N
 T = PTFE
 V = FKM
- 8 PORTING**
 S = Default (Suction Right/ Discharge Right)
 T = Suction Right / Discharge Left
 X = Suction Left / Discharge Right
 Y = Suction Left / Discharge Left
 K = Suction Bottom / Discharge Center Front
 L = Suction Bottom / Discharge Center Rear
 N = Suction Bottom / Discharge Right
 O = Suction Bottom / Discharge Left
 P = Suction Right / Discharge Center Front
 Q = Suction Right / Discharge Center Rear
 U = Suction Left / Discharge Center Front
 V = Suction Left / Discharge Center Rear
 4 = All Ports Open (Standard ports will be left un-plugged)
 6 = Dual Suction End Ports / Dual Discharge End Ports
 7 = All Ports on Pump Open - No Plugs Included

- 9 SPECIAL OPTION (HARDWARE, MUFFLER, LUG)**
 7 = Stainless Steel Hardware, Standard Muffler
 8 = Stainless Steel Hardware, Premium Muffler
 B = PTFE Coated Stainless Steel Hardware, Standard Muffler
 C = PTFE Coated Stainless Steel Hardware, Premium Muffler
 F = Stainless Steel Hardware, Standard Muffler, Grounding Lug Installed
 G = Stainless Steel Hardware, Premium Muffler, Grounding Lug Installed
 H = PTFE Coated Stainless Steel Hardware, Standard Muffler, Grounding Lug Installed
 I = PTFE Coated Stainless Steel Hardware, Premium Muffler, Grounding Lug Installed
 Note: Equipment must be grounded to achieve ATEX rating it is recommended to configure the pump with a grounding lug option for ATEX applications.
- 10 SPECIAL OPTION (OTHER)**
 0 = Standard
 1 = Cycle Counter Valve
 2 = Solenoid Adaptor Valve 110/50 Volt AC, 120/60 Volt AC, DIN 43650B Connector
 3 = Solenoid Adaptor Valve 110/50 Volt AC, 120/60 Volt AC Explosion Proof
 4 = Solenoid Adaptor Valve 220/50 Volt AC, 240/60 Volt AC, 12 Volt DC, DIN 43650B Connector
 5 = Solenoid Adaptor Valve 220/50 Volt AC, 240/60 Volt AC, 12 Volt DC Explosion Proof
 6 = Solenoid Adaptor Valve 220/50 Volt AC, 240/60 Volt AC, 125 Volt DC, DIN 43650B Connector
 7 = Solenoid Adaptor Valve 220/50 Volt AC, 240/60 Volt AC, 125 Volt DC Explosion Proof
 8 = Solenoid Adaptor Valve 24 Volt DC, DIN 43650B Connector
 9 = Solenoid Adaptor Valve 24 Volt DC, Explosion Proof
 A = Grease Free (No lubrication assembly)

WET END REPAIR KIT

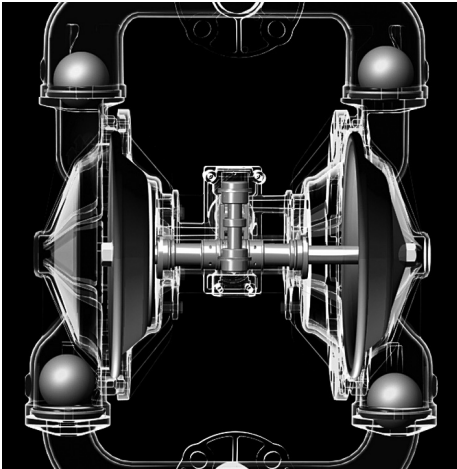
Wet end kits are available and consist of diaphragms, (back-up diaphragms if required), balls, seats and seat O-Rings. See matrix below.



Bold indicates recommended options

PRINCIPLES OF OPERATION

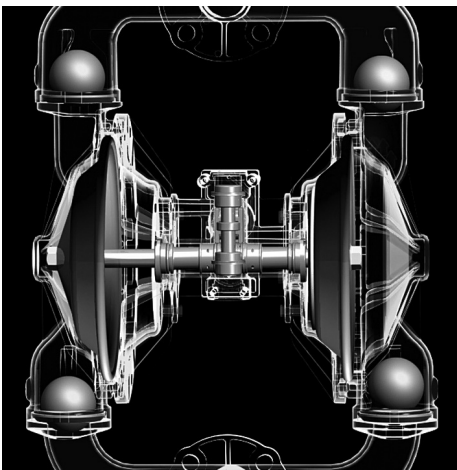
HOW AN AIR OPERATED DOUBLE DIAPHRAGM PUMP WORKS



The air-valve directs pressurized air behind the diaphragm on the right, causing the diaphragm on the right to move outward (to the right).

Since both the right diaphragm and the left diaphragm are connected via a diaphragm rod, when the right diaphragm moves to the right, the left diaphragm (through the action of the diaphragm rod) moves to the right also.

When the diaphragm on the left side is moving to the right, it is referred to as suction stroke. When the left diaphragm is in its suction stroke, the left suction ball moves upward (opens) and the left discharge ball moves downward (closes). This action creates suction and draws liquid into the left side chamber.



The air-valve directs pressurized air behind the left diaphragm, causing the left diaphragm to move outward (to the left).

Since both the left diaphragm and the right diaphragm are connected via a diaphragm rod, when the left diaphragm moves to the left, the right diaphragm (through the action of the diaphragm rod) moves to the left also.

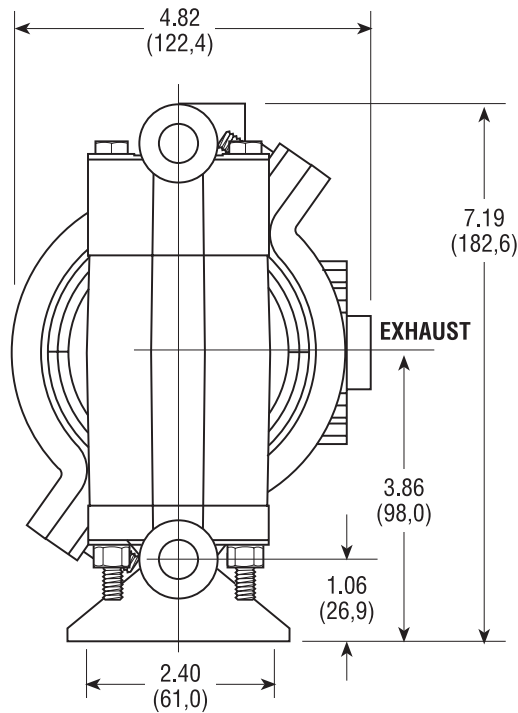
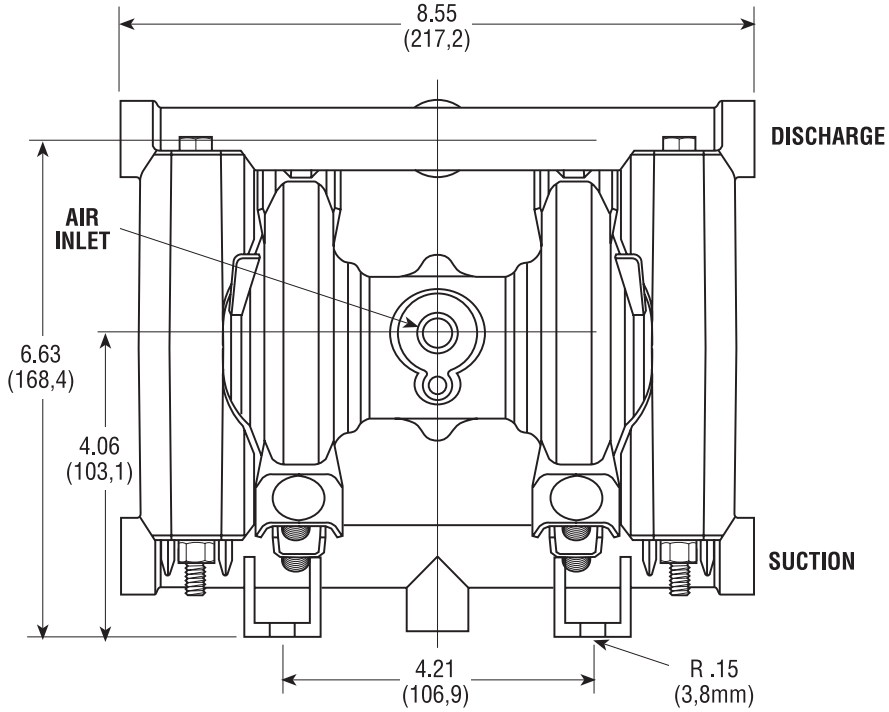
When the diaphragm on the left side moves outward, the left discharge ball moves upward (opens) and the left suction ball moves downward (closes). This causes the liquid to leave the left side liquid outlet of the pump.

Simultaneously, the right diaphragm moves inward (to the left), which causes the right suction ball to open and the right discharge to close, which in turn causes suction, drawing liquid into the right chamber.

The process of alternating right suction / left discharge (and vice-versa) continues as long as compressed air is supplied to the pump.

3/8" PUMP DIMENSIONS

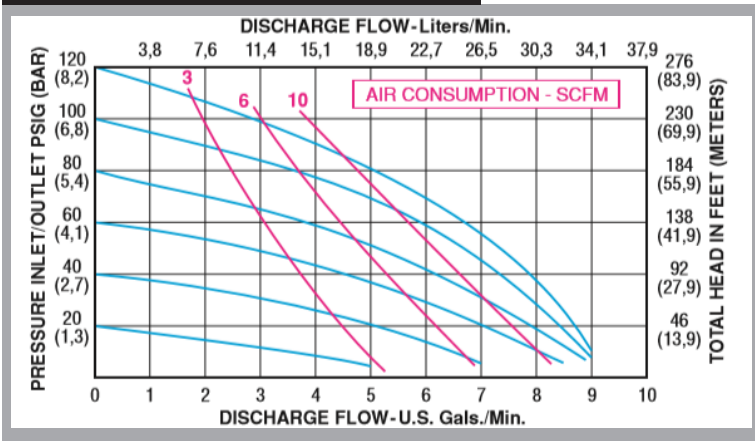
CLAMPED PLASTIC



NOTE: AIR INLET IS ON THE SIDE WITH STAINLESS STEEL INSERT. THE AIR VALVE ASSEMBLY IS ON THE OPPOSITE SIDE OF THE PUMP.

PERFORMANCE CURVES

PERFORMANCE CURVE



Performance Specifications

Max. Flow:	9 gpm (34.0 lpm)
Max. Air Pressure:	120 psi (8.2 bar)
Max. Solids:	1/16" (1.6 mm)
Max. Suction Lift Dry:	10 ft-H ₂ O (3.0 m-H ₂ O)
Max. Suction Lift Wet:	26 ft-H ₂ O (7.9 m-H ₂ O)
Weight Polypropylene & Conductive Nylon:	3.8 lbs (1.7 kg)
Weight PVDF:	5 lbs (2.3 kg)
Air Inlet:	1/4" FNPT
Liquid Inlet FNPT/FBSPT:	3/8"
Liquid Outlet FNPT/FBSPT:	3/8"
Height:	7.19" (182.6 mm)
Width:	8.55" (217.2 mm)
Depth:	4.82" (122.4 mm)

*Flow rates indicated on the chart(s) shown were determined by pumping water at flooded suction. For optimum life and performance, pumps should be specified so that daily operation parameters will fall in the center of the pump performance curve.

INSTALLATION, TROUBLESHOOTING AND MAINTENANCE

INSTALLATION PIPING

Whenever possible ensure the pump is installed using the shortest possible pipe lengths with the minimum amount of pipe fittings. Ensure all piping is supported independent of the pump.

Suction and discharge piping should not be smaller than the connection size of the pump. When pumping liquids of high viscosity, larger piping may be used, in order to reduce frictional pipe loss.

Employ flexible hoses in order to eliminate the vibration caused by the pump. Mounting feet can also be used to reduce vibration effects.

All hoses should be reinforced, non-collapsible and be capable of high vacuum service. Ensure that all piping and hoses are chemically compatible with the process and cleaning fluid.

For processes where pulsation effects should be reduced, employ a pulsation dampener on the discharge side of the pump.

For self-priming applications, ensure all connections are airtight and the application is within the pumps dry-lift capability. Refer to product specifications for further details.

For flooded suction applications, install a gate valve on the suction piping in order to facilitate service.

For unattended flooded suction operation, it is recommended to pipe the exhaust air above the liquid source. In the event of a diaphragm failure this will reduce or eliminate the possibility of liquid discharging through the exhaust onto the ground.

LOCATION

Ensure that the pump is installed in an accessible location, in order to facilitate future service and maintenance.

AIR

Ensure that the air supply is sufficient for the volume of air required by the pump. Refer to product specifications for further details. For reliable operation, install a 5 micron air filter, air-valve and pressure regulator. Do not exceed the pumps maximum operating pressure of 120 psig.

REMOTE OPERATION

Utilize a three way solenoid valve for remote operation. This ensures that air between the solenoid and the pump is allowed to “bleed off,” ensuring reliable operation. Liquid transfer volume is estimated by multiplying displacement per stroke times the number of strokes per minute

NOISE

Correct installation of the muffler reduces sound levels. Refer to product specifications for further details.

SUBMERGED OPERATION

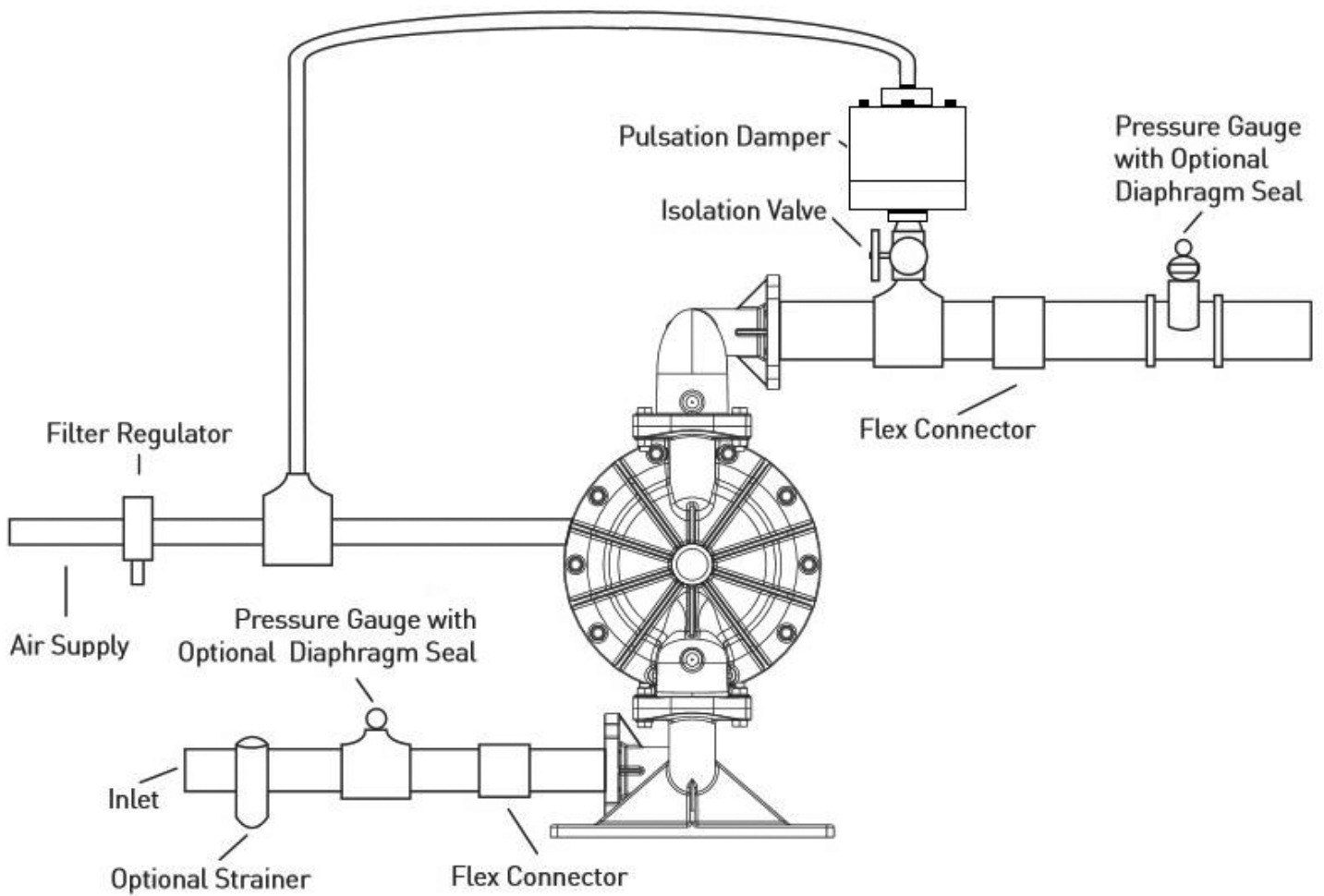
For submersible operation, pipe the air exhaust to atmosphere

GROUNDING THE PUMP

Loosen grounding screw and install a grounding wire. Tighten grounding screw. Wire size should be a 12 gauge wire or larger. Connect the other end of the wire to a true earth ground. Equipment must be grounded to achieve ATEX rating and it is recommended to configure the pump with a grounding lug option.



SUGGESTED INSTALLATION



This illustration is a generic representation of an air operated double-diaphragm pump.

TROUBLESHOOTING

PROBLEM

EFFECT/SOLUTION

Pump Will Not Cycle

- Discharge line closed or plugged
- Discharge filter blocked
- Check valve stuck
- Air filter blocked
- Air supply valve closed
- Air supply hooked up to muffler side of pump
- Compressor not producing air or turned off
- Muffler iced or blinded
- Diaphragm ruptured
- Plant air supply line ruptured
- Air valve wear/debris
- Pilot sleeve wear/debris
- Diaphragm rod broken
- Diaphragm plate loose

Pumped Fluid Coming Out of Muffler

- Diaphragm ruptured
- Diaphragm plate loose
- Inlet liquid pressure excessive (above 10 psig)

Pump Cycles but no Flow

- Inlet strainer clogged
- Suction valve closed
- Suction line plugged
- No liquid in the suction tank
- Suction lift excessive
- Debris stuck in valves
- Excessive wear of check valves
- Air leak on suction side with suction lift

Pump Cycles with Closed Discharge Valve

- Debris stuck in check valve
- Excessive wear of check valves

Pump Running Slowly/Not Steady

- Air compressor undersized
- Leak in air supply
- Air-line, filter regulator or needle valve undersized
- Muffler partially iced or blinded
- Air valve gasket leak or misalignment
- Air valve wear/debris
- Pilot sleeve wear/debris
- Liquid fluid filter blocked
- Pump may be cavitating, reduce speed of operation
- Suction strainer clogged

Pump Will Not Prime

- Air leak in suction pipe
- Air leak in pump manifold connections
- Suction strainer and lines clogged
- Excessive lift conditions
- Check valve wear
- Debris in check valve

OPERATION

The Air-Operated Double Diaphragm Pump requires a minimum of 20 psig of air to operate, with some variation according to diaphragm material. Increasing the air pressure results in a more rapid cycling of the pump and thus a higher liquid flow rate. In order to not exceed 120 psig of inlet air pressure, and for accurate control of the pump, it is suggested to use a pressure regulator on the air inlet.

An alternate means of controlling the flow-rate of the pump is to use an inlet air valve and partially open or close accordingly. When the air valve is completely in the closed position, the pump will cease to operate.

A third method of controlling the flow rate of the pump is to use a liquid discharge valve. Closing the liquid discharge valve will cause a decrease in the flow rate since the pump will operate against a higher discharge pressure.


Solenoid control of the inlet air may also be used in order to facilitate remote operation. A three way solenoid valve is recommended, in order to allow the air to “bleed off” between the solenoid and the pump.

Do not use valves for flow control on the suction side of the pump. (Closing or partially closing a liquid suction valve restrict the suction line and may cause damage to the diaphragms.) Suction strainers may be employed to reduce or eliminate larger solids, but routine maintenance is necessary in order to prevent a restriction on the suction.

MAINTENANCE

Due to the unique nature of each application, periodic inspection of the pump is the best method to determine a proper maintenance schedule. A record should be kept of all repairs made to an installed pump. This will serve as the best predictor of future maintenance.

Typical maintenance involves replacing of “wear-parts” such as the diaphragms, balls, valve seats and O-rings. Proper maintenance can ensure trouble-free operation of the pump. Refer to repair and assembly instructions for further details.

 **WARNING** Maintenance must not be performed when a hazardous atmosphere is present.

MAINTENANCE SCHEDULE

WEEKLY (OR DAILY)

Make a visual check of the pump. If pumped fluid is leaking out of the pump, pipe fittings or muffler turn off pump and schedule maintenance.

EVERY THREE MONTHS

Inspect fasteners and tighten any loose fasteners to recommended torque settings.

Schedule pump service based on pump’s service history.

REPAIR AND ASSEMBLY

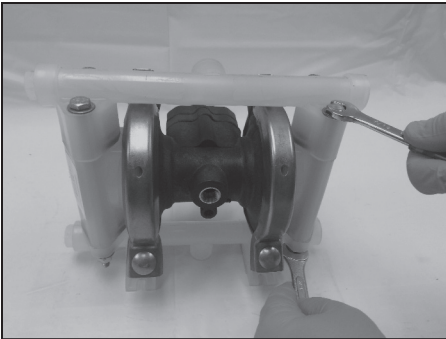
PUMP WET END REMOVAL

TOOLS NEEDED

- 1) Two Wrenches, $\frac{7}{16}$ Inch
- 2) One Wrench, $\frac{1}{2}$ Inch
- 3) Two Wrenches, $\frac{3}{4}$ Inch
- 4) One Screwdriver, Straight Blade

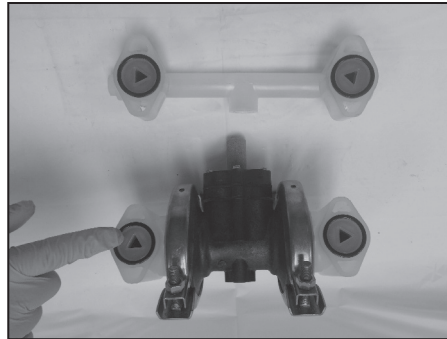
⚠ WARNING Prior to servicing the pump, ensure that the air and fluid lines are closed and disconnected. While wearing personal protective equipment, flush, drain and process liquid from the pump in a safe manner.

⚠ WARNING Maintenance must not be performed when a hazardous atmosphere is present.



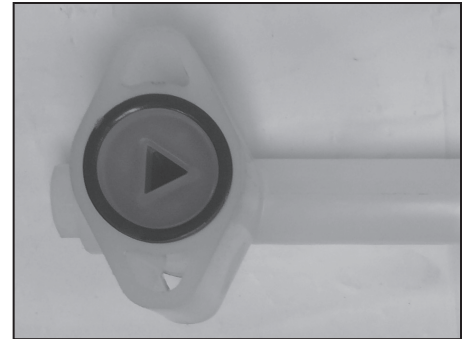
STEP 1

Using the $\frac{7}{16}$ inch wrenches remove four "Hex-Head Cap Screws", eight "Washers" and four "Hex Nuts" from the "Discharge Manifold", "Outer Chamber" and "Suction Manifold".



STEP 2

Remove the "Discharge Manifold".



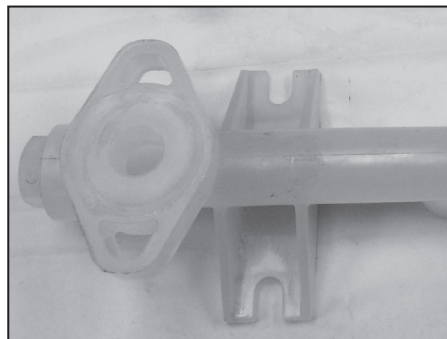
STEP 3

Remove the "O-Ring", "Valve Seat" and "Ball" from the "Discharge Manifold".



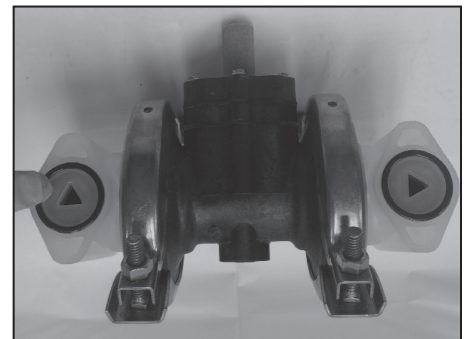
STEP 4

Set the "Intermediate" with attached "Outer Chambers" aside.



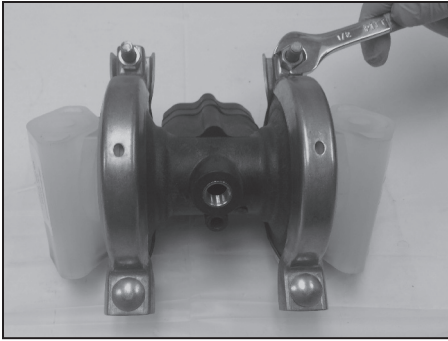
STEP 5

Remove the "Suction Manifold".



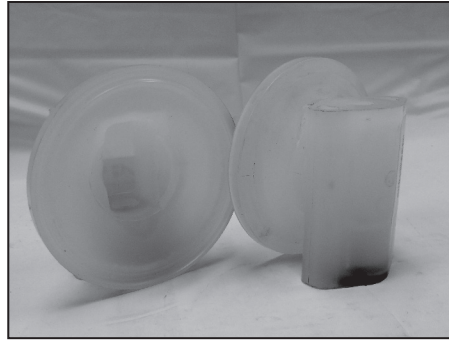
STEP 6

Remove the "O-Ring", "Valve Seat" and "Ball" from the "Outer Chambers".



STEP 7

In order to remove both “Outer Chambers”, using the ½ inch wrench, remove the “Chamber Clamps” from each side of the “Intermediate”.



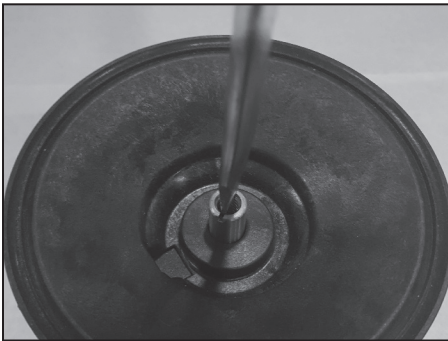
STEP 8

Remove both “Outer Chambers” from the “Intermediate”.



STEP 9

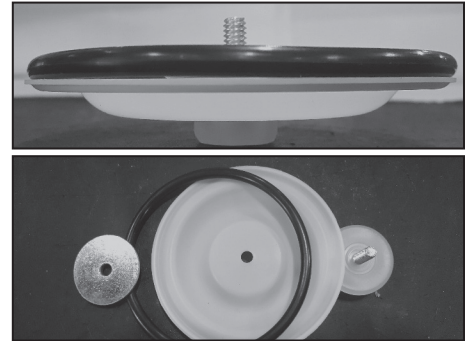
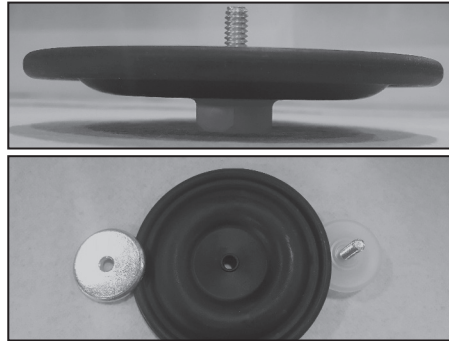
Using two ¾ Inch wrenches, remove “Outer Diaphragm Plate”, “Diaphragm” and “Inner Diaphragm Plate” (washer) from one side of the pump.



STEP 10

Placing the ¾ inch wrench on the remaining “Outer Diaphragm Plate” and the straight blade screwdriver on the “Diaphragm Rod”, remove the remaining “Outer Diaphragm Plate”, “Diaphragm” and “Inner Diaphragm Plate” (washer) from the other side of the pump.

Note PTFE diaphragms also contain an O-Ring on the “Intermediate” side.



PUMP WET END ASSEMBLY

To assemble the wet end of the pump, reverse the order of disassembly. Ensure all hardware is fastened in accordance with torque specifications (see page 15). Inverting one of the diaphragms during reassembly will facilitate ease of assembly.

When positioning clamps use soapy water or a compatible lubricating spray on the inside of band clamps to aid assembly. Tap with a mallet on the outside of clamp to help position the clamp while tightening the fasteners. The band clamp fasteners and cap screws are stainless steel. To prevent galling always apply an anti-seize compound to the thread.

Note: When using pumps built with PTFE O-Rings, always replace with new PTFE O-Rings, since the original O-Rings may not reseal the pump.

REPAIR AND ASSEMBLY

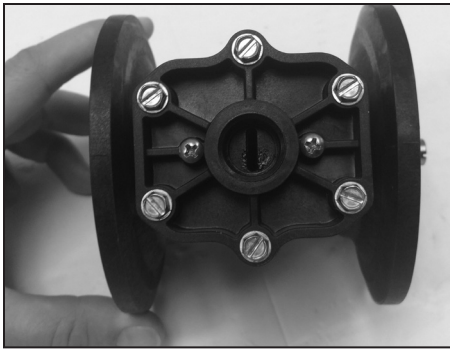
AIR VALVE REMOVAL

TOOLS NEEDED

- 1) One Wrench, 1/4 Inch
- 2) One Screwdriver, Straight Blade
- 3) One Hex Key, 7/64 Inch (3mm)

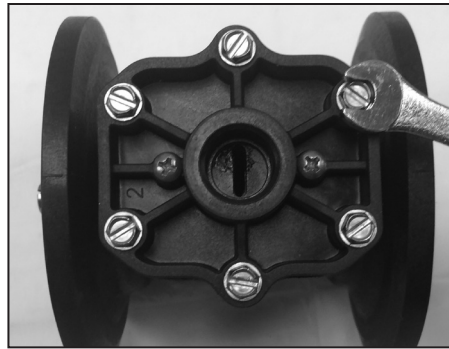
⚠ WARNING Prior to servicing the pump, ensure that the air and fluid lines are closed and disconnected. While wearing personal protective equipment, flush, drain and process liquid from the pump in a safe manner.

⚠ WARNING Maintenance must not be performed when a hazardous atmosphere is present.



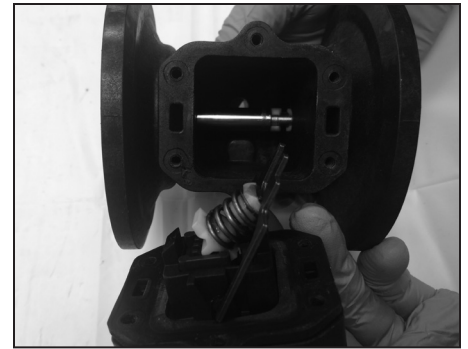
STEP 1

Rotate the "Intermediate" to the exhaust muffler side.



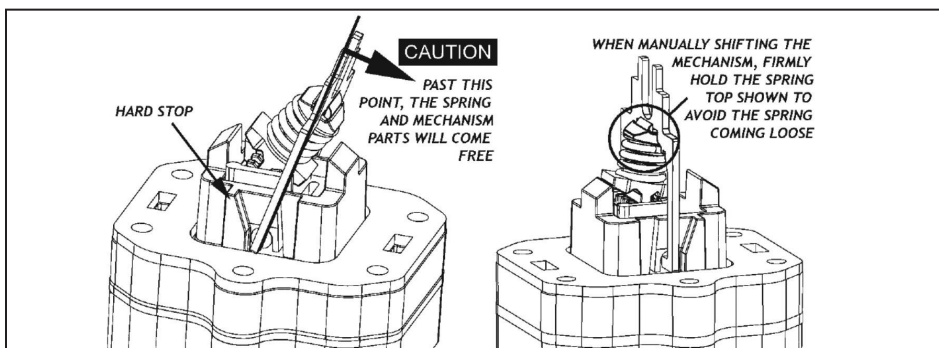
STEP 2

Using the 1/4 wrench (or straight blade screwdriver) remove six "Screws" from the "Muffer Plate". Note the center two "Screws" should not be removed.



STEP 3

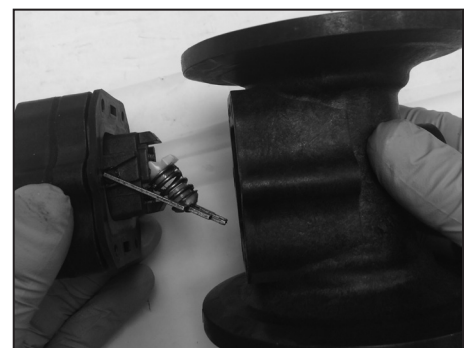
Stabilize the "Air Valve" mechanism to prevent it from shifting. Move the mechanism to the "Hard Stop" position. See Step 4-5.



STEP 4

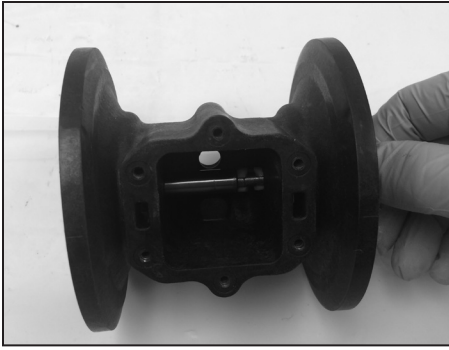
CAUTION: Only one side of the valve mechanism has a hard-stop. Shifting the mechanism past its operating position can cause the spring to pop free and internal components to come loose. Use caution when shifting the mechanism manually.

STEP 5



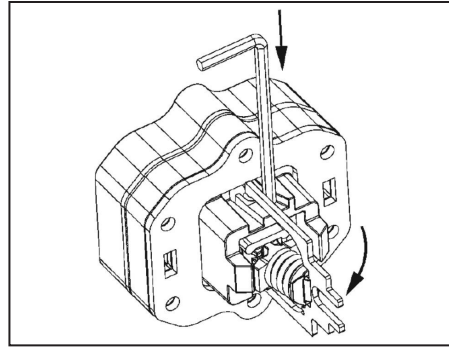
STEP 6

Remove the "Air Valve" from the "Intermediate". Set the mechanism to the the "Hard Stop" position.



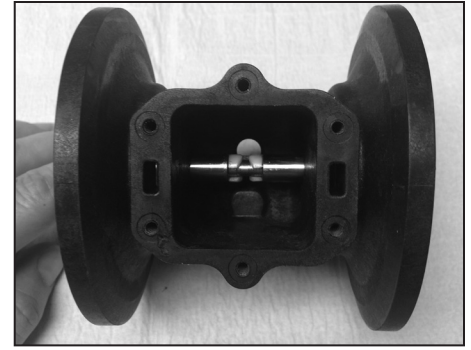
STEP 7

Note the way the mechanism threads the “Rod” and “Rod Guide”.



STEP 8

To reinstall the “Air Valve”, the spring mechanism should be on the side with the hard-stop. Prop the spring retainer into a neutral position by inserting a $\frac{7}{64}$ ” or 3mm hex key as shown between the hard-stop and the spring retainer.



STEP 9

Adjust the “Rod Guide” towards the center of the “Intermediate”. Slide the “Air Valve” into place so that the forks slide into the rod guide. Pull the hex key free and push the “Air Valve” fully into place. Reinstall the “Muffler Plate” screws.

AIR VALVE ASSEMBLY

To assemble the air valve, reverse the order of disassembly. During assembly, ensure that the open side of the lip-seals are both facing each other inward. Lubrication of the air valve assembly, with a non-synthetic lubricant, is recommended. Magna-Lube or Magna-Plate are recommended for assembly lubrication (see detailed parts list for ordering information).

Note: If the lip-seals are installed incorrectly, they will be unable to rotate.

TORQUE SPECIFICATION CHART

RECOMMENDED TORQUE SPECIFICATIONS

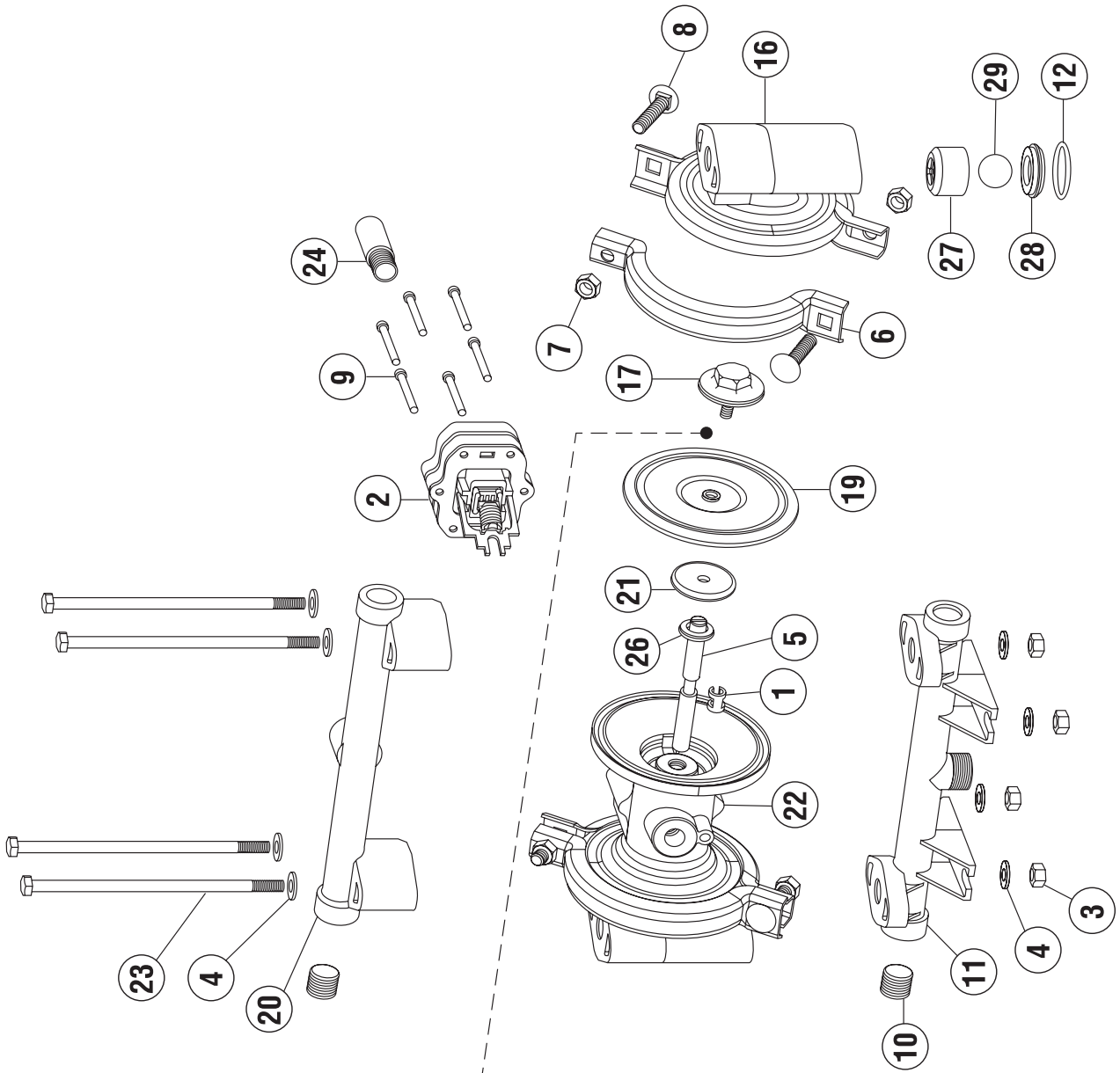
	3/8” Pumps
Manifold Bolts	10 in-lbs (1.13 N-m)
Band Clamps (Chambers)	13.3 ft-lbs (18.0 N-m)
Air Valve Screws	12 in-lbs (1.35 N-m)
Diaphragm Plates	40 in-lbs (4.5 N-m)

Note: Always torque the chamber clamps prior to the manifold bolts. When reassembling, loosely tighten all external fasteners adjusting and aligning gradually, in an alternating fashion, tighten to torque requirements listed above.

Note: When using pumps built with PTFE O-Rings, always replace with new PTFE O-Rings, since the original O-Rings may not reseal the pump.

EXPLODED VIEW & PARTS LIST

C038-SQ*-****-*** CLAMPED PLASTIC



Diaphragm configuration for PTFE pumps.

PTFE Diaphragm requires O-ring.

PARTS LIST - CLAMPED PLASTIC

C038-SQ*_****_***

ASSEMBLY PART NUMBERS	PUMP MODEL	PART NO.	MATERIAL
WET END ASSEMBLY 19, 29, 28, 12	ALL MODELS	CWE-038-****-P	VARIOUS

ELASTOMERS

WETTED ELASTOMERS

BUNA-N (NITRILE)

is a general purpose elastomer used with water and many oils. Temperature range 10°F to 180°F (-12°C to 82°C).

GEOLAST®

is an injection molded thermoplastic material with characteristics similar to Nitrile. Has excellent abrasion resistance. Temperature range 10°F to 180°F (-12°C to 82°C).

EPDM

is a general purpose elastomer with good resistance to many acids and bases. Temperature range -40°F to 280°F (-40°C to 138°C).

SANTOPRENE®

is an injection molded material with characteristics similar to EPDM. Has excellent abrasion resistance. Temperature range -40°F to 225°F (-40°C to 107°C).

FKM

is an elastomer with good corrosion resistance to a wide variety of chemicals. Temperature range -40°F to 350°F (-40°C to 177°C).

PTFE (POLYTETRAFLUOROETHYLENE)

is a thermoplastic polymer that is inert to most chemicals. Temperature range 40°F to 220°F (4°C to 104°C).

Most of the above elastomers are available in FDA approved formulations.

Geolast® is a registered trademark of ExxonMobil Chemical Co.

Santoprene® is a registered trademark of ExxonMobil Chemical Co.

Hytrel® is a registered trademark of DuPont Performance Elastomers L.L.C.

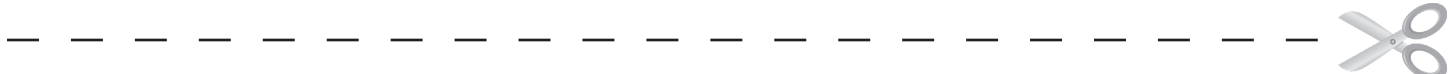
Magnalube® is a registered trademark of Carleton-Stuart Corp.

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REGISTRATION FORM

Pump Model _____ Pump Serial Number _____

Company Name _____

Name _____ Email _____

Phone # _____ City _____ State _____ Zip _____

Qty of Pumps _____ Fluid Pumping _____

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