

E-Flo[®] 4-Ball Piston Pumps

311593N
EN

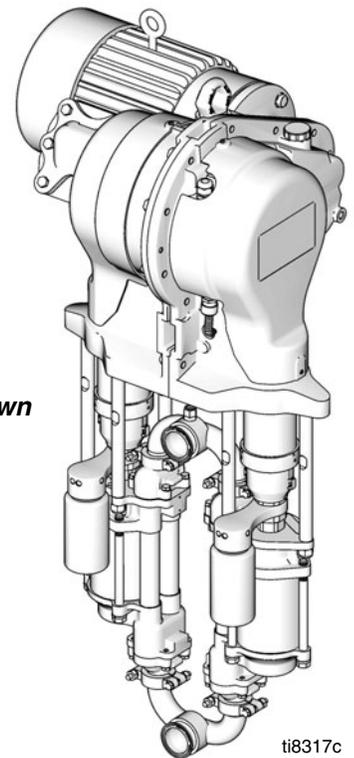
**Durable, energy efficient piston pumps for high volume paint circulation applications.
For professional use only.**

See page 3 for model information, including maximum working pressure. See page 5 for approvals.



Important Safety Instructions

Read all warnings and instructions in this manual.
Save these instructions.



E-Flo 4000 Pump Shown

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Related Manuals

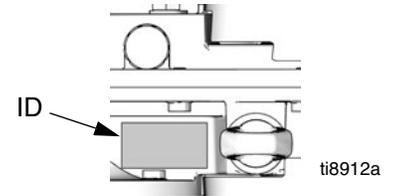
Manual Description

311592	E-Flo Installation Manual
311594	E-Flo Repair-Parts Manual
311595	Pneumatic Back Pressure Regulator
311596	Variable Frequency Drive Instructions
311603	Sensor Circuit Option
3A0539	High-Flo Lowers

Models

E-Flo 4-Ball Piston Pumps

Check your pump's identification plate (ID) for the 6-digit part number of your pump. Use the following matrix to define the construction of your pump, based on the six digits. For example, Pump Part No. **E P 2 1 6 0** represents electric power (**E**), pump (**P**), 230/460V motor (**2**), sensor circuit installed (**1**), 2000 cc MaxLife lower (**6**), and no stand installed (**0**). To order replacement parts, see the Repair-Parts manual 311594.



E	P	2		1		6		0	
First Digit	Second Digit	Third Digit		Fourth Digit		Fifth Digit		Sixth Digit	
Power Source	Equipment Style	Motor		Sensor Circuit		Lower Size		Stand Option	
E (electric)	P (pump)	0	No motor	0	No circuit installed	1	1000 cc Chrome	0	No stand installed
		1	230/400V, 5 HP, ATEX	1	Circuit installed	2	1500 cc Chrome	1	Stand installed
		2	230/460V, 5 HP, UL/CSA			3	2000 cc Chrome		
		3	230/400V, 3 HP, ATEX			4	1000 cc MaxLife®		
		4	230/460V, 3 HP, UL/CSA			5	1500 cc MaxLife		
						6	2000 cc MaxLife		
						7	750 cc Chrome		
						8	750 cc MaxLife		

Maximum Working Pressure and Pump Operational Limits

E-Flo 1500: 425 psi (2.93 MPa, 29.3 bar) Maximum Working Pressure

E-Flo 2000: 460 psi (3.22 MPa, 32.2 bar) Maximum Working Pressure

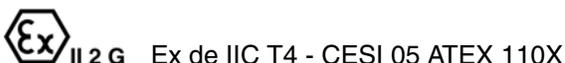
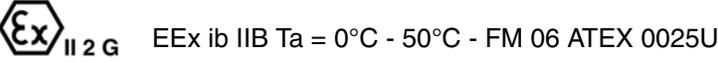
E-Flo 3000: 330 psi (2.31 MPa, 23.1 bar) Maximum Working Pressure

E-Flo 4000: 250 psi (1.75 MPa, 17.5 bar) Maximum Working Pressure

See **Technical Data**, page 18, for pressure and flow limits.

Approvals

The E-Flo Pump meets requirements of the following approval agencies.
 Refer to the individual components for other specific hazardous location listings.

Component	Part No.	Approvals
Mechanical Pump		 
Motor	ATEX EP1XXX EP3XXX	 
	UL/CSA EP2XXX EP4XXX	 Class I, Group D, Class II, Group F and G, Division 1, T3B Hazardous Locations 
IS Sensor Circuit	EPX1XX	  Class 1, Div. 1, Group C & D T3 Hazardous Locations   Ex ib IIB Ta = 0°C - 50°C - KTL 13-KB4BO-0088

Warnings

The following warnings are for the setup, use, grounding, maintenance, and repair of this equipment. The exclamation point symbol alerts you to a general warning and the hazard symbols refer to procedure-specific risks. When these symbols appear in the body of this manual, refer back to these Warnings. Product-specific hazard symbols and warnings not covered in this section may appear throughout the body of this manual where applicable.

 WARNING	
 	<p>FIRE AND EXPLOSION HAZARD</p> <p>Flammable fumes, such as solvent and paint fumes, in work area can ignite or explode. To help prevent fire and explosion:</p> <ul style="list-style-type: none"> • Use equipment only in well ventilated area. • Eliminate all ignition sources; such as pilot lights, cigarettes, portable electric lamps, and plastic drop cloths (potential static arc). • Keep work area free of debris, including solvent, rags and gasoline. • Do not plug or unplug power cords, or turn power or light switches on or off when flammable fumes are present. • Ground all equipment in the work area. See Grounding instructions. • Use only grounded hoses. • Hold gun firmly to side of grounded pail when triggering into pail. • If there is static sparking or you feel a shock, stop operation immediately. Do not use equipment until you identify and correct the problem. • Keep a working fire extinguisher in the work area. <p>Static charge may build up on plastic parts during cleaning and could discharge and ignite flammable vapors. To help prevent fire and explosion:</p> <ul style="list-style-type: none"> • Clean plastic parts only in a well ventilated area. • Do not clean with a dry cloth. • Do not operate electrostatic guns in equipment work area.
	<p>EQUIPMENT MISUSE HAZARD</p> <p>Misuse can cause death or serious injury.</p> <ul style="list-style-type: none"> • Do not operate the unit when fatigued or under the influence of drugs or alcohol. • Do not exceed the maximum working pressure or temperature rating of the lowest rated system component. See Technical Data in all equipment manuals. • Use fluids and solvents that are compatible with equipment wetted parts. See Technical Data in all equipment manuals. Read fluid and solvent manufacturer's warnings. For complete information about your material, request MSDS forms from distributor or retailer. • Check equipment daily. Repair or replace worn or damaged parts immediately with genuine manufacturer's replacement parts only. • Do not alter or modify equipment. • Use equipment only for its intended purpose. Call your distributor for information. • Route hoses and cables away from traffic areas, sharp edges, moving parts, and hot surfaces. • Do not kink or over bend hoses or use hoses to pull equipment. • Keep children and animals away from work area. • Comply with all applicable safety regulations.

 WARNING	
	<p>ELECTRIC SHOCK HAZARD</p> <p>Improper grounding, setup, or usage of the system can cause electric shock.</p> <ul style="list-style-type: none"> • Turn off and disconnect power at main switch before disconnecting any cables and before servicing equipment. • Connect only to grounded power source. • All electrical wiring must be done by a qualified electrician and comply with all local codes and regulations.
	<p>PRESSURIZED EQUIPMENT HAZARD</p> <p>Fluid from the gun/dispense valve, leaks, or ruptured components can splash in the eyes or on skin and cause serious injury.</p> <ul style="list-style-type: none"> • Follow Pressure Relief Procedure in this manual, when you stop spraying and before cleaning, checking, or servicing equipment. • Tighten all fluid connections before operating the equipment. • Check hoses, tubes, and couplings daily. Replace worn or damaged parts immediately.
	<p>MOVING PARTS HAZARD</p> <p>Moving parts can pinch or amputate fingers and other body parts.</p> <ul style="list-style-type: none"> • Keep clear of moving parts. • Do not operate equipment with protective guards or covers removed. • Pressurized equipment can start without warning. Before checking, moving, or servicing equipment, follow the Pressure Relief Procedure in this manual. Disconnect power or air supply.
	<p>TOXIC FLUID OR FUMES HAZARD</p> <p>Toxic fluids or fumes can cause serious injury or death if splashed in the eyes or on skin, inhaled, or swallowed.</p> <ul style="list-style-type: none"> • Read MSDS's to know the specific hazards of the fluids you are using. • Store hazardous fluid in approved containers, and dispose of it according to applicable guidelines. • Always wear impervious gloves when spraying or cleaning equipment.
	<p>PERSONAL PROTECTIVE EQUIPMENT</p> <p>You must wear appropriate protective equipment when operating, servicing, or when in the operating area of the equipment to help protect you from serious injury, including eye injury, inhalation of toxic fumes, burns, and hearing loss. This equipment includes but is not limited to:</p> <ul style="list-style-type: none"> • Protective eyewear • Clothing and respirator as recommended by the fluid and solvent manufacturer • Gloves • Hearing protection
	<p>BURN HAZARD</p> <p>Equipment surfaces and fluid that's heated can become very hot during operation. To avoid severe burns, do not touch hot fluid or equipment. Wait until equipment/fluid has cooled completely.</p>

Overview

An electric motor (B) provides input to a 75:1 gear reducer (GR), which drives two fluid pumps (FP). See FIG. 1. The stroke positions of the two pumps are offset to achieve consistent flow from the pump assembly. See FIG. 2.

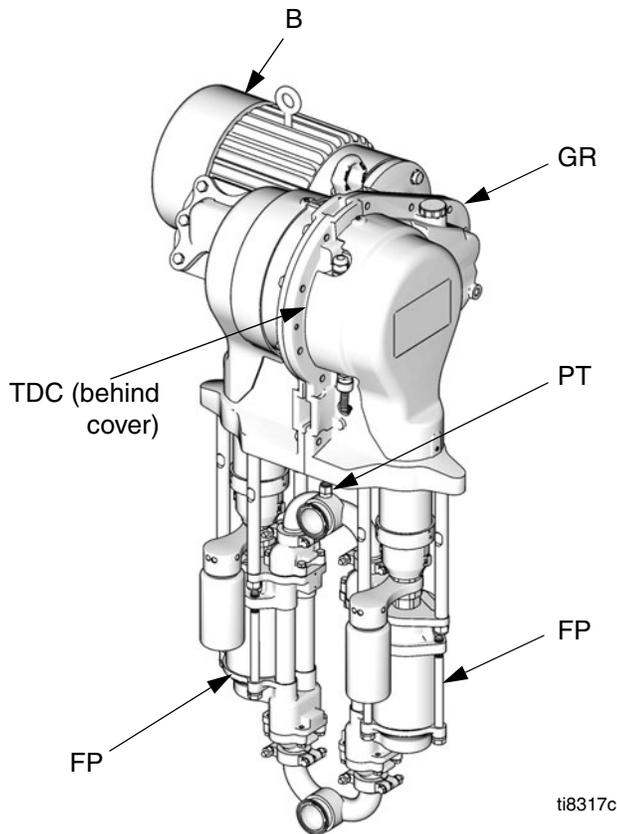


FIG. 1. E-Flo Electric Circulation Pump

The optional sensor circuit includes a top dead center (TDC) sensor which assists software in measuring motor speed, and a pressure transducer (PT) with circuit board, which measures fluid pressure at the pump outlet. The Graco VFD software mimics the effect of a camshaft, constantly adjusting motor speed to keep steady fluid flow and achieve minimal pressure variation. The output shaft of the gearbox and the connecting rods experience the effect of the imaginary camshaft by speeding up when the pressure drops (pump lower is at a changeover) and slowing down when pressure increases (both lowers are pumping).

The VFD can be controlled by a local control box mounted in the hazardous area, via communication protocol (such as modbus), or directly from the keypad.

FIG. 3 shows a layout of a typical North American system. The pump (A) may be controlled by a local control box (C) mounted in the hazardous area, a variable frequency drive (D) mounted in the non-hazardous area, or remotely from a computer (Y). See manual 311592 for pump and accessory installation information.

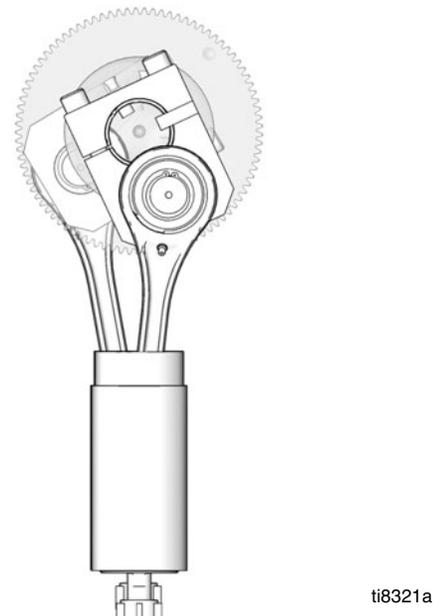
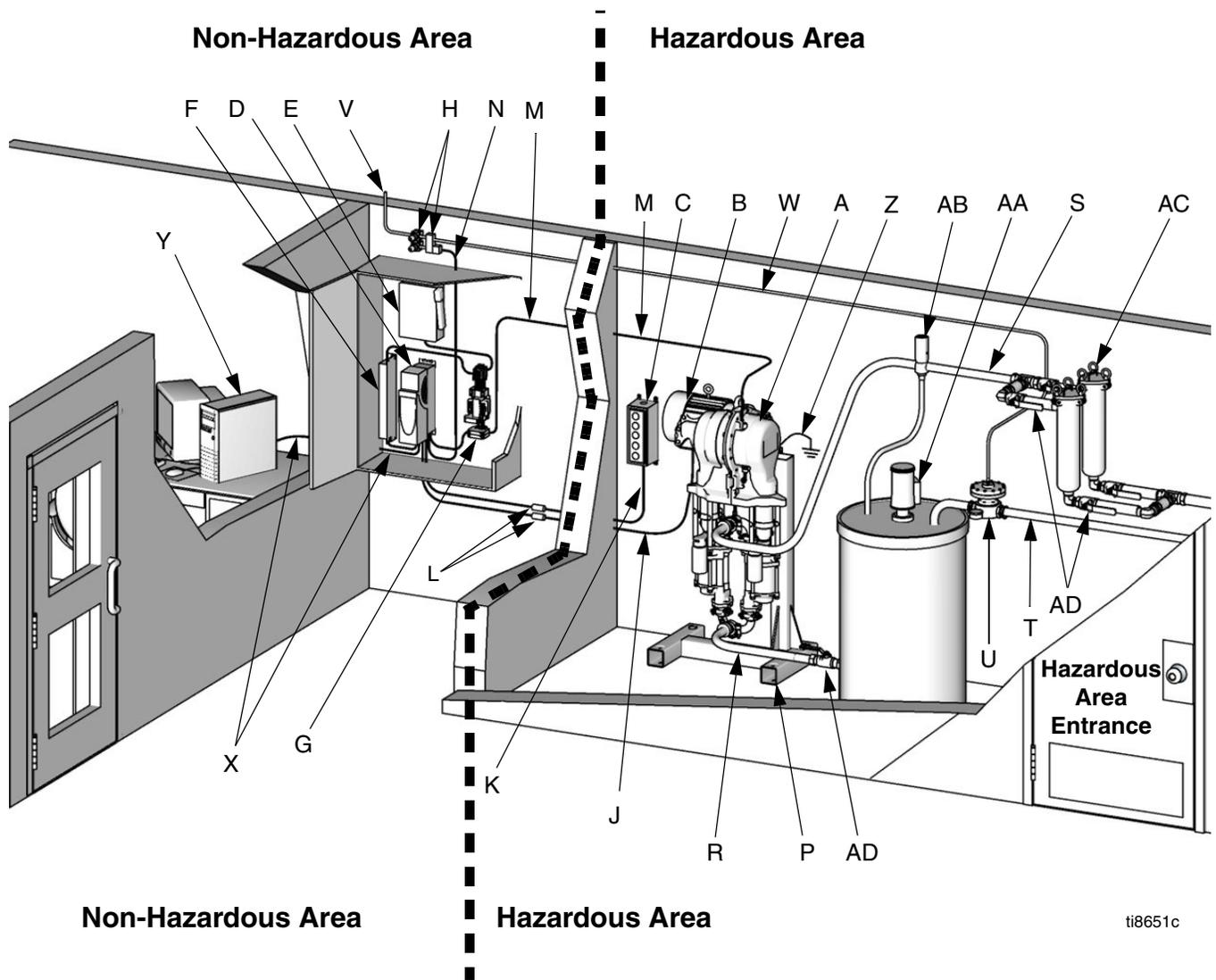


FIG. 2. Cutaway Showing Offset Stroke Positions



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FIG. 3: Typical Installation

Key:

- A E-Flo Electric Circulation Pump
- B* Explosion-Proof Electric Motor
- C* Local Control Box
- D* Variable Frequency Drive (VFD)
- E** System Power Disconnect Switch
- F* Electrical Noise Filter
- G* Power Module
- H* VFD/BPR Pneumatic Control Kit
- J** Electric Power Cable, VFD to Electric Motor
- K** Electric Control Cable, Local Control Box to VFD
- L** Explosion-Proof Seal Fittings
- M** Electric IS Control Cable, Power Module to Pump Sensor Circuit
- N** Electric Cable, VFD to 3-Way Solenoid Valve (2 meters provided by Graco)
- P* Pump Stand
- R** Fluid Inlet Line
- S** Fluid Outlet Line

- T** Fluid Return Line
- U* Pneumatic Back Pressure Regulator
- V** Air Supply Lines to 3-Way Solenoid Valve
- W** Air Line, Solenoid Valve to Back Pressure Regulator
- X** Ethernet Cable, VFD to Computer
- Y** Personal Computer
- Z** Pump Ground Wire
- AA* Explosion-Proof Electric Agitator
- AB** Pressure Relief
- AC* Fluid Filters
- AD* Fluid Line Isolation Valves

* Option available from Graco.

** Supplied by integrator.

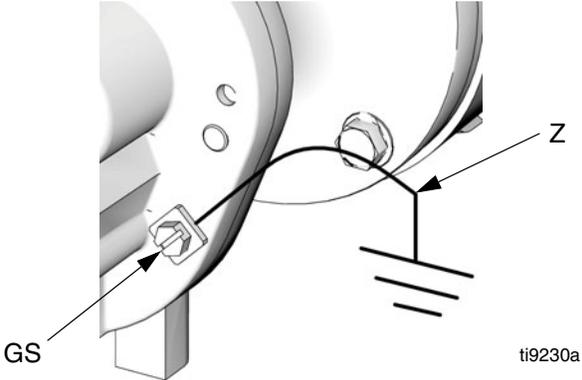
Ground the System

The equipment must be grounded. Grounding reduces the risk of static and electric shock by providing an escape wire for the electrical current due to static build up or in the event of a short circuit.



Ground the following equipment:

- *Pump:* use ground screw (GS) to attach a ground wire (Z) to the pump. Tighten the screw securely. Connect the other end of the ground wire to a true earth ground.



- *Variable frequency drive:* grounded through proper connection to power source.
- *Local control box:* follow your local code.
- *Fluid supply container:* follow your local code.
- *Solvent pails used when flushing:* follow your local code. Use only metal pails, which are conductive, placed on a grounded surface. Do not place pail on a nonconductive surface, such as paper, plastic, or cardboard, which interrupts grounding continuity.

Controls and Indicators

Variable Frequency Drive (VFD)

Use a variable frequency drive (VFD) accessory to provide motor drive control to the pump. Graco supplies accessory 240V and 480V VFDs that optimize pump performance. See manual 311596.

Local Control Box

The local control box contains five controls. See Fig. 4.

Secure/Disable Switch

- Push in to secure.
- Pull out to disable.

Start/Stop Switch

- Set to START to start pump.
- Set to STOP to stop pump.

Alarm Reset Button

Press to clear an alarm.

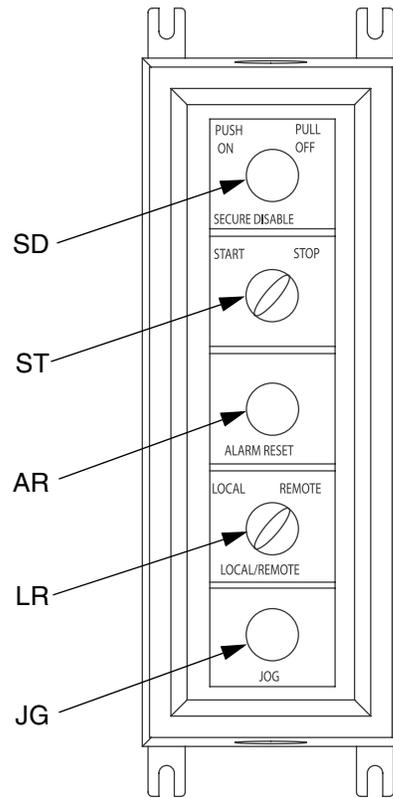
Local/Remote Switch

- Set to LOCAL to control pump using local control box.
- Set to REMOTE to control pump from a PC in a remote location.

Jog Button

Press to enter jog mode.

120373 UL/CSA Control Box



120991 ATEX Control Box

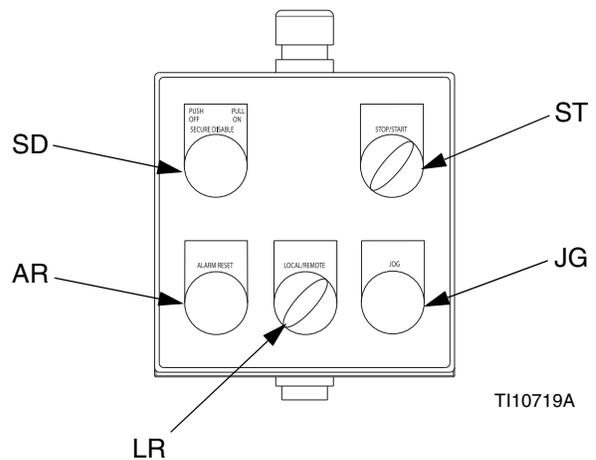


FIG. 4: Local Control Box

Setup

Fill gear reducer reservoir with oil

Open the fill cap (FC) and fill the gear reducer oil reservoir with 2 quarts (1.9 liters) of Graco 288414 Oil (twelve 1 quart bottles). Check the oil level in the sight glass (SG) on the gear reducer housing. Do not overfill. See FIG. 5.

NOTE: 2 quarts brings oil level above sight glass (SG) when off, but level drops when operating.

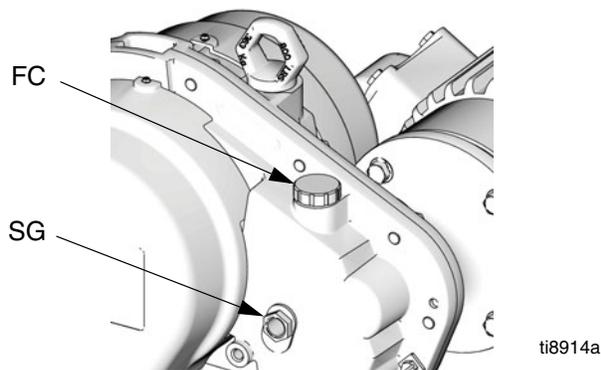


FIG. 5. Oil Fill

Fill TSL Reservoirs

Part No. 206995 Throat Seal Liquid (TSL) carries residue from the pump rod into the reservoir. Fill the TSL reservoirs (R) with Graco 206994 Throat Seal Liquid (TSL). See FIG. 6. See **Changing the TSL** on page 17 for fill instructions.

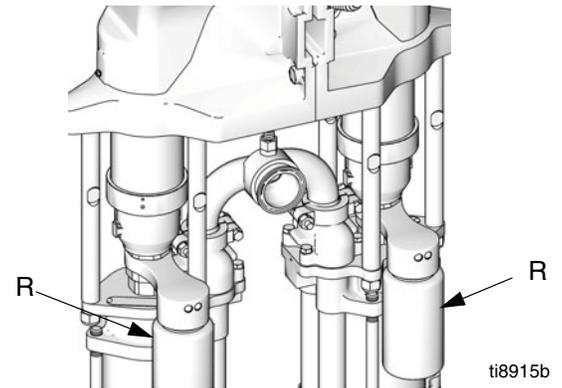


FIG. 6. Fill TSL Reservoirs

Flush before using equipment

The equipment was tested with Stoddard Solvent, which is left in the fluid passages to protect parts. To avoid contaminating your fluid with solvent, flush the equipment with a compatible solvent or water before using the equipment. See **Flushing**, page 17.

Operation

Pressure Relief Procedure

						
System pressure can cause the pump to cycle unexpectedly, which could result in serious injury from splashing or moving parts.						

1. Set START/STOP switch (ST) to STOP. See FIG. 4.
2. Push in SECURE DISABLE (SD) switch.
3. Open the back pressure regulator and all fluid drain valves in the system, having a waste container ready to catch drainage. Leave open until you are ready to pressurize system again.
4. Check that pressure gauges on fluid supply and return lines read zero. If gauges do not read zero, determine cause and carefully relieve pressure by VERY SLOWLY loosening a fitting. Clear obstruction before pressurizing system again.

Priming

1. Open the back pressure regulator and any other accumulators in the system.
2. Start the pump, see **Startup**.
3. Set START/STOP switch (ST) to STOP. See FIG. 4.
4. Set the back pressure regulator as desired. The system is ready to run.

Startup

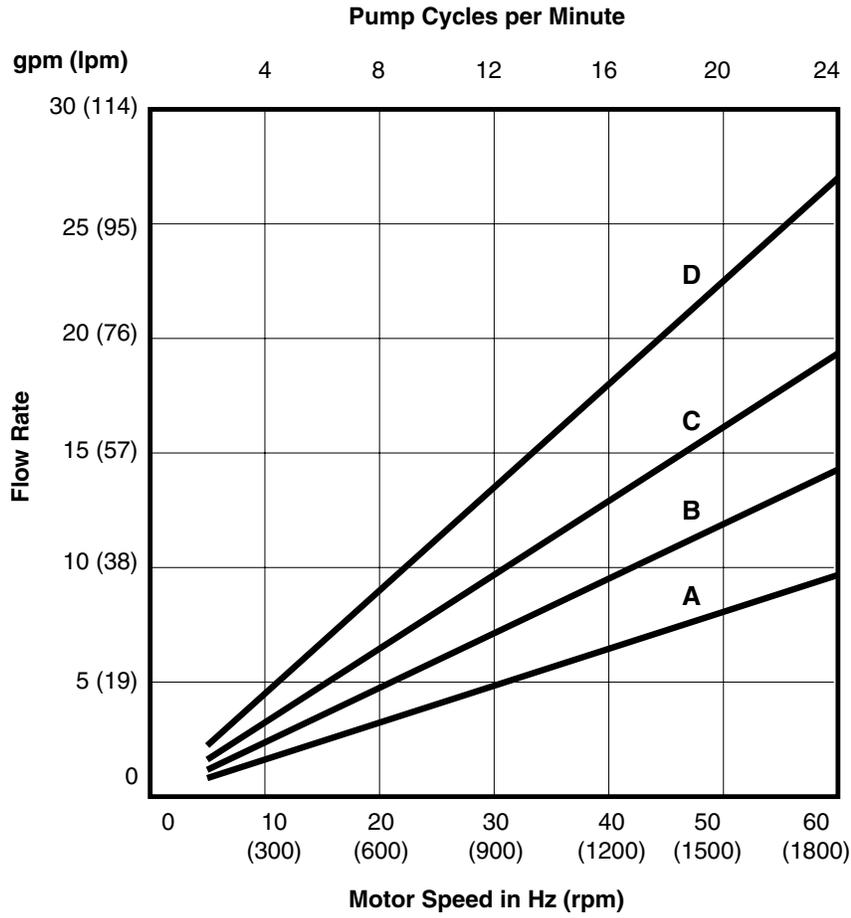
1. Close the main power disconnect.
2. Use the VFD to set motor to a low flow (approximately 15 Hz). Adjust as needed. See VFD manual 311596 for specific flow set procedure.
3. Push in SECURE DISABLE (SD) switch.
4. Set START/STOP switch (ST) to STOP. See FIG. 4.
5. Pull the SECURE DISABLE switch (SD) out to disengage it.
6. Set the motor speed on the VFD to achieve the desired flow rate (see FIG. 7).

NOTICE
Do not exceed a motor speed of 60 Hz for more than 3 minutes.

7. Set START/STOP switch (ST) to START. The speed will ramp up; it is not an immediate change.
8. Set BPR to obtain desired line pressure.

Shutdown

Relieve pressure, page 14.



Key:

- A** 750 cc Pumps
- B** 1000 cc Pumps
- C** 1500 cc Pumps
- D** 2000 cc Pumps

Equations for each line:

$$\text{Flow (gpm)} = 1.13 \times \frac{30 \times \text{VFD (Hz)}}{75.16}$$

$$\text{Flow (gpm)} = 0.811 \times \frac{30 \times \text{VFD (Hz)}}{75.16}$$

$$\text{Flow (gpm)} = 0.598 \times \frac{30 \times \text{VFD (Hz)}}{75.16}$$

$$\text{Flow (gpm)} = 0.406 \times \frac{30 \times \text{VFD (Hz)}}{75.16}$$

FIG. 7: Motor Speed and Flow Chart

Maintenance

Preventive Maintenance Schedule

Establish a preventive maintenance schedule based on the equipment's repair history.

Check Gear Reducer Oil Level

Every day, check the oil level in the sight glass (SG) on the gear reducer, with the motor running. Oil level (with motor running) should fall between top and bottom of the sight glass (SG). Open the fill cap (FC) and fill the gear reducer oil reservoir as required with Graco 288414 Oil (package includes twelve 1 quart bottles). Do not overfill. See FIG. 8.

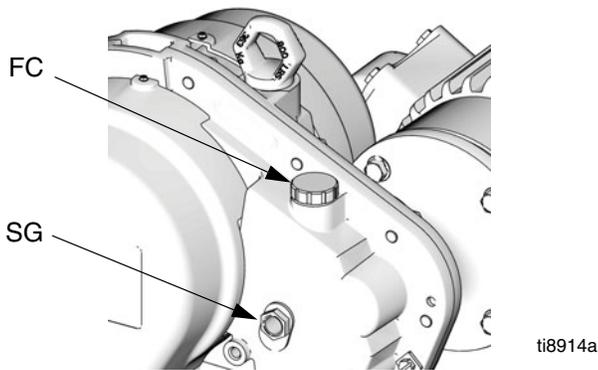


FIG. 8. Oil Fill

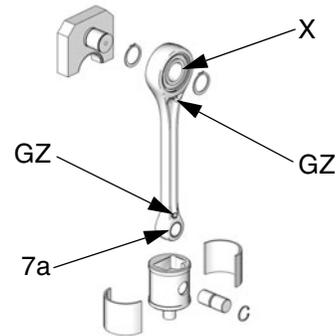
Gear Box and Drive Lubrication

Replace the gear box lubricant after a break-in period of 200,000-300,000 cycles. Order 288414 Replacement Oil.

Following the break-in period, replace the gear box lubricant once a year.

See FIG. 9. Every 6 months, lubricate the wrist pin bearing (7a) on the connecting rod with 1 shot (1 cc) of 107411 Grease or equivalent, using grease zerk (GZ). Replace both wrist pin bearings annually. Order Wrist Pin Replacement Kit 255216. Lubricate the crank pin bearing (X) annually, using grease zerk (GZ).

NOTE: A faint clicking may be heard while the motor is running. This is normal and is due to necessary clearances between the coupler (28), motor shaft, and motor key. If the intensity increases significantly over time, it could indicate the coupler is wearing and should be replaced. Do not open the gear reducer. The gear reducer is not field serviceable beyond the maintenance recommended in this manual

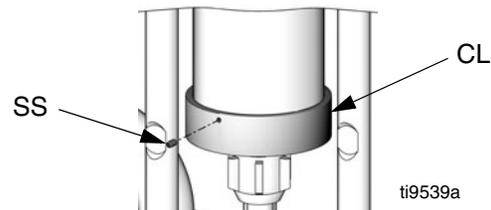


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FIG. 9. Lubricate Wrist Pin Bearing Every 6 Months

Clean the Slider Cylinder Collectors

Every month, check the slider cylinder collectors for dirt or debris. Remove the 2-piece shield covering the coupling assembly. Loosen the three set screws (SS) on the collector (CL). Lower the collector and wipe the inside with a clean, damp cloth. Return the collector to its operating position. Tighten the screws finger tight. Reinstall the shields.



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FIG. 10. Slider Cylinder Collector

Flushing

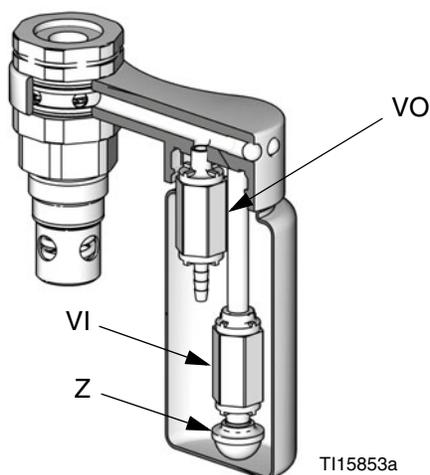


- Flush before changing colors, before storing, and before repairing equipment.
 - Flush at the lowest pressure possible. Check connectors for leaks and tighten as necessary.
 - Flush with a fluid that is compatible with the fluid being dispensed and the equipment wetted parts.
1. Follow **Pressure Relief Procedure**, page 14.
 2. Supply the appropriate flushing material to the system.
 3. Set pump to lowest possible fluid pressure, and start the pump.
 4. Flush long enough to thoroughly clean the system.
 5. Follow **Pressure Relief Procedure**, page 14.

Changing the TSL

Check the condition of the TSL and the level in the reservoir every week, minimum. TSL should be changed at least every month.

Part No. 206995 Throat Seal Liquid (TSL) carries residue from the pump rod into the reservoir. Discoloration of the TSL fluid is to be expected during normal operation. After some time the TSL will thicken and darken, and must be replaced. Thick, dirty TSL will not pump through the lines and will harden in the pump wet-cup.



How long TSL lasts depends on which chemicals are used, how much is used, what pressure, and condition of the pump seal and rod.

A drop in the level of TSL in the reservoir indicates that the throat packings are starting to wear. Add TSL to the reservoir and keep the level above the Minimum fill line. Monitor the usage and condition of the TSL. If pumped material bypasses the throat packings and enters the TSL reservoir, replace the packings.

To change the TSL:

1. Shut off the pump.



To avoid the buildup of static charge, do not rub the plastic bottle with a dry cloth while it is attached to the pump. Remove the bottle to clean, if needed.

2. Remove and empty the reservoir bottle. Clean any residue.
3. Clean screen (Z) of inlet check valve (VI). If check valves are not sealing and dirty TSL is getting into the wet-cup, replace the check valves (VI, VO). See FIG. 11.
4. Fill the reservoir to the Maximum fill line with Throat Seal Liquid (TSL).
5. Run pump. Each time pump rod reaches bottom of stroke, check that some TSL is pumped from reservoir through wet-cup and back to reservoir.

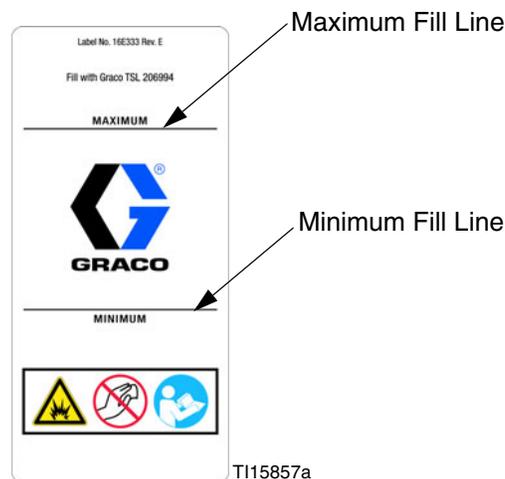
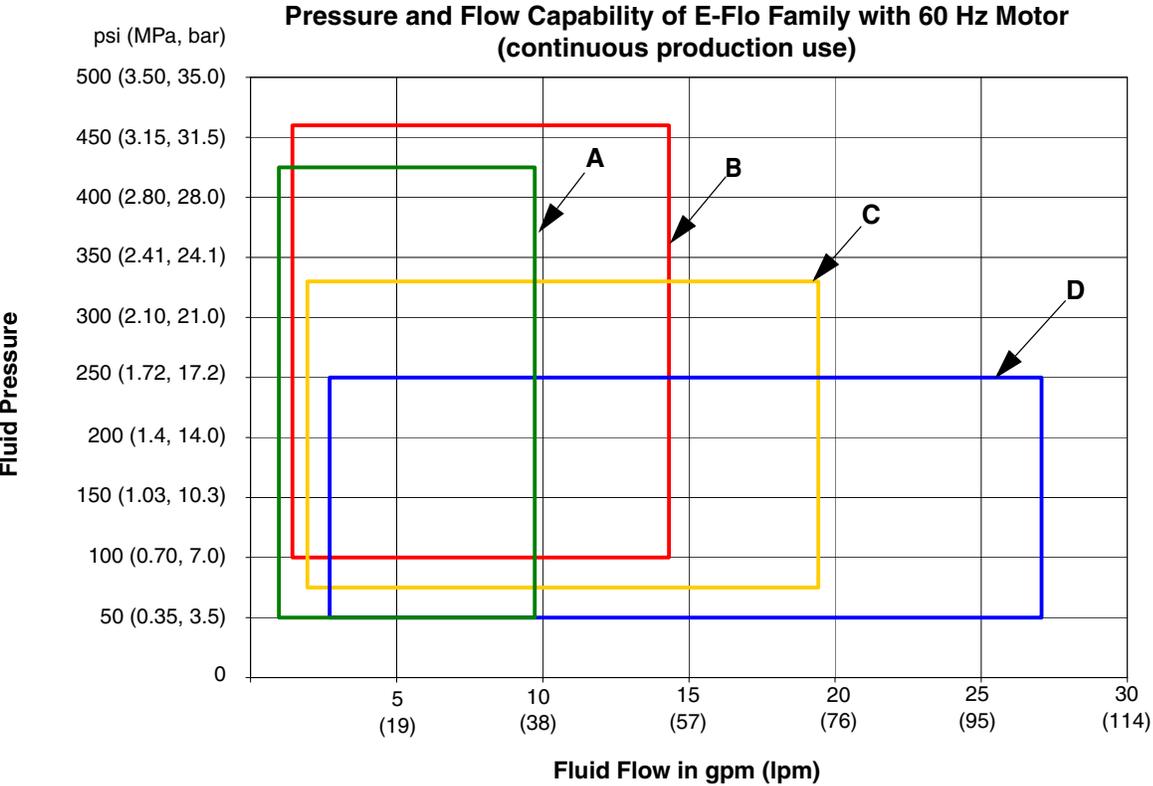
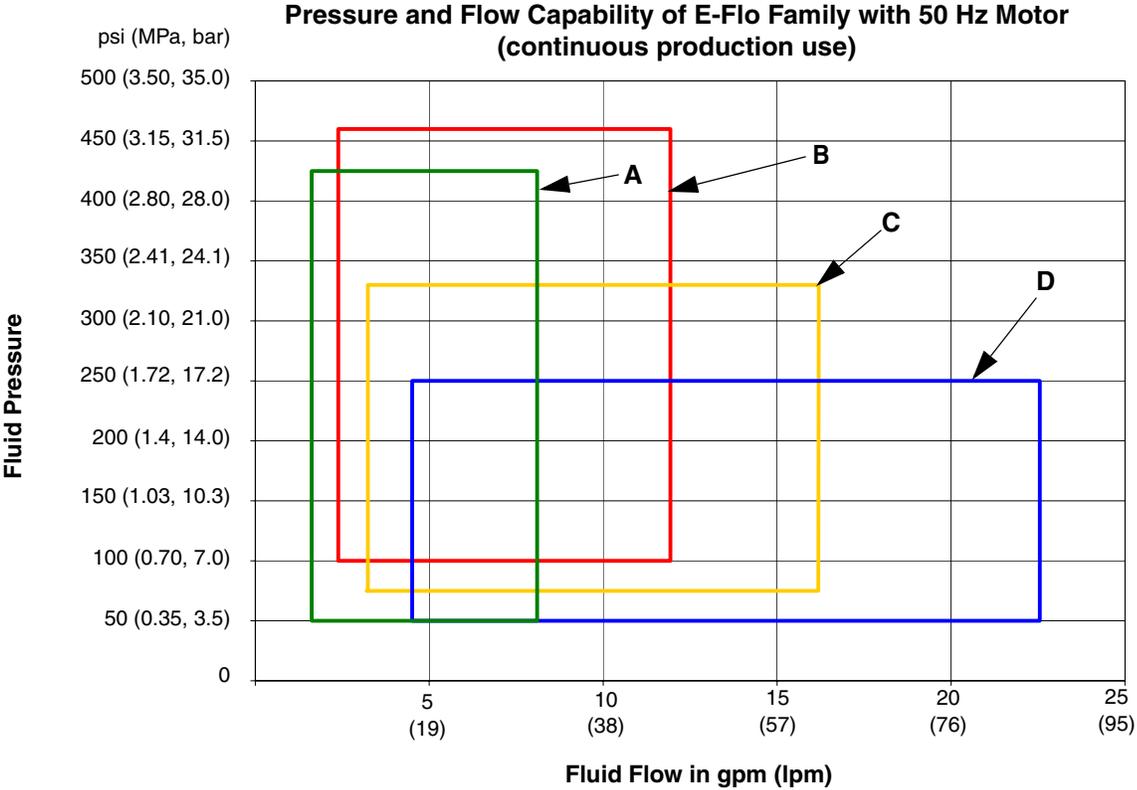


FIG. 11. Cutaway of TSL Reservoir, and Fill Lines

Technical Data

Maximum Working Pressure	<i>E-Flo 1500</i> : 425 psi (2.93 MPa, 29.3 bar) <i>E-Flo 2000</i> : 460 psi (3.22 MPa, 32.2 bar) <i>E-Flo 3000</i> : 330 psi (2.31 MPa, 23.1 bar) <i>E-Flo 4000</i> : 250 psi (1.75 MPa, 17.5 bar)
Maximum Fluid Temperature	150°F (66°C)
Electrical Requirements	<i>European Models</i> : 230/400 Vac, 3 phase, 20 A/15 A <i>North American Models</i> : 230/460 Vac, 3 phase, 20 A/15 A
Ambient Temperature Range	32-104°F (0-40°C)
Maximum Fluid Output	See charts on page 19.
Fluid Inlet and Outlet Size	2 in. Tri-clamp
Gear Reducer Oil Capacity	2 quarts (1.9 liters)
Required Gear Reducer Lubricant	ISO VG220 grade oil (Graco Part No. 288414)
Weight (with motor and 2000 cc lowers)	<i>Pump</i> : 550 lb (249 kg)
Wetted Parts	<i>Lower</i> : see manual 3A0539 300 Series SST, CV-75, 17-4 PH SST, PTFE
Electric Motor	<i>E-Flo 1500</i> : 3 HP, 1800 rpm (60 Hz) or 1500 rpm (50 Hz), NEMA 182 TC Frame <i>E-Flo 2000/3000/4000</i> : 5 HP, 1800 rpm (60 Hz) or 1500 rpm (50 Hz), NEMA 184 TC Frame
Maximum Production Motor Speed	1500 rpm (50 Hz) 1800 rpm (60 Hz)
Maximum Motor Torque	<i>E-Flo 1500</i> : 9.1 ft-lb (12.3 N•m) <i>E-Flo 2000/3000/4000</i> : 15 ft-lb (20.3 N•m)
Gear Reduction Ratio	75.16:1



Graco Standard Warranty

Graco warrants all equipment referenced in this document which is manufactured by Graco and bearing its name to be free from defects in material and workmanship on the date of sale to the original purchaser for use. With the exception of any special, extended, or limited warranty published by Graco, Graco will, for a period of twelve months from the date of sale, repair or replace any part of the equipment determined by Graco to be defective. This warranty applies only when the equipment is installed, operated and maintained in accordance with Graco's written recommendations.

This warranty does not cover, and Graco shall not be liable for general wear and tear, or any malfunction, damage or wear caused by faulty installation, misapplication, abrasion, corrosion, inadequate or improper maintenance, negligence, accident, tampering, or substitution of non-Graco component parts. Nor shall Graco be liable for malfunction, damage or wear caused by the incompatibility of Graco equipment with structures, accessories, equipment or materials not supplied by Graco, or the improper design, manufacture, installation, operation or maintenance of structures, accessories, equipment or materials not supplied by Graco.

This warranty is conditioned upon the prepaid return of the equipment claimed to be defective to an authorized Graco distributor for verification of the claimed defect. If the claimed defect is verified, Graco will repair or replace free of charge any defective parts. The equipment will be returned to the original purchaser transportation prepaid. If inspection of the equipment does not disclose any defect in material or workmanship, repairs will be made at a reasonable charge, which charges may include the costs of parts, labor, and transportation.

THIS WARRANTY IS EXCLUSIVE, AND IS IN LIEU OF ANY OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO WARRANTY OF MERCHANTABILITY OR WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE.

Graco's sole obligation and buyer's sole remedy for any breach of warranty shall be as set forth above. The buyer agrees that no other remedy (including, but not limited to, incidental or consequential damages for lost profits, lost sales, injury to person or property, or any other incidental or consequential loss) shall be available. Any action for breach of warranty must be brought within two (2) years of the date of sale.

GRACO MAKES NO WARRANTY, AND DISCLAIMS ALL IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, IN CONNECTION WITH ACCESSORIES, EQUIPMENT, MATERIALS OR COMPONENTS SOLD BUT NOT MANUFACTURED BY GRACO. These items sold, but not manufactured by Graco (such as electric motors, switches, hose, etc.), are subject to the warranty, if any, of their manufacturer. Graco will provide purchaser with reasonable assistance in making any claim for breach of these warranties.

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