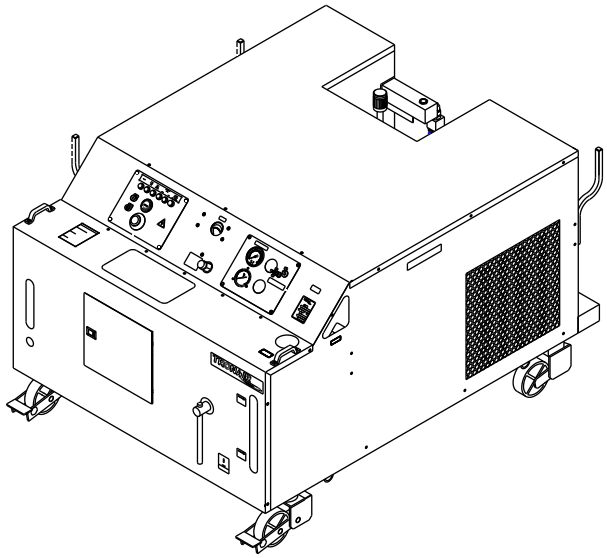
TRONAIR®

OPERATION & SERVICE MANUAL



58X3 Series
5813, 5823, 5833
Hydraulic Power Unit

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06/2022 – Rev. 01

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1.0 PRODUCT INFORMATION

1.1 DESCRIPTION

Hydraulic Power Unit

Model Number	**Fluid Type**
5813	MIL-PRF-5606
5823	MIL-PRF-83282
5833	Aviation Phosphate Ester, Type IV

1.2 MODEL & SERIAL NUMBER

Reference nameplate on unit.

1.3 MANUFACTURER

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1.4 FUNCTION

The Hydraulic Power Unit (HPU) provides a source of clean, pressurized hydraulic fluid for performing required aircraft maintenance. An electric motor drives a pressure compensated piston pump. Filters are provided on the pressure and return systems. A bypass (dump) valve allows starting and stopping of the unit under a no-load, safe condition. The unit may use either the aircraft or on-board HPU reservoir. Cooling is provided for continuous operation.

1.5 REQUIREMENTS

Adequate electrical power must be provided for proper functioning of the HPU. See the unit nameplate for proper voltage and frequency. See the Technical Manual for proper sizing of electrical supply and protection equipment in the facility.

2.0 SAFETY INFORMATION

2.1 USAGE AND SAFETY INFORMATION

The HPU provides pressurized hydraulic fluid for performing aircraft maintenance.

To insure safe operations please read the following statements and understand their meaning. Also refer to your equipment manufacturer's manual for other important safety information. This manual contains safety precautions which are explained below. Please read carefully.

WARNING! — Warning is used to indicate the presence of a hazard that ***can cause severe personal injury, death, or substantial property damage*** if the warning notice is ignored.

CAUTION! — Caution is used to indicate the presence of a hazard that ***will or can cause minor personal injury or property damage*** if the caution notice is ignored.

2.2 EXPLANATION OF WARNING & DANGER SIGNS

Accidental Starts! Before servicing the HPU or equipment, always disconnect electrical power supply to prevent accidental starting.

Rotating Parts! Keep hands, feet, hair, and clothing away from all moving parts to prevent injury. Never operate the HPU with covers, shrouds, or guards removed.

Electrical Shock! Never touch electrical wires or components while the HPU is attached to the power source. They can be sources of electrical shock. DO NOT operate HPU with cabinet panels removed.

Pressurized Fluid! Before servicing the HPU or equipment, always open the bypass valve to relieve any residual pressure in the hydraulic system.

2.3 COMPONENT SAFETY FEATURES

- Pump/Motor coupling guard
- Sheet metal panels
- Pressure and return system relief valves
- Control circuit fuses
- Motor overload protection
- 3- Phase Power Input Fuses

2.4 FUNCTIONAL SAFETY FEATURES

- Emergency shut off switch
- Floor lock
- Calibration port shut off valve
- Fluid sample shut off valve

2.5 PERSONAL PROTECTION EQUIPMENT

- Safety glasses must be worn when operating the HPU.
- Additional equipment recommended by the fluid manufacturer (gloves, etc.). ***Reference Appendix VII Material Safety Data Sheet pertaining to fluid(s).***

2.6 SAFETY GUIDELINES

- Operator must be properly trained prior to operating the HPU.
- HPU power switch must be in "Off" position when connecting or disconnecting hoses to the aircraft.
- Bypass valve must be in the "Open" position when starting or stopping the HPU.
- Electrical power must be disconnected from the HPU and the bypass valve must be in the "Open" position before servicing the HPU.

2.7 GENERAL COMMENTS

The HPU is intended to be operated by personnel trained in the proper use in conjunction with the aircraft maintenance manual.

The HPU must be used in accordance with the Technical and Operator Manuals and the intended aircraft.

3.0 PREPARATION PRIOR TO FIRST USE

3.1 GENERAL

Prior to operating the HPU, the user should become familiar with this Operator Manual.

3.2 SERVICING RESERVOIR

Fill the reservoir with the correct fluid (see label next to reservoir fill for correct type of fluid) until fluid level is above the minimum fluid level mark but below the maximum fluid level. See Figure 6.3.1 Front Panel Controls for reservoir fill location. NOTE: Leave the Reservoir Selector Valve in the Aircraft Reservoir position (as shipped) until the Hydraulic Power Unit reservoir has been filled.

3.3 CONNECTING ELECTRICAL LEADS

Electrical Shock! Never touch electrical wires or components while electrical power is attached. Only qualified electricians should connect the electrical leads.

Install the proper electrical plug onto the electrical cord. Read ***5.0 Training*** and ***6.0 Operation*** of this manual and become familiar with control locations. Reference ***5.1 Electrical Power and Protection Requirements Table*** for power requirements and fuse sizes. Follow instructions in ***5.4.1 Pump Rotation Checking Procedure***.

WARNING!

Balanced three phase voltage must be available to prevent overheating and damage to the motor.

Voltage unbalanced between phases occurs when the voltages differ from one another.

Some reasons for imbalance are:

1. **Unequal loading of each phase**
2. **Poor connections in the supply**
3. **Single phase condition caused by blown fuses or bad connections**

If these conditions occur in the incoming power system, a protective devise, such as a voltage monitor, should be installed on the machine to prevent motor damage.

4.0 TRAINING

4.1 TRAINING REQUIREMENTS

The employer of the operator is responsible for providing a training program sufficient for the safe operation of the HPU.

4.2 TRAINING PROGRAM

The employer provided operator training program should cover safety procedures concerning use of the HPU in and around the intended aircraft at the intended aircraft servicing location.

4.3 OPERATOR TRAINING

The operator training should provide the required training for safe operation of the HPU.

NOTE: Maintenance and Trouble Shooting are to be performed by a skilled and trained technician.

5.0 OPERATION

5.1 OPERATING PARAMETERS

- The user shall use the HPU in accordance with the aircraft manufacturer's instructions.
- The user shall operate the HPU in accordance with the Technical and Operator Manuals.
- The employer of the operator shall provide all necessary training.
- The electrical power supply for the HPU must include a fused disconnect using Type J or Type R fuses or equivalent magnetic type circuit breakers designed for protecting an electrical motor. This necessary equipment is for protection of the HPU, power cord, and customer-supplied plug and receptacle. *Reference the Table below:*

ELECTRICAL POWER AND PROTECTION REQUIREMENTS

60 Hz Applications			
Voltage	380	460	575
Full Load Amps	130	121	96.8
Locked Rotor Amps	908	789	632
Recommended Fuse Size	175	150	125
Maximum Fuse Size	200	175	150

50 Hz Applications			
Voltage	380	415	440
Full Load Amps	146	134	124
Locked Rotor Amps	849	778	734
Recommended Fuse Size	200	175	150
Maximum Fuse Size	200	200	175

5.2 NUMERICAL VALUES

5.2.1 Fluid

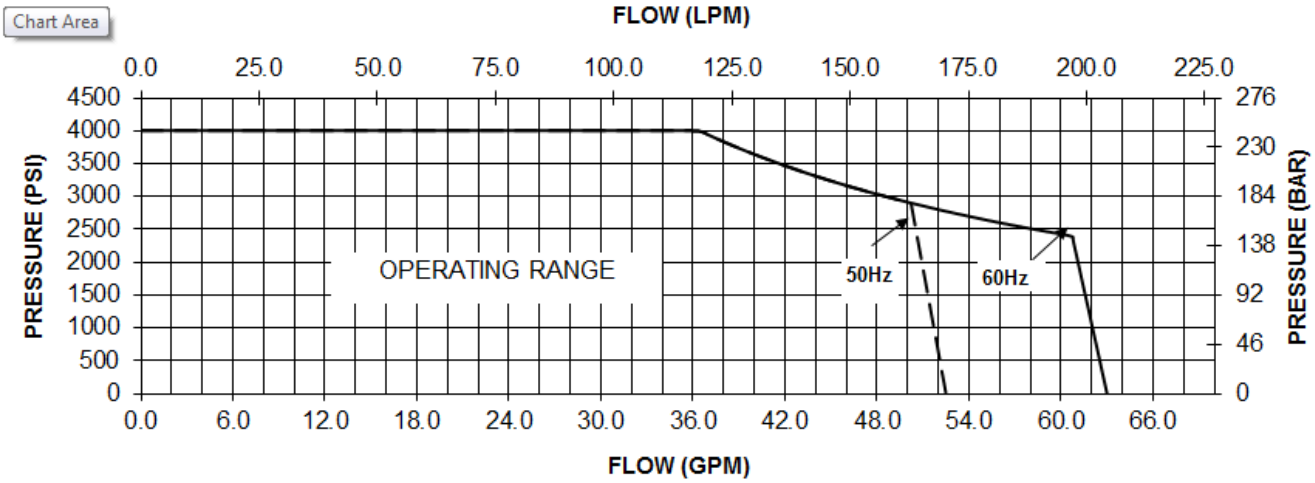
Model Number	**Fluid Type**
5813	MIL-PRF-5606
5823	MIL-PRF-83282
5833	Aviation Phosphate Ester, Type IV

5.2.2 Physical

- Weight (Dry): 6,000 lbs (2722 kg) Estimated
- Dimensions:
  - Width 68-5/8 in (35 cm) Add 6.0 in (15.2 cm) for Split System
  - Height 62-7/8 in (25 cm)
  - Depth 101-13/16 in (40 cm) Add 11 in (25 cm) for trailer option
- Power Cord: 50 ft (15.24 m) long
- Pressure Hoses: 25 ft (7.62 m)..... Standard Length
  50 ft (15.24 m)..... Optional Length
  -16 (1 in, 25.4 mm)..... Working Diameter
- Return Hoses: 25 ft (7.62 m)..... Standard Length
  50 ft (15.24 m)..... Optional Length
  -24 (1½ in, 38.1 mm)..... Working Diameter
- Hand Pump Hose: 15 ft (4.57 m)..... Standard Length
  -4 (¼ in, 6.35 mm) Working Diameter

5.2.3 Motor Driven Hydraulic Pump

- A pressure compensated, adjustable maximum volume piston pump.
- Maximum flow at 60 Hz ..... 63 gpm (239 lpm)
- Maximum flow at 50 Hz ..... 53 gpm (200 lpm)
- Maximum operating pressure at 50 Hz and 60 Hz ..... 4,000 psi (276 bar)
- System pressure relief valve setting ..... 4,250 psi (293 bar)
- Performance Curve for 50 Hz and 60 Hz



5.2.4 Electric Motor

A 100 horsepower, TEFC electric motor is the prime mover for the HPU. This is attached to the hydraulic pump using a pump/motor adapter and a spider/coupling rotating interface.

MOTOR POWER REQUIREMENTS

60 Hz Applications	
Voltage	**Full Load Amps**
380	130
460	121
575	96.8

50 Hz Applications	
Voltage	**Full Load Amps**
380	146
415	134
440	124

5.2.5 Filters

- Pressure ..... 2 micron rating, non-bypass high collapse microglass type. Non-cleanable element.
- Return ..... 5 micron rating, 25 psi (1.72 bar) bypass microglass type. Non-cleanable element.
- Hand Pump *(Option M)* ..... 2 micron rating, non-bypass microglass type. Non-cleanable element.
- Air/Desiccant ..... 3 micron filter, silica gel desiccant type. Non-cleanable element.

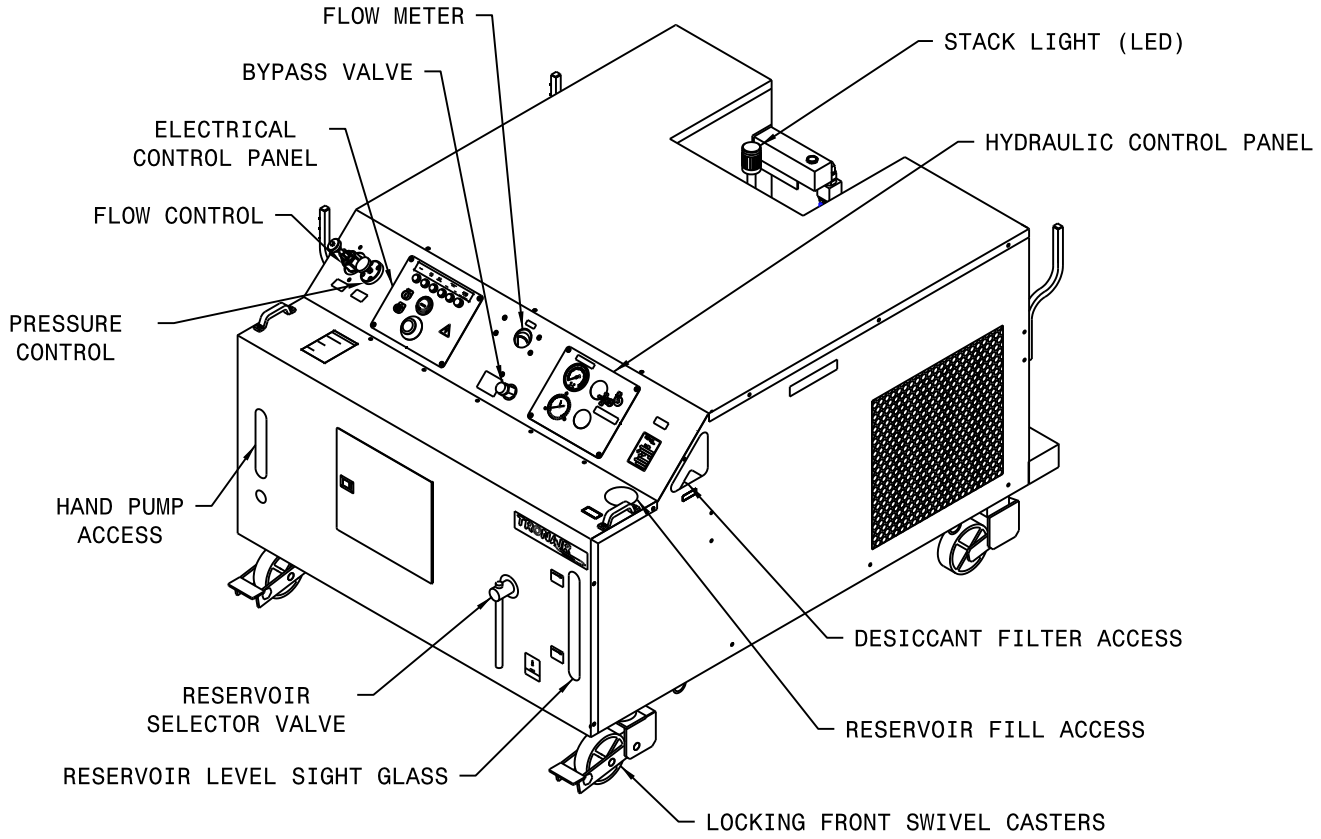
5.2.6 Hand Pump *(Option M)*

Two stage hand pump, low pressure stage 0–500 psi (0–34.47 bars) and 500–5,000 psi (34.47–344.74 bars) high pressure stage. Pump automatically changes stage internally based on system pressure.

Low Pressure Stage:	Piston Diameter	1½ in (38.1 mm)
	Working Pressure	0–500 psi (0–34.47 bar)
	Displacement/Stroke	2.1 in3 (34.4 cm3)
	Force/100 psi (6.89 bar)	12.0 lbs/100 psi (7.74 N/bar)
High Pressure Stage:	Piston Diameter	5/8 in (15.88 mm)
	Working Pressure	500–5,000 psi (34.47–344.74)
	Displacement/Stroke	0.4 in3 (6.55 cm3)
	Force/100 psi (6.89 bar)	2.2 lbs/100 psi (1.42 N/bar)
Pressure Relief Setting:	5,250 psi (362.0 bar)	

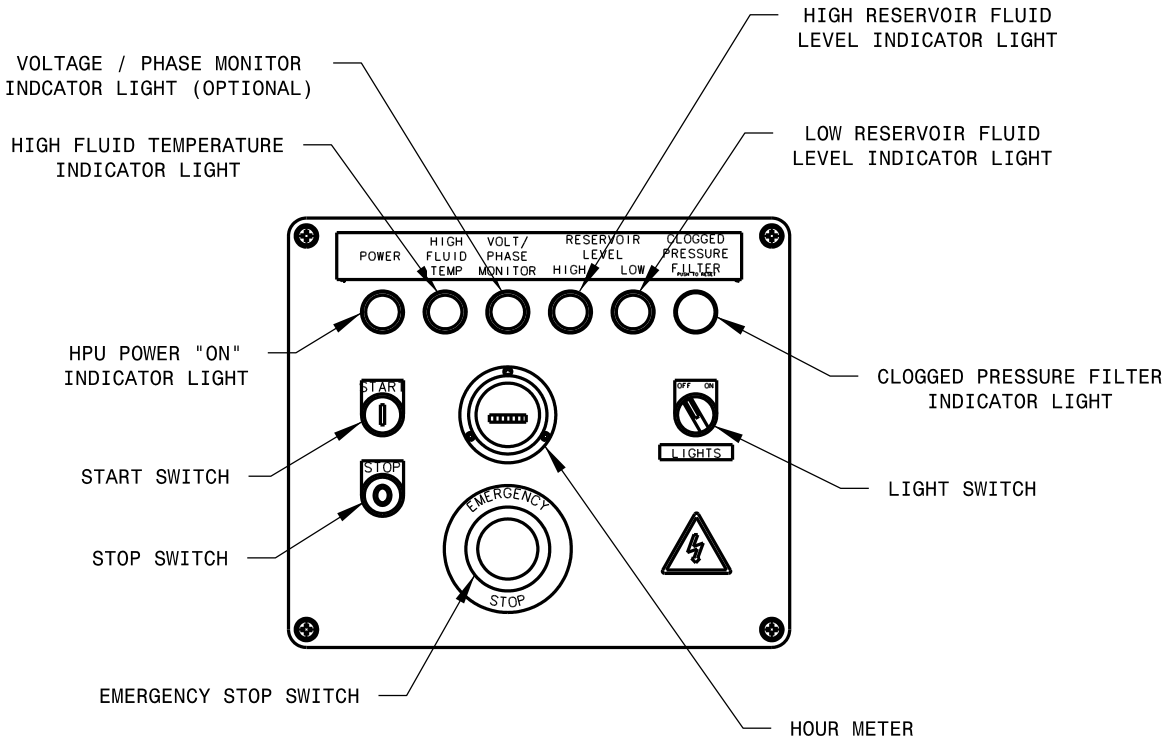
5.3 LOCATION & LAYOUT OF CONTROLS

5.3.1 Front Panel Controls



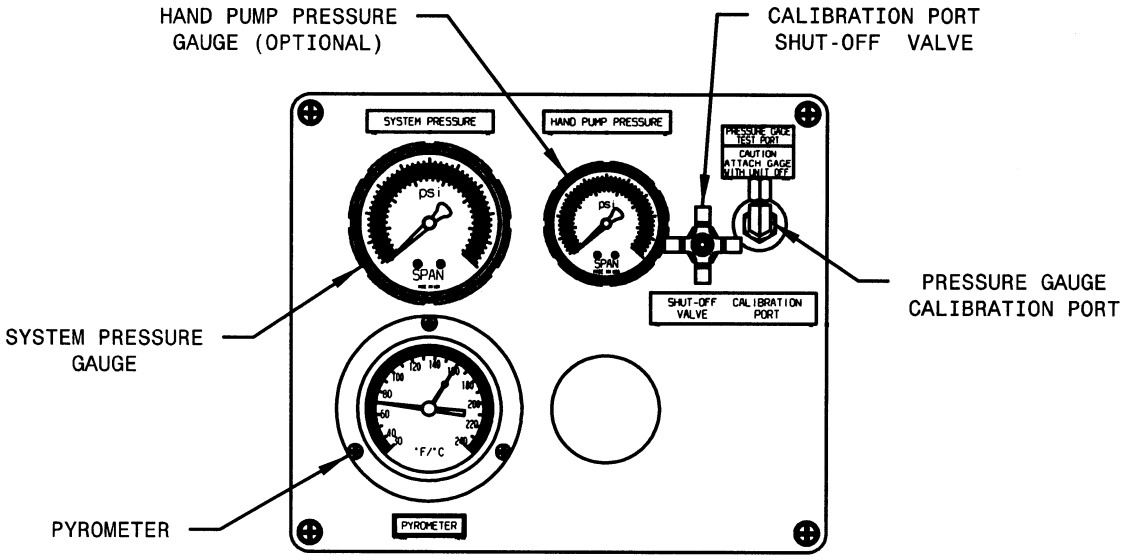
Electrical Control Panel	See Section 6.3.2
Hydraulic Control Panel	See Section 6.3.3
Bypass Valve	For loading and unloading the motor driven hydraulic pump
Flowmeter	Displays the flow from the motor driven hydraulic pump
Reservoir Selector	For selecting between using the aircraft reservoir or the HPU reservoir
Sight Gauge	Visual indicator displays the fluid level in the reservoir
Reservoir Fill Access	Locking cap for servicing the HPU reservoir
Desiccant Filter	Access to the reservoir air filter/desiccant filter
Hand Pump *(Option M)*	Access for hand pump and relief screw, handle stored inside
Locking Swivel Caster	Locking/unlocking, foot actuated and released locking front caster
Stack Light *(Option SL)*	Displays green LED light when unit is running
Flow Control	See 6.3.5 Hydraulic Pump Controls
Pressure Control	See 6.3.5 Hydraulic Pump Controls

5.3.2 Electrical Control Panel



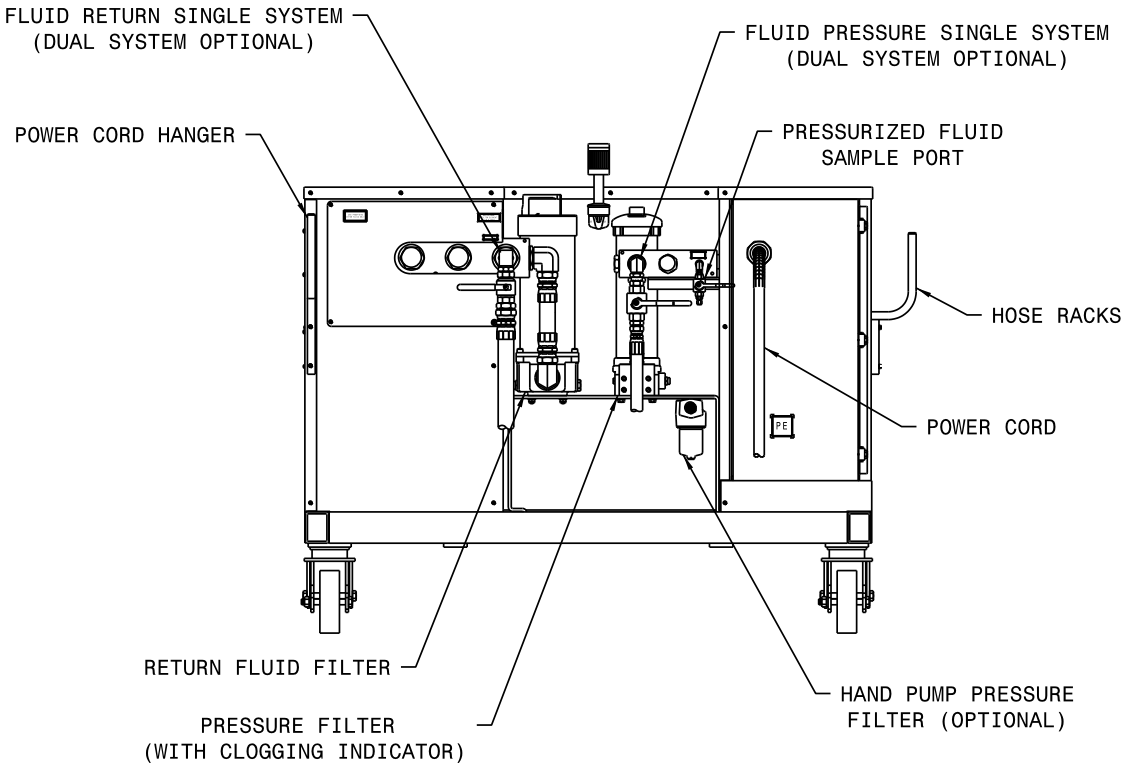
Emergency Stop	Removes power to all electrical devices, must turn to reset
Stop Switch	Turns off the electric motors driving the hydraulic pump and cooling fan
Start Switch	Turns on the electric motors driving the hydraulic pump and cooling fan
HPU Power "On" Indicator Light	Light is illuminated when the electric motors driving the hydraulic pump and cooling fan are on
High Fluid Temperature Indicator Light	Light is illuminated when the return fluid temperature reaches 160° F (71° C) or above. The HPU will shut down when light is illuminated. The HPU can be re-started when the fluid has cooled and the indicator light is off
High Reservoir Fluid Level Indicator Light	Light is illuminated when the fluid level in the reservoir is above the normal operating range. The HPU will shut down until the fluid level is restored to a normal operating level
Light Switch	Turns on lights for viewing return sight gauge instrumentation in low light conditions
Low Reservoir Fluid Level Indicator Light	Light is illuminated when the fluid level in the reservoir is below the normal operating range. The HPU will shut down until the fluid level is restored to a normal operating level
Voltage/Phase Monitor Indicator Light	Light is illuminated if any of the following conditions occur - Voltage imbalance between L1, L2, L3, greater than 5% - Loss of voltage from L1, L2, L3 - Over voltage from L1, L2, L3, greater than 5% - Change in phase orientation between L1, L2, L3. The HPU will shut down until the electrical problem is corrected
Clogged Pressure Filter Indicator Light	Light is illuminated when the pressure filter element requires changing. The HPU will not shut down when illuminated. Pressing the illuminated button will reset the light

5.3.3 Hydraulic Control Panel



System Pressure Gauge	Displays the system pressure on an analog fluid dampened gauge
Pyrometer	Displays the fluid temperature in the return system on an analog gauge. A warning indicator preset to 160° F (71° C) warns of high operating temperature
Pressure Gauge Calibration Port	Allows for calibration of the system pressure gauge up to the operating pressure of HPU. Calibration port shut off valve must be used in conjunction with the calibration port
Calibration Port Shut Off Valve *(Part of Calibration Port)*	Used to shut off pressure to the calibration port. This valve should only be opened when the external standard gage is attached. (See Operation & Service Manual for proper procedure)
Hand Pump Pressure Gauge *(Option M)*	Displays the hand pump system pressure on an analog fluid dampened gauge

5.3.4 Rear Panel Controls

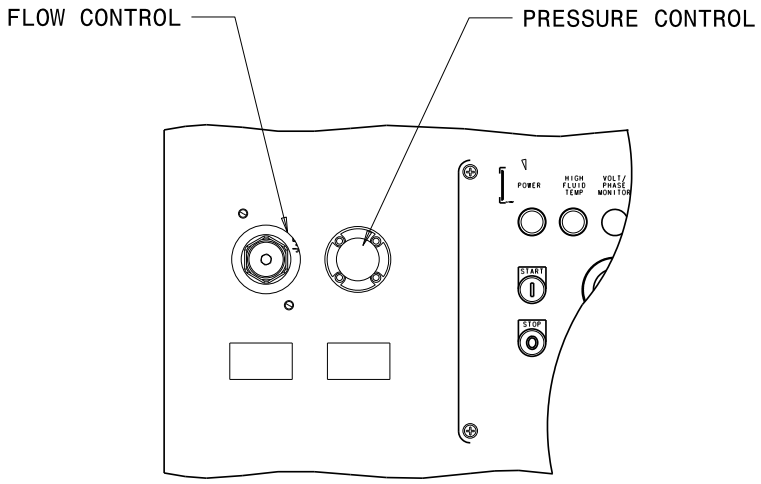


* Fluid Pressure System	The source of pressurized fluid from the HPU that flows to the aircraft pressure system through the pressure hose
* Fluid Return System	Fluid returning to the HPU from the aircraft that flows through the return hoses
Pressure Fluid Filter	Filters the pressurized fluid before it flows to the aircraft pressure system
Return Fluid Filter	Filters the fluid returning from the aircraft before it enters the HPU
Pressurized Fluid Sample Port	A sample valve is provided to obtain a fluid sample for analysis. In order to obtain a representative sample, it is suggested that ANSI/B93.19M-1972(R1993) be followed
Hand Pump Pressure Filter *(Option M)*	Filters the pressurized fluid before it flows to the aircraft system
Hose Racks	Location for storing the pressure, return and optional hand pump hoses when not in use
Power Cord Hanger	Location for storing the power cord when not in use

* ***Split System (Optional) consists of two (2) each of these items.***

5.3.5 Hydraulic Pump Controls

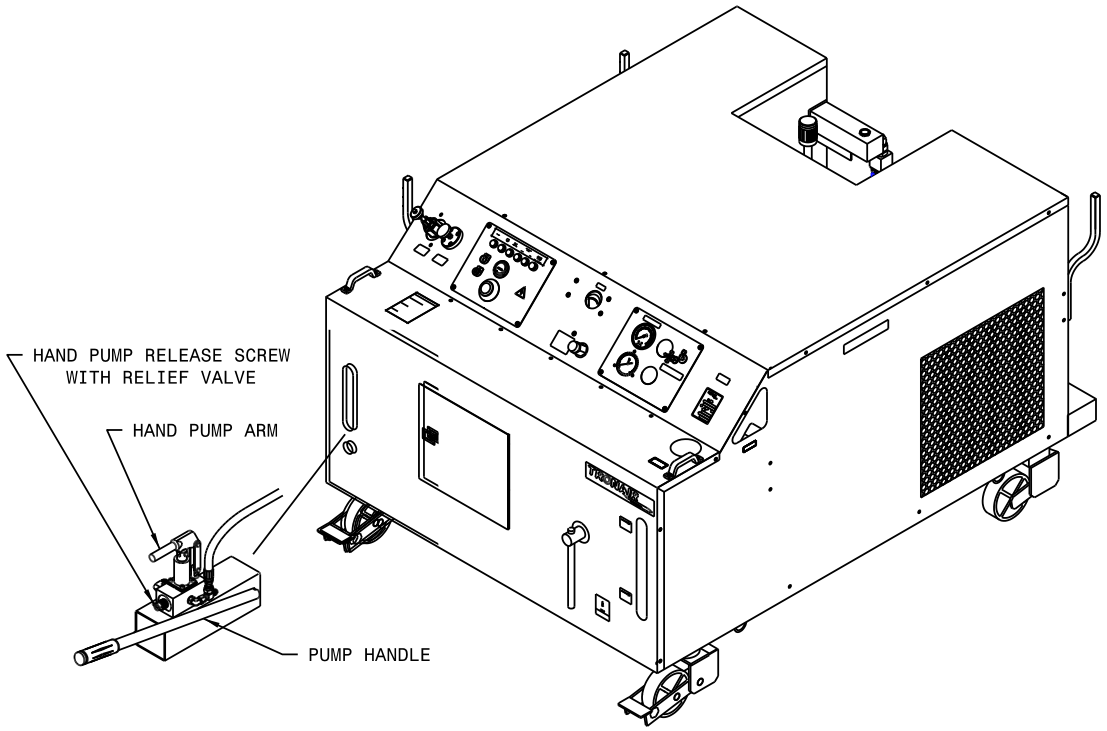
The hydraulic pump flow control and pressure control are located through the pump control access door.



Flow Control	This control is used to set the maximum flow required from the HPU
Pressure Control	The pressure control is used to set the system pressure of the HPU during operation

5.3.6 Hand Pump Controls *(Option M)*

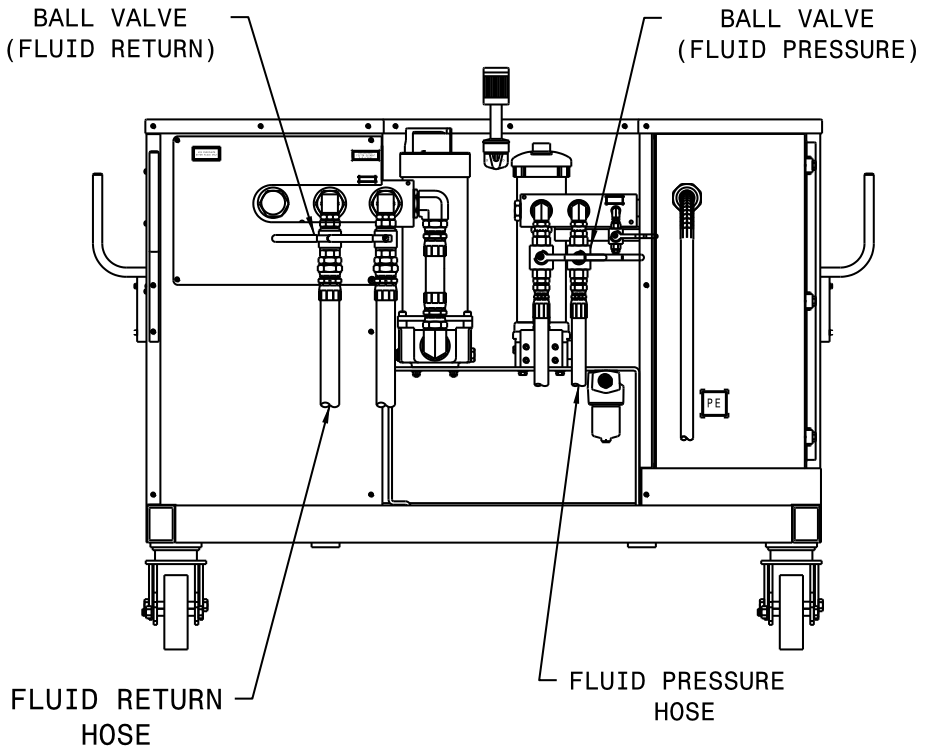
Reference 5.8 Hand Pump Operation



Pump Handle	Located inside the front access door is the hand pump handle used for opening and closing the hand pump relief screw and stroking the hand pump arm
Hand Pump Relief Screw	Accessed through the front panel opening, this screw allows opening and closing of the hand pump hydraulic circuit using the hand pump handle
Hand Pump Arm	The handle is used to access the hand pump arm used for up and down motion to produce hydraulic flow and pressure

5.3.7 Split System Controls ***(****Option C)*

Reference 5.7 Split System Operation



Fluid Pressure Ball Valve	Used to turn on and off the flow to separate aircraft systems. Always use in either fully open or fully closed position; never use in a partially open position
Fluid Pressure Hose	Connects HPU to aircraft pressure systems
Fluid Return Hose	Connects HPU to aircraft return systems
Fluid Return Ball Valve	Used to turn on and off the flow from separate aircraft systems. Always use in either fully open or fully closed position; never use in a partially open position

WARNING!

NEVER open or close split system valves without shutting off the Hydraulic Power Unit. Damage to the aircraft system or reservoir may result if either return line valve is closed while the machine is running.

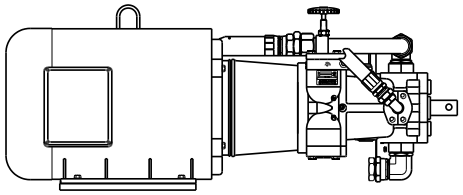
5.4 START UP PROCEDURES

5.4.1 Pump Rotation Check Procedure (First Time Use or Change of Electrical Supply Only)

Phase Monitor (Options H – J Only): Check that the phase monitor light on the instrument panel is not illuminated. If the light is illuminated, change any two of the three input leads at the plug. Once the phase monitor light is not illuminated with power attached, check for proper motor rotation.

To check rotation (with or without Phase Monitor):

a. Close the fluid pressure ball valve(s) at the rear of the HPU. Reference ***5.3.4*** for location of ball valve.
b. Open the bypass valve on the instrument panel fully counter-clockwise.
c. Set the flow control on the pump to maximum flow (fully counter-clockwise).
d. Place the reservoir selector valve in HPU Reservoir position.
e. Remove the pump/motor coupling guard. Reference Pump/Motor Coupling Access. figure



Pump/Motor Coupling Access

Rotating Parts! Keep hands, feet, hair, and clothing away from all moving parts to prevent injury. Never operate the HPU with covers, shrouds, or guards removed.

Electrical Shock! Never touch electrical wires or components while the HPU is attached to the power source. They can be sources of electrical shock. Do not operate HPU with cabinet panels removed.

f. Verify that the unit has been prepared for use by connecting electrical leads and servicing the reservoir. (Reference 3.0 Preparation Prior to First Use)
g. Keeping hands clear of the pump/motor coupling area, momentarily press the start button and immediately press the stop button.
h. Observe direction of rotation of the pump/motor coupling. When the Operator is facing the front panel, the pump/motor coupling should be rotating in a clockwise direction.
i. If the pump/motor coupling is rotating in a counter-clockwise direction, change any two of the three leads at the plug. Observe direction of rotation to verify that pump/motor is rotating in a clockwise direction.
j. Replace the pump/motor coupling guard.

5.4.2 Initial Start Up of the HPU

a. Unit must be prepared per ***4.0 Preparation Prior to First Use*** and ***6.4.1 Pump Rotation Check Procedure (First Time Use or Change of Electrical Supply Only)*** before starting the HPU.
b. Operator must be familiar with this manual and be properly trained prior to starting the HPU.
c. Close the fluid pressure ball valve(s) at the rear of the HPU. Reference ***5.3.4*** for location of ball valve.
d. Open the bypass valve on the instrument panel fully counter-clockwise.
e. Set the flow control on the pump to maximum flow (fully counter-clockwise).
f. Place the reservoir selector valve in HPU Reservoir position.
g. Press the start switch; the flowmeter should show full flow immediately. If no flow displays on the flow meter, press the stop switch immediately and reference ***8.2 No Flow*** in Trouble Shooting section.
h. Adjust the flow down to approximately 10–20 gpm (38–76 lpm).
i. Close the bypass valve, adjust the pressure control until 3,000 psi (206.84 bar) is displayed on the pressure gauge. (If no pressure displays on the system pressure gauge after adjusting the pressure control, reference ***Trouble Shooting 8.4 No Pressure or Reduced Pressure)***.
j. Open the bypass valve; press the stop switch

NOTE: Maintenance and Trouble Shooting are to be performed by a skilled and trained technician.

5.5 PRELIMINARY ADJUSTMENTS FOR OPERATION

The following are basic to the operation of the HPU and should be thoroughly understood. The pressure and flow controls have lock nuts to prevent rotation of the control shaft during operation. These nuts should be moved away from the pump during adjustment of flow or pressure in order to eliminate binding of the control shafts.

5.5.1 Flow Control Adjustment

a. Open bypass valve.
b. Select "Hydraulic Power Unit" position with reservoir selector valve.
c. Start HPU.
d. Adjust flow control on pump for maximum desired flow. Observing the flowmeter, read flow in gallons (liters) per minute directly from flowmeter. Be sure the control shaft lock nut is loose during adjustment. Tighten after adjustment to maintain setting.

5.5.2 Pressure Control Adjustment

a. Open bypass valve.
b. Select "Hydraulic Power Unit" position with reservoir selector valve.
c. Start HPU.
d. Close bypass valve.
e. Adjust pressure control for desired pressure; observing the system pressure gauge, read in psi (bars). Be sure the control shaft lock nut is loose during adjustment. Tighten after adjustment to maintain setting.

NOTE: Once the flow and pressure controls have been adjusted, it is not necessary to change these settings after each operation unless desired.

5.5.3 Reservoir Selector Valve Operation

Operation of the reservoir selector valve allows the operator to select either the aircraft reservoir (closed loop) or the HPU reservoir (open loop).

CAUTION!

The reservoir selector valve should only be operated when the HPU is not running. The operation of the reservoir selector valve should be done prior to starting the HPU.

a. Aircraft Reservoir Position (Closed Loop)
In this position, the HPU is dependent on the aircraft reservoir and system for an adequate supply of fluid. Cavitation, due to an inadequate fluid supply from the aircraft, may be indicated by erratic fluctuation of the system pressure gauge or flowmeter. At times, the aircraft fluid supply will be restricted due to small return oil lines in the aircraft. If this is a problem, decrease the flow control setting until the cavitation is eliminated.

b. HPU Reservoir Position (Open Loop)
In this position, the HPU reservoir supplies fluid to the pump and accepts return fluid from the aircraft. It is desirable to operate the HPU in this mode since it eliminates any possibility of cavitation.

Since the HPU reservoir is vented to atmosphere and the aircraft is at a higher level, it is normal for the aircraft reservoir to drain into the HPU reservoir. It is, therefore, necessary to be sure that sufficient room is available in the HPU reservoir to accommodate the additional fluid.

CAUTION!

The aircraft system reservoir must be serviced after completion of operational testing.

In the "HPU Reservoir" position, faster landing gear swings are usually possible since there is no restriction to flow at the pump inlet.

5.5.4 Bypass Valve Operation

The bypass valve is used for unloading the pump. The valve should be either in the fully open or fully closed position only. Do not operate the valve in a partially open position.

a. Start Up Operation
The bypass valve must be opened prior to starting the HPU in order to allow the motor to start under a no load condition and not pressurize the aircraft hydraulic system.

b. Shut Down Operation:
Prior to shutdown, the bypass valve must be opened to bleed off any residual system pressure.

CAUTION!

Excessive heat, which could damage machine components, will be generated if the bypass valve is partially open or is used for regulating flow or pressure.

- **Use the flow and pressure controls for regulation.**
- **Use the bypass valve for unloading the system only.**

5.5.5 RETURN BACK-PRESSURE VALVE OPERATION

The **backpressure** valve is used for maintaining a preset (adjustable) pressure in the return line from the aircraft. The **backpressure bypass** valve allows fluid to flow directly from the aircraft to the HPU reservoir, bypassing the backpressure valve. The **return line pressure gauge** displays the pressure in the return line from the aircraft (See figure 6.3.4 on page 11). The **backpressure bypass** valve can also be used to slowly relieve the backpressure in the return line.

Return Backpressure Setting:

1. Disconnect electrical power from the HPU.
2. Connect the pressure and return hoses together (matching systems).
3. Open the pressure and return system **ball valves**.
4. Connect electrical power to the HPU.
5. Open the system bypass valve, start the HPU, set the flow to one (5) gpm.
6. With the HPU running, close the **system bypass** valve and the **return bypass** valve.
7. While observing the return line **pressure gauge**, adjust the **return backpressure** valve to the desired pressure by turning the knob clockwise to increase pressure; counterclockwise to decrease pressure.
8. Open the **system bypass** valve.
9. Shut off the HPU.
10. Disconnect electrical power from the HPU.
11. Return the hoses to the original condition.

NOTE: Once the back pressure valve has been adjusted, it is not necessary to change the setting after each operation.

5.5.6 RETURN SIGHTGAUGE

The **return sightgauge** is used for monitoring the return fluid from the aircraft. This gauge displays the fluid in return line, allowing a visual check for air in the aircraft hydraulic system (See figure 6.3.4). A light behind the sightgauge is supplied for easy viewing in poor lighting conditions (See figure 6.3.2).

5.6 BLEEDING AIR FROM SYSTEM

Rapid fluctuations of the pressure gauge and flow meter are indications of cavitation or entrapped air in the hydraulic lines and/or components. Air may enter the system when:

- Operating the unit with insufficient oil in the reservoir.
- Changing a component on the aircraft.
- Changing hose connections and/or couplings.

5.6.1 To Easily Purge the Unit of Air

a. Fill reservoir to recommended level.
b. Open bypass valve.
c. Place reservoir selector valve in “Hydraulic Power Unit” position.
d. Start unit and adjust flow control to maximum position.

NOTE: If fluid is not flowing, shut off HPU and reference 8.2 No Flow in Trouble Shooting section

e. Run unit for five (5) minutes and shut off.
f. If additional bleeding is required, connect the pressure and return hoses together and open all pressure and return ball valves at the rear of the HPU. Start the HPU and slowly close the bypass valve (system pressure should remain under 200 psi (approximately 14 bar). Allow fluid to flow at full flow for five (5) minutes, then shut the HPU off.

WARNING!

Failure to open the return ball valves will cause hose or valve rupture. Property damage and personal injury can result.

5.7 SPLIT SYSTEM OPERATION

The split system option allows control of fluid flow to aircraft with two hydraulic systems. The systems consist of two sets of hoses and valves located in the pressure and return systems. The valves are mounted on the rear of the hydraulic power unit and are of the 90° ball type. The valves are open when the operating handle is in line with the valve.

Although both systems may be operated simultaneously, usually only one system is required at any one time. If both valve sets are open simultaneously, the pump output will be divided between the two systems. Also, cross flow between aircraft reservoirs may occur if a reservoir level or pressure differential exists. Select valve positions prior to starting machine.

5.7.1 To Operate the Split System

a. Before starting machine, open pressure and return valves of the same system.

WARNING!

Ensure pressure and return hoses of the same system are paired and used together.

b. After completing tests on one system, shut the machine off before selecting the second system.

WARNING!

NEVER open or close split system valves without shutting off the Hydraulic Power Unit. Damage to the aircraft system or reservoir may result if either return line valve is closed while the machine is running.

5.8 HAND PUMP OPERATION *(Option M)*

The Hand Pump Option allows for filling the reservoir (low pressure) or static testing of components or system (high pressure). The hand pump circuit is separate from the main hydraulic system; a separate filter and hose are attached to the back panel of the HPU.

5.8.1 To Operate the Hand Pump

a. Remove the pump handle from inside the front access door. (Reference ***5.3.6 – Hand Pump Controls***)
b. Insert the end of the pump handle through the front panel opening into the hand pump relief screw.
c. Turn the pump handle clockwise to close the relief screw.
d. Insert the pump handle onto the hand pump arm through the front panel slot.
e. Pump the handle using an up and down motion. Observe the hand pump system pressure on the hydraulic control panel (***Figure 6.3.3 Hydraulic Control Panel***). The pump is an automatic two stage pump. 500 psi (34.47 bar) can be produced with high fluid flow and 5,000 psi (344.74 bar) can be produced with low fluid flow.
f. Turning the relief screw in a counter-clockwise direction releases hydraulic pressure in the hand pump system.

Pressurized Fluid! Before disconnecting the hand pump pressure hose, ALWAYS open the relief screw valve to relieve any residual pressure in the hydraulic system.

5.9 SAMPLE VALVE

A sample valve is provided on the rear of the unit to obtain a fluid sample for analysis or inspection.In order to obtain a representative fluid sample, it is suggested that ANSI/B93.19M-1972 (R1993) be followed. *Reference Appendix VIII*.

Pressurized Fluid! Before servicing the HPU or equipment, ALWAYS open the bypass valve to relieve any residual pressure in the hydraulic system.

5.10 EMERGENCY SHUT DOWN PROCEDURE

In the event an emergency shut down is necessary, press the emergency stop switch located on the electrical panel. (Reference ***5.3.2 – Electrical Control Panel***) Open the bypass valve to remove any system pressure.

5.11 DESCRIPTION OF ALARM SYSTEMS

Reference **5.3.2 – Electrical Control Panel**

5.11.1 High Fluid Temperature Indicator

The indicator light for high fluid temperature is an active light which will illuminate when the return fluid temperature is 160° F (71° C) or above. The HPU will shut down if the light is illuminated. The HPU can be re-started when the fluid has cooled sufficiently and the light has shut off.

If the high temperature light is illuminated reference section 8***.0 Trouble Shooting***.

5.11.2 Voltage/Phase Monitor Indicator

The indicator light for the voltage/phase monitor is an active light which will illuminate if there is a problem with the incoming electrical power source. The HPU will shut down if the light is illuminated.

If the voltage/phase monitor light is illuminated, reference section 8.0 Trouble Shooting.

5.11.3 High and Low Reservoir Level Indicator *(Option L)*

The indicator lights for high and low reservoir level are active lights which will illuminate when the reservoir fluid level is either above the maximum level or below the minimum level. The HPU will shut down if either of the lights are illuminated.

If the light on either of the reservoir level indicator lights, restore the fluid level in the reservoir to a normal operating range.

5.11.4 Clogged Filter Indicator Light

The indicator light for the clogged filter is a passive light which will illuminate if the pressure filter element becomes clogged or is in need of replacement. The HPU will not shut down if the light is illuminated.

If the clogged filter indicator light is illuminated, the pressure filter element requires changing. Reference 9.5.1 Pressure Filter Element) for maintenance procedure. Pressing the clogging filter indicator light will reset the light and the light will turn off.

NOTE: Maintenance and Trouble Shooting are to be performed by a skilled and trained technician.

5.12 INFREQUENT HPU USE

If the unit is not used frequently Tronair recommends operating the unit monthly. Operating regularly assures that the seals are kept lubricated, eliminates air pockets in the system, reduces moisture in the fluid and helps extend the hose life.

5.12.1 Infrequent HPU Use Start Up Procedure

1. Assure that the HPU reservoir is filled between the minimum and maximum level
2. Connect the unit to a proper electrical power source
3. If unit is equipped with a run around kit, connect the pressure and return hoses together
4. Place the reservoir selector valve in “HPU Reservoir” position
5. Open the return ball valves on the back of the unit
6. Pressure ball valves
   a. If unit **IS** equipped with a runaround kit **ensure the hoses are connected to each other**, open the pressure ball valves on the back of the unit
   b. If the hoses **are not connected to each other**, close the pressure ball valves on the back of the unit
7. Verify the return ball valves on the back of the unit are open
8. Fully open the bypass valve
9. Adjust the pressure control to the minimum setting (CCW)
10. Start the unit and verify the flow is above “0” on the flowmeter
    a. If flow is present: adjust the flow control to increase flow (CW)
    b. If no flow is immediately present: turn unit off, verify the motor rotation (see 3.3 Connecting Electrical Leads), correct rotation if necessary
11. Set flow to ½ the maximum flow capacity of the unit. You may need to increase the pressure adjustment to achieve flow.
12. Bypass valve
    a. If unit **IS** equipped with a runaround kit **ensure the hoses are connected to each other**, fully close the bypass valve
    b. If the hoses **are not connected to each other**, leave the bypass valve fully open
13. Operate the unit for 15-30 minutes in this condition. Fluid temperature should reach 100º-130º F (37.8º-54.4º C)
14. At the completion of the 15-30 minute circulation run, open the bypass valve and shut off the unit
15. Remove the electric power
16. Place the selector valve in the Aircraft Reservoir position
17. Close the pressure and return ball valves on the back of the unit

6.0 PACKAGING AND STORAGE

6.1 PACKAGING REQUIREMENTS

a. Drain hydraulic fluid until level is below the minimum fluid level indicator.
b. Block up the unit on a pallet so the wheels are not touching the pallet or shipping container.
c. Plug all hose ends.
d. Strap unit to pallet or shipping container using the tie down rings located on the frame bottom.

NOTE: Use at least four (4) straps with a minimum 8,000 lb (3,629 kg) capacity each.

6.2 HANDLING

The unit is designed to be moved by hand using the handles located on the front of the unit. The unit can be lifted by means of a fork truck from the center of the machine. Lifting must be from the motor side of the unit only.

***NOTE: Be sure the forks are long enough to reach the frame cross members for stability during lifting. Spread the forks to their maximum width for stability. Reference Figure HPU on Forklift*.**

6.3 PACKAGING PROTECTION

No special packaging material for cushioning or suspension is required.

6.4 LABELING OF PACKAGING

Packaging should be labeled as follows:

DO NOT DROP
THIS SIDE UP
DO NOT STACK

6.5 STORAGE COMPATIBILITY

No special considerations for short term storage (less than three months).

6.6 STORAGE ENVIRONMENT

Cover HPU with a suitable, non-abrasive tarp if storing outside. For storage periods greater than three months, drain hydraulic fluid from all hoses and the reservoir. Cover unit to protect outside surface.

If storing outside, protect unit from freezing water, sand, dirt, and direct sunlight. A cover is highly recommended.

6.7 STORAGE SPACE AND HANDLING FACILITIES

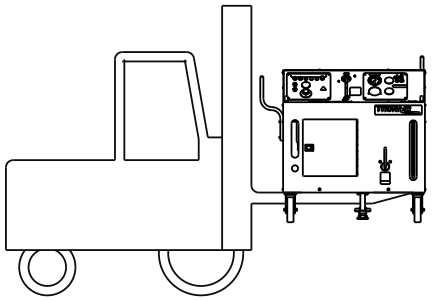
- Weight (Dry): 6,000 lbs (2,722 kg)
- Dimensions**:** Width 68-5/8 in (35 cm) Add 6.0 in (15.2 cm) for Split System
  Height 62-7/8 in (25 cm)
  Depth 101-13/16 in (40 cm) Add 11 in (25 cm) for trailer option

7.0 TRANSPORTATION

1. Do not stack Hydraulic Power Units.
2. The unit can be lifted by means of a fork truck from the motor side center of the HPU.

NOTE: Be sure the forks are long enough to reach frame cross members for stability during lifting. Spread the forks to their maximum width for stability. Reference figure HPU on Forklift.

- Weight (Dry)**:** 6,000 lbs (2,722 kg) *Estimated*



HPU on Forklift

8.0 TROUBLE SHOOTING

The following is a guide to solutions of common problems associated with the HPU. See related Appendices for Hydraulic and Electrical Schematics.

If the problem is not resolved using the trouble shooting information, call the manufacturer for Technical Assistance (See Section ***1.3 Manufacturer***).

NOTE: Maintenance and Trouble Shooting are to be performed by a skilled and trained Technician.

8.1 HPU WILL NOT START

Possible Cause	Solution
Supply power off	Check incoming power and restore power. Check across-the-line voltage on all three phase legs
Supply power fuses are blown/ circuit breakers tripped	Check and replace. Check across-the-line voltage on all three phase legs
Control Transformer fuses blown	Check and replace
Supply power phase or voltage incorrect *(Phase/Voltage Monitor Option G – J only)*	Voltage/Phase Monitor Indicator light will be illuminated Refer to Section 3.3 Connecting Electrical Leads
Reservoir fluid level is too high or too low *(Electric Reservoir Level Option L only)*	One reservoir level indicator light (Low or High) will be illuminated. Fill the reservoir above the Minimum Fluid Level arrow to extinguish the Low Level light. Drain fluid below the Maximum Fluid Level arrow to extinguish the High Level light
High return fluid temperature *(Electric Over-Temperature Option S only)*	High Fluid Temperature indicator light will be illuminated. Allow the hydraulic fluid to cool until the light goes out. Refer to Section 8.5 for over-heated causes
Motor has tripped thermal overload device	Allow the motor to cool. The thermal overload device (motor starter) will reset automatically after sufficient cooling. The tripped condition is usually caused by loading the motor beyond its rated capacity; however, any condition (such as unbalanced voltage) that causes an increase in amperage can result in a tripped condition

NOTE: Using the bypass valve to meter flow or pressure will increase the motor load and may cause the thermal overload device to trip. Refer to section 6.5.4 Bypass Valve Operation for proper use of the bypass valve.

8.2 NO FLOW

Possible Cause	Solution
Motor turning in wrong direction	See Section 3.3 Connecting Electrical Leads
Flow control set too low	Increase flow setting
Fluid level in reservoir too low	Service the HPU reservoir
Air in pump inlet lines	Disconnect the HPU from the aircraft. Fill the HPU reservoir to a level above the pump inlet port. Set the reservoir selector valve to the HPU Reservoir position. **Fully open the Bypass Valve.** Close the Pressure and Return ball valves at the rear of the unit. Adjust the pump flow to maximum and "bump" the start and stop switches to "jog" the motor. Flow should be indicated at the Flowmeter on first or second "jog"

NOTE: Under some conditions where a large amount of air has entered the system, the pump may not be able to draw an initial prime. If this occurs, loosen the inlet hose near the pump and allow air to escape. Re-tighten the hose when fluid appears.

Possible Cause	Solution
Motor is turning but pump is not	Check pump and motor couplings to ensure they are tight
Flow path does not exist	A flow path (such as a moving actuator or an open circuit) must exist for flow to be present. When system pressure exceeds the compensator control setting, or when the system no longer requires flow, the control de-strokes the pump while maintaining the preset pressure

8.3 REDUCED FLOW

Possible Cause	Solution
Flow control set too low	Increase flow setting.
Pressure adjustment is set too low	Slightly increase pressure setting.
Pressure compensator control is reducing pump output	When system pressure exceeds the compensator control setting, or when the system no longer requires flow, the control de-strokes the pump while maintaining the preset pressure.
Pump inlet is not receiving enough fluid (cavitation)	Follow the procedure for “Air in pump inlet lines” in Section 8.2.
Motor is “Single Phasing”	Motor is not getting power on all three phase legs. Check across-the-line voltage on all three phase legs.
Supply voltage is 50 Hz	Pumps used on 50 Hz units will flow at only 83% of the pump nameplate rating. An HPU designed to run on 50 Hz will supply flow as stated in the specifications for that unit.

8.4 NO PRESSURE or REDUCED PRESSURE

Possible Cause	Solution
Pressure adjustment is set too low	Increase pressure adjustment.
Motor is “Single Phasing”	Motor is not getting power on all three phase legs. Check across-the-line voltage on all three phase legs.
Pump inlet is not receiving enough fluid (cavitation)	Follow the procedure for “Air in pump inlet lines” in Section 8.2.
Flow path is open	Pressure is resistance to flow. The HPU will reach full pressure as flow paths (such as moving actuators and open valves) are closed.

8.5 FLUID OVERHEATS

Possible Cause	Solution
Fan is not functioning properly	Check the cooler fan output. Forced air should be easily detected at the right hand side of the HPU. Check the fuses for the fan motor (See Appendices – Electrical Schematic INS-2016).
Bypass valve or rear ball valve is being used in a partially closed position	The bypass valve and all ball valves must be used in a fully open or fully closed position. These valves are not intended for metering flow. All flow adjustments must be made using the pump flow control.

8.6 HAND PUMP (*Option M)* IS NOT PUMPING FLUID

Possible Cause	Solution
Release screw is open	Use the slotted end of the pump handle to close the release screw located at the base of the pump.
Ball valve is closed	Open the ball valve for the pump inlet line located at the bottom of the reservoir.
Pump piston is filled with air	If the pump is not primed after several strokes, remove the bleed screw from the top of the pump piston (See Section *9.13.9.a – Pump Diagram*). Slowly stroke the pump until fluid is present at the bleed screw. Replace the bleed screw.

9.0 MAINTENANCE

If the unit is not used frequently Tronair recommends operating the unit monthly. Operating regularly assures that the seals are kept lubricated, eliminates air pockets in the system, reduces moisture in the fluid and helps extend the hose life. If the unit is not used frequently see 5.12 Infrequent Use Procedure.

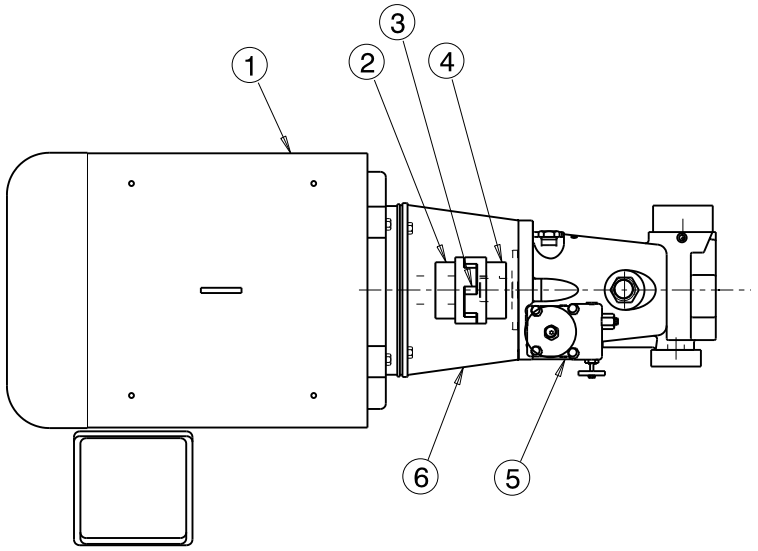
9.1 GENERAL

Periodically inspect the HPU for loose fasteners, hose fittings, damaged hoses, and worn electrical cables. Make repairs as needed for safe operation.

Reference Sections ***9.2* – 9.15** for Parts Lists, Descriptions and Illustrations.

9.2 ELECTRIC MOTOR

The Electric Motor is pre-greased by the manufacturer. Periodic greasing is necessary on a frequently used HPU. ***Reference Appendix – Lincoln Motor Manual*** for details.



Parts List

Item	Part Number	Description	Qty
1	Reference table below	Electric Motor	1
2	H-2552-30	Coupling (Motor Half)	1
3	H-2551	Spider (Hytrel)	1
4	H-3245	Coupling (Pump Half)	1
5	Reference 10.3 and 10.3.1	Motor Driven Hydraulic Pump	1
6	HC-1427-08	Pump/Motor Adapter	1

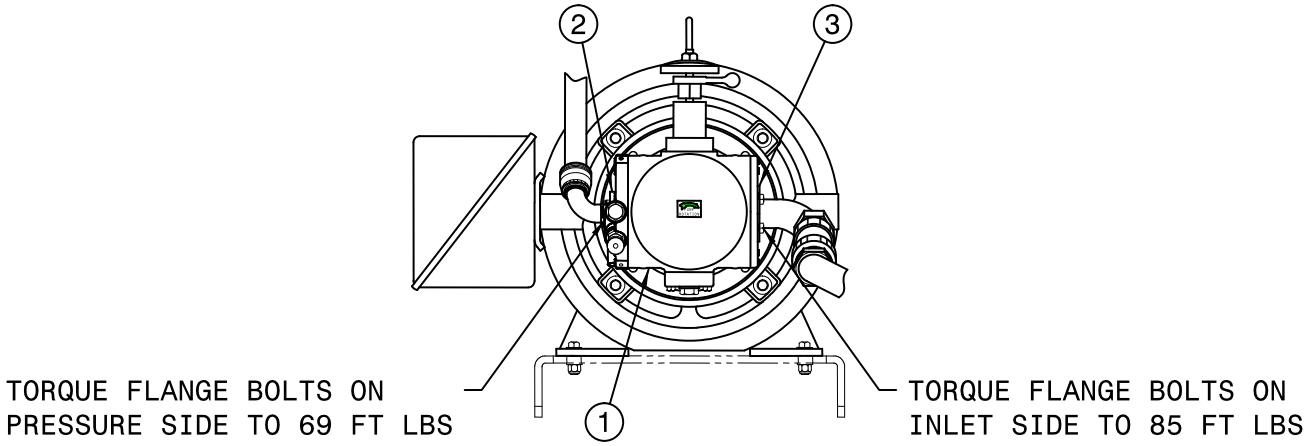
60 Hz Applications	
Voltage	**Part Number**
380	EC-1224-17
460	EC-1224-17
575	EC-1224-18

50 Hz Applications	
Voltage	**Part Number**
380	EC-1224-17
415	EC-1224-17
440	EC-1224-17

9.3 MOTOR DRIVEN HYDRAULIC PUMP

The hydraulic pump does not require regular maintenance. Under normal operating conditions, the pump will perform for thousands of hours of use without rebuilding. See ***Appendix VI – Denison PV Series Pumps*** for further details.

9.3.1 Motor Driven Hydraulic Pump Replacement Parts



Model 5813 & 5823 Parts List

Fluid Type: MIL-PRF-5606 & MIL-PRF-83282

Item	Part Number	Description	Qty
♦ 1	♦ HC-2956	Assembly, Hydraulic Pump	1
2	HC-2664-03-S-V	Kit, Flange *(Pressure Side)*	1
3	N-3191-07	Kit, Flange *(Inlet Side)*	1
N/S	N-2007-29-S-V	Fitting, Connector *(Case Drain Port)*	1
N/S	N-2924	Connector, in-line Orifice	

♦ ***Refer to section 9.14 for listing of Replacement Labels.***

Model 5833 Parts List

Fluid Type: Aviation Phosphate Ester, Type IV

Item	Part Number	Description	Qty
1	♦ HC-2720-01	Assembly, Hydraulic Pump	1
2	HC-2664-03-S-E	Kit, Flange *(Pressure Side)*	1
3	N-2674-07	Kit, Flange *(Inlet Side)*	1
N/S	N-2007-29-S-E	Fitting, Connector *(Case Drain Port)*	1
N/S	N-2924	Connector, in-line Orifice	1

♦ ***Refer to section 9.14 for listing of Replacement Labels.***

9.3.2 Motor Driven Hydraulic Pump Replacement Kits List

Fluid Type: Aviation Phosphate Ester, Type IV, V

Part Number	Description
*	Kit, Shaft and Bearing Assembly
*	Kit, Shaft Seal

* ***Call Tronair for Details***

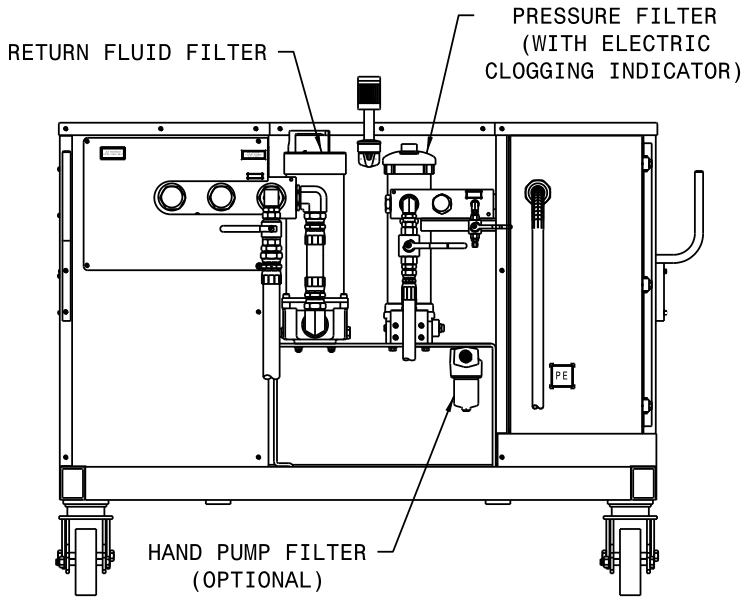
9.4 HYDRAULIC FLUID

Any time an unusual color, smell or visual indicator is noticed with the hydraulic fluid, a sample analysis should be performed to determine the condition of the fluid. (See ***6.9 – Sample Valve Operation***)

Refer to the manufacturer of the specific fluid for your unit to obtain additional information:

Model Number	**Fluid Type**
5813	MIL-PRF-5606
5823	MIL-PRF-83282
5833	Aviation Phosphate Ester, Type IV

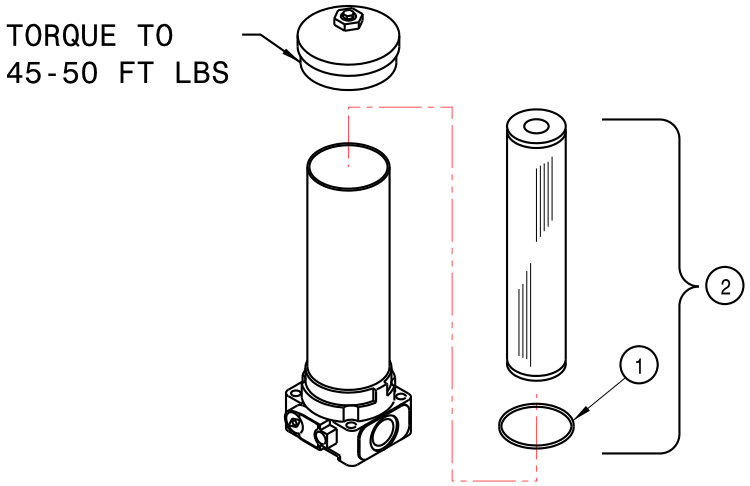
9.5 FILTERS



9.5.1 Pressure Filter Element

Replace the filter element any time the clogged filter indicator light is triggered.
Replace the filter element annually to ensure proper cleanliness of the hydraulic system. This is a minimum requirement.

Standard filter changes depend on how frequently the HPU is used and the cleanliness of the fluid, along with the environment to which the HPU is exposed. Periodic fluid analysis is recommended to properly determine the optimum frequency of filter element changes.



Model 5813 & 5823 Parts List

Fluid Type: MIL-PRF-5606 & MIL-PRF-83282

Item	Part Number	Description	Qty
1	HC-2007-246	O-ring	1
2	K-5033	Kit, Filter Element	1

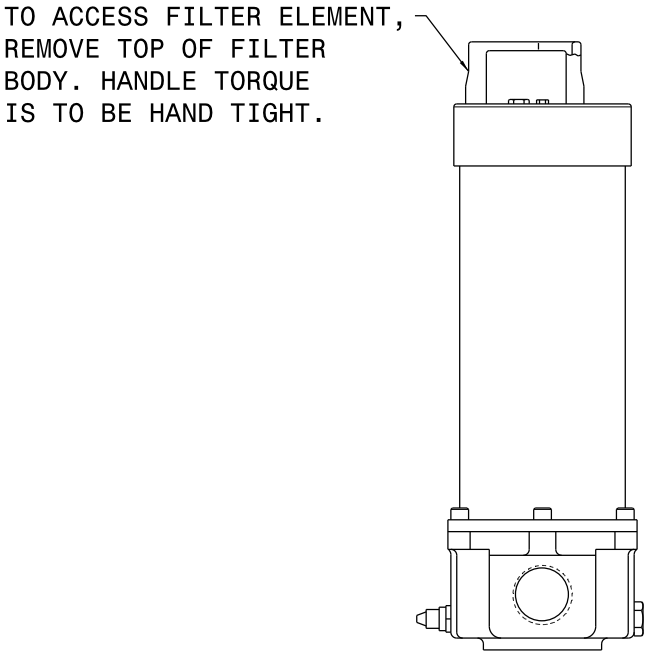
Model 5833 Parts List

Fluid Type: Aviation Phosphate Ester, Type IV

Item	Part Number	Description	Qty
1	HC-2006-246	O-ring	1
2	K-3588	Kit, Filter Element	1

9.5.2 Return Filter Element

Replace the return filter element at the same time the pressure filter element is being replaced.



Model 5813 & 5823 Parts List

Fluid Type: MIL-PRF-5606 & MIL-PRF-83282

Item	Part Number	Description	Qty
N/S	HC-2007-257	O-ring	1
N/S	♦ K-5034	Kit, Replacement Filter Element	1

♦ ***HC-2007-257 O-ring is included in Kit.***

Model 5833 Parts List

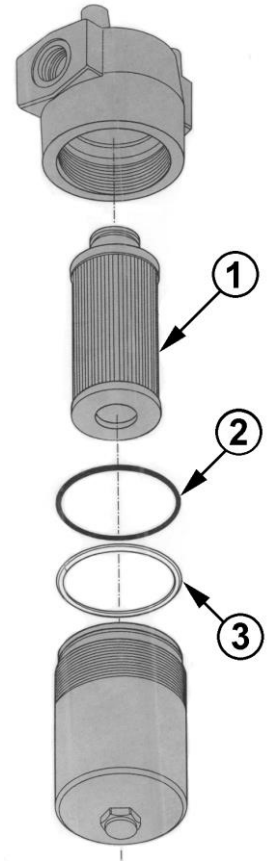
Fluid Type: Aviation Phosphate Ester, Type IV

Item	Part Number	Description	Qty
N/S	HC-2006-257	O-ring	1
N/S	♦ K-3587	Kit, Replacement Filter Element	1

♦ ***HC-2006-257 O-ring is included in Kit.***

9.5.3 Hand Pump *(Option M)* Filter Element

Replacement of the hand pump filter element is dictated by frequency of use and the cleanliness of the fluid, along with the environment to which the HPU is exposed. Changing the hand pump filter element at the same time as the pressure filter element will ensure a regular maintenance schedule.



Model 5813 & 5823 Parts List

Fluid Type: MIL-PRF-5606 & MIL-PRF-83282

Item	Part Number	Description	Qty
2 & 3	K-3832	O-ring and Backup Ring	1
1 - 3	K-3831	Kit, Replacement Filter Element	1

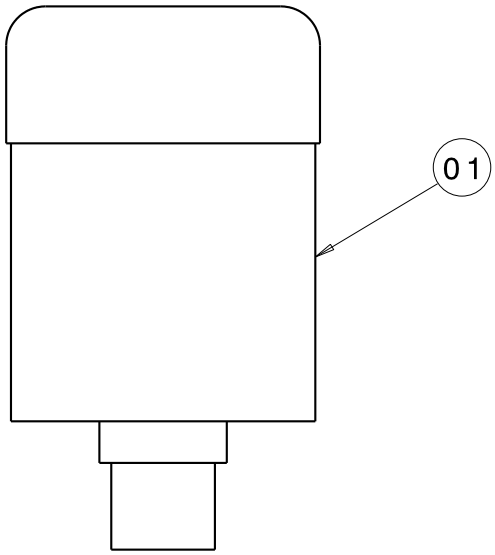
Model 5833 Parts List

Fluid Type: Aviation Phosphate Ester, Type IV

Item	Part Number	Description	Qty
2 & 3	K-3797	O-ring and Backup Ring	1
1 - 3	K-3752	Kit, Replacement Filter Element	1

9.5.4 Desiccant Air Filter

Replace the desiccant/air filter whenever the material inside the element is pink or reddish in color (see Element Label for details).



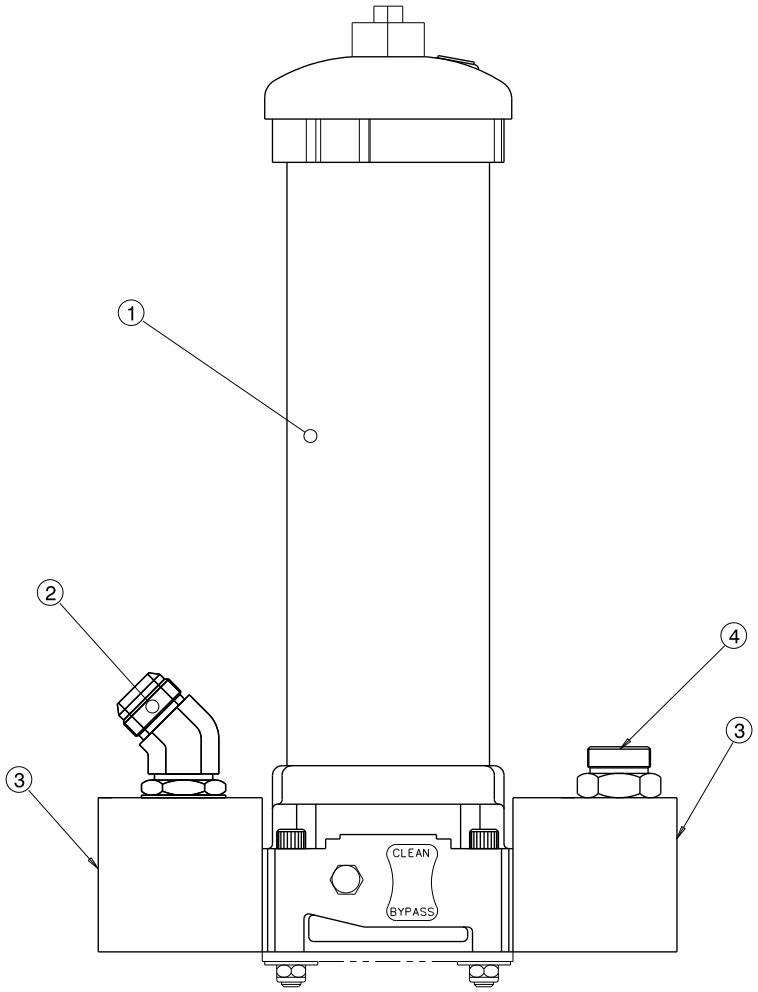
Parts List

Item	Part Number	Description	Qty
1	HC-1763	Filter Element	1

9.5.5 Pressure Filter Assembly with Electric Filter Clogging Indicator

The Electric Filter Clogging Indicator does not require regular general maintenance. The panel light will illuminate when the clogging indicator senses a 50 psi differential pressure across the filter element. Installing a new filter element will eliminate the clogged condition. Pushing the illuminated button will reset the indicator light.

NOTE: Higher flow rates will result in higher differential pressures. (Example: The clogging indicator may sense a 50 psi differential pressure at a flow rate of 34 gpm but not show a clogged condition when the flow rate is reduced to 10 gpm.



Model 5813 & 5823 Parts List

Fluid Type: MIL-PRF-5606 & MIL-PRF-83282

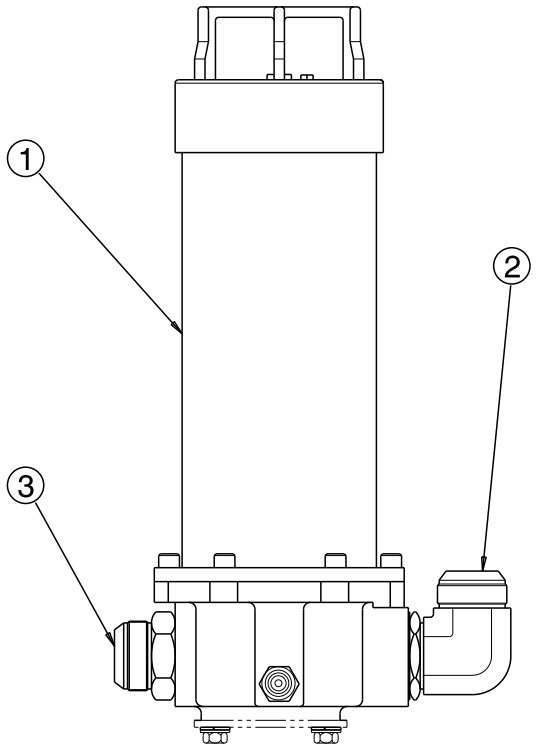
Item	Part Number	Description	Qty
1	HC-2659	Filter, Pressure	1
2	N-2974-S-V	Elbow, 45º Straight Thread	1
3	HC-2106	Flange, Elbow	1
4	N-2507-25-S-V	Connector, Male Ferulok	1

Model 5833 Parts List

Fluid Type: Aviation Phosphate Ester, Type IV

Item	Part Number	Description	Qty
1	HC-2053	Filter, Pressure	1
2	N-2974-S-E	Elbow, 45º Straight Thread	1
3	HC-2106	Flange, Elbow	1
4	N-2507-25-S-E	Connector, Male Ferulok	1

9.5.6 Return Filter Assembly



Model 5813 & 5823 Parts List

Fluid Type: MIL-PRF-5606 & MIL-PRF-83282

Item	Part Number	Description	Qty
1	HC-2661	Filter, Return	1
2	N-2001-33-S-V	Elbow, Straight Thread	1
3	N-2007-33-S-V	Connector, #32 Straight Thread	1

Model 5833 Parts List

Fluid Type: Aviation Phosphate Ester, Type IV

Item	Part Number	Description	Qty
1	HC-2052	Filter, Return	1
2	N-2001-33-S-E	Elbow, Straight Thread	1
3	N-2007-33-S-E	Connector, #32 Straight Thread	1

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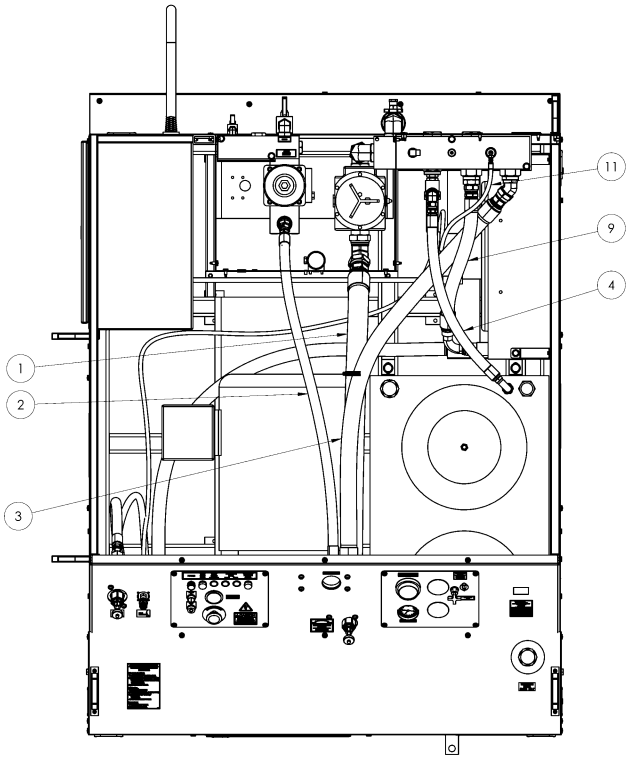
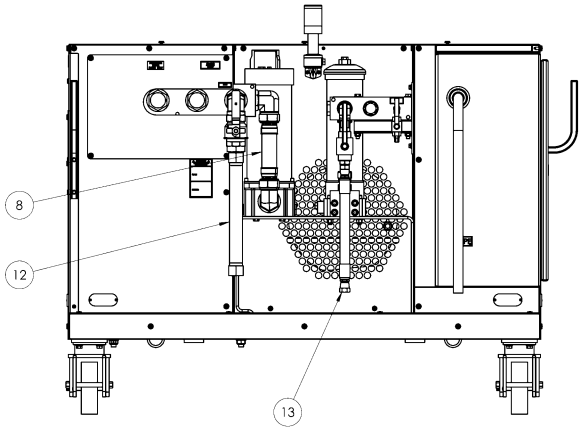
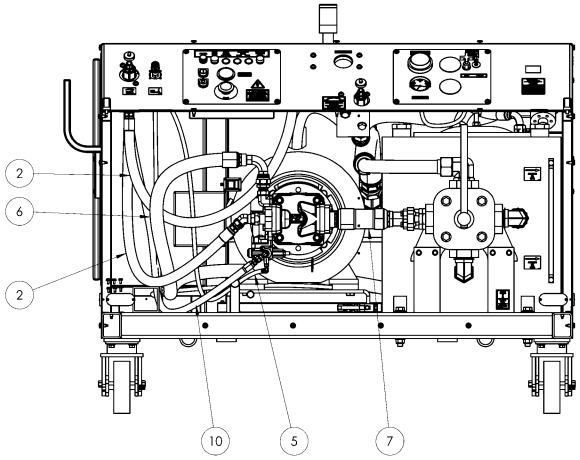
9.6 HYDRAULIC HOSES

Hoses used on the HPU must be periodically inspected for damage, blisters, leaks, or hose end problems. Any damaged or defective hose should be replaced as soon as possible.

Hoses used on Aviation Phosphate Ester, Type IV units have a shorter useful life than hoses used on Mineral Base units. Surface moisture is normal with Aviation Phosphate Ester, Type IV hoses as long as the fluid does not form into drops.







9.6 HYDRAULIC HOSES *(continued)*

Model 5813 & 5823 Parts List

Fluid Type: MIL-PRF-5606 & MIL-PRF-83282

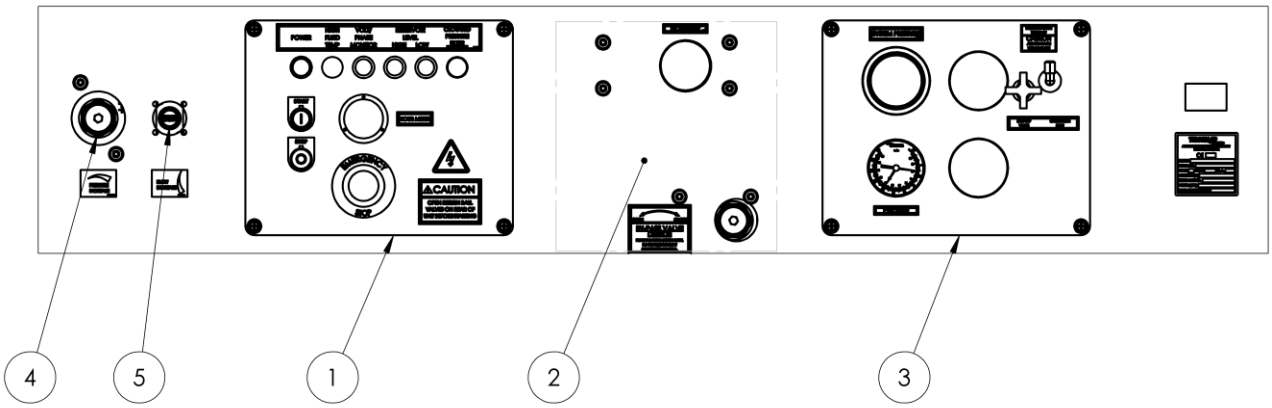
Item	Part Number	Description	Qty
1	TF-1039-32-59.0	Assembly, Hose #32	1
2	TF-1117-37-57.5	Assembly, Hose #16	3
3	TF-1039-04-70.5	Assembly, Hose #24	1
4	TF-1039-09-37.5	Assembly, Hose #16	1
5	TF-1038-14-66.0	Assembly, Hose #4	1
6	TF-1039-33-110	Assembly, Hose #20	1
7	TF-1196-11-12.5	Assembly, Hose #32	1
8	TF-1039-32-11.7	Assembly, Hose #32	1
9	TF-1039-33-29.0	Assembly, Hose #20	1
10	TF-1195-02-75.0	Assembly, Hose #8	1
11	TF-1038-14-180	Assembly, Hose #4	1
12	TF-1038-40*300	External Pressure Hose	1
13	TF-1038-04*300	External Return Hose	1
14	TF-1038-16-24.0	Assembly, Hose #4	1
15	TF-1038-16-32.0	Assembly, Hose #4	1

Model 5833 Parts List

Fluid Type: Aviation Phosphate Ester, Type IV

Item	Part Number	Description	Qty
1	TF-1041-18*59.0	Assembly, Hose #32	1
2	TF-1117-37-57.5	Assembly, Hose #16	3
3	TF-1041-04*70.5	Assembly, Hose #24	1
4	TF-1041-16*37.5	Assembly, Hose #16	1
5	TF-1041-05*66.0	Assembly, Hose #4	1
6	TF-1041-32*110	Assembly, Hose #20	1
7	TF-1196-11-12.5	Assembly, Hose #32	1
8	TF-1041-18*11.7	Assembly, Hose #32	1
9	TF-1041-54*29.0	Assembly, Hose #20	1
10	TF-1195-02-75.0	Assembly, Hose #8	1
11	TF-1041-05-180	Assembly, Hose #4	1
12	TF-1040-05*300	External Pressure Hose	1
13	TF-1041-04*300	External Return Hose	1
14	TF-1040-42-24.0	Assembly, Hose #4	1
15	TF-1040-42-32.0	Assembly, Hose #4	1

9.7 INSTRUMENT PANEL



Model 5813 & 5823 Parts List

Fluid Type: MIL-PRF-5606 & MIL-PRF-83282

Item	Part Number	Description	Qty
1	See Section 9.7.1	Electric Panel	1
2	See Section 9.7.3	Assembly, Control Block	1
3	See Section 9.7.2	Hydraulic Panel	1
4	Z-9150-03	Assembly, Flow Control	1
5	Z-9149-03	Assembly, Pressure Control	1

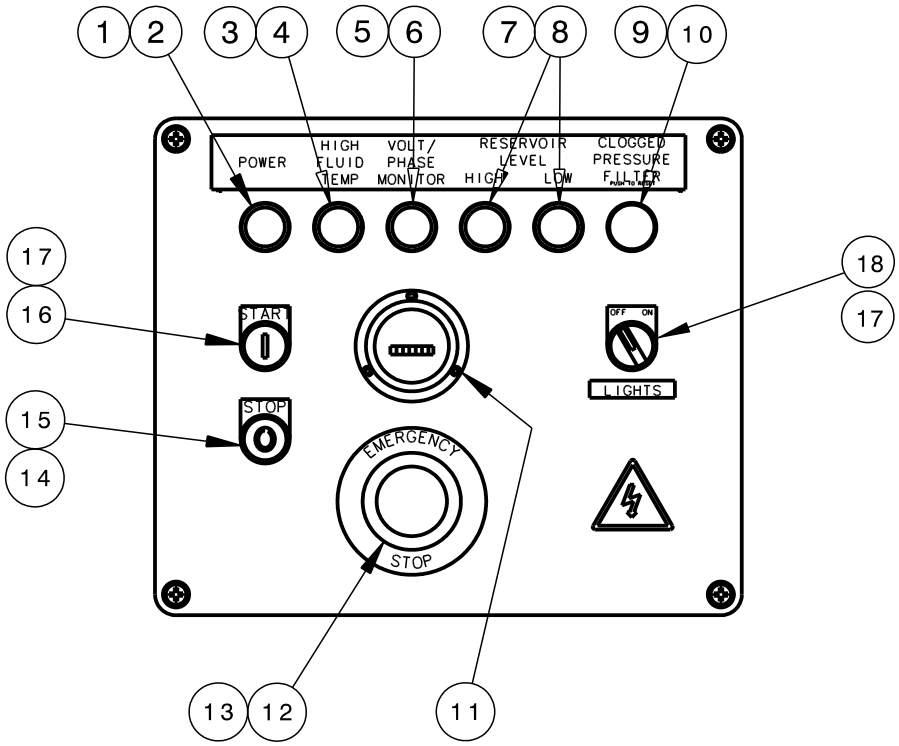
Model 5833 Parts List

Fluid Type: Aviation Phosphate Ester, Type IV

Item	Part Number	Description	Qty
1	See Section 9.7.1	Electric Panel	1
2	See Section 9.7.3	Assembly, Control Block	1
3	See Section 9.7.2	Hydraulic Panel	1
4	Z-9150	Assembly, Flow Control	1
5	Z-9149	Assembly, Pressure Control	1

9.7.1 Electric Panel

The Electric Panel does not require regular general maintenance.

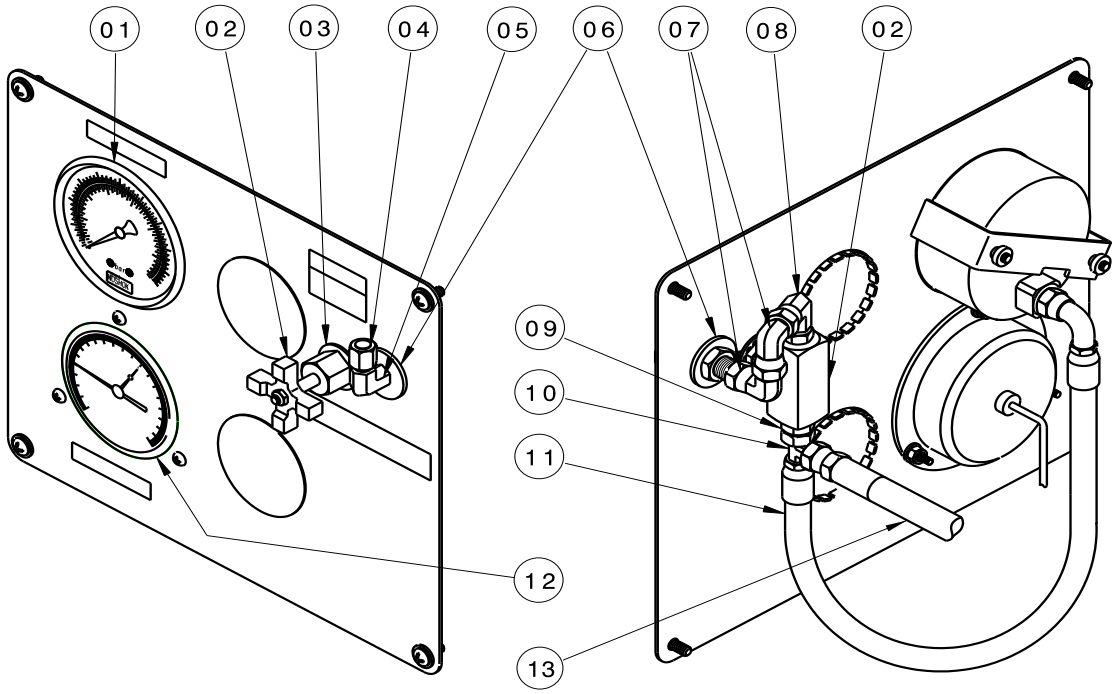


Parts List

Item	Component	Part Number	Description	Qty
1	Standard	EC-1945-01	Light, Diffused Pilot	1
2	Standard	EC-1951-MN5G	Power, Module w/Latch	1
3	Option	EC-1945-03	Light, Diffused Pilot	1
4	Option	EC-1951-MN5Y	Power, Module w/Latch	1
5	Option	EC-1945-03	Light, Diffused Pilot	1
6	Option	EC-1951-MN5Y	Power, Module w/Latch	1
7	Option	EC-1945-04	Light, Diffused Pilot	2
8	Option	EC-1951-MN5B	Power, Module w/Latch	2
9	Option	EC-1952	Push Button, Illuminated/Flush	1
10	Option	EC-1944	Power, Module w/Contact/Latch	1
11	Option	EC-1577	Hour Meter (50 Hz Operation)	1
		EC-1578	Hour Meter (60 Hz Operation)	1
12	Option	EC-1948	Switch, Emergency Stop	1
13	Standard	EC-1946-MX02	Contact Block w/Latch	1
14	Standard	EC-1953-ME205	Push Button, Non-Illuminated	1
15	Standard	EC-1946-MX01	Contact Block w/Latch	1
16	Standard	EC-1953-MF306	Push Button, Non-Illuminated	1
17	Standard	EC-1946-MX10	Contact Block w/Latch1	1
18	Special	EC-1947	Switch, Selector Non-Illuminated	1
N/S	Special	EC-1767	Light Base	6
N/S	Special	EC-1825	Light Bulb	6
N/S	Special	SC-1776	Light Shield	6

9.7.2 Hydraulic Panel

Annual calibration of instrumentation is recommended. See Section ***11.0 – Calibration of Instrumentation*** for details of calibration.



9.7.2 Hydraulic Panel *(continued)*

Model 5813 & 5823 Parts List

Fluid Type: MIL-PRF-5606 & MIL-PRF-83282

Item	Part Number	Description	Qty
1	HC-2144	Gauge, Pressure	1
2	HC-1900-03	Valve, Needle	1
3	HC-1122	Kit, Panel Mounting	1
4	N-2008-03-S	Cap, ¾ JIC	1
5	N-2022-03-S	Elbow, Bulkhead Union #4	1
6	G-1250-1080W	Flatwasher, 7/16 Wide	1
7	N-2002-03-S	Elbow, 90° Swivel Nut #4	2
8	N-2049-07-S-V	Elbow, 90° Swivel 6-4	1
9	N-2007-03-S-V	Connector, Straight Thread	1
10	N-2016-03-S	Tee, Swivel Nut Run #4	1
11	TF-1038-16*24.0	Assembly, Hose	1
12	HC-2268-03	Gauge, Pyrometer	1
13	TF-1038-16*32.0	Assembly, Hose	1

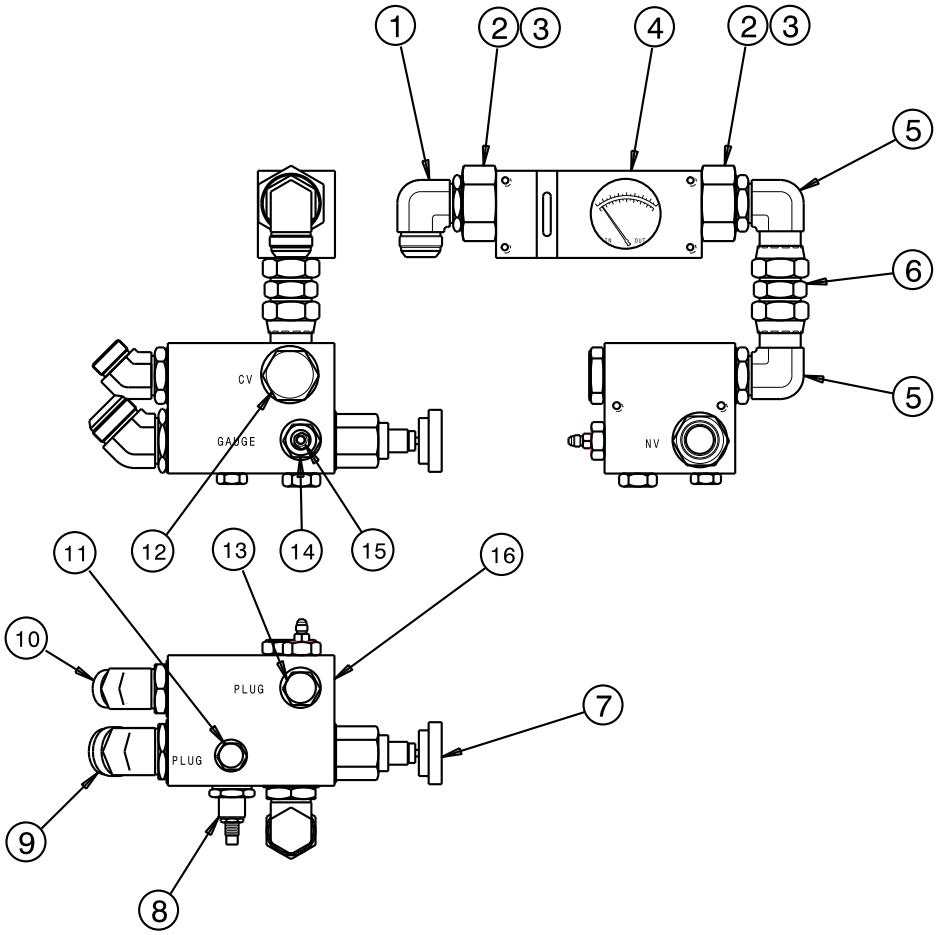
Model 5833 Parts List

Fluid Type: Aviation Phosphate Ester, Type IV

Item	Part Number	Description	Qty
1	HC-2144	Gauge, Pressure	1
2	HC-1900-02	Valve, Needle	1
3	HC-1122	Kit, Panel Mounting	1
4	N-2008-03-S	Cap, ¾ JIC	1
5	N-2022-03-S	Elbow, Bulkhead Union #4	1
6	G-1250-1080W	Flatwasher, 7/16 Wide	1
7	N-2002-03-S	Elbow, 90° Swivel Nut #4	2
8	N-2049-07-S-E	Elbow, 90° Swivel 6-4	1
9	N-2007-03-S-E	Connector, Straight Thread	1
10	N-2016-03-S	Tee, Swivel Nut Run #4	1
11	TF-1040-42*24.0	Assembly, Hose	1
12	HC-2268-02	Gauge, Pyrometer	1
13	TF-1040-42*32.0	Assembly, Hose	1

9.7.3 Control Block Assembly

The Control Block Assembly components do not require regular general maintenance.



9.7.3 Control Block Assembly *(continued)*

Model 5813 & 5823 Parts List

Fluid Type: MIL-PRF-5606 & MIL-PRF-83282

Item	Part Number	Description	Qty
1	N-2001-27-S-V	Elbow, Straight Thread	1
2	N-2676	Reducer, Straight Thread Modified	2
3	HC-2014-924	O-ring, Series 3	2
4	HC-2075	Flowmeter (Calibrated)	1
5	N-2634-07-S-V	Elbow, 90° Swivel, ORFS Tube End (-20)	2
6	N-2665-13-S-V	ORFS Tube End (-20)	1
7	HC-2213	Valve, Needle	1
8	HC-2665	Valve, Relief Cartridge	1
9	N-2042-14-S-V	Elbow, 45° Straight Thread (-24)	1
10	N-2042-25-S-V	Elbow, Male 45°	1
11	N-2053-07-S-V	Plug, O-ring Hex Head (-10)	1
12	HC-2664	Valve, Check	1
13	N-2053-08-S-V	Plug, O-ring Hex Head (-12)	1
14	N-2463-34-S-V	Fitting, Reducer/Expander (12-4)	1
15	N-2007-03-S-V	Connector, Straight Thread (-04)	1
16	J-3331	Manifold, Pressure	1

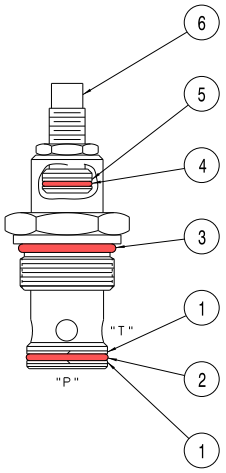
Model 5833 Parts List

Fluid Type: Aviation Phosphate Ester, Type IV

Item	Part Number	Description	Qty
1	N-2973-S-E	Elbow, Straight Thread	1
2	N-2676	Reducer, Straight Thread Modified	2
3	HC-2013-924	O-ring, Series 3	2
4	HC-2075-A1	Flowmeter (Calibrated)	1
5	N-2634-07-S-E	Elbow, 90° Swivel, ORFS Tube End (-20)	2
6	N-2665-13-S-E	ORFS Tube End (-20)	1
7	HC-2214	Valve, Needle	1
8	HC-1772	Valve, Relief Cartridge	1
9	N-2042-14-S-E	Elbow, 45° Straight Thread (-24)	1
10	N-2974-S-E	Elbow, Male 45°	1
11	N-2053-07-S-E	Plug, O-ring Hex Head (-10)	1
12	HC-2103	Valve, Check	1
13	N-2053-08-S-E	Plug, O-ring Hex Head (-12)	1
14	N-2463-34-S-E	Fitting, Reducer/Expander (12-4)	1
15	N-2007-03-S-E	Connector, Straight Thread (-04)	1
16	J-3331	Manifold, Pressure	1

9.7.3.a System Pressure Relief Valve

The System Pressure Relief Valve does not require regular general maintenance. It is possible however, for a contaminant to hold the relief valve in a partially open condition. If service is required, the new or repaired relief valve must be reset to 4,250 psig.



Model 5813 & 5823 Parts List

Fluid Type: MIL-PRF-5606 & MIL-PRF-83282

Item	Part Number	Description	Qty
1	HC-2037	Ring, Backup	2
2	HC-2007-119	O-ring, Series 2	1
3	HC-2014-916	O-ring, Series 3	1
4	HC-2007-015	O-ring, Series 2	1
5	HC-2020-015	Ring, Backup	1
♦ 6	HC-2665	Valve, Pressure Relief *(Not Set)*	1

♦ ***Item 6 consists of Items 1 – 5.***

Model 5833 Parts List

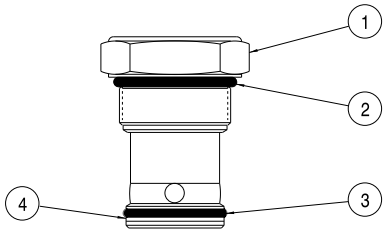
Fluid Type: Aviation Phosphate Ester, Type IV

Item	Part Number	Description	Qty
1	HC-2037	Ring, Backup	2
2	HC-2006-119	O-ring, Series 2	1
3	HC-2013-916	O-ring, Series 3	1
4	HC-2006-015	O-ring, Series 2	1
5	HC-2020-015	Ring, Backup	1
♦ 6	HC-1772	Valve, Pressure Relief *(Not Set)*	1

♦ ***Item 6 consists of Items 1 – 5.***

9.7.3.b Check Valve

The Check Valve does not require regular general maintenance.



Model 5813 & 5823 Parts List

Fluid Type: MIL-PRF-5606 & MIL-PRF-83282

Item	Part Number	Description	Qty
♦ 1	HC-2664	CHECK VALVE	1
2	HC-2014-920	O-RING, SERIES 3	1
3	HC-2007-124	O-RING, SERIES 2	1
4	HC-2020-124	BACKUP RING	1

♦ ***Item 1 consists of Items 2 – 4.***

Model 5833 Parts List

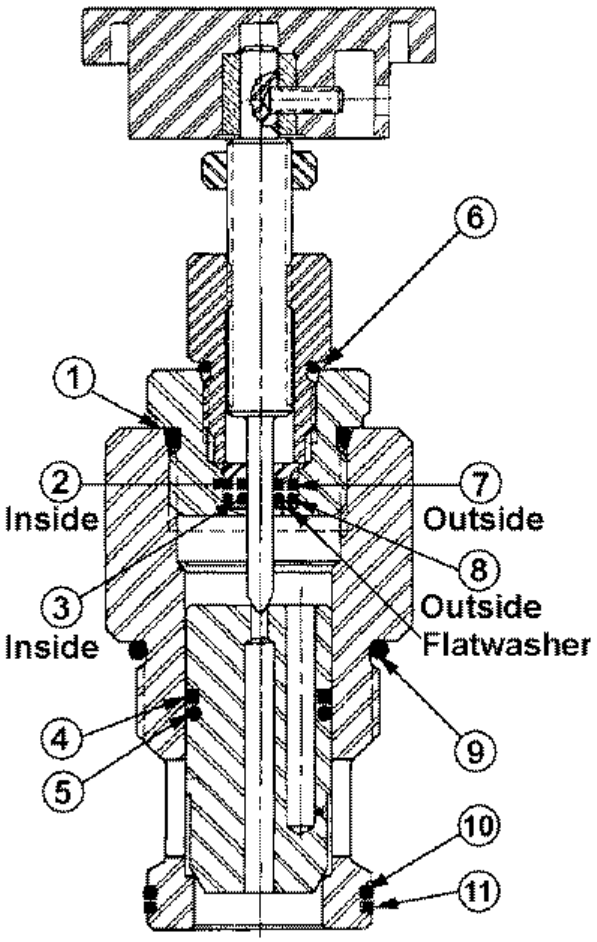
Fluid Type: Aviation Phosphate Ester, Type IV

Item	Part Number	Description	Qty
♦ 1	HC-2103	CHECK VALVE	1
2	HC-2013-920	O-RING, SERIES 3	1
3	HC-2006-124	O-RING, SERIES 2	1
4	HC-2020-124	BACKUP RING	1

♦ ***Item 1 consists of Items 2 – 4.***

9.7.3.c Bypass Valve

The Bypass Valve does not require regular general maintenance.



9.7.3.c Bypass Valve *(continued)*

Model 5813 & 5823 Parts List

Fluid Type: MIL-PRF-5606 & MIL-PRF-83282

Item	Part Number	Description	Qty
1	HC-2014-914	O-RING, SERIES 3	1
2	HC-2020-008	RING, BACKUP (TEFLON)	1
3	HC-2007-008	O-RING, SERIES 3	1
4	HC-2020-019	RING, BACKUP (TEFLON)	1
5	HC-2007-019	O-RING, SERIES 2	1
6	HC-2014-908	O-RING, SERIES 3	1
7	HC-2020-012	RING, BACKUP (TEFLON)	1
8	HC-2007-012	O-RING, SERIES 2	1
9	HC-2014-920	O-RING, SERIES 3	1
10	HC-2007-028	O-RING, SERIES 2	1
11	HC-2020-028	RING, BACKUP (TEFLON)	1
♦12	HC-2214	VALVE, NEEDLE	1

♦ ***Item 12 consists of Items 1 – 11.***

Model 5833 Parts List

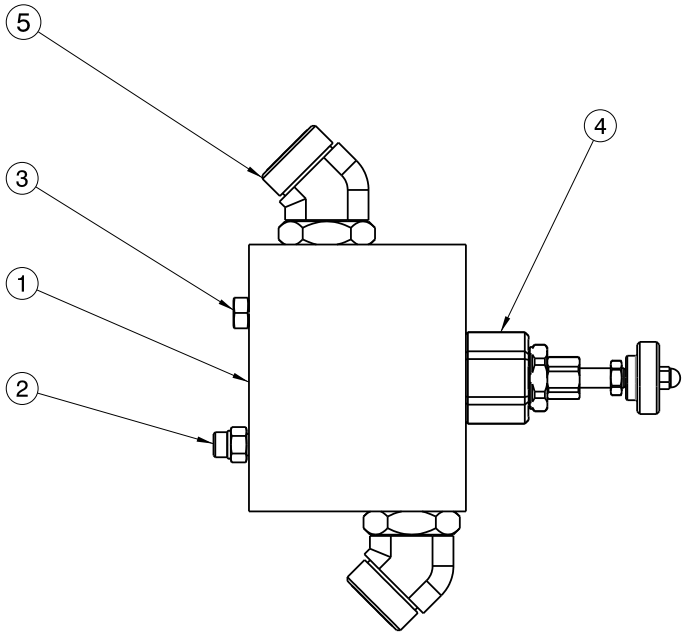
Fluid Type: Aviation Phosphate Ester, Type IV

Item	Part Number	Description	Qty
1	HC-2013-914	O-RING, SERIES 3	1
2	HC-2020-008	RING, BACKUP (TEFLON)	1
3	HC-2006-008	O-RING, SERIES 3	1
4	HC-2020-019	RING, BACKUP (TEFLON)	1
5	HC-2006-019	O-RING, SERIES 2	1
6	HC-2013-908	O-RING, SERIES 3	1
7	HC-2020-012	RING, BACKUP (TEFLON)	1
8	HC-2006-012	O-RING, SERIES 2	1
9	HC-2013-920	O-RING, SERIES 3	1
10	HC-2006-028	O-RING, SERIES 2	1
11	HC-2020-028	RING, BACKUP (TEFLON)	1
♦12	HC-2214	VALVE, NEEDLE	1

♦ ***Item 12 consists of Items 1 – 11.***

9.7.4 Pump Flow Control

The Pump Flow Control does not require regular general maintenance



Model 5813 & 5823 Parts List

Fluid Type: MIL-PRF-5606 & MIL-PRF-83282

Item	Part Number	Description	Qty
1	J-5799	MAINFOLD	1
2	N-2007-08-S-V	CONNECTOR, STRAIGHT THREAD	1
3	N-2053-05-S-V	PLUG, HEX HEAD WITH O-RING	1
4	HC-2213	VALVE, NEEDLE	1
5	N-2974-S-V	ELBOW, 45° ORFS	2

Model 5833 Parts List

Fluid Type: Aviation Phosphate Ester, Type IV, V

Item	Part Number	Description	Qty
1	J-5799	MAINFOLD	1
2	N-2007-08-S-E	CONNECTOR, STRAIGHT THREAD	1
3	N-2053-05-S-E	PLUG, HEX HEAD WITH O-RING	1
4	HC-2214	VALVE, NEEDLE	1
5	N-2633-18-S-E	ELBOW, 45° ORFS	2

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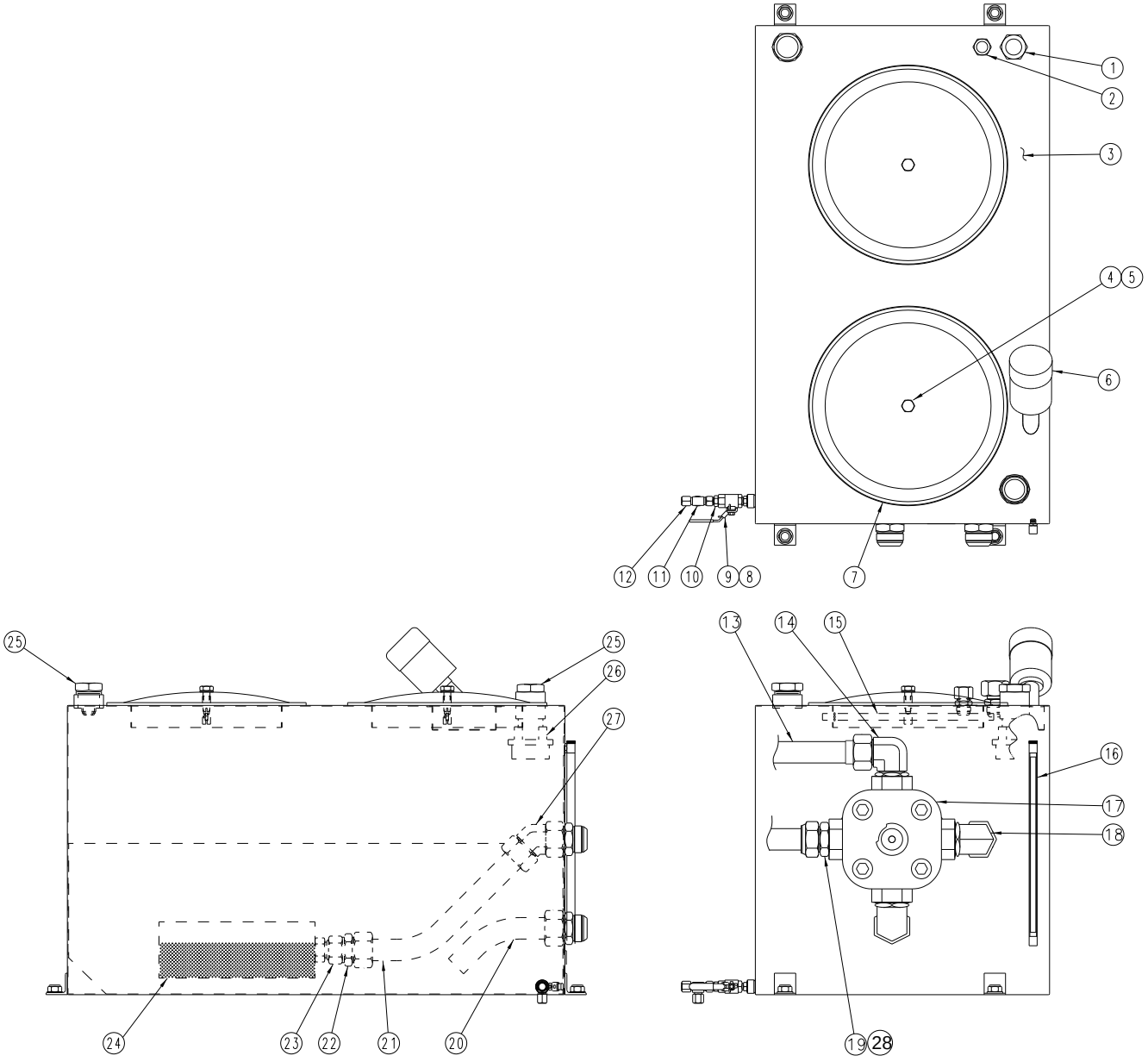
9.8 RESERVOIR ASSEMBLY

Replace the desiccant air filter whenever the material inside the element is pink or reddish in color (See Element label for details). The Reservoir Assembly does not require regular general maintenance. If periodic inspections for silt are desired, be certain to thoroughly clean the dome cover and surrounding area before removing the dome cover.



9.8 RESERVOIR ASSEMBLY *(continued)*

Model 5813 & 5823 Parts List

Fluid Type: MIL-PRF-5606 & MIL-PRF-83282

Item	Part Number	Description	Qty
1	N-2008-12-S	Cap, #24	1
2	N-2008-10-S	Cap, #16	1
3	H-2553	Reservoir, 150 gallon (567.8 lt) Stainless Steel	1
4	H-1735-02	Washer, Nylon	2
5	G-1100-110024	Bolt, Hex Head, Grade 5, 5/8 –11 x 2 1/2" long	2
6	HC-1763	Filter, Desiccant	1
7	H-2560	Assembly, Cover	2
8	HC-2014-908	O-ring, Series 3	1
9	HC-1761	Valve, Ball, SAE #8 Lockable	1
10	N-2007-11-S-V	Connector, Straight Thread #8 SAE x #8 JIC	1
11	N-2016-06-S	Tee, Swivel Run, #8 JIC	1
12	N-2008-06-S	Cap, #8	2
13	Z-5803	Assembly, Return Tube	1
14	N-2001-33-S-V	Elbow, Straight Thread	1
15	Z-5338	Assembly, Clamp	1
16	HC-2340-18	Gauge, Sight	1
17	HC-2657	Valve, Selector	1
18	N-2049-32-S-V	Elbow, 90° Swivel, #32 SAE	2
19	N-2007-33-S-V	Connector, Straight Thread	1
20	Z-5802	Assembly, Hydraulic Tube	1
21	Z-5801	Assembly, Hydraulic Tube	1
22	N-2009-30-S	Connector, Male	1
23	N-2210-31-S	Reducer, Pipe Thread	1
24	HC-1397-07	Diffuser, 3" NPT	1
25	N-2206-09-S	Plug, Hex Head, 2" NPT	2
26	HC-1542	Strainer, Nipple Style	1
27	N-2081-11-S	Elbow, 45° Swivel Nut	1
28	N-3011	Anchor, Flange	1

9.8 RESERVOIR ASSEMBLY *(continued)*

Model 5833 Parts List

Fluid Type: Aviation Phosphate Ester, Type IV

Item	Part Number	Description	Qty
1	N-2008-12-S	Cap, #24	1
2	N-2008-10-S	Cap, #16	1
3	H-2553	Reservoir, 150 gallon (567.8 lt) Stainless Steel	1
4	H-1735-02	Washer, Nylon	2
5	G-1100-110024	Bolt, Hex Head, Grade 5, 5/8 –11 x 2 1/2" long	2
6	HC-1763	Filter, Desiccant	1
7	H-2562	Assembly, Cover	2
8	HC-2013-908	O-ring, Series 3	1
9	HC-1761	Valve, Ball, SAE #8 Lockable	1
10	N-2007-11-S-E	Connector, Straight Thread #8 SAE x #8 JIC	1
11	N-2016-06-S	Tee, Swivel Run, #8 JIC	1
12	N-2008-06-S	Cap, #8	2
13	Z-5803	Assembly, Return Tube	1
14	N-2001-33-S-E	Elbow, Straight Thread	1
15	Z-5338	Assembly, Clamp	1
16	HC-1383-18	Gauge, Sight	1
17	HC-2198	Valve, Selector	1
18	N-2049-32-S-E	Elbow, 90° Swivel, #32 SAE	2
19	N-2007-33-S-E	Connector, Straight Thread	1
20	Z-5802	Assembly, Hydraulic Tube	1
21	Z-5801	Assembly, Hydraulic Tube	1
22	N-2009-30-S	Connector, Male	1
23	N-2210-31-S	Reducer, Pipe Thread	1
24	HC-1397-07	Diffuser, 3" NPT	1
25	N-2206-09-S	Plug, Hex Head, 2" NPT	2
26	HC-1542	Strainer, Nipple Style	1
27	N-2081-11-S	Elbow, 45° Swivel Nut	1
28	N-3011	Anchor, Flange	1

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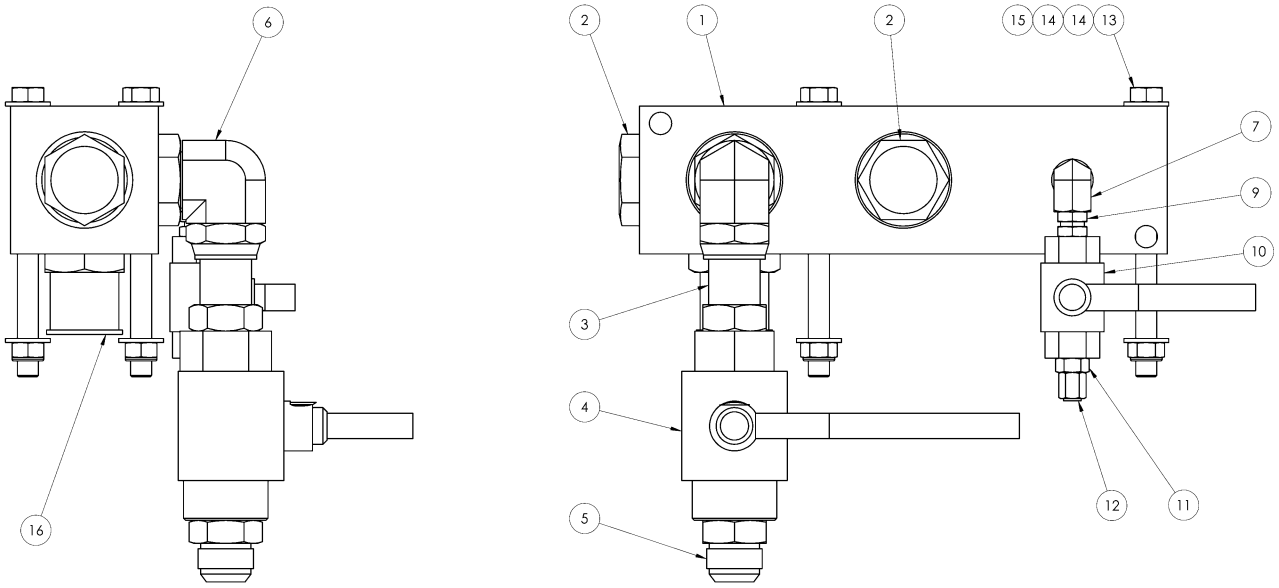
9.9 PRESSURE MANIFOLD ASSEMBLY

The Pressure Manifold does not require regular general maintenance other than ensuring fitting connections remain tight and leak free.



9.9 PRESSURE MANIFOLD ASSEMBLY *(continued)*

Model 5813 & 5823 Parts List

Fluid Type: MIL-PRF-5606 & MIL-PRF-83282

Item	Part Number	Description	Qty
1	HC-2054	MANIFOLD, PRESSURE	1
2	N-2053-11-S-V	PLUG, O-RING HEX HEAD	2
3	N-2650-06-S-V	CONNECTOR, ORFS SWIVEL	1
4	HC-2206-05	VALVE, BALL	1
5	N-2975-S-V	CONNECTOR, STRAIGHT THREAD	1
6	N-2630-20-S-V	ELBOW, 90° ORFS	1
7	N-2661-02-S-V	ELBOW, STRAIGHT THREAD	1
9	N-2464-05-S-V	UNION, STRAIGHT THREAD	1
10	HC-2206-02	VALVE, BALL	1
11	N-2007-05-S-V	CONNECTOR, STRAIGHT THREAD	1
12	N-2008-03-S	CAP	1
13	G-1100-109564	BOLT, ½-20 X 6-1/2 HED HD GR 5	2
14	G-1250-1090N	FLATWASHER, ½ NARROW	4
15	G-1202-1095	STOPNUT, ½-20 ELASTIC	2
16	N-2507-25-S-V	CONNECTOR, STRAIGHT THREAD (-20)	

Model 5833 Parts List

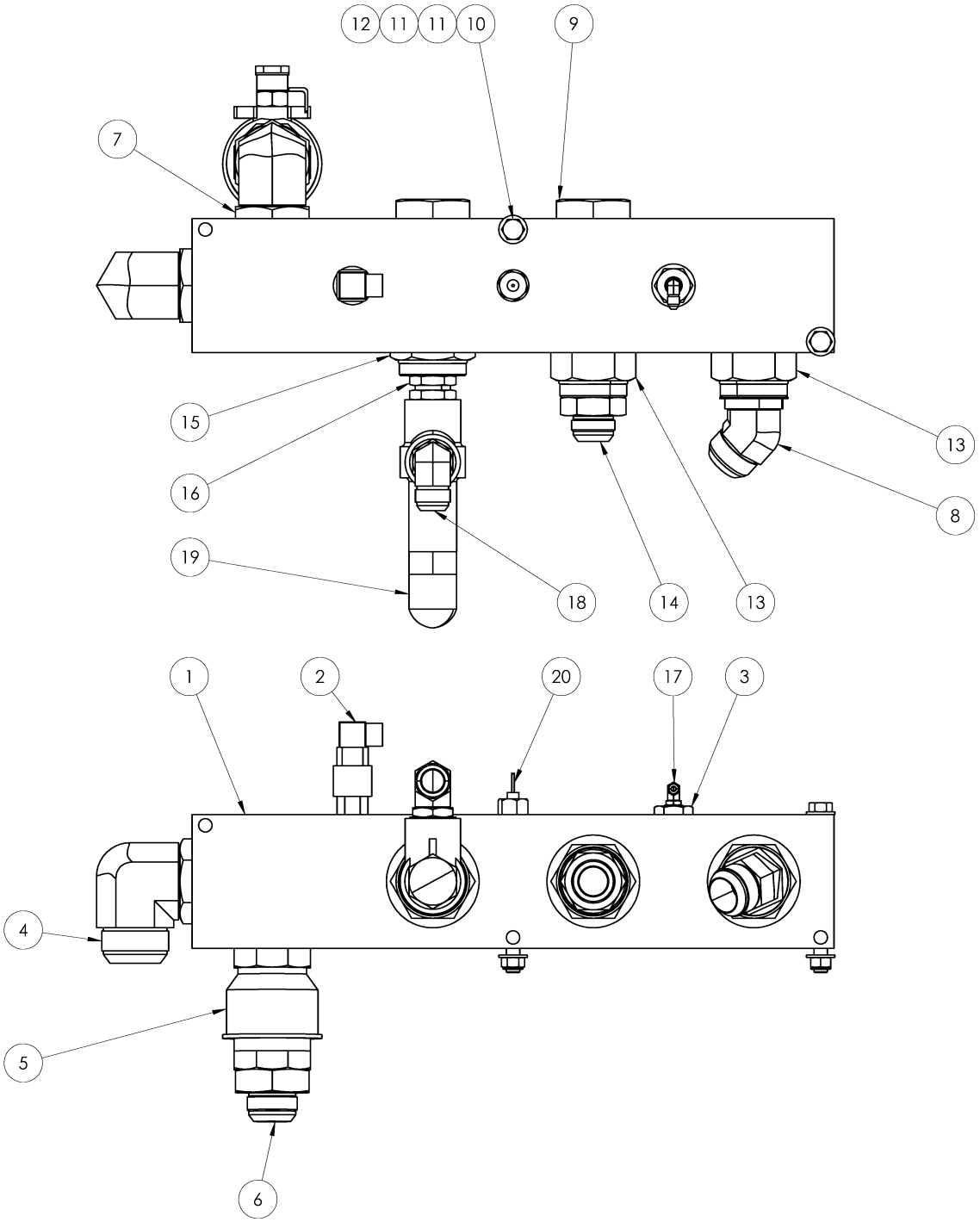
Fluid Type: Aviation Phosphate Ester, Type IV

Item	Part Number	Description	Qty
1	HC-2054	MANIFOLD, PRESSURE	1
2	N-2053-11-S-E	PLUG, O-RING HEX HEAD	2
3	N-2650-06-S-E	CONNECTOR, ORFS SWIVEL	1
4	HC-1771-05	VALVE, BALL	1
5	N-2975-S-E	CONNECTOR, STRAIGHT THREAD	1
6	N-2630-20-S-E	ELBOW, 90° ORFS	1
7	N-2661-02-S-E	ELBOW, STRAIGHT THREAD	1
9	N-2464-05-S-E	UNION, STRAIGHT THREAD	1
10	HC-1771-02	VALVE, BALL	1
11	N-2007-05-S-E	CONNECTOR, STRAIGHT THREAD	1
12	N-2008-03-S	CAP	1
13	G-1100-109564	BOLT, ½-20 X 6-1/2 HED HD GR 5	2
14	G-1250-1090N	FLATWASHER, ½ NARROW	4
15	G-1202-1095	STOPNUT, ½-20 ELASTIC	2
16	N-2507-25-S-E	CONNECTOR, STRAIGHT THREAD (-20)	

9.10 RETURN MANIFOLD ASSEMBLY

The Return Manifold does not require regular general maintenance.

NOTE: DO NOT attempt to adjust the Return System Pressure Relief Valve. See Section 9.9.1 – Return System Pressure Relief Valve for details.



9.10 RETURN MANIFOLD ASSEMBLY *(continued)*

Model 5813 & 5823 Parts List

Fluid Type: MIL-PRF-5606 & MIL-PRF-83282

Item	Part Number	Description	Qty
1	HC-2049	MANIFOLD, RETURN	1
2	EC-1782-03	SWITCH, TEMPERATURE	1
3	N-2463-34-S-V	FITTING, REDUCER/EXPANDER	1
4	N-2001-33-S-V	ELBOW, STRAIGHT THREAD	1
5	HC-2058-03	VALVE, BALL	1
6	N-2007-32-S-V	CONNECTOR, STRAIGHT THREAD	1
7	N-2666-09-S-V	ELBOW, STRAIGHT THREAD	1
8	N-2042-14-S-V	ELBOW, 45 DEG STR THD	1
9	N-2053-13-S-V	PLUG, HEX HD W/O-RING	2
10	G-1100-109560	BOLT, 1/2-20 X 6.0" HEX HD GR 5	2
11	G-1250-1090N	FLATWASHER. 1/2 NARROW	4
12	G-1202-1095	STOPNUT, 1/2-20 ELASTIC	2
13	N-2463-28-S-V	FITTING, REDUCER/EXPANDER	2
14	N-2007-30-S-V	CONNECTOR, STRAIGHT THREAD	1
15	N-2463-26-S-V	FITTING, REDUCER/EXPANDER	1
16	N-2464-10-S-V	UNION, #16 STRAIGHT THREAD	1
17	N-2001-03-S-V	ELBOW, STRAIGHT THREAD	1
18	N-2001-24-S-V	ELBOW, STRAIGHT THREAD	1
19	HC-2202	VALVE,PRE-SET PRESS RELIEF(PE)	1
20	HC-2268-03	GAUGE, PYROMETER (PE)	1

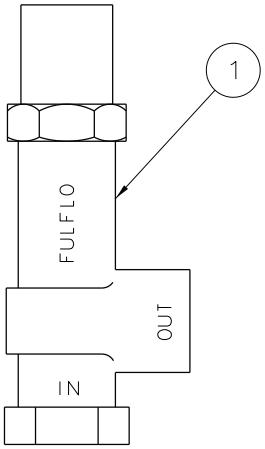
Model 5833 Parts List

Fluid Type: Aviation Phosphate Ester, Type IV

Item	Part Number	Description	Qty
1	HC-2049	MANIFOLD, RETURN	1
2	EC-1782-02	SWITCH, TEMPERATURE	1
3	N-2463-34-S-E	FITTING, REDUCER/EXPANDER	1
4	N-2001-33-S-E	ELBOW, STRAIGHT THREAD	1
5	HC-2058-03	VALVE, BALL	1
6	N-2007-32-S-E	CONNECTOR, STRAIGHT THREAD	1
7	N-2666-09-S-E	ELBOW, STRAIGHT THREAD	1
8	N-2042-14-S-E	ELBOW, 45 DEG STR THD	1
9	N-2053-13-S-E	PLUG, HEX HD W/O-RING	2
10	G-1100-109560	BOLT, 1/2-20 X 6.0" HEX HD GR 5	2
11	G-1250-1090N	FLATWASHER. 1/2 NARROW	4
12	G-1202-1095	STOPNUT, 1/2-20 ELASTIC	2
13	N-2463-28-S-E	FITTING, REDUCER/EXPANDER	2
14	N-2007-30-S-E	CONNECTOR, STRAIGHT THREAD	1
15	N-2463-26-S-E	FITTING, REDUCER/EXPANDER	1
16	N-2464-10-S-E	UNION, #16 STRAIGHT THREAD	1
17	N-2001-03-S-E	ELBOW, STRAIGHT THREAD	1
18	N-2001-24-S-E	ELBOW, STRAIGHT THREAD	1
19	HC-2202	VALVE,PRE-SET PRESS RELIEF(PE)	1
20	HC-2268-02	GAUGE, PYROMETER (PE)	1

9.10.1 Return System Pressure Relief Valve

The Return System Pressure Relief Valve can be purchased as a preset assembly. If the relief valve is serviced by the end user, the valve must be set to crack at 150+/-7 psig **before** being re-installed on the HPU.



Model 5813 & 5823 Parts List

Fluid Type: MIL-PRF-5606 & MIL-PRF-83282

Item	Part Number	Description	Qty
1	HC-2201	Valve, Pressure Relief (*Pre-set*)	1
N/S	♦ HC-2007-220	O-ring, Series 2	1

♦ ***Included with Item 1.***

Model 5833 Parts List

Fluid Type: Aviation Phosphate Ester, Type IV

Item	Part Number	Description	Qty
1	HC-2202	Valve, Pressure Relief (*Pre-set*)	1
N/S	♦ HC-2006-220	O-ring, Series 2	1

♦ ***Included with Item 1.***

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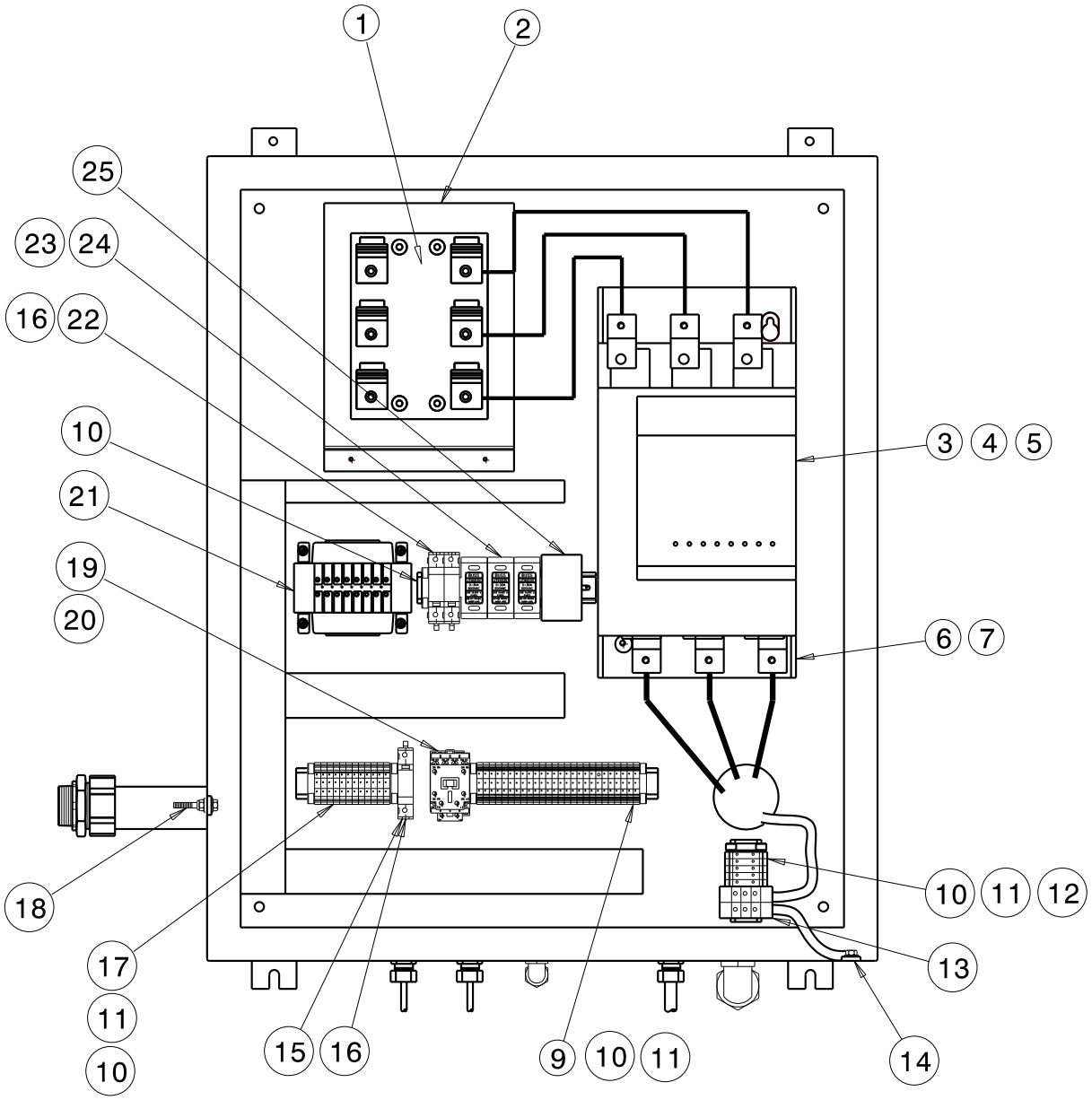
9.11 ELECTRICAL COMPONENTS

Regularly inspect the external power cord for nicks, cuts, abrasion, and fluid damage. Replace power cord if damage is found. Reference ***9.0 Provision of Spares*** for recommended spare fuses.

Reference following page for component descriptions.



100 HP ASSEMBLY

NOTE: Set Item 6 to Automatic Reset position. Set "A2" to its corresponding full load amps listed in 5.2.4 Motor Power Requirements. Wire per Electrical Schematic INS-1608. Reference Wire Diagram INS-1661.

9.11 ELECTRICAL COMPONENTS *(continued)*

Parts List

Fluid Type: Aviation Phosphate Ester, Type IV

Item	Part Number	Description	Qty
2	EC-1560	Fuse Block, Class J	1
4	EC-1724	Kit, Terminal Lug	2
5	EC-1746	Kit, Terminal Cover	1
6	EC-1564	Relay, Overload	1
7	EC-1603	Shield, Anti-Tamper	1
9	EC-1956-02	Block, IEC Terminal Red	26
10	EC-1959	Anchor, IEC, End	7
11	EC-1960-01	Barrier, End	3
12	EC-1958	Block, IEC Ground	5
13	EC-1957	Block, IEC Ground	2
14	EC-1532-04	Lug, Ground	2
15	EC-1542-14	Fuse, LP-CC Low Peak 1-6/10 A (*Secondary*)	1
16	EC-1541-01	Fuse Holder, IEC Class CC	*Ref*
17	EC-1956-03	Block, IEC Terminal, Blue	12
18	EC-1432-04	Lug, Ground	1
19	EC-1591-04	Latch, Mechanical	1
20	EC-1564	Relay, Control	1
21	EC-1804-04	Transformer, Control (200 W)	1
23	EC-1596-01	Fuse Holder, Class J	3
24	EC-1557-01	Fuse, Class J (Heat Exchanger)	3
26	EC-1675-12	Fuse, KTK-R 2 amp (*Optional*)	*Ref*
N/S	EC-1227-05*0600	Power Cord	1

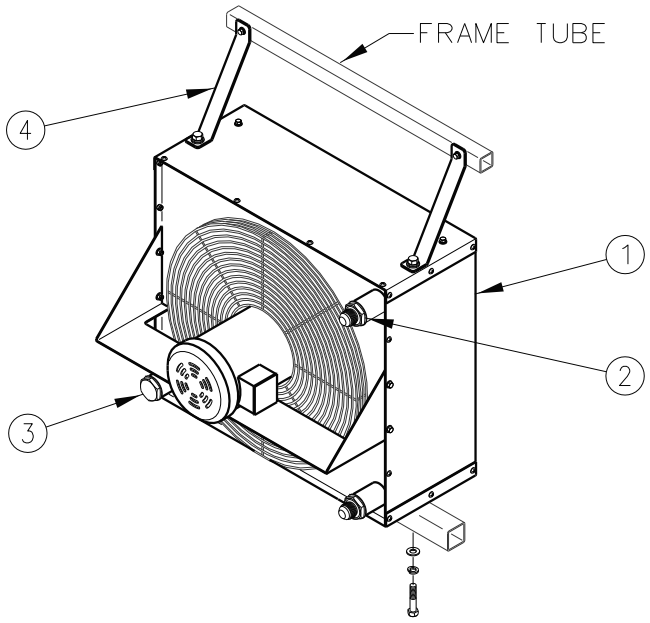
THE FOLLOWING PARTS ARE APPLICATION SPECIFIC
Be sure to locate the correct voltage and hertz of the unit before selecting the part

Item	60 Hz Applications			Description	Qty
	380	460	575		
1	EC-1556-08	EC-1556-07	EC-1556-06	Fuse, Class J	3
3	EC-1974	EC-1974	EC-2022	Controller, Softstart Motor	1
22	EC-1726-14	EC-1726-11	EC-1726-08	Fuse, Class CC (*Primary*)	2
23	EC-1596-01	EC-1596-01	EC-1596-01	Fuse Holder, Class J	3
25	EC-1543-03	EC-1543-04	EC-1543-05	Monitor, Phase (*Optional*)	*Ref*

Item	50 Hz Applications			Description	Qty
	380	415	440		
1	EC-1556-09	EC-1556-08	EC-1556-08	Fuse, Class J	3
3	EC-1975	EC-1975	EC-1975	Controller, Softstart Motor	1
22	EC-1726-14	EC-1726-13	EC-1726-12	Fuse, Class CC (*Primary*)	2
23	EC-1596-01	EC-1596-01	EC-1596-01	Fuse Holder, Class J	3
25	EC-1543-03	EC-1543-04	EC-1543-05	Monitor, Phase (*Optional*)	*Ref*

9.12 HEAT EXCHANGER ASSEMBLY

The Heat Exchanger Assembly does not require regular general maintenance.



Model 5813 & 5823 Parts List

Fluid Type: MIL-PRF-5606 & MIL-PRF-83282

Item	Part Number	Description	Qty
1	Reference Table below	Heat Exchanger	1
2	N-2007-28-S-V	Connector, #20 SAE x #20 JIC	2
3	N-2066-20-S-V	Plug, #20 SAE (Hidden)	1
4	J-3403-01	Strap	2

Model 5833 Parts List

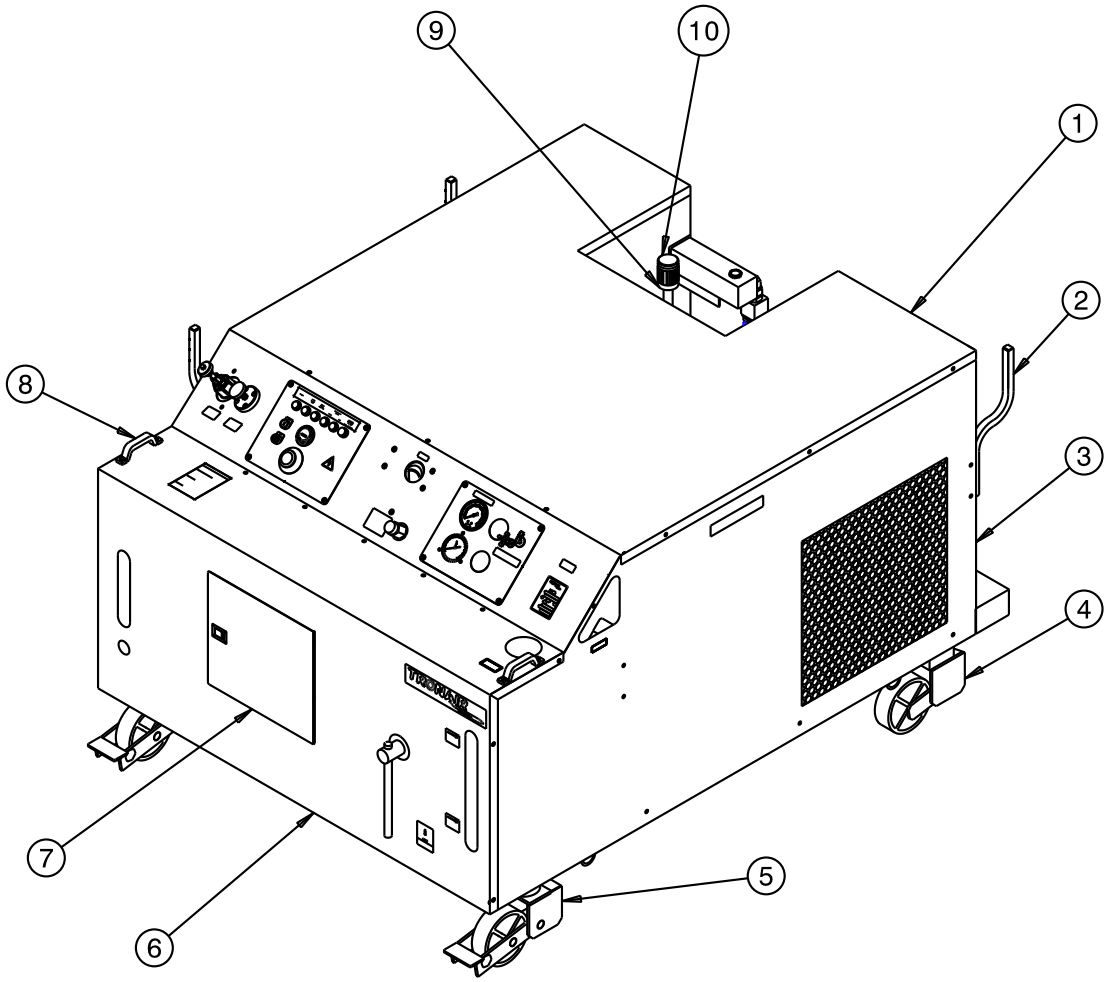
Fluid Type: Aviation Phosphate Ester, Type IV

Item	Part Number	Description	Qty
1	Reference Table below	Heat Exchanger	1
2	N-2007-28-S-E	Connector, #20 SAE x #20 JIC	2
3	N-2066-20-S-E	Plug, #20 SAE (Hidden)	1
4	J-3403-01	Strap	2

Voltage	Frequency	Part Number
380V	60 Hz	HC-2138-01
460V	60 Hz	HC-2138-01
575V	60 Hz	HC-2138-02
380V	50 Hz	HC-2138-01
415V	50 Hz	HC-2138-01
440V	50 Hz	HC-2138-01

9.13 EXTERNAL COMPONENTS

Keep HPU clean. Do not allow labels to become damaged; thusly illegible. Regularly inspect casters and floor locks to ensure safe working condition.



Parts List

Item	Part Number	Description	Qty
1	S-1799-01	TOP PANEL	1
2	Z-5549-01	HANGER	3
3	Z-5382-01	RIGHT SIDE PANEL	1
4	U-1102	RIGID CASTER	2
5	U-1101	SWIVEL CASTER	2
6	Z-9146	FRONT PANEL	1
7	Z-5397	FRONT ACCESS DOOR	1
8	H-1780	HANDLE	2
9	EC-1794	BOX, VERTICAL MOUNT JUNCTION	1
10	EC-1791	LIGHT, POLE MOUNTED STACK	1
N/S	Z-5383-01	LEFT SIDE PANEL	1
N/S	S-1804-01	RETURN MANIFOLD ACCESS PANEL	1
N/S	S-1896-01	SKIRT PANEL (UNDER ELECTRICAL BOX)	1
N/S	S-1798-01	BACK PANEL	1

9.14 ADDITIONAL FEATURES

9.14.1 50 ft (15.2 m) Hoses *(Option B)*

Refer to Section ***10.6 Hydraulic Hoses*** concerning hose inspection.

Model 5813 & 5823 Parts List

Fluid Type: MIL-PRF-5606 & MIL-PRF-83282

Part Number	Description	Qty
TF-1038-40*300	PRESSURE HOSE, 25 FT/7.6 M	1 per Option
TF-1039-04*300	RETURN HOSE, 25 FT/7.6 M	1 per Option
N-2011-10-S	UNION, #16	1 per Option
N-2011-12-S	UNION, #12	1 per Option

Model 5833 Parts List

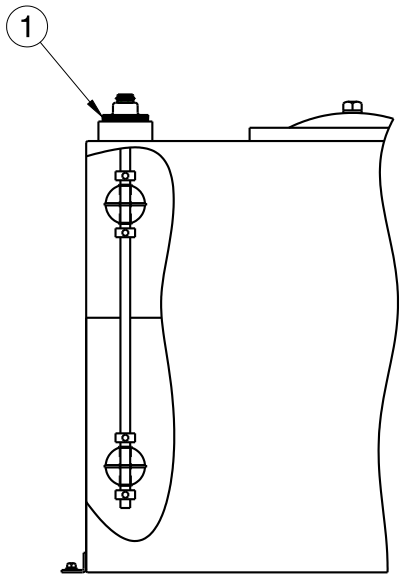
Fluid Type: Aviation Phosphate Ester, Type IV

Part Number	Description	Qty
TF-1040-05*300	PRESSURE HOSE, 25 FT/7.6 M	1 per Option
TF-1041-04*300	RETURN HOSE, 25 FT/7.6 M	1 per Option
N-2011-10-S	UNION, #16	1 per Option
N-2011-12-S	UNION, #12	1 per Option

9.14.2 Electric Reservoir Level *(Option L)*

The Electric Reservoir Level switch does not require regular general maintenance. Panel indicator lights will indicate low or high fluid level.

NOTE: Wire per Electrical Schematic INS-1608. Reference Wiring Diagram INS-1661. Reference 9.7.1 Electrical Panel for Panel Light.

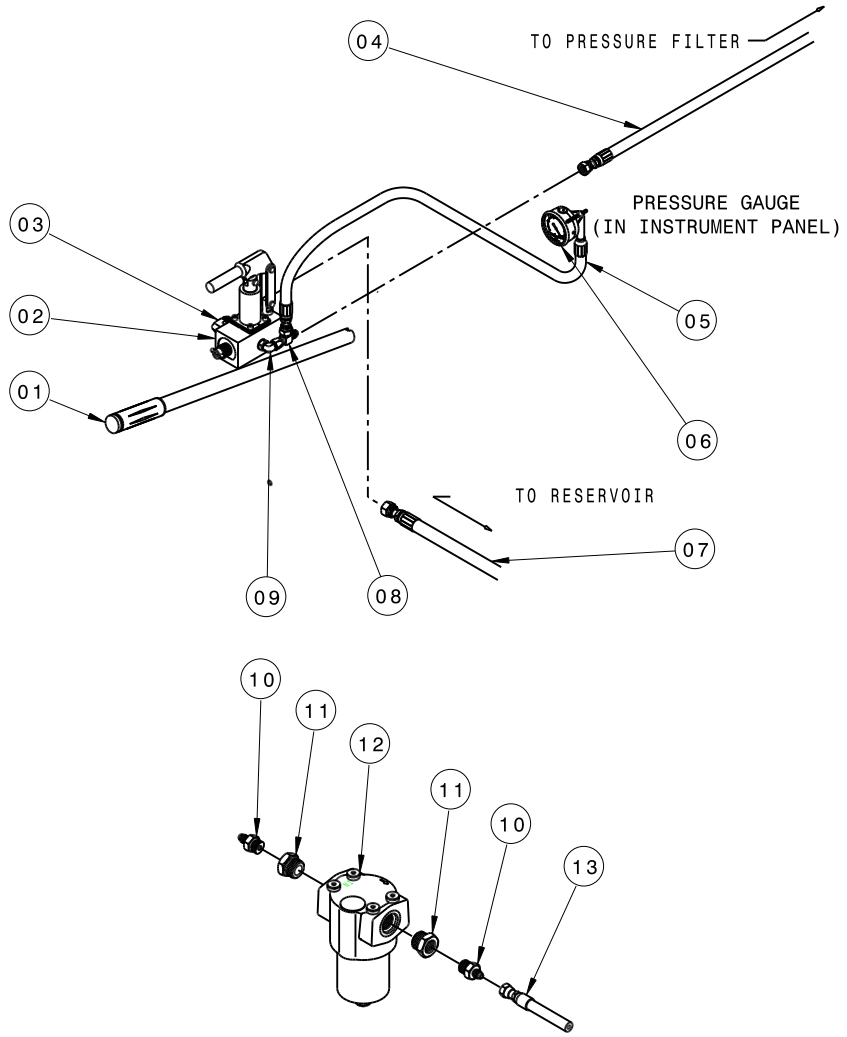


Parts List

Item	Part Number	Description	Qty
1	EC-1783	MULTI-LEVEL SWITCH (includes Plug-in Cable)	1

9.14.3 Hand Pump *(Option M)*

Refer to Section **9*.6 Hydraulic Hoses*** concerning hose inspection for general maintenance on Items 4, 5, 7 and 13 hose assemblies. Refer to Section ***9.5.3 – Hand Pump*** *(Optional)* ***Filter*** .



9.14.3 Hand Pump *(Option M) (continued)*

Model 5813 & 5823 Parts List

Fluid Type: MIL-PRF-5606 & MIL-PRF-83282

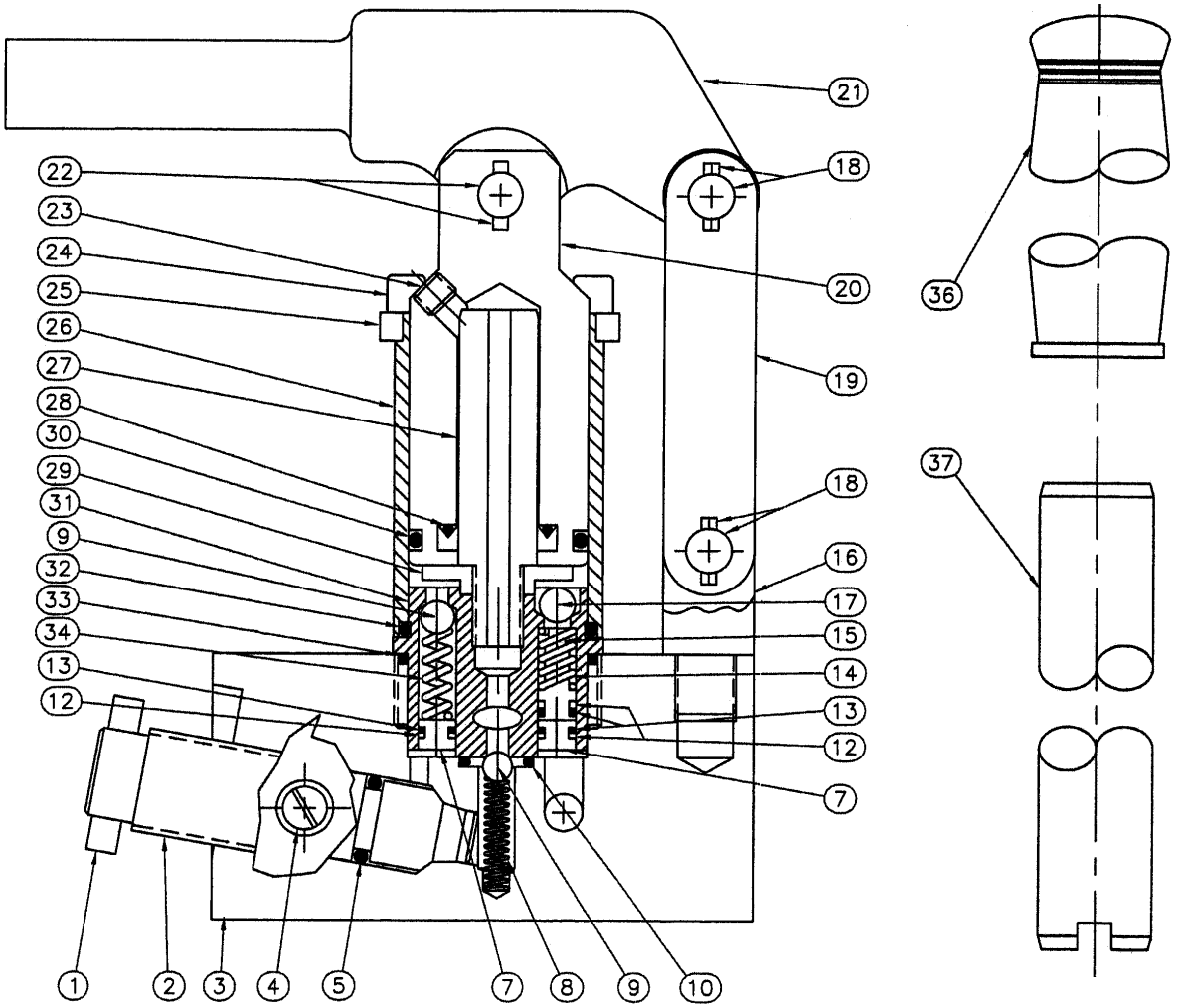
Item	Part Number	Description	Qty
1	H-1009-01	PUMP HANDLE	1
2	HC-1779	HAND PUMP, TWO STAGE	1
3	N-2001-11-S-V	ELBOW, #8 SAE X #8 JIC FLARE	1
4	TF-1038-14-75.0	HOSE ASSEMBLY, #4	1
5	TF-1038-15-79.0	HOSE ASSEMBLY, #4	1
6	HC-2146	PRESSURE GAUGE	1
7	TF-1037-21-36.0	HOSE ASSEMBLY, #8	1
8	N-2016-03-S	TEE, SWIVEL NUT, #4	1
9	N-2001-05-S-V	ELBOW, #6 SAE X #4 JIC FLARE	1
10	N-2007-06-S-V	FITTING, MALE CONNECTOR	1
11	N-2463-10-S-V	REDUCER FITTING	2
12	HC-2250	PRESSURE FILTER	1
13	TF-1038-14-180	HOSE ASSEMBLY, #4	1

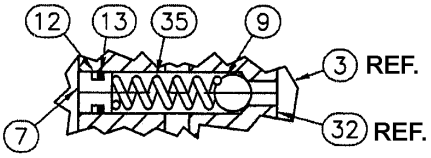
Model 5833 Parts List

Fluid Type: Aviation Phosphate Ester, Type IV

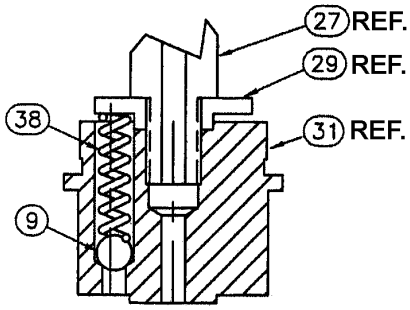
Item	Part Number	Description	Qty
1	H-1009-01	PUMP HANDLE	1
2	HC-1779	HAND PUMP, TWO STAGE	1
3	N-2001-11-S-E	ELBOW, #8 SAE X #8 JIC FLARE	1
4	TF-1041-05-76.0	HOSE ASSEMBLY, #4	1
5	TF-1040-42*79.0	HOSE ASSEMBLY, #4	1
6	HC-2146	PRESSURE GAUGE	1
7	TF-1041-21*36.0	HOSE ASSEMBLY, #8	1
8	N-2016-03-S	TEE, SWIVEL NUT, #4	1
9	N-2001-05-S-E	ELBOW, #6 SAE X #4 JIC FLARE	1
10	N-2007-06-S-E	FITTING, MALE CONNECTOR	1
11	N-2463-10-S-E	REDUCER FITTING	2
12	HC-1777	PRESSURE FILTER	1
13	TF-1041-05*180	HOSE ASSEMBLY, #4	1

9.14.3.a Two Stage Pump with Relief





HIGH PRESSURE INLET
CHECK CAVITY VIEW



LOW PRESSURE INLET
CHECK CAVITY VIEW

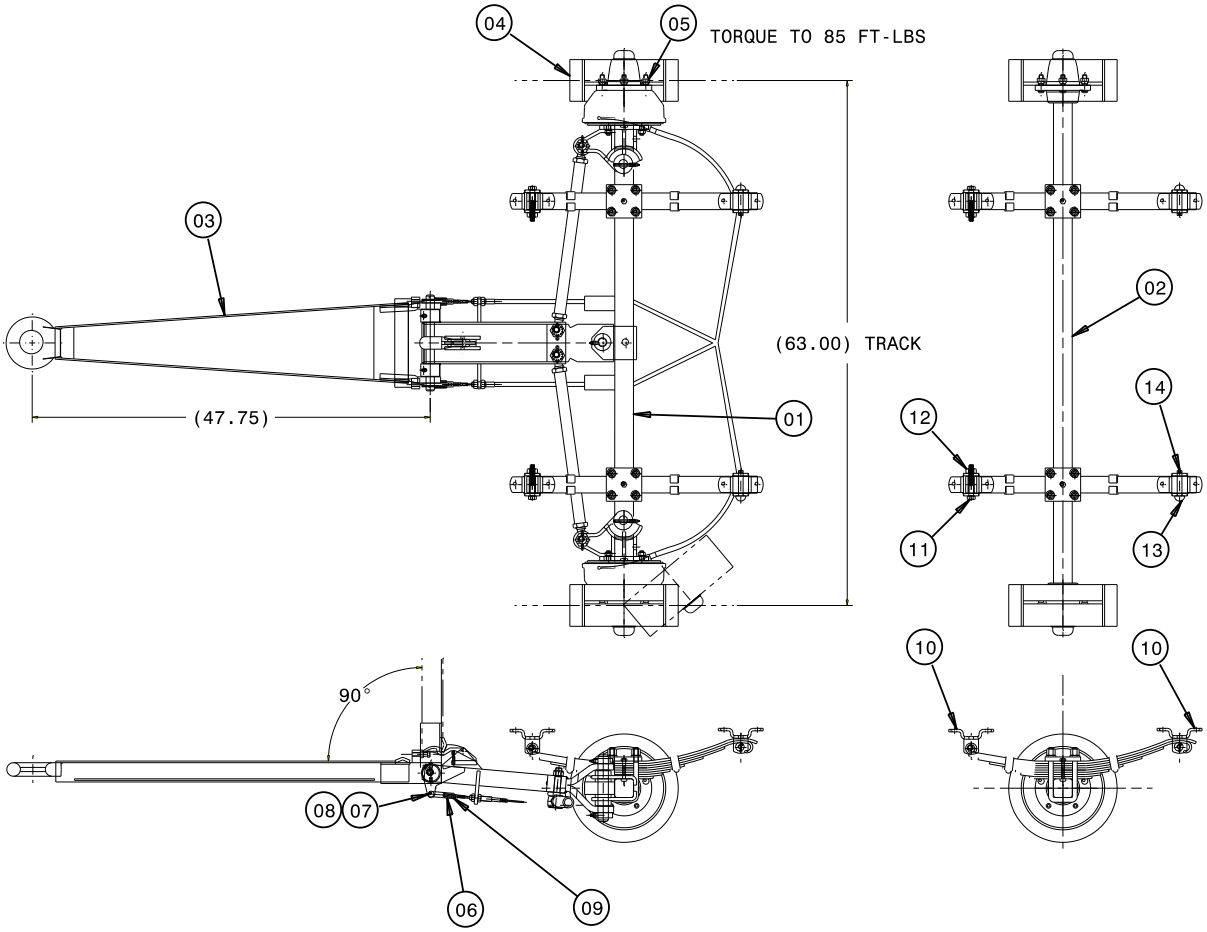
9.14.3.a Two Stage Pump with Relief (*continued*)

Parts List

Item	Part Number	Description	Qty
1	519-000	PIN	1
3	CXC-990022-001	BODY	1
7	505-001	PLUG, VALVE BODY	3
15	571-121	PISTON, BYPASS ASSEMBLY	1
16	508-000	PIVOT	1
20	566-125	PISTON L.P	1
23	583-120	PLUG	1
24	09-ADDF-04-20 X 56	TIE ROD	4
25	582-125	FLANGE	1
26	563-121	TUBE	1
27	562-125	H.P. PISTON	1
29	564-120	RETAINER	1
31	560-120	VALVE BODY	1
36	H-1223	GRIP, HANDLE	1
37	H-1009-01	HANDLE WITH GRIP	1
	HK-1095	**KIT, INTERNAL PARTS**; *consists of*:	
6	*(Not Shown)*	BALL, RELEASE	0
8		SPRING, OUTLET CHECK	1
9		BALL, CHECK	4
14		SPRING, BYPASS	1
17		BALL, BYPASS	1
34		SPRING, L.P. OUTLET	1
35		SPRING, H.P. OUTLET	1
38		SPRING, INTAKE L.P	1
	HK-1030	**KIT, PUMP SEAL**; *consists of*:	
5		O-RING, EPR	1
10		O-RING, EPR	1
12		BACKUP RING (TEFLON)	4
13		O-RING, EPR	4
28		H.P. PISTON SEAL	1
30		O-RING, EPR	1
32		O-RING, EPR	1
33		O-RING, EPR	1
	HK-1068	**KIT, PUMP LINKAGE**; *consists of*:	
18		PIN LINKAGE ASSEMBLY	2
19		STRAP	2
21		HANDLE BRACKET	1
22		CLEVIS PIN ASSEMBLY	1
	HK-3117	**KIT, RELEASE SCREW**; *consists of*:	
2		SCREW, RELEASE/RELIEF	1
4		RETAINER, RELEASE SCREW	1

9.14.4 Towing Trailer (*Option N*)

Capacity ..... 6,500 lbs (2,948 kg)
Front Axle Capacity ..... 3,250 lbs (1,474 kg)
Rear Axle Capacity ..... 3,250 lbs (1,474 kg)
Tires ..... 13x5x10 - Rated at 2,580 lbs (1,170 kg) at 6 mph (9.6 kph)



Parts List

Item	Part Number	Description	Qty
1	9-2196	ASSEMBLY, FRONT AXLE	1
2	18-2146	ASSEMBLY, REAR AXLE	1
3	47-3504	ASSEMBLY, DRAWBAR	1
4	1-3761	ASSEMBLY, WHEEL & TIRE	4
5	4603-1	NUT, WHEEL ½-20 UN	20
6	5205	YOKE	2
7	5206	PIN, YOKE	2
8	4800-2	PIN, COTTER $^{3}/_{32}$ X 0.75	2
9	4601-47	NUT, HEX $^{3}/_{8}$ -24 NF	2
10	4251	BRACKET, SPRING	8
11	4901-19	BOLT, GRADE 5, $^{9}/_{16}$ -12 UN X 3.75" LONG	4
12	4601-33	NUT, HEX, $^{9}/_{16}$ -12 UN	4
13	5403-1	RIVET	4
14	4800-3	PIN, COTTER, $^{1}/_{8}$ X 1" LONG	4

9.15 REPLACEMENT LABELS PARTS LISTS

9.15.1 Base Unit

Part Number	Description	Qty
V-1001	"Made in USA"	1
V-1033	"TRONAIR"	1
V-1050	ISO Electrical Shock Symbol	2
V-1348	"FLOW (Increase)"	1
V-1366	"HPU BY-PASS VALVE"	1
V-1374	"ROTATION"	1
V-1470	"CAUTION…"	1
V-1882	Control Panel Lights	1
V-1883	"HOUR METER"	1
V-1884	"FLOWMETER"	1
V-1886	"PYROMETER"	1
V-1888	"SHUT-OFF/CALIBRATION PORT"	1
V-1893	"SAMPLE VALVE"	1
V-1894	"PRESSURE"	1
V-1895	"RETURN"	1
V-1896	"MAXIMUM OIL LEVEL"	1
V-1897	"MINIMUM OIL LEVEL"	1
V-1898	"PRESSURE and FLOW CONTROLS INSIDE"	1
V-1900	"WARNING KEEP 5 FT CLEAR…"	2
V-1914	Reservoir Selector Valve	1
V-1918	"PE"	1
V-1919	"OPERATING INSTRUCTIONS…"	1

9.15.2 Fluid Labels

Model 5813 Parts List

Fluid Type: MIL-PRF-5606

Part Number	Description	Qty
V-1975	"MIL-PRF-5606"	2

Model 5823 Parts List

Fluid Type: MIL-PRF-83282

Part Number	Description	Qty
V-1976	"MIL-PRF-83282"	2

Model 5833 Parts List

Fluid Type: Aviation Phosphate Ester, Type IV and V

Part Number	Description	Qty
V-1977	"PHOSPHATE ESTER FLUIDS ONLY"	2

9.15.3 Filter Element Kit Labels

Model 5813 & 5823 Parts List

Fluid Type: MIL-PRF-5606 & MIL-PRF-83282

Part Number	Description	Qty
V-2601	"REPLACEMENT FILTER ELEMENT K-5033"	1
V-2600	"REPLACEMENT FILTER ELEMENT K-5034"	1
V-1916	"REPLACEMENT DESICCANT FILTER ELEMENT HC-1763"	1

Model 5833 Parts List

Fluid Type: Aviation Phosphate Ester, Type IV

Part Number	Description	Qty
V-1956	"REPLACEMENT FILTER ELEMENT K-3588"	1
V-1955	"REPLACEMENT FILTER ELEMENT K-3587"	1
V-1916	"REPLACEMENT DESICCANT FILTER ELEMENT HC-1763"	1

9.15.4 Split System *(Option C)* Labels

Part Number	Description	Qty
V-2004	"SYSTEM 1 PRESSURE"	1
V-2005	"SYSTEM 2 PRESSURE"	1
V-2006	"SYSTEM 1 RETURN"	1
V-2007	"SYSTEM 2 RETURN"	1

9.15.5 Hand Pump *(Option M)* Labels

Model 5813 & 5823 Parts List

Fluid Type: MIL-PRF-5606 & MIL-PRF-83282

Part Number	Description	Qty
V-1887	"HAND PUMP PRESSURE"	1
V-1915	"HAND PUMP"	1
V-2050	"REPLACEMENT FILTER ELEMENT K-3831"	1

Model 5833 Parts List

Fluid Type: Aviation Phosphate Ester, Type IV

Part Number	Description	Qty
V-1887	"HAND PUMP PRESSURE"	1
V-1915	"HAND PUMP"	1
V-1989	"REPLACEMENT FILTER ELEMENT K-3752"	1

10.0 PROVISION OF SPARES

10.1 SOURCE OF SPARE PARTS

TRONAIR, Inc.
1 Air Cargo Pkwy East
Swanton, Ohio 43558 USA

Telephone: (419) 866-6301 or 800-426-6301
Fax: (419) 867-0634
E-mail: sales@tronair.com
Website: www.tronair.com

10.2 RECOMMENDED SPARE PARTS LISTS

It is recommended that the following spare parts be kept on hand and available for immediate use during maintenance.

10.2.1 Spare Electrical Parts

Part Number	Description	Qty
Refer to Section 9.10 Electrical Components Item 22	Fuse, Transformer Primary	2
EC-1542-12	Fuse, Transformer Secondary	1
Refer to Section 9.10 Electrical Components Item 24	Fuse, Heat Exchanger	3

10.2.2 Spare Parts

Model 5813 & 5823 Parts List

Fluid Type: MIL-PRF-5606 & MIL-PRF-83282

Part Number	Description	Qty
HC-1763	Desiccant Filter Element	1
K-5033	Kit, Pressure Filter Element	1
K-5034	Kit, Return Filter Element	1
*	Kit, Shaft Seal	1
K-3752	Kit, Hand Pump Filter Element *(Optional)*	1

* ***Call Tronair for details***

Model 5833 Parts List

Fluid Type: Aviation Phosphate Ester, Type IV

Part Number	Description	Qty
HC-1763	Desiccant Filter Element	1
K-3588	Kit, Pressure Filter Element	1
K-3587	Kit, Return Filter Element	1
*	Kit, Shaft Seal	1
K-3752	Kit, Hand Pump Filter Element *(Optional)*	1

* ***Call Tronair for details***

11.0 CALIBRATION OF INSTRUMENTATION

All gauges on the Hydraulic Power Unit can be either returned to Tronair for calibration or certified by the end user if proper calibration equipment is available. Gauges returned to Tronair for calibration will be tested with standards traceable to N.I.S.T. (National Institute of Standards and Technology). Tronair recommends calibration of instrumentation at yearly intervals, but actual calibration dates may be based upon frequency of use and the end users quality system. For information on returning gauges for calibration, Reference 12.1 – Source of Calibration.

11.1 SOURCE OF CALIBRATION

TRONAIR, Inc.
1 Air Cargo Pkwy East
Swanton, Ohio 43558 USA

Telephone: (419) 866-6301 or 800-426-6301
Fax: (419) 867-0634
E-mail: sales@tronair.com
Website: www.tronair.com

11.2 ANALOG PRESSURE GAUGE – System Pressure

11.2.1 Self Calibration

An accurate pressure calibration gauge is required for calibration of the System Pressure gauge. There are two methods available. Method A can be used if the HPU is equipped with a calibration port *(Option Q)*. Method B must be used if the HPU is **not** equipped with a calibration port. Follow the necessary steps below.
NOTE: Method A can only test the gauge up to the rated operating pressure of the HPU (4,000 psi).

Method A: Shut off HPU and disconnect from aircraft. Close the calibration port **Shut-off Valve** on the instrument panel of the HPU. Attach the "Master" calibration gauge to the **Calibration Port** on the instrument panel.

Set up the HPU as follows:
Reservoir Selector Valve..... Set to HPU Reservoir
Bypass Valve ..... Open
Pressure Ball Valves (at rear of unit)..... Closed
Return Ball Valves (at rear of unit) ..... Closed

Start the HPU. Open the calibration port Shut-off Valve. Close the Bypass valve to build system pressure. Record gauge values at the designated increments.

Open the Bypass valve.

Shut off the HPU and close the calibration port Shut-off Valve before disconnecting the "Master" calibration gauge.

Method B: Shut off the HPU and disconnect it from the power source. Remove the **Hydraulic Panel** from the front instrument panel (four screws). Disconnect the hose from the System Pressure gauge (remove gauge from panel if necessary). Attach calibration test equipment to the gauge and record gauge values at the designated increments.

SYSTEM PRESSURE GAUGE (HC-2144)

Applied Pressure (System Pressure Gauge) (psig)	Minimum Acceptable (psig)	Maximum Acceptable (psig)	Gauge Movement (Direction)	Indicated Pressure (Calibration Gauge) (psig)
1000	910	1090	Increasing	
2000	1910	2090	Increasing	
3000	2910	3090	Increasing	
4000	3910	4090	Increasing	
5000	4910	5090	Increasing	
6000	5910	6090	Increasing	
5000	4910	5090	Decreasing	
4000	3910	4090	Decreasing	
3000	2910	3090	Decreasing	
2000	1910	2090	Decreasing	
1000	910	1090	Decreasing	
Allowable operating tolerance: +/- 1.5% of full scale (90 psig) at room temperature (70° F).				

11.3 ANALOG PRESSURE GAUGE (Hand Pump Pressure- *Option M Only*)

11.3.1 Self Calibration

An accurate pressure calibration gauge is required for calibration of the Hand Pump Pressure gauge. Follow the necessary steps below.

Shut off the HPU and disconnect it from the power source. Remove the **Hydraulic Panel** from the front instrument panel (four screws). Disconnect the hose from the Hand Pump Pressure gauge (remove gauge from panel if necessary). Attach calibration test equipment to the gauge and record gauge values at the designated increments.

HAND PUMP PRESSURE GAUGE (HC-2146)

Applied Pressure (Hand Pump Pressure Gauge) (psig)	Minimum Acceptable (psig)	Maximum Acceptable (psig)	Gauge Movement (Direction)	Indicated Pressure (Calibration Gauge) (psig)
1000	700	1300	Increasing	
2000	1700	2300	Increasing	
5000	4800	5200	Increasing	
8000	7700	8300	Increasing	
10,000	9700	10,300	Increasing	
8000	5940	8300	Decreasing	
5000	4800	5200	Decreasing	
2000	1700	2300	Decreasing	
1000	700	1300	Decreasing	
Allowable operating tolerance:	+/- 3% of full scale (300 psig) at room temperature (70° F).			
	+/- 2% of full scale for middle third of scale (200 psig) at room temperature (70° F).			

11.4 ANALOG TEMPERATURE GAUGE *(Pyrometer)*

11.4.1 Self Calibration

An accurate temperature calibration gauge is required for calibration of the Pyrometer. The pyrometer bulb is located in the return manifold (rear of unit) and can be accessed by removal of the HPU top panel. See Section 9.7.2 – Pyrometer for location. Follow the necessary steps below.

1 Remove the pyrometer bulb from the return manifold by removing the slotted brass nut that retains the bulb in the well.
2 Connect the temperature calibration gauge to the bulb of the pyrometer.

The Temperature Value Must Be:

Pyrometer Temperature Display (° F)	Minimum Acceptable (° F)	Maximum Acceptable (° F)	Temperature Calibration gauge (° F)
160	158	162	

12.0 IN SERVICE SUPPORT

Contact Tronair, Inc. for technical services and information. See Section 1.3 – Manufacturer.

13.0 GUARANTEES/LIMITATION OF LIABILITY

Tronair products are warranted to be free of manufacturing or material defects for a period of one year after shipment to the original customer. This is solely limited to the repair or replacement of defective components. This warranty does not cover the following items:

a) Parts required for normal maintenance
b) Parts covered by a component manufacturers warranty
c) Replacement parts have a 90-day warranty from date of shipment

If you have a problem that may require service, contact Tronair immediately. Do not attempt to repair or disassemble a product without first contacting Tronair, any action may affect warranty coverage. When you contact Tronair be prepared to provide the following information:

a) Product Model Number
b) Product Serial Number
c) Description of the problem

If warranty coverage is approved, either replacement parts will be sent or the product will have to be returned to Tronair for repairs. If the product is to be returned, a Return Material Authorization (RMA) number will be issued for reference purposes on any shipping documents. Failure to obtain a RMA in advance of returning an item will result in a service fee. A decision on the extent of warranty coverage on returned products is reserved pending inspection at Tronair. Any shipments to Tronair must be shipped freight prepaid. Freight costs on shipments to customers will be paid by Tronair on any warranty claims only. Any unauthorized modification of the Tronair products or use of the Tronair products in violation of cautions and warnings in any manual (including updates) or safety bulletins published or delivered by Tronair will immediately void any warranty, express or implied.

The obligations of Tronair expressly stated herein are in lieu of all other warranties or conditions expressed or implied. **Any unauthorized modification of the Tronair products or use of the Tronair products in violations of cautions and warnings in any manual (including updates) or safety bulletins published or delivered by Tronair will immediately *void any warranty, express or implied* and Tronair *disclaims any and all liability for injury (WITHOUT LIMITATION and including DEATH), loss or damage arising from or relating to such misuse*.**

14.0 APPENDICES

APPENDIX I	Declaration of Conformity
APPENDIX II	Hydraulic Schematic (INS-2370)
APPENDIX III	Electrical Schematic (INS-2238)
APPENDIX IV	Wiring Diagram (INS-1664)
APPENDIX V	Lincoln Motor Manual
APPENDIX VI	Oilgear Load Sense Pump Manual, PVG 150 Service Instructions
APPENDIX VII	Safety Data Sheet (SDS) pertaining to Hydraulic Fluid
APPENDIX VIII	Instrument Certification Notice

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APPENDIX I

Declaration of Conformity

Declaration of Conformity

The design, development and manufacture is in accordance with European Community guidelines

Mobile Hydraulic Power Unit
(Electric Motor Driven)

Relevant draft complied with by the machinery:
prEN 1915-1:1995

Relevant standards complied with by the machinery:
prEN 982:1996
prEN 60204-1:1997
HFPA/JIC T2.24.1-1990
ISO 4021:1997
ARP 1247B
NFPA 70/NEC 1999

Identification of person empowered to sign on behalf of the Manufacturer:

Patrick Finch

Quality Assurance Representative

Tronair, Inc.
1 Air Cargo Pkwy East
Swanton, OH 43558

Phone: (419) 866-6301 | 800-426-6301
Web: www.tronair.com
Email: sales@tronair.com

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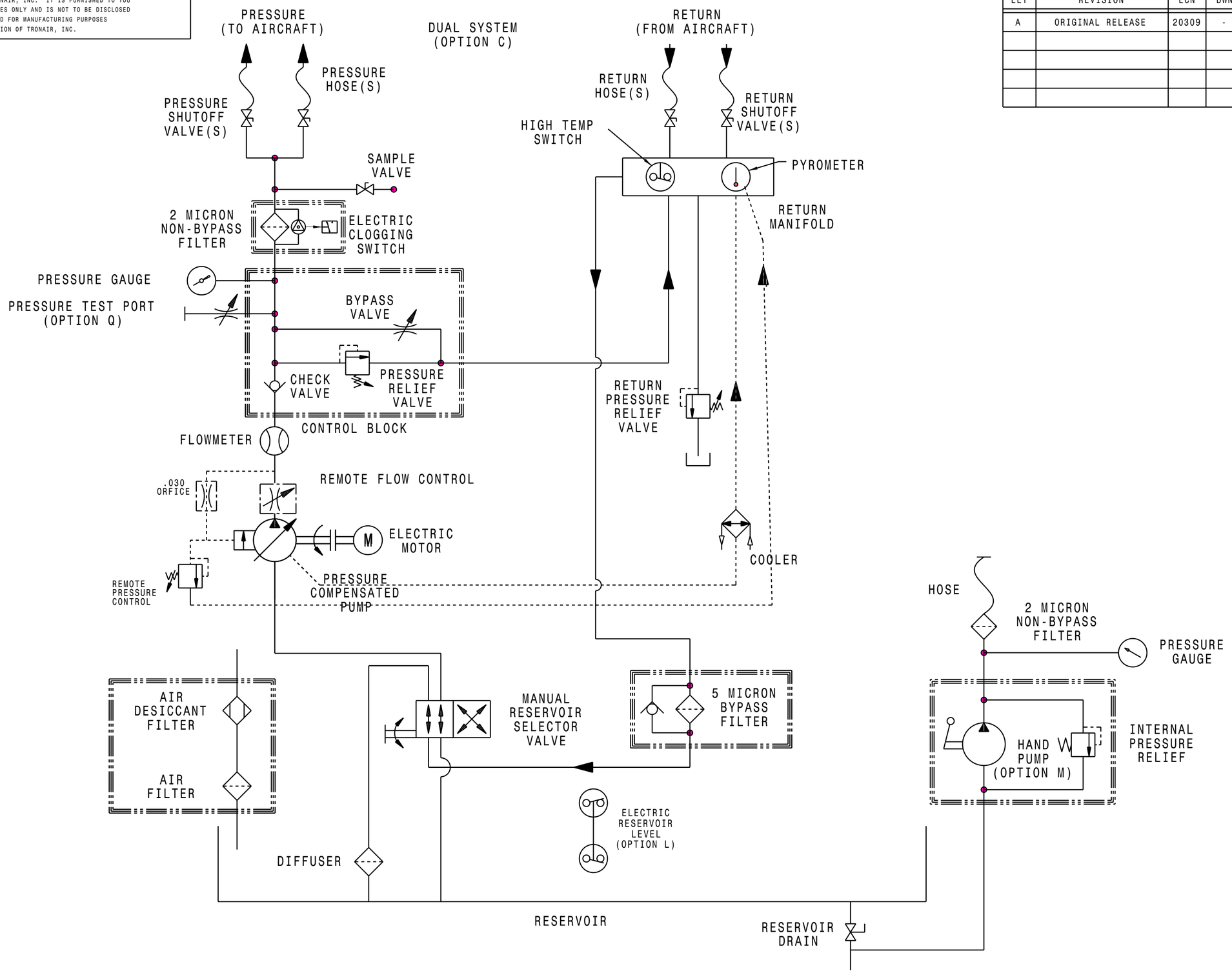
APPENDIX II

Hydraulic Schematic
(INS-2370)

LET	REVISION	ECN	DWN	CHK	DATE
A	ORIGINAL RELEASE	20309	-	-	01-30-17



MAKE FROM: N / A			
MATERIAL: N / A	TYPE: N / A		
FINISH: N / A			
REFERENCE: N / A		SIZE C	
SCALE: FULL	DO NOT SCALE DRAWING		

BREAK ALL SHARP EDGES AND CORNERS

TOLERANCES UNLESS OTHERWISE SPECIFIED

DECIMAL	.X	± .100
	.XX	± .030
	.XXX	± .010
FRACTION	X/XX	± 1/16

ANGLES: ± 1/2 DEGREE

< > INDICATES CRITICAL DIMENSIONS

( ) INDICATES REFERENCE DIMENSIONS

TRONAIR AIRCRAFT GROUND SUPPORT EQUIPMENT

DWN BY	CKD BY	
CDG	PEH	01-31-17

SCHEMATIC, HYDRAULIC

05	INS-2370	REV A

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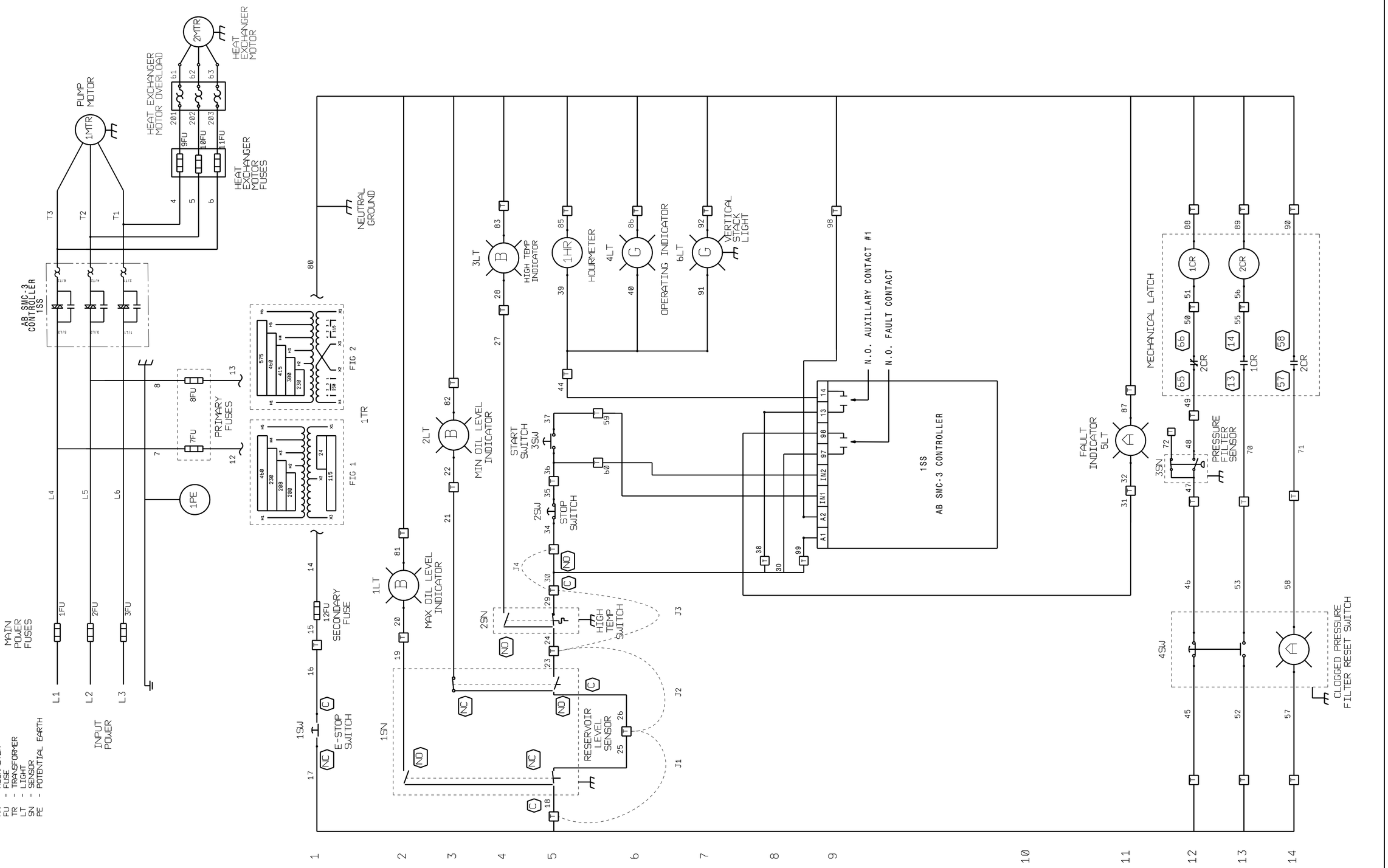
APPENDIX III

Electrical Schematic
(INS-2238)

LET	REVISION	ECN	DWN	CHK	DATE
A	ORIGINAL RELEASE	19173	-	-	11-27-13
B	ADDED WIRES 70 & 71	21208	ADO	PEH	03-19-19



COMPONENT ABBREVIATION

MS	- MOTOR STARTER
SS	- SOFT START
MTR	- MOTOR
SW	- SWITCH
CR	- CONTROL RELAY
HR	- HOURMETER
FU	- FUSE
TR	- TRANSFORMER
LT	- LIGHT
SN	- SENSOR
PE	- POTENTIAL EARTH

WIRE COLORS:

NEUTRAL	- LT. BLUE
POWER	- RED
INTERCONNECTION	- RED
3 PHASE	- BLACK
GROUND	- GREEN/YELLOW

(XX) - DEVICE TERMINATION

(XX) - TERMINAL BLOCK CONNECTION

1TB - GROUND TERMINAL BLOCK

2TB - NEUTRAL TERMINAL BLOCK

3TB - CONTROL TERMINAL BLOCK

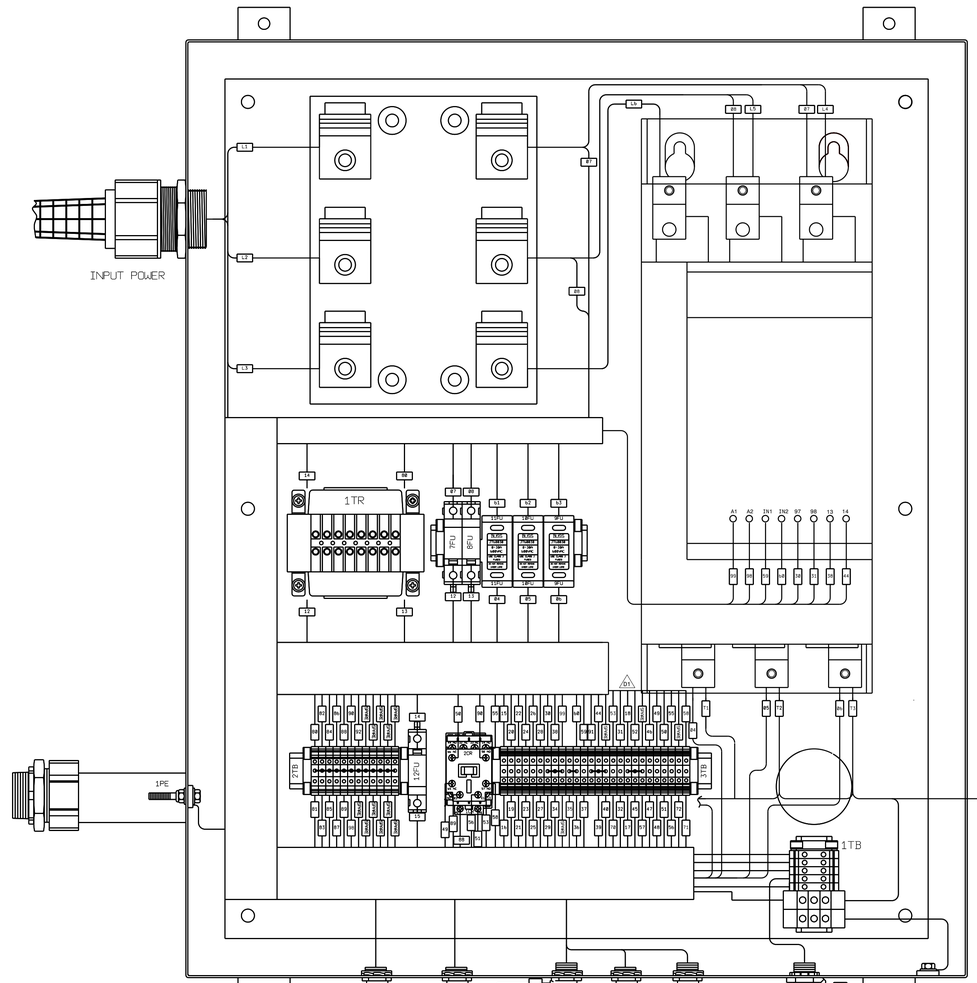
--- OPTIONS JUMPER

MAKE FROM: N / A		BREAK ALL SHARP EDGES AND CORNERS	TRONAIR AIRCRAFT GROUND SUPPORT EQUIPMENT		
MATERIAL: N / A	TYPE: N / A	TOLERANCES UNLESS OTHERWISE SPECIFIED	DWN BY WCG	CKD BY PEH	11-27-13
FINISH: MILL		DECIMAL .X ± .100 / .XX ± .030 / .XXX ± .010 / FRACTION X/XX ± 1/16 / ANGLES: ± 1/2 DEGREE	SCHEMATIC, HPU ELECTRICAL (CE/CSA)		
REFERENCE:	SIZE C	< > INDICATES CRITICAL DIMENSIONS / ( ) INDICATES REFERENCE DIMENSIONS	05	INS-2238	REV B
SCALE: N. S. R.	DO NOT SCALE DRAWING				

APPENDIX IV

Wiring Diagram
(INS-1664)

LET	REVISION	ECN	DWN	CHK	DATE
-	ORIGINAL RELEASE	11765	-	-	05-18-01
A	1. ADDED STACK LT. 2. WIRE 93 WAS 91. 3. UPDATED GEOMETRY	12249	WCG	PEH	11-04-02
B	CHANGED SOFT START AND WIRING	15354	WCG	PEH	05-06-08
C	ADDED TERMINALS	16953	JMB	PEH	04-15-09
D	DELETED 41, 42, 61 TERMINALS	18738	JMB	PEH	09-20-12
E	ADDED WIRES 70 & 71	21208	ADO	PEH	03-19-19



MAKE FROM: N / A	BREAK ALL SHARP EDGES AND CORNERS	TRONAIR AIRCRAFT GROUND SUPPORT EQUIPMENT
MATERIAL: N / A TYPE: N / A	TOLERANCES UNLESS OTHERWISE SPECIFIED DECIMAL .X ± .100 .XX ± .030 .XXX ± .010 FRACTION X/XX ± 1/16 ANGLES: ± 1/2 DEGREE	DWN BY SJD CKD BY WJL 05-18-01
FINISH: MILL	< > INDICATES CRITICAL DIMENSIONS ( ) INDICATES REFERENCE DIMENSIONS	INSTRUCTION, WIRING DIAGRAM (CE)
REFERENCE: 150 HP SIZE D		05 INS-1664 REV E
SCALE: N / A DO NOT SCALE DRAWING		

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APPENDIX V

Lincoln Motor Manual

Carefully read and fully understand this Owner's Manual prior to installation, operation and maintenance of your motor.

1. SAFETY DEPENDS ON YOU

Lincoln motors are designed and manufactured with safety in mind. However, your overall safety can be increased by properly installing, operating and maintaining the motor. Read and observe all instructions, warnings and specific safety precautions included in this manual and THINK BEFORE YOU ACT!

2. RECEIVING AND INSPECTION

Check packing list and inspect motor to make certain no damage has occurred in shipment. Claims for any damage done in shipment must be made by the purchaser against the transportation company.

Turn the motor shaft by hand to be certain that it rotates freely. Be careful not to cut yourself on the shaft keyway; it is razor sharp!

Check the nameplate for conformance with power supply and control equipment requirements.

3. HANDLING

⚠ WARNING

FALLING EQUIPMENT can injure.

- **Lift only with equipment of adequate lifting capacity.**
- **If so equipped, use lift ring(s) on the motor to lift ONLY the motor and accessories mounted by Lincoln.**

In case of assemblies on a common base, the motor lift ring(s) CANNOT be used to lift the assembly and base but, rather, the assembly should be lifted by a sling around the base or by other lifting means provided on the base. In all cases, care should be taken to assure lifting in the direction intended in the design of the lifting means. Likewise, precautions should be taken to prevent hazardous overloads due to deceleration, acceleration or shock forces.

4. STORAGE

Motor stock areas should be clean, dry, vibration free and have a relatively constant ambient temperature. For added bearing protection while the motor is in storage, turn the motor shaft every six months.

A motor stored on equipment and component equipment prior to installation should be kept dry and protected from the weather. If the equipment is exposed to the atmosphere, cover the motor with a waterproof cover. Motors should be stored in the horizontal position with drains operable and positioned in the lowest point. CAUTION: Do not completely surround the motor with the protective covering. The bottom area should be open at all times.

Windings should be checked with a megohm-meter (Megger) at the time equipment is put in storage. Upon removal from storage, the resistance reading must not have dropped more than 50% from the initial reading. Any drop below this point necessitates electrical or mechanical drying. Note the sensitivity of properly connected megohm-meters can deliver erroneous values. Be sure to carefully follow the megohm-meter's operating instructions when making measurements.

All external motor parts subject to corrosion, such as the shaft and other machined surfaces, must be protected by applying a corrosion-resistant coating.

5. INSTALLATION

For maximum motor life, locate the motor in a clean, dry, well ventilated place easily accessible for inspecting, cleaning and lubricating. The temperature of the surrounding air should not exceed 104°F (40°C) except for motors with nameplates indicating a higher allowable maximum ambient temperature.

⚠ WARNING

MOVING PARTS can injure.

- **BEFORE starting motor, be sure shaft key is captive.**
- **Consider application and provide guarding to protect personnel.**

5.1 INSTALLATION – MECHANICAL

Base

Mount the motor on a firm foundation or base sufficiently rigid to prevent excessive vibration. On foot-mounted motors, use appropriately sized bolts through all four mounting holes. For frames which have six or eight mounting holes, use the two closest the drive shaft and two on the end opposite the drive shaft (one on each side of the frame). If necessary, properly shim the motor to prevent undue stress on the motor frame and to precision align the unit.

Position

Standard motors may be mounted in any position. The radial and thrust load capacity of the motor's bearing system provides for this feature.

Drains

All motors have drain holes located in the end brackets. As standard, drains are in place for the horizontal with feet down mounting position. Other positions may require either rotation of the end brackets or drilling additional holes to attain proper drainage. Be sure existing drain or vent holes do not permit contaminant entry when motor is mounted in the other positions.

Additional drain holes exist near the bearing cartridge in both end brackets of 284T thru 449T steel frame motors. The drain holes are closed with a plastic plug. When the motor is vertically mounted, the plug located in the lower end bracket must be removed. To access the plug on blower end, simply remove the shroud; on some models, it is also necessary to take off the blower.

Drive – Power Transmission

The pulley, sprocket, or gear used in the drive should be located on the shaft as close to the shaft shoulder as possible. Do not drive the unit on the shaft as this will damage the bearings. Coat the shaft lightly with heavy oil before installing pulley.

Belt Drive: Align the pulleys so that the belt(s) will run true. Consult the belt manufacturer's catalog for recommended tension. Properly tension the belt; excessive tension will cause premature bearing failure. If possible, the lower side of the belt should be the driving side. On multiple belt installations be sure all belts are matched for length.

Chain Drive: Mount the sprocket on the shaft as close to the shaft shoulder as possible. Align the sprockets so that the chain will run true. Avoid excessive chain tension.

Gear Drive and Direct Connection: Accurate alignment is essential. Secure the motor and driven unit rigidly to the base. Shims may be needed to achieve proper alignment.

Excessive motor vibration may result if the full length of the motor shaft key is not completely engaged by the coupling or sheave. For these situations, adjustment of the key length is required.

5.2 INSTALLATION – ELECTRICAL

⚠ WARNING

ELECTRIC SHOCK can kill.

- **Disconnect input power supply before installing or servicing motor.**
- **Motor lead connections can short and cause damage or injury if not well secured and insulated.**
- **Use washers, lock washers and the largest bolt size which will pass through the motor lead terminals in making connections.**
- **Insulate the connection, equal to or better than the insulation on the supply conductors.**
- **Properly ground the motor — see GROUNDING.**

Check power supply to make certain that voltage, frequency and current carrying capacity are in accordance with the motor nameplate.

Proper branch circuit supply to a motor should include a disconnect switch, short circuit current fuse or breaker protection, motor starter (controller) and correctly sized thermal elements or overload relay protection.

Short circuit current fuses or breakers are for the protection of the branch circuit. Starter or motor controller overload relays are for the protection of the motor.

Each of these should be properly sized and installed per the National Electrical Code and local codes.

Properly ground the motor – See GROUNDING.

Terminal Box

Remove the appropriate knockout. For terminal boxes without a knockout, either a threaded power-conduit entry hole is provided or the installer is responsible for supplying a correctly sized hole.

The majority of terminal boxes can be rotated in place to allow power lead entry from the 3, 6, 9 or 12 o'clock direction.

Motor Connection

All single speed and two-speed Lincoln motors are capable of across-the-line or autotransformer starting. Reference the lead connection diagram located on the nameplate or inside of the terminal box cover.

Single speed motors have reduced voltage start capability per the following chart.

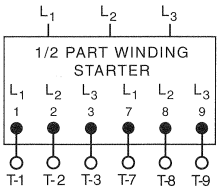
Number of Motor Leads	Number of Rated Voltages	Lead Numbers	YDS	PWS
3	Single	1-3	No	No
6	Single	1-3, 7-9	No	Yes
	Single	1-6	Yes	No
	Dual	1-6	Yes(1)	No
9	Dual	1-9	No	No
12	Single	1-12	Yes	Yes
	Dual	1-12	Yes	No(2)

(1) YDS capability on lower voltage only.
(2) PWS capability on lower voltage only, 1200 RPM, 324T-365T steel frame motors with Model Number efficiency letters of "S" or "H".

Contact Customer Service at 1-800-668-6748 (phone),
1-888-536-6867 (fax) or mailbox@lincolnmotors.com (e-mail) for a copy of across-the-line and other reduced voltage start connection diagrams.

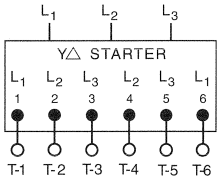
Connection Diagram 1

Single Voltage, 6 Leads
Part Winding Start Connection



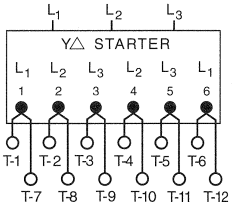
Connection Diagram 2

Single Voltage, 6 Leads
Y△ Start Connection



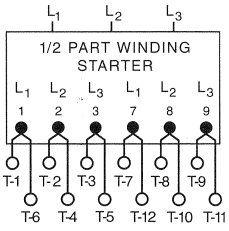
Connection Diagram 3

Single Voltage, 12 Leads
Y△ Start Connection



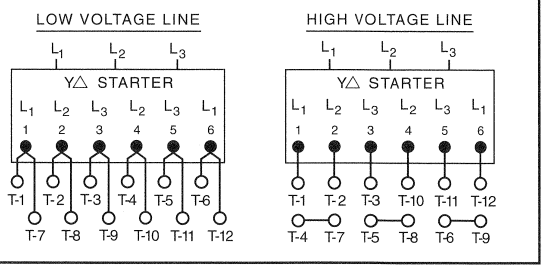
Connection Diagram 4

Single Voltage, 12 Leads
Part Winding Start Connection



Connection Diagram 5

Dual Voltage, 12 Leads
Y△ Start Connection



Space Heater (option)

Leads for space heaters are identified as H1 and H2. Heater voltage and watts are marked on the motor nameplate and should be checked prior to connection to power source.

Thermostat (option)

Leads for thermostats (normally closed, automatic reset contacts) are identified as P1 and P2. Connect these to a relay or signaling device. Motor line current cannot be handled by the thermostat.

Table 1 — Thermostat Contact Ratings

Voltage (60 Hz)	110V	220V
Max. Cont. Current (amps)	3.0	1.5
Min. Cont. Current (amps)	0.2	0.1

Thermistor (option)

Leads for thermistors are identified as P3 and P4. Thermistors require connection to Texas Instruments® Control Module Model 32AA or its equivalent for proper operation. This item may be purchased from Lincoln - see LC100 catalog.

Brake (option)

Carefully read and fully understand the instructions supplied by the brake manufacturer (see inside of brake housing or separately enclosed sheet). Contact the brake manufacturer for additional information.

GROUNDING

⚠ WARNING

ELECTRIC SHOCK can kill.

- **Connect the motor frame to a good earth ground per the National Electrical Code and local codes to limit the potential to ground in the event of contact between live electrical parts and the metal exterior.**

Lincoln motors may be electrically connected to earth ground using a terminal box mounting screw or a separate grounding screw when provided. Both are accessible inside the mounted terminal box. When a bronze mounting screw is supplied, always use it as the grounding point. In making the ground connection, the installer should make certain that there is a good electrical connection between the grounding lead and the motor.

6. OPERATION

Three phase squirrel cage induction motors will operate successfully, but not necessarily in accordance with nameplate ratings, at voltages 10 percent above or below nameplated value at the design frequency.

⚠ WARNING

MOVING PARTS can injure.

- **Before starting the motor, remove all unused shaft keys and loose rotating parts to prevent them from flying off and causing bodily injury.**
- **Keep away from moving parts.**

ELECTRIC SHOCK can kill.

- **Do not operate with covers removed.**
- **Do not touch electrically live parts.**

After checking that the shaft key is secure, operate the motor free of load and check the direction of rotation. If the motor rotates in the wrong direction, interchange any two supply leads.

Couple the motor to its load and operate it for a minimum of one hour. During this period, check for any unusual noise or thermal conditions. Check the actual operating current to be sure that the nameplate current times service factor is not exceeded for steady continuous loads.

7. MAINTENANCE

⚠ WARNING

ELECTRIC SHOCK can kill.

- **Internal parts of the motor may be at line potential even when it is not rotating.**
- **Disconnect all input power to the drive and motor before performing any maintenance.**

Lincoln motors have been designed and manufactured with long motor life expectancy and trouble-free operation in mind.

Periodically inspect the motor for excessive dirt, friction or vibration. Dust may be blown from an inaccessible location using compressed air. Keep the ventilation openings clear to allow free passage of air. Make sure the drain holes in the motors are kept open and the shaft slinger is positioned against the end bracket. Grease or oil can be wiped by using a petroleum solvent.

Overheating of the bearings caused by excessive friction is usually caused by one of the following factors:

1. Bent shaft.
2. Excessive belt tension.
3. Excessive end or side thrust from the gearing, flexible coupling, etc.
4. Poor alignment.

Damaging vibrations can be caused by loose motor mountings, motor misalignment resulting from the settling or distortion of the foundation, or it may be transmitted from the driven machine. Vibration may also be caused by excessive belt or chain tension.

BEARING SYSTEM

Lincoln motors have a high quality, premium design bearing system. Bearing sizes and enclosures are identified on most motor nameplates. The majority are double-shielded, deep-groove ball bearings. Double-sealed ball bearings are used on some motors in frames 56 and 143T thru 145T. A drive-end cylindrical roller bearing is standard on Crusher Duty motors, frames 405T and larger.

Lubrication instructions and/or grease specifications provided on the motor supersede the following information.

In general, the motor's bearing system has sufficient grease to last indefinitely under normal service conditions. For severe or extreme service conditions, it is advisable to add one-quarter ounce of grease to each bearing per the schedule listed in Table 2. Use a good quality, moisture-resistant, polyurea-based grease such as Chevron SRI #2. Lithium based greases are not compatible with polyurea-based greases; mixing the two types may result in the loss of lubrication.

Motors designed for low ambient applications have bearings with special low temperature grease. Use Beacon 325 lithium based grease or equivalent per the appropriate interval in Table 2.

Motors designed for high ambient applications have bearings with special high temperature grease. Use Dow Corning DC44 silicone grease or equivalent per the interval in Table 2 under "Extreme".

Severe Service: Operating horizontally, 24 hours per day, vibration, dirty, dusty, high humidity, weather exposure, or ambient temperatures from 104-130°F (40-55°C).

Extreme Service: Operating vertically, heavy vibration or shock, heavy duty cycle, very dirty or ambient temperatures from 130-150°F (55-65°C).

Table 2 : Bearing Lubrication Intervals

Motor Syn Speed	Motor Horsepower	Service Conditions	
		Severe	Extreme
BALL BEARINGS			
1800 RPM and slower	1/4 to 7-1/2 HP	2 years	6 months
	10 to 40 HP	1 year	3 months
	50 HP and up	6 months	3 months
above 1800 RPM	all sizes	3 months	3 months
ROLLER BEARINGS			
all speeds	all sizes	3 months	3 months

When adding lubricant, keep all dirt out of the area. Wipe the fitting completely clean and use clean grease dispensing equipment. More bearing failures are caused by dirt introduced during greasing than from insufficient grease.

If the motor is equipped with a relief port or tube, make certain it is open and free of caked or hardened grease. Before replacing relief plugs, allow excess grease or pressure to vent by running the motor for several minutes after lubrication.

⚠ CAUTION

- **LUBRICANT SHOULD BE ADDED AT A STEADY MODERATE PRESSURE. IF ADDED UNDER HEAVY PRESSURE BEARING SHIELD(S) MAY COLLAPSE.**
- **DO NOT OVER GREASE.**

PARTS

All parts should be ordered from Authorized Motor Warranty Stations. Call your Lincoln Motors Sales Office for location and phone number. A "Service Directory" listing all Authorized Motor Warranty Stations by geographic location is available; request Bulletin SD-6. These shops stock GENUINE Lincoln replacement parts and have factory trained personnel to service your motor.

8. WHO TO CALL

For the location and phone number of the Lincoln Motors District Sales Office nearest you, check your local Yellow Pages or call 1-800-MOTOR-4-U (1-800-668-6748) or visit our web site at
www.lincolnmotors.com.

9. WARRANTY

Lincoln Motors, the Seller, warrants all new *standard* motors and accessories thereof against defects in workmanship and material provided the equipment has been properly cared for and operated under normal conditions. All warranty periods begin on the date of shipment to the original purchaser. Warranty periods for ***low voltage (< 600 V)*** motors are defined in the following chart. The warranty period for ***medium voltage (> 600 V)*** motors is one year on sine-wave power. Contact Lincoln for warranty period on PWM power.

Model Number Prefix	Efficiency Code(s)	Frame Sizes	Warranty Period	
			Sine-Wave Power	PWM Power
AA, AF, AN	S, P, B	143T-286T	5 Yrs	2 Yrs*
CF, SD	M	143T-215T	2 Yrs	1 Yr
CF, CN, CS, CP	E, H, P, B	143T-449T	5 Yrs	2 Yrs*
		182U-449U	5 Yrs	2 Yrs*
C5, C6	H, P	M504-689	3 Yrs	Contact Lincoln #
MD, SE	S	284T-445T	5 Yrs	1 Yr
RC, RJ, SC	H	56-145T	5 Yrs	2 Yrs*
RD, RF	S	56-56H	5 Yrs	2 Yrs*
REW, SEW	S	56-256T	1 Yr	1 Yr
SD, SF	S, H, P, B	143T-449T	5 Yrs	2 Yrs*
Field Kits and Accessories			5 Yrs	

* Applies to motors with a service factor of 1.15 or higher. Motors with a 1.0 service factor have a 1 year warranty on PWM power.

If the Buyer gives the Seller written notice of any defects in equipment within any period of the warranty and the Seller's inspection confirms the existence of such defects, then the Seller shall correct the defect or defects at its option, either by repair or replacement F.O.B. its own factory or other place as designated by the Seller. The remedy provided the Buyer herein for breach of Seller's warranty shall be exclusive.

No expense, liability or responsibility will be assumed by the Seller for repairs made outside of the Seller's factory without written authority from the Seller.

The Seller shall not be liable for any consequential damages in case of any failure to meet the conditions of any warranty. The liability of the Seller arising out of the supplying of said equipment or its use by the Buyer, whether on warranties or otherwise, shall not in any case exceed the cost of correcting defects in the equipment in accordance with the above guarantee. Upon the expiration of any period of warranty, all such liability shall terminate.

The foregoing guarantees and remedies are exclusive and except as above set forth there are no guarantees or warranties with respect to accessories or equipment, either expressed or arising by option of law or trade usage or otherwise implied, including with limitation the warranty of merchantability, all such warranties being waived by the Buyer.

Lincoln™ MOTORS

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IM566-A December 1999

- indicates change since last printing.

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APPENDIX VI

Oilgear
Load Sense Pump Manual
PVG 150 Service Instructions

SERVICE INSTRUCTIONS "P-1NN/F" SINGLE PRESSURE COMPENSATOR WITH LOAD SENSE FOR PVG-150 PUMP, A1 SERIES CONTROL

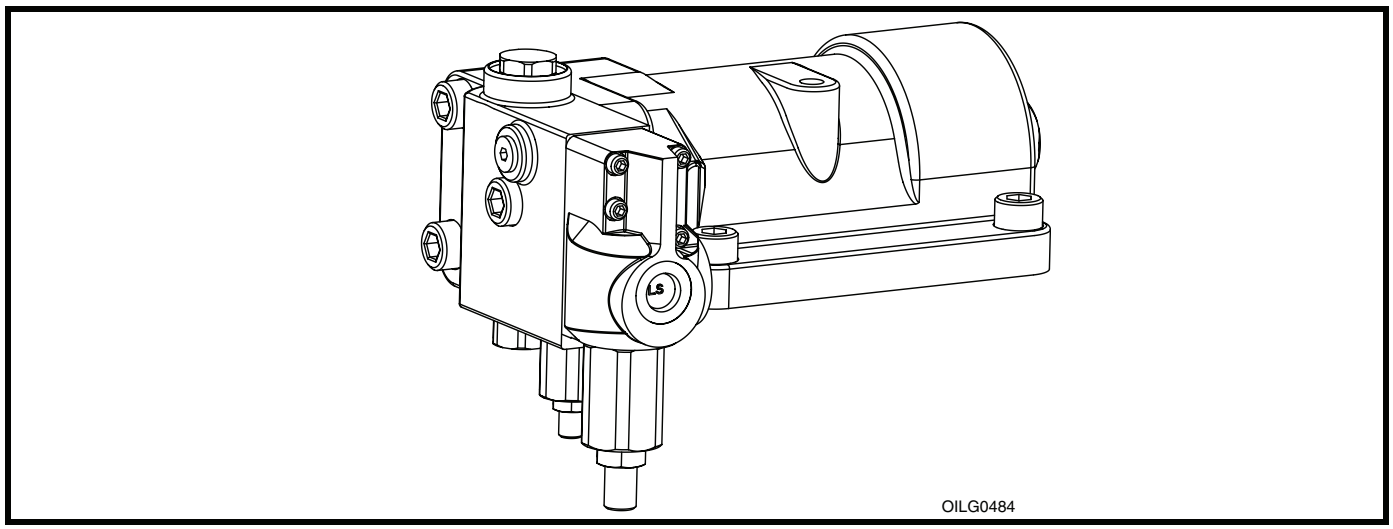

Figure 1. Typical Oilgear Type "P-1NN/F" Single Pressure Compensator w/Load Sense Control for PVG-150 Pumps

PURPOSE OF INSTRUCTIONS

These instructions will simplify the installation, operation, troubleshooting and maintenance of Oilgear type "P-1NN/F" Single Pressure Compensator w/Load Sense controlled units.

This material will inform you about the basic construction, principle of operation and service parts listings. Some controls may be modified for specific applications from those described in this bulletin and other changes may be made without notice.

REFERENCE MATERIAL

Fluid Recommendations .....Bulletin 90000
Contamination Evaluation Guide.....Bulletin 90004
Filtration Recommendations .....Bulletin 90007
Piping Information .....Bulletin 90011
Installation of Vertically Mounted Axial Piston Units .....Bulletin 90014
PVG Pumps -150 Service Instructions.....Bulletin 947034
PVG Open Loop Pumps, Sales .....Bulletin 47019-J

PVG-150 PUMP INSTALLATIONS

Single Pressure Compensator w/Load Sense "P-1NN/F," Installation..... Data Sheet 47378
Basic Pump, Installation..... Data Sheet 47375
Through Shaft Basic Pump, Installation..... Data Sheet 47376
Gear Pump, Installation..... Data Sheet 47945
Dual Pump 2-Bolt SAE Adapters, Installation..... Data Sheet 47387
Dual Pump 4-Bolt SAE Adapters, Installation..... Data Sheet 47388

THE OILGEAR COMPANY
2300 South 51st Street
Milwaukee, Wisconsin 53219
www.oilgear.com

Read and understand this entire instruction sheet before repairing or adjusting your Oilgear product.

Those who use and maintain this equipment must be thoroughly trained and familiar with the product. If incorrectly used or maintained, this product and its equipment can cause severe injury.

SAFETY SYMBOLS

The following signal words are used in this instruction sheet to identify areas of concern where your safety may be involved. Carefully read the text and observe any instructions provided to ensure your safety.

⚠ DANGER ⚠

THIS SIGNAL WORD INDICATES AN IMMINENTLY HAZARDOUS SITUATION WHICH, IF NOT AVOIDED, WILL RESULT IN DEATH OR SERIOUS INJURY.

⚠ WARNING

This signal word indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION

This signal word indicates that a potentially hazardous situation exists which, if not avoided, may result in damage to equipment or minor personal injury.

NOTE *While not directly relevant to the topic being discussed, the NOTE is used to emphasize information provided, or provide additional information which may be of benefit.*

⚠ WARNING

This service information is designed for the maintenance of your Oilgear product. It contains the information on the correct procedures determined by Oilgear for the safe manner of servicing. Always keep this instruction sheet in a location where it is readily available for the persons who use and maintain the product. Additional copies of this instruction sheet are available through Oilgear. Contact us at 414-327-1700 or visit our website: www.oilgear.com. Please contact us if you have any questions regarding the information in this instruction bulletin.

NOTE *The cleanliness of working on this pump control or the hydraulic system is extremely important to the safety and reliability of the pump and the system. Always make sure the fittings are clean on the outside before removing them from their connections, are capped and plugged when removed, and are placed in a clean rag or container until they are reinstalled.*

⚠ WARNING

Some service operations may require special tools or equipment. If you require information on these items, please contact Oilgear before attempting these repairs and service operations.

⚠ WARNING

Read, understand and follow the safety guidelines, dangers and warnings contained in this instruction sheet to promote reliable operation and prevent serious personal injury.

⚠ WARNING

DO NOT attempt to service this machinery in an environment where safety regulations are not established and in place.

⚠ WARNING

DO NOT operate the hydraulic system if a leak is present. Serious injury may result.

⚠ WARNING

Hydraulic systems operate under very high pressure. Hydraulic fluid escaping from a pressurized system can penetrate unprotected body tissue. DO NOT inspect for hydraulic leaks with bare hands or other exposed body parts. As a minimum, wear leather gloves prior to inspecting for leaks and use cardboard or wood. If leaks are present, relieve pressure and allow system to cool prior to servicing. If injured by escaping hydraulic oil, contact a physician immediately. Serious complications may arise if not treated immediately. If you have questions regarding inspecting for hydraulic leaks, please contact Oilgear prior to servicing.

⚠ WARNING

Hydraulic hoses and tubing must be inspected on a daily basis for leaks, cuts, abrasions, damage and improper clearance along any mounting frame for hidden damage before the unit is put into service. Replace damaged hoses or hoses you suspect are damaged before the system is returned to service! Hoses must be replaced every 2 years. Failure to properly inspect and maintain the system may result in serious injury.

⚠ WARNING

Hydraulic systems are hot. DO NOT TOUCH! Serious personal injury may result from hot oil. When you have completed working on the hydraulic system, thoroughly clean any spilled oil from the equipment. Do not spill any hydraulic fluids on the ground. Clean any hydraulic fluids from your skin as soon as you have completed maintenance and repairs. Dispose of used oil and system filters as required by law.

⚠ WARNING

Use hoses, fittings and adapters with the correct SAE rating when replacing hoses to prevent possible serious injury. Always replace hoses, fittings and adapters with replacements that have a proper, suitable, working pressure rating. Replacement hoses must be of the correct length and must comply with the hose manufacturer's and Oilgear's installation guidelines and recommendations.

⚠ WARNING

Hydraulic hoses have the SAE ratings marked on the hose to assist you in selecting the correct hose. The same manufacturer must supply any replacement hydraulic hoses and fitting assemblies. As an example: Brand "X" hose and brand "Y" fitting will not normally be compatible. No "Twist" is allowed in the hydraulic hoses. "Twist" may result in premature hose failure. This can cause serious injury. Please contact Oilgear for assistance when required.

⚠ WARNING

Hydraulic cylinders can be holding a function in a certain position when the pump is off. An example of this is a function being held in the lift or partial lift position by the cylinders. If a hydraulic line is removed or the hydraulic circuits or controls are being worked on, gravity may allow the function being held in position to drop. All workers and personnel must remain clear of these areas when working on or operating the hydraulic system. Block and secure all devices and functions which apply before beginning work or operation. Failure to comply with this can result in serious injury or death.

⚠ WARNING

Any hydraulic pipe which is replaced must conform to SAE J1065 specifications. If incorrect hydraulic pipe is installed, the hydraulic system may fail, causing serious injury. Damaged or leaking fittings, pipes or hoses must be replaced before the system is returned to service.

⚠ WARNING

DO NOT heat hydraulic pipe. The carbon content of this steel tube is such that if heated for bending, and either water or air quenched, the pipe may lose its ductility and thereby be subject to failure under high pressure conditions. Serious injury can result. Damaged or leaking pipes must be replaced before the system is returned to service. Please contact Oilgear if you require assistance or have questions.

⚠ WARNING

All hydraulic pressure must be relieved from the hydraulic system prior to removing any components from the system. To relieve the hydraulic pressure from the hydraulic system, turn off the motor and operate the control panel with the key in the ON position. Failure to comply can result in serious injury. If you have any questions concerning relieving the hydraulic pressure from the system, please contact Oilgear.

⚠ WARNING

Hydraulic components can be heavy. Use caution while lifting these components. Serious personal injury can be avoided with proper handling of the components.

⚠ WARNING

Please contact Oilgear if you require assistance. When performing hydraulic test procedures, use the proper hydraulic gauges. Installing an incorrect test gauge could result in serious injury if the gauge fails. Use properly rated hydraulic hoses to allow the test gauge to be read away from moving parts and functions.

⚠ WARNING

Increasing hydraulic pressure beyond the recommendations may result in serious damage to the pump and system or serious personal injury, and may void the Oilgear Warranty. If you have questions concerning hydraulic pressures or testing procedures, please contact Oilgear before attempting the test procedures or making adjustments.

⚠ WARNING

An Oilgear pump or pump control must not be modified in any way without authorization from Oilgear. Modifications may not comply with safety standards, including ANSI safety standards, and may result in serious personal injury. Please contact Oilgear if you require assistance.

⚠ WARNING

DO NOT enter under hydraulic-supported equipment unless it is fully supported or blocked. Failure to follow this procedure can result in serious injury or death.

⚠ WARNING

Any Oilgear pump safety decals must be replaced anytime they are damaged, missing or cannot be read clearly. Failure to have proper decals in place can result in serious injury or death. (If you require safety decals, please contact Oilgear for replacement safety decals, at no charge.)

⚠ WARNING

Be sure everyone is clear of the area around the hydraulic system before operating after servicing. Remain attentive at all times when operating to check your work until you are completely sure it is safe to return to service. Failure to heed this warning may result in serious personal injury or death.

⚠ WARNING

Wear the proper protective clothing when operating, servicing or maintaining the hydraulic system or the Oilgear pump. Wear the correct protective gear, safety glasses, gloves and safety shoes. Serious injury can result without proper protective gear.

⚠ WARNING

Make sure to keep hands, feet and other parts of your body clear of revolving or moving parts. Failure to comply can cause serious injury.

⚠ WARNING

DO NOT wear watches, rings or jewelry while working with electrical and mechanical equipment. These items can be hazardous and can cause serious and painful injuries if they come into contact with electrical wires, moving parts or hydraulic equipment.

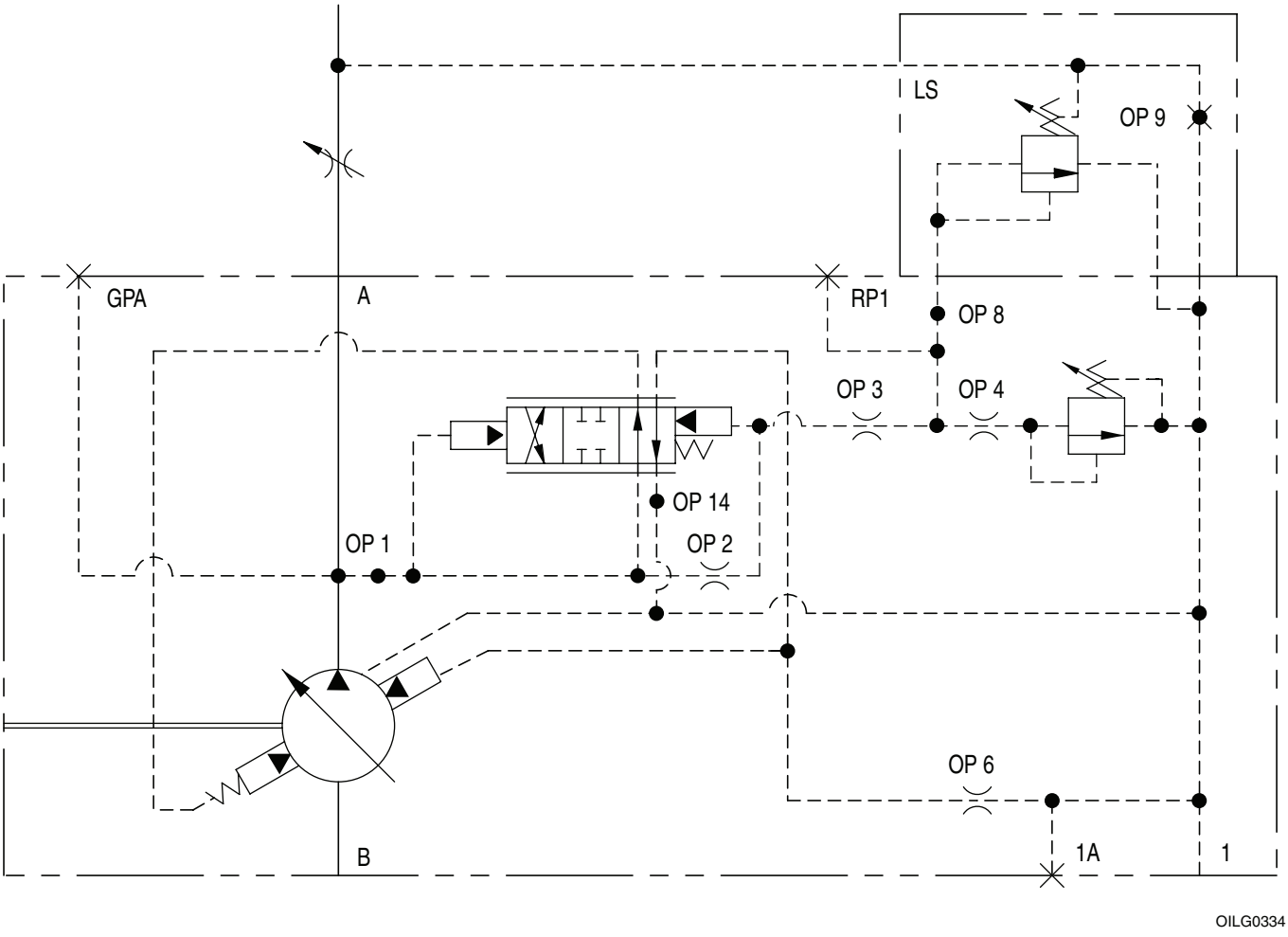

Figure 2. ASA Diagram for "P-1NN/F" Control Shown with Typical Pump

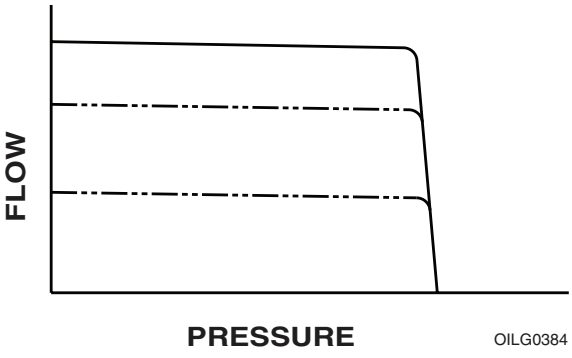

Figure 3. Curve Indicating Flow Versus Pressure for "P-1NN/F" Type Control

TROUBLESHOOTING

PROBLEM	CAUSES	REMEDY
Unresponsive or Unstable Control	Swashblock bearing surface and/or saddle bearings worn or damaged	Refer to 947034 Pump Service Instructions.
	Fluid is contaminated	Inspect and clean if necessary. Refer to Filtration Recommendations Bulletin 90007.
	Damaged or sticking load sense spool	Inspect and clean if necessary. Replace damaged parts.
	Contamination trapped between control piston and bore not allowing piston to move smoothly	
	Contamination trapped between control spool and bore not allowing spool to move smoothly	
	Insufficient control flow	Increase size of control orifice “OP 6.”
	Worn or damaged pilot relief seat and/or poppet	Inspect and replace if necessary.
	Faulty remote function circuit	
	Hydraulic line between remote fuction and pump port RP1 is incorrect	Change hydraulic line.
Insufficient Outlet Volume	Improper load sense adjustment	Adjust load sense CW to increase flow.
	Swashblock bearing surface and/or saddle bearings worn or damaged	Refer to 947034 Pump Service Instructions.
	Low input drive speed	
	Worn cylinder barrel and/or valve plate mating surfaces	
	Failed drive shaft	
	Worn or damaged piston shoes and/or swashblock	
	Worn pistons and/or piston bores	
	Maximum volume stop adjusted incorrectly	Adjust maximum volume stop CCW to increase flow.
	Pressure compensator is set too close to operating pressure	Adjust pressure compensator CW to increase pressure.
	Control piston stuck off stroke	Inspect and replace if necessary.
	Faulty remote function circuit	
Unable to Develop Full Pressure	System requires more flow than available	Check system for leaks or open functions.
	Pressure compensator adjustment not set correctly	Adjust pressure compensator CW to increase pressure.
	Contamination in control spool	Inspect and clean if necessary.
	Contamination in load sense spool	
	Worn or damaged pilot relief seat and/or poppet	Inspect and replace if necessary.
	Control piston stuck off stroke	
	Faulty remote function circuit	
Excessive Pressure	Swashblock bearing surface and/or saddle bearings worn or damaged	Refer to 947034 Pump Service Instructions.
	Pressure compensator adjustment not set correctly	Adjust pressure compensator CCW to decrease pressure.
	Contamination in “OP 3” or “OP 4”	Inspect and clean if necessary.
	Restricted passage between outlet and control spool	
	Contamination trapped between control piston and bore not allowing piston to move smoothly	Inspect and clean if necessary. Replace damaged parts.
	Contamination trapped between control spool and bore not allowing spool to move smoothly	
	Faulty remote function circuit	Inspect and replace if necessary.

PRINCIPLE OF OPERATION

Operation for a typical pump is described. Section diagrams are a representation of typical pumps with “P-1NN/F” control.

Functionally, the swashblock (and resultant displacement) is positioned by two opposite acting control pistons (unloading control piston and bias control piston).

See control parts drawing for actual configuration and location of part assemblies, orifices, connections and ports.

STARTING

The bias spring **(329)** positions the control pistons and connected pump swashblock so that the pump is at maximum displacement to raise pressure in the system.

RAISING PRESSURE - LOADING

Pump outlet pressure is ported to the control through Port “OP 1” to the control spool **(305)** and to the bias control piston **(303).** Outlet pressure is also transmitted through orifice Port “OP 2,” allowing the pressure acting on either end of the control spool **(305)** to be equal. In this condition, the control spool **(305)** is held in position only by the spring **(328)**.

The outlet pressure through Port “OP 2” is further transmitted through Port “OP 3” and Port “OP 4” to the adjustable pressure compensator relief valve and to the load sense spool **(353)**.

NOTE The load sense spool **(353)** is held in the closed position by both a spring **(355)**, and the load pressure **(P2)** piped to the spring chamber.

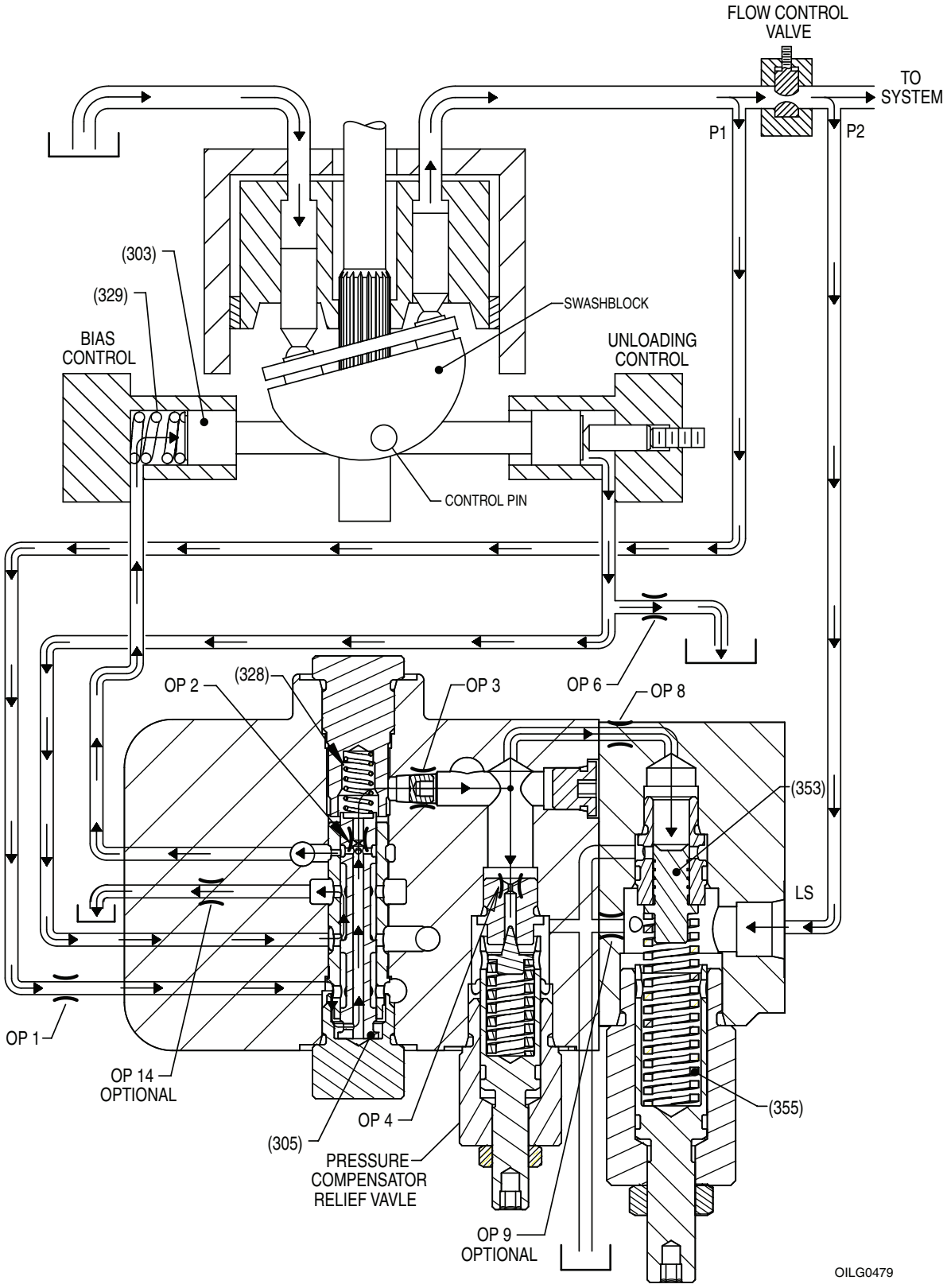

Figure 4. Raising Pressure - Loading

LOAD SENSE CONTROL - UNLOADING

The load sensing module matches flow to load demand. As the load on the system increases, pump pressure will increase while keeping the flow (volume) constant. The load sense spool **(353)** senses and maintains a constant pressure differential across the flow control valve in the delivery line. Pump flow becomes a function of the flow control valve opening area. For a given flow control valve setting, the pump will maintain a constant flow regardless of changes in pump input speed and/or working pressure.

As differential pressure across the flow control valve increases, the pressure differential across the load sense spool **(353)** increases, causing the load sense spool **(353)** to shift and allow flow through the load sense valve to drain. Pressure on the spring end of the control spool **(305)** is decreased, causing a pressure differential across the spool **(305)**. The pressure differential forces the control spool **(305)** to shift and compress the spring **(328)**. Outlet pressure is then ported to the unloading control piston **(302)**, and fluid behind the bias control piston **(303)** is ported to drain. Pump displacement will decrease until differential pressure across the flow control valve reaches the setting of the load sense valve.

As differential pressure across the flow control valve decreases, the pressure differential across the load sense spool **(353)** decreases, causing the load sense spool **(353)** to shift and close off the path to drain. Pressure on either side of the control spool **(305)** will become equal and the spring **(328)** will force the spool **(305)** to shift. Fluid from the unloading control piston **(302)** is then ported to drain and outlet pressure is ported to the bias control piston **(303)**. Pump displacement will increase until the differential pressure across the flow control valve reaches the setting of the load sense valve.

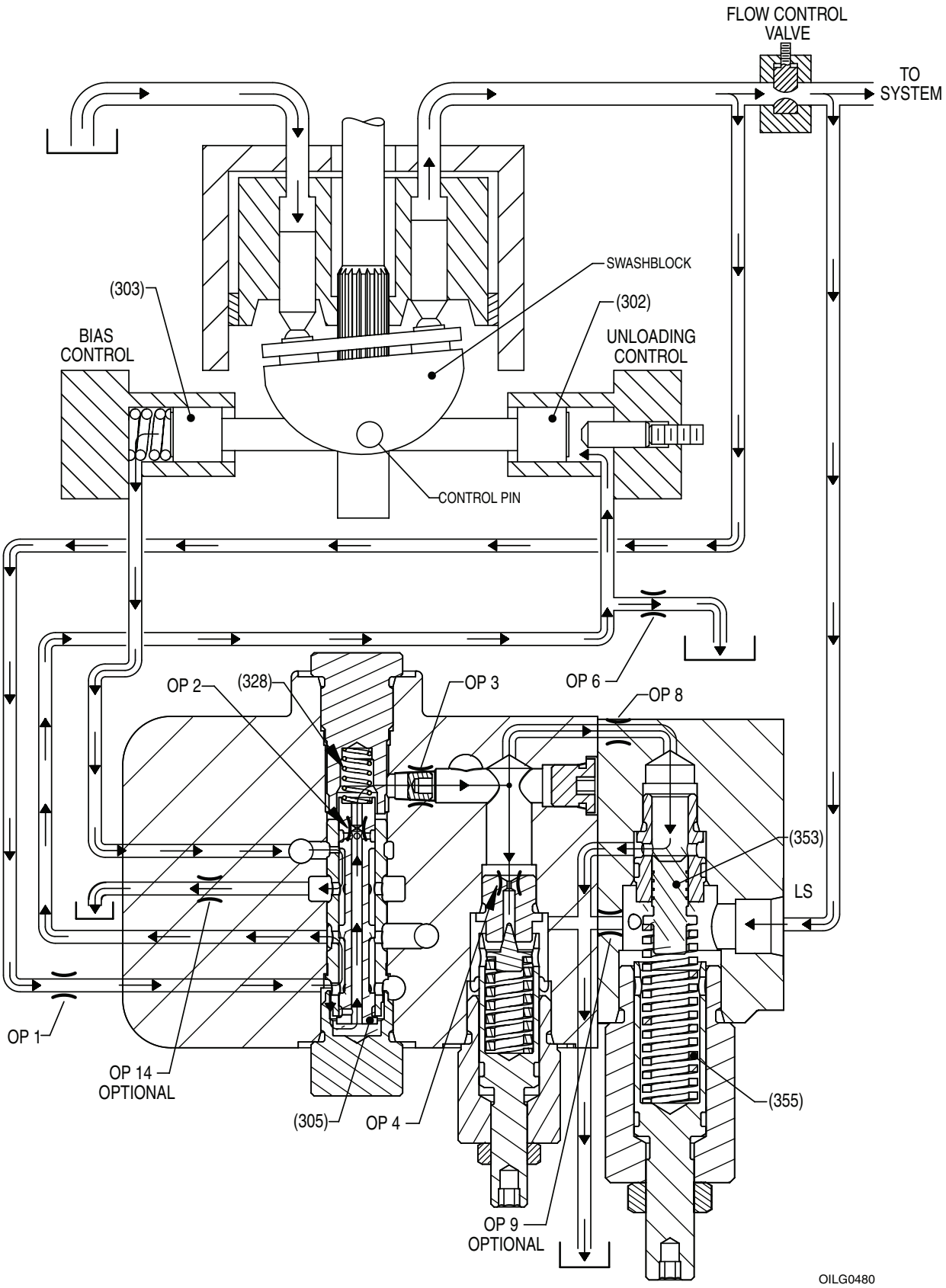

Figure 5. Load Sense Control - Unloading

COMPENSATING PRESSURE - UNLOADING

When pressure on the relief valve poppet **(307)** exceeds the presetting of the relief valve spring **(327)**, the relief valve poppet **(307)** moves off seat **(308)** and allows flow through the relief valve to drain. Pressure on the spring end of the control spool **(305)** is decreased, causing a pressure differential across the spool **(305)**. The pressure differential forces the control spool **(305)** to shift and compress the spring **(328)**. Outlet pressure is then ported to the unloading control piston **(302)**, and fluid behind the bias control piston **(303)** is ported to drain. Pump displacement will decrease to maintain system pressure as set by the relief valve adjuster **(310)**.

HOLDING PRESSURE

If the system pressure drops below the preset compensating pressure, the relief valve poppet **(307)** seats and closes the path to drain. Pressure on either side of the control spool **(305)** will become equal and the spring **(328)** will shift the spool **(305)** to the original position **(Figure 4)**. Fluid from the unloading control piston **(302)** is then ported to drain and outlet pressure is ported to the bias control piston **(303)**. Pump displacement will increase until the relief valve setting is reached again.

ORIFICE FUNCTIONS

Orifice Number	Decreasing orifice diameter will result in: (increasing diameter will do the opposite)
“OP 1”	Decreased “off stroke” time, do not decrease to less than .125"
“OP 2”	Do not change
“OP 3”	Do not change
“OP 4”	Do not change
“OP 6”	Decreased stability
“OP 8”	Increased stability
“OP 9”	Optional
“OP 14”	Decreased “on stroke” time, do not decrease to less than .081"

“OP 1” Orifice not used (standard)

“OP 2” Integral to spool, item 305

“OP 4” Integral to seat, item 308

“OP 6” .089 orifice

“OP 8” Orifice not used (standard)

“OP 14” Orifice not used (standard)

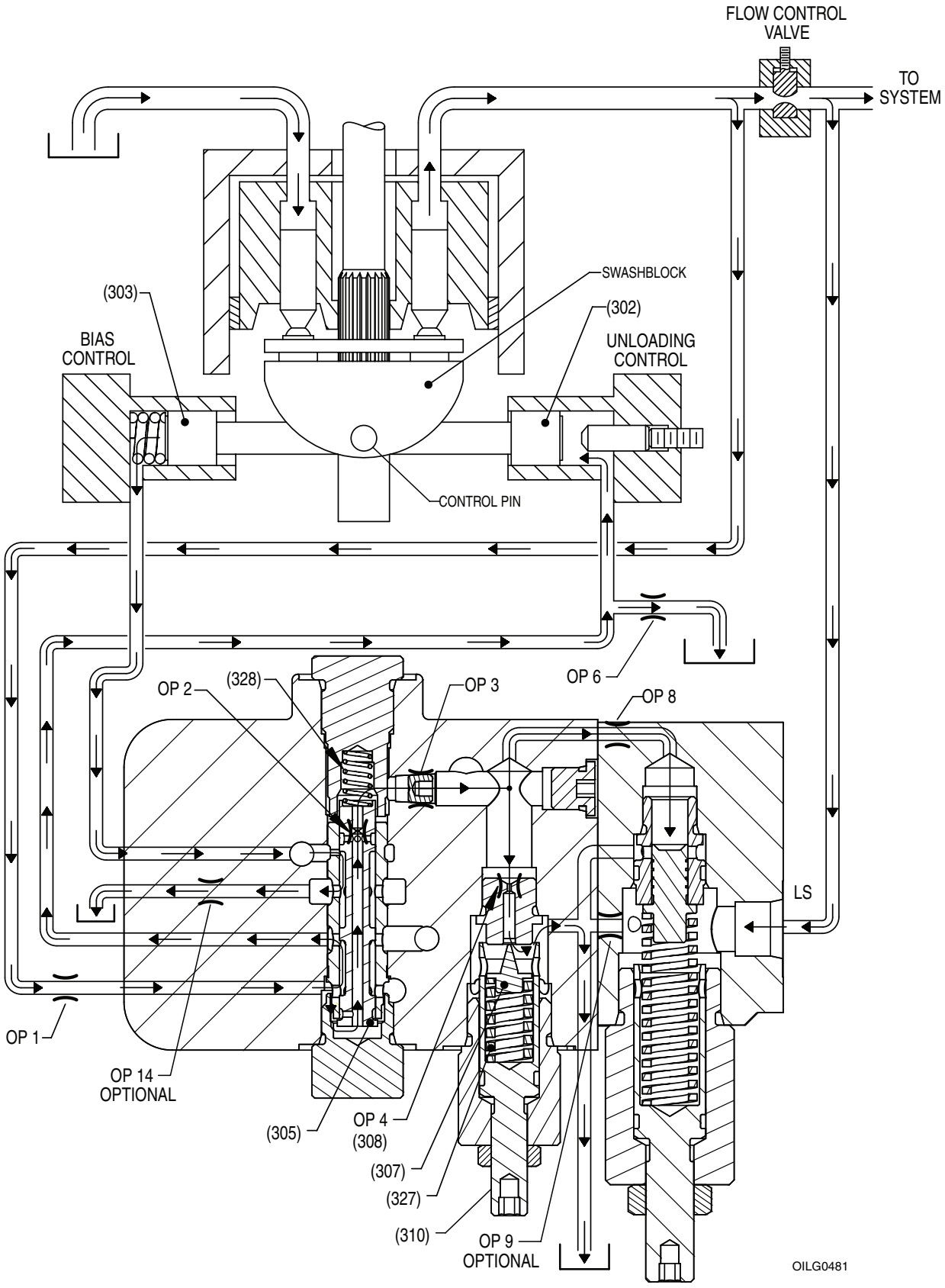

Figure 6. Compensating Pressure - Unloading

SCREW AND PLUG TORQUES FOR PVG-150 “P-1NN/F” CONTROL

Item Number	Head Type & Hex Size	Tightening Torque
306	7/8 external	50 ft•lb (68 N•m)
308	7/16 external	200 in•lb (23 N•m)
309	1 external	80 ft•lb (108 N•m)
315A	3/8 internal	100 ft•lb (136 N•m)
315B	3/8 internal	100 ft•lb (136 N•m)
316	3/8 internal	100 ft•lb (136 N•m)
319	5/32 internal	48 in•lb (5 N•m)
321	3/16 internal	120 in•lb (14 N•m)
322	7/8 external	50 ft•lb (68 N•m)
323	1 1/4 external	120 ft•lb (163 N•m)
325	5/32 internal	48 in•lb (5 N•m)
342	1/8 internal	45 in•lb (5 N•m)
351	1 1/4 external	85 ft•lb (115 N•m)
354	5/8 external	70±10 in•lb (8±1 N•m)
356	5/32 internal	57 in•lb (6 N•m)
364	3/32 internal	20 in•lb (2 N•m)
720	1 1/4 external	120 ft•lb (163 N•m)

CONTROL O-RING SEALS

Item Number	ARP 568 Uniform Size Number	Shore A Durometer		
		Viton	HNBR	EPR
314	-140	70	75	80
330	-013	90	90	80
331	-014	90	90	80
333	-906	90	90	80
334	-908	90	90	80
335	-910	90	90	80
336	-912	90	90	80
337	-014	*	*	*
338	-904	90	90**	80
345	-903	90	90**	80
358	-010	90	90	80
359	-016	90	90	80
360	-906	90	90	80
361	-912	90	90	80
362	-014	90	90	80
399	-014	*	*	*
1014	-014	90	90	80
1912	-912	90	90	80

* Teflon Backup Ring
** 90 durometer viton seals used

PARTS LIST FOR PVG-150 "P-1NN/F" CONTROL

Parts used in these assemblies are per Oilgear specifications. Use only Oilgear parts to ensure compatibility with assembly requirements. When ordering replacement parts, be sure to include pump type and serial number, and bulletin number and item number. Specify the type of hydraulic fluid to ensure seal and packing compatibility.

Item	Description	Qty
301	Control Housing	1
302	Unloading Control Piston	1
303	Bias Control Piston	1
304	End Cap	1
305	Control Spool	1
306	End Plug, Spring End	1
307	Relief Valve Poppet	1
308	Seat	1
309	Pilot Relief Bonnet	1
310	Relief Valve Adjuster	1
312	Shim	4
314	O-ring	1
315A	Screw	2
315B	Screw	1
316	Screw	4
318	Jam Nut	1
319	Orifice	1
321	SAE #4 Plug	2
322	Filter End Plug	1
323	Maximum Volume Plug	1
325	Orifice	1
327	Relief Valve Spring	1
328	Bias Spring	1
329	Bias Spring	1
330	O-ring	3
331	O-ring	1
333	O-ring	1
333	O-ring	1
334	O-ring	2

Item	Description	Qty
335	O-ring	1
336	O-ring	1
337	Backup Ring	1
338	O-ring	2
340	Permanent Plug	2
342	SAE #3 Plug	1
345	O-ring	2
348	Roll Pin	4
350	Load Sense Module	1
351	Load Sense Bonnet	1
352	Load Sense Adjusting Screw	1
353	Load Sense Spool	1
354	Load Sense Seat	1
355	Spring	1
356	Screw	4
358	O-ring	3
359	O-ring	2
360	O-ring	1
361	O-ring	1
362	Backup Ring	2
364	Setscrew	1
365	Jam Nut	1
399	Backup Ring	1
718	Maximum Stop Adjusting Screw	1
719	Jam Nut	1
720	Maximum Stop Bonnet	1
1014	O-ring	1
1912	O-ring	1

PVG-150 P-1NN/F Control Service Kits

Reference: 520167-102 Ass'y Drwg

Document Number: 520167-SK2

Revision: 0

Sheet 1 of 1

Description	Kit No.	Design Series	Items Included (quantity is 1 unless noted)
Control Pistons & Spring			
All	K318946-001	A1	302, 303, 329
Pressure Compensator Relief			
Viton Seals	L723987-101	A1	307, 308, 312(4), 327, 333
HNBR Seals	L723987-104		
EPR Seals	L723987-103		
Load Sense & Press. Comp. Relief			
Viton Seals	L723987-108	A1	307, 308, 312(4), 327, 333, 353, 354, 355, 359(2), 360, 362(2)
HNBR Seals	L723987-111		
EPR Seals	L723987-110		
Pressure Compensator Spool			
All	L724407-002	A1	305, 328
Pressure Compensator Adjuster			
Viton Seals	L300574HS04	A1	309, 310, 318, 331, 335, 337
HNBR Seals	L300574HS10		
EPR Seals	L300574HS06		
Load Sense Adjuster			
Viton Seals	L318966-002	A1	351, 352, 359, 361, 362, 365
HNBR Seals	L318966-005		
EPR Seals	L318966-004		
Adjustable Maximim Volume Stop			
Viton Seals	L516319-006	A1	399, 718, 719, 720, 1014, 1912
HNBR Seals	L516319-007		
EPR Seals	L516319-008		
Control Seal Kit			
Viton Seals	K516336-023	A1	314, 330(3), 331, 333, 334(2), 335, 336, 337, 338(2), 345(2), 358(3), 359(2), 360, 361, 362(2), 399, 1014, 1912
HNBR Seals	K516336-024		
EPR Seals	K516336-025		
End Cap Assembly			
Viton Seals	K520143-104	A1	303, 304, 305, 306, 307, 308, 309, 310, 312(4), 314, 315A(2), 315B, 318, 321(2), 322, 325, 327, 328, 330(3), 331, 333, 334(2), 335, 337, 338(2), 340(2), 348(4)
HNBR Seals	K520143-105		
EPR Seals	K520143-106		
Load Sense Module			
Viton Seals	L723004-001	A1	350, 351, 352, 353, 354, 355, 356(4), 358(3), 359(2), 360, 361, 362(2), 364, 365
HNBR Seals	L723004-817		
EPR Seals	L723004-803		

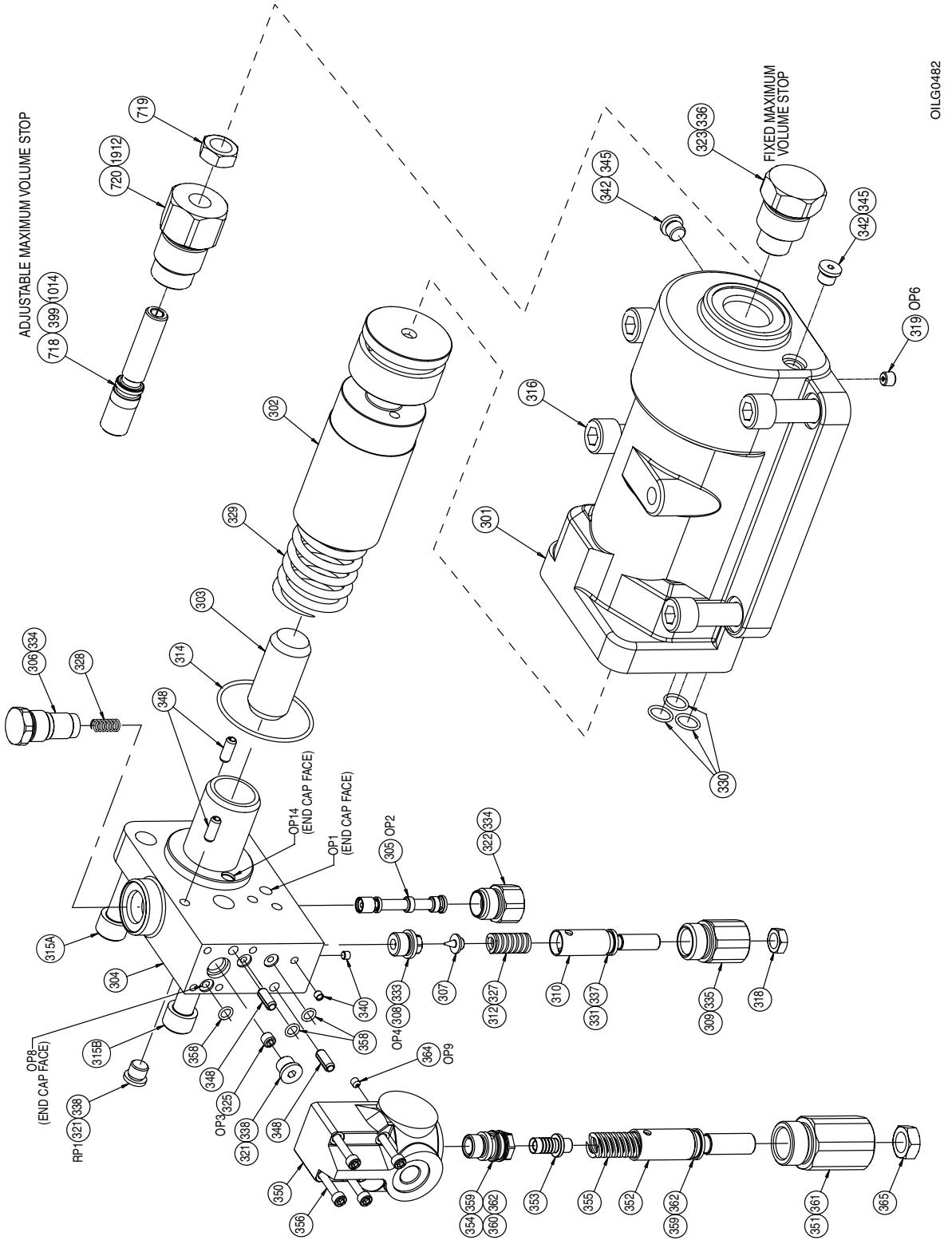

Figure 7. Exploded Parts Drawing for PVG-150 “P-1NN/F” Single Pressure Compensator w/Load Sense Control (520167-102 sheet 1)

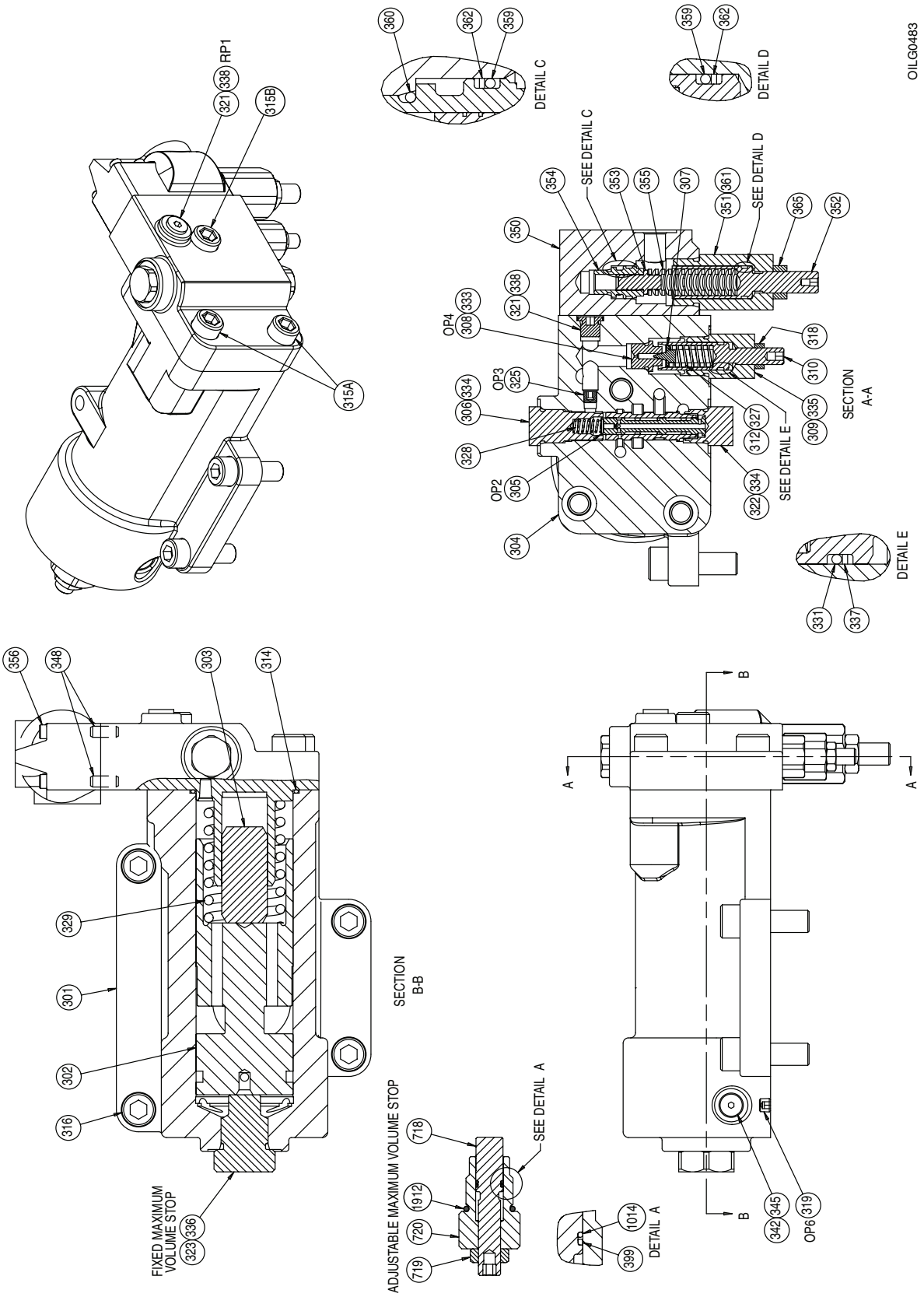

Figure 8. Cross Section Parts Drawing for PVG-150 "P-1NN/F" Single Pressure Compensator Control (520167-102 sheet 2)

NOTES

AFTER SALES SERVICES

At Oilgear we build products to last. It is the nature of this type of machinery to require proper maintenance regardless of the care we put into manufacturing. Oilgear has several service programs in place to help you.

STAY-ON-STREAM SERVICE

By signing up for Oilgear's Stay-On-Stream program, you can prepare for problems before they happen. Certain field tests such as fluid testing, slip testing and electronic profile recording comparisons can be performed by our field service people or your own factory trained personnel. These tests can indicate problems before they become "down-time" difficulties.

SERVICE SCHOOLS

Oilgear conducts training to train your maintenance personnel. "General" hydraulic or electronic training is conducted at our Milwaukee, Wisconsin plant on a regular basis. "Custom" training, specifically addressing your particular hydraulic and electro-hydraulic equipment, can be conducted at your facilities.

SPARE PARTS AVAILABILITY

Prepare for your future needs by stocking Oilgear original factory parts. Having the correct parts and necessary skills "in-plant" enables you to minimize "down-time." Oilgear has developed parts kits to cover likely future needs. Oilgear Field Service Technicians are also ready to assist you and your maintenance people in troubleshooting and repairing equipment.

Oilgear
PERFORMANCE
ASSURANCE

Issued: February 2010

THE OILGEAR COMPANY
2300 South 51st Street
Milwaukee, Wisconsin 53219
www.oilgear.com

Bulletin 947676

OILGEAR TYPE “PVG” PUMPS
150 (SERIES A1)
SERVICE INSTRUCTIONS

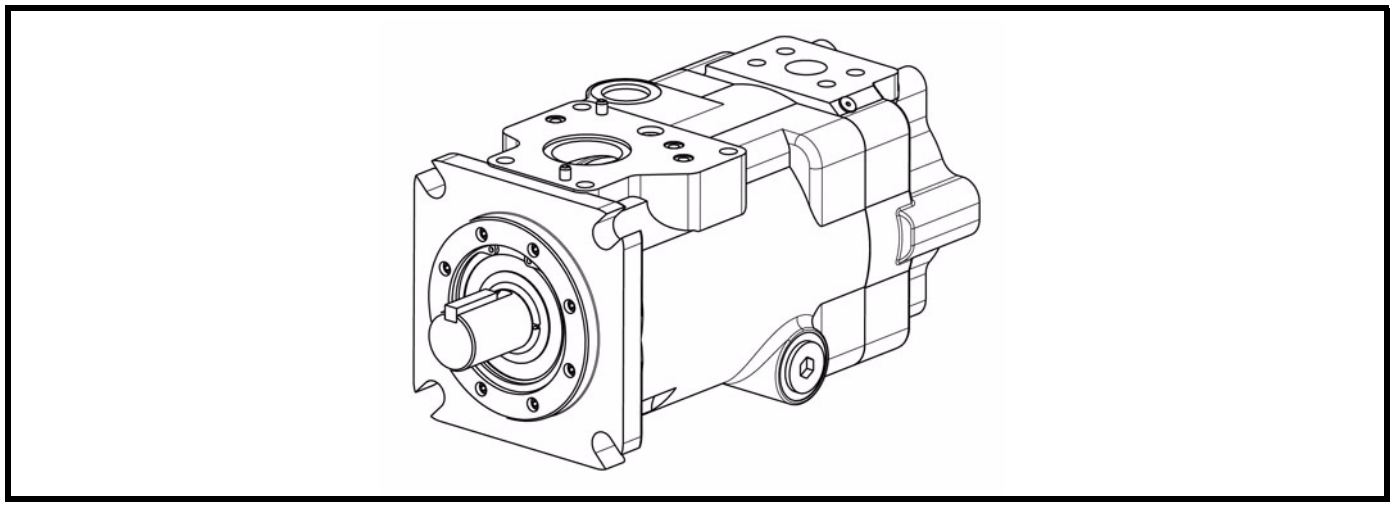

Figure 1. Typical Oilgear “PVG” Open Loop Pump

PURPOSE OF INSTRUCTIONS

These instructions will simplify the installation, operation, maintenance and troubleshooting of Oilgear type “PVG” pumps.

Become familiar with the construction, principle of operation and characteristics of your pump to help you attain satisfactory performance, reduce shut-down and increase the pump's service life. Some pumps have been modified from those described in this bulletin and other changes may be made without notice.

REFERENCE MATERIAL

Fluid Recommendations .....Bulletin 90000
Contamination Evaluation Guide.....Bulletin 90004
Filtration Recommendations .....Bulletin 90007
Piping Information .....Bulletin 90011
Installation of Vertically Mounted Axial Piston Units .....Bulletin 90014
PVG Open Loop Pumps, Sales..... Bulletin 47019-I

Pump Control Instructions, Series F1U

“P-1NN” Single Pressure Compensator.....Bulletin 947675
“P-1NN/F” Single Pressure Compensator w/Load Sense.....Bulletin 947676
“P-1NN/G” Horsepower Limiter w/Load Sense .....Bulletin 947677
“P-1NN/H” Single Pressure Compensator w/H.P. Limiter .....Bulletin 947678
“P-1NN/K” Single Pressure w/Load Sense, Minimum Standby.....Bulletin 947683
“P-1NN/L” Single Pressure w/HP Limiter & Load Sense, Minimum Standby ....Bulletin 947684
“P-2” Dual Pressure Compensator.....Bulletin 947679
“P-A” or “P-B” Electronic Pressure Compensator .....Bulletin 947681
“P-C” Single Pressure - Soft Start.....Bulletin 947680
“P-CNN/H” Single Pressure - Soft Start w/H.P. Limiter .....Bulletin 947685
“P-2NN/H” Dual Pressure Compensator w/H.P. Limiter .....Bulletin 947686
“P-E” Electronic Displacement Control .....Bulletin 947682

THE OILGEAR COMPANY
2300 South 51st Street
Milwaukee, Wisconsin 53219

Read and understand this entire instruction sheet before repairing or adjusting your Oilgear product.

Those who use and maintain this equipment must be thoroughly trained and familiar with the product. If incorrectly used or maintained, this product and its equipment can cause severe injury.

SAFETY SYMBOLS

The following signal words are used in this instruction sheet to identify areas of concern where your safety may be involved. Carefully read the text and observe any instructions provided to ensure your safety.

⚠ DANGER ⚠

THIS SIGNAL WORD INDICATES AN IMMINENTLY HAZARDOUS SITUATION WHICH, IF NOT AVOIDED, WILL RESULT IN DEATH OR SERIOUS INJURY.

⚠ WARNING

This signal word indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION

This signal word indicates that a potentially hazardous situation exists which, if not avoided, may result in damage to equipment or minor personal injury.

NOTE *While not directly relevant to the topic being discussed, the NOTE is used to emphasize information provided, or provide additional information which may be of benefit.*

⚠ WARNING

This service information is designed for the maintenance of your Oilgear product. It contains the information on the correct procedures determined by Oilgear for the safe manner of servicing. Always keep this instruction sheet in a location where it is readily available for the persons who use and maintain the product. Additional copies of this instruction sheet are available through the Oilgear Company. Or visit our website: www.oilgear.com. Please contact us if you have any questions regarding the information in this instruction bulletin.

NOTE *The cleanliness of working on this pump or the hydraulic system is extremely important to the safety and reliability of the pump and the system. Always make sure the fittings are clean on the outside before removing them from their connections, are capped and plugged when removed and placed in a clean rag or container until they are reinstalled.*

⚠ WARNING

Some service operations may require special tools or equipment. If you require information on these items, please contact Oilgear before attempting these repairs and service operations.

⚠ WARNING

Read, understand, and follow the safety guidelines, dangers, and warnings contained in this instruction sheet to promote reliable operation and prevent serious personal injury.

⚠ WARNING

DO NOT attempt to service this machinery in an environment where safety regulations are not established and in place.

⚠ WARNING

DO NOT operate the hydraulic system if a leak is present. Serious injury may result.

⚠ WARNING

Hydraulic systems operate under very high pressure. Hydraulic fluid escaping from a pressurized system can penetrate unprotected body tissue. DO NOT inspect for hydraulic leaks with bare hands or other exposed body parts. As a minimum, wear leather gloves prior to inspecting for leaks and use cardboard or wood. If leaks are present, relieve pressure and allow system to cool prior to servicing. If injured by escaping hydraulic oil, contact a physician immediately. Serious complications may arise if not treated immediately. If you have questions regarding inspecting for hydraulic leaks, please contact Oilgear prior to servicing.

⚠ WARNING

Hydraulic hoses and tubing must be inspected on a daily basis for leaks, cuts, abrasions, damage and improper clearance along any mounting frame for hidden damage before the unit is put into service. Replace damaged hoses or hoses you suspect are damaged before the system is returned to service! Hoses must be replaced every two years. Failure to properly inspect and maintain the system may result in serious injury.

⚠ WARNING

Hydraulic systems are hot. DO NOT TOUCH! Serious personal injury may result from hot oil. When you have completed working on the hydraulic system, thoroughly clean any spilled oil from the equipment. Do not spill any hydraulic fluids on the ground. Clean any hydraulic fluids from your skin as soon as you have completed maintenance and repairs. Dispose of used oil and system filters as required by law.

⚠ WARNING

Use correct hoses, fittings, and adapters with the correct SAE rating when replacing hoses to prevent possible serious injury. Always replace hoses, fittings, and adapters with replacements that have a proper, suitable, working pressure rating. Replacement hoses must be of the correct length and must comply with the hose manufacturer's and Oilgear's installation guidelines and recommendations.

⚠ WARNING

Hydraulic hoses have the SAE ratings marked on the hose to assist you in selecting the correct hose. The same manufacturer must supply any replacement hydraulic hoses and fitting assemblies. As an example: Brand "X" hose and brand "Y" fitting will not normally be compatible. No "Twist" is allowed in the hydraulic hoses. "Twist" may result in premature hose failure. This can cause serious injury. Please contact Oilgear for assistance when required.

⚠ WARNING

Hydraulic cylinders can be holding a function in a certain position when the pump is OFF. An example of this is a function being held in the lift or partial lift position by the cylinders. If a hydraulic line is removed or the hydraulic circuits or controls are being worked on, gravity may allow the function being held in position to drop. All workers and personnel must remain clear of these areas when working on or operating the hydraulic system. Block and secure all devices and functions which apply before beginning work or operation. Failure to comply with this can result in serious injury or death.

⚠ WARNING

Any hydraulic pipe which is replaced must conform to SAE J1065 specifications. If incorrect hydraulic pipe is installed, the hydraulic system may fail, causing serious injury. Damaged or leaking fittings, pipes or hoses must be replaced before the system is returned to service.

⚠ WARNING

DO NOT heat hydraulic pipe. The carbon content of this steel tube is such that if heated for bending, and either water or air quenched, the pipe may lose its ductility and thereby be subject to failure under high pressure conditions. Serious injury can result. Damaged or leaking pipes must be replaced before the system is returned to service. Please contact Oilgear if you require assistance or have questions.

⚠ WARNING

All hydraulic pressure must be relieved from the hydraulic system prior to removing any components from the system. To relieve the hydraulic pressure from the hydraulic system, turn off the motor and operate the control panel with the key in the ON position. Failure to comply can result in serious injury. If you have any questions concerning relieving the hydraulic pressure from the system, please contact Oilgear.

⚠ WARNING

Hydraulic components can be heavy. Use caution while lifting these components. Serious personal injury can be avoided with proper handling of the components.

⚠ WARNING

Please contact Oilgear if you require assistance, when performing hydraulic test procedures, use the proper hydraulic gauges. Installing an incorrect test gauge could result in serious injury if the gauge fails. Use properly rated hydraulic hoses to allow the test gauge to be read away from moving parts and functions.

⚠ WARNING

Increasing hydraulic pressure beyond the recommendations may result in serious damage to the pump and system or serious personal injury and may void the Oilgear Warranty. If you have questions concerning hydraulic pressures or testing procedures, please contact Oilgear before attempting the test procedures or making adjustments.

⚠ WARNING

An Oilgear pump must not be modified in any way without authorization from Oilgear. Modifications may not comply with safety standards, including ANSI safety standards, and may result in serious personal injury. Please contact Oilgear if you require assistance.

⚠ WARNING

DO NOT enter under hydraulic supported equipment unless they are fully supported or blocked. Failure to follow this procedure can result in serious injury or death.

⚠ WARNING

Any Oilgear pump safety decals must be replaced anytime they are damaged, missing, or cannot be read clearly. Failure to have proper decals in place can result in serious injury or death. (If you require safety decals, please contact Oilgear for replacement safety decals, at no charge.)

⚠ WARNING

Be sure everyone is clear of the area around the hydraulic system before operating after servicing. Remain attentive at all times when operating to check your work until you are completely sure it is safe to return to service. Failure to heed this warning may result in serious personal injury or death.

⚠ WARNING

Wear the proper protective clothing when operating, servicing or maintaining the hydraulic system or the Oilgear pump. Wear the correct protective gear, safety glasses, gloves, and safety shoes. Serious injury can result without proper protective gear.

⚠ WARNING

Make sure to keep hands and feet and other parts of your body clear of revolving or moving parts. Failure to comply can cause serious injury.

⚠ WARNING

DO NOT wear watches, rings, or jewelry while working with electrical and mechanical equipment. These items can be hazardous and can cause serious and painful injuries if they come into contact with electrical wires, moving parts, or hydraulic equipment.

PREPARATION AND INSTALLATION

MOUNTING

Pump Without Reservoir - The pump can be mounted in any position. But, the recommended mounting position is with the drive shaft on a horizontal plane and the case drain port 1 on the top side. Secure the pump to a rigid mounting surface. Refer to the referenced Oilgear Piping Information Bulletin 90011.

Pump With Reservoir - These pumps are usually fully piped and equipped. It may be necessary to connect to a super-charge circuit when used. Mount reservoir on level foundation with the reservoir bottom at least six inches above floor level to facilitate fluid changes.

PIPING AND FITTINGS

Refer to the referenced Oilgear Piping Information Bulletin 90011 and individual circuit diagram before connecting the pump to the system. Inlet velocity must not exceed 5 fps (1,5 mps). Inlet should be unrestricted and have a minimum of fittings.

NOTE *DO NOT use an inlet strainer.*

Arrange line from “case drain” so the case remains full of fluid (non-siphoning). Case pressure must be less than 25 psi (1,7 bar). For higher case pressures, special shaft seals are required; contact our Customer Service. Each drain line must be a separate line, unrestricted, full sized and connected directly to the reservoir below the lowest fluid level. Make provisions for opening this line without draining (siphoning) reservoir.

⚠ WARNING

Running the pump in NEUTRAL position (zero delivery) for extended periods without a supercharge circuit can damage the pump. The system and pump must be protected against overloads by separate high pressure relief valves. Install bleed valve(s) at the highest point(s) in system.

POWER

Power is required in proportion to volume and pressure used. Motor size recommendations for specific applications can be obtained from The Oilgear Company. Standard low starting torque motors are suitable for most applications.

CAUTION

DO NOT start or stop unit under load unless system is approved by Oilgear. It may be necessary to provide delivery bypass in some circuits.

DRIVE

Verify rotation direction plate on the pump's housing. Clockwise pumps must be driven clockwise and counterclockwise pumps must be driven counterclockwise. Use direct drive coupling. Size and install coupling per manufacturer's instructions.

CAUTION

DO NOT drive the coupling onto the pump drive shaft. If it is too tight, it may be necessary to heat coupling for installation. Refer to manufacturer's instructions.

Misalignment of pump shaft to driver's shaft should not exceed 0.005 inches (0,13 mm) Total Indicator Readout (TIR) in any plane.

FILTRATION

Keep the fluid clean at all times to ensure long life from your hydraulic system. Refer to the referenced Oilgear Filtration Recommendations bulletin 90007 and Oilgear Contamination Evaluation Guide Bulletin 90004. Oilgear recommends use of a filter in the pressure or return line. Replace filter element(s) when the filter condition indicator reaches change area at normal fluid temperature. Drain and thoroughly clean filter case. Use replacement element(s) of same beta 10 ratio (normally a ratio of 4 with hydraulic oils).

FLUID COOLING

When the pump is operated continuously at the rated pressure or frequently at peak load, auxiliary cooling of the fluid may be necessary. Fluid temperature should not exceed limits specified in the referenced Oilgear Fluid Recommendations Bulletin 90000.

AIR BREATHER

On most installations, an air breather is mounted on top of fluid reservoir. It is important for the breather to be the adequate size to allow air flow in and out of reservoir as fluid level changes. Keep the breather case filled to the “fluid level” mark. About once every six months, remove cover, wash screen in solvent and allow screen to dry, clean and refill case to level mark and install screen. Refer to the manufacturer's recommendations.

FLUID, FILLING AND STARTING RECOMMENDATIONS

Refer to instruction plate on the unit, reservoir, machine and/or reference, Fluid Recommendations bulletin. Fire resistant fluids and phosphate ester fluids can be used in accordance with fluid manufacturer's recommendations.

1. Pump all fluid into reservoir through a clean (beta 10 ratio of 4 or more) filter. Fill reservoir to, but not above, “high level” mark on the sight gauge.
2. **Remove case drain line and fill pump case with hydraulic fluid.**
3. Turn drive shaft a few times by hand with a spanner wrench to make sure parts rotate. Torque to turn drive shaft should be 9 to 24 ft•lb (12 to 32 N•m).

With pump under “no load” or with pump control at NEUTRAL:

4. Turn drive unit ON and OFF several times before allowing pump to reach full speed. The system can usually be filled by running the pump and operating the control.
5. The fluid level in the reservoir should decrease. Stop the pump. **DO NOT** allow the fluid level to go beyond the “low level.” If the level reaches “low level” mark, add fluid and repeat step.

NOTE *With differential (cylinder) systems, the fluid must not be above “high level” when the ram is retracted or below “low level” when extended. Bleed air from the system by loosening connections or opening petcocks at the highest point in the system. Close connections or petcocks tightly when solid stream of fluid appears.*

CONSTRUCTION

See **Figure 3**.

1. A drive shaft **(301)** runs through the center line of pump housing **(001)** and valve plate **(401)** with the pump cylinder barrel **(101)** splined to it.
2. A bearing **(306)** supports the outboard end of the drive shaft and a bushing supports the inboard end. (The bushing is part of valve plate assembly.)
3. The pump cylinder barrel is carried in a polymerous (journal type) cylinder bearing **(202)**.
4. The valve plate **(401)** has two crescent shaped ports.
5. The pumping piston/shoe assemblies **(102)** in the cylinder barrel are held against a swashblock **(201)** by a shoe retainer **(104)**.
6. The shoe retainer is held in position by the fulcrum ball **(103)** which is forced outward by the shoe retainer spring **(105)**.
7. The spring acts against the pump cylinder barrel, forcing it against the valve plate while also forcing the piston shoes against the swashblock.
8. The semi-cylindrical shaped swashblock limits the piston stroke and can be swiveled in arc shaped saddle bearings **(204)**.
9. The swashblock is swiveled by a control (included in referenced material). Refer to **PRINCIPLE OF OPERATION**.

PRINCIPLE OF OPERATION

The illustrations show the pump driven counter-clockwise (left hand) from the top (plan) view.

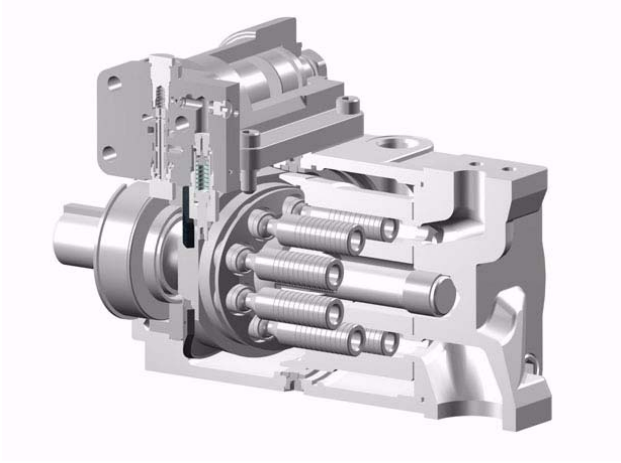

Figure 2. Cut-away of a Typical "PVG" Pump

Position B, Pump During Full Delivery From PORT B - Figure 3

Rotating the drive shaft **(301)** counter-clockwise turns the splined cylinder, which contains the pumping pistons **(102)**. When the cylinder rotates, the pistons move in and out within their bores as the shoes ride against the angled **(C)** swashblock **(201)**.

As the cylinder rotates, the individual piston bores are connected, alternately, to the crescent shaped port **A** and port **B** in the valve plate. While connected to the suction port **A**, each piston moves outward **(OUT)**, drawing fluid from port **A** into the piston bore until its outermost stroke **(D)** is reached. At this point, the piston bore passes from port **A** to port **B**.

While rotating across the crescent port **B**, each piston moves across the angled swashblock face and then each piston is forced inward **(IN)**. Each piston then displaces fluid through the crescent to port **B** until its innermost stroke **(D)** is reached. At this point, the piston bore passes from the **A** to the **B** crescent again and the cycle is repeated.

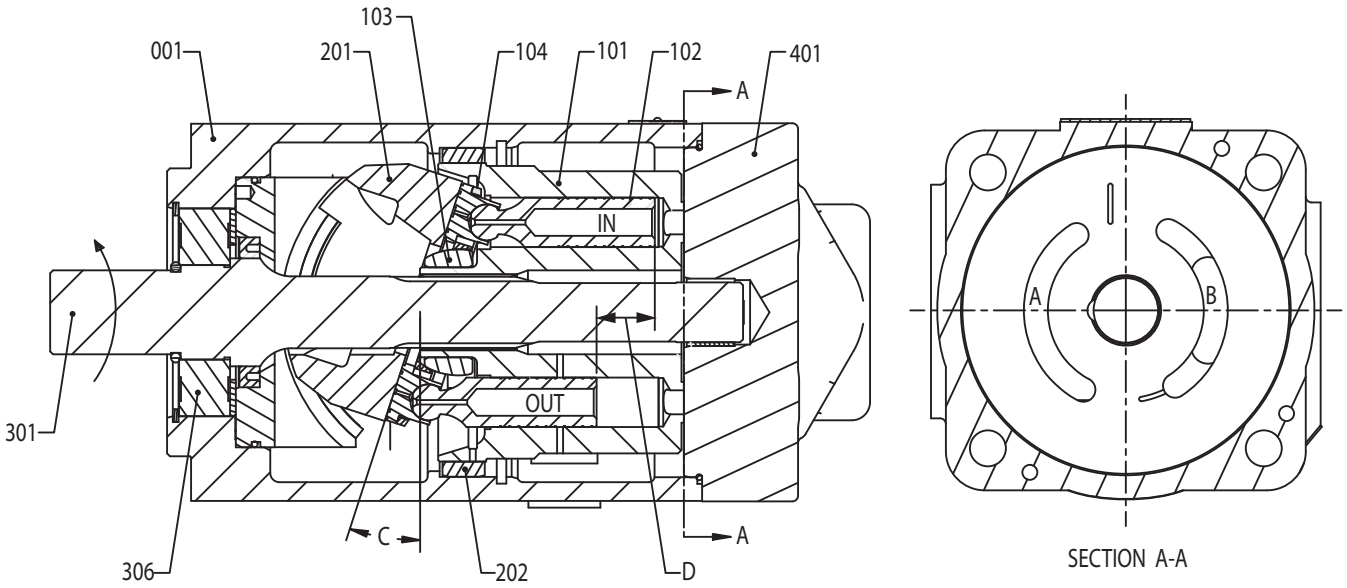

Figure 3. Position B, Pump During Full Delivery From Port B

Position B/2, Pump During One Half Delivery From PORT B - Figure 4

This illustration shows that the angle **(E)** of the swashblock determines the length of the piston stroke **(F)**, (the difference between outermost and innermost position) which determines the amount of delivery from the pump. In this case, the stroke angle **(E)** is one-half of the stroke, which means the piston stroke is one-half and the pump delivery is one-half.

Position N, Pump In Neutral, No Stroke, No Delivery - Figure 5

Neutral position results when the control centers the swashblock. The swashblock angle **(G)** is now zero and swashblock face is parallel to the cylinder face. There is no inward or outward motion of the pump pistons as piston shoes rotate around the swashblock face. With no inward and outward motion or no stroke **(H)**, **NEUTRAL** no fluid is being displaced from the piston bores to the crescents in the valve plate and there is no delivery from pump ports.

NOTE *Illustration reference numbers match the part item number in the parts list.*

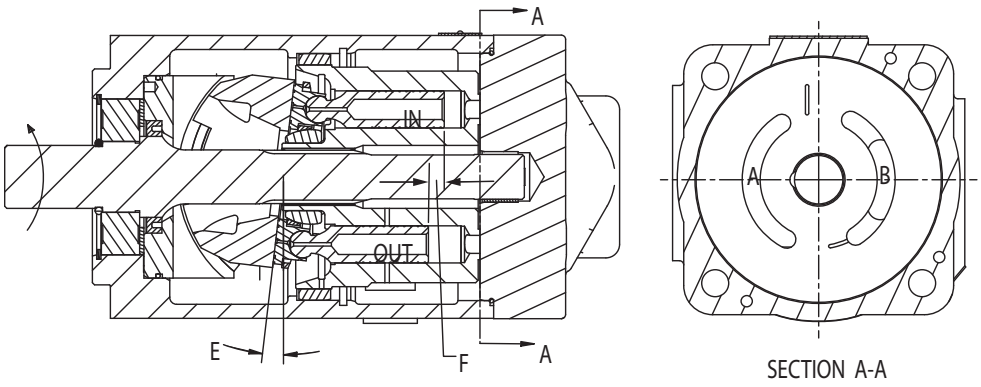

Figure 4. Position B/2, Pump During One Half Delivery From Port B

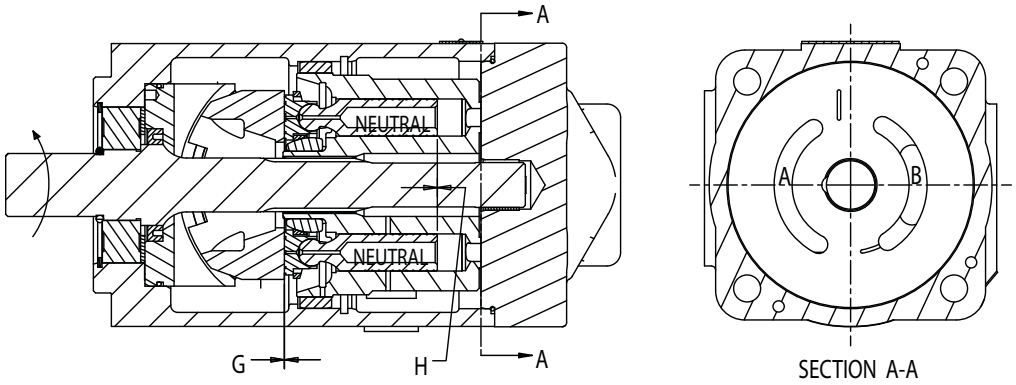

Figure 5. Position N, Pump In Neutral, No Stroke, No Delivery

Refer to **SPECIFICATIONS**

SPECIFICATIONS

NOTE *Refer to reference material, pump control material and individual application circuit for exceptions.*

Unit	THEORETICAL MAXIMUM DISPLACEMENT		RATED CONTINUOUS PRESSURE		PEAK PRESSURE		FLOW RATE at 1800 rpm rated continuous pressure and 14,7 psia (bar abs) inlet condition		MAXIMUM SPEED	POWER INPUT at rated continuous pressure & 1800 rpm	
	in 3/rev	ml/rev	psi	bar	psi	bar	gpm	l/mi	rpm	hp	kw
PVG 150	9.16	150,0	5000	344,8	5800	400,0	63.0	238,5	2400	215	160,4

Case pressure should be less than 25 psi (1,7 bar). For higher case pressure, consult factory.

Table 1. Nominal Performance Data with 150-300 SSU viscosity fluids.

Unit	Length		Width		Height		Weight		Face Mounting
	inches	mm	inches	mm	inches	mm	lbs.	kg	
PVG 150	14.2	360,7	7.9	200,7	8.1	205,7	171*	78	SAE “D” 4 bolt

All dimensions (without controls) are approximate. For detailed dimensions, contact your Oilgear Representative.
* Weight with "P" Control and non-thru shaft valve plate.

Table 2. Nominal Dimensions without controls.

Refer to installation drawings for more detailed dimensions and port configurations.

TROUBLESHOOTING

PROBLEM	CAUSES	REMEDY
Unresponsive or Sluggish Control	Swashblock saddle bearings **(204)** worn or damaged.	Refer to referenced control instruction material.
		Inspect bearings. Replace.
Insufficient Pump Volume	Delivery limited by faulty control	Refer to appropriate control instruction material.
	Obstructed suction circuit or insufficient supercharge volume.	Inspect for obstruction and verify supercharge.
	Insufficient drive motor speed.	Refer to appropriate power material.
	Worn or grooved cylinder barrel **(101)** and/or valve plate **(401)** mating surfaces.	Inspect components. Replace.
	Worn piston/shoe assemblies **(102)** or piston bores in cylinder **(101)**.	
	Worn or damaged piston shoe or swashblock **(201)**.	
Irregular or Unsteady Operation	Faulty control.	Inspect components. Replace. Refer to referenced pump control instruction materials.
	Fluid level in reservoir is low or supercharge is insufficient.	Verify fluid level and/or supercharge.
	Air entering hydraulic system.	Inspect system for leak.
	Worn axial piston pump.	Inspect components. Replace.
	Faulty output circuit components (cylinder, motors, valves or other related components).	Inspect components. Replace.
Loss of Pressure	Worn piston pump.	Inspect components. Replace.
	Worn or grooved cylinder barrel **(101)** and/or valve plate **(401)** mating surfaces.	
	Worn piston/shoe assemblies **(102)** or piston bores in cylinder.	
	Faulty output circuit components.	
Excessive or High Peak Pressure	Faulty output circuit components.	Check the relief valves.
Excessive Noise	Pump stopped or started incorrectly under load.	Verify operation procedure of pump.
	Low fluid level in reservoir or insufficient supercharge causing cavitation.	Verify fluid level and/or supercharge.
	Air entering hydraulic system.	Inspect system for leak.
	Fluid too cold or viscosity too high.	Verify fluid temperature and/or type.
	Suction line problem i.e.; obstructions in line, line too long, line diameter too small or too many bends and/or loops in line.	Inspect line for obstruction.
	Broken or worn piston/shoe assembly **(102)**.	Inspect components. Replace.
	Pump rotating in wrong direction.	Inspect operation direction of pump.
Excessive Heating	Operating pump above rated or peak pressure.	Verify pump limitations.
	Low fluid level in reservoir or insufficient supercharge.	Verify fluid level and/or supercharge.
	Air entering hydraulic system.	Inspect system for leak.
	Worn piston pump.	Inspect components. Replace.
	Worn or grooved cylinder barrel **(101)** and/or valve plate **(401)** mating surfaces.	
	Faulty output circuit components (continuous blowing relief valves or "slip" through valves, cylinder or other components.	
	Insufficient cooling provision or clogged coolers.	Inspect for obstruction.

TESTING AND ADJUSTING

⚠ WARNING

Shut the pump OFF and release pressure from the system before disassembling components. Failure to comply with these instructions could result in personal injury or death. Blocking the pressure line between the pump and the system (or pump) high pressure relief valve will result in damage and could result in serious personal injury.

PISTON PUMP

To check for a worn piston pump, make a leak measurement test from the case drain while the pump is under pressure. After the unit is warm, either install a flow meter in the drain line or have the flow from the drain line directed into a large container or reservoir. The pump case must remain full of fluid during this test.

CAUTION

DO NOT run a pump on stroke against a blocked output unless it is protected by a high pressure relief valve and then run no longer than necessary to check slip. Limit discharge to prevent dropping reservoir fluid below low level.

With an accurate high pressure gauge in the pressure line, start the pump and stall (or block) output device to raise system pressure to maximum (as set by system relief valve). Read the measurement on the flow meter or time and measure the case drain flow to fill a known size container and calculate the flow rate.

NOTE *Additional leakage indicates wear, but does not become critical until it impairs performance.*

DISASSEMBLY

NOTE *The cleanliness of working on this pump or the hydraulic system is extremely important to the safety and reliability of the pump and the system.*

When disassembling or assembling the pump, choose a clean, dry, dust and sand free area where no traces of abrasive particles are in the air which can damage the pump and system. DO NOT work near welding, sandblasting, grinding benches or similar conditions.

Always make sure the fittings are clean on the outside before removing them from their connections. Make sure they are capped and plugged when removed. Place them on a clean surface and in a clean rag or container until they are reinstalled. When cleaning parts which have been disassembled, it is important to use CLEAN cleaning solvents and parts are allowed to dry. All tools and gauges should be clean prior to working with the system and use new, CLEAN lint free rags to handle and dry parts.

⚠ WARNING

DO NOT attempt to remove or install any components or assembly while the pump and system is running. Always stop the pump, shut OFF the power and release pressure from the system before servicing or testing. Be sure provisions have been made so the case drain line can be disconnected from the unit without causing the line to drain (siphon) the reservoir.

(continued)

DISASSEMBLY (Continued)

1. Disconnect case drain line from port **1** or **1A**.
2. Drain pump case through the remaining (port **1** or **1A**) on the bottom of case. If plugs are inaccessible, it may be necessary to remove the pump from the mounting and drive motor before draining it.
3. After removing the pump from the mounting and before disassembly, cap or plug all ports and clean the outside of unit thoroughly to prevent dust from entering the system. See **Figures 8** and **9**.

NOTE *Depending on what part or parts are to be inspected, it may not be necessary to completely take apart all assemblies.*

CONTROL GROUP

Refer to the reference material for the information which applies to the control your pump is equipped with. Some force is required to remove the control housing.

1. Remove socket head cap screws.
2. Lift the control group assembly, with control pin, straight up from the top of the pump assembly. The control pin may or may not remain in the swashblock **(201)**.
3. Remove control O-rings from the pump housing.

VALVE PLATE GROUP

If another pump is coupled to thru-shaft pumps, it will be necessary to remove coupling half before removing valve plate.

1. Block the pump on a bench with the drive shaft facing down.
2. Remove the valve plate **(401)** by removing four socket head cap screws **(403)** and lifting it straight up.
3. Remove valve plate O-ring **(1013)** and **(1261)**.

ROTATING GROUP

⚠ WARNING

The rotating group is heavy. Be careful not to damage cylinder wear surface which mates against the valve plate, bearing diameters or piston shoes. Use proper lifting techniques and assistance from others to prevent personal injury.

1. Place the pump in a horizontal position.
2. Remove the rotating group slowly by pulling the cylinder barrel **(101)** from the housing.
3. Identify (number) each pump piston shoe assembly **(102)** and its respective bore in the cylinder barrel **(101)** and shoe retainer **(104)** for easy reassembly.
4. See Figure 6. Lift out shoe retainer **(104)** with pistons **(102)** and remove the fulcrum ball **(103)** and shoe retainer springs **(105)**.

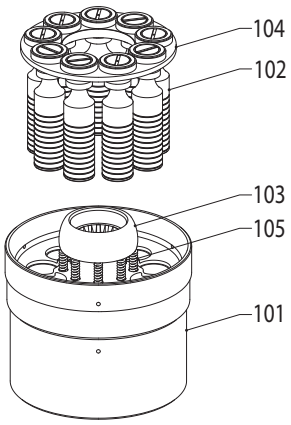

Figure 6. Rotating Group Disassembly

5. Remove plugs **(205)** and pull the hydrodynamic bearing **(202)** from the housing.

DRIVE SHAFT GROUP

1. Remove the drive key **(303)**, if used and the drive shaft bearing retainer ring **(305)**.
2. Grasp outboard end of drive shaft **(301)** and pull it out of the pump housing.
3. Remove the shaft seal retainer **(302)** and shaft seal **(007)** if necessary.

SWASHBLOCK GROUP

Reach inside the case and remove the swashblock **(201)** and saddle bearings **(204A** and **204B)**.

INSPECTION

Clean all parts thoroughly and allow them to dry. Inspect all seals and O-rings for hardening, cracking or deterioration. Replace if necessary or if you suspect damage. Check all locating pins for damage and springs for cracking or signs of wear.

⚠ WARNING

Wear proper protective gear when using solvents or compressed air, servicing or maintaining the hydraulic system or the Oilgear pump. Wear correct protective gear, safety glasses, gloves, and safety shoes. Serious injury can result without proper protective gear.

CONTROL GROUP

Refer to the reference material on pump controls. Be sure to carefully check the control pin for cracks and/or signs of fatigue. Check fit of the pin in the swashblock. It should be a slip-fit without side-play. Replace if necessary or if you suspect damage.

VALVE PLATE GROUP

Inspect the valveplate **(401)** surface which mates with the cylinder barrel **(101)** for excessive wear. Remove minor defects by lightly stoning the surface with a hard stone which is flat to within 0.001 inches (0,03 mm).

NOTE *Be sure to stone lightly. Any excessive stoning will remove the hardened surface. If wear or damage is extensive, replace the valve plate.*

ROTATING GROUP

Inspect cylinder barrel **(101)** piston bores and the face which mate with the valve plate for wear. Remove minor defects on the face by lightly stoning or lapping the surface.

Inspect the cylinder bearing **(202)** for damage and replace if necessary. Check all piston and shoe assemblies **(102)** to be sure they ride properly on the swashblock.

NOTE *Be sure to stone lightly. Any excessive stoning will remove the hardened surface. If wear or damage is extensive and defects cannot be removed, replace the cylinder barrel.*

See **Figure 7**. Check each shoe face for nicks and scratches, and the shoe for smooth pivot action on the piston.

NOTE *If one or more piston/shoe assembly needs to be replaced, replace all the piston/shoe assemblies. When installing new piston/shoe assemblies or the rotating group, make sure the pistons move freely in their respective bores.*

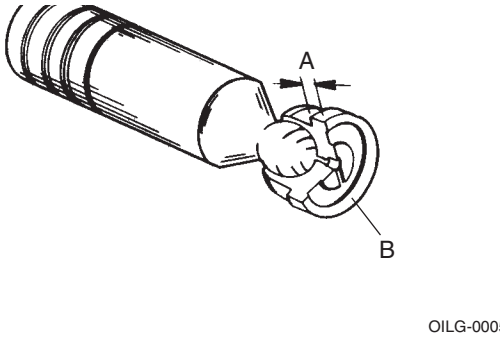

Figure 7. Piston and Shoe Inspection

(A) All shoes must be equal within 0.002 inches (0,025 mm) at this dimension.
(B) All shoe faces must be free of nicks.

NOTE *End play should not exceed 0.002 inches (0,076 mm) when new or 0.006 inches (0,152 mm) when worn.*

SWASHBLOCK GROUP

Inspect the swashblock **(201)** for wear. If defects are minor, stone the swashblock lightly. If damage is extensive, replace the swashblock.

Check the small holes in the face of the swashblock. The holes provide “porting” for the hydrostatic balance fluid of the piston/shoe assembly to be channeled through the swashblock to the face of the saddle bearing, providing pressure lubrication.

Compare the saddle bearing **(204)** thickness in a worn area to thickness in an unworn area. Replace saddle bearings if the difference is greater than 0.015 inches (0,4 mm).

Check the mating surface of swashblock for cracks or excessive wear. The swashblock movement in the saddle bearings must be smooth. Replace if necessary.

NOTE *Be sure to stone lightly. Any excessive stoning will remove the hardened surface. If wear or damage is extensive and defects cannot be removed, replace if necessary or if you suspect them of being bad.*

DRIVE SHAFT GROUP

Check:

- the shaft seal **(007)** for deterioration or cracks. Replace if necessary (press-out).
- the shaft bearing **(306)** for galling, pitting, binding or roughness.
- the rear shaft bushing in valve plate.
- the shaft and its splines for wear. Replace any parts necessary.

ASSEMBLY

See **Figures 8** and **9**. Follow the disassembly procedures in reverse for re-assembling the pump.

During assembly, install new seals and O-rings. Apply a thin film of CLEAN grease or hydraulic fluid to sealing components to ease assembly. If a new rotating group is used, lubricate thoroughly with CLEAN hydraulic fluid. Apply fluid generously to all wear surfaces.

SWASHBLOCK GROUP

If removed,

1. Press shaft seal **(007)** into the saddle **(216)**.
2. Align hole in bottom of saddle **(216)** with pin **(217)** in housing. Install saddle in housing and fasten with eight (8) screws **(225)**.
3. Place housing on a bench with the mounting flange side down.
4. Grease the back side of each saddle bearing **(204A** and **204B)** and install on the appropriate side of the saddle **(216)**.
5. The swashblock is inserted from the valve plate end. Insert swashblock **(201)** into the pump housing. Once in place, be sure the swashblock swivels in the saddle bearings. With new bearings, swiveling may be stiff and not always smooth.
6. The bearing **(202)** should be positioned with the half moon mill cut positioned towards the control face. The bearing should fit into place with a little difficulty and be square to the axis of the pump.
7. Tap bearing into place if necessary using extreme care not to damage the bearing.
8. Assemble plugs **(205)** with O-rings **(1906)** into case.

DRIVE SHAFT GROUP

1. Place the housing on its side with the axis horizontal.
2. Install the seal retainer **(302)**.
3. Lubricate the shaft seal **(007)** and shaft.
4. Insert the drive shaft **(301)** and bearing assembly into the housing.
5. Lock in place with the drive shaft bearing retainer ring **(305)**.

ROTATING GROUP

See **Figure 6.**

1. Place the cylinder barrel **(101)**, wear surface down, on a clean cloth.
2. Place the nine (9) shoe retainer springs **(105)** in the spring pockets of the barrel with the fulcrum ball **(103)** on top of it.
3. Insert the identified pistons **(102)** into their corresponding identified holes of the shoe retainer **(104)**. As a unit, fit the pistons into their corresponding, identified bores in the cylinder barrel. **DO NOT FORCE.** When parts are aligned properly, the pistons will fit smoothly.

⚠ WARNING

The rotating group weight is heavy. Be careful not to damage cylinder wear surface which mates against the valve plate, bearing diameters or piston shoes. Use proper lifting techniques and assistance from others to prevent personal injury.

The rotating group can now be carefully installed over the end of the drive shaft **(301)** and into the pump housing **(001)**.

NOTE *When installing the rotating group, support the weight of the cylinder barrel **(101)**, as cylinder spline is passed over the tailshaft, to avoid scratching or damage.*

4. Push cylinder forward until the cylinder spline reaches the drive shaft spline and rotate slightly to engage shaft splines. Continue to slide cylinder forward until it encounters the cylinder bearing **(202)**. Lifting the rear of the shaft slightly helps the cylinder **(101)** and the cylinder bearing **(202)** engagement. Continue pushing the cylinder forward until the piston shoes contact the swashblock. The back of the cylinder should protrude approximately 0.25 inches (6 mm) from the back of the pump housing.

VALVE PLATE GROUP

1. Place the pump housing on a bench with the open end facing up.
2. Install new O-rings **(1013)** and **(1261)** on the housing.
3. Assemble the valve plate **(401)** onto the housing **(001)** making sure the screw holes are aligned.
4. Hand-tighten the hex head cap screw **(403)** closest to O-ring **(1013)** first, then alternately tighten the other cap screws. On thru-shaft units connected to another pump or device, install coupling **(501)**.

Refer to **PREPARATION** and **INSTALLATION** when pump is ready to be returned to service.

PVG Pump	Fastener or Plug	Description	Head Type/Size	Tightening Torque
150	205	Hydrobearing Retaining Plug	1/4" Internal Hex	200 in•lb (23 N•m)
	225	1/4-20 SCHS x 1.5" lg	3/16" Internal Hex	120 in•lb (14 N•m)
	403	3/4-10 SHCS x 2.5" lg	5/8" Internal Hex	244 ft•lb (330 N•m)
	503	3/8-16 HHCS x 1" lg	9/16" External Hex	183 in•lb (20 N•m)
		1/2-13 HHCS x 1.25" lg	3/4" External Hex	37 ft•lb (50 N•m)
		5/8-11 HHCS x 1.5" lg	15/16" External Hex	74 ft•lb (100 N•m)
		3/4-10 HHCS x 2.25" lg	1-1/8" External Hex	132 ft•lb (179 N•m)
	507	3/8-16 SHCS x 63" lg	5/16" Internal Hex	45 ft•lb (61 N•m)
		1/2-13 SHCS x 1.5" lg	3/8" Internal Hex	100 ft•lb (136 N•m)
	601	SAE #2 Plug	1/8" Internal Hex	45 in•lb (5 N•m)
	602	SAE #3 Plug	1/8" Internal Hex	45 ft•lb (61 N•m)
	609	SAE #16 Plug	5/8" Internal Hex	135 ft•lb (183 N•m)

Table 3. PVG Pump Torques

PARTS LIST

Parts used in these assemblies are per Oilgear specifications. Use only Oilgear parts to ensure compatibility with assembly requirements. When ordering replacement parts, be sure to include pump type and serial number, bulletin number and item number. Specify type of hydraulic fluid to assure seal and packing compatibility.

NOTE *Parts drawings may not be identical to Oilgear drawings referenced.*

PARTS LIST drawings on pages 23 through 26.

Item	Qty.	Description
		HOUSING ASSEMBLY GROUP
001	1	Housing, Pump
003	1	Nameplate, Identification
006	2	Pin
008	2	Screw
217	1	Pin
1916	1	Seal, O-ring
		ROTATING GROUP
101	1	Barrel, Cylinder
102	9	Assembly, Piston/Shoe
103	1	Ball, Hold-Down
104	1	Retainer, Shoe
105	9	Spring, Shoe Retainer
		SWASHBLOCK ASSEMBLY GROUP
007	1	Seal, Shaft
201	1	Swashblock
202	1	Bearing, Cylinder
204a	1	Bearing, Saddle (Suction Side)
204b	1	Bearing, Saddle (Pressure Side)
205	2	Plug, Bearing Retaining
207	2	Pin
216	1	Saddle
225	8	Screw
1253	1	Seal, O-ring
1906	2	Seal, O-ring

Item	Qty.	Description
		DRIVE SHAFT ASSEMBLY GROUP
301	1	Drive Shaft
302	1	Retainer, Shaft Seal
303	1	Key, Drive Shaft
304	1	Retaining Ring
305	1	Retaining Ring
306	1	Bearing, Shaft
		VALVE PLATE ASSEMBLY GROUP
401	1	Valve Plate
403	4	Screw
601	2	Plug (RH units only)
602	1	Plug (LH units only)
1013	1	Seal, O-ring
1261	1	Seal, O-ring
1902	2	Seal, O-ring (RH units only)
1903	1	Seal, O-ring (LH units only)

O-RING SEALS

	ARP 568 Size Number & Shore A Durometer		
Item Number	Viton	HNBR	EPR
1013	013/90	013/90	013/80
1042	042/70	042/90	042/80
1049	049/70	049/90	049/80
1138	138/70	138/75	138/80
1153	153/70	153/75	153/80
1155	155/70	155/75	155/80
1158	158/70	158/75	158/80
1159	159/70	159/75	159/80
1163	163/70	163/75	163/80
1253	253/70	253/75	253/80
1261	261/70	261/75	261/80
1902	902/90	*	902/80
1903	903/90	*	903/80
1906	906/90	*	906/80
1916	916/90	*	916/80

* Viton O-rings are used for all SAE plugs.

SERVICE KITS

Document Number: 520147-SK

Revision: 0 (10-2-09)

Sheet 1 of 3

PVG 150 Pump Service Kits

SERVICE KIT Drawings on pages 23 through 26.

Description	Kit No.	Design Series	Items Included (quantity is 1 unless noted)
Housing Kits			
LH (CCW)	K520140-001	A1	001, 003, 006(2), 008(2), 217, 609, 1916
RH (CW)	K520140-002	A1	
Shaft & Bearing Kits			
Viton or HNBR Seals			
1.75" Dia Keyed (Code Y)	K520218-001	A1	301, 302, 303, 304, 305, 306
1.75" Dia Keyed Thru Shaft (Code Y)	K520218-002	A1	
1.75" Dia Spline (Code S)	K520218-011	A1	
1.75" Dia Spline Thru Shaft (Code S)	K520218-012	A1	
1.75" Dia Spline (Code L)	K520218-003	A1	
1.75" Dia Spline Thru Shaft (Code L)	K520218-004	A1	
EPR Seals			
1.75" Dia Keyed (Code Y)	K520218-005	A1	301, 302, 303, 304, 305, 306
1.75" Dia Keyed Thru Shaft (Code Y)	K520218-006	A1	
1.75" Dia Spline (Code S)	K520218-009	A1	
1.75" Dia Spline Thru Shaft (Code S)	K520218-010	A1	
1.75" Dia Spline (Code L)	K520218-007	A1	
1.75" Dia Spline Thru Shaft (Code L)	K520218-008	A1	
Swashblock			
All	514534-104	A1	201
Saddle Bearing			
Suction Side	318350-007	A1	204A
Pressure Side	318350-010	A1	204B
Hydrodynamic Bearing Kit			
Viton or HNBR Seals	K318358-001	A1	202, 205(2), 1906(2)
EPR Seals	K318358-002	A1	
Rotating Group Kit			
All	L514529-101	A1	101, 102(9), 103, 104, 105(9)
Piston & Shoe Subassembly			
All	L318356	A1	102(9)
Shoe Retainer & Fulcrum Ball Kit			
All	L514529-102	A1	103, 104
Valve Plate Kits			
Viton Seals			
LH (CCW), Non Thru Shaft	K520207-001	A1	401, 403(4), 602, 1013, 1261, 1903
RH (CW), Non Thru Shaft	K520207-002	A1	401, 403(4), 601(2), 1013, 1261, 1902(2)
LH (CCW), Thru Shaft	K520208-001	A1	401, 403(4), 602, 1013, 1261, 1903
RH (CW), Thru Shaft	K520208-002	A1	401, 403(4), 601(2), 1013, 1261, 1902(2)
HNBR Seals			
LH (CCW), Non Thru Shaft	K520207-101	A1	401, 403(4), 602, 1013, 1261, 1903
RH (CW), Non Thru Shaft	K520207-102	A1	401, 403(4), 601(2), 1013, 1261, 1902(2)
LH (CCW), Thru Shaft	K520208-101	A1	401, 403(4), 602, 1013, 1261, 1903
RH (CW), Thru Shaft	K520208-102	A1	401, 403(4), 601(2), 1013, 1261, 1902(2)
EPR Seals			
LH (CCW), Non Thru Shaft	K520207-201	A1	401, 403(4), 602, 1013, 1261, 1903
RH (CW), Non Thru Shaft	K520207-202	A1	401, 403(4), 601(2), 1013, 1261, 1902(2)
LH (CCW), Thru Shaft	K520208-201	A1	401, 403(4), 602, 1013, 1261, 1903
RH (CW), Thru Shaft	K520208-202	A1	401, 403(4), 601(2), 1013, 1261, 1902(2)

PVG 150 Pump Service Kits

SERVICE KIT Drawings on pages 23 through 26.

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Sheet 2 of 3

Description	Kit No.	Design Series	Items Included (quantity is 1 unless noted)
Basic Seal Kits			
Viton Seals	K516175-D01	A1	007, 1013, 1902(2), 1903, 1906(2), 1253, 1261, 1916
HNBR Seals	K516175-D11	A1	
EPR Seals	K516175-D21	A1	
Seal Kits for Options			
Standard Cover Plate			
Viton Seals	238270-138	A1	1138
HNBR Seals	252194-138	A1	
EPR Seals	242080-138	A1	
SAE C 2-Bolt Adapter			
Viton Seals	238270-049	A1	1049
HNBR Seals	252305-049	A1	
EPR Seals	242080-049	A1	
SAE C 4-Bolt Adapter			
Viton Seals	L250667-025	A1	1049, 1159
HNBR Seals	L250667-026	A1	
EPR Seals	L250667-027	A1	
SAE B 2-Bolt Adapter			
Viton Seals	L250667-017	A1	1155, 1158
HNBR Seals	L250667-029	A1	
EPR Seals	L250667-018	A1	
SAE B 4-Bolt Adapter			
Viton Seals	L250667-022	A1	1049, 1155
HNBR Seals	L250667-023	A1	
EPR Seals	L250667-024	A1	
SAE A Adapter			
Viton Seals	L250667-014	A1	1042, 1153
HNBR Seals	L250667-028	A1	
EPR Seals	L250667-015	A1	
Shaft Seals			
Viton Seals	249823	A1	007
HNBR Seals	249823-002	A1	
EPR Seals	251281	A1	
Cover Plate Kits			
Viton Seals	K319076-101	A1	507(4), 508, 1138
HNBR Seals	K319076-201	A1	
EPR Seals	K319076-301	A1	
SAE A 2-Bolt Coupling & Adapter Kits			
Viton Seals	K319076-102	A1	501, 502, 503(2), 504(2), 507(4), 1042, 1153
HNBR Seals	K319076-202	A1	
EPR Seals	K319076-302	A1	
SAE B 2-Bolt Coupling & Adapter Kits			
Viton Seals	K319076-103	A1	501, 502, 503(2), 504(2), 1155, 1158
HNBR Seals	K319076-203	A1	
EPR Seals	K319076-303	A1	

PVG 150 Pump Service Kits

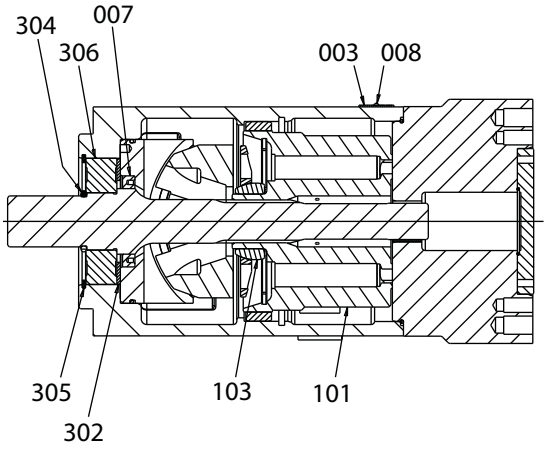
SERVICE KIT Drawings on pages 23 through 26.

Document Number: 520147-SK

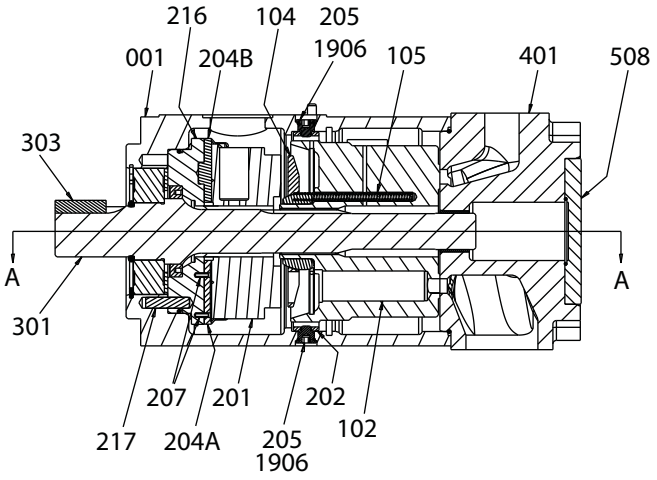
Revision: 0 (10-2-09)

Sheet 3 of 3

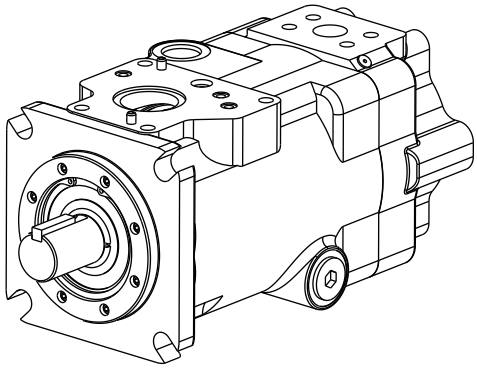
Description	Kit No.	Design Series	Items Included (quantity is 1 unless noted)
SAE B 4-Bolt Coupling & Adapter Kits			
Viton Seals	K319076-104	A1	501, 502, 503(4), 504(4), 507(4), 1049, 1155
HNBR Seals	K319076-204	A1	
EPR Seals	K319076-304	A1	
SAE C 2-Bolt Coupling & Adapter Kits			
Viton Seals	K319076-105	A1	501, 503(2), 504(2),1049
HNBR Seals	K319076-205	A1	
EPR Seals	K319076-305	A1	
SAE C 4-Bolt Coupling & Adapter Kits			
Viton Seals	K319076-106	A1	501, 502, 503(4), 504(4),507(4), 1049, 1159
HNBR Seals	K319076-206	A1	
EPR Seals	K319076-306	A1	
Name Tag & Screws			
All	L50921	A1	003, 008(2)



Section A-A
LH Shown



Section B-B
LH Shown



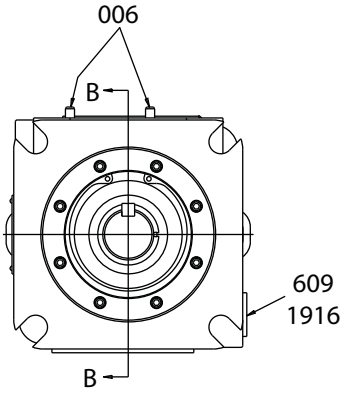


Figure 8. Cross Section and Exploded Parts Drawing for PVG 150 (520147-201 sheet 1 of 5)

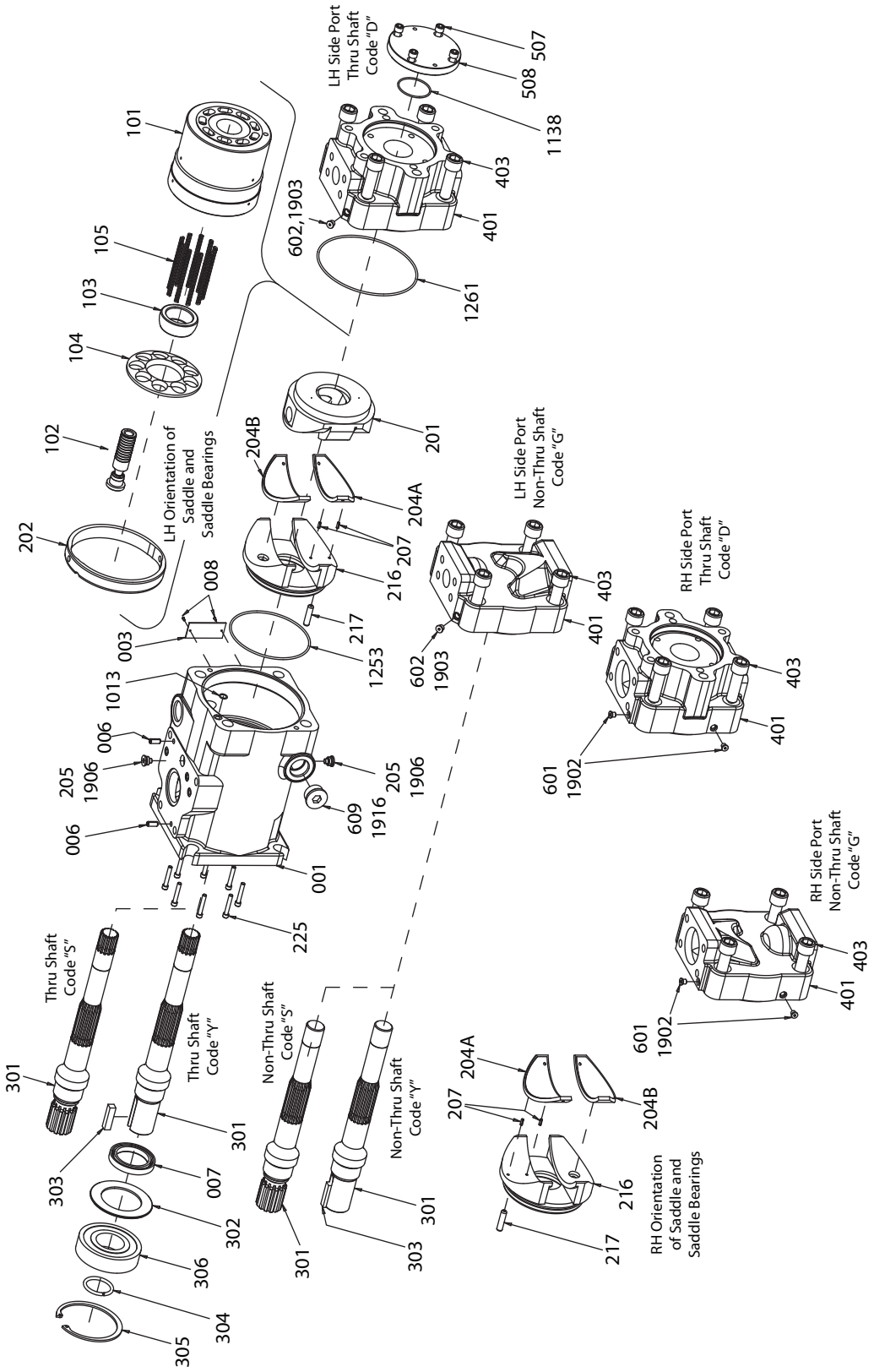


Figure 9. Exploded Parts Drawing for PVG 150 (520147-201 sheet 2 of 5)

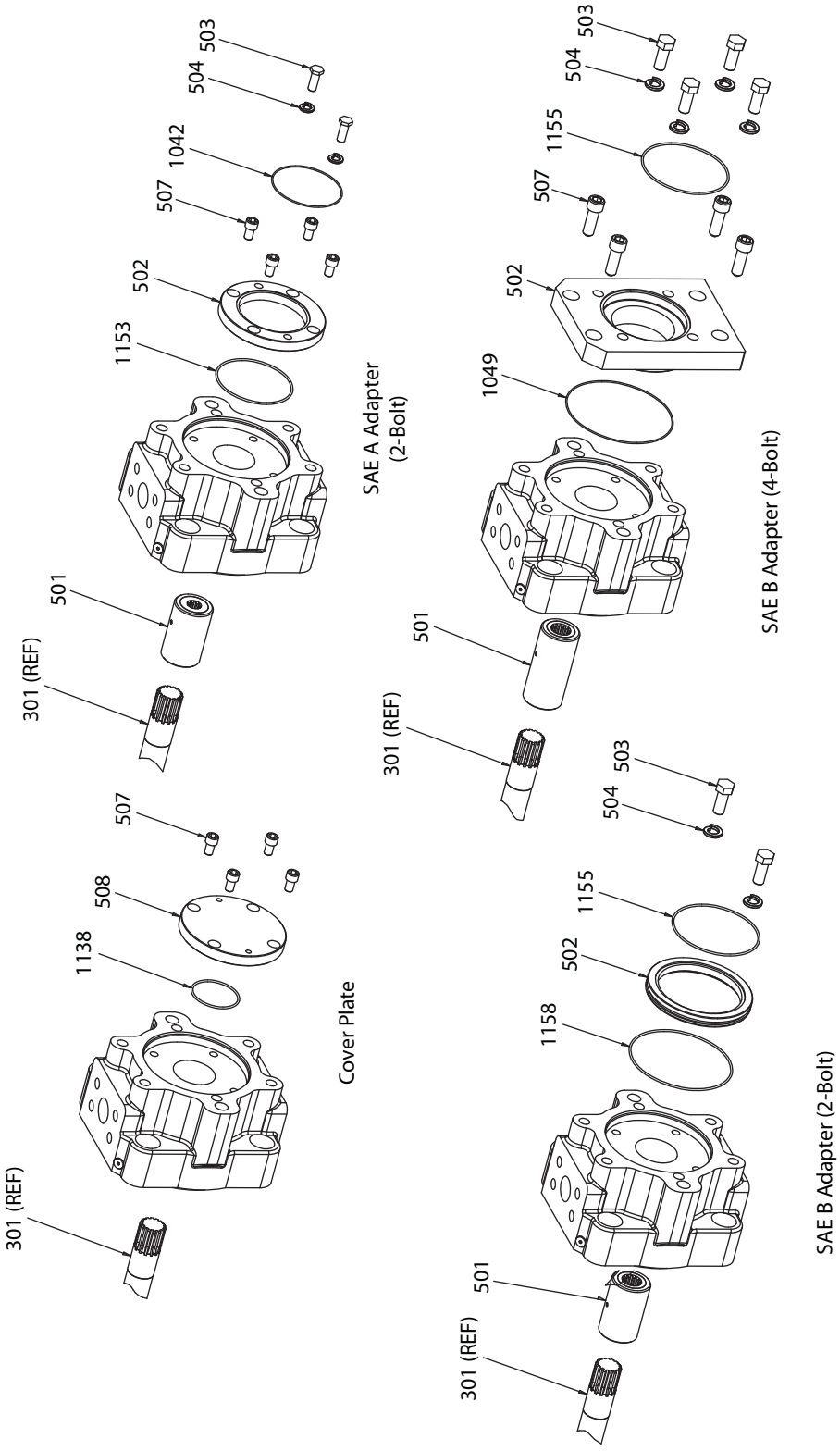


Figure 10. Exploded Parts Drawing for PVG 150 (520147-201 sheet 3 of 5)

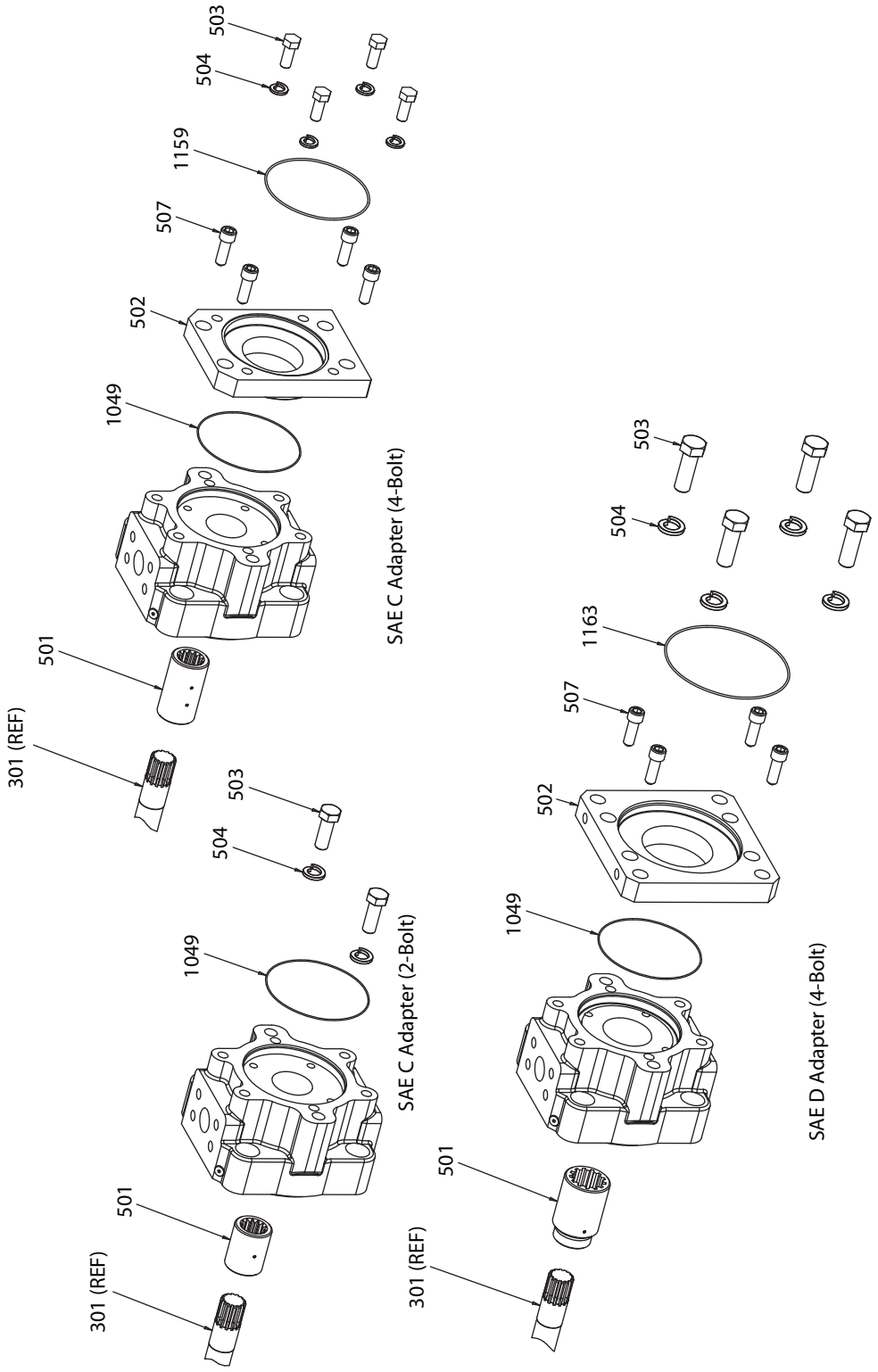


Figure 11. Cross Section and Exploded Parts Drawing for PVG 150 (520147-201 sheet 4 of 5)

NOTES

AFTER SALES SERVICES

At Oilgear we build products to last. It is the nature of this type of machinery to require proper maintenance regardless of the care we put into manufacturing. Oilgear has several service programs in place to help you.

STAY-ON-STREAM SERVICE

By signing up for Oilgear's Stay-On-Stream program, you can prepare for problems before they happen. Certain field tests such as fluid testing, slip testing and electronic profile recording comparisons can be performed by our field service people or your own factory trained personnel. These tests can indicate problems before they become “down-time” difficulties.

SERVICE SCHOOLS

Oilgear conducts training to train your maintenance personnel. “General” hydraulic or electronic training is conducted at our Milwaukee, Wisconsin plant on a regular basis. “Custom” training, specifically addressing your particular hydraulic and electro-hydraulic equipment can be conducted at your facilities.

SPARE PARTS AVAILABILITY

Prepare for your future needs by stocking Oilgear original factory parts. Having the correct parts and necessary skills “in-plant” enables you to minimize “down-time.” Oilgear has developed parts kits to cover likely future needs. Oilgear Field Service Technicians are also ready to assist you and your maintenance people in troubleshooting and repairing equipment.

THE OILGEAR COMPANY
2300 South 51st Street
Milwaukee, Wisconsin 53219

Issued: October 2009

Bulletin 947034

APPENDIX VII

Safety Data Sheet
(SDS)
Hydraulic Fluid

Skydrol® LD4 Fire Resistant Hydraulic Fluid

Version	Revision Date:	SDS Number:	Date of last issue: 06/02/2015
2.2	08/09/2016	150000093409	Date of first issue: 10/24/2013

SDSUS / PRD / 0001

SECTION 1. IDENTIFICATION

Product name : Skydrol® LD4 Fire Resistant Hydraulic Fluid

Product code : P3410201

Manufacturer or supplier's details

Company name of supplier : Eastman Chemical Company

Address : 200 South Wilcox Drive
Kingsport TN 37660-5280

Telephone : (423) 229-2000

Emergency telephone number : CHEMTREC: +1-800-424-9300, +1-703-527-3887 CCN7321
For emergency transportation information, in the United States: call CHEMTREC at 800-424-9300 or call 423-229-2000.

Recommended use of the chemical and restrictions on use

Recommended use : Hydraulic fluids

Restrictions on use : None known.

SECTION 2. HAZARDS IDENTIFICATION

GHS Classification

Skin irritation : Category 2

Carcinogenicity : Category 2

GHS label elements

Hazard pictograms :

Signal word : Warning

Hazard statements : H315 Causes skin irritation.
H351 Suspected of causing cancer.

Precautionary statements : **Prevention:**
P201 Obtain special instructions before use.
P202 Do not handle until all safety precautions have been read and understood.
P264 Wash skin thoroughly after handling.
P280 Wear protective gloves/ protective clothing/ eye protection/ face protection.

Response:
P302 + P352 IF ON SKIN: Wash with plenty of soap and water.
P308 + P313 IF exposed or concerned: Get medical advice/ attention.
P332 + P313 If skin irritation occurs: Get medical advice/ attention.
P362 Take off contaminated clothing and wash before reuse.
Storage:
P405 Store locked up.
Disposal:
P501 Dispose of contents/ container to an approved waste disposal plant.

Other hazards

None known.

SECTION 3. COMPOSITION/INFORMATION ON INGREDIENTS

Components

Chemical name	CAS-No.	Concentration (% w/w)
Tributyl phosphate	126-73-8	55 - 65
Dibutylphenylphosphate	2528-36-1	20 - 30
Butyl diphenyl phosphate	2752-95-6	5 - 10
7-Oxabicyclo[4.1.0]heptane-3-carboxylic acid, 2-ethylhexyl ester	62256-00-2	< 10
butylated hydroxytoluene	128-37-0	1

SECTION 4. FIRST AID MEASURES

If inhaled : Move to fresh air.
If breathing is difficult, give oxygen.
Consult a physician if necessary.

In case of skin contact : Wash off immediately with plenty of water for at least 15 minutes.
Get medical attention if symptoms occur.
Wash contaminated clothing before reuse.

In case of eye contact : In case of contact, immediately flush eyes with plenty of water for at least 15 minutes.
Get medical attention if symptoms occur.

If swallowed : Call a physician or poison control centre immediately.
Do not induce vomiting without medical advice.
Rinse mouth.
Never give anything by mouth to an unconscious person.

Most important symptoms and effects, both acute and delayed : Causes skin irritation.
Suspected of causing cancer.

Notes to physician	:	Treat symptomatically.

SECTION 5. FIREFIGHTING MEASURES

Suitable extinguishing media	:	Water spray Carbon dioxide (CO2) Dry chemical Foam
Unsuitable extinguishing media	:	Do not use a solid water stream as it may scatter and spread fire.
Hazardous combustion products	:	carbon dioxide, carbon monoxide oxides of phosphorus
Further information	:	Use a water spray to cool fully closed containers. Do not allow run-off from fire fighting to enter drains or water courses.
Special protective equipment for firefighters	:	Wear an approved positive pressure self-contained breathing apparatus in addition to standard fire fighting gear.

SECTION 6. ACCIDENTAL RELEASE MEASURES

Personal precautions, protective equipment and emergency procedures	:	Ventilate the area. Avoid breathing dust/ fume/ gas/ mist/ vapours/ spray. Avoid contact with skin and eyes. Material can create slippery conditions. Wear appropriate personal protective equipment. Local authorities should be advised if significant spillages cannot be contained.
Environmental precautions	:	Clear up spills immediately and dispose of waste safely. Avoid release to the environment. Collect spillage.
Methods and materials for containment and cleaning up	:	Contain spillage, soak up with non-combustible absorbent material, (e.g. sand, earth, diatomaceous earth, vermiculite) and transfer to a container for disposal according to local / national regulations (see section 13).

SECTION 7. HANDLING AND STORAGE

Advice on safe handling	:	Do not breathe vapours or spray mist. Handle product only in closed system or provide appropriate exhaust ventilation at machinery. In case of insufficient ventilation, wear suitable respiratory equipment. Wear appropriate personal protective equipment. Avoid contact with skin, eyes and clothing.

Wash thoroughly after handling.
Wash contaminated clothing before reuse.
Drain or remove substance from equipment prior to break-in or maintenance.
Handle in accordance with good industrial hygiene and safety practice.

Conditions for safe storage : Store locked up.
Keep container tightly closed in a dry and well-ventilated place.
Keep in a cool place away from oxidizing agents.

SECTION 8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Components with workplace control parameters

Components	CAS-No.	Value type (Form of exposure)	Control parameters / Permissible concentration	Basis
Tributyl phosphate	126-73-8	TWA (Inhalable fraction and vapor)	5 mg/m3	ACGIH
		TWA	0.2 ppm 2.5 mg/m3	NIOSH REL
		TWA	5 mg/m3	OSHA Z-1
		TWA	0.2 ppm 2.5 mg/m3	OSHA P0
Dibutylphenylphosphate	2528-36-1	TWA	0.3 ppm	ACGIH
butylated hydroxytoluene	128-37-0	TWA (Inhalable fraction and vapor)	2 mg/m3	ACGIH
		TWA	10 mg/m3	NIOSH REL
		TWA	10 mg/m3	OSHA P0

Hazardous components without workplace control parameters

Components	CAS-No.
7-Oxabicyclo[4.1.0]heptane-3-carboxylic acid, 2-ethylhexyl ester	62256-00-2

Engineering measures : Good general ventilation (typically 10 air changes per hour) should be used. Ventilation rates should be matched to conditions. If applicable, use process enclosures, local exhaust ventilation, or other engineering controls to maintain airborne levels below recommended exposure limits. If exposure limits have not been established, maintain airborne levels to an acceptable level.

Personal protective equipment

Respiratory protection : Use a properly fitted, particulate filter respirator complying with an approved standard if a risk assessment indicates this is necessary.

Respirator selection, use, and maintenance must be in accordance with regulatory requirements, if applicable.
If engineering controls do not maintain airborne concentrations below recommended exposure limits (where applicable) or to an acceptable level (in countries where exposure limits have not been established), an approved respirator must be worn.

Hand protection

Remarks : Wear suitable gloves. Please observe the instructions regarding permeability and breakthrough time which are provided by the supplier of the gloves. Also take into consideration the specific local conditions under which the product is used, such as the danger of cuts, abrasion, and the contact time. After contamination with product change the gloves immediately and dispose of them according to relevant national and local regulations.

Eye protection : Wear safety glasses with side shields (or goggles).

Skin and body protection : Wear suitable protective clothing.

Protective measures : Ensure that eye flushing systems and safety showers are located close to the working place.

SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance	:	oily
Colour	:	purple
Odour	:	odourless
pH	:	No data available
Melting point/range	:	< -62 °C
Flash point	:	160 °C Method: Cleveland open cup
Vapour pressure	:	0.27 hPa (25 °C)
Relative density	:	1.004 - 1.014 (25 °C)
Viscosity		
Viscosity, kinematic	:	< 2000 mm2/s (-54 °C)
		11.15 mm2/s (38 °C)
		3.83 mm2/s (99 °C)

SECTION 10. STABILITY AND REACTIVITY

Reactivity	:	None reasonably foreseeable.
Chemical stability	:	Stable under normal conditions.
Possibility of hazardous reactions	:	None known.
Conditions to avoid	:	None known.
Incompatible materials	:	Strong oxidizing agents
Hazardous decomposition products	:	Emits acrid smoke and fumes when heated to decomposition.

SECTION 11. TOXICOLOGICAL INFORMATION

Acute toxicity

Not classified based on available information.

Product:

Acute oral toxicity	:	LD50 (Rat, Male and Female): 2,100 mg/kg
Acute inhalation toxicity	:	LC50 (Rat, male): > 5.8 mg/l Exposure time: 4 h Test atmosphere: dust/mist Assessment: The substance or mixture has no acute inhalation toxicity Remarks: (highest concentration tested)
Acute dermal toxicity	:	LD50 Dermal (Rabbit, Male and Female): > 3,160 mg/kg Assessment: The substance or mixture has no acute dermal toxicity

Components:

Tributyl phosphate:

Acute oral toxicity	:	LD50 Oral (Rat, Male and Female): 1,553 mg/kg Method: Acute Oral Toxicity Assessment: Harmful if swallowed.
Acute inhalation toxicity	:	LC50 (Rat, Male and Female): > 4.242 mg/l Exposure time: 4 h Test atmosphere: dust/mist Assessment: The substance or mixture has no acute inhalation toxicity
Acute dermal toxicity	:	LD50 Dermal (Rabbit, Male and Female): > 3,100 mg/kg Assessment: The substance or mixture has no acute dermal toxicity

Dibutylphenylphosphate:

Acute oral toxicity : Acute toxicity estimate (Rat, Male and Female): 2,400 - 3,000 mg/kg
Assessment: Not classified

Acute inhalation toxicity : LCLo (Rat, Male and Female): > 5 mg/l
Exposure time: 4 h
Test atmosphere: dust/mist

LC50 (Rat, Male and Female): > 5 mg/l
Exposure time: 4 h
Test atmosphere: dust/mist
Assessment: Not classified

Acute dermal toxicity : LD50 Dermal (Rabbit, Male and Female): > 5,000 mg/kg
Assessment: Not classified

7-Oxabicyclo[4.1.0]heptane-3-carboxylic acid, 2-ethylhexyl ester:
Acute oral toxicity : LD50 Oral (Rat, Male and Female): 4,470 mg/kg

Acute dermal toxicity : LD50 Dermal (Rabbit, Male and Female): > 7,940 mg/kg

butylated hydroxytoluene:
Acute oral toxicity : LD50 Oral (Rat): > 6,000 mg/kg

Acute dermal toxicity : LD50 Dermal (Guinea pig): > 20,000 mg/kg

Skin corrosion/irritation

Causes skin irritation.

Product:

Species: Rabbit
Exposure time: 24 h
Assessment: irritating
Result: moderate irritation

Components:

Tributyl phosphate:
Species: Rabbit
Exposure time: 4 h
Assessment: Causes skin irritation.
Method: Acute Dermal Irritation / Corrosion
Result: irritating

Dibutylphenylphosphate:
Species: Rabbit
Assessment: Not classified

Species: Humans
Exposure time: 24 h
Assessment: Not classified

7-Oxabicyclo[4.1.0]heptane-3-carboxylic acid, 2-ethylhexyl ester:
Species: Rabbit

Exposure time: 24 h
Assessment: Not classified as hazardous.
Result: slight to moderate irritation

butylated hydroxytoluene:
Species: Rabbit
Exposure time: 24 h
Result: very slight

Serious eye damage/eye irritation

Not classified based on available information.

Product:

Species: Rabbit
Result: slight
Exposure time: 24 h
Assessment: Not classified

Components:

Tributyl phosphate:
Species: Rabbit
Result: slight irritation
Exposure time: 24 h
Assessment: Not classified
Method: Acute Eye Irritation / Corrosion

Dibutylphenylphosphate:
Species: Rabbit
Result: slight
Assessment: Not classified

7-Oxabicyclo[4.1.0]heptane-3-carboxylic acid, 2-ethylhexyl ester:
Species: Rabbit
Result: slight irritation
Exposure time: 24 h
Assessment: Not classified

butylated hydroxytoluene:
Species: Rabbit
Result: none

Respiratory or skin sensitisation

Skin sensitisation: Not classified based on available information.
Respiratory sensitisation: Not classified based on available information.

Product:

Test Type: Human experience
Assessment: Not classified
Method: Human Repeat Insult Patch Test
Result: Does not cause skin sensitisation.

Components:

Tributyl phosphate:
Test Type: Skin Sensitization
Species: Guinea pig
Assessment: Not classified
Result: Does not cause skin sensitisation.

Test Type: Skin Sensitization
Species: Humans
Assessment: Not classified
Result: Does not cause skin sensitisation.

Dibutylphenylphosphate:
Test Type: Human experience
Species: Humans
Assessment: Not classified
Result: non-sensitizing

7-Oxabicyclo[4.1.0]heptane-3-carboxylic acid, 2-ethylhexyl ester:
Test Type: Skin Sensitization
Species: Guinea pig
Result: May cause sensitisation by skin contact.

butylated hydroxytoluene:
Test Type: Skin sensitisation
Species: Guinea pig
Result: non-sensitizing

Germ cell mutagenicity

Not classified based on available information.

Product:

Genotoxicity in vitro	:	Test Type: Salmonella typhimurium assay (Ames test) Metabolic activation: +/- activation Result: negative
	:	Test Type: Mutagenicity - Mammalian Metabolic activation: +/- activation Method: In vitro Mammalian Chromosome Aberration Test Result: negative

Components:

Tributyl phosphate:

Genotoxicity in vitro	:	Test Type: Mutagenicity - Bacterial Metabolic activation: +/- activation Method: Bacterial Reverse Mutation Assay Result: negative
	:	Test Type: Mutagenicity - Mammalian Metabolic activation: +/- activation Method: In vitro Mammalian Chromosome Aberration Test Result: equivocal
Genotoxicity in vivo	:	Species: Rat (Male and Female)

Application Route: oral: gavage
Method: Mammalian Bone Marrow Chromosome Aberration Test
Result: negative

Dibutylphenylphosphate:

Genotoxicity in vitro : Test Type: Salmonella typhimurium assay (Ames test)
Metabolic activation: +/- activation
Method: Bacterial Reverse Mutation Assay
Result: negative

: Test Type: Mutagenicity - Mammalian
Metabolic activation: +/- activation
Method: In vitro Mammalian Cell Gene Mutation Test
Result: negative

: Test Type: Chromosome aberration test in vitro
Metabolic activation: +/- activation
Method: In vitro Mammalian Chromosome Aberration Test
Result: negative

: Test Type: Mutagenicity - Mammalian
Metabolic activation: - activation
Method: Genetic Toxicology: DNA Damage and Repair, Unscheduled DNA Synthesis in Mammalian Cells In Vitro
Result: negative

Genotoxicity in vivo : Species: Rat (Male and Female)
Application Route: intraperitoneal injection
Result: negative

7-Oxabicyclo[4.1.0]heptane-3-carboxylic acid, 2-ethylhexyl ester:

Genotoxicity in vitro : Test Type: Salmonella typhimurium assay (Ames test)
Metabolic activation: +/- activation
Method: Bacterial Reverse Mutation Assay
Result: negative

: Test Type: Mutagenicity - Mammalian
Metabolic activation: +/- activation
Method: In vitro Mammalian Chromosome Aberration Test
Result: equivocal

: Test Type: Mutagenicity - Mammalian
Metabolic activation: +/- activation
Method: In vitro Mammalian Cell Gene Mutation Test
Result: negative

Genotoxicity in vivo : Species: Rat (Male and Female)
Application Route: intraperitoneal injection
Method: Mammalian Bone Marrow Chromosome Aberration Test
Result: equivocal

Carcinogenicity

Suspected of causing cancer.

Components:

Tributyl phosphate:
Species: Rat, (Male and Female)
Application Route: Ingestion
Method: EPA OTS 798.3300
Remarks: Limited evidence of a carcinogenic effect.
May cause cancer.

IARC	No component of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.
OSHA	No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by OSHA.
NTP	No component of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP.

Reproductive toxicity

Not classified based on available information.

Components:

Tributyl phosphate:

Effects on fertility	:	Test Type: Two Generation Reproductive Toxicity Study Species: Rat Sex: Male and Female Application Route: Ingestion NOAEL: 225 mg/kg, Method: EPA OTS 798.4900
Effects on foetal development	:	Species: Rat Application Route: Oral 750 mg/kg Method: EPA OTS 798.4900

Dibutylphenylphosphate:

Effects on fertility	:	Species: Rat Sex: Male and Female Application Route: Ingestion NOAEL: 5 mg/l, F1: Lowest observed adverse effect level 50 mg/kg, F2: Lowest observed adverse effect level 50 mg/kg, Method: EPA OTS 798.4900
Effects on foetal development	:	Species: Rat Application Route: oral (gavage)

300 mg/kg
3 mg/kg

STOT - single exposure

Not classified based on available information.

Components:

Tributyl phosphate:
Assessment: Based on available data, the classification criteria are not met.

Dibutylphenylphosphate:
Assessment: Not classified

STOT - repeated exposure

Not classified based on available information.

Components:

Tributyl phosphate:
Assessment: Based on available data, the classification criteria are not met.

Dibutylphenylphosphate:
Exposure routes: inhalation (dust/mist/fume)
Target Organs: Respiratory system
Assessment: Not classified

Repeated dose toxicity

Product:

Species: Rat, Male and Female
NOAEL: 40 mg/m3
Application Route: Inhalation
Exposure time: 28 days
Target Organs: Blood, Respiratory system
Remarks: Irritating to eyes and respiratory system.

Components:

Tributyl phosphate:
Species: Mouse, Male and Female
NOEL: 75 mg/kg
Application Route: in feed
Exposure time: 90 days

Dibutylphenylphosphate:
Species: Rat, Male and Female
NOAEL: 5 mg/kg
LOAEL: 50 mg/kg
Application Route: oral (feed)
Exposure time: 90 days

Species: Rat, Male and Female
NOAEC: 5 mg/m3
Application Route: Inhalation

Exposure time: 90 days

Species: Rabbit, Male and Female
No observed adverse effect level: 100 mg/kg bw/day
Application Route: Dermal Study
Exposure time: 21 d

Aspiration toxicity

Not classified based on available information.

Product:

Not applicable

Components:

7-Oxabicyclo[4.1.0]heptane-3-carboxylic acid, 2-ethylhexyl ester:
Not applicable

Experience with human exposure

Product:

Inhalation	:	Remarks: None known.
Skin contact	:	Remarks: Causes skin irritation.
Eye contact	:	Remarks: Contact with the eyes may be very painful but does not cause damage.
Ingestion	:	Remarks: None known.

SECTION 12. ECOLOGICAL INFORMATION

Ecotoxicity

Product:

Toxicity to fish	:	LC50 (Oncorhynchus mykiss (rainbow trout)): 5.2 mg/l Exposure time: 96 h
Toxicity to daphnia and other aquatic invertebrates	:	LC50 (Daphnia magna (Water flea)): 5.8 mg/l Exposure time: 48 h
Toxicity to algae	:	EC50 (Selenastrum capricornutum (green algae)): 8.2 mg/l Exposure time: 96 h

Components:

Tributyl phosphate:

Toxicity to fish	:	LC50 (Oncorhynchus mykiss (rainbow trout)): 4.2 mg/l Exposure time: 96 h
Toxicity to daphnia and other	:	EC50 (Daphnia magna (Water flea)): 1.8 mg/l

aquatic invertebrates		Exposure time: 48 h
Toxicity to algae	:	EC50 (Desmodesmus subspicatus (Scenedesmus subspicatus)): 1.1 mg/l Exposure time: 72 h
Toxicity to fish (Chronic toxicity)	:	NOEC (Oncorhynchus mykiss (rainbow trout)): 0.82 mg/l Exposure time: 95 d 1.7 mg/l
Toxicity to daphnia and other aquatic invertebrates (Chronic toxicity)	:	NOEC (Daphnia magna (Water flea)): 1.3 mg/l Exposure time: 21 d

Dibutylphenylphosphate:

Toxicity to fish	:	LL50 (Cyprinus carpio (Carp)): 1.8 mg/l Exposure time: 96 h
Toxicity to daphnia and other aquatic invertebrates	:	EC50 (Daphnia magna (Water flea)): 1.4 mg/l Exposure time: 48 h
Toxicity to algae	:	EL50 (Selenastrum capricornutum (green algae)): 9.6 mg/l Exposure time: 72 h Method: EL50 method of the water accommodated fraction (W.A.F.) NOELR (Selenastrum capricornutum (green algae)): 3.5 mg/l Exposure time: 72 h Method: EL50 method of the water accommodated fraction (W.A.F.)
Toxicity to fish (Chronic toxicity)	:	NOEC (Oncorhynchus mykiss (rainbow trout)): > 0.11 mg/l Exposure time: 60 d
Toxicity to daphnia and other aquatic invertebrates (Chronic toxicity)	:	NOEC (Daphnia magna (Water flea)): 0.106 mg/l Exposure time: 21 d

butylated hydroxytoluene:

Toxicity to fish	:	LC50 (Fish): 0.199 mg/l Exposure time: 96 h
Toxicity to daphnia and other aquatic invertebrates	:	EC50 (Daphnia (water flea)): 0.48 mg/l Exposure time: 48 h
Toxicity to algae	:	EC50 (Chlorella pyrenoidosa (aglae)): 0.758 mg/l Exposure time: 96 h

Persistence and degradability

Product:

Biochemical Oxygen Demand (BOD)	:	Remarks: not determined

Chemical Oxygen Demand (COD)	:	Remarks: not determined

Components:

Tributyl phosphate:

Biodegradability	:	Result: Readily biodegradable

Dibutylphenylphosphate:

Biodegradability	:	Method: Ready Biodegradability: Manometric Respirometry Test Remarks: Readily biodegradable Method: Ready Biodegradability: Modified MITI Test (I) Remarks: Not readily biodegradable.

7-Oxabicyclo[4.1.0]heptane-3-carboxylic acid, 2-ethylhexyl ester:

Biodegradability	:	Concentration: 100 mg/l Method: Ready Biodegradability: Modified MITI Test (I) Remarks: Readily biodegradable

Bioaccumulative potential

Components:

Tributyl phosphate:

Bioaccumulation	:	Species: Cyprinus carpio (Carp) Bioconcentration factor (BCF): 20 Exposure time: 56 d Method: OECD Test Guideline 305 Bioconcentration factor (BCF): 35 Exposure time: 38 d
Partition coefficient: n-octanol/water	:	Pow: 10,100

Dibutylphenylphosphate:

Bioaccumulation	:	Species: Cyprinus carpio (Carp) Bioconcentration factor (BCF): 35 Method: OECD Test Guideline 305

Mobility in soil

No data available

Other adverse effects

Product:

Ozone-Depletion Potential	:	Regulation: 40 CFR Protection of Environment; Part 82 Protection of Stratospheric Ozone - CAA Section 602 Class I Substances

Remarks: This product neither contains, nor was manufactured with a Class I or Class II ODS as defined by the U.S. Clean Air Act Section 602 (40 CFR 82, Subpt. A, App.A + B).

SECTION 13. DISPOSAL CONSIDERATIONS

Disposal methods

Waste from residues : This product meets the criteria for a synthetic used oil under the U.S. EPA Standards for the Management of Used Oil (40 CFR 279). Those standards govern recycling and disposal in lieu of 40 CFR 260 -272 of the Federal hazardous waste program in states that have adopted these used oil regulations. Consult your attorney or appropriate regulatory official to be sure these standards have been adopted in your state. Recycle or burn in accordance with the applicable standards. Dispose of in accordance with local regulations.

SECTION 14. TRANSPORT INFORMATION

International Regulation

IATA-DGR
Not regulated as a dangerous good

IMDG-Code
Not regulated as a dangerous good

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code
Not applicable for product as supplied.

National Regulations

49 CFR
Not regulated as a dangerous good

SECTION 15. REGULATORY INFORMATION

EPCRA - Emergency Planning and Community Right-to-Know Act

SARA 311/312 Hazards : Acute Health Hazard
Chronic Health Hazard

SARA 302 : No chemicals in this material are subject to the reporting requirements of SARA Title III, Section 302.

SARA 313 : This material does not contain any chemical components with known CAS numbers that exceed the threshold (De Minimis) reporting levels established by SARA Title III, Section 313.

Clean Air Act

This product neither contains, nor was manufactured with a Class I or Class II ODS as defined by the U.S. Clean Air Act Section 602 (40 CFR 82, Subpt. A, App.A + B).
This product does not contain any hazardous air pollutants (HAP), as defined by the U.S. Clean Air Act Section 112 (40 CFR 61).
This product does not contain any chemicals listed under the U.S. Clean Air Act Section 112(r) for Accidental Release Prevention (40 CFR 68.130, Subpart F).
This product does not contain any chemicals listed under the U.S. Clean Air Act Section 111 SOCMI Intermediate or Final VOC's (40 CFR 60.489).

Clean Water Act

This product does not contain any Hazardous Substances listed under the U.S. CleanWater Act, Section 311, Table 116.4A.
This product does not contain any Hazardous Chemicals listed under the U.S. CleanWater Act, Section 311, Table 117.3.
This product does not contain any toxic pollutants listed under the U.S. Clean Water Act Section 307

The components of this product are reported in the following inventories:

DSL	:	All components of this product are on the Canadian DSL
AICS	:	On the inventory, or in compliance with the inventory
ENCS	:	On the inventory, or in compliance with the inventory
KECI	:	Not listed
PICCS	:	Not listed
IECSC	:	On the inventory, or in compliance with the inventory
TSCA	:	On TSCA Inventory

TSCA list

No substances are subject to a Significant New Use Rule.

No substances are subject to TSCA 12(b) export notification requirements.

SECTION 16. OTHER INFORMATION

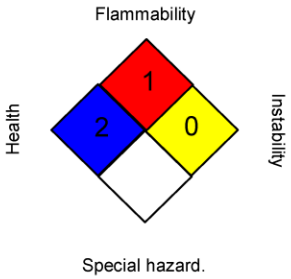
Full text of other abbreviations

AICS - Australian Inventory of Chemical Substances; ASTM - American Society for the Testing of Materials; bw - Body weight; CERCLA - Comprehensive Environmental Response, Compensation, and Liability Act; CMR - Carcinogen, Mutagen or Reproductive Toxicant; DIN - Standard of the German Institute for Standardisation; DOT - Department of Transportation; DSL - Domestic Substances List (Canada); ECx - Concentration associated with x% response; EHS - Extremely Hazardous Substance; ELx - Loading rate associated with x% response; EmS - Emergency Schedule; ENCS - Existing and New Chemical Substances (Japan); ErCx - Concentration associated with x% growth rate response; ERG - Emergency Response Guide; GHS - Globally Harmonized System; GLP - Good Laboratory Practice; HMIS - Hazardous Materials Identification System; IARC - International Agency for Research on Cancer; IATA - International Air Transport

Association; IBC - International Code for the Construction and Equipment of Ships carrying Dangerous Chemicals in Bulk; IC50 - Half maximal inhibitory concentration; ICAO - International Civil Aviation Organization; IECSC - Inventory of Existing Chemical Substances in China; IMDG - International Maritime Dangerous Goods; IMO - International Maritime Organization; ISHL - Industrial Safety and Health Law (Japan); ISO - International Organisation for Standardization; KECI - Korea Existing Chemicals Inventory; LC50 - Lethal Concentration to 50 % of a test population; LD50 - Lethal Dose to 50% of a test population (Median Lethal Dose); MARPOL - International Convention for the Prevention of Pollution from Ships; MSHA - Mine Safety and Health Administration; n.o.s. - Not Otherwise Specified; NFPA - National Fire Protection Association; NO(A)EC - No Observed (Adverse) Effect Concentration; NO(A)EL - No Observed (Adverse) Effect Level; NOELR - No Observable Effect Loading Rate; NTP - National Toxicology Program; NZIoC - New Zealand Inventory of Chemicals; OECD - Organization for Economic Co-operation and Development; OPPTS - Office of Chemical Safety and Pollution Prevention; PBT - Persistent, Bioaccumulative and Toxic substance; PICCS - Philippines Inventory of Chemicals and Chemical Substances; (Q)SAR - (Quantitative) Structure Activity Relationship; RCRA - Resource Conservation and Recovery Act; REACH - Regulation (EC) No 1907/2006 of the European Parliament and of the Council concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals; RQ - Reportable Quantity; SADT - Self-Accelerating Decomposition Temperature; SARA - Superfund Amendments and Reauthorization Act; SDS - Safety Data Sheet; TCSI - Taiwan Chemical Substance Inventory; TSCA - Toxic Substances Control Act (United States); UN - United Nations; UNRTDG - United Nations Recommendations on the Transport of Dangerous Goods; vPvB - Very Persistent and Very Bioaccumulative

Further information

NFPA:



HMIS III:

HEALTH	2*
FLAMMABILITY	1
PHYSICAL HAZARD	0

0 = not significant, 1 =Slight,
2 = Moderate, 3 = High
4 = Extreme, * = Chronic

Sources of key data used to compile the Safety Data Sheet	:	www.EastmanAviationSolutions.com
Revision Date	:	08/09/2016

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text.

US / EN

APPENDIX VIII

Instrument Certification Notice

Instrument Certification Notice

The gauge Certificates of Calibration supplied for the gauge(s) on this unit contain the calibration data for the actual instrument calibrated, along with the calibration date of the **STANDARD** used to perform the calibration check.

The due date for re-calibration of the instrument should be based upon the date the instrument was placed in service in your facility. Re-calibration should be done on a periodic basis as dictated by the end user's quality system or other overriding requirements.

Note that Tronair, Inc. does not supply certificates of calibration on pyrometers unless requested at the time of placed order. This instrument is considered a reference indicator only and is not critical to the test(s) being performed on the aircraft.

Tronair, Inc.
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