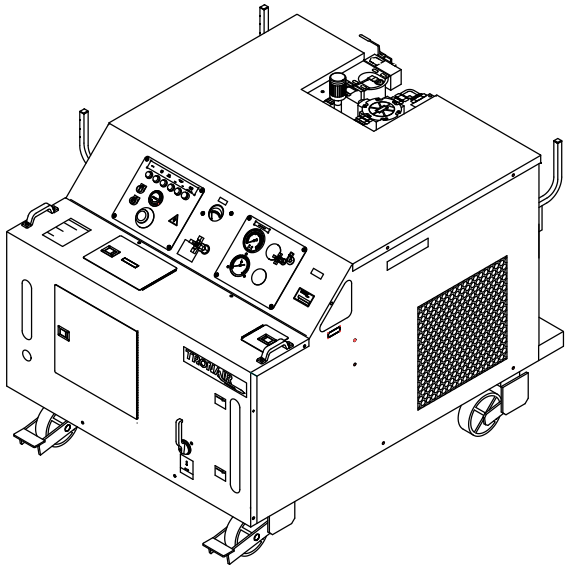
Operation & Service Instructions



Model: 5631
Hydraulic Power Unit

CE

01/2016 – Rev. 09

1740 Eber Rd
Holland, OH 43528-9794
USA

Tronair, Inc.
www.tronair.com
Email: sales@tronair.com

Phone: (419) 866-6301
800-426-6301
Fax: (419) 867-0634

REVISION	DATE	TEXT AFFECTED
01	03/2004	Major revision
02	05/2004	pg 26 Modified part number for 50 Hz application pg 48 Modified part number for item 19 pg 49 Modified part number for item 19
03	06/2006	Modified 9.3.2 Modified 9.7.1 Electric Panel Parts List
04	06/2008	Modified 12.2.1 Self Calibration
05	10/2009	Modified 9.10 Electrical Components Added 9.10.1 Electrical Components With 100 ft Input Cord Option
06	06/2010	Modified illustration for 5.3.5 Hydraulic Pump Controls and 9.2 Electric Motor, modified 9.3.1 Hydraulic Pump Replacement Parts
07	07/2011	9.10.1 Electrical Components with 100 ft. Input Cord Option modified Parts List and illustration
08	12/2015	Modified Parts List
09	01/2016	Modified 5.2.3 Hydraulic Pump

TABLE OF CONTENTS

PAGE

This product can not be modified without the written approval of Tronair, Inc. Any modifications done without written approval voids all warranties and releases Tronair, Inc., it suppliers, distributors, employees, or financial institutions from any liability from consequences that may occur. Only Tronair OEM replacement parts shall be used.

1.0 PRODUCT INFORMATION

1.1 DESCRIPTION

Hydraulic Power Unit
Model Number: 5631
Fluid Type: Aviation Phosphate Ester, Type IV

1.2 MODEL & SERIAL NUMBER

Reference nameplate on unit

1.3 MANUFACTURER

TRONAIR, Inc.
1740 Eber Road
Holland, Ohio 43528-9794 USA

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

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

2.0 SAFETY INFORMATION *(continued)*

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 pertaining to 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. (Reference Technical Manual for details on 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 5.3.1 Front Panel Controls*** for reservoir fill location.

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 plug onto the electrical cord. If motor rotation is not correct, change any two of the three leads at the plug. **Reference 11.0 Electrical Power and Protection Requirements** for power requirements and fuse sizes**.** (See ***5.4 Start up Procedures*** before starting HPU.)

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	208	230	380	460	575
Full Load Amps	117.2	106	57	53	42
Locked Rotor Amps	642	580	348	290	232
Recommended Fuse Size	150	150	80	70	60
Maximum Fuse Size	175	150	80	80	60

50 Hz Applications					
Voltage	200	220	380	415	440
Full Load Amps	120.5	103	62	60	56
Locked Rotor Amps	642	570	372	360	303
Recommended Fuse Size	150	125	80	80	70
Maximum Fuse Size	175	150	90	90	80

5.2 NUMERICAL VALUES

5.2.1 Fluid

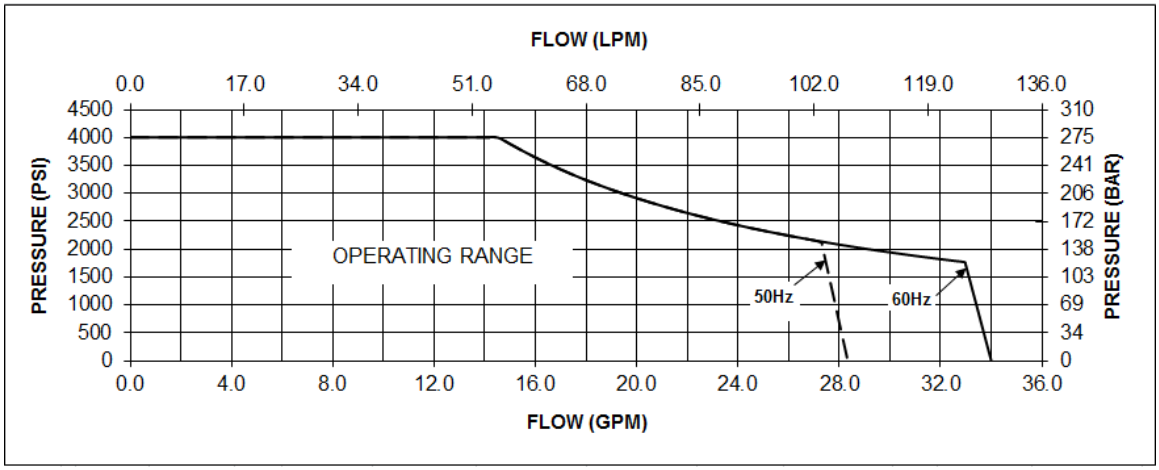
Model: 5631
Fluid Type: Aviation Phosphate Ester, Type IV

5.2.2 Physical

- Weight (Dry)**:** 3,150 lbs (1,430 kg)
- Dimensions**:** Width 63.75 in (162 cm) *Add 7.5 in (19 cm) for Dual System*
  Height 59 in (149.9 cm)
  Depth 78 in (198 cm)
- 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
  -6 (3/8 in, 9.53 mm) ..... Working Diameter

5.2.3 Hydraulic Pump

- A pressure compensated, adjustable maximum volume piston pump.
- Maximum flow at 60 Hz.....34 gpm (129 lpm)
- Maximum flow at 50 Hz.....28 gpm (107 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 40 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**
208	117.2
230	106.0
380	57.0
460	53.0
575	42.0

50 Hz Applications	
Voltage	**Full Load Amps**
200	120.5
220	103.0
380	62.0
415	60.0
440	56.0

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.

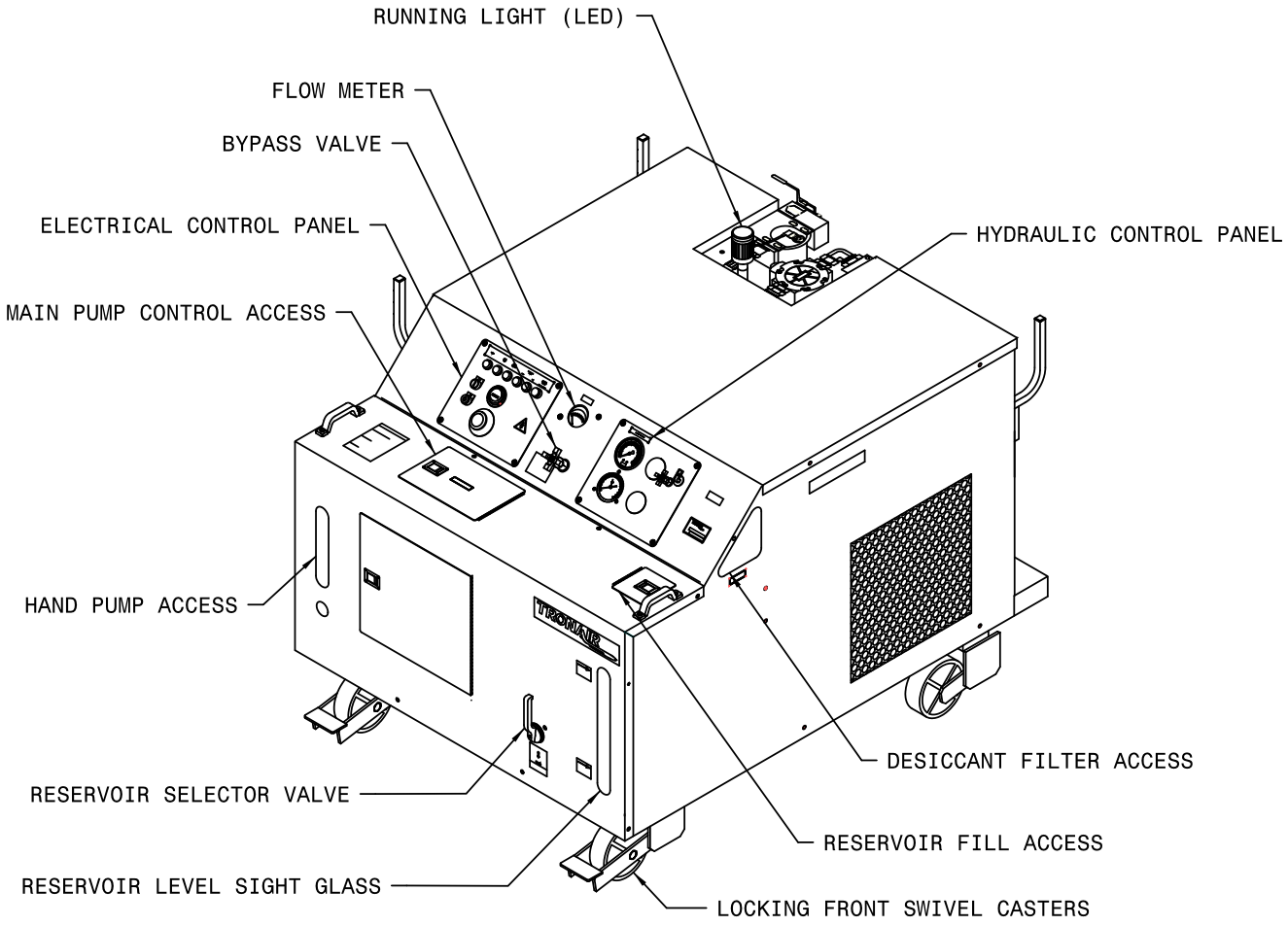
Low Pressure Stage:	Piston Diameter	1½ in (38.1 mm)
	Working Pressure	0–500 psi (0–34.47 bar)
	Displacement/Stroke	2.1 in^3 (34.4 cm^3)
	Force/100 psi (6.89 bar)	12.0 lbs/100 psi (7.74 N/bar)
High Pressure Stage:	Piston Diameter	5/8 inch (15.88 mm)
	Working Pressure	500–5000 psi (34.47–344.74)
	Displacement/Stroke	0.4 in^3 (6.55 cm^3)
	Force/100 psi (6.89 bar)	2.2 lbs/100 psi (1.42 N/bar)
Pressure Relief Setting:	5,250 psi (362.0 bar)	

5.0 Operation continued on following page.

5.0 OPERATION *(continued)*

5.3 LOCATION & LAYOUT OF CONTROLS

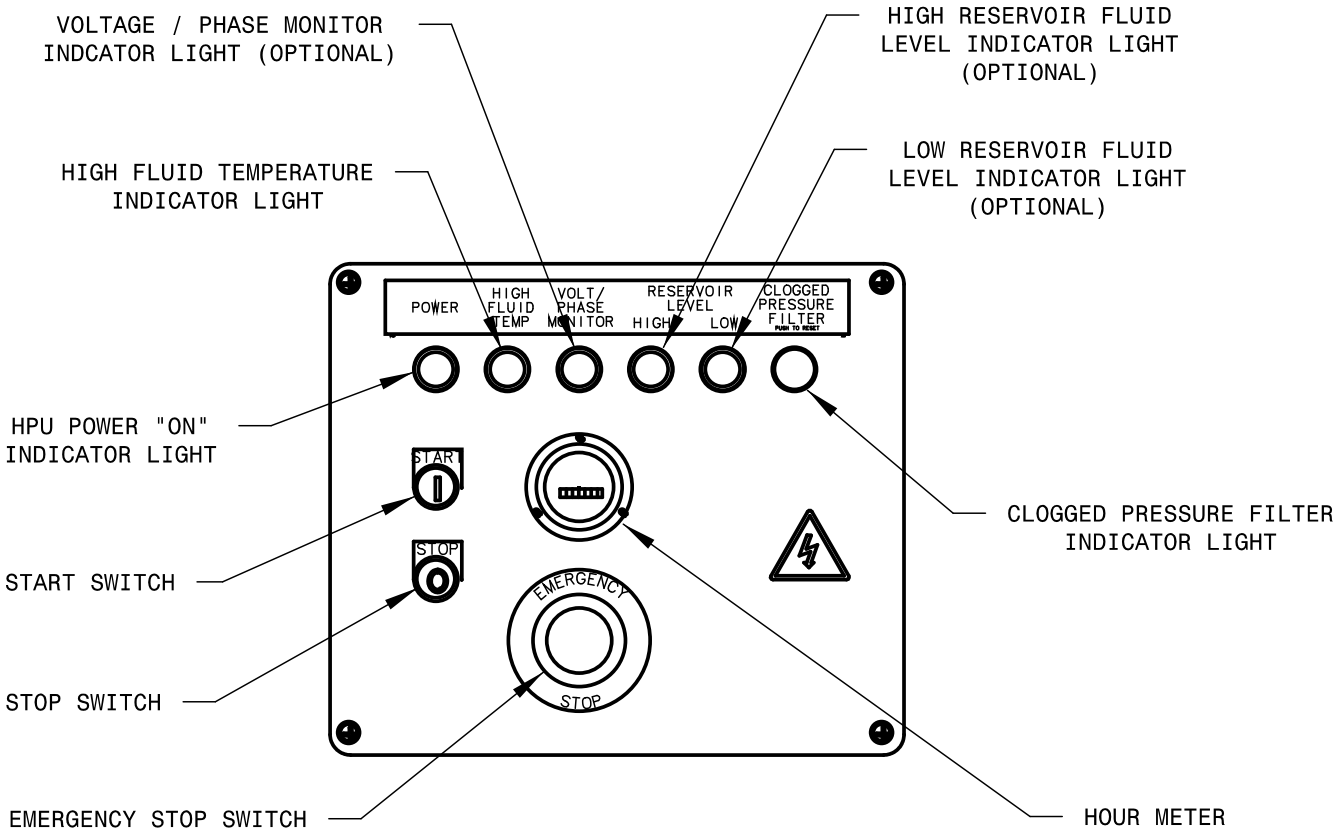
5.3.1 Front Panel Controls



Electrical Control Panel	See Section 5.3.2
Hydraulic Control Panel	See Section 5.3.3
Bypass Valve	For loading and unloading the motor driven hydraulic pump
Flowmeter	Displays the flow from the motor driven hydraulic pump
Pump Control Access	See Figure 5.3.5 - Hydraulic Pump Controls
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
Running Light	Displays green LED light when unit is running

5.3 LOCATION & LAYOUT OF CONTROLS *(continued)*

5.3.2 Electrical Control Panel

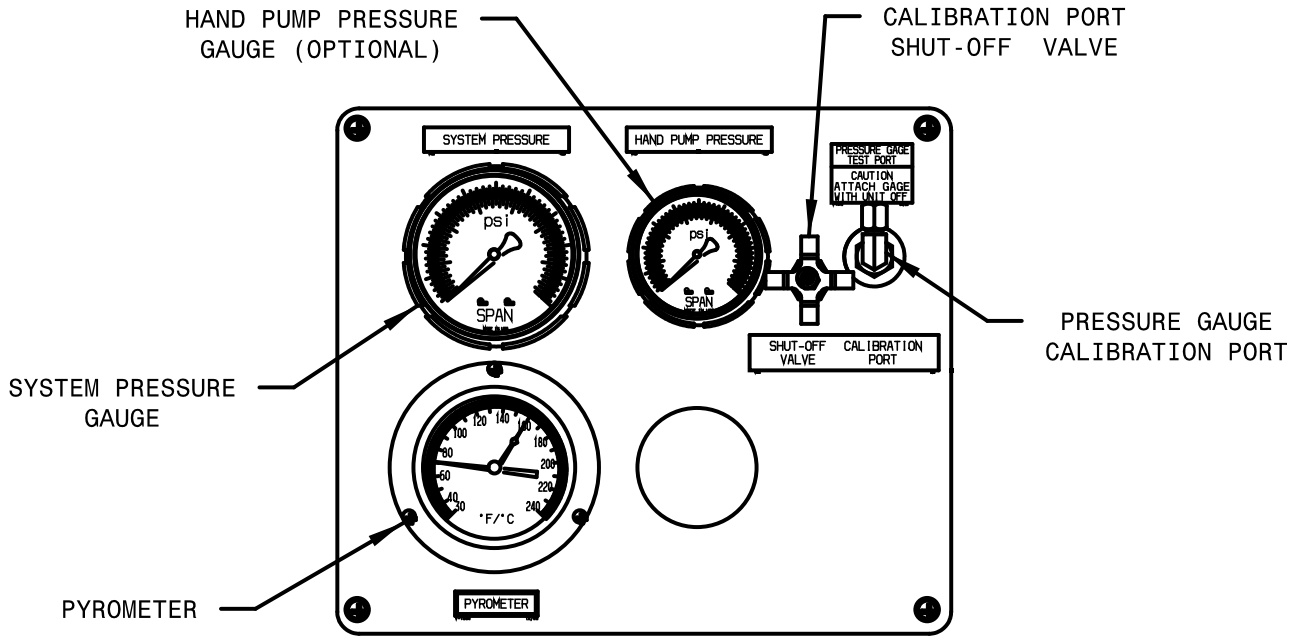


Emergency Stop	Removes power to all electrical devices, must turn to reset
Stop Switch	Turns off the electric motors driving the hydraulic pump and cooling fan
Start Switch	Turns on the electric motors driving the hydraulic pump and cooling fan
HPU Power "On" Indicator Light	Light is illuminated when 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 *(Option L)*	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
Low Reservoir Fluid Level Indicator Light *(Option L)*	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 *(Options G – J)*	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

5.3.2 Electrical control panel continued on following page.

5.3 LOCATION & LAYOUT OF CONTROLS *(continued)*

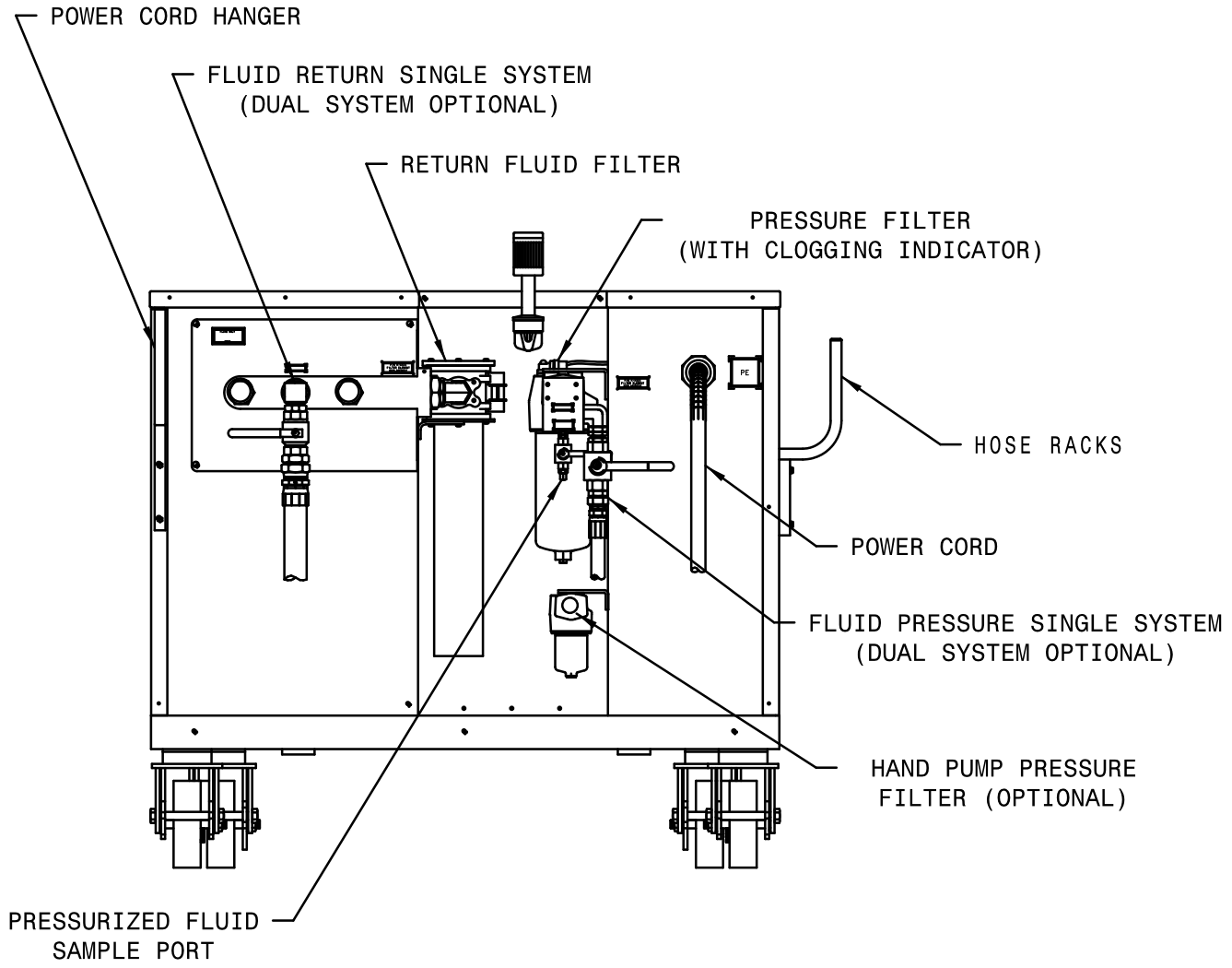
5.3.3 Hydraulic Control Panel



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	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 LOCATION & LAYOUT OF CONTROLS *(continued)*

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

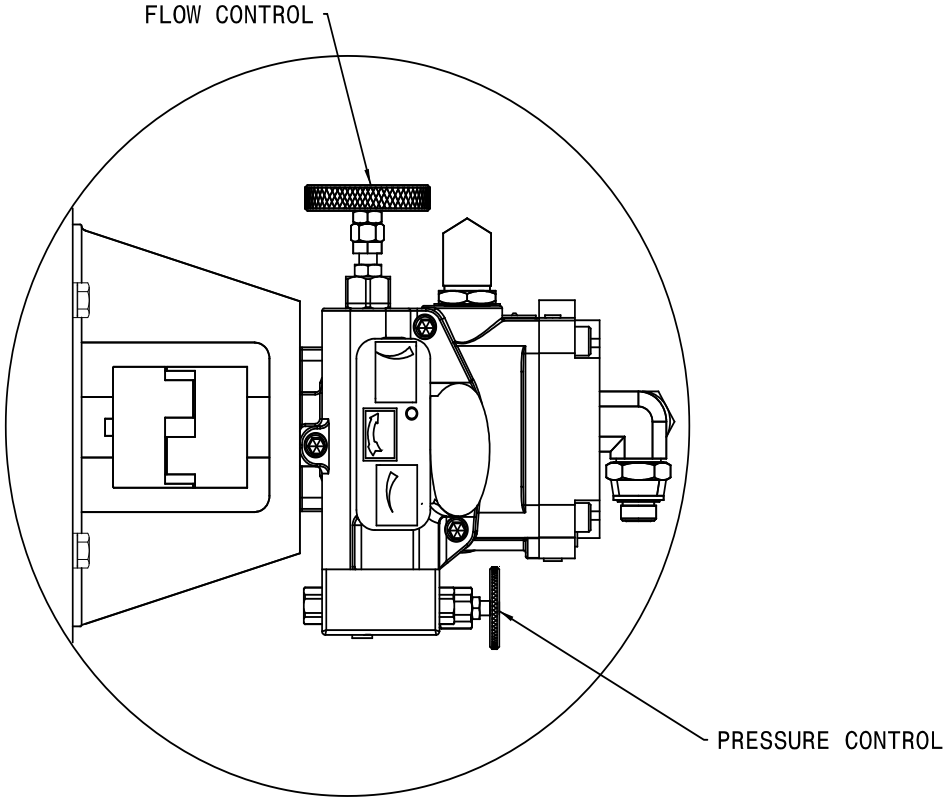
∗ ***Dual System (Optional) consists of two (2) each of these items.***

5.3 Location & Layout of Controls continued on following page.

5.3 LOCATION & LAYOUT OF CONTROLS *(continued)*

5.3.5 Hydraulic Pump Controls

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

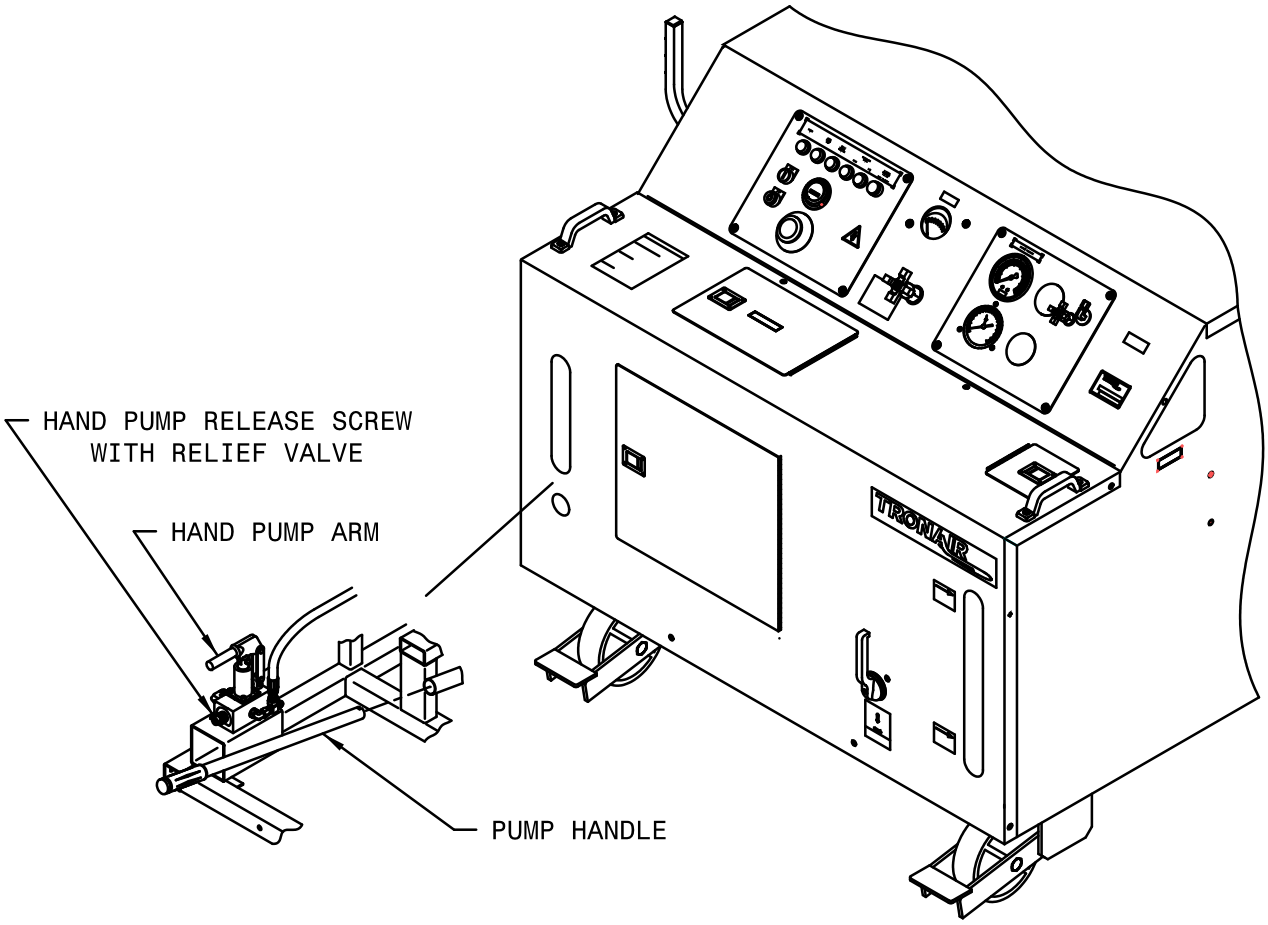


Flow Control	This control is used to set the maximum flow required from the HPU
Pressure Control	The pressure control is used to set the system pressure of the HPU during operation

5.3 LOCATION & LAYOUT OF CONTROLS *(continued)*

5.3.6 Hand Pump Controls *(Option M)*

Reference 5.8 Hand Pump Operation.



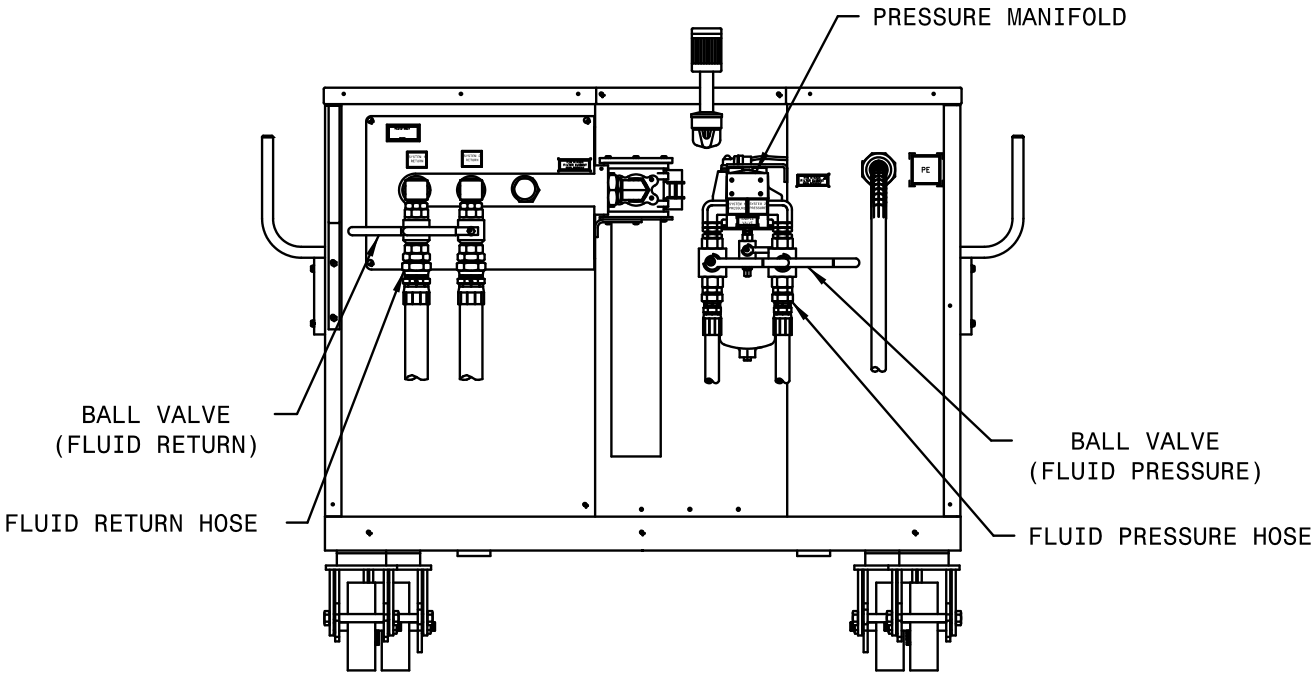
Pump Handle	Located inside the front access door is the hand pump handle used for opening and closing the hand pump relief screw and stroking the hand pump arm
Hand Pump Relief Screw	Accessed through the front panel opening, this screw allows opening and closing of the hand pump hydraulic circuit using 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 Location & Layout of Controls continued on following page.

5.3 LOCATION & LAYOUT OF CONTROLS *(continued)*

5.3.7 Dual System Controls *(Option C)*

Reference 5.7 Dual System Operation.



Pressure Manifold	Houses the pressure valves
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 dual 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.

5.0 OPERATION *(continued)*

5.4 START UP PROCEDURES

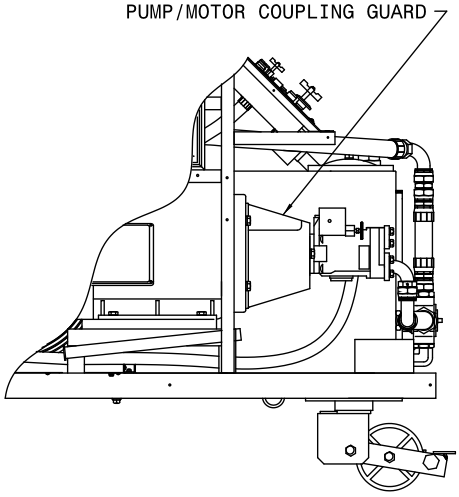
5.4.1 Procedure for First Time or Different Electrical Supply ONLY

Phase Monitor (Options G – 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.

a. Remove the pump/motor coupling guard. Reference 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.



Pump/Motor Coupling Access

b. Verify that the unit has been prepared for use by connecting electrical leads and servicing the reservoir. (Reference section *3.0 Preparation Prior to First Use*.)
c. Keeping hands clear of the pump/motor coupling area momentarily press the start button and immediately press the stop button.
d. 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.
e. 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.
f. Replace the pump/motor coupling guard.

5.4.2 Initial Start Up of the HPU

a. Unit must be prepared per section *3.0 Preparation Prior to First Use* and section *5.4.1 First Time or Different 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. Connect quick disconnects to hose ends or cap the pressure and return hose ends.
d. Place the reservoir selector valve in "HPU Reservoir" position.
e. Place the bypass valve in the "Open" position.
f. Press the start switch and adjust the flow control until approximately 10 gpm (38 lpm) is displayed on the flowmeter. (If no flow displays on the flowmeter after adjusting the flow control, reference *Trouble Shooting 8.2 No Flow*).
g. Close the bypass valve, adjust the pressure control until 3,000 psi (206.84 bars) 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)*.
h. 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 Preliminary adjustments for operation continued on following page.

5.5 PRELIMINARY ADJUSTMENTS FOR OPERATION *(continued)*

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.**

5.6 BLEEDING AIR FROM SYSTEM

Rapid fluctuations of the pressure gage 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 BLEEDING AIR FROM SYSTEM *(continued)*

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 of Technical Manual

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 bars)**. 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 DUAL SYSTEM OPERATION *(Option C)*

The dual 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 90o 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 Dual 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 dual 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 (***5.3.3 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.

5.0 Operation continued on following page.

5.0 OPERATION *(continued)*

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 shutdown 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 *(Options G – J)*

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 section 9.13.11 Electric Filter Clogging Indicator (Option R) 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.

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 4,000 lb (1,814 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 7.0 HPU on Forklift.

6.3 PACKAGING PROTECTION

No special packaging material for cushioning or suspension is required.

6.0 PACKAGING AND STORAGE *(continued)*

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.

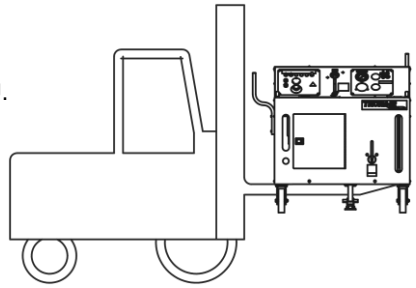
6.7 STORAGE SPACE AND HANDLING FACILITIES

- Weight (Dry)**:** 3,150 lbs (1,430 kg)
- Dimensions**:** Width 63 ¾ in (162 cm) *Add 7.5 in (19 cm) for Dual System.*
  Height 59 in (149.9 cm)
  Depth 78 in (198 cm)

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.



HPU on Forklift

8.0 TROUBLE SHOOTING

The following is a guide to solutions of common problems associated with the HPU. See related Appendix 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	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 5.5.4 Bypass Valve Operation for proper use of the bypass valve.

8.0 Trouble shooting continued on following page.

8.0 TROUBLE SHOOTING *(continued)*

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.

8.0 TROUBLE SHOOTING *(continued)*

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-1608).
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

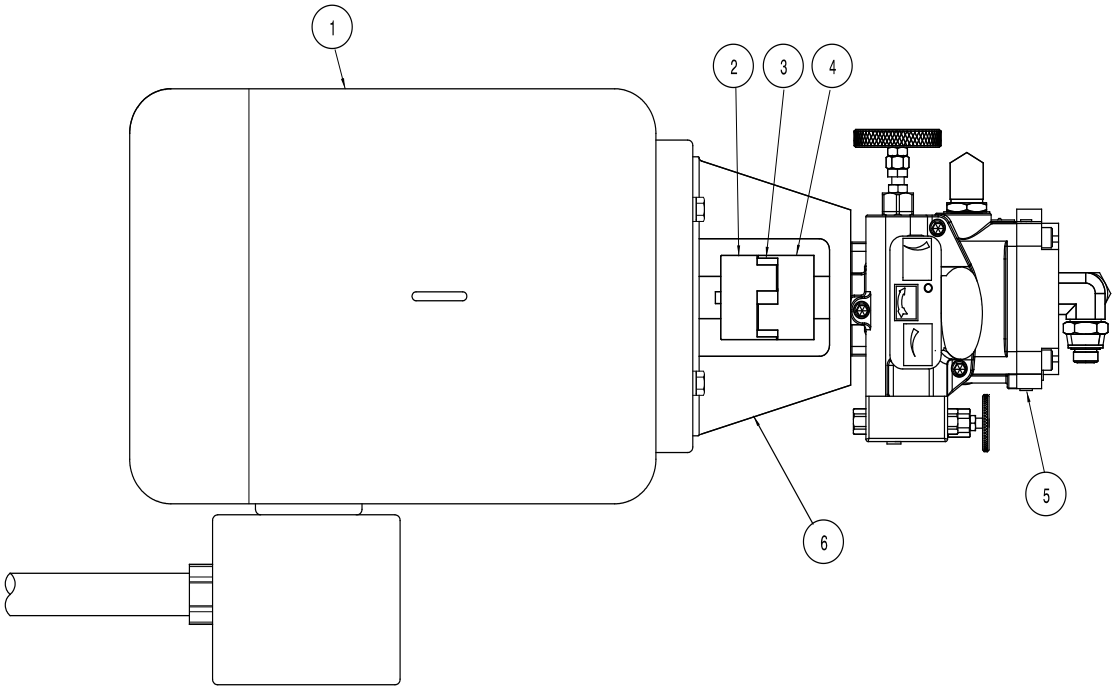
9.1 GENERAL

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 – 9.14 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-2226-03	Coupling (Motor Half)	1
3	H-2229	Spider (Hytrel)	1
4	H-2226-14	Coupling (Pump Half)	1
5	Reference 9.3 and 9.3.1	Motor Driven Hydraulic Pump	1
6	HC-1427-02	Pump/Motor Adapter	1

60 Hz Applications	
Voltage	**Part Number**
208	EC-1224-05
230	EC-1224-05
380	EC-1224-04
460	EC-1224-05
575	EC-1224-06

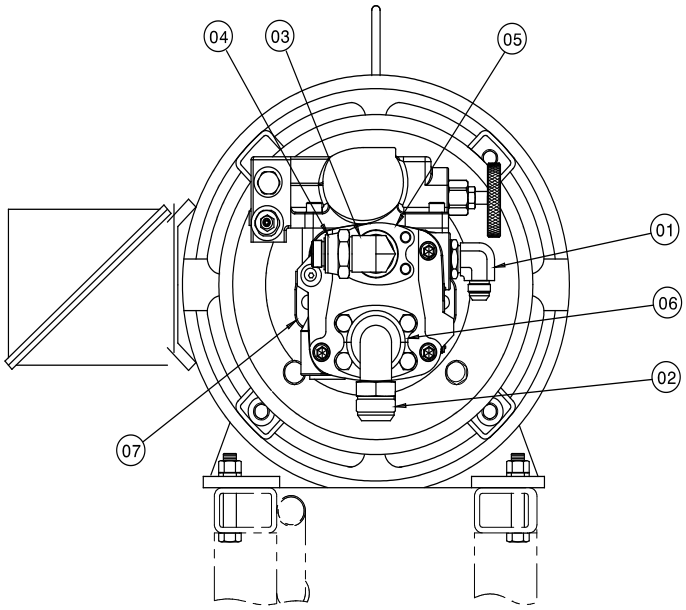
50 Hz Applications	
Voltage	**Part Number**
200	EC-1555-15
220	EC-1555-14
380	EC-1224-05
415	EC-1224-05
440	EC-1555-13

9.0 MAINTENANCE *(continued)*

9.3 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 – Oilgear Pump Manual for further details.

9.3.1 Hydraulic Pump Replacement Parts



Parts List

Fluid Type: Aviation Phosphate Ester, Type IV

Item	Part Number	Description	Qty
1	N-2001-24-S-E	Elbow, 12-16	1
2	N-2078-11	Flange, 90° Elbow	1
3	N-2679-12	Flange, Elbow	1
4	N-2055-20-S-E	Reducer, Tube	1
5	N-2664-03-S-E	Kit, Flange	1
6	N-2545-06-S-E	Kit, Flange	1
7	K-4414	Hydraulic Pump	1

9.3.2 Hydraulic Pump Replacement Seal Kits

Parts List

Fluid Type: Aviation Phosphate Ester, Type IV

Part Number	Description
K517105-B13	Kit, Pump Seal
K-517107-004	Kit, Control Seal
L517104-313	Kit, Shaft and Bearing Seal

9.0 Maintenance continued on following page.

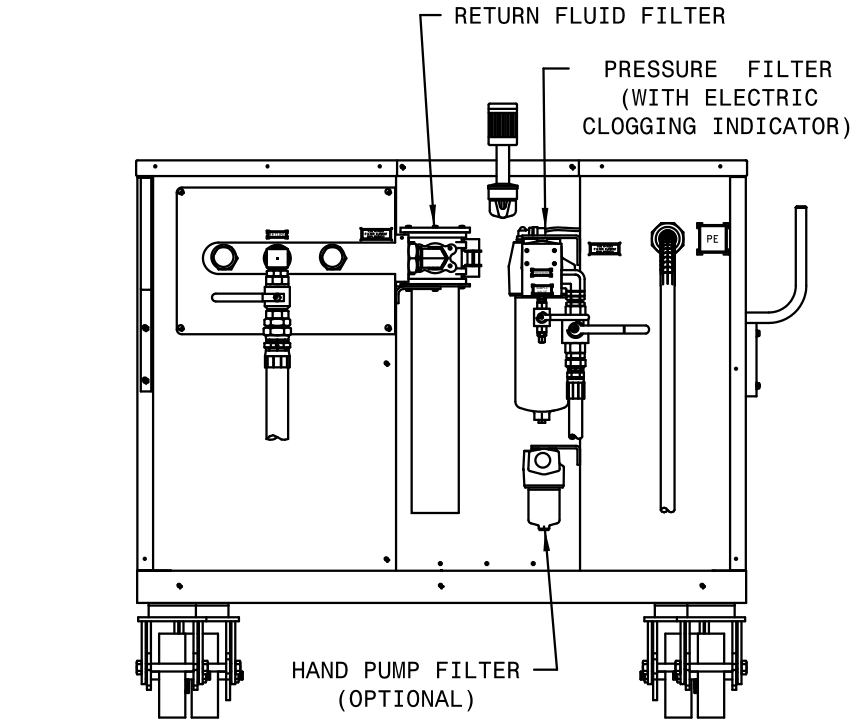
9.0 MAINTENANCE (*continued*)

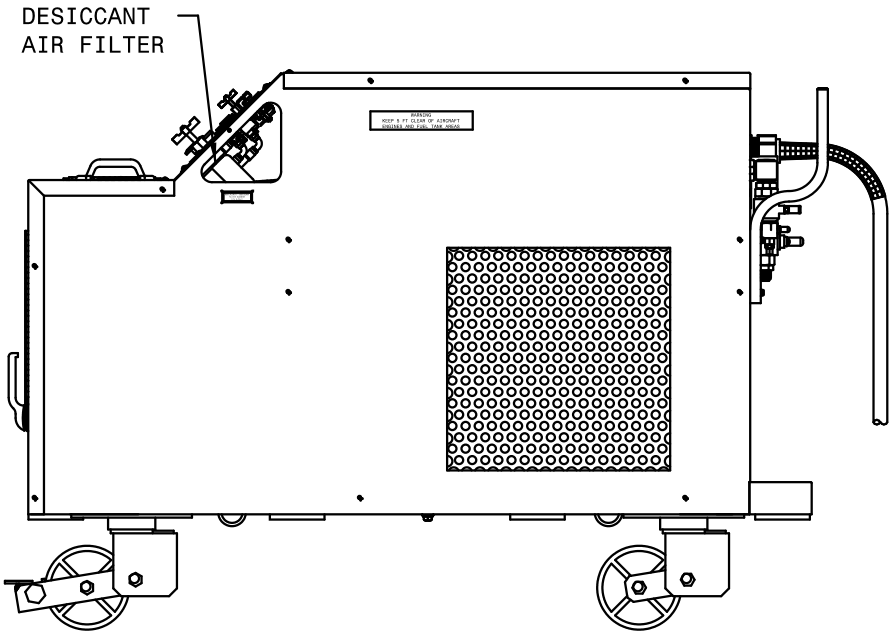
9.4 HYDRAULIC FLUID

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 Section 5.9 – Sample Valve Operation)

Refer to the manufacturer of the specific fluid for your unit to obtain additional information:
Model Number: 5631
Fluid Type: Aviation Phosphate Ester, Type IV

9.5 FILTERS





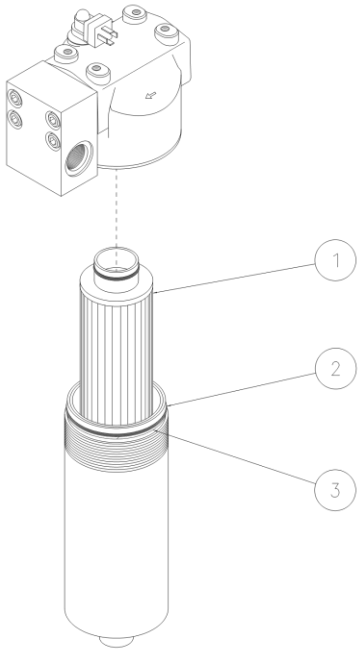
9.5 FILTERS *(continued)*

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.



Parts List

Fluid Type: Aviation Phosphate Ester, Type IV

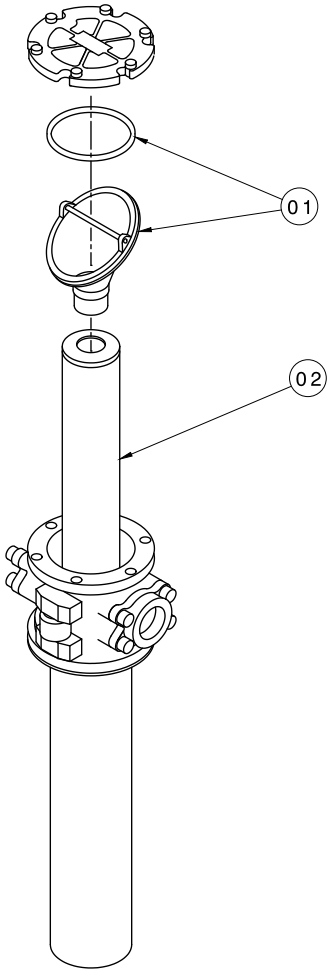
Item	Part Number	Description	Qty
2 & 3	K-3799	O-ring and Backup Ring	1
1, 2, 3	HK-3614	Kit, Replacement Filter Element	1

9.5 Filters continued on following page.

9.5 FILTERS (*continued*)

9.5.2 Return Filter Element

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



Parts List

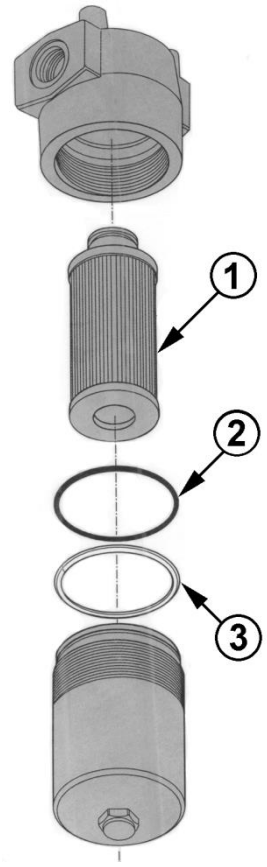
Fluid Type: Aviation Phosphate Ester, Type IV

Item	Part Number	Description	Qty
1	HC-2006-350	O-ring (Bowl)	2
1 & 2	K-3616	Kit, Replacement Filter Element	1

9.5 FILTERS (*continued*)

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.



Parts List

Fluid Type: Aviation Phosphate Ester, Type IV

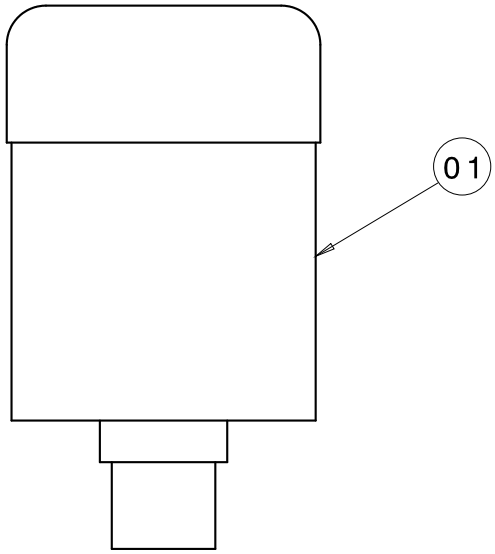
Item	Part Number	Description	Qty
2 & 3	K-3797	O-ring and Backup Ring	1
1, 2, 3	K-3752	Kit, Replacement Filter Element	1

9.5 Filters continued on following page.

9.5 FILTERS *(continued)*

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

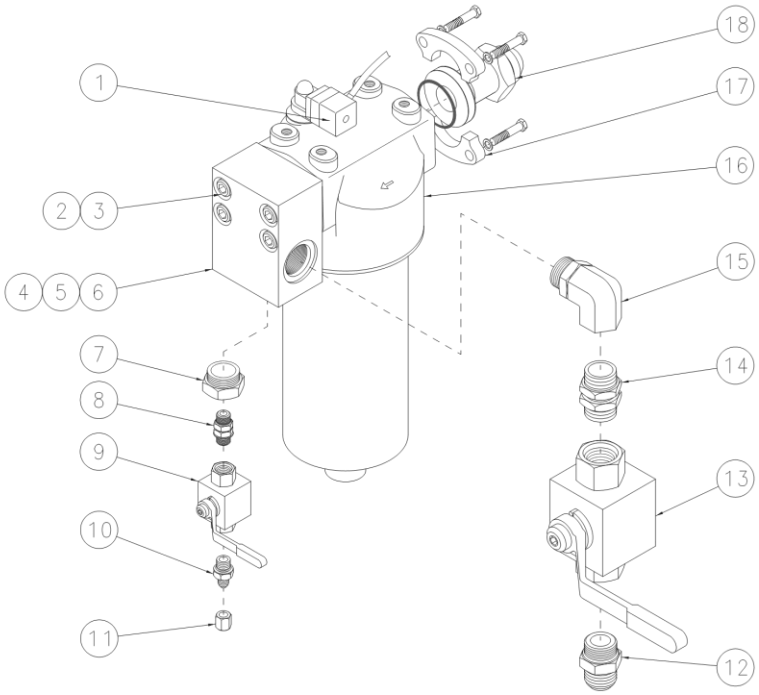
Item	Part Number	Description	Qty
1	HC-1763	Filter Element	1

9.5 FILTERS *(continued)*

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 98 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 98 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.



Parts List

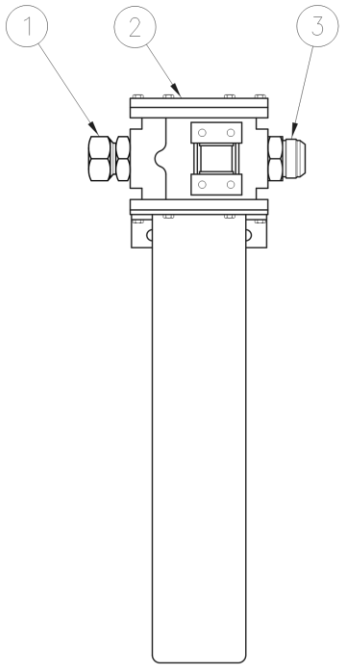
Fluid Type: Aviation Phosphate Ester, Type IV

Item	Part Number	Description	Qty
1	EC-1778	DIN Connector Cable	1
2	G-1151-109224	Screw, Socket Head Cap, ½-13	1
3	G-1251-1090HC	Lockwasher, high collar	1
4	J-3280	Flange, SAE Adapter	1
5	HC-2000-222	O-ring, Series 2	1
6	N-2053-10-S-E	Plug, Hex Head with O-ring	1
7	N-2463-31-S-E	Fitting, Reducer/Expander	1
8	N-2464-05-S-E	Union, #6 Straight Thread	1
9	HC-1771-02	Valve, Ball	1
10	N-2007-05-S-E	Connector, Straight Thread	1
11	N-2008-03-S	Cap, #4	1
12	N-2007-24-S-E	Connector, Straight Thread	1
13	HC-1771-05	Valve, Ball	1
14	N-2464-10-S-E	Union, #16 Straight Thread	1
15	N-2661-06-S-E	Elbow, Straight Thread	1
16	HC-2044-02	Filter, Pressure	1
17	N-2664-03-S-E	Kit, Flange	1
18	N-2667-05	Adapter, Flange	1

9.5.5 Pressure filter assembly with electric filter clogging indicator continued on following page.

9.5 FILTERS *(continued)*

9.5.6 Return Filter Assembly



Parts List

Fluid Type: Aviation Phosphate Ester, Type IV

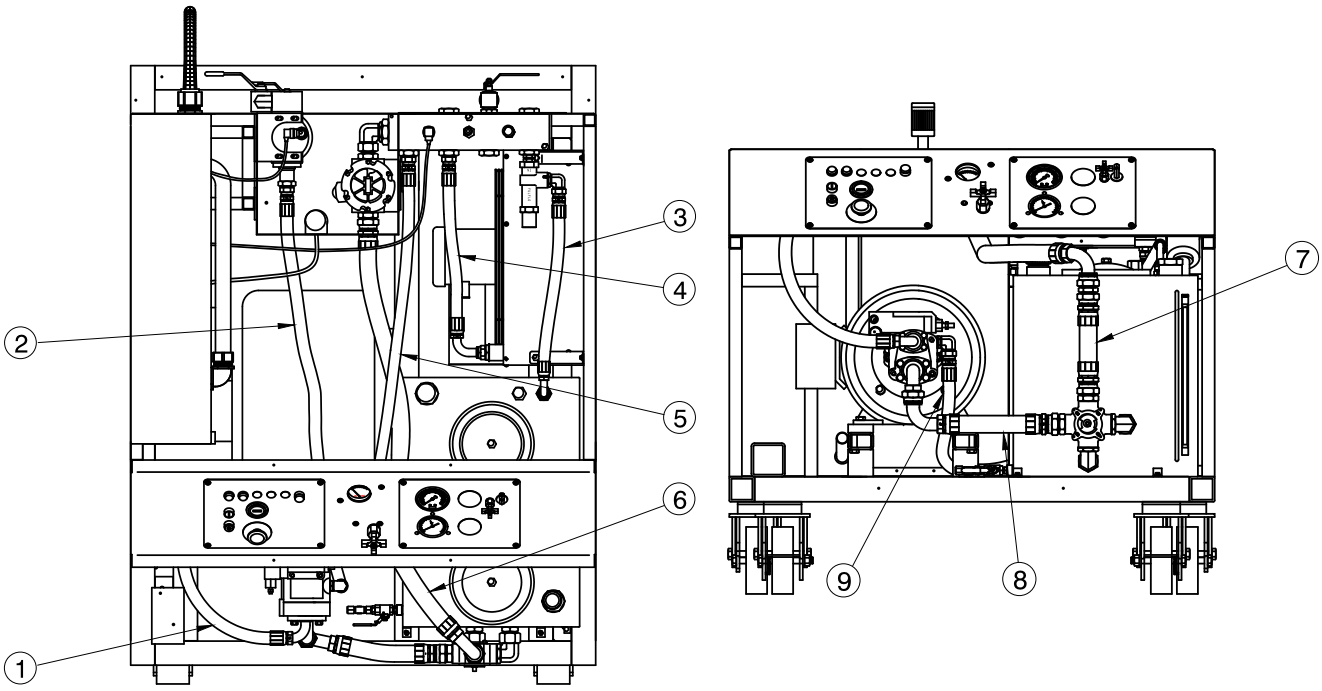
Item	Part Number	Description	Qty
1	N-2036-13-S-E	Fitting, 37° Swivel	1
2	HC-2045-02	Filter, Return	1
3	N-2007-31-S-E	Connector, #24 Straight Thread	1

9.0 MAINTENANCE *(continued)*

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.



Parts List

Fluid Type: Aviation Phosphate Ester, Type IV

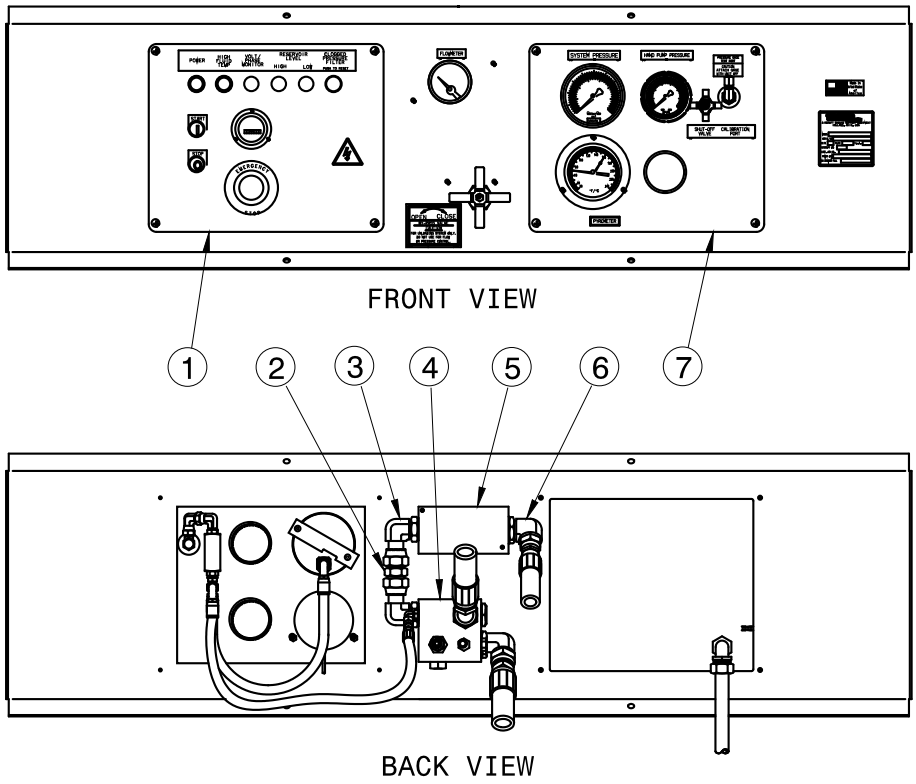
Item	Part Number	Description	Qty
1	TF-1040-43*80.5	Assembly, Hose #16	1
2	TF-1040-02*41.4	Assembly, Hose #16	1
3	TF-1041-16*27.0	Assembly, Hose #16	1
4	TF-1041-16*27.0	Assembly, Hose #16	1
5	TF-1041-52*50.5	Assembly, Hose #16	1
6	TF-1041-17*56.5	Assembly, Hose #24	1
7	TF-1041-04*11.5	Assembly, Hose #24	1
8	TF-1040-47*17.3	Assembly, Hose #24	1
9	TF-1041-01*60.0	Assembly, Hose #16	1
Not Shown	TF-1040-05*300	External Pressure Hose	1
Not Shown	TF-1041-04*300	External Return Hose	1

9.0 Maintenance continued on following page.

9.0 MAINTENANCE (*continued*)

9.7 INSTRUMENT PANEL

Refer to Section 9.6 Hydraulic Hoses concerning hose inspection for general maintenance on Item 3 Hose Assembly.



Parts List

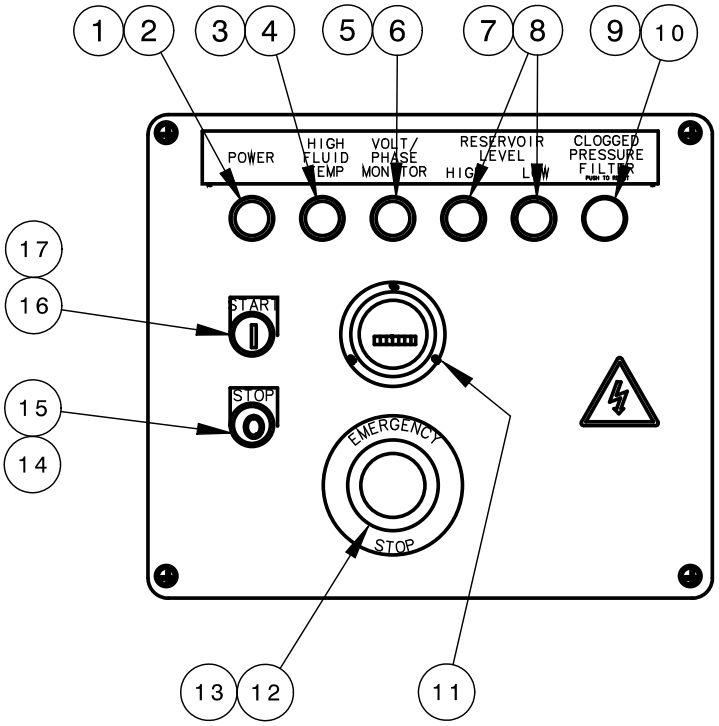
Fluid Type: Aviation Phosphate Ester, Type IV

Item	Part Number	Description	Qty
1	*See Page 35*	Electric Panel	1
2	N-2665-08-S-E	Fitting, ORFS Tube End	1
3	N-2634-05-S-E	Elbow, 90°	1
4	*See Page 37*	Assembly, Pressure Manifold	1
5	HC-1404	Flowmeter	1
	HC-1404-01	Flowmeter (Calibrated)	1
6	N-2001-25-S-E	Elbow, 90°	1
7	*See Page 36*	Hydraulic Panel	1

9.7 INSTRUMENT PANEL *(continued)*

9.7.1 Electric Panel

The Electric Panel does not require regular general maintenance.



Parts List

Fluid Type: Aviation Phosphate Ester, Type IV

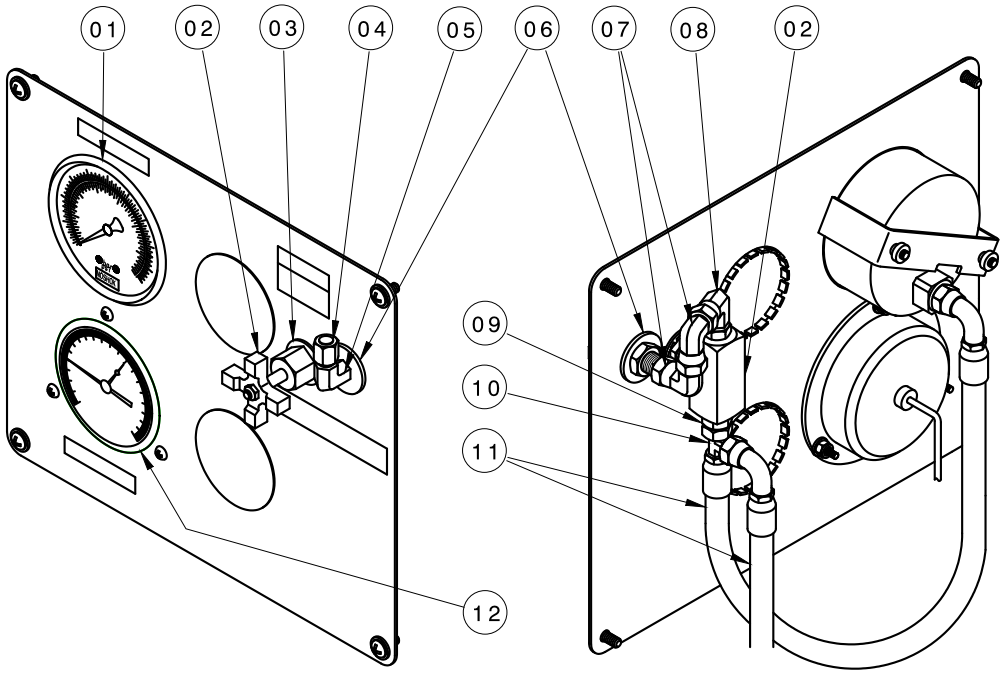
Item	Component	Part Number	Description	Qty
1	Standard	EC-1945-01	Light, Diffused Pilot	1
2	Standard	EC-1951-MN5G	Power, Module w/Latch	1
3	Option	EC-1945-03	Light, Diffused Pilot	1
4	Option	EC-1951-MN5Y	Power, Module w/Latch	1
5	Option	EC-1945-03	Light, Diffused Pilot	1
6	Option	EC-1951-MN5Y	Power, Module 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	Standard	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

9.7 Instrument Panel continued on following page.

9.7 INSTRUMENT PANEL (*continued*)

9.7.2 Hydraulic Panel

Annual calibration of instrumentation is recommended. See Section 12.0 – Calibration of Instrumentation for details of calibration.



Parts List

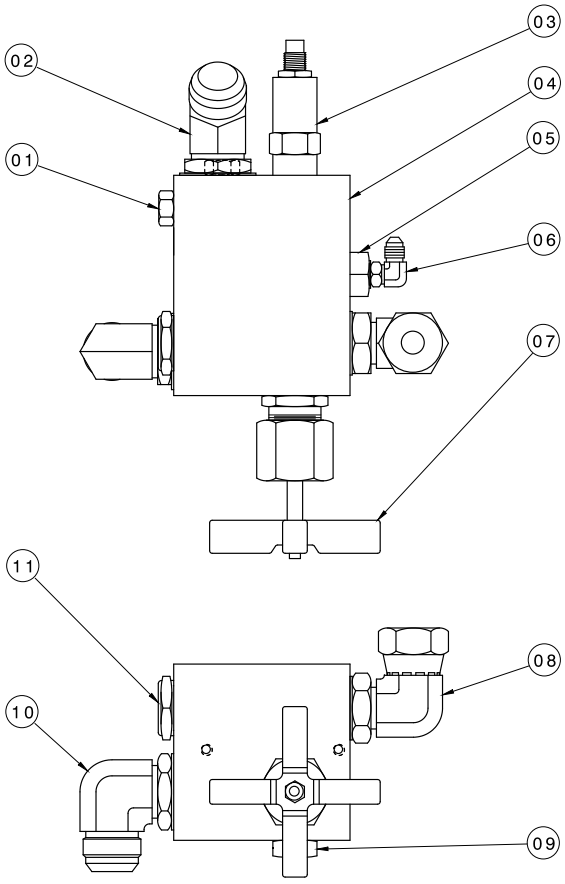
Fluid Type: Aviation Phosphate Ester, Type IV

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	2
12	HC-1769-02	Gauge, Pyrometer	1

9.7 INSTRUMENT PANEL *(continued)*

9.7.3 Pressure Manifold Assembly

The Pressure Manifold components do not require regular general maintenance.



Parts List

Fluid Type: Aviation Phosphate Ester, Type IV

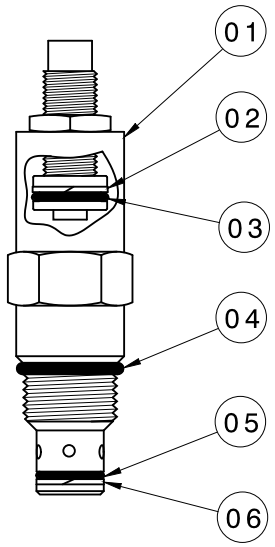
Item	Part Number	Description	Qty
1	N-2053-05-S-E	Plug, O-ring Hex Head	2
2	N-2042-16-S-E	Connector, 45° Straight Thread	1
3	HC-1445	Valve, Pressure Relief	1
4	J-3245	Manifold, Pressure	1
5	N-2463-36-S-E	Fitting, Reducer-Expander	1
6	N-2001-03-S-E	Connector, Straight Thread	1
7	HC-1927-06	Valve, Needle	1
8	N-2634-05-S-E	Elbow, 90° Swivel & O-ring	1
9	N-2053-07-S-E	Plug, O-ring Hex Head	1
10	N-2001-24-S-E	Elbow, Straight Thread 90°	1
11	HC-2159	Valve, Check	1

9.7.3 Pressure manifold assembly continued on following page

9.7.3 Pressure Manifold Assembly *(continued)*

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 3,750 psig.



Parts List

Fluid Type: Aviation Phosphate Ester, Type IV

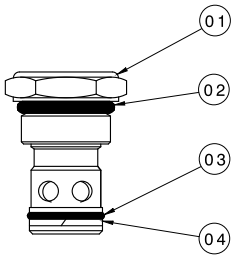
Item	Part Number	Description	Qty
♦ 1	HC-1445	Pressure Relief Valve *(Not Set)*	1
2	HC-2020-015	Backup Ring, *(Teflon)*	1
3	HC-2006-015	O-ring, Series 2	1
4	HC-2013-910	O-ring, Series 3	1
5	HC-2006-014	O-ring, Series 2	1
6	HC-2020-014	Backup Ring, *(Teflon)*	1

♦ ***Item 1 consists of Items 2 – 6.***

9.7.3 Pressure Manifold Assembly *(continued)*

9.7.3.b Check Valve

The Check Valve does not require regular general maintenance.



Parts List

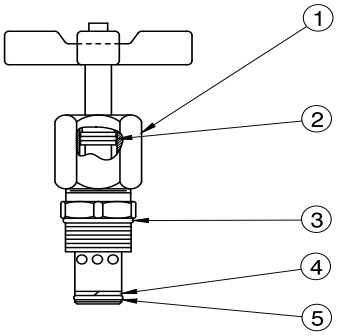
Fluid Type: Aviation Phosphate Ester, Type IV

Item	Part Number	Description	Qty
♦ 1	HC-2159	Check Valve	1
2	HC-2013-912	O-ring, Series 3	1
3	HC-2006-115	O-ring, Series 2	1
4	HC-2020-115	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.



Parts List

Fluid Type: Aviation Phosphate Ester, Type IV

Item	Part Number	Description	Qty
♦ 1	HC-1927-06	Needle Valve	1
2	HC-2006-112	O-ring	1
3	HC-2013-916	O-ring	1
4	HC-2020-118	Backup Ring	1
5	HC-2006-118	O-ring	1

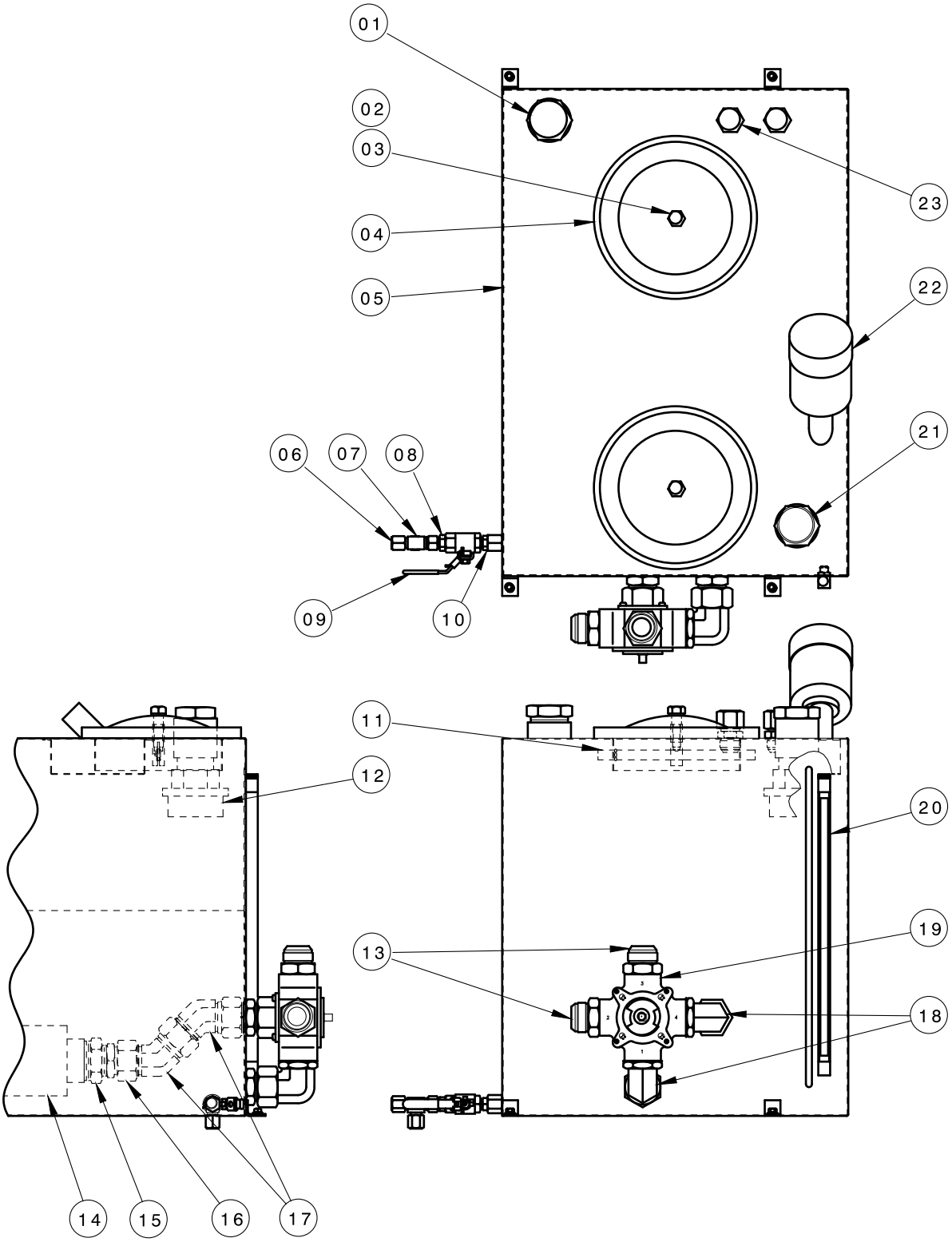
♦ ***Item 1 consists of Items 2 – 5.***

9.0 Maintenance continued on following page.

9.0 MAINTENANCE *(continued)*

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. The Selector Valve (Item 19) is not field serviceable.



9.8 RESERVOIR ASSEMBLY *(continued)*

Parts List

Fluid Type: Aviation Phosphate Ester, Type IV

Item	Part Number	Description	Qty
1	N-2206-09-S	Plug, Hex Head, 2" NPT	1
2	G-1202-1100	Stopnut, Elastic ⅝ - 11	2
3	H-1735-02	Washer, Nylon	2
4	H-1741	Assembly, Cover	2
5	H-2537	Reservoir, 70 gallon (Stainless Steel)	1
6	N-2008-06-S	Cap, #8	2
7	N-2016-06-S	Tee, Swivel Run, #8 JIC	1
8	N-2007-11-S-E	Connector, Straight Thread #8 SAE x #8 JIC	1
9	HC-1761	Valve, Ball SAE #8 Lockable	1
10	HC-2013-908	O-ring, Series 3	1
11	Z-2199	Assembly, Clamp	2
12	HC-1542	Strainer, Nipple Style	1
13	N-2007-31-S-E	Connector, Straight Thread #24 SAE x #24 JIC	2
14	HC-1397-05	Diffuser	1
15	N-2210-25-S	Reducer, Pipe Thread	1
16	N-2030-15-S	Fitting, Swivel Nut	1
17	N-2081-10-S	Fitting, 45° Swivel Nut	2
18	HC-2049-24-S-B	Elbow, 90° Swivel, #24	2
19	HC-2042-02	Valve, Selector, #24 SAE	1
20	HC-1383-18	Gauge, Sight, 18"	1
21	N-2206-09-SS	Plug, Hex Head	1
22	HC-1763	Filter, Desiccant	1
23	N-2008-10-S	Cap, #10	2

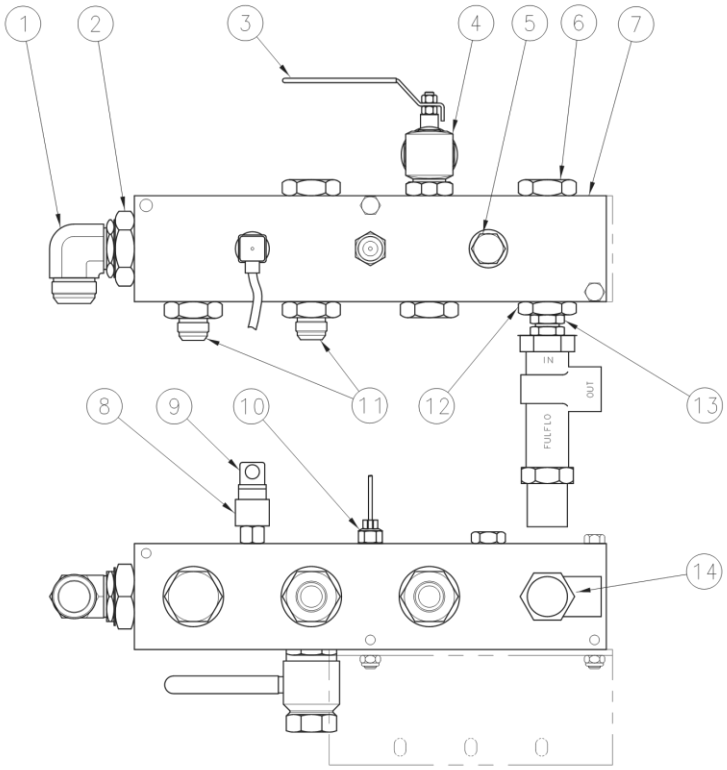
9.0 Maintenance continued on following page.

9.0 MAINTENANCE *(continued)*

9.9 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.



Parts List

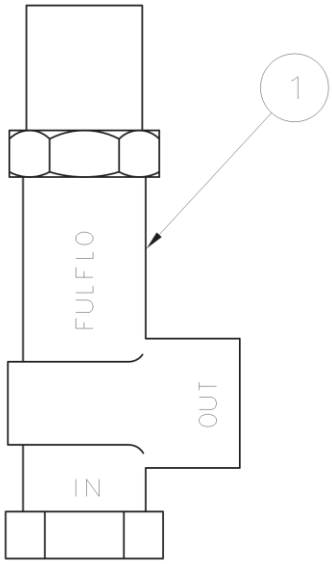
Fluid Type: Aviation Phosphate Ester, Type IV

Item	Part Number	Description	Qty
1	N-2001-31-S-E	Elbow, Straight Thread, #24 SAE x #24 JIC	1
2	N-2463-28-S-E	Fitting, Reducer/Expander, 24/32 SAE	1
3	HC-2058-02	Valve, Ball	1
4	N-2666-08-S-E	Elbow, Straight Thread, #24 SAE	1
5	N-2053-08-S-E	Plug, Hex Head, #12 O-ring	1
6	N-2053-12-S-E	Plug, Hex Head, #24 O-ring	3
7	HC-2043	Manifold, Return	1
8	EC-1782-02	Switch, Temperature	1
9	EC-1778	Cable, DIN Connector	1
10	HC-1769-02	Gauge, Pyrometer	*Ref.*
11	N-2007-34-S-E	Connector, Straight Thread, #24 SAE x #16 JIC	2
12	N-2463-24-S-E	Fitting, Reducer/Expander, 16/24	1
13	N-2464-10-S-E	Union, Straight Thread #16 SAE	1
14	HC-2202	Valve, Pressure Relief (*Pre-set*)	1

9.9 RETURN MANIFOLD ASSEMBLY *(continued)*

9.9.1 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.



Parts List

Fluid Type: Aviation Phosphate Ester, Type IV

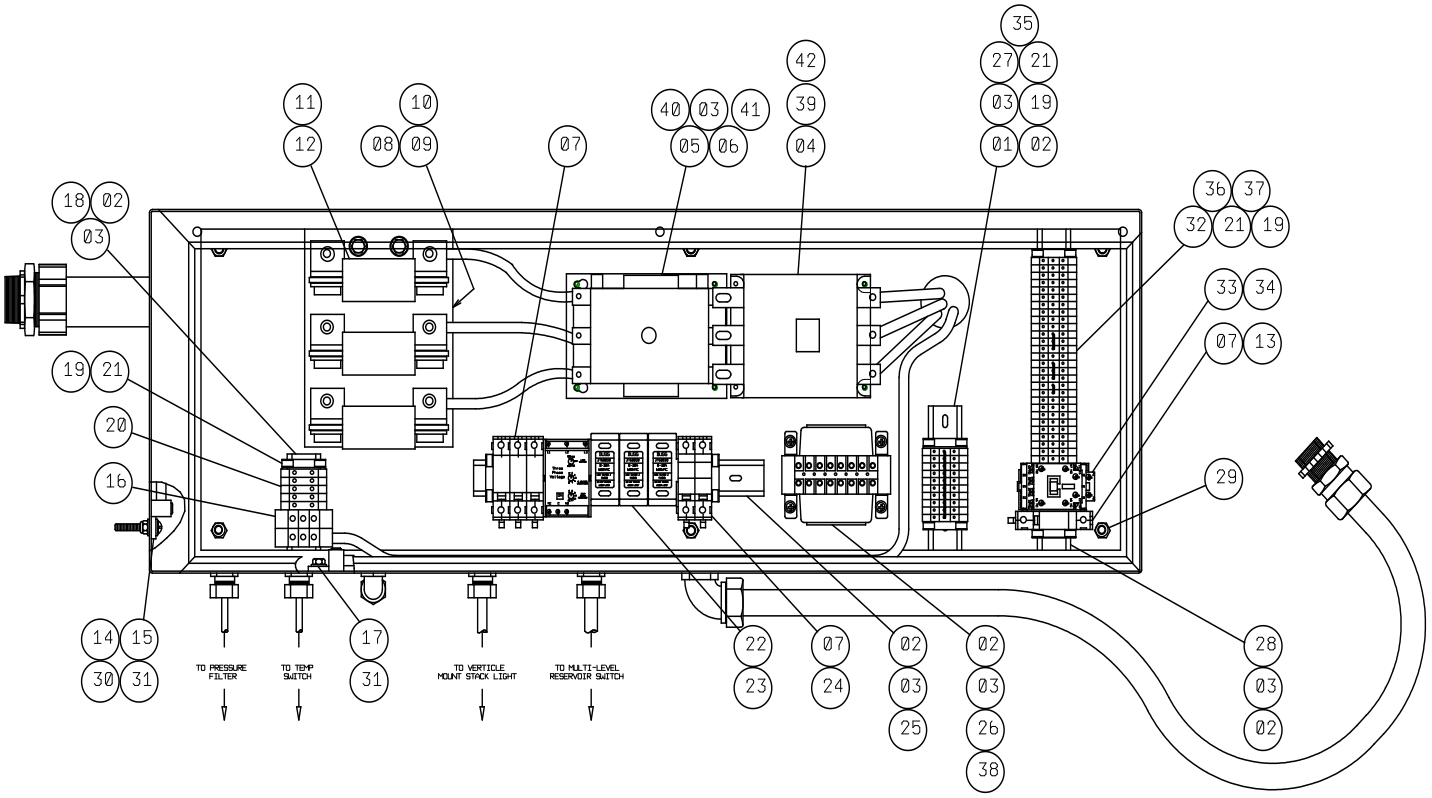
Item	Part Number	Description	Qty
1	HC-2202	Pressure Relief Valve (Pre-Set)	1
Not Shown	♦ HC-2006-220	O-ring, Series 2	1

♦ ***Included with Item 1.***

9.0 Maintenance continued on following page.

9.10 ELECTRICAL COMPONENTS

Regularly inspect the external power cord for nicks, cuts, abrasion, and fluid damage. Replace power cord if damage is found. See Section 10.0 Provision of Spares for recommended spare fuses.



Set Item 04 to Automatic Reset position. Wire per Electrical Schematic INS-1608. Reference Wire Diagram INS-1597.

Parts List

Item	Part Number	Description	Qty
1	EC-1598	Rail, Din	1
2	G-1159-103504	Screw, RD HD CRS REC, #10-32 x ½ Long	12
3	G-1250-1030N	Flatwasher, #10 Narrow	16
7	EC-1541-01	Fuse Holder, IEC Class CC	3
9	G-1100-106506	Bolt, HH GR 5, 5/16-24 x ¾ Long	4
10	G-1250-1060N	Flatwasher, 5/16 Narrow	4
13	EC-1542-09	Fuse, LP-CC-Low Peak 1-6/10A	1
14	EC-1432-04	Lug, Ground	1
15	G-1159-105516	Screw, RND HD CRS REC, ¼ - 28 x 1 ¾ Long	1
16	EC-1957	Block, IEC Ground	2
17	EC-1532-02	Lug, Ground	1
18	EC-1600	Rail, Din	1
19	EC-1959	Anchor, IEC End	7
20	EC-1958	Block, IEC Ground	5
21	EC-1960-01	Barrier, End	3
22	EC-1596-01	Fuse Holder, Class J	3
25	EC-1599	Rail, Din	1
27	EC-1956-03	Block, IEC Terminal (Blue)	10

9.10 ELECTRICAL COMPONENTS *(continued)*

Parts List

Item	Part Number	Description	Qty
28	EC-1597	Rail, Din	1
29	G-1202-1070	Stopnut, Elastic 3/8 – 16	6
30	G-1202-1055	Stopnut, Elastic ¼ - 28	1
31	G-1250-1050N	Flatwasher, ¼ Narrow	4
32	EC-1956-02	Block, IEC Terminal (Red)	28
33	EC-1591-04	Latch, Mechanical	1
34	EC-1564	Relay, Control	1
35	EC-1961-04	Jumper, Center	1
36	EC-1961-02	Jumper, Center	2
37	EC-1961-01	Jumper, Center	1
38	EC-1826	Guard, Finger Touchproof	1
40	G-1159-103510	Screw, RD HD CRS REC, #10-32 x 1 ¾ LG	6
42	EC-1965	Shield, Current Adjustment	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
	208	230	380	460	575		
4	EC-1920	EC-1920	EC-1920	EC-1525	EC-1525	Relay, Overload	1
5	EC-1922	EC-1922	EC-1922	EC-1842	EC-1842	Contactor, IEC Motor	1
6	EC-1924-01	EC-1924-01	EC-1924-01	N/A	N/A	Lug Set, Terminal	2
8	EC-1560	EC-1560	EC-1559	EC-1559	EC-1563	Fuse Block, Class J	1
11	J-3492	J-3492	EC-1585-06	EC-1585-06	EC-1585-12	Cover, Sami Fuse	3
12	EC-1556-07	EC-1556-07	EC-1556-01	EC-1556-01	EC-1556-30	Fuse, Class J	3
23	EC-1557-03	EC-1557-03	EC-1557-01	EC-1557-01	EC-1557-01	Fuse, Class J	3
24	EC-1726-15	EC-1726-14	EC-1726-08	EC-1726-07	EC-1726-07	Fuse, Class CC	2
26	EC-1804-03	EC-1147	EC-1804-03	EC-1147	EC-1804-03	Transformer, Control (150 W)	1
39	EC-1924-02	EC-1924-02	EC-1924-02	N/A	N/A	Lug Set, Terminal	1
41	N/A	N/A	N/A	EC-1607	EC-1607	Block, Auxiliary Contact	1

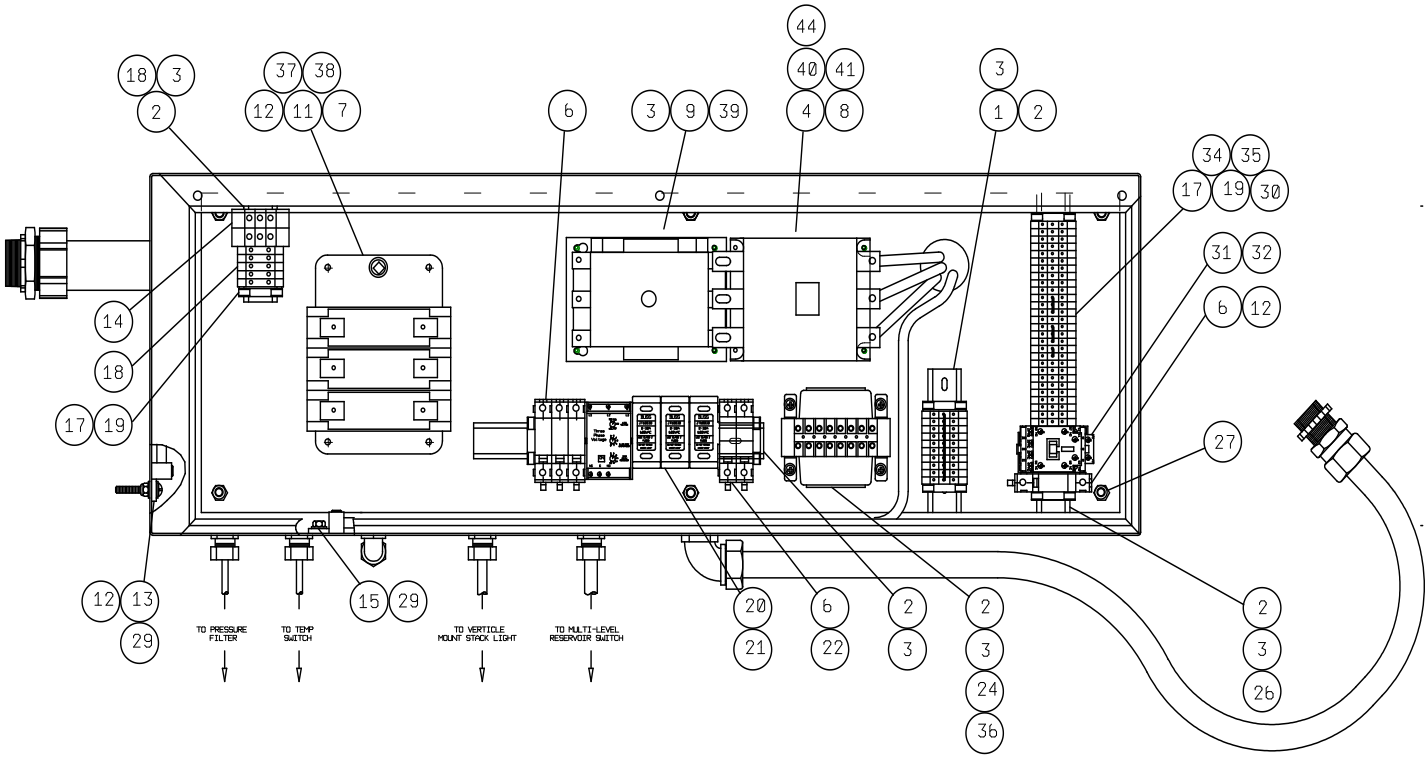
Item	50 Hz Applications					Description	Qty
	200	220	380	415	440		
4	EC-1920	EC-1920	EC-1525	EC-1525	EC-1525	Relay, Overload	1
5	EC-1922	EC-1922	EC-1842	EC-1842	EC-1842	Contactor, IEC Motor	1
6	EC-1924-01	EC-1924-01	N/A	N/A	N/A	Lug Set, Terminal	2
8	EC-1560	EC-1560	EC-1559	EC-1559	EC-1559	Fuse Block, Class J	1
11	J-3492	J-3492	EC-1585-06	EC-1585-06	EC-1585-06	Cover, Sami Fuse	3
12	EC-1556-07	EC-1556-06	EC-1556-01	EC-1556-01	EC-1556-01	Fuse, Class J	3
23	EC-1557-03	EC-1557-03	EC-1557-01	EC-1557-01	EC-1557-01	Fuse, Class J	3
24	EC-1726-16	EC-1726-15	EC-1726-08	EC-1726-08	EC-1726-08	Fuse, Class CC	2
26	EC-1804-03	EC-1147	EC-1804-03	EC-1147	EC-1804-03	Transformer, Control (150 W)	1
39	EC-1924-02	EC-1924-02	N/A	N/A	N/A	Lug Set, Terminal	1
41	N/A	N/A	EC-1607	EC-1607	EC-1607	Block, Auxiliary Contact	1

9.10 Electrical Components continued on following page.

9.10 ELECTRICAL COMPONENTS *(continued)*

9.10.1 Electrical Components With 100 ft. Input Cord Option

Regularly inspect the external power cord for nicks, cuts, abrasion, and fluid damage. Replace power cord if damage is found. See Section 10.0 Provision of Spares for recommended spare fuses.



Set Item 04 to Automatic Reset position. Wire per Electrical Schematic INS-1608. Reference Wire Diagram INS-1597.

Parts List

Item	Part Number	Description	Qty
1	EC-1598	Rail, Din	1
2	G-1159-103504	Screw, RD HD CRS REC, #10-32 x ½ Long	12
3	G-1250-1030N	Flatwasher, #10 Narrow	16
6	EC-1541-01	Fuse Holder, IEC Class CC	3
9	G-1159-103510	Screw, RD HD CRS REC, #10-32 x 1 ¾ LG	6
11	EC-1542-09	Fuse, LP-CC-Low Peak 1-6/10A	1
12	EC-1432-04	Lug, Ground	1
13	G-1159-105516	Screw, RND HD CRS REC, ¼ - 28 x 1 ¾ Long	1
14	EC-1957	Block, IEC Ground	2
15	EC-1532-02	Lug, Ground	1
16	EC-1600	Rail, Din	1
17	EC-1959	Anchor, IEC End	7
18	EC-1958	Block, IEC Ground	5
19	EC-1960-01	Barrier, End	3
20	EC-1596-01	Fuse Holder, Class J	3
23	EC-1599	Rail, Din	1
25	EC-1956-03	Block, IEC Terminal (Blue)	10
26	EC-1597	Rail, Din	1
27	G-1202-1070	Stopnut, Elastic 3/8 – 16	6

9.10.1 Electrical Components With 100 ft. Input Cord Option *(continued)*

Parts List

Item	Part Number	Description	Qty
28	G-1202-1055	Stopnut, Elastic ¼ - 28	1
29	G-1250-1050N	Flatwasher, ¼ Narrow	8
30	EC-1956-02	Block, IEC Terminal (Red)	28
31	EC-1591-04	Latch, Mechanical	1
32	EC-1564	Relay, Control	1
33	EC-1961-04	Jumper, Center	1
34	EC-1961-02	Jumper, Center	2
35	EC-1961-01	Jumper, Center	1
36	EC-1826	Guard, Finger Touchproof	1
37	EC-1858	Shaft, Operating	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
	208	230	380	460	575		
4	EC-1920	EC-1920	EC-1920	EC-1525	EC-1525	Relay, Overload	1
5	EC-1922	EC-1922	EC-1922	EC-1587	EC-1587	Contactor, IEC Motor	1
7	EC-1859	EC-1859	EC-1890	EC-1890	EC-1894	Disconnect, Fused	1
8	EC-1924-02	EC-1924-02	EC-1924-02	N/A	N/A	Lug Set, Terminal	2
10	EC-1556-07	EC-1556-07	EC-1556-02	EC-1556-01	EC-1557-31	Fuse, Class J	3
21	EC-1557-03	EC-1557-03	EC-1557-01	EC-1557-01	EC-1557-01	Fuse, Class J	3
22	EC-1726-15	EC-1726-14	EC-1726-08	EC-1726-07	EC-1726-07	Fuse, Class CC	2
24	EC-1804-03	EC-1147	EC-1804-03	EC-1147	EC-1804-03	Transformer, Control (150 W)	1
38	EC-1875	EC-1875	N/A	N/A	N/A	Handle, Operating	1
39	N/A	N/A	N/A	EC-1607	EC-1607	Block, Auxiliary Contact	1
40	N/A	N/A	N/A	EC-1965	EC-1965	Shield, Current Adjustment	1
41	N/A	N/A	N/A	EC-1606	EC-1606	Shield, Contact	1

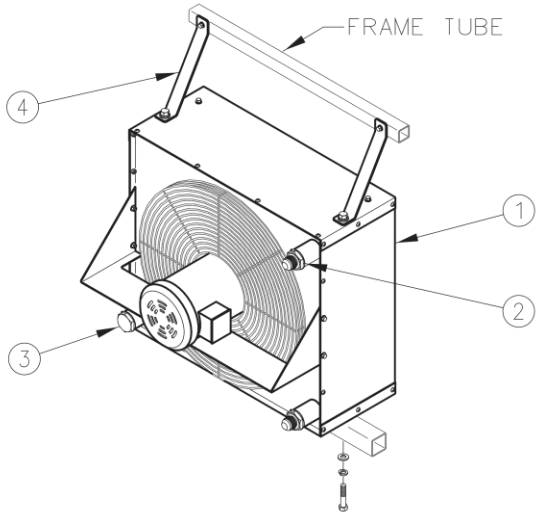
Item	50 Hz Applications					Description	Qty
	200	220	380	415	440		
4	EC-1920	EC-1920	EC-1925	EC-1525	EC-1525	Relay, Overload	1
5	EC-1922	EC-1922	EC-1587	EC-1587	EC-1587	Contactor, IEC Motor	1
7	EC-1859	EC-1859	EC-1890	EC-1890	EC-1890	Disconnect, Fused	1
8	EC-1924-02	EC-1924-02	N/A	N/A	N/A	Lug Set, Terminal	2
10	EC-1556-08	EC-1556-07	EC-1556-02	EC-1556-02	EC-1556-02	Fuse, Class J	3
21	EC-1557-03	EC-1557-03	EC-1557-01	EC-1557-01	EC-1557-01	Fuse, Class J	3
22	EC-1726-16	EC-1726-15	EC-1726-08	EC-1726-08	EC-1726-08	Fuse, Class CC	2
24	EC-1804-03	EC-1147	EC-1804-03	EC-1147	EC-1804-03	Transformer, Control (150 W)	1
38	EC-1875	EC-1875	N/A	N/A	N/A	Handle, Operating	1
39	N/A	N/A	EC-1607	EC-1607	EC-1607	Block, Auxiliary Contact	1
40	N/A	N/A	EC-1965	EC-1965	EC-1965	Shield, Current Adjustment	1
41	N/A	N/A	EC-1606	EC-1606	EC-1606	Shield, Contact	1

9.10.1 Electrical Components With 100 ft. Input Cord Option continued on the following page.

9.0 MAINTENANCE *(continued)*

9.11 HEAT EXCHANGER ASSEMBLY

The Heat Exchanger Assembly does not require regular general maintenance.



Parts List

Fluid Type: Aviation Phosphate Ester, Type IV

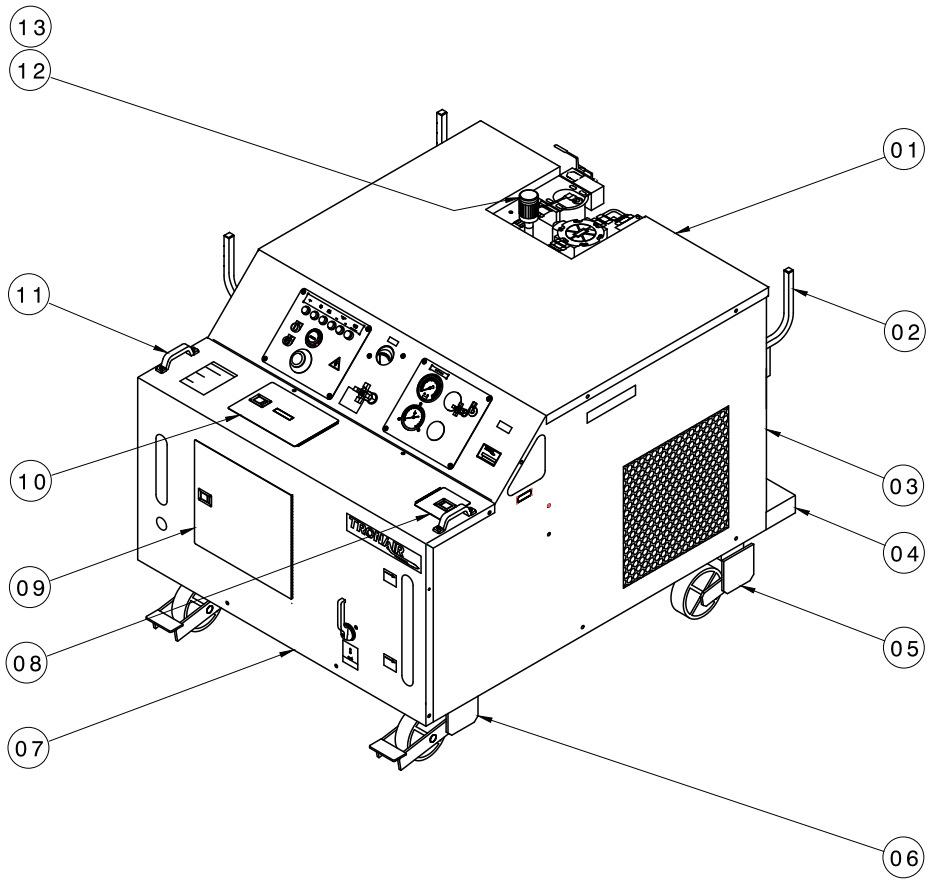
Item	Part Number	Description	Qty
1	Reference Table below	Heat Exchanger	1
2	N-2007-27-S-E	Connector, #20 SAE x #16 JIC	1
3	N-2066-20-S-E	Plug, O-ring #20	1
4	J-3404-01	Strap	2

Voltage	Frequency	Part Number
208v	60 Hz	HC-2137-01
230v	60 Hz	HC-2137-01
380v	60 Hz	HC-2137-01
460v	60 Hz	HC-2137-01
575v	60 Hz	HC-2137-02
200v	50 Hz	HC-2137-01
220v	50 Hz	HC-2137-01
380v	50 Hz	HC-2137-01
415v	50 Hz	HC-2137-01
440v	50 Hz	HC-2137-01

9.0 MAINTENANCE *(continued)*

9.12 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-1763-01	Top Panel	1
2	Z-5549-01	Hanger	3
3	Z-5362-01	Right Side Panel	1
4	S-1782-01	Panel, End	1
5	U-1099	Rigid Caster	2
6	U-1100	Swivel Caster	2
7	Z-5408-01	Front Panel	1
8	Z-4781	Filler Door	1
9	Z-5576	Front Access Door	1
10	Z-4783	Pump Access Door	1
11	H-1780	Handle	2
12	EC-1794	Box, Vertical Mount Junction	1
13	EC-1791	Light, Pole Mounted Stack	1
Not Shown	Z-5367-01	Left Side Panel	1
Not Shown	Z-5165-01	Frame	1
Not Shown	S-1703-01	Electrical Box Cover	1

9.0 Maintenance continued on following page.

9.0 MAINTENANCE (*continued*)

9.13 ADDITIONAL FEATURES

9.13.1 50 ft (15.2 m) Hoses *(Option B)*

Refer to Section 9.6 Hydraulic Hoses concerning hose inspection.

Parts List

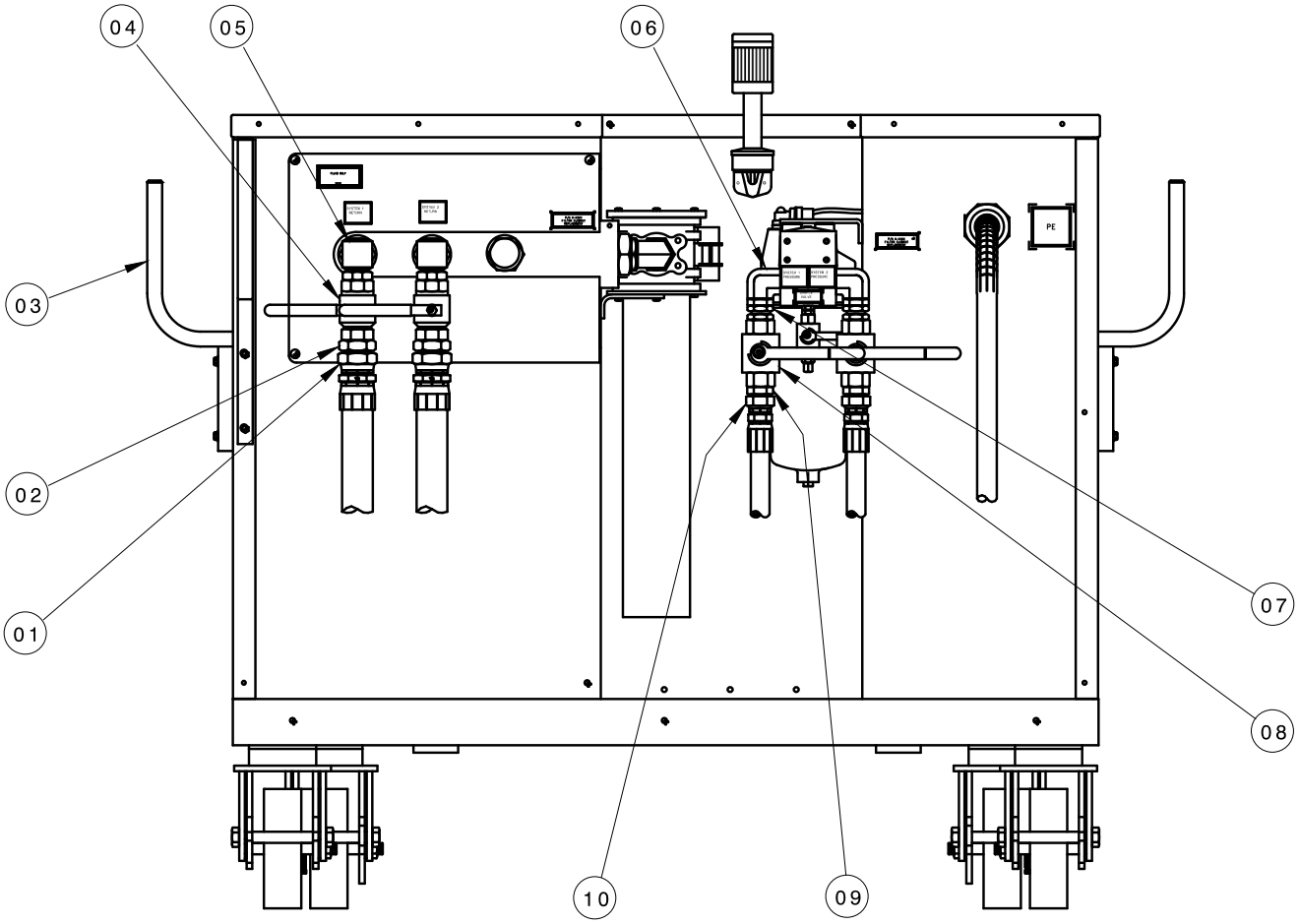
Fluid Type: Aviation Phosphate Ester, Type IV

Part Number	Description	Qty
TF-1040-05*300	Pressure Hose, 50 ft/15 m	1 per Option
TF-1041-04*300	Return Hose, 50 ft/15 m	1 per Option
N-2011-10-S	Union, #16	1 per Option
N-2011-12-S	Union, #24	1 per Option

9.13 ADDITIONAL FEATURES *(continued)*

9.13.2 Dual System *(Option C)*

Refer to Section 9.6 Hydraulic Hoses concerning hose inspection.



Parts List

Fluid Type: Aviation Phosphate Ester, Type IV

Item	Part Number	Description	Qty
1	TF-1041-04*300	Assembly, Hose #24	1
2	N-2007-31-S-E	Connector, Straight Thread	1
3	Z-5549-01	Weldment, Hose Hanger	2
4	HC-2058-02	Valve, Ball	1
5	N-2666-08-S-E	Elbow, Straight Thread #24	1
6	N-2661-06-S-E	Elbow, Straight Thread	1
7	N-2464-10-S-E	Union, #16 Straight Thread	1
8	HC-1771-05	Valve, Ball	1
9	N-2007-24-S-E	Connector, Straight Thread	1
10	TF-1041-04*300	Assembly, Hose #16	1

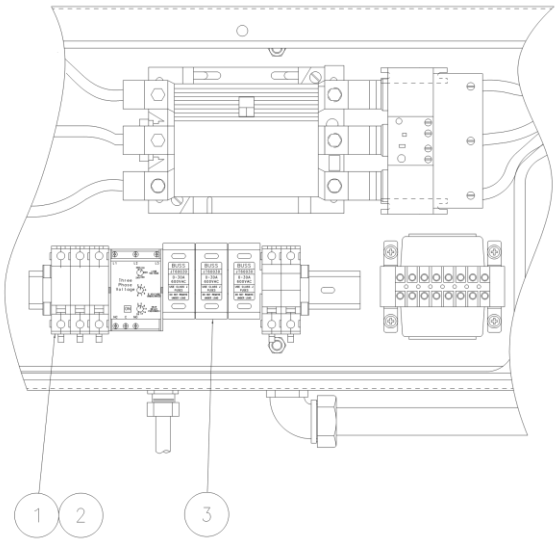
9.13 Additional Features continued on following page.

9.13 ADDITIONAL FEATURES *(continued)*

9.13.3 Voltage/Phase Monitor *(Options G – J)*

The Voltage/Phase Monitor does not require regular general maintenance. The panel indicator light will illuminate if a tripped condition exists. If the Voltage/Phase Monitor is causing the HPU to shut off, verify the ♦Phase Monitor settings shown. Continued tripping may indicate a serious electrical problem. See Section ***10.0 – Provision of Spares*** for recommended spare fuses.

NOTE: Wire per Electrical Schematic INS-1608. Reference Wiring Diagram INS-1597. Reference Section 9.7.1 Electrical Panel Panel Light.



Parts List

Item	Part Number	Description	Qty
1	EC-1541-01	Fuse Holder, IEC Class CC	3
2	EC-1675-12	Fuse, KTK-R, 2 amp	3
♦ 3	See Table below	Phase Monitor	1

Phase Monitor

Option	Voltage	Frequency	Part Number
G	200 – 230	50/60 Hz	EC-1543-02
H	380	50/60 Hz	EC-1543-03
I	415 – 460	50/60 Hz	EC-1543-04
J	575	60 Hz	EC-1543-05

♦ Setting Instructions for Item 3:

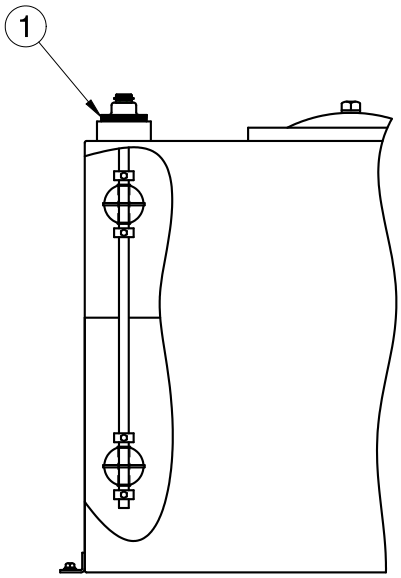
1. Set ***Line Voltage*** to match the voltage rating of the Hydraulic Power Unit.
2. Set ***% Voltage Unbalanced*** to 5% for 60 Hz unit or 6% for 50 Hz unit.
3. Set ***Trip Delay*** to three (3) seconds.

9.13 ADDITIONAL FEATURES (*continued*)

9.13.4 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-1597. Reference 9.7.1 Electrical Panel for Panel Light.



Parts List

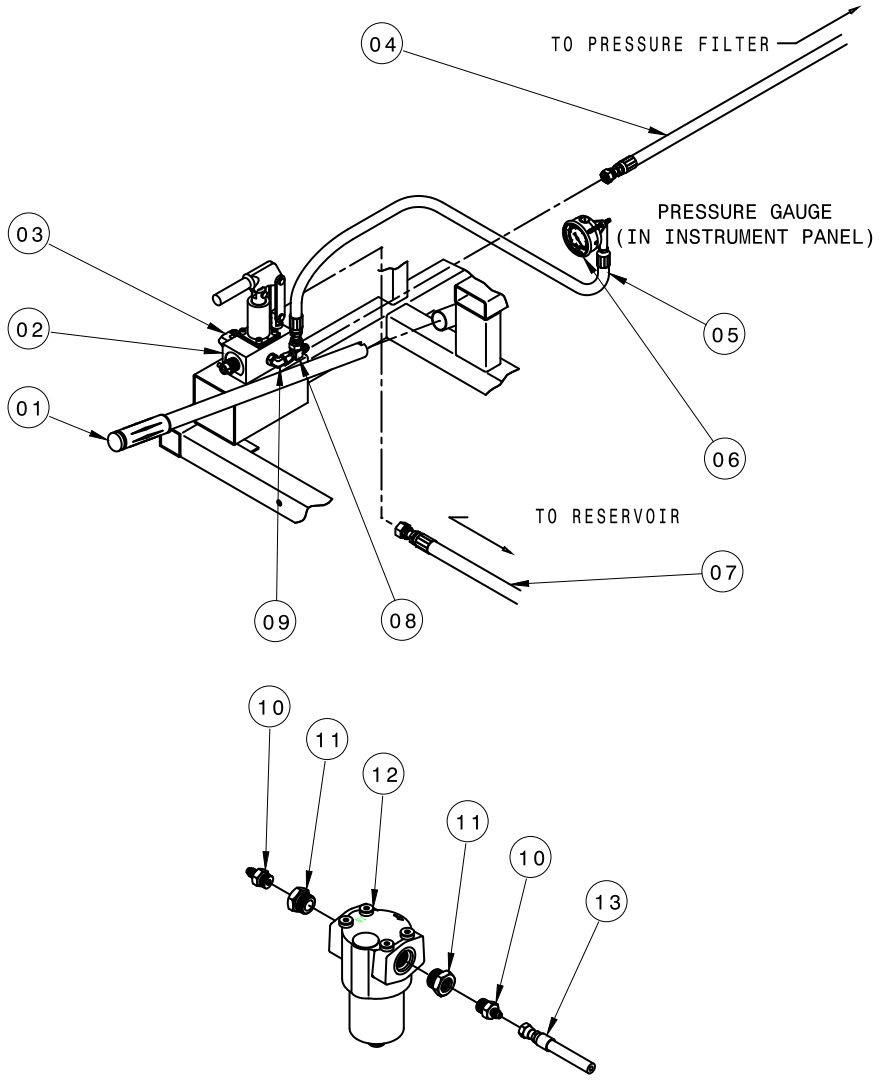
Item	Part Number	Description	Qty
1	EC-1783	Multi-Level Switch (includes Plug-in Cable)	1

9.13 Additional Features continued on following page.

9.13 ADDITIONAL FEATURES (*continued*)

9.13.5 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.



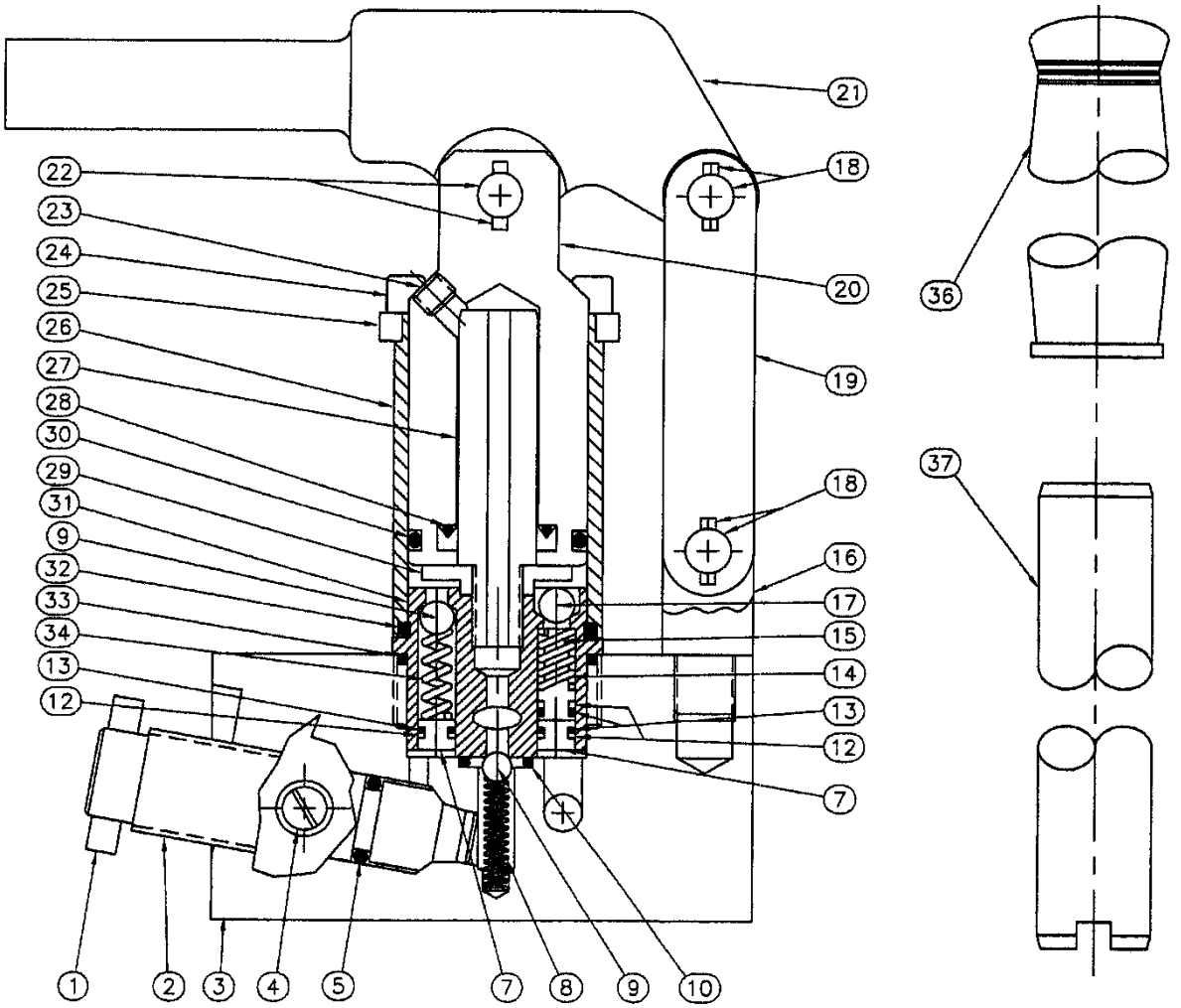
Parts List

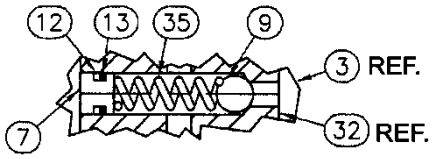
Item	Part Number	Description	Qty
1	H-1009-01	Pump Handle	1
2	HC-1779	Hand Pump, Two Stage	1
3	N-2001-11-S-E	Elbow, #8 SAE x #8 JIC Flare	1
4	TF-1040-15*56.5	Hose Assembly, #4	1
5	TF-1040-15*56.5	Hose Assembly, #4	1
6	HC-2146	Pressure Gauge	1
7	TF-1041-25*38.0	Hose Assembly, #8	1
8	N-2016-05-S	Tee, Swivel Nut, #6	1
9	N-2001-08-S-E	Elbow, #6 SAE x #6 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

This page left blank intentionally.

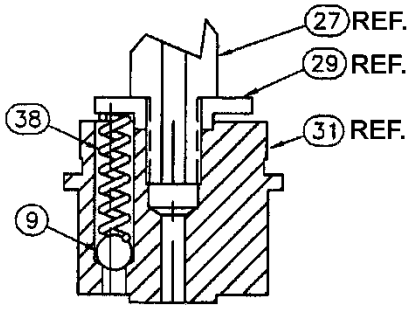
9.13.5 Hand Pump (Option M) *(continued)*

9.13.5.a Two Stage Pump with Relief





HIGH PRESSURE INLET
CHECK CAVITY VIEW



LOW PRESSURE INLET
CHECK CAVITY VIEW

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

Parts List

Fluid Type: Aviation Phosphate Ester, Type IV

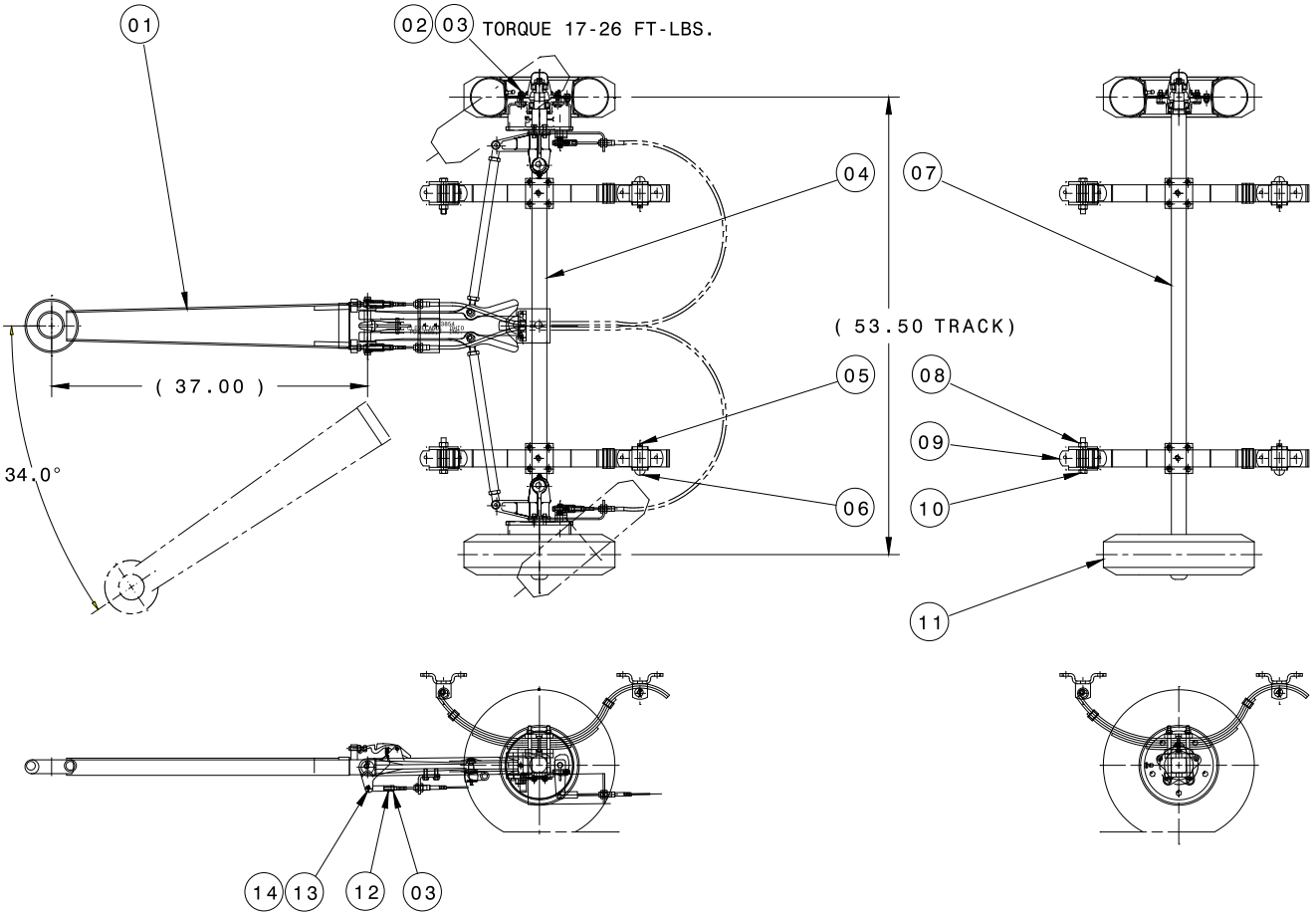
Item	Part Number	Description	Qty
1	519-000	Pin	1
3	CXC-990022-001	Body	1
7	505-001	Plug, Valve Body	3
15	571-121	Piston, Bypass Assembly	1
16	508-000	Pivot	1
20	566-125	Piston L.P	1
23	583-120	Plug	1
24	09-ADDF-04-20 X 56	Tie Rod	4
25	582-125	Flange	1
26	563-121	Tube	1
27	562-125	H.P. Piston	1
29	564-120	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

9.13 Additional Features continued on following page.

9.13 ADDITIONAL FEATURES *(continued)*

9.13.6 Towing Trailer *(Option N)*

Capacity: 4,000 lbs (1,814 kg)
Front Axle Capacity: 2,000 lbs (907 kg)
Rear Axle Capacity: 2,000 lbs (907 kg)
Tires: 4.80-8NHS x 6 Ply
Rated at 970 lbs (440 kg) (105 psi at 10 mph/7.24 bar at 16 kph)



Parts List

Item	Part Number	Description	Qty
1	59-3502	Assembly, Drawbar	1
2	4700-4	Lockwasher (3/8)	20
3	4601-47	Nut, Hex Head (3/8-24)	22
4	6-1395	Assembly, Front Axle	1
5	4800-3	Pin, Cotter	4
6	5403-1	Rivet	4
7	8-1345	Assembly, Rear Axle	1
8	4601-33	Nut, Self-Locking (9/16-12)	4
9	4251	Bracket, Spring	8
10	4901-19	Bolt (9/16-12 x 3¾")	4
11	5-3705	Wheel and Tire Assembly	4
12	5205	Yoke	2
13	5206	Pin, Yoke	2
14	4800-2	Pin, Cotter (3/32 x ¾")	2

9.0 MAINTENANCE *(continued)*

9.14 REPLACEMENT LABELS PARTS LISTS

9.14.1 Base Unit

Part Number	Description	Qty
V-1001	"Made in USA"	1
V-1033	"TRONAIR"	1
V-1050	ISO Electrical Shock Symbol	2
V-1365	"SYSTEM PRESSURE"	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
V-2008	"FLOW INCREASE"	1
V-2009	"PRESSURE INCREASE"	1

9.14.2 Fluid Labels

Fluid Type: Aviation Phosphate Ester, Type IV

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

9.14.3 Filter Element Kit Labels

Fluid Type: Aviation Phosphate Ester, Type IV

Part Number	Description	Qty
V-1960	"REPLACEMENT FILTER ELEMENT K-3614"	1
V-1962	"REPLACEMENT FILTER ELEMENT K-3616"	1
V-1916	"REPLACEMENT DESICCANT FILTER ELEMENT HC-1763"	1

9.14 Replacement labels parts lists continued on following page.

9.14.4 Dual System (Option C)

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

9.14.5 Hand Pump (Option M) Labels

Part Number	Description	Qty
V-1887	"HAND PUMP PRESSURE"	1
V-1915	"HAND PUMP"	1
V-1988	"REPLACEMENT FILTER ELEMENT K-3751"	1

10.0 PROVISION OF SPARES

10.1 SOURCE OF SPARE PARTS

TRONAIR, Inc.
1740 Eber Road
Holland, Ohio 43528-9794 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 20	Fuse, Transformer Primary	2
EC-1542-09	Fuse, Transformer Secondary	1
Refer to Section 9.10 Electrical Components Item 22	Fuse, Heat Exchanger	3
EC-1675-12	Fuse, Phase Monitor *(Optional)*	3
Refer to Section 9.10 Electrical Components Item 2	Fuse, Main Power	3

10.2.2 Spare Parts

Fluid Type: Aviation Phosphate Ester, Type IV

Part Number	Description	Qty
HC-1763	Desiccant Filter Element	1
TBD	Kit, Gaskets and O-rings for Main Pump	1
K-3614	Kit, Pressure Filter Element	1
K-3616	Kit, Return Filter Element	1
TBD	Kit, Shaft Seal and Retainer for Main Pump	1
K-3752	Kit, Hand Pump Filter Element *(Optional)*	1

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.
1740 Eber Road
Holland, Ohio 43528-9794 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).				

11.0 Calibration of instrumentation continued on following page

11.0 CALIBRATION OF INSTRUMENTATION *(continued)*

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

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-1660)
APPENDIX III	Electrical Schematic (INS-1608 & INS-2016)
APPENDIX IV	Wiring Diagram (INS-1597 & 2046)
APPENDIX V	Lincoln Motor Manual
APPENDIX VI	Oilgear Pump Manual
APPENDIX VII	Material Safety Data Sheet (MSDS) pertaining to Hydraulic Fluid
APPENDIX VIII	ANSI/B93.19M-1972 (R1993-Excerpt)
APPENDIX IX	Instrument Certification Notice

TRONAIR®

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:

David L. Kidd

Quality Assurance Representative

1740 Eber Rd
Holland, OH 43528-9794
USA

Tronair, Inc.
www.tronair.com
Email: sales@tronair.com

Phone: (419) 866-6301
800-426-6301
Fax: (419) 867-0634

TRONAIR®

APPENDIX II

Hydraulic Schematic
(INS-1660)

TRONAIR®

APPENDIX III

Electrical Schematics
(INS-1608 & INS-2016)

TRONAIR®

APPENDIX IV

Wiring Diagrams
(INS-1597 & INS-2046)

TRONAIR®

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.

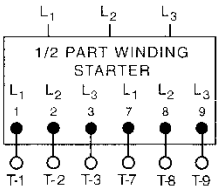
Number of Motor Leads	Number of Rated Voltages	Lead Numbers	YDS	PWS
3	Single	1-3	No	No
6	Single	1-3, 7-9	No	Yes
	Single	1-6	Yes	No
	Dual	1-6	Yes(1)	No
9	Dual	1-9	No	No
12	Single	1-12	Yes	Yes
	Dual	1-12	Yes	No(2)

(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.

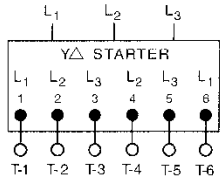
Connection Diagram 1

Single Voltage, 6 Leads
Part Winding Start Connection



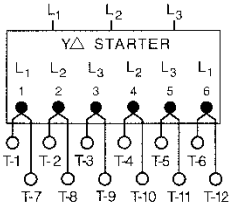
Connection Diagram 2

Single Voltage, 6 Leads
Y△ Start Connection



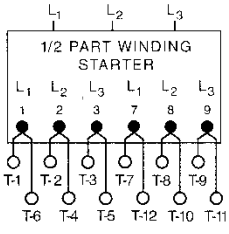
Connection Diagram 3

Single Voltage, 12 Leads
Y△ Start Connection



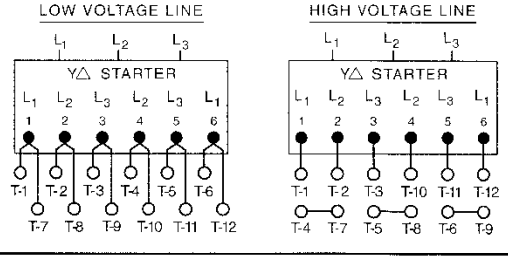
Connection Diagram 4

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

LINCOLN MOTORS
Cleveland OH 44117-2525 USA
Tel: 1-800-MOTOR-4-U (668-6748)
Fax: 1-888-536-6867
Web: www.lincolnmotors.com
E-Mail: mailbox@lincolnmotors.com

IM566-A December 1999

- indicates change since last printing.

TRONAIR®

APPENDIX VI

Oilgear Pump Manual

OILGEAR TYPE "PVG" PUMPS - 048/065/075/100/130 SERVICE INSTRUCTIONS

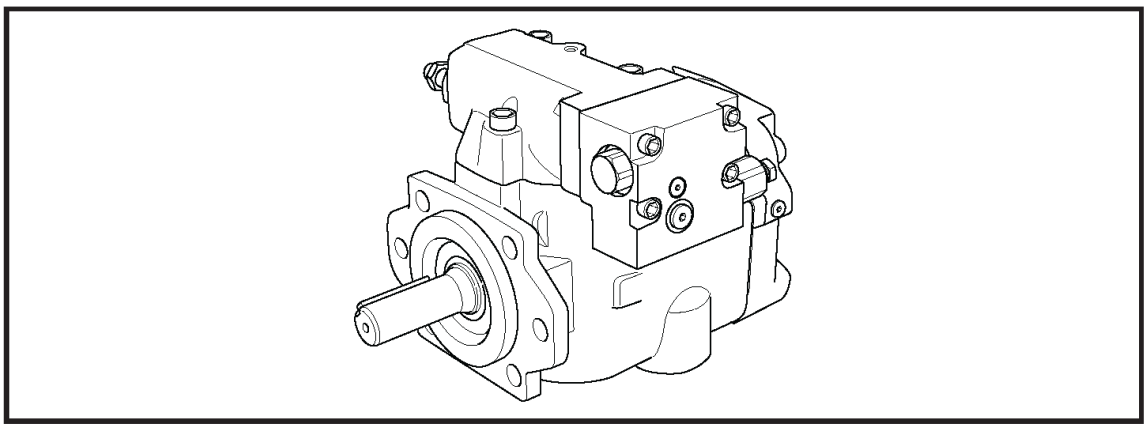


Figure 1. Typical Oilgear "PVG" Open Loop Pump

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

Pump Control Instructions

"P-1NN" Pressure Compensator ..... Data Sheet 947541
"P-1NN/F" Pressure Compensator w/Load Sense ..... Data Sheet 947542
"P-1NN/H" Pressure Compensator w/H.P. Limited..... Data Sheet 947543
"P-1NN/G" Horsepower Limit w/Load Sense ..... Data Sheet 947544
"P-2 -" Dual Pressure Compensator ..... Data Sheet 947545
"P-A" and "P-B" Electrohydraulic Proportional Pressure Compensator ..... Data Sheet 947546
"P-C -" Soft Starting ..... Data Sheet 947547
"V-S" Electrohydraulic Servo Valve w/o Amplifier..... Data Sheet 947719
"V-A" Electrohydraulic Servo Valve w/Amplifier..... Data Sheet 947720

Revised Dec., 2003

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. (Contact phone number.) 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 thepump 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 or hydraulic chock 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 and the special shaft seals 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.

Unit	048/065/075/100/130
Approximate Torque to turn drive shaft	9-24 ft•lb (12-32 N•m)

Table 1. Torque to Turn Shaft

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 **Figures 2, 8** and **9**.

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**.

SPECIFICATIONS

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

Unit	THEORETICAL MAXIMUM DISPLACEMENT		RATED CONTINUOUS PRESSURE		MAXIMUM 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 048	2.93	48,0	5000	344,8	5800	400,0	21.1	79,9	2700	73	54,5
PVG 065	3.98	65,0	5000	344,8	5800	400,0	28.8	108,9	2700	100	74,6
PVG 075	4.60	75,4	3750	258,6	4250	293,1	33.3	126,0	2700	89	66,4
PVG 100	6.00	98,3	5000	344,8	5800	400,0	42.4	160,5	2400	150	111,9
PVG 130	7.94	130,2	3750	258,6	4250	293,1	57.6	218,0	2400	150	111,9

Case pressure should be less than 25 psi (1,7 bar). For higher pressure, consult factory.
Higher speeds available - consult factory.

Table 2. 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 048, 065, 075	12.0	303,0	6.9	174,5	6.3	160,4	68*	31	SAE “B” 2 and 4 bolt
PVG 100, 130	13.0	330,5	8.4	212,9	7.3	185,7	110*	50	SAE “C” 2 bolt

All dimensions (without controls) are approximate. For detailed dimensions, contact your Oilgear Representative.
* Weight with P Control and rear port valve plate

Table 3. Nominal Dimensions and Weights without controls.

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

TROUBLESHOOTING

PROBLEM	CAUSES	REMEDY
Unresponsive or Sluggish Control	Low control input (pilot) pressure for “R” and “V” volume type controls only.	Refer to referenced control instruction material.
	Swashblock saddle bearings **(204)** worn or damaged.	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.
	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 and 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.

PRINCIPLE OF OPERATION

The illustrations show the pump driven clockwise (right hand) from the top (plan) view.

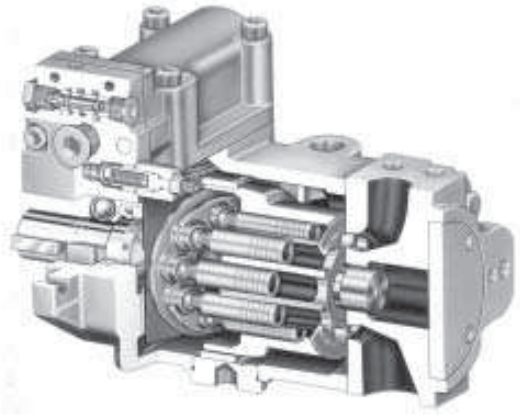


Figure 2. Cut-a-way of a Typical "PVG" Pump (92011R)

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

Rotating the drive shaft **(301)** 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 upper (port **A**) and lower (port **B**) in the valve plate. While connected to the upper side (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 the upper crescent port **A** to the lower crescent port **B**.

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

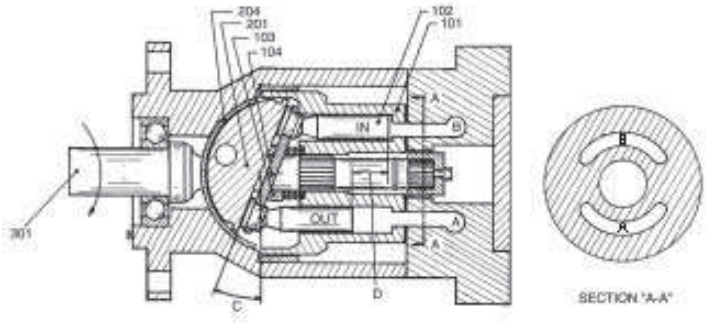


Figure 3. Position B, Pump During Full Delivery From Port B

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.*

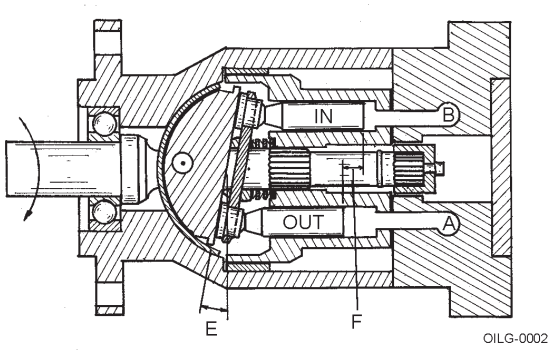


Figure 4. Position B/2, Pump During One Half Delivery From Port B

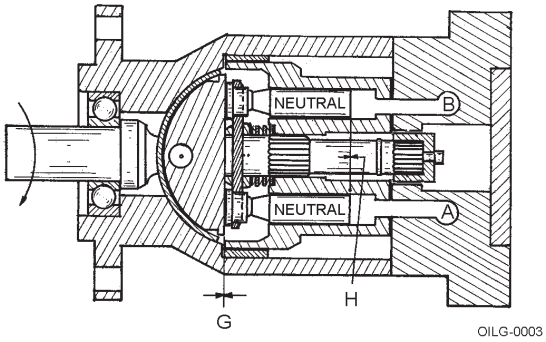


Figure 5. Position N, Pump In Neutral, No Stroke, No Delivery

Refer to **SPECIFICATIONS**

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 used to fill a known size container and calculate the flow rate in terms of cubic inches per minute (cipm). The leakage should conform to **Table 4**.

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 9** and **10**.

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 gasket and 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 hex head cap screws **(403)** and lifting it straight up.
3. Remove valve plate gasket **(411)** and O-ring **(404)**.

Unit - Size		Case Slip at Full Stroke and Indicated Pressure						
		500 psi	1000 psi	2000 psi	3000 psi	3750 psi	4000 psi	5000 psi
048, 065, 075	cipm	130	195	455	760	1070	N/A	N/A
	lpm	2,1	3,2	7,5	12,5	17,5	N/A	N/A
100	cipm	190	250	400	600		900	1200
	lpm	3,1	4,1	6,5	9,8		14,7	19,7
130	cipm	300	400	600	1000	1400	N/A	N/A
	lpm	4,9	6,6	9,8	16,4	22,9	N/A	N/A

Table 4. NOMINAL CASE SLIP versus High Pressure at 1800 rpm (Viscosities of 90-110 SSU)

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.

On thru-shaft pumps, the tailshaft bushing assembly **(307, 308, 309)** or a coupling will have to be removed (a "jacking" screw can be used) before the rotating group can be disassembled.

1. Place the pump in a horizontal position.
2. Remove the rotating group by turning shaft **(301)** slowly, while 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 spring **(105)**.

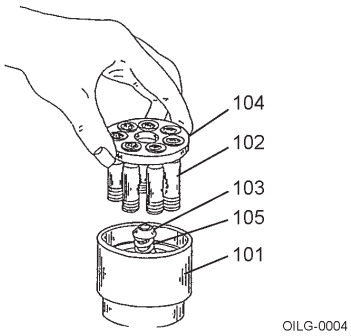


Figure 6. Rotating Group Disassembly (5V-12015-L).

5. Remove retaining ring **(208)** and pull the hydrodynamic bearing **(202)** and roll pins, if necessary, **(205)** from the housing. Note the position of roll pin **(205)** inside of case.

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)** from the housing only if necessary.

SWASHBLOCK GROUP

On 100/130 remove guide plate **(203)** and **(206)** first. Reach inside the case and remove the swashblock **(201)** and saddle bearings **(204)**.

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 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 or scoring. 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 and scoring. 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.*

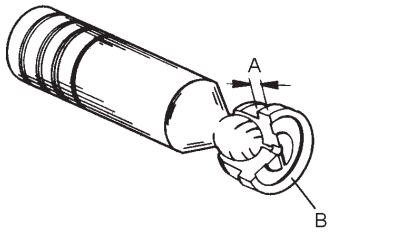


Figure 7. Piston and Shoe Inspection (5V-12015-L)

(A) All shoes must be equal within 0.001 inches (0,025 mm) at this dimension.
(B) All shoe faces must be free of nicks.

NOTE *End play should not to exceed 0.003 inches (0,076 mm) when new or 0.006 inches (0,152 mm) when worn.*

SWASHBLOCK GROUP

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

Check the small hole in the face of the swashblock. The hole provides “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, 9 and 10**. Follow the disassembly procedures in reverse for re-assembling the pump.

During assembly, install new gaskets, 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 front of pump housing.
2. Place housing on a bench with the mounting flange side down.
3. Press the two roll pins **(207)** (if they are replaced or removed) into the pump housing so the pins extend 0.050 to 0.065 inches (1,3 to 1,6 mm) from the case.
4. Grease the back side of each saddle bearing **(204)** and place on the pin to locate the bearings in the pump case. Make sure the pins do not
protrude.
5. PVG 100 and 130, the swashblock is inserted from the valve plate end. PVG 048, 065 and 075, the swashblock is inserted through the control mounting face. 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. PVG 110, 130; assemble **(203)** and **(206)**.
6. Make sure the roll pin **(205)** is inserted into the cylinder bearing **(202)**. Position the cylinder bearing so the pin is located nearest the control facing the outboard end of the drive shaft **(301)**. The bearing should be positioned with "scarf" cuts (PVG 130 only) positioned top and bottom and with the pin **(205)** located on top of internal cast boss. 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. Insert retaining ring **(208)** to hold bearing in place.

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 shoe retainer spring **(105)** in the center 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.** If everything is 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 tail 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 tailshaft 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 be located approximately 0.4 inches (10,2 mm) outside the back of the pump housing.

NOTE *On thru-shaft pumps without another pump or device connected to them, slide assembly onto the shaft **(301)** and secure cap assembly **(307, 309)** in with socket head shoulder screw **(308)**.*

VALVE PLATE GROUP

1. Place the pump housing on a bench with the open end facing up.
2. Install new O-ring **(411)** and gasket **(407)** on the housing.
3. Position the valve plate **(401)** on pins **(005)** and housing. Make sure the tail end of shaft engages the bushing.
4. Hand-tighten the hex head cap screw **(403)** closest to O-ring **(404)** first, then alternately tighten the other cap screws. On thru-shaft units connected to another pump or device, install coupling (half).

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

PVG Assembly Torques		
	Pump	
Item no.	048/065/075	100/130
002	100 ft-lb	100 ft-lb
004	37 ft-lb	37 ft-lb
206	N/A	87 in-lb
308	57 in-lb	57 in-lb
403	100 ft-lb	100 ft-lb
408	45 in-lb	45 in-lb
409	45 in-lb	45 in-lb
410	120 in-lb	120 in-lb
503 cover plate	28 ft-lb	28 ft-lb
503 SAE A or A-A adapt	15 ft-lb	15 ft-lb
503 SAE B adapter	37 ft-lb	37 ft-lb
503 SAE C adapter	N/A	74 ft-lb
507	28 ft-lb	28 ft-lb

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.

Item	Qty.	Description
		HOUSING ASSEMBLY GROUP
001	1	Housing, Pump
003	1	Nameplate, Identification
004	1	Plug
005	4	Pin, Roll - 048, 065, 130
005	2	Pin, Roll - 100, 130
006	2	Pin, Roll - 100, 130
007	1	Seal, Shaft
008	2	Screw
010	1	Seal, O-ring
		ROTARY ASSEMBLY GROUP
101	1	Barrel, Cylinder
102	9	Assembly, Piston/Shoe
103	1	Ball, Fulcrum
104	1	Retainer, Shoe
105	1	Spring, Shoe Retainer
		SWASHBLOCK ASSEMBLY GROUP
201	1	Swashblock
202	1	Bearing, Cylinder
203	1	Guide Plate - 100, 130 only
204	2	Bearing, Saddle
205	1	Pin, Roll (2 for PVG 130)
206	2	Screw - 100, 130 only
207	2	Pin, Roll
208	1	Ring, Retainer

PARTS LIST drawings on pages 19, 20 and 30.

Parts are common between pumps. Only the differences are shown.

O-ring Sizes

ARP 568 Uniform Size number with Durometer

	Pump	
Item Number	048, 065, 075	100, 130
010	916 - 70	916 - 70
404	012 - 90	013 - 90
405	902 - 90	902 - 90
406	903 - 90	903 - 90
407	904 - 90	904 - 90
413	138 - 70	138 - 70

Item	Qty.	Description
		DRIVE SHAFT ASSEMBLY GROUP
301	1	Drive Shaft
302	1	Retainer, Seal Side
303	1	Key, Drive Shaft (keyed shafts only)
304	1	Ring, Retainer, External
305	1	Ring, Retainer, Internal
306	1	Bearing, Front
307	1	Bushing (used on thru-shaft w/ cover plate)
308	1	Screw (used on thru-shaft w/ cover plate)
309	1	Roll Pin (used on thru-shaft w/ cover plate)
		VALVE PLATE ASSEMBLY GROUP
401	1	Valve Plate w/bearing
403	4	Screw, Socket Head Cap (048, 065, 075)
403	4	Screw, Hex Head Cap (100, 130)
404	1	Seal, O-ring
405	1	Seal, O-ring
406	1	Seal, O-ring (not required for all versions)
407	1	Seal, O-ring
408	1	Plug, #2 HP
409	1	Plug, #3 HP (not required for all versions)
410	1	Plug, #4 HP
411	1	Gasket, Valve Plate

PARTS LIST drawings on pages 19, 20 and 30.

Parts are common between pumps. Only the differences are shown.

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

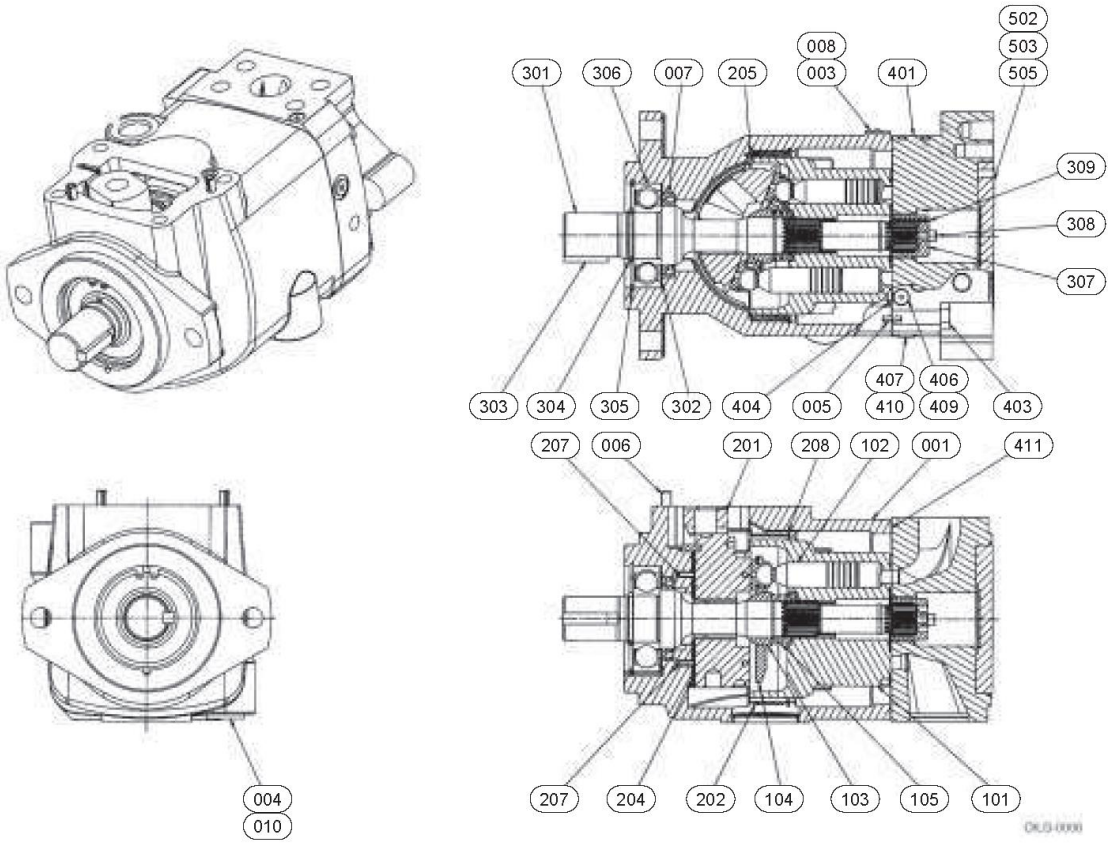


Figure 8. Cross section and plan view parts drawing, PVG 100/130 (516246 sheet 1 of 3).

NOTE *Pins shown out of position. Hydrobearing **(202)** to be assembled with scarf cuts positioned top and bottom with pins **(205)**, which locate on top of internal cast boss (PVG 130 only).*

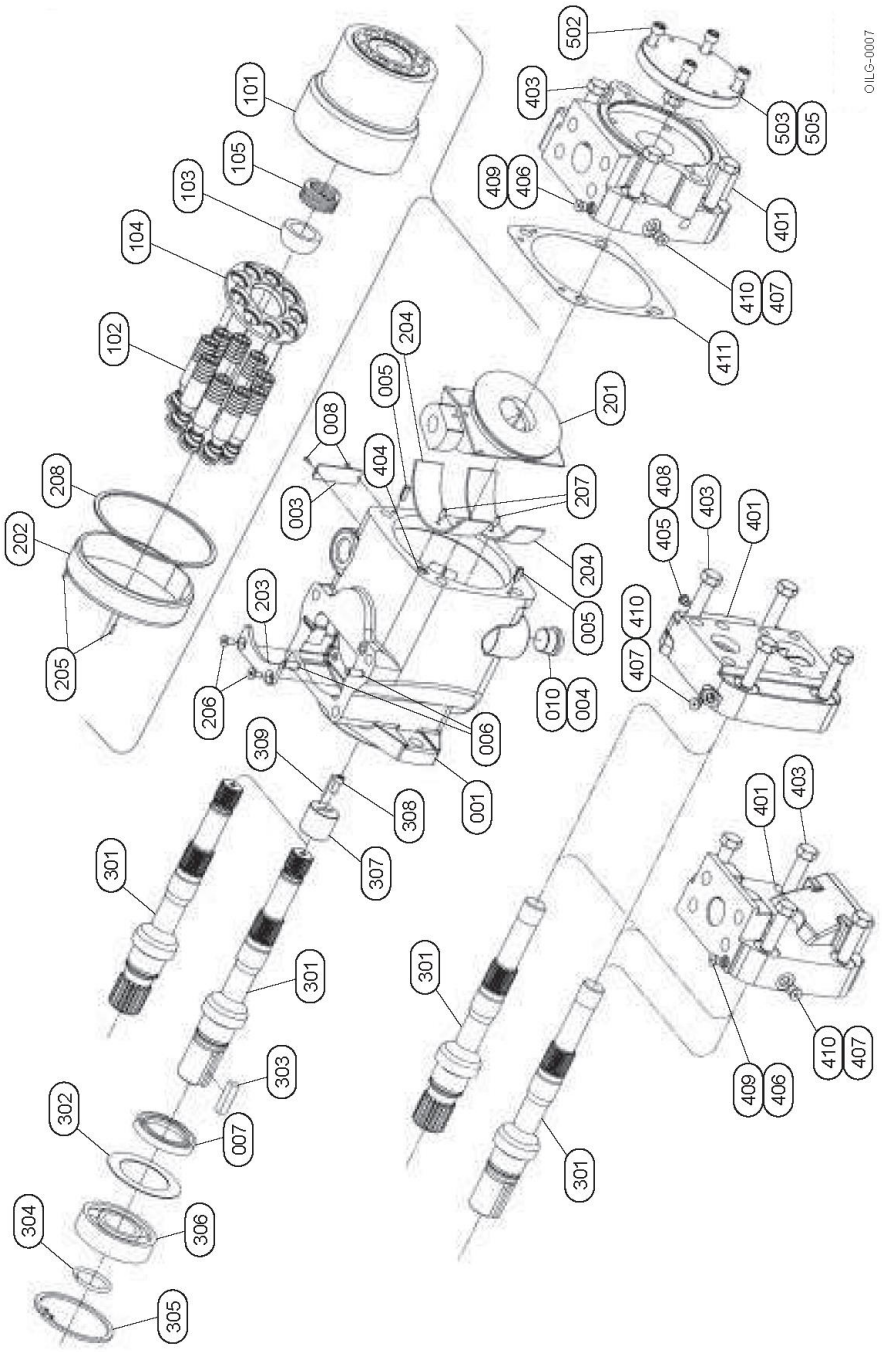


Figure 9. Exploded parts drawing, PVG 100/130 (516246 sheet 2 of 3).

SERVICE KITS

PVG B Pump Service Kits

SERVICE KIT Drawings on pages 30 and 31.

Document Number: 517105-SK
Revision: 0 (10-6-03)
Sheet 1 of 3

Description	Kit No.	Design Series	Items Included (quantity is 1 unless noted)
Housing Kits			
Viton Seals	L517105-604	All(A)	001,002,003,004,005(4),007,008(2),010,011,207(2)
Nitrile Seals	L517105-603	All(A)	
EPR Seals	L517105-602	All(A)	
Shaft & Bearing Kits			
Viton or Nitrile seals			
1" Dia. Keyed (Code Y) Std	L517104-301	All	301B,302,303,304,305,306
13T, 16/32 Spline (Code K) Std	L517104-305	All	301C,302,304,305,306
15T, 16/32 Spline (Code S) Std	L517104-302	All	301A,302,304,305,306
1" Dia. Keyed (Code Y) T-S	L517104-303	All	301D,302,303,304,305,306
13T, 16/32 Spline (Code K) T-S	L517104-306	All	301E,302,304,305,306
15T, 16/32 Spline (Code S) T-S	L517104-304	All	301E,302,304,305,306
EPR Seals			
1" Dia. Keyed (Code Y) Std	L517104-313	All	301B,302,303,304,305,306
13T, 16/32 Spline (Code K) Std	L517104-315	All	301C,302,304,305,306
15T, 16/32 Spline (Code S) Std	L517104-317	All	301A,302,304,305,306
1" Dia. Keyed (Code Y) T-S	L517104-312	All	301D,302,303,304,305,306
13T, 16/32 Spline (Code K) T-S	L517104-314	All	301E,302,304,305,306
15T, 16/32 Spline (Code S) T-S	L517104-316	All	301E,302,304,305,306
Swashblock			
All	516597-050	B2(B)	201
Saddle Bearing			
Standard	L517105-220	All	204(2)
High Temp	L517105-221	All	
Hydrodynamic Bearing Kit			
All	L517105-210	All	202,205,208
Rotating Group			
PVG-048/065	L517104-103	B2(B)	101,102(9),103,104,105
PVG-075	L517105-103	B2(B)	
Piston & Shoe Sub-Assembly			
PVG-048/065	K407905-R65	B2(B)	102(9)
PVG-075	K407905-A75	B2(B)	
Shoe Retainer & Fulcrum Ball			
PVG-048/065	L319221-365	All	103,104
PVG-075	L319221-375	All	

PVG B Pump Service Kits

Reference: 517105 Ass'y Drwg

Document Number: 517105-SK
Revision: 0 (10-6-03)
Sheet 2 of 3

Description	Kit No.	Design Series	Items Included (quantity is 1 unless noted)
Valve Plate Kits			
PVG-048/065 Rear Port LH			401A,403(4),404,405,406,407,408,409,410,411
Viton Seals	L517104-401	All	
Nitrile Seals	L517104-411	All	
EPR Seals	L517104-408	All	
PVG-048/065 Rear Port RH			401B,403(4),404,405,406,407,408,409,410,411
Viton Seals	L517104-402	All	
Nitrile Seals	L517104-412	All	
EPR Seals	L517104-413	All	
PVG-048/065 Side Port LH			401C,403(4),404,405,406,407,408,409,410,411
Viton Seals	L517104-405	All	
Nitrile Seals	L517104-414	All	
EPR Seals	L517104-415	All	
PVG-048/065 Side Port RH			401D,403(4),404,405,406,407,408,409,410,411
Viton Seals	L517104-406	All	
Nitrile Seals	L517104-416	All	
EPR Seals	L517104-417	All	
PVG-048/065 Side Port, Thru-Shaft LH			401E,403(4),404,405(2),407(2),408(2),410(2),411
Viton Seals	L517104-403	All	
Nitrile Seals	L517104-418	All	
EPR Seals	L517104-410	All	
PVG-048/065 Side Port, Thru-Shaft RH			401F,403(4),404,405(2),406,407,408(2),409,410,411
Viton Seals	L517104-404	All	
Nitrile Seals	L517104-419	All	
EPR Seals	L517104-420	All	
PVG-075 Rear Port LH			401A,403(4),404,405,406,407,408,409,410,411
Viton Seals	L517105-401	All	
Nitrile Seals	L517105-417	All	
EPR Seals	L517105-410	All	
PVG-075 Rear Port RH			401B,403(4),404,405,406,407,408,409,410,411
Viton Seals	L517105-402	All	
Nitrile Seals	L517105-418	All	
EPR Seals	L517105-411	All	
PVG-075 Side Port LH			401C,403(4),404,405,406,407,408,409,410,411
Viton Seals	L517105-405	All	
Nitrile Seals	L517105-419	All	
EPR Seals	L517105-414	All	
PVG-075 Side Port RH			401D,403(4),404,405,406,407,408,409,410,411
Viton Seals	L517105-406	All	
Nitrile Seals	L517105-420	All	
EPR Seals	L517105-415	All	
PVG-075 Side Port, Thru-Shaft LH			401E,403(4),404,405(2),407(2),408(2),410(2),411
Viton Seals	L517105-403	All	
Nitrile Seals	L517105-409	All	
EPR Seals	L517105-412	All	
PVG-075 Side Port, Thru-Shaft RH			401F,403(4),404,405(2),406,407,408(2),409,410,411
Viton Seals	L517105-404	All	
Nitrile Seals	L517105-416	All	
EPR Seals	L517105-413	All	

PVG B Pump Service Kits

Reference: 517105 Ass'y Drwg

Document Number: 517105-SK
Revision: 0 (10-6-03)
Sheet 3 of 3

Description	Kit No.	Design Series	Items Included (quantity is 1 unless noted)
Basic Seal Kit			
Viton Seals	K517105-B11	All	007,010,011,404,405(2),406,407(2),411 Control 313,330,341(2)
Nitrile Seals	K517105-B12	All	
EPR Seals	K517105-B13	All	
Seal Kits for Options			
Standard Cover Plate			505
Viton Seals	238270-138	All	
Nitrile Seals	233370-138	All	
EPR Seals	242080-138	All	
SAE B Adaptor			505,506
Viton Seals	L250667-017	All	
Nitrile Seals	L250667-016	All	
EPR Seals	L250667-018	All	
SAE A Adaptor			505,506
Viton Seals	L250667-014	All	
Nitrile Seals	L250667-013	All	
EPR Seals	L250667-015	All	
SAE A-A Adaptor			505,508
Viton Seals	L250667-019	All	
Nitrile Seals	L250667-020	All	
EPR Seals	L250667-021	All	
Shaft Seal			
Viton Seals	51155-5	All	007
Nitrile Seals	51155-7	All	
EPR Seals	L51155-3RP	All	
Cover Plate Kit			
Viton Seals	L319076-101	All	307,308,309,502,503(4),505
Nitrile Seals	L319076-105	All	
EPR Seals	L319076-115	All	
Rear Shaft Cover Kit			
All	L319263	All	307,308,309
SAE B Adaptor/Coupling Kit			
Viton Seals	L319076-100	All	501,502,503(2),504(2),505,506
Nitrile Seals	L319076-107	All	
EPR Seals	L319076-108	All	
SAE A Adaptor/Coupling Kit 9 tooth			
Viton Seals	L319076-103	All	501,502,503(2),504(2),505,506,507(4)
Nitrile Seals	L319076-109	All	
EPR Seals	L319076-110	All	
SAE A Adaptor/Coupling Kit 11 tooth			
Viton Seals	L319076-106	All	501,502,503(2),504(2),505,506,507(4)
Nitrile Seals	L319076-111	All	
EPR Seals	L319076-112	All	
SAE A-A Adaptor/Coupling Kit			
Viton Seals	L319076-104	All	501,502,503(2),504(2),505,507(4),508
Nitrile Seals	L319076-113	All	
EPR Seals	L319076-114	All	
Name Tag & Screws			
All	L50921	All	003,008(2)

Std = Rear ported or Side ported w/o thru-shaft, T-S = Side ported w/ thru-shaft

(A) Pump cases are interchangeable
A1 series has #12 SAE threaded case drain connection
B1 and B2 have #16 SAE threaded case drain connection

(B) Swashblock and Rotating group/piston and shoe assembly must have matching design series
B2 parts must all be same design series
A1, B1 parts can be intermixed between series

PVG C Pump Service Kits

Document Number: 516246-SK
Revision: 0 (10-6-03)
Sheet 1 of 6

Description	Kit No.	Design Series	Items Included (quantity is 1 unless noted)
Housing Kits			
USA			001,002,003,004,005(2),006(2),007,008(2),010,011,207(2)
Viton Seals	L516275-601	All(A)	
Nitrile Seals	L516275-603	All(A)	
EPR Seals	L516275-602	All(A)	
Metric			
Viton Seals	L516679-601	All(A)	
Nitrile Seals	L516679-602	All(A)	
EPR Seals	L516679-605	All(A)	
Shaft & Bearing Kits			
Viton or Nitrile seals			
1.50" Dia. Keyed (Code Z) Short	L516175-301	All(B)	301D,302,303,304,305,306
1.50" Dia. Keyed (Code Y) Std	L516175-307	All(B)	301D,302,303,304,305,306
14T, 12/24 Spline (Code K) Std	L516175-305	All	301E,302,304,305,306
17T, 12/24 Spline (Code S) Std	L516175-302	All	301E,302,304,305,306
1.50" Dia. Keyed (Code Z) T-S Short	L516175-303	All(B)	301A,302,303,304,305,306
1.50" Dia. Keyed (Code Y) T-S	L516175-308	All(B)	301A,302,303,304,305,306
14T, 12/24 Spline (Code K) T-S	L516175-306	All	301B,302,304,305,306
17T, 12/24 Spline (Code S) T-S	L516175-304	All	301B,302,304,305,306
EPR Seals			
1.50" Dia. Keyed (Code Z) Short	L516175-328	All(B)	301D,302,303,304,305,306
1.50" Dia. Keyed (Code Y) Std	L516175-322	All(B)	301D,302,303,304,305,306
14T, 12/24 Spline (Code K) Std	L516175-324	All	301E,302,304,305,306
17T, 12/24 Spline (Code S) Std	L516175-326	All	301E,302,304,305,306
1.50" Dia. Keyed (Code Z) T-S Short	L516175-327	All(B)	301A,302,303,304,305,306
1.50" Dia. Keyed (Code Y) T-S	L516175-321	All(B)	301A,302,303,304,305,306
14T, 12/24 Spline (Code K) T-S	L516175-323	All	301B,302,304,305,306
17T, 12/24 Spline (Code S) T-S	L516175-325	All	301B,302,304,305,306
Swashblock			
All	515794	All	201
Guide Plate Assembly			
USA	L516175-225	All	203,206(2)
Metric	L516679-225	All	
Saddle Bearing			
Standard	L516175-220	All	204(2)
High Temp	L516175-221	All	
Hydrodynamic Bearing Kit			
PVG-100	L516175-210	All	202,205,208
PVG-130	L516275-210	All	
Rotating Group			
PVG-100	L516175-101	All	101,102(9),103,104,105
PVG-130	L516275-102	C2(C)	

Description	Kit No.	Design Series	Items Included (quantity is 1 unless noted)
Piston & Shoe Sub-Assembly			
PVG-100	K407812-800	All	102(9)
PVG-130	K407837-800	All	
Shoe Retainer & Fulcrum Ball			
PVG-100	L318925-001	All	103,104
PVG-130	L318926	All	
Valve Plate Kits			
USA			
PVG-100 Rear Port LH			401D,403(4),404,405,407,408,410,411
Viton Seals	L516175-401	All	
Nitrile Seals	L516175-413	All	
EPR Seals	L516175-407	All	
PVG-100 Rear Port RH			401D,403(4),404,405,406,407,408,409,410,411
Viton Seals	L516175-402	All	
Nitrile Seals	L516175-414	All	
EPR Seals	L516175-408	All	
PVG-100 Side Port LH			401E,403(4),404,405,406,407,408,409,410,411
Viton Seals	L516175-405	All	
Nitrile Seals	L516175-417	All	
EPR Seals	L516175-411	All	
PVG-100 Side Port RH			401E,403(4),404,405,406,407,408,409,410,411
Viton Seals	L516175-406	All	
Nitrile Seals	L516175-418	All	
EPR Seals	L516175-412	All	
PVG-100 Side Port, Thru-Shaft LH			401A,403(4),404,405(2),406,407,408(2),409,410,411
Viton Seals	L516175-403	All	
Nitrile Seals	L516175-415	All	
EPR Seals	L516175-409	All	
PVG-100 Side Port, Thru-Shaft RH			401A,403(4),404,405(2),406,407,408(2),409,410,411
Viton Seals	L516175-404	All	
Nitrile Seals	L516175-416	All	
EPR Seals	L516175-410	All	
PVG-130 Rear Port LH			401D,403(4),404,405,407,408,410,411
Viton Seals	L516275-401	C2(C)	
Nitrile Seals	L516275-425	C2(C)	
EPR Seals	L516275-407	C2(C)	
PVG-130 Rear Port RH			401D+D161,403(4),404,405,406,407,408,409,410,411
Viton Seals	L516275-402	C2(C)	
Nitrile Seals	L516275-428	C2(C)	
EPR Seals	L516275-408	C2(C)	
PVG-130 Side Port LH			401E,403(4),404,405,406,407,408,409,410,411
Viton Seals	L516275-405	C2(C)	
Nitrile Seals	L516275-417	C2(C)	

Description	Kit No.	Design Series	Items Included (quantity is 1 unless noted)
PVG-130 Side Port RH			401E,403(4),404,405,406,407,408,409,410,411
Viton Seals	L516275-424	C2(C)	
Nitrile Seals	L516275-418	C2(C)	
EPR Seals	L516275-412	C2(C)	
PVG-130 Side Port, Thru-Shaft LH			401A,403(4),404,405(2),406,407,408(2),409,410,411
Viton Seals	L516275-403	C2(C)	
Nitrile Seals	L516275-415	C2(C)	
EPR Seals	L516275-409	C2(C)	
PVG-130 Side Port, Thru-Shaft RH			401A,403(4),404,405(2),406,407,408(2),409,410,411
Viton Seals	L516275-404	C2(C)	
Nitrile Seals	L516275-416	C2(C)	
EPR Seals	L516275-410	C2(C)	
Metric			
PVG-100 Rear Port LH			401D,403(4),404,405,407,408,410,411
Viton Seals	L516678-401	All	
Nitrile Seals	L516678-407	All	
EPR Seals	L516678-408	All	
PVG-100 Rear Port RH			401D,403(4),404,405,406,407,408,409,410,411
Viton Seals	L516678-402	All	
Nitrile Seals	L516678-409	All	
EPR Seals	L516678-410	All	
PVG-100 Side Port LH			401E,403(4),404,405,406,407,408,409,410,411
Viton Seals	L516678-405	All	
Nitrile Seals	L516678-411	All	
EPR Seals	L516678-412	All	
PVG-100 Side Port RH			401E,403(4),404,405,406,407,408,409,410,411
Viton Seals	L516678-406	All	
Nitrile Seals	L516678-413	All	
EPR Seals	L516678-414	All	
PVG-100 Side Port, Thru-Shaft LH			401A,403(4),404,405(2),406,407,408(2),409,410,411
Viton Seals	L516678-403	All	
Nitrile Seals	L516678-415	All	
EPR Seals	L516678-416	All	
PVG-100 Side Port, Thru-Shaft RH			401A,403(4),404,405(2),406,407,408(2),409,410,411
Viton Seals	L516678-404	All	
Nitrile Seals	L516678-417	All	
EPR Seals	L516678-418	All	
PVG-130 Rear Port LH			401D,403(4),404,405,407,408,410,411
Viton Seals	L516679-425	C2(C)	
Nitrile Seals	L516679-427	C2(C)	
EPR Seals	L516679-429	C2(C)	
PVG-130 Rear Port RH			401D+D161,403(4),404,405,406,407,408,409,410,411
Viton Seals	L516679-420	C2(C)	
Nitrile Seals	L516679-414	C2(C)	
EPR Seals	L516679-430	C2(C)	
PVG-130 Side Port LH			401E,403(4),404,405,406,407,408,409,410,411
Viton Seals	L516679-407	C2(C)	
Nitrile Seals	L516679-419	C2(C)	
EPR Seals	L516679-431	C2(C)	

Description	Kit No.	Design Series	Items Included (quantity is 1 unless noted)
PVG-130 Side Port RH			401E,403(4),404,405,406,407,408,409,410,411
Viton Seals	L516679-428	C2(C)	
Nitrile Seals	L516679-432	C2(C)	
EPR Seals	L516679-433	C2(C)	
PVG-130 Side Port, Thru-Shaft LH			401A,403(4),404,405(2),406,407,408(2),409,410,411
Viton Seals	L516679-421	C2(C)	
Nitrile Seals	L516679-434	C2(C)	
EPR Seals	L516679-435	C2(C)	
PVG-130 Side Port, Thru-Shaft RH			401A,403(4),404,405(2),406,407,408(2),409,410,411
Viton Seals	L516679-404	C2(C)	
Nitrile Seals	L516679-436	C2(C)	
EPR Seals	L516679-437	C2(C)	
Basic Seal Kit			
USA			007,010,011,404,405(2),406,407(2),411 Control 330,313
Viton Seals	K516175-C11	All	
Nitrile Seals	K516175-C12	All	
EPR Seals	K516175-C13	All	
Metric			
Viton Seals	K516678-C11	All	
Nitrile Seals	K516678-C12	All	
EPR Seals	K516678-C13	All	
Seal Kits for Options			
Standard Cover Plate			505
Viton Seals	238270-138	All	
Nitrile Seals	233370-138	All	
EPR Seals	242080-138	All	
SAE C Adaptor			505
Viton Seals	238270-049	All	
Nitrile Seals	233370-049	All	
EPR Seals	242080-049	All	
SAE B Adaptor			505,506
Viton Seals	L250667-017	All	
Nitrile Seals	L250667-016	All	
EPR Seals	L250667-018	All	
SAE A Adaptor			505,506
Viton Seals	L250667-014	All	
Nitrile Seals	L250667-013	All	
EPR Seals	L250667-015	All	
SAE A-A Adaptor			505,508
Viton Seals	L250667-019	All	
Nitrile Seals	L250667-020	All	
EPR Seals	L250667-021	All	
Shaft Seal			
Viton Seals	51156-5	All	007
Nitrile Seals	51156-7	All	
EPR Seals	L51156-3RP	All	

Description	Kit No.	Design Series	Items Included (quantity is 1 unless noted)
Cover Plate Kit			
USA			307,308,309,502,503(4),505
Viton Seals	L319076-001	All	
Nitrile Seals	L319076-013	All	
EPR Seals	L319076-301	All	
Metric			
Viton Seals	L319076-M01	All	
Nitrile Seals	L319076-M07	All	
EPR Seals	L319076-M08	All	
Rear Shaft Cover Kit			
All	L319066-006	All	307,308,309
SAE C Adaptor/Coupling Kit			
USA			501,503(2),504(2),505
Viton Seals	L319076	All	
Nitrile Seals	L319076-008	All	
EPR Seals	L319076-300	All	
Metric			
Viton Seals	L319076-M00	All	
Nitrile Seals	L319076-M09	All	
EPR Seals	L319076-M10	All	
SAE B-B Adaptor/Coupling Kit			
USA			501,502,503(2),504(2),505,506
Viton Seals	L319076-005	All	
Nitrile Seals	L319076-012	All	
EPR Seals	L319076-014	All	
Metric			
Viton Seals	L319076-M05	All	
Nitrile Seals	L319076-M11	All	
EPR Seals	L319076-M12	All	
SAE B Adaptor/Coupling Kit			
USA			501,502,503(2),504(2),505,506
Viton Seals	L319076-002	All	
Nitrile Seals	L319076-007	All	
EPR Seals	L319076-302	All	
Metric			
Viton Seals	L319076-M02	All	
Nitrile Seals	L319076-M13	All	
EPR Seals	L319076-M14	All	
SAE A Adaptor/Coupling Kit 9 tooth			
USA			501,502,503(2),504(2),505,506,507(4)
Viton Seals	L319076-003	All	
Nitrile Seals	L319076-011	All	
EPR Seals	L319076-303	All	
Metric			
Viton Seals	L319076-M03	All	
Nitrile Seals	L319076-M15	All	
EPR Seals	L319076-M16	All	

Description	Kit No.	Design Series	Items Included (quantity is 1 unless noted)
SAE A Adaptor/Coupling Kit 11 tooth			
USA			501,502,503(2),504(2),505,506,507(4)
Viton Seals	L319076-006	All	
Nitrile Seals	L319076-015	All	
EPR Seals	L319076-016	All	
Metric			
Viton Seals	L319076-M06	All	
Nitrile Seals	L319076-M17	All	
EPR Seals	L319076-M18	All	
SAE A-A Adaptor/Coupling Kit			
USA			501,502,503(2),504(2),505,507(4),508
Viton Seals	L319076-004	All	
Nitrile Seals	L319076-017	All	
EPR Seals	L319076-018	All	
Metric			
Viton Seals	L319076-M04	All	
Nitrile Seals	L319076-M19	All	
EPR Seals	L319076-M20	All	
Name Tag & Screws			
All	L50921	All	003,008(2)

Std = Rear ported or Side ported w/o thru-shaft, T-S = Side ported w/ thru-shaft
(A) Pump cases are interchangeable
A1 series has #12 SAE threaded case drain connection
B1, C1, C2, D3, D4, E1 have #16 SAE threaded case drain connection
(B) Code "Y" shaft is length of Code "Z" shaft for Design Series "A1"
Parts are interchangeable between Design Series
(C) PVG130 Valve plate and Rotating group must be matched
A1, B1, C1 parts can be intermixed between series
C2, D3, D4, E1parts can be intermixed between series

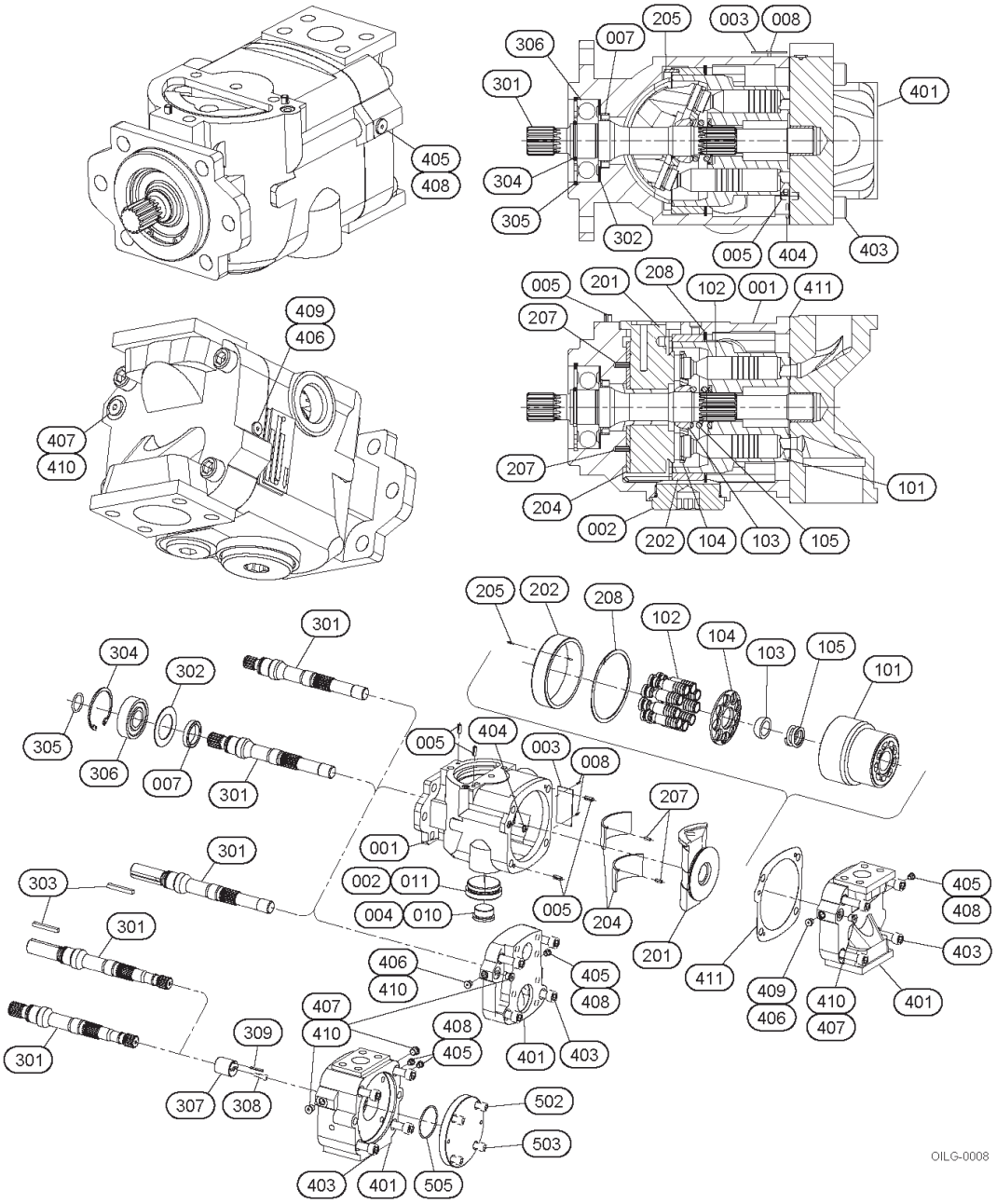
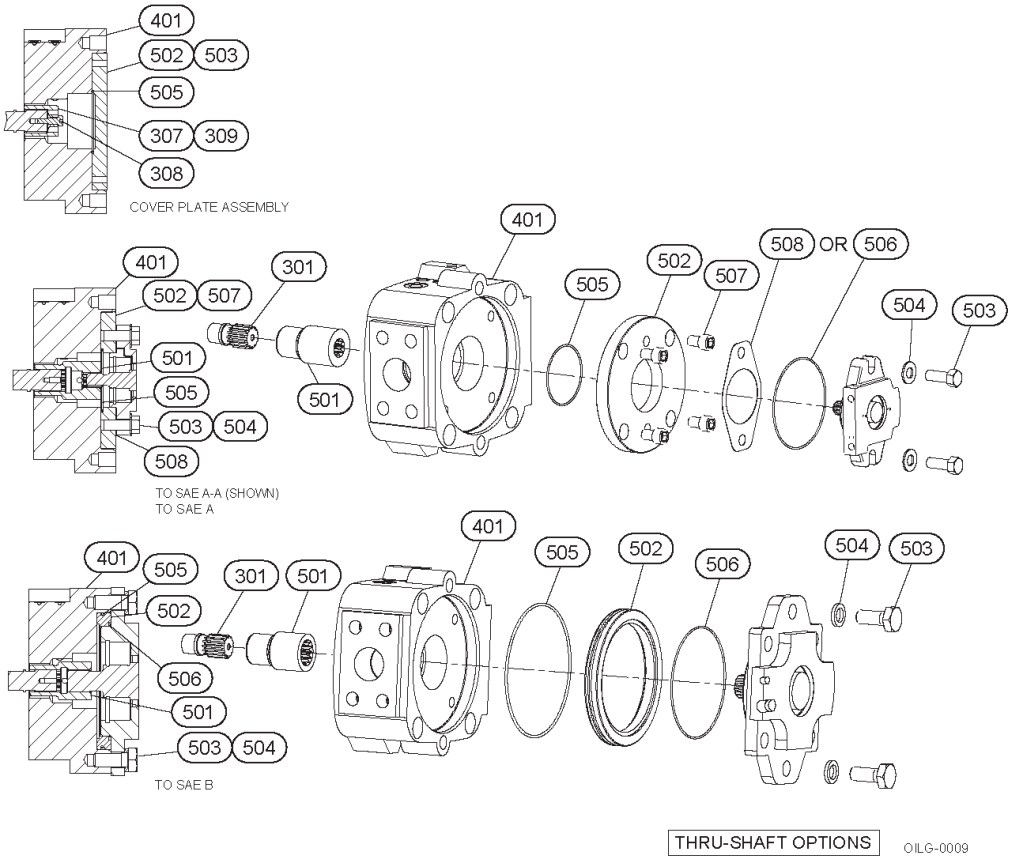
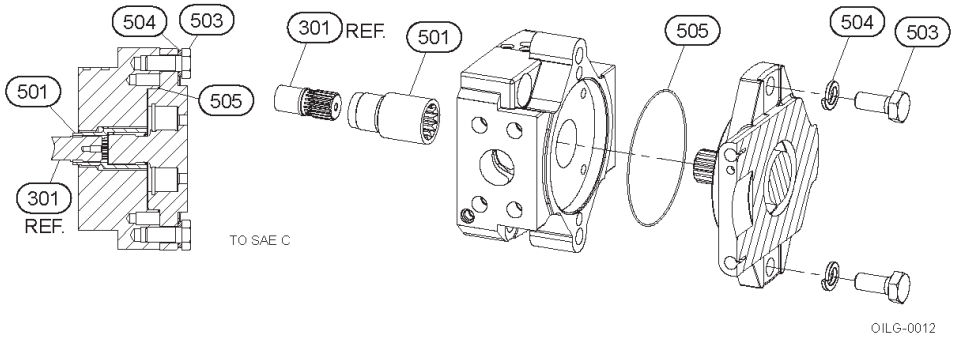


Figure 10. Cross Section and Exploded Parts Drawing for PVG 048, 065 and 075 (517105 sheet 1 and 2)

NOTE *Cylinder bearing* ***(202)*** *to be held in position with roll pin* ***(205)*** *which must be located in the cast side slot of housing* ***(001)****.*



Available for PVG 048, 065, 075, 100 and 130
(Drawing 517105 sheet 6 and 7)



Available for PVG 100 and 130
(Drawing 516246 sheet 6, 7 and 8)

Figure 11. Cross Section and Exploded Parts Drawing

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-Steam 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
phone: 414/327-1700 fax: 414/327-0532
www.oilgear.com

Revised Dec., 2003

Bulletin 947019B

TRONAIR®

APPENDIX VII

Material Safety Data Sheet (MSDS) Hydraulic Fluid

Solutia Inc.

Material Safety Data Sheet

1. PRODUCT AND COMPANY IDENTIFICATION

Product name: SKYDROL® LD4 Fire resistant hydraulic fluid

Reference Number: 000000000183 Date: 03/18/2003

Company Information:

United States:
Solutia Inc.
575 Maryville Center Drive, P.O. Box 66760
St. Louis, MO 63166-6760
Emergency telephone: Chemtrec: 1-800-424-9300
Non-Emergency telephone: 1-314-674-6661

Canada:
Solutia Canada Inc.
6800 St. Patrick Street
LaSalle, PQ H8N 2H3
Emergency telephone: CANUTEC: 1-613-996-6666
Non-Emergency telephone: 1-314-674-6661

Mexico:
Solutia MEXICO, S. DE R.L. DE C.V.
Blvd. Manuel Avila Camacho No. 40 Piso 12 Colonia Lomas de Chapultepec
Edificio Torre Esmeralda11000 Mexico, D.F.
Emergency telephone: SETIQ: (in Mexico) 01-800-002-1400
Non-Emergency telephone: (in Mexico) 555-202-5600

Brazil:
Solutia Brazil Ltd.
Avenue Jorge Bei Maluf, 2105
CEP 08686-000 Suzano, SP
Emergency telephone: 0800 193-190
Non-Emergency telephone: 5511 4745-8569

2. COMPOSITION/INFORMATION ON INGREDIENTS

Components	CAS No.	Average concentration	Concentration range	Units
tributyl phosphate	126-73-8	58.2		%
dibutyl phenyl phosphate	2528-36-1		30.0 - 60.0	%
butyl diphenyl phosphate	2752-95-6		5.0 - 10.0	%
2,6-di-tert-butyl-p-cresol	128-37-0		1.0 - 5.0	%
2-ethylhexyl 7-oxabicyclo[4.1.0] heptane-3-carboxylate	62256-00-2		<=10.0	%

3. HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW

Form: oily, liquid
Colour: clear to purple
Odour: odourless

WARNING STATEMENTS

WARNING!
Causes eye irritation
Causes skin irritation
Causes respiratory tract irritation
Contains material which may cause urinary bladder damage based on animal data

POTENTIAL HEALTH EFFECTS

Likely routes of exposure:	eye and skin contact inhalation
Eye contact:	Highly irritating to eyes.
Skin contact:	Highly irritating to skin. No more than slightly toxic if absorbed. Repeated contact may cause a drying, solvent like action on the skin.
Inhalation:	Severely irritating if inhaled. No more than slightly toxic if inhaled. Significant adverse health effects are not expected to develop under normal conditions of exposure.
Ingestion:	No more than slightly toxic if swallowed. Significant adverse health effects are not expected to develop if only small amounts (less than a mouthful) are swallowed.
Signs and symptoms of overexposure:	coughing sneezing headache nausea/vomiting
Target organs/systems:	Contains material which may cause urinary bladder damage based on animal data

Refer to Section 11 for toxicological information.

4. FIRST AID MEASURES

If in eyes:	
If on skin:	Immediately flush the area with plenty of water. Remove contaminated clothing. Wash skin gently with soap as soon as it is available. Get medical attention. Wash clothing before reuse.
If inhaled:	Remove patient to fresh air. If not breathing, give artificial respiration. If breathing is difficult give oxygen. Remove material from eyes, skin and clothing.
If swallowed:	Immediate first aid is not likely to be required. A physician or Poison Control Center can be contacted for advice. Wash heavily contaminated clothing before reuse.

Notes to physicians: After flushing eyes for at least 15 minutes, opthalmic preparations of sterile mineral or castor oil may be instilled one time in the exposed eye for relief of pain.

5. FIRE FIGHTING MEASURES

Flash point:	160 C	Cleveland Open Cup
Fire point:	176 C	ASTM D-2155
Autoignition temperature:	398 C	ASTM D-2155

Hazardous products of combustion: None known;

Extinguishing media: Water spray, foam, dry chemical, or carbon dioxide

Unusual fire and explosion hazards: None known

Fire fighting equipment: Firefighters, and others exposed, wear self-contained breathing apparatus. Equipment should be thoroughly decontaminated after use.

6. ACCIDENTAL RELEASE MEASURES

Personal precautions: Use personal protection recommended in section 8.

Environmental precautions: Keep out of drains and water courses.

Methods for cleaning up: Contain large spills with dikes and transfer the material to appropriate containers for reclamation or disposal. Absorb remaining material or small spills with an inert material and then place in a chemical waste container. Flush spill area with water.

Refer to Section 13 for disposal information and Sections 14 and 15 for reportable quantity information.

7. HANDLING AND STORAGE

Handling
Avoid breathing vapour or mist.
Avoid contact with eyes, skin and clothing.
Use with adequate ventilation.
Keep container closed.
Wash thoroughly after handling.

Emptied containers retain vapour and product residue. Observe all recommended safety precautions until container is cleaned, reconditioned or destroyed. Do not reuse this container.

Storage
General: Stable under normal conditions of handling and storage.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Eye protection: Wear chemical goggles.
Have eye flushing equipment available.

Hand protection:	Wear chemical resistant gloves. Consult the glove/clothing manufacturer to determine the appropriate type glove/clothing for a given application. See Solutia Glove Facts for permeation data.
Body protection:	Wear suitable protective clothing. Wear full protective clothing if exposed to splashes. Consult the glove/clothing manufacturer to determine the appropriate type glove/clothing for a given application. Wash contaminated skin promptly. Launder contaminated clothing and clean protective equipment before reuse. Have safety shower available at locations where skin contact can occur. Wash thoroughly after handling.
Respiratory protection:	Avoid breathing vapour or mist. Use approved respiratory protection equipment (full facepiece recommended) when airborne exposure limits are exceeded. If used, full facepiece replaces the need for face shield and/or chemical goggles. Consult the respirator manufacturer to determine the appropriate type of equipment for a given application. See Solutia Respirator Facts. Observe respirator use limitations specified by the manufacturer.
Ventilation:	Provide natural or mechanical ventilation to control exposure levels below airborne exposure limits. If practical, use local mechanical exhaust ventilation at sources of air contamination such as processing equipment.
Airborne exposure limits:	(ml/m3 = ppm)
SKYDROL® LD4	No specific occupational exposure limit has been established.
tributyl phosphate	ACGIH TLV: 0.2 ml/m3 ; 2.2 mg/m3 ; ; 8-hr TWA OSHA PEL: 5 mg/m3 ; ; 8-hr TWA Mexican OEL: 0.2 ml/m3 ; 2.5 mg/m3 ; ; 8-hr TWA Mexican OEL: 0.4 ml/m3 ; 5 mg/m3 ; ; 15-min STEL
dibutyl phenyl phosphate	ACGIH TLV: 0.3 ml/m3 ; 3.5 mg/m3 ; skin * ; 8-hr TWA * skin absorption of this material may add to the overall exposure.
2,6-di-tert-butyl-p-cresol	ACGIH TLV: 2 mg/m3 ; ; 8-hr TWA Mexican OEL: 10 mg/m3 ; ; 8-hr TWA Mexican OEL: 20 mg/m3 ; ; 15-min STEL

Components referred to herein may be regulated by specific Canadian provincial legislation. Please refer to exposure limits legislated for the province in which the substance will be used.

9. PHYSICAL AND CHEMICAL PROPERTIES

Specific gravity:	1.004 - 1.014 @ 25 C
Viscosity :	10.8 - 11.6 mPa.s @ 38 C

NOTE: These physical data are typical values based on material tested but may vary from sample to sample. Typical values should not be construed as a guaranteed analysis of any specific lot or as specifications for the product.

10. STABILITY AND REACTIVITY

Conditions to avoid:	Elevated temperatures
Materials to avoid -	Contact with strong oxidizing agents.
Hazardous reactions:	Hazardous polymerization does not occur.
Hazardous decomposition products:	phosphorus oxides (PxOy); carbon monoxide (CO); carbon dioxide

11. TOXICOLOGICAL INFORMATION

This product has been tested for toxicity. Results from Solutia sponsored studies or from the available public literature are described below.

Acute animal toxicity data

Oral:	LD50 , rat, 2,100 mg/kg , Slightly toxic following oral administration.
Dermal:	LD50 , rabbit, > 3,160 mg/kg , Practically nontoxic after skin application in animal studies.
Inhalation:	LC50 , rat, > 5.8 mg/l , , No mortality or signs of toxicity at the highest level achievable.
Eye irritation:	rabbit , Slightly irritating to eyes (rabbit)., 24 h
Skin irritation:	rabbit , Moderately irritating to skin., 24 h
Skin sensitization:	Human experience , Predictive patch testing on human volunteers did not produce dermal sensitization.
Repeat dose toxicity:	rat, inhalation, 28 days, Repeated exposure produced eye irritation in animal models. Repeated exposure produced respiratory tract irritation in animal models. Produced effects on body weight, serum enzymes and/or organ weights in repeat dose studies.
Neurotoxicity:	chicken, gavage, acute. Brain cholinesterase inhibition.
Mutagenicity:	No genetic effects were observed in standard tests using bacterial and animal cells.

Components

Data from Solutia studies and/or the available scientific literature on the components of this material which have been identified as hazardous chemicals under the criteria of the OSHA Hazard Communication Standard (29 CFR 1910.1200) or the Canadian Hazardous Products Act are discussed below.

tributyl phosphate	Slightly toxic following oral administration. Practically nontoxic after skin application in animal studies.

	Slightly irritating to eyes (rabbit). Highly irritating to skin (rabbit). Produced no dermal sensitization (guinea pigs). Repeated oral administration produced multiple systemic effects. No delayed neurotoxicity was observed in animal models. This material produced tumours in laboratory animals at dose levels that exceed the maximum tolerated dose. The weight of the evidence indicates that this material is not mutagenic in in-vitro assays.
dibutyl phenyl phosphate	Slightly toxic following oral administration. Practically nontoxic after skin application in animal studies. Practically non irritating to eyes (rabbit). Practically non irritating to skin (rabbit). Produced no dermal sensitization (guinea pigs). Repeated skin exposure produced irritation in animal studies. Produced effects on body weight, serum enzymes and/or organ weights in repeat dose studies. Repeated oral administration produced multiple organ effects. No delayed neurotoxicity was observed in animal models. No birth defects were noted in rats given the active ingredient orally during pregnancy. This material had no effect on reproduction or fertility. Produced developmental toxicity. The weight of the evidence indicates that this material is not mutagenic in in-vitro assays.
2,6-di-tert-butyl-p-cresol	Slightly irritating to skin, eyes and respiratory system in animal models. Produced effects on body weight, serum enzymes and/or organ weights in repeat dose studies. Both positive and negative responses observed in standard tests for genetic changes.
2-ethylhexyl 7-oxabicyclo[4.1.0] heptane-3-carboxylate	Slightly toxic following oral administration. Practically nontoxic after skin application in animal studies. Practically non irritating to eyes (rabbit). Slightly irritating to skin (rabbit). No mortality or signs of toxicity at the highest level tested. Produced dermal sensitization (guinea pigs). The weight of the evidence indicates that this material is not mutagenic in in-vitro assays. The weight of the evidence indicates that this material is mutagenic in in-vivo assays.

12. ECOLOGICAL INFORMATION

Environmental Toxicity:

Invertebrates	48 h, EC50	Water flea (Daphnia magna)	5.8 mg/l
Fish:	96 h, EC50	Rainbow trout (Oncorhynchus mykiss)	5.2 mg/l
	96 h, EC50	Fathead minnow (Pimephales promelas)	4.8 mg/l
Algae:	96 h, EC50	Algae (Selenastrum capricornutum)	10 mg/l

Environmental fate

Biodegradation

Readily biodegradable.

13. DISPOSAL CONSIDERATIONS

US EPA RCRA Status:	This material when discarded is not a hazardous waste as that term is defined by the Resource, Conservation and Recovery Act (RCRA), 40 CFR 261.
Disposal considerations:	Incineration Recycle
Miscellaneous advice:	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. Local, state, provincial, and national disposal regulations may be more or less stringent. This product should not be dumped, spilled, rinsed or washed into sewers or public waterways.

14. TRANSPORT INFORMATION

The data provided in this section is for information only. Please apply the appropriate regulations to properly classify your shipment for transportation.

US DOT	
Other:	Not regulated for transport.
Canadian TDG	
Other:	Not regulated for transport.

15. REGULATORY INFORMATION

All components are in compliance with the following inventories:	U.S. TSCA, EU EINECS, Canadian DSL, Australian AICS, Korean, Japanese ENCS, Chinese
Canadian WHMIS classification:	D2(B) - Materials Causing Other Toxic Effects
SARA Hazard Notification:	
Hazard Categories Under Title III Rules (40 CFR 370):	Immediate Delayed
Section 302 Extremely Hazardous Substances:	
Section 313 Toxic Chemical(s):	

CERCLA Reportable Quantity:

Not applicable

This product has been classified in accordance with the hazard criteria of the Canadian Controlled Products Regulation and the MSDS contains all the information required by the Canadian Controlled Products Regulation.

Refer to Section 11 for OSHA/HPA Hazardous Chemical(s) and Section 13 for RCRA classification.

Safety data sheet also created in accordance with Brazilian law NBR 14725

16. OTHER INFORMATION

Product use: Hydraulic fluids and additives

Reason for revision: Significant changes to the following section(s):, Section 2, Section 8, Section 15

	Health	Fire	Reactivity	Additional Information
Suggested NFPA Rating	2	1	0	
Suggested HMIS Rating:	2	1	0	G

Prepared by the Solutia Hazard Communication Group. Please consult Solutia @ 314-674-6661 if further information is needed.

TRONAIR®

APPENDIX VIII

ANSI/B93.19M-1972
(R1993-Excerpt)

AMERICAN NATIONAL STANDARD

ANSI/B93.19M-1972 (R1993)
First edition
6 December 1972

AMERICAN NATIONAL STANDARDS INSTITUTE • A NATIONAL STANDARD FOR FLUID POWER

Hydraulic fluid power — Particulate contamination analysis — Extraction of fluid samples from lines of an operating system

(Technically identical to ISO 4021:1977)
(NFPA/T2.9.1-1972)
(Metric only)

SPONSOR

National
FLUID POWER
Association

Descriptors: hydraulic fluid power, liquids, chemical analysis, sampling, contamination.

Hydraulic fluid power — Particulate contamination analysis — Extraction of fluid samples from lines of an operating system

0 Introduction

In hydraulic fluid power systems, power is transmitted and controlled through a fluid under pressure within an enclosed circuit. The fluid is both a lubricant and a power-transmitting medium

Reliable system performance requires control of the fluid medium. Qualitative and quantitative determination of particulate contamination in the fluid medium requires precision in obtaining the sample and determining the nature and extent of contamination.

The most representative sample is obtained from a system while the fluid is following in a turbulent manner. This standard gives the procedure for obtaining that sample, known as a dynamic sample.

1 Scope

This standard specifies a method of extracting dynamic fluid samples from a line of an operating hydraulic fluid power system.

The hydraulic fluid samples must be representative of the particulate contaminant in the fluid flowing at the point of sampling. (The samples are used for particulate contamination analysis.)

2 References

ISO 1219, *Fluid power systems and components — Graphic symbols.*

ISO 5598, *Fluid power — Vocabulary.*

3 Definitions

3.1 fluid sampling, dynamic: The extraction of a sample of fluid from a turbulent section of a flow stream.

3.2 fluid sampling, static: The extraction of a sample of fluid from a fluid at rest.

3.3 sampler, turbulent: A device for creating turbulence in the main stream while extracting a fluid sample.

3.4 For definitions of other terms used, see ISO 5598.

4 Graphic symbols

Graphic symbols used are in accordance with ISO 1219.

5 Rules

5.1 Use a dynamic fluid sampling method (see clause 7).

5.2 Control the rate of sample extraction only by means of a capillary restriction.

5.3 Attach the sampling device permanently, or by a quick disconnect coupling.

6 Sampling device

Note — Take normal precautions to safeguard personnel and equipment.

6.1 Use a typical sampling device as shown in the figure if turbulent flow conditions exist in the main stream.

6.1.1 Permanently attach the ball valve or the valved portion of the quick disconnect coupling to the port through which the sample is to be taken.

6.1.2 Provide a dust cap for the item in 6.1.1.

6.1.3 Use the remaining equipment only for sampling.

6.1.4 Select capillary tubing having an inside diameter and length consistent with the sampling rate desired.

6.1.4.1 Do not use capillary tubing having an inside diameter smaller than 1,25 mm. Other cross-sections (such as rectangular) may be used provided that the smallest inside dimension is not less than 1 mm.

6.1.4.2 Sharpen and deburr the ends of the capillary tube to facilitate subsequent piercing of the film covering the sampling bottle mouth.

6.2 If turbulence in the flow stream cannot be ensured, use a means of creating turbulence such as a turbulent flow sampler.

7 Sampling procedure

7.1 Where a sampling device incorporating a quick disconnect coupling is used, attach the separable portions of the sampling device to the permanently attached portion.

7.2 Open the ball valve.

7.3 Pass a minimum of 200 cm^3 of fluid through the sampling device before collecting the fluid.

7.4 Without disturbing the ball valve, place the sampling bottle in position to collect the fluid.

7.4.1 Use the sharp end of the capillary tubing to pierce the plastic film covering the bottle mouth.

7.4.2 Take a sample of not more than 75 % and not less than 50 % of the sampling bottle volume.

7.5 When a sufficient sample has been collected, remove the sampling bottle before turning off the flow with the ball valve.

7.6 Recap the sample bottle immediately after withdrawing the capillary tubing.

7.7 Where a sampling device incorporating a quick disconnect coupling is used, disconnect the separable portions of the sampling device and remove any residual fluid films by flushing with a suitable solvent.

7.8 Immediately upon disconnection, replace the dust cap on the permanently mounted section of the quick disconnect coupling.

8 Identification statement

Use the following statement in test reports, catalogs and sales literature when electing to comply with this standard:

"Method of extracting fluid samples conforms to ANSI/B93.19M-1972, *Hydraulic fluid power — Particulate contamination analysis — Extraction of fluid samples from lines of an operating system.*"

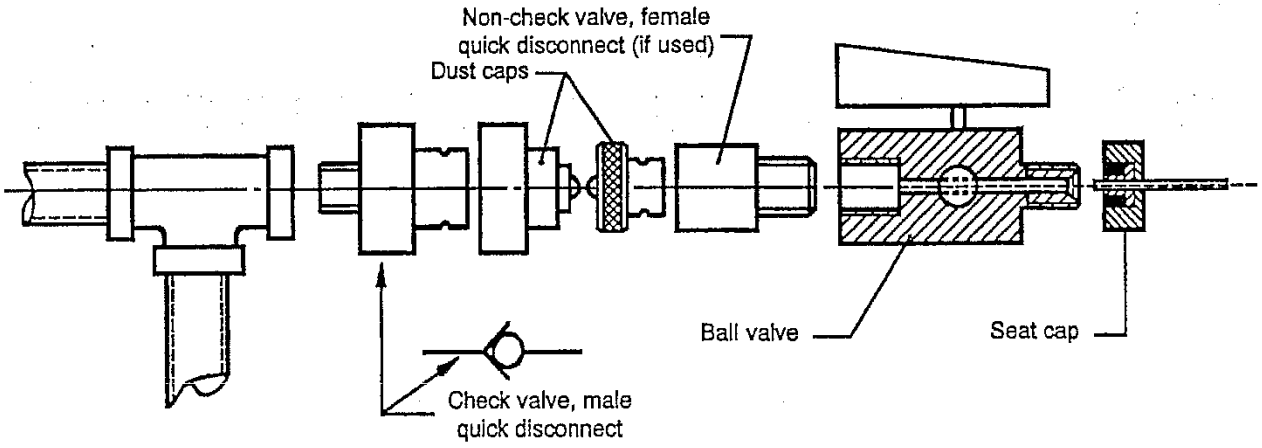


Figure 1 — Typical field type sampling device

TRONAIR®

APPENDIX IX

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 flow meters or pyrometers unless requested at the time of placed order. These instruments are considered reference indicators only and are not critical to the test(s) being performed on the aircraft.

1740 Eber Rd
Holland, OH 43528-9794
USA

Tronair, Inc.
www.tronair.com
Email: sales@tronair.com

Phone: (419) 866-6301
800-426-6301
Fax: (419) 867-0634