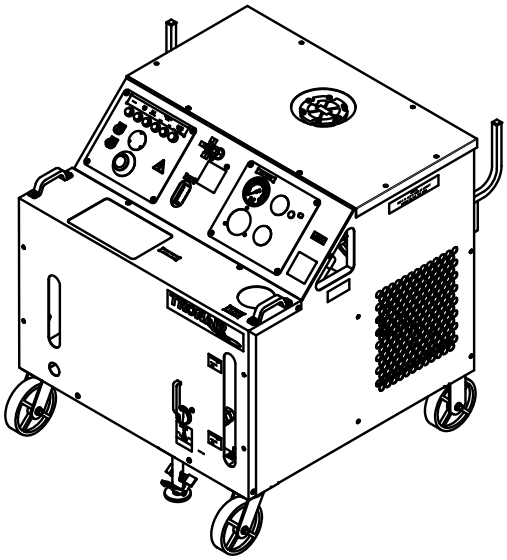
Operation & Service Instructions



Model: 5410
Hydraulic Power Unit

12/2007 – Rev. 07

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Hydraulic Power Unit

REVISION	DATE	TEXT AFFECTED
01	07/10/2003	Configuration change. Major revision to entire document. Reference previous revision.
02	12/30/2003	pg 45 Replaced Figure 10.11 Electrical Components; Modified comment on figure. pg 47 Modified part numbers for Items 5 & 6 pg 48 Modified part numbers for item 5 & 6 pg 49 Deleted
03	05/2004	pg 26 Modified part numbers for item 50 Hz applications pg 47 Modified part numbers for item 7 pg 48 Modified part numbers for item 7
05	02/2005	pg 48 Modified part numbers and illustration
06	06/2007	Modified 10.7.1 Electric Panel Parts List
07	12/2007	Modified 10.7.1 Electric Panel Parts List

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1.0 PRODUCT INFORMATION

1.1 DESCRIPTION

Hydraulic Power Unit (HPU)

Model Number:	**Fluid Type:**
5410	MIL-H-5606

1.2 MODEL & SERIAL NUMBER

Reference nameplate on unit.

1.3 MANUFACTURER

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1.4 FUNCTION

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

1.5 REQUIREMENTS

Adequate electrical power must be provided for proper functioning of the HPU. See the unit nameplate for proper voltage and frequency. See Section 3.0 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 ensure safe operations, please read the following statements and understand their meaning. Also refer to your aircraft manufacturer's manual for other important safety information.

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.

2.0 Safety Information continued on following page.

2.0 SAFETY INFORMATION *(continued)*

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

2.4 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: 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 COMMENT

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

2.8 GENERAL COMMENT

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

3.0 ELECTRICAL POWER REQUIREMENTS

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	73.0	66.0	38.0	33.0	26.0
Locked Rotor Amps	404	365	221	182	146
Recommended Fuse Size	100	90	50	45	35
Maximum Fuse Size	110	100	60	50	40

50 Hz Applications					
Voltage	200	220	380	415	440
Full Load Amps	75.0	72.0	36.0	36.0	35.0
Locked Rotor Amps	415	382	221	200	191
Recommended Fuse Size	100	90	45	45	45
Maximum Fuse Size	110	110	50	50	50

4.0 PREPARATION PRIOR TO FIRST USE

4.1 GENERAL

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

4.2 SERVICING RESERVOIR

Fill the reservoir with the correct fluid (see label next to reservoir fill for correct type of fluid) until fluid level is above the minimum fluid level mark but below the maximum fluid level. See ***Figure 6.3.1 Front Panel Controls*** for reservoir fill location.

4.3 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 ***Section 3.0 Electrical Power and Protection Requirements*** for power requirements and fuse sizes**.** (See ***6.4 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.

5.0 TRAINING

5.1 TRAINING REQUIREMENTS

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

5.2 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.

5.3 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.

6.0 OPERATION

6.1 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.

6.2 NUMERICAL VALUES

6.2.1 Fluid

(See Nameplate on unit for Model Number.)

Fluid Type:	**Model:**
MIL-H-5606	5410

6.2.2 Physical

- Weight (Dry)**:** 1,450 lbs (568 kg)
- Dimensions**:** Width 51 in (129.5 cm)
  Height 50 in (127.0 cm)
  Depth 54 in (137.2 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
  -12 (¾ in, 19.1 mm) ..... Working Diameter
- Return Hoses: 25 ft (7.62 m) ..... Standard Length
  50 ft (15.24 m) ..... Optional Length
  -16 (1 in, 25.4 mm) ..... Working Diameter
- Hand Pump Hose: 15 ft (4.57 m) ..... Standard Length
  -4 (¼ in, 6.4 mm) ..... Working Diameter

6.2 NUMERICAL VALUES *(continued)*

6.2.3 Motor Driven Hydraulic Pump

- A pressure compensated, adjustable maximum volume piston pump.
- Maximum flow at 60 Hz: .....15 gpm (56.7 lpm)
- Maximum flow at 50 Hz: .....12 gpm (47.3 lpm)
- Maximum operating pressure at 50 Hz and 60 Hz:.....3,500 psi (241 bar)
- System pressure relief valve setting:.....3,750 psi (258 bar)
- Performance Curve for 50 Hz and 60 Hz: .....Reference ***Figure 6.2.3***

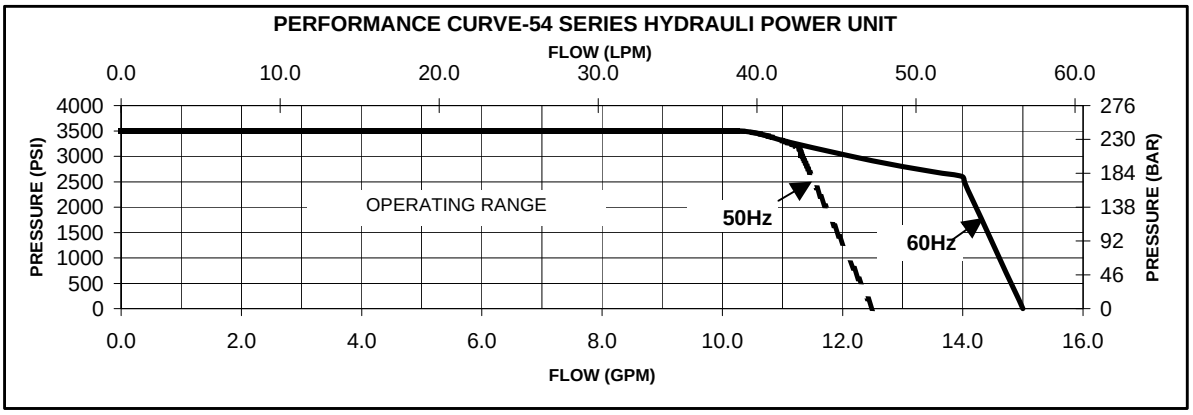

FIGURE 6.2.3 – **Performance Curve (50 Hz and 60 Hz)**

6.2.4 Electric Motor

A 25 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			**50 Hz Applications**	
Voltage	**Full Load Amps**		**Voltage**	**Full Load Amps**
208	73.0		200	75.0
230	66.0		220	72.0
380	38.0		380	36.0
460	33.0		415	36.0
575	26.0		440	35.0

FIGURE 6.2.4 **- Motor Power Requirements**

6.2 Numerical Values continued on following page.

6.2 NUMERICAL VALUES *(continued)*

6.2.5 Filters

- Pressure: ..... 2 micron rating, non-bypass high collapse microglass type. Non-cleanable element.
- Return: ..... 5 micron rating, 15 psi (1.03 bars) 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.

6.2.6 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 in (15.88 mm)
  Working Pressure: ..... 500 – 5,000 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)

6.0 OPERATION *(continued)*

6.3 LOCATION & LAYOUT OF CONTROLS

6.3.1 Front Panel Controls

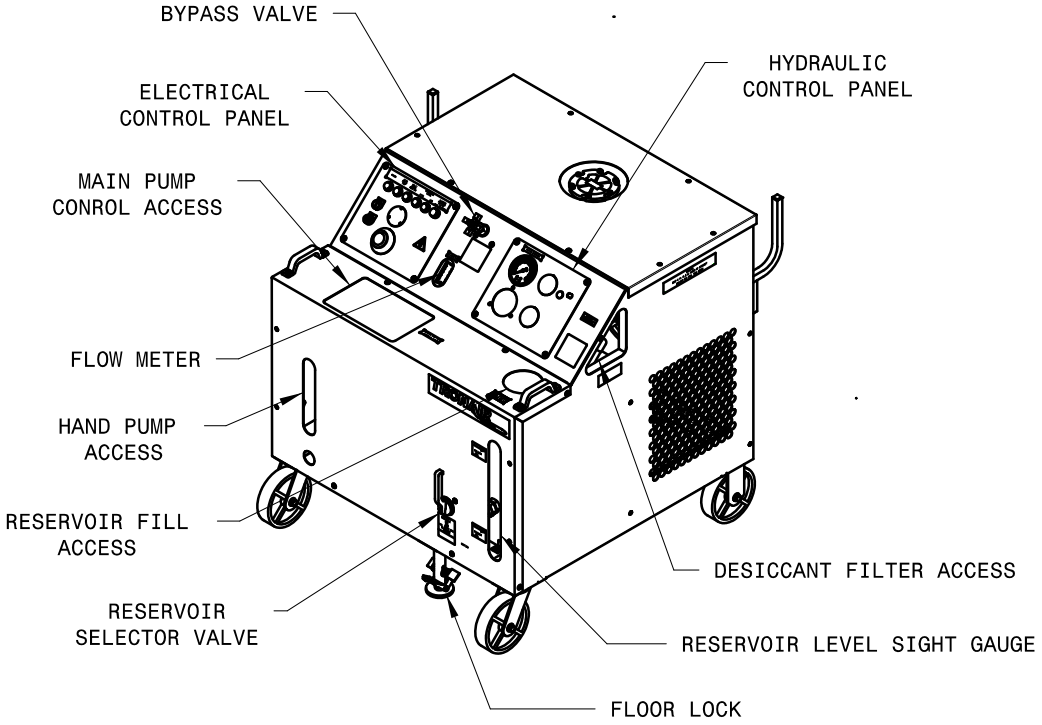

FIGURE 6.3.1 **– Front Panel Controls**

- Electrical Control Panel: ..... *See Section 6.3.2*
- Hydraulic Control Panel:..... *See Section 6.3.3*
- Bypass Valve:..... For loading and unloading the motor driven hydraulic pump.
- Flowmeter:..... Displays the flow from the motor driven hydraulic pump.
- Pump Control Access:..... See ***Figure 6.3.5 – 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.
- Floor Lock:..... Locking/unlocking, foot actuated and released floor lock.

6.3 Location & Layout of Controls continued on following page.

6.3 LOCATION & LAYOUT OF CONTROLS *(continued)*

6.3.2 Electrical Control Panel

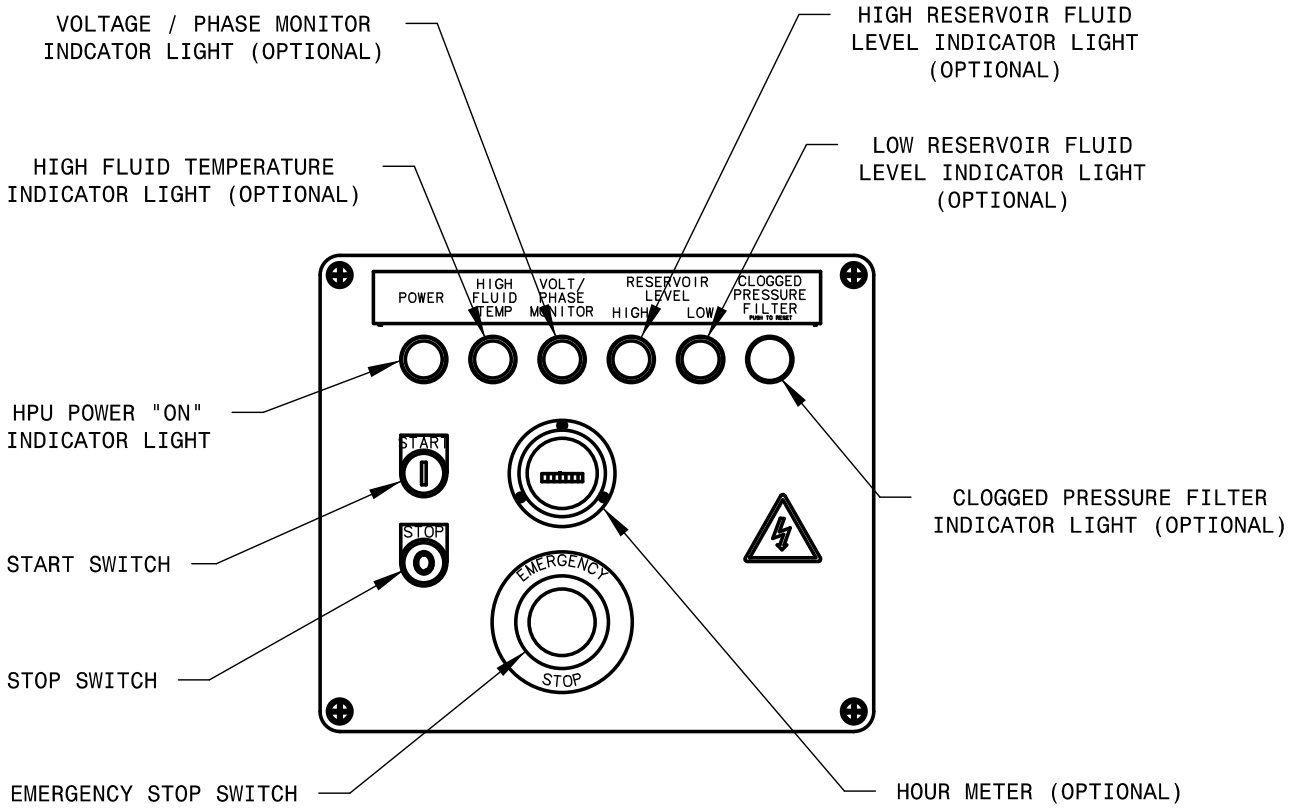

FIGURE 6.3.2 **– Electrical Control Panel**

- 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 *(Option S)*: ..... 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.

6.3.2 Electrical Control Panel *(continued)*

- 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 *(Option R)*: ..... 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.

6.3 Location & Layout of Controls continued on following page.

6.3 LOCATION & LAYOUT OF CONTROLS *(continued)*

6.3.3 Hydraulic Control Panel

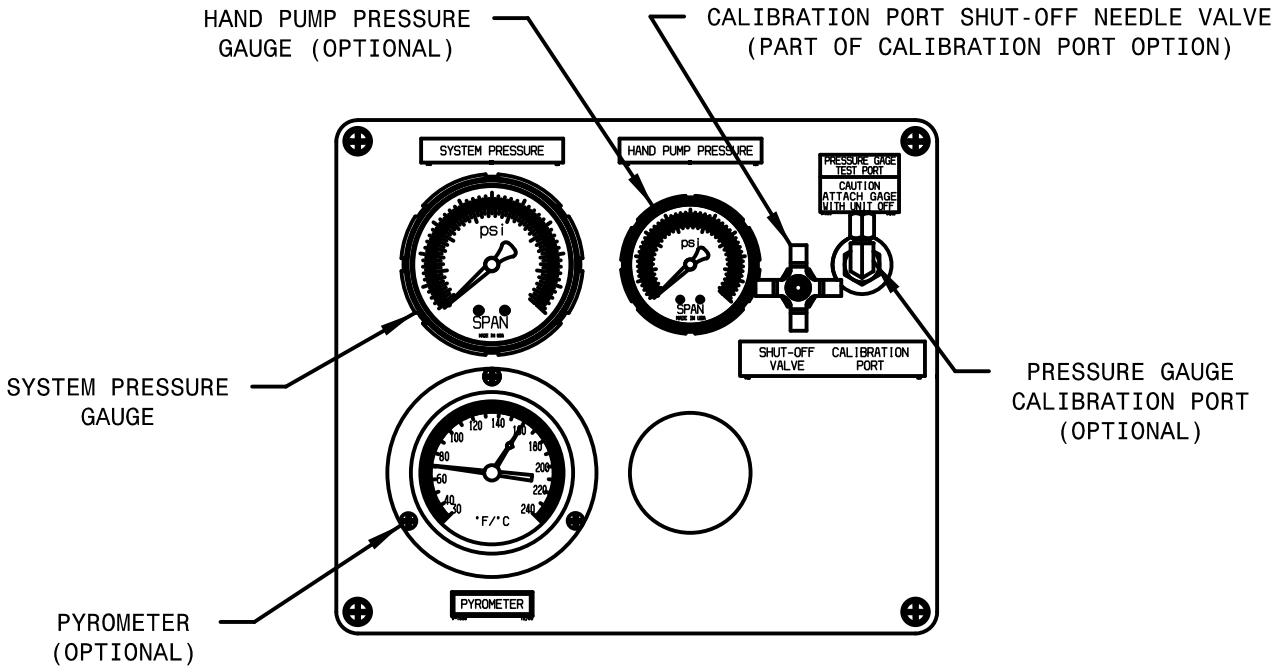

FIGURE 6.3.3 – **Hydraulic Control Panel**

- System Pressure Gauge: ..... Displays the system pressure on an analog fluid dampened gauge.
- Pyrometer *(Option K)*:..... 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 *(Option Q)*: ..... Allows for calibration of the system pressure gauge up to the operating pressure of HPU. Calibration port shut off valve must be used in conjunction with the calibration port.
- Calibration Port Shut Off Valve:..... *(Part of Calibration Port Option Q)* Used to shut off pressure to the calibration port. This valve should only be opened when the external standard gage is attached. (See Technical Manual for proper procedure.)
- Hand Pump Pressure Gauge (Option M): ..... Displays the hand pump system pressure on an analog fluid dampened gauge.

6.3 LOCATION & LAYOUT OF CONTROLS *(continued)*

6.3.4 Rear Panel Controls

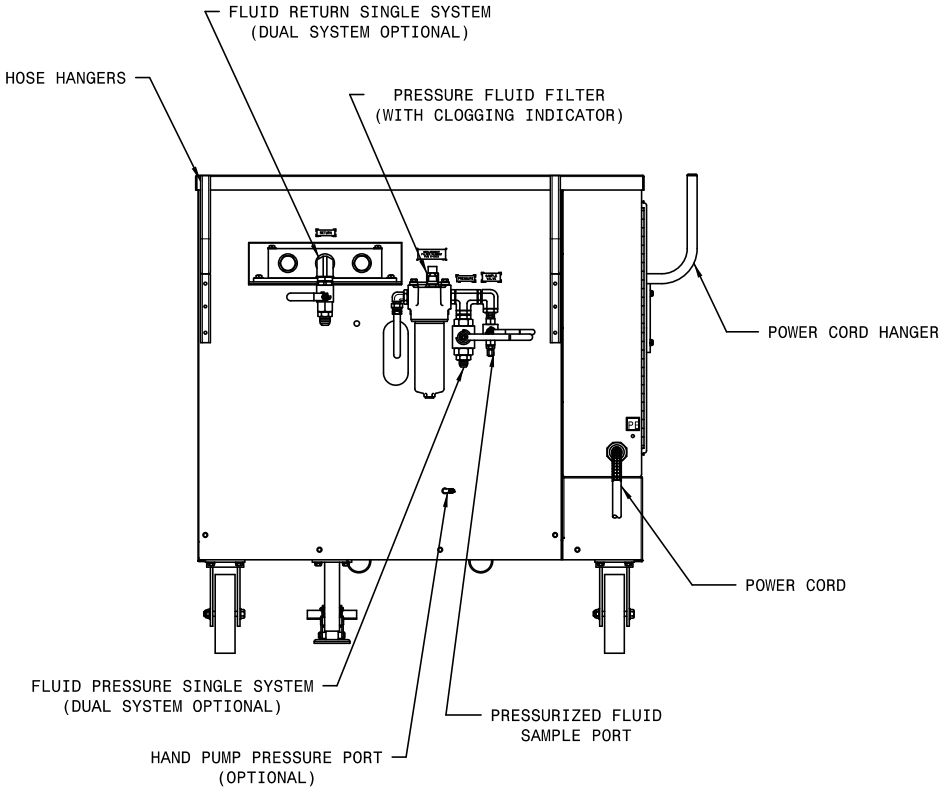

***FIGURE 6.3.4* – Rear Panel Controls**

- * 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.
- 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 Port:..... Pressurized fluid from hand pump filter. *(Option M)*
- 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.***

6.3 Location & Layout of Controls continued on following page.

6.3 LOCATION & LAYOUT OF CONTROLS *(continued)*

6.3.5 Hydraulic Pump Controls

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

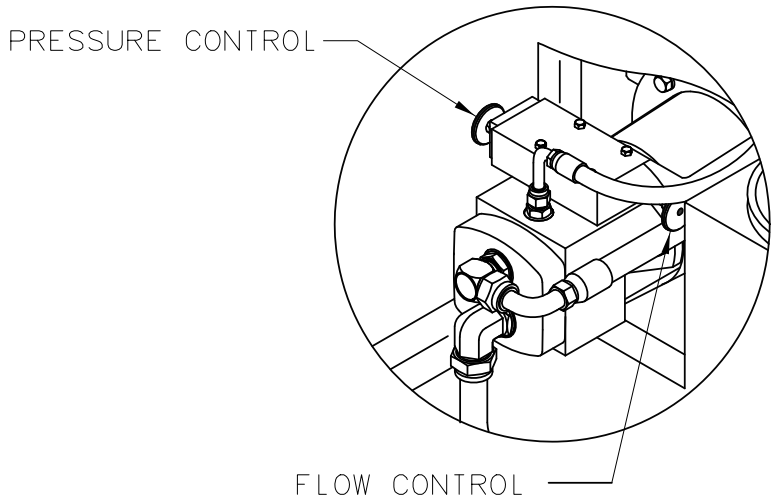

***FIGURE 6.3.5* – Hydraulic Pump Controls**

- 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.

6.3 LOCATION & LAYOUT OF CONTROLS *(continued)*

6.3.6 Hand Pump Controls *(Option M)*

Reference 6.9 Hand Pump Operation.

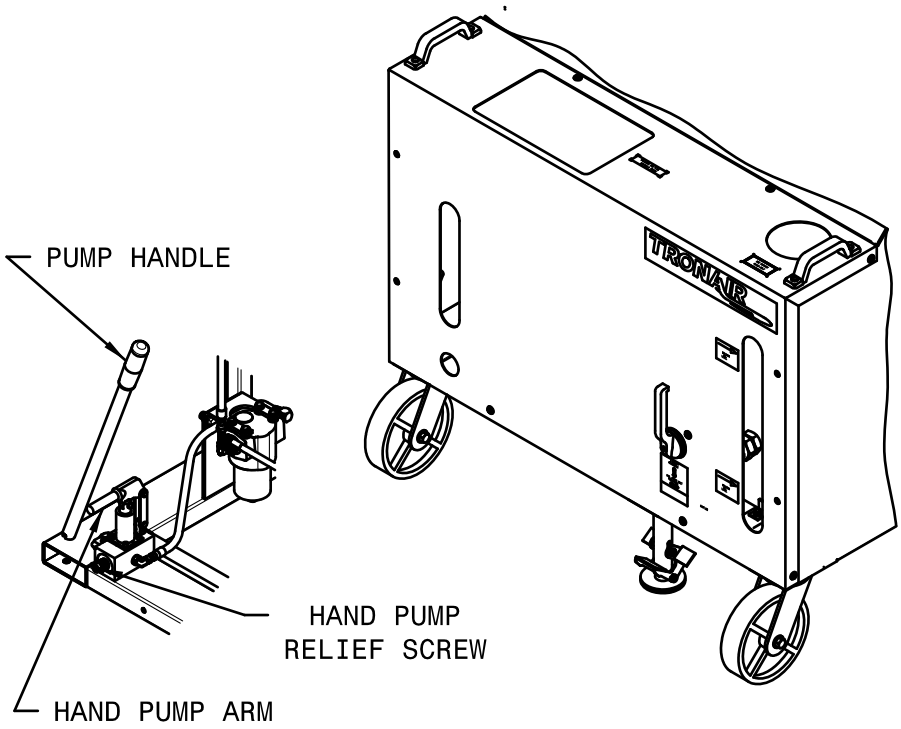

FIGURE 6.3.6 **– Hand Pump Controls**

- 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.

6.3 Location & Layout of Controls continued on following page.

6.3 LOCATION & LAYOUT OF CONTROLS *(continued)*

6.3.7 Dual System Controls *(Option C)*

Reference 6.7 Dual System Operation.

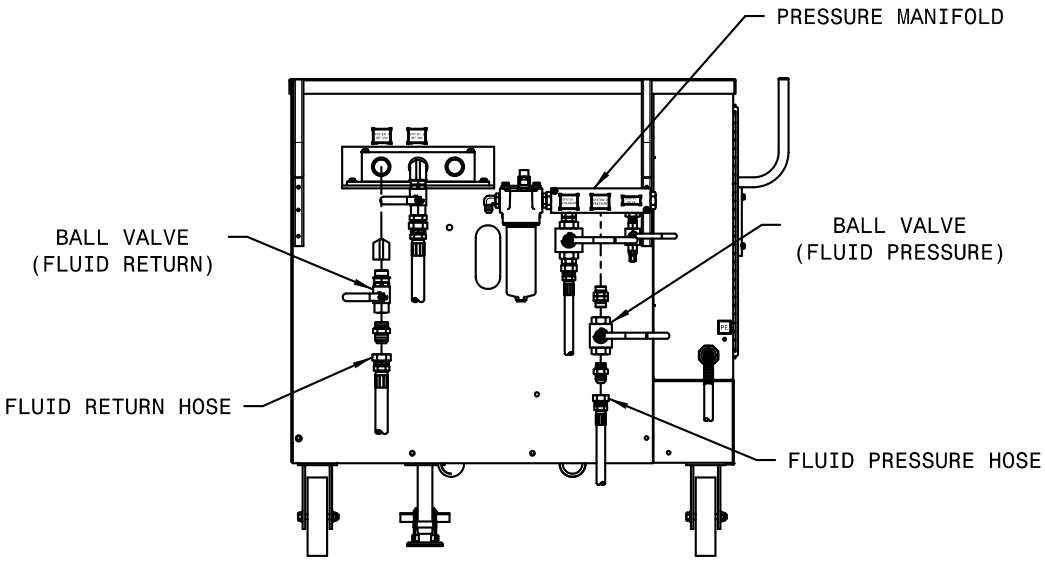

FIGURE 6.3.7 **–Dual System Controls**

- 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.

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.

- 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.

6.3 LOCATION & LAYOUT OF CONTROLS *(continued)*

6.3.8 Dual System Crossover Check Controls *(Option D)*

Reference 6.8 Dual System Crossover Check Operation.

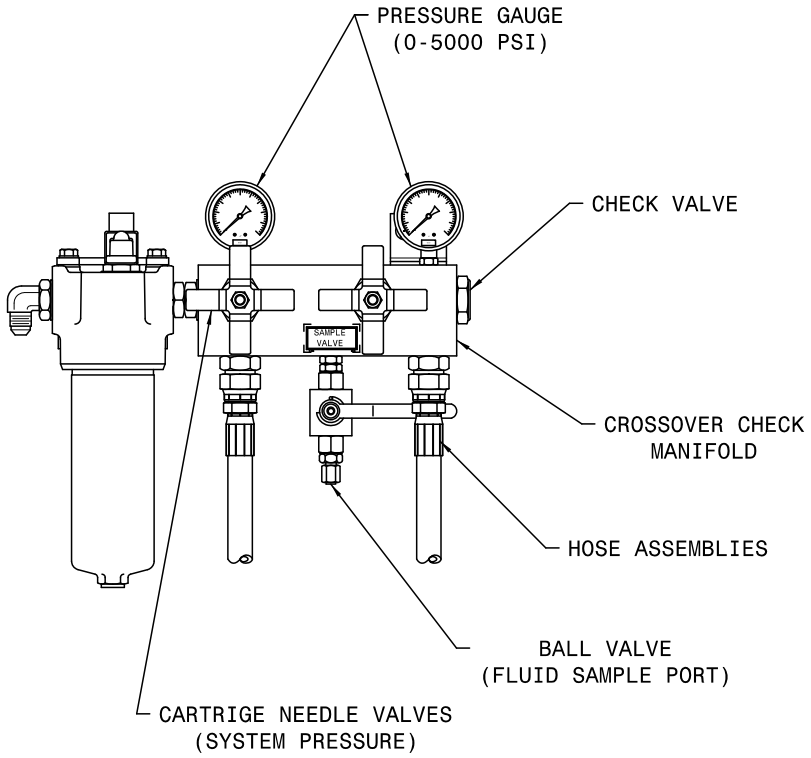

***FIGURE 6.3.8* – Dual System Crossover Check Controls**

- Pressure Gauge: ..... Displays the pressure in each aircraft system.
- Hose Assembly:..... Connects HPU to aircraft pressure system.
- Ball Valve:..... Turns on and off the fluid for taking contamination samples.
- Crossover Check Manifold: ..... Houses the valves and gauges.
- Cartridge Needle Valve: ..... Used to turn on and off the flow to the separate aircraft pressure systems. Always use in either fully open or fully closed position; never use in a partially open position.
- Check Valve:..... Prevents cross flow from System 2 pressure line to System 1 pressure line.

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.

6.0 Operation continued on following page.

6.0 OPERATION *(continued)*

6.4 START UP PROCEDURES

6.4.1 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 ***Figure 6.4.1 – Pump/Motor Coupling Access***.

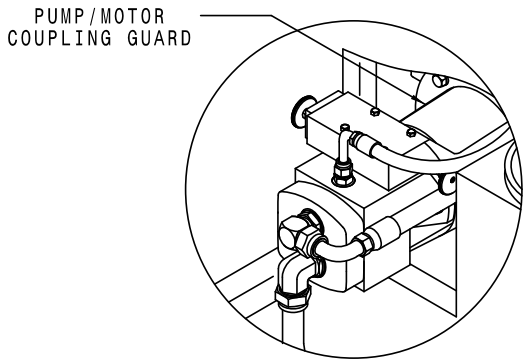

FIGURE 6.4.1 **– Pump/Motor Coupling Access**

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.

b. Verify that the unit has been prepared for use by connecting electrical leads and servicing the reservoir. (Reference Section 4*.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.

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.

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.

6.4.2 Initial Start Up of the HPU

a. Unit must be prepared per Section *4.0 Preparation Prior to First Use* and Section *6.4.1 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.

6.4.2 Initial Start Up of the HPU *(continued)*

f. Press the start switch and adjust the flow control until 6 gpm (22.71 lpm) is displayed on the flowmeter. (If no flow displays on the flowmeter after adjusting the flow control, reference Trouble Shooting 9.2 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 9.4 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.

6.5 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.

6.5.1 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.

6.5.2 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.

6.5.3 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.

6.5.3 Reservoir selector valve operation continued on following page.

6.5.3 Reservoir Selector Valve Operation *(continued)*

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.

6.5.4 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.**

6.6 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.

6.6.1 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 9.2 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.

6.6.1 To Easily Purge the Unit of Air *(continued)*

WARNING!

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

6.7 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 90° ball type. The valves are open when the operating handle is in line with the valve.

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

6.7.1 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.

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.

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

6.8 DUAL SYSTEM CROSSOVER CHECK *(Option D)*

The Dual System feature of this option allows control of fluid flow to the aircraft with two hydraulic systems. The systems consist of two sets of hoses and valves located at the rear of the unit on the pressure and return manifolds. The return system valves are of the 90° ball type and are open when the handle is in line with the valve. The pressure system valves are cartridge type needle valves.

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.

The Dual System Crossover Check option adds a check valve and pressure gauges to the dual system feature. The check valve prevents cross flow from System 2 pressure line to System 1 pressure line, while the gauges allow bleed down pressure in each line to be read when the needle valves are closed.

6.8.1 To Operate the Dual System with Crossover Check

a. Before starting the 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.

6.8.1 To operate the dual system with crossover check continued on following page.

6.8.1 To Operate the Dual System with Crossover Check *(continued)*

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.

c. Follow the aircraft manufacturer's instructions for proper use of the crossover check capabilities.

6.9 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.

6.9.1 To Operate the Hand Pump

a. Remove the pump handle from inside the front access door. (Reference ***Figure 6.3.6 – Hand Pump Controls***)
b. Insert the end of the pump handle through the front panel opening into the hand pump relief screw.
c. Turn the pump handle clockwise to close the relief screw.
d. Insert the pump handle onto the hand pump arm through the front panel slot.
e. Pump the handle using an up and down motion. Observe the hand pump system pressure on the hydraulic control panel (Figure 6.3.3 – Hydraulic Control Panel). The pump is an automatic two stage pump. 500 psi (34.47 bar) can be produced with high fluid flow and 5,000 psi (344.74 bar) can be produced with low fluid flow.
f. Turning the relief screw in a counter-clockwise direction releases hydraulic pressure in the hand pump system.

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

6.10 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) (*Reference Appendix)* be followed.

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

6.11 EMERGENCY SHUT DOWN PROCEDURE

In the event an emergency shut down is necessary, press the emergency stop switch located on the electrical panel. (Reference ***Figure 6.3.2 – Electrical Control Panel***) Open the bypass valve to remove any system pressure.

6.0 OPERATION *(continued)*

6.12 DESCRIPTION OF ALARM SYSTEMS

Reference ***Figure 6.3.2 – Electrical Control Panel***.

6.12.1 High Fluid Temperature Indicator *(Option S)*

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 ***9.0 Trouble Shooting***.

6.12.2 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 ***9.0 Trouble Shooting***.

6.12.3 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.

6.12.4 Clogged Filter Indicator Light *(Option R)*

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 ***10.14.10 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.

7.0 PACKAGING AND STORAGE

7.1 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 2,000 lbs (907.2 kg) capacity each.

7.2 HANDLING

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

NOTE: Be sure the forks are long enough to reach the frame cross members for stability during lifting. Spread the forks to their maximum width for stability. Reference Figure 8.0 – HPU on Forklift.

7.0 Packaging and storage continued on following page.

7.0 PACKAGING AND STORAGE *(continued)*

7.3 PACKAGING PROTECTION

No special packaging material for cushioning or suspension is required.

7.4 LABELING OF PACKAGING

Packaging should be labeled as follows: **DO NOT DROP**
THIS SIDE UP
DO NOT STACK

7.5 STORAGE COMPATIBILITY

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

7.6 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.

7.0 PACKAGING AND STORAGE *(continued)*

7.7 STORAGE SPACE AND HANDLING FACILITIES

- Weight (Dry)**:** 1,450 lbs (658 kg)
- Dimensions**:** Width 51 in (129.5 cm)
  Height 50 in (127.0 cm)
  Depth 54 in (137.2 cm)

8.0 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 8.0 – HPU on Forklift.***

- Weight**:** 1,200 lbs (544 kg)

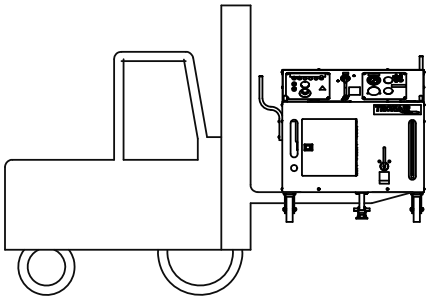

FIGURE 8.0 **– HPU on Forklift**

9.0 TROUBLE SHOOTING

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

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

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

9.1 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 ***4.3 Connecting Electrical Leads***.
Reservoir fluid level is too high or too low. *(Electric Reservoir Level Option L only)*	One reservoir level indicator light (Low or High) will be illuminated. Fill the reservoir above the Minimum Fluid Level arrow to extinguish the Low Level light. Drain fluid below the Maximum Fluid Level arrow to extinguish the High Level light.
High return fluid temperature *(Electric Over-Temperature Option S only)*	High Fluid Temperature indicator light will be illuminated. Allow the hydraulic fluid to cool until the light goes out. Refer to Section 9.5 for over-heated causes.
Motor has tripped thermal overload device	Allow the motor to cool. The thermal overload device (motor starter) will reset automatically after sufficient cooling. The tripped condition is usually caused by loading the motor beyond its rated capacity, however, any condition (such as unbalanced voltage) that causes an increase in amperage can result in a tripped condition.

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

9.0 Trouble shooting continued on following page.

9.0 TROUBLE SHOOTING *(continued)*

9.2 NO FLOW

Possible Cause	Solution
Motor turning in wrong direction.....	See Section ***4.3 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.

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.

9.3 REDUCED FLOW

Possible Cause	Solution
Flow control is 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 9.2.
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.

9.0 TROUBLE SHOOTING *(continued)*

9.4 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 9.2.
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.

9.5 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-1725).
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.)

9.6 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 *10.13.9.a – Pump Diagram*). Slowly stroke the pump until fluid is present at the bleed screw. Replace the bleed screw.

10.0 MAINTENANCE

10.1 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 **10.2** – **10.14** for Parts Lists, Descriptions and Illustrations.

10.2 ELECTRIC MOTOR

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

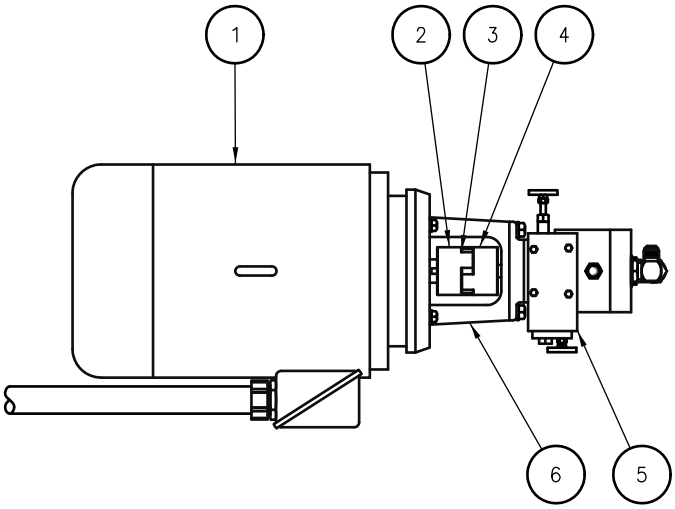

FIGURE 10.2 – **Electric Motor/Hydraulic Pump Assembly**

PARTS LIST

Item	Part Number	Description	Qty
1	*Reference following:*	Electric Motor	1

60 Hz Applications		50 Hz Applications	
Voltage	**Part Number**	**Voltage**	**Part Number**
208	EC-1224-02	200	EC-1224-02
230	EC-1224-02	220	EC-1555-11
380	EC-1224-01	380	EC-1555-12
460	EC-1224-02	415	EC-1224-02
575	EC-1224-03	440	EC-1555-11

2	H-2225-01	Coupling (Motor Half)	1
3	H-2228	Spider (Hytrel)	1
4	H-2225-02	Coupling (Pump Half)	1
5	*Reference 10.3 & 10.3.1*	Motor Driven Hydraulic Pump	1
6	HC-1810-03	Pump/Motor Adapter	1

10.0 MAINTENANCE *(continued)*

10.3 MOTOR DRIVEN HYDRAULIC PUMP

The hydraulic pump does not require regular maintenance. Under normal operating conditions, the pump will perform for thousands of hours of use without rebuilding. See ***Appendices – Oil Gear Pump Manual*** for further details.

10.3.1 Motor Driven Hydraulic Pump Assembly

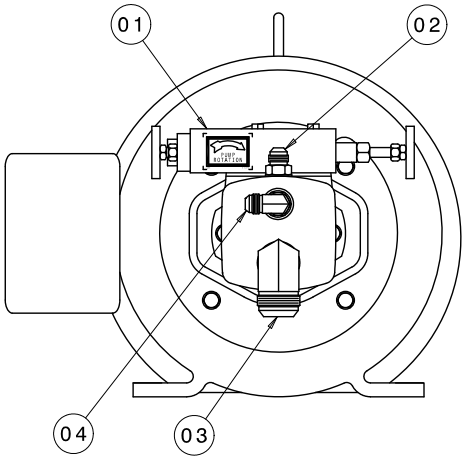

FIGURE 10.3.1 – **Motor Drive Hydraulic Pump Assembly**

Fluid Type: MIL-H-5606

	Item	Part Number	Description	Qty
♦	1	Z-4223	Assembly, Hydraulic Pump (Painted pump with knobs. *Does not include fittings, labels or coupling half.)*	1
	2	N-2007-20-S-B	Connector, Male #10 SAE x #12 JIC	1
	3	N-2001-28-S-B	Elbow, 90° Male #20 SAE x #20 JIC	1
	4	N-2001-21-S-B	Elbow, 90° Male #16 SAE x #12 JIC	1

♦ ***Refer to section 10.14 for listing of Replacement Labels.***

10.3.2 Motor Driven Hydraulic Pump Replacement Kits List

Fluid Type: MIL-H-5606

Part Number	Description
K-2405	Kit, Shaft Seal and Retainer
K-1996	Kit, Gaskets and O-rings
K-3655	Kit, Shaft and Bearing Assembly

10.0 Maintenance continued on following page.

10.0 MAINTENANCE *(continued)*

10.4 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 ***6.10 – Sample Valve Operation***)

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

Model Number: **Fluid Type:**

5410 ..... MIL-H-5606

10.5 FILTERS

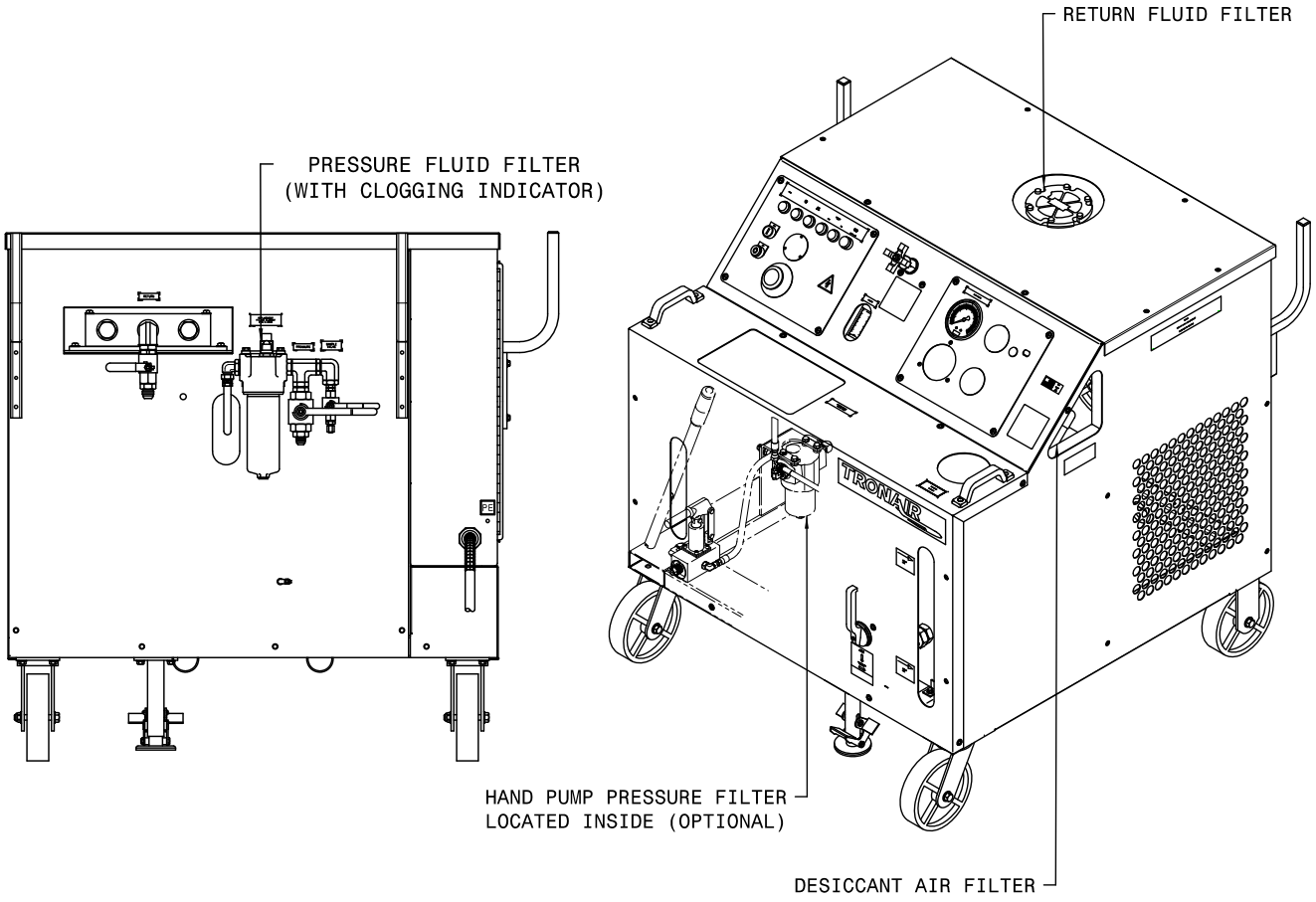

FIGURE 10.5 **– Filter Locations**

10.5 FILTERS *(continued)*

10.5.1 Pressure Filter

Replace the filter element any time the clogged filter indicator light *(Option R)* is triggered or when the pop-up indicator located on the filter head changes to red during operation.

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.

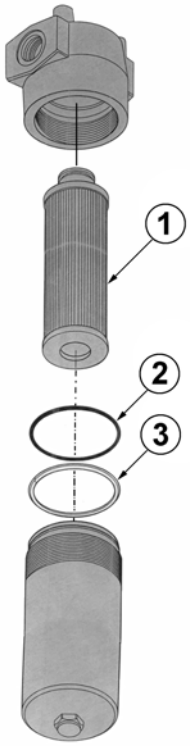

FIGURE 10.5.1 **– Pressure Filter**

PARTS LIST

Fluid Type: MIL-H-5606

Item	Part Number	Description	Qty
2 & 3	K-3796	Kit, Seal	1
1, 2 & 3	K-3492	Kit, Replacement Filter Element	1

10.5 Filters continued on following page.

10.5 FILTERS *(continued)*

10.5.2 Return Filter

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

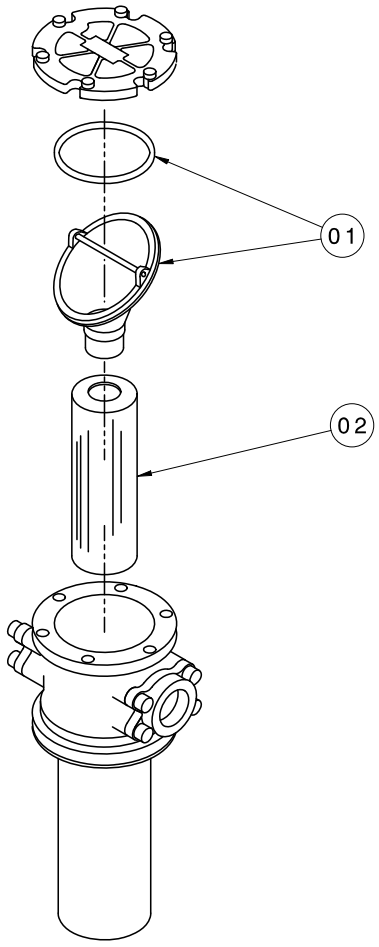

FIGURE 10.5.2 **– Return Filter**

PARTS LIST

Fluid Type: MIL-H-5606

Item	Part Number	Description	Qty
1	HC-2000-350	O-ring	2
1 & 2	K-3493	Kit, Replacement Filter Element	1

10.5 FILTERS *(continued)*

10.5.3 Hand Pump *(Option M)* Filter

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.

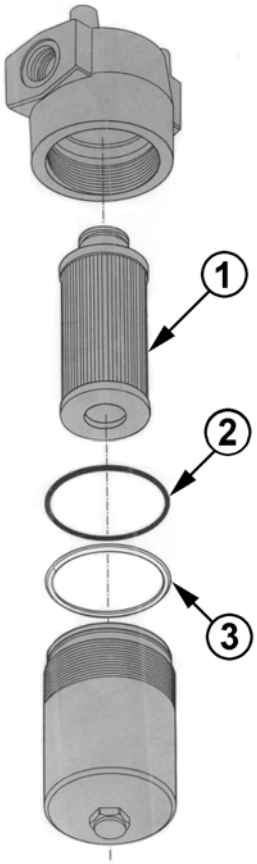

***FIGURE 10.5.3* – Hand Pump (Option M) Filter**

PARTS LIST

Fluid Type: MIL-H-5606

Item	Part Number	Description	Qty
2 & 3	K-3796	Kit, Seal	1
1, 2 & 3	K-3751	Kit, Replacement Filter Element	1

10.5 Filters continued on following page.

10.5 FILTERS *(continued)*

10.5.4 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).

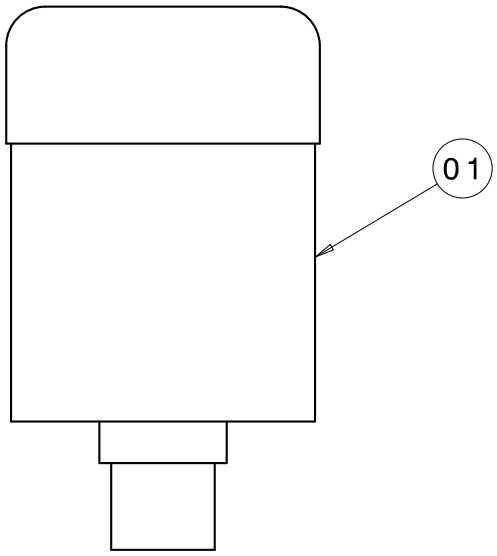

FIGURE 10.5.4 **– Desiccant Air Filter**

PARTS LIST

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

10.0 MAINTENANCE *(continued)*

10.6 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.

Hose Location		
Item	**From**	**To**
1	Selector Valve	Pump Inlet
2	Pump Outlet	Flowmeter
3	Control Manifold	Pressure Filter
4	Control Manifold	Pressure Gauge
5	Case Drain	Cooler (Rear)
6	Cooler (Front)	Return Manifold
7	Control Manifold	Return Manifold
8	Return Filter	Selector Valve (Top)
9	Return Pressure Relief Valve	Reservoir

FIGURE 10.6 **– Hydraulic Hoses**

PARTS LIST

Fluid Type: MIL-H-5606

Item	Part Number	Description	Qty
1	TF-1039-11*12.8	Assembly, Hose #20	1
2	TF-1038-01*37.0	Assembly, Hose #12	1
3	TF-1038-33*32.8	Assembly, Hose #12	1
4	TF-1038-16*23.0	Assembly, Hose #4	1
5	TF-1039-16*38.3	Assembly, Hose #12	1
6	TF-1039-15*16.3	Assembly, Hose #12	1
7	TF-1039-01*31.3	Assembly, Hose #12	1
8	TF-1039-11*35.3	Assembly, Hose #20	1
9	TF-1038-08*17.5	Assembly, Hose #8	1
Not Shown	TF-1038-10*300	External Pressure Hose #12	1
Not Shown	TF-1039-02*300	External Return Hose #16	1

10.0 Maintenance continued on following page.

10.0 MAINTENANCE *(continued)*

10.7 INSTRUMENT PANEL

Refer to Section ***10.6 Hydraulic Hoses*** concerning hose inspection for general maintenance on Hose Assembly (***Item 3 in Figure 10.7***).

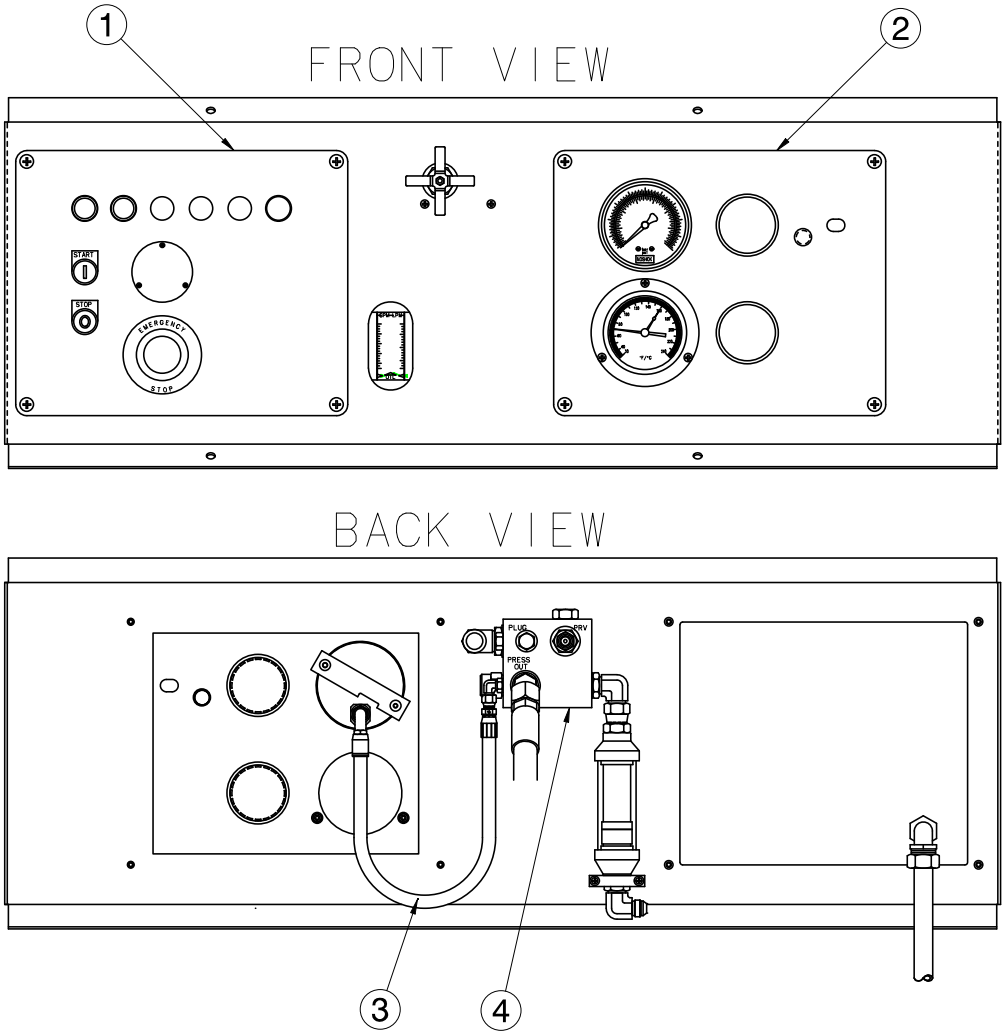

FIGURE 10.7 **– Instrument Panel**

PARTS LIST

Fluid Type: MIL-H-5606

Item	Part Number	Description	Qty
1	*See Page 35*	Electric Panel	1
2	*See Page 36*	Hydraulic Panel	1
3	*See Page 33*	Assembly, Hose #4	1
4	*See Page 37*	Control Block/Flowmeter	1

10.7 INSTRUMENT PANEL *(continued)*

10.7.1 Electric Panel

The Electric Panel does not require regular general maintenance.

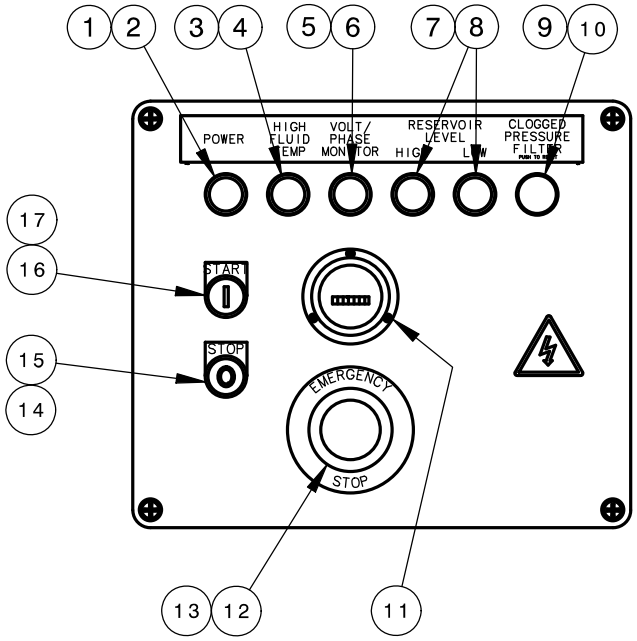

FIGURE 10.7.1 **– Electric Panel**

PARTS LIST

Item	Component	Part Number	Description	Qty
1	Standard	EC-1945-01	Light, Diffused Pilot	1
2	Standard	EC-1951-MN5G	Power, Module w/Latch	1
3	Option	EC-1945-03	Light, Diffused Pilot	1
4	Option	EC-1951-MN5Y	Power, Module w/Latch	1
5	Option	EC-1945-03	Light, Diffused Pilot	1
6	Option	EC-1951-MN5Y	Power, Module w/Latch	1
7	Option	EC-1945-04	Light, Diffused Pilot	2
8	Option	EC-1951-MN5B	Power, Module w/Latch	2
9	Option	EC-1952	Push Button, Illuminated/Flush	1
10	Option	EC-1944	Power, Module w/Contach/Latch	1
11	Option	EC-1577	Hour Meter (50 Hz Operation)	1
11	Option	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/Latch	1

10.7 Instrument Panel continued on following page.

10.7 INSTRUMENT PANEL *(continued)*

10.7.2 Hydraulic Panel

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

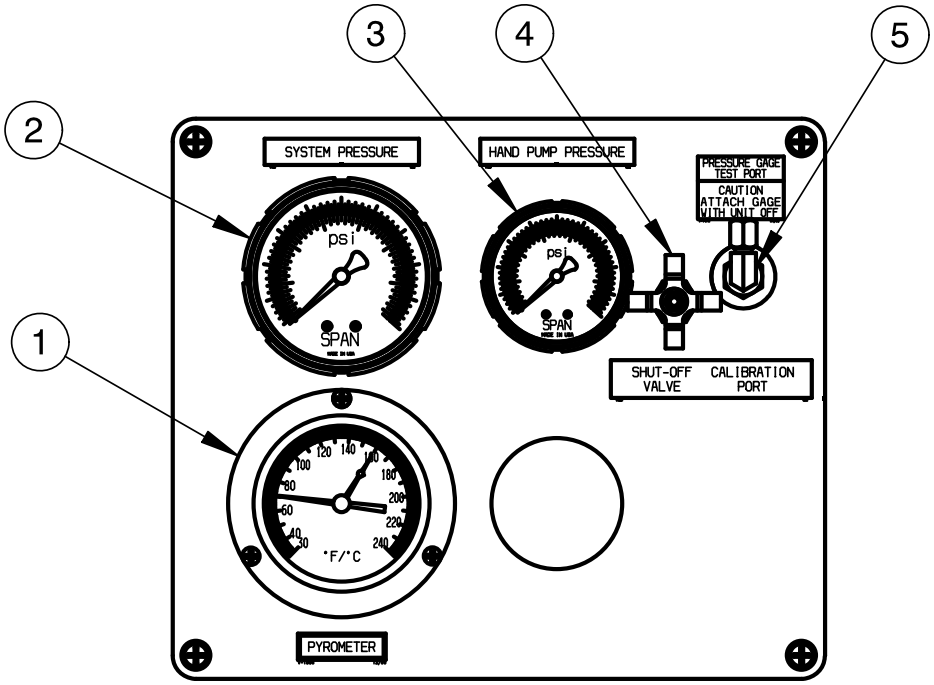

FIGURE 10.7.2 – **Hydraulic Panel**

PARTS LIST

Fluid Type: MIL-H-5606

Item	Part Number	Description	Qty
1	HC-1769-01	Pyrometer *(Optional)*	1
2	HC-2144	System Pressure Gauge	1
3	HC-2146	Pressure Gauge *(Hand Pump Option Only)*	1
4	HC-1900-01	Shut Off Needle Valve *(Calibration Port Option Only)*	1
5	*See Section 10.14.9*	Calibration Port *(Optional)*	1

10.7 INSTRUMENT PANEL *(continued)*

10.7.3 Control Block/Flowmeter

The Control Block components do not require regular general maintenance.

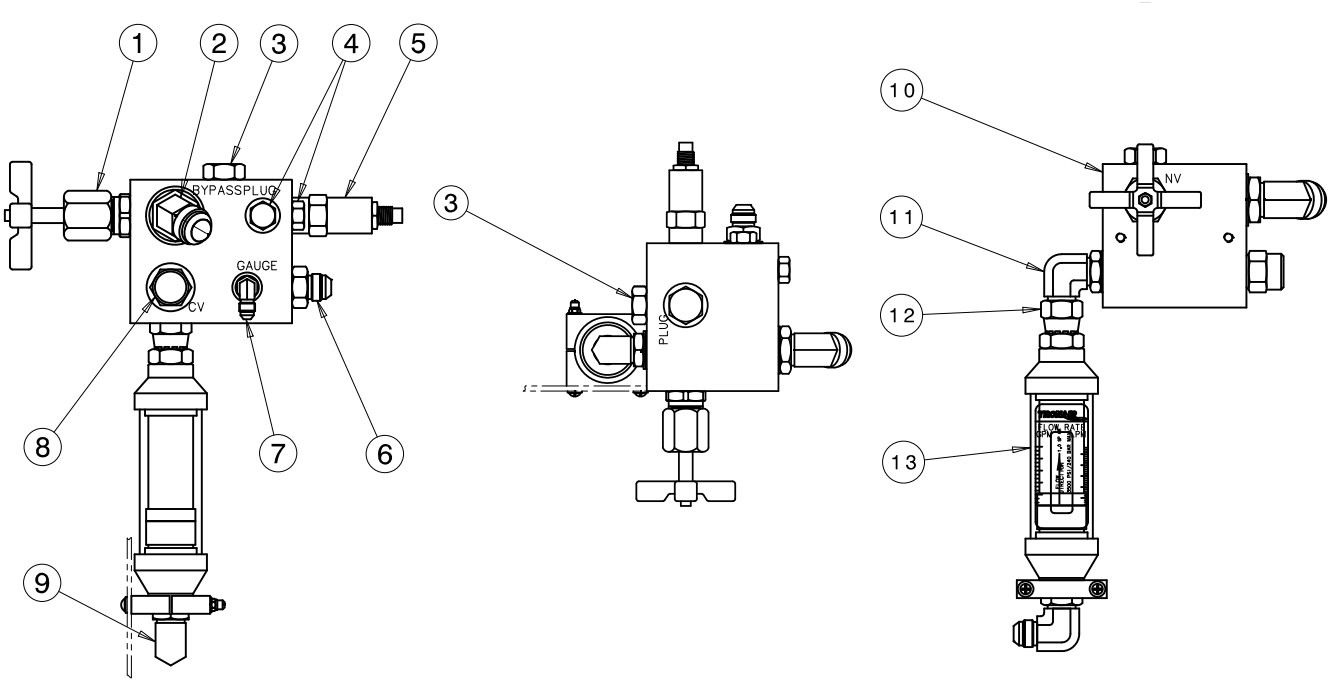

FIGURE 10.7.3 **– Control Block/Flowmeter**

PARTS LIST

Fluid Type: MIL-H-5606

Item	Part Number	Description	Qty
1	HC-1254-04	Needle Valve	1
2	N-2042-09-S-B	Elbow, 45° Straight Thread (#12)	1
3	N-2066-10-S-B	O-ring Hex Plug (#10)	2
4	N-2066-06-S-B	O-ring Hex Plug (#6)	2
5	HC-2127	Pressure Relief Valve	1
6	N-2007-20-S-B	Connector, Straight Thread (#12-10)	1
7	N-2001-03-S-B	Elbow, Straight Thread (#4)	1
8	HC-1673	Check Valve	1
9	N-2001-20-S-B	Elbow, Straight Thread (#12-10)	1
10	J-3399	Pressure Manifold	1
11	N-2001-15-S-B	Elbow, Straight Thread ((#10)	1
12	N-2036-07-S-B	Swivel, 37° Female (#10)	1
13	HC-2129	Flowmeter, 15 gpm/3,500 psi	1

10.7.3 Control Block/Flowmeter continued on following page.

10.7.3 Control Block/Flowmeter *(continued)*

10.7.3.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.

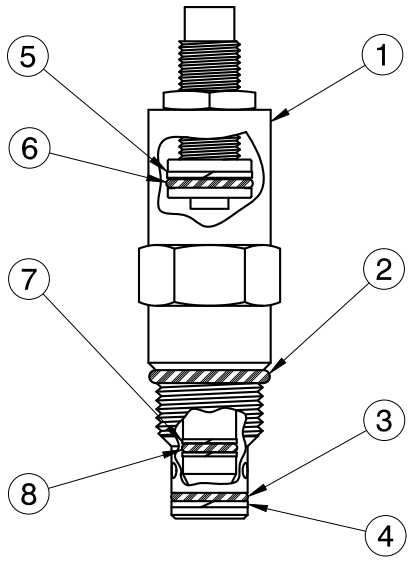

FIGURE 10.7.3.a **– System Pressure Relief Valve**

PARTS LIST

Fluid Type: MIL-H-5606

Item	Part Number	Description	Qty
1	HC-2127	Pressure Relief Valve *(Not Set)*	1
2	HC-2010-910	O-ring, Series 3	1
3	HC-2000-014	O-ring, Series 2	1
4	HC-2020-014	Backup Ring *(Teflon)*	1
5	HC-2020-015	Backup Ring *(Teflon)*	1
6	HC-2000-015	O-ring, Series 2	1
7	HC-2020-011	Backup Ring *(Teflon)*	2
8	HC-2000-011	O-ring, Series 2	1

10.7.3 Control Block/Flowmeter *(continued)*

10.7.3.b Check Valve

The Check Valve does not require regular general maintenance.

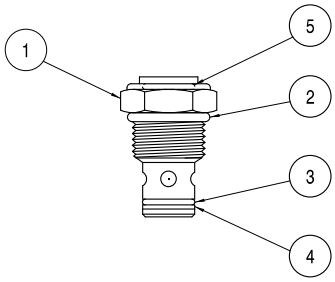

FIGURE 10.7.3.b **– Check Valve**

PARTS LIST

Fluid Type: MIL-H-5606

Item	Part Number	Description	Qty
1	HC-1673	Check Valve	1
2	HC-2010-910	O-ring, Series 3	1
3	HC-2000-014	O-ring, Series 2	1
4	HC-2020-014	Backup Ring	1
5	HC-2010-905	O-ring, Series 3	1

10.7.3.c Bypass Valve

The Bypass Valve does not require regular general maintenance.

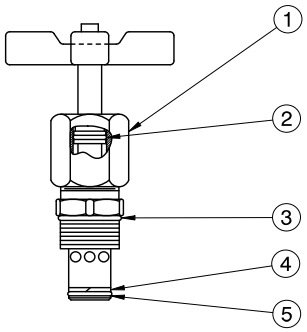

FIGURE 10.7.3.c **– Bypass Valve**

PARTS LIST

Fluid Type: MIL-H-5606

Item	Part Number	Description	Qty
1	HC-1254-04	Needle Valve	1
2	HC-2000-111	O-ring	1
3	HC-2010-912	O-ring	1
4	HC-2020-114	Backup Ring	1
5	HC-2000-114	O-ring	1

10.0 Maintenance continued on following page.

10.0 MAINTENANCE *(continued)*

10.8 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 9) is not field serviceable.

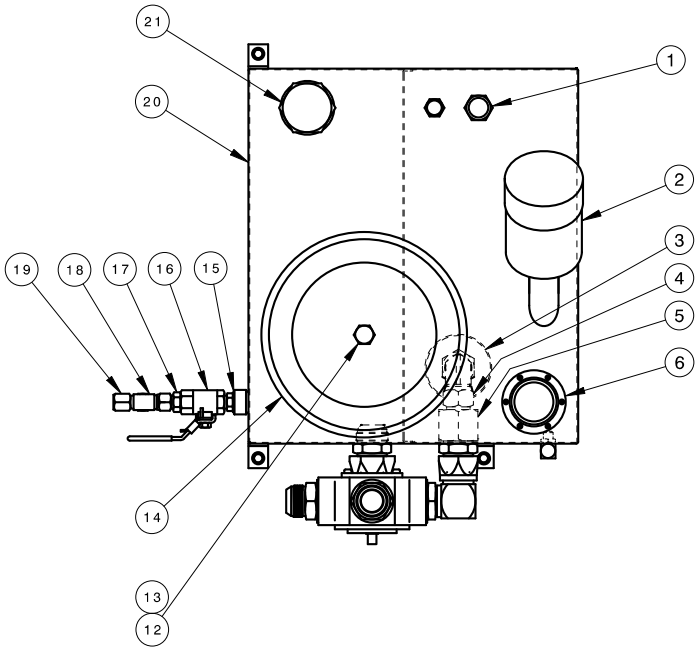

FIGURE 10.8 – **Reservoir Assembly**

PARTS LIST

Fluid Type: MIL-H-5606

Item	Part Number	Description	Qty
1	N-2008-08-S	Cap, #12	1
2	HC-1763	Desiccant Filter	1
3	HC-1397-02	Diffuser, 1" NPT	1
4	N-2035-08-S	Elbow, Swivel Male, #16 JIC x 1" NPT	1
5	N-2055-25-S	Tube Reducer, #20 x #16 JIC	1
6	HC-2193-06	Filler, Non-vented	1
12	H-1735-02	Washer, Nylon	1
13	G-1100-110016	Bolt, Hex Head, Grade 5, 5/8-11 x 1 ¾" long	1
14	H-1740	Cover Assembly	1
15	N/A	N/A	N/A
16	HC-1761	Ball Valve, SAE #8 Lockable	1
17	N-2007-11-S-B	Connector, Straight Thread #8 SAE x #8 JIC	1
18	N-2016-06-S	Tee, Swivel Run, #8 JIC	1
19	N-2008-06-S	Cap, #8	3
20	Z-5525	Reservoir, 30 gallon (113.4 lt)	1
21	N-2206-09-S	Plug, Hex Head, 2" NPT	1

10.8 RESERVOIR ASSEMBLY *(continued)*

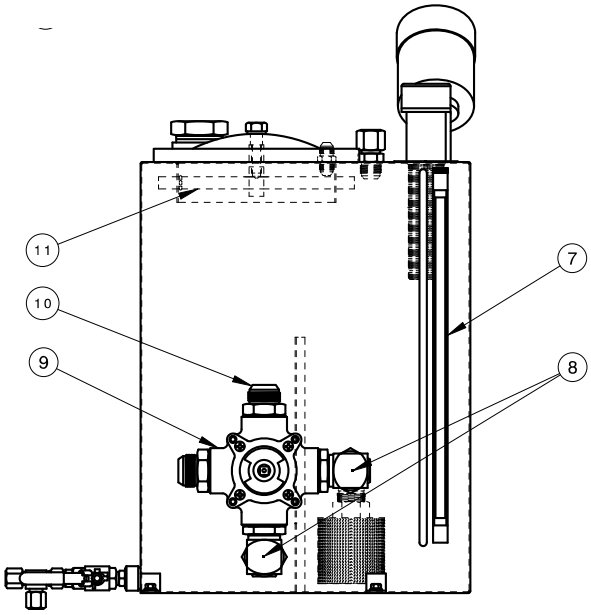

FIGURE 10.8 **– Reservoir Assembly**

PARTS LIST

Fluid Type: MIL-H-5606

Item	Part Number	Description	Qty
7	HC-1382-18	Sight Gauge	1
8	N-2049-20-S-B	Elbow, 90° Swivel, #20	2
9	HC-1764-01	Selector Valve, #20 SAE	1
10	N-2007-28-S-B	Connector, Straight Thread #20 SAE	2
11	Z-2394-01	Clamp Assembly	1

10.0 Maintenance continued on the following page.

10.0 MAINTENANCE *(continued)*

10.9 RETURN MANIFOLD ASSEMBLY

Refer to Section ***10.5.2 – Return Filter*** for information on changing filter element.

NOTE: DO NOT attempt to adjust the Return System Pressure Relief Valve. See Section 10.9.1 – Return System Pressure Relief Valve for details.

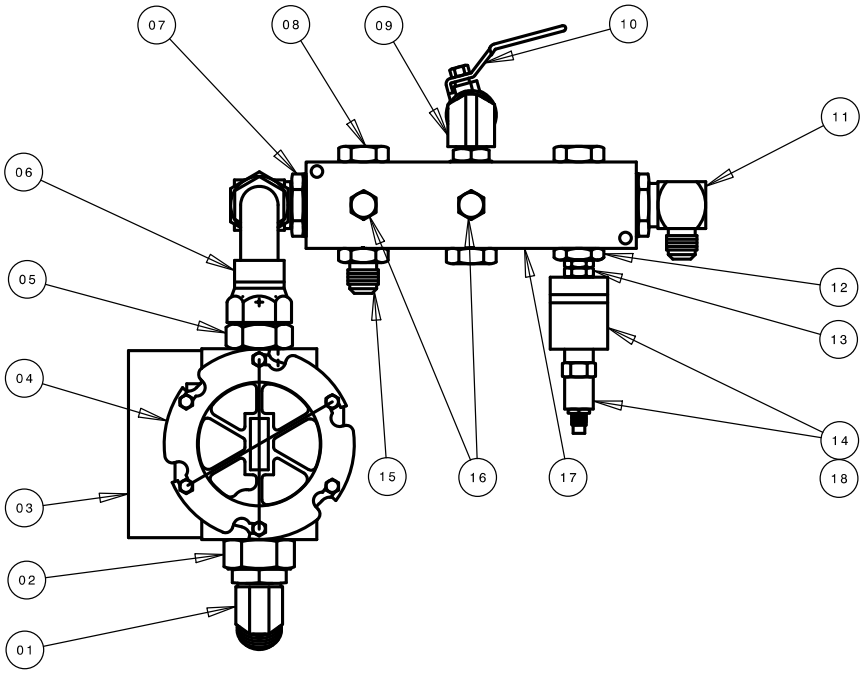

FIGURE 10.9 **– Return Manifold Assembly**

PARTS LIST

Fluid Type: MIL-H-5606

Item	Part Number	Description	Qty
1	N-2042-13-S-B	Elbow, 45° Straight Thread #20 JIC x #20 SAE	1
2	N-2463-25-S-B	Fitting, Reducer/Expander 24/20 SAE	1
3	H-1581	Bracket, Filter	1
4	HC-1906-01	Filter, Return	1
5	N-2007-30-S-B	Connector, Straight Thread, #20 JIC x #24 SAE	1
6	N-2063-04	Elbow, Bent Swivel Nut	1
7	N-2049-20-S-B	Elbow, 90° Swivel, #20 SAE x #20 JIC	1
8	N-2053-10-S-B	Plug, Hex Head, #16 O-ring	3
9	N-2638-06-S-B	Elbow, 90° #16 SAE x #16 SAE	1
10	HC-1766-05	Valve, Ball	1
11	N-2001-37-S-B	Elbow, 90° #12 JIC x #20 SAE	1
12	N-2463-16-S-B	Fitting, Reducer/Expander 16/8 SAE	1
13	N-2464-06-S-B	Union, Straight Thread #8 x #8 SAE	1
14	HC-2199	Valve, Pressure Relief (*Pre-Set*)	1
15	N-2007-21-S-B	Connector, Straight Thread, #12 JIC x #16 SAE	1
16	N-2053-06-S-B	Plug, Hex Head, #8 O-ring	2
17	HC-2205	Manifold, Return	1
18	N-2001-11-S-B	Elbow, Straight Thread #8 SAE x #8 JIC	1

10.9 RETURN MANIFOLD ASSEMBLY *(continued)*

10.9.1 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.

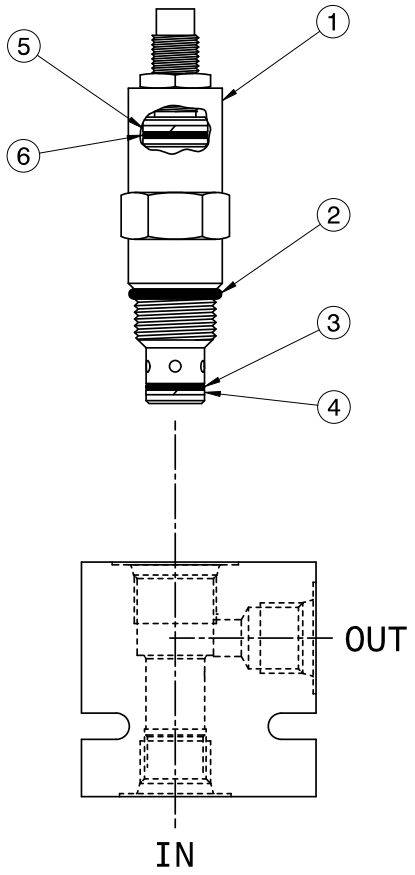

FIGURE 10.9.1 **– Return System Pressure Relief Valve**

PARTS LIST

Fluid Type: MIL-H-5606

Item	Part Number	Description	Qty
1	HC-2199	Pressure Relief Valve *(includes Valve Block)*	1
2	HC-2010-910	O-ring, Series 3	1
3	HC-2000-014	O-ring, Series 2	1
4	HC-2020-014	Backup Ring (Teflon)	1
5	HC-2020-015	Backup Ring (Teflon)	1
6	HC-2000-015	O-ring, Series 2	1

10.0 Maintenance continued on following page.

10.0 MAINTENANCE *(continued)*

10.10 PRESSURE FILTER ASSEMBLY (Single System)

Refer to Section 10.5.1 for information on changing filter element.

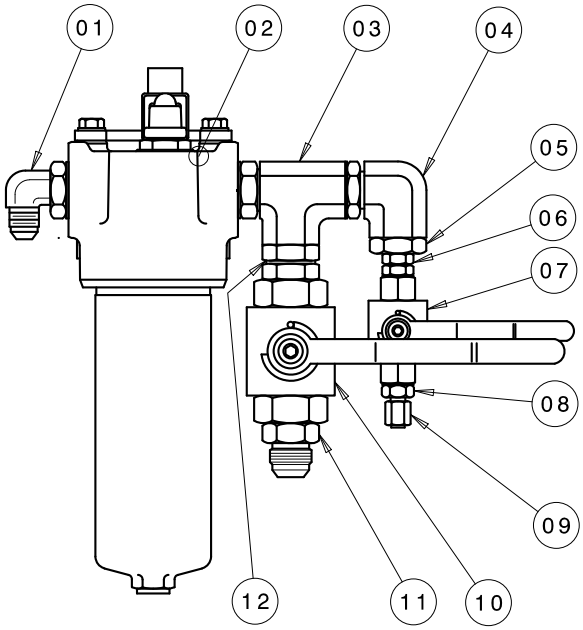

FIGURE 10.10 **– Pressure Filter Assembly**

PARTS LIST

Fluid Type: MIL-H-5606

Item	Part Number	Description	Qty
1	N-2001-18-S-B	Elbow, Straight Thread #8-12	1
2	HC-1907-01	Filter, Pressure	1
3	N-2660-05-S-B	Tee, Straight Thread #12	1
4	N-2661-05-S-B	Elbow, Straight Thread #12	1
5	N-2463-35-S-B	Union, Straight Thread #12 Male x #6 Female	1
6	N-2464-05-S-B	Union, Male Straight Thread #6	1
7	HC-1768-02	Valve, Ball SAE #6	1
8	N-2007-05-S-B	Connector, Straight Thread #6 SAE x ¼ JIC	1
9	N-2008-03-S	Cap, #4 Female	1
10	HC-1768-04	Valve, Ball SAE #12	1
11	N-2007-18-S-B	Connector, Straight Thread #12	1
12	N-2464-08-S-B	Union, Male Straight Thread #12	1

10.0 MAINTENANCE *(continued)*

10.11 ELECTRICAL COMPONENTS

Regularly inspect the external power cord for nicks, cuts, abrasion, and fluid damage. Replace power cord if damage is found. See Section ***11.0 – Provision of Spares*** for recommended spare fuses.

Reference Pages 46 & 47 for Parts Lists.

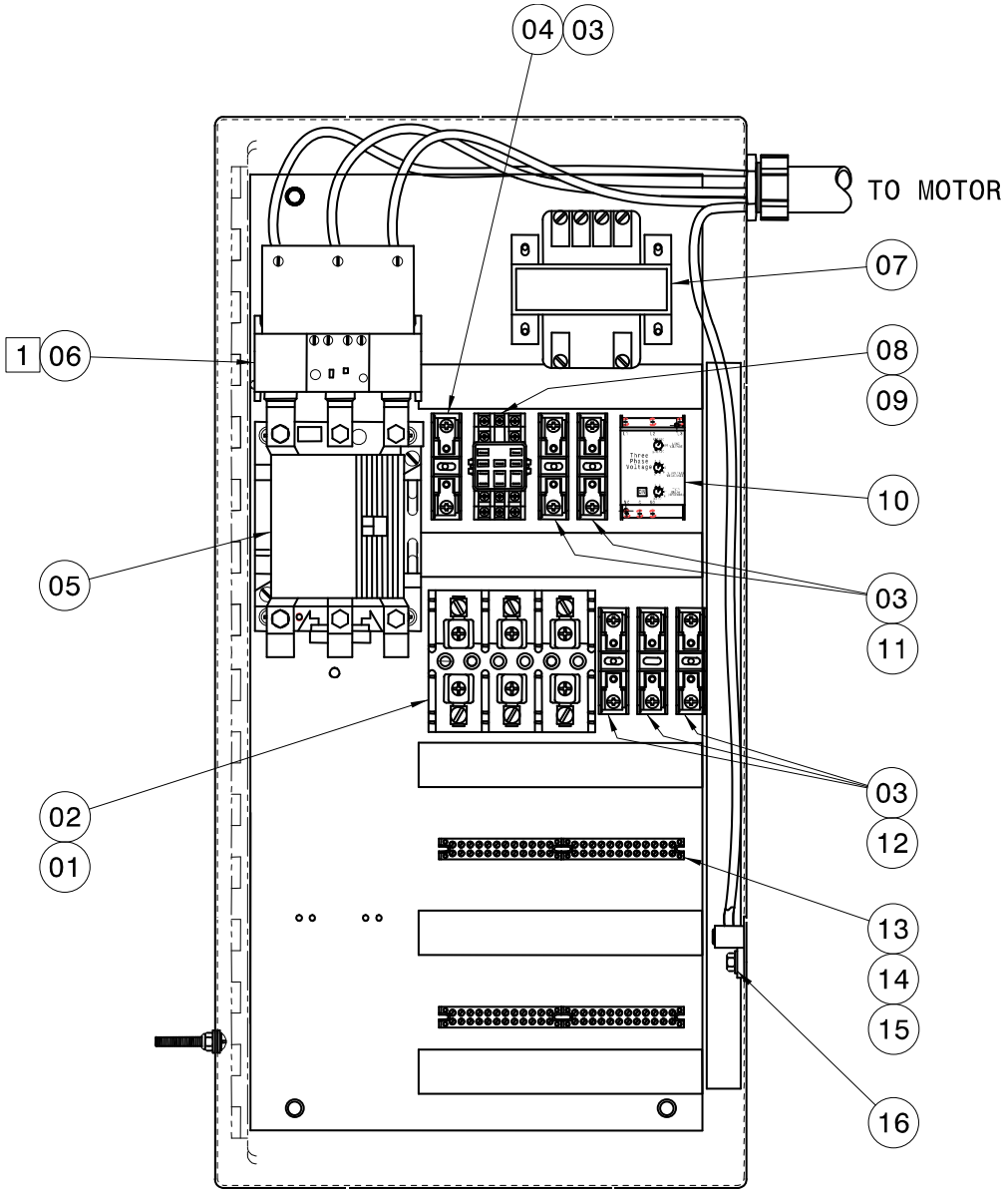

FIGURE 10.11 **– Electrical Components**

1 Set Item 06 to "Auto" and set "A2" to its corresponding full load amps. Wire per Appendix - Electrical Schematic INS-1725 and wire diagram INS-1747.

10.11 Electrical Components continued on following page.

10.11 ELECTRICAL COMPONENTS *(continued)*

PARTS LIST

Item	60 Hz Applications					Description	Qty
	208	230	380	460	575		
1	EC-1674	EC-1674	EC-1674	EC-1674	EC-1674	Fuse Holder, Class J	1
2	EC-1557-02	EC-1557-02	EC-1557-01	EC-1557-01	EC-1557-01	Fuse, Class J	3
3	EC-1420	EC-1420	EC-1420	EC-1420	EC-1420	Fuse Block, Single Pole	6
4	EC-1542-04	EC-1542-04	EC-1542-04	EC-1542-04	EC-1542-04	Fuse, LP-CC-Low Peak	1
5	EC-1537	EC-1587	EC-1587	EC-1586	EC-1586	Contactor, IEC Motor	1
6	EC-1533	EC-1525	EC-1525	EC-1589	EC-1589	Relay, Overload	1
7	EC-1804-02	EC-1676-02	EC-1804-02	EC-1676-02	EC-1804-02	Transformer (100 W)	1
8	EC-1677	EC-1677	EC-1677	EC-1677	EC-1677	Relay Socket *(Option R)*	1
9	EC-1678	EC-1678	EC-1678	EC-1678	EC-1678	Relay *(Option R)*	1
10	EC-1543-02	EC-1543-02	EC-1543-03	EC-1543-04	EC-1543-05	Phase/Voltage Monitor *(Option G-J)*	1
11	EC-1726-09	EC-1726-08	EC-1726-05	EC-1726-04	EC-1726-04	Fuse, Class CC	2
12	EC-1419-09	EC-1419-09	EC-1419-09	EC-1419-09	EC-1419-09	Fuse, KTK, 2 amp *(Option G-J)*	3
13	EC-1784	EC-1784	EC-1784	EC-1784	EC-1784	Direct Mount Terminal	6
14	EC-1786	EC-1786	EC-1786	EC-1786	EC-1786	Insulation Sleeve	1
15	EC-1785	EC-1785	EC-1785	EC-1785	EC-1785	Comb Jumper	1
16	EC-1532-01	EC-1532-01	EC-1532-01	EC-1532-01	EC-1532-01	Ground Lug	1
Not Shown	EC-1544	N/A	N/A	N/A	N/A	Kit, Terminal Lug	2
Not Shown	N/A	EC-1607	EC-1607	EC-1607	EC-1607	Block, Auxiliary Contact	1
Not Shown	EC-1227-03*0600	EC-1227-03*0600	EC-1227-02*0600	EC-1171-02*0600	EC-1171-02*0600	External Power Cord	1

10.11 ELECTRICAL COMPONENTS *(continued)*

PARTS LIST

Item	50 Hz Applications					Description	Qty
	200	220	380	415	440		
1	EC-1674	EC-1674	EC-1674	EC-1674	EC-1674	Fuse Holder, Class J	1
2	EC-1557-04	EC-1557-04	EC-1557-01	EC-1557-01	EC-1557-01	Fuse, Class J	3
3	EC-1420	EC-1420	EC-1420	EC-1420	EC-1420	Fuse Block, Single Pole	6
4	EC-1542-04	EC-1542-04	EC-1542-04	EC-1542-04	EC-1542-04	Fuse, LP-CC-Low Peak	1
5	EC-1587	EC-1587	EC-1586	EC-1586	EC-1586	Contactor, IEC Motor	1
6	EC-1525	EC-1525	EC-1589	EC-1589	EC-1589	Relay, Overload	1
7	EC-1804-02	EC-1804-02	EC-1804-02	EC-1804-02	EC-1804-02	Transformer (100 W)	1
8	EC-1677	EC-1677	EC-1677	EC-1677	EC-1677	Relay Socket *(Option R)*	1
9	EC-1678	EC-1678	EC-1678	EC-1678	EC-1678	Relay *(Option R)*	1
10	EC-1543-02	EC-1543-02	EC-1543-03	EC-1543-04	EC-1543-04	Phase/Voltage Monitor *(Option G-J)*	1
11	EC-1726-10	EC-1726-09	EC-1726-05	EC-1726-05	EC-1726-04	Fuse, Class CC	2
12	EC-1419-09	EC-1419-09	EC-1419-09	EC-1419-09	EC-1419-09	Fuse, KTK, 2 amp *(Option G-J)*	3
13	EC-1784	EC-1784	EC-1784	EC-1784	EC-1784	Direct Mount Terminal	6
14	EC-1786	EC-1786	EC-1786	EC-1786	EC-1786	Insulation Sleeve	1
15	EC-1785	EC-1785	EC-1785	EC-1785	EC-1785	Comb Jumper	1
16	EC-1532-01	EC-1532-01	EC-1532-01	EC-1532-01	EC-1532-01	Ground Lug	1
Not Shown	EC-1607	EC-1607	EC-1607	EC-1607	EC-1607	Block, Auxiliary Contact	1
Not Shown	EC-1227-03*0600	EC-1227-03*0600	EC-1171-02*0600	EC-1171-02*0600	EC-1171-02*0600	External Power Cord	1

10.0 Maintenance continued on following page.

10.0 MAINTENANCE *(continued)*

10.12 HEAT EXCHANGER ASSEMBLY

The Heat Exchanger Assembly does not require regular general maintenance.

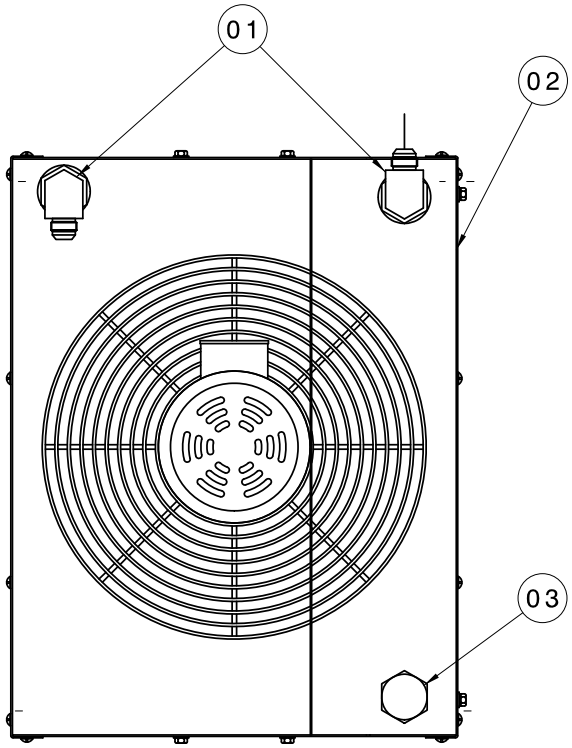

FIGURE 10.12 **– Heat Exchanger Assembly**

PARTS LIST

Fluid Type: MIL-H-5606

Item	Part Number	Description	Qty
1	N-2001-37-S-B	Elbow, Straight Thread (12-20)	1
2	*Reference Table below*	Heat Exchanger	1
3	N-2066-20-S-B	Plug, O-ring #20	1

Voltage	Frequency	Part Number
208v	60 Hz	HC-2136-01
230v	60 Hz	HC-2136-01
380v	60 Hz	HC-2136-01
460v	60 Hz	HC-2136-01
575v	60 Hz	HC-2136-02
200v	50 Hz	HC-2136-01
220v	50 Hz	HC-2136-01
380v	50 Hz	HC-2136-01
415v	50 Hz	HC-2136-01
440v	50 Hz	HC-2136-01

10.0 MAINTENANCE *(continued)*

10.13 EXTERNAL COMPONENTS

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

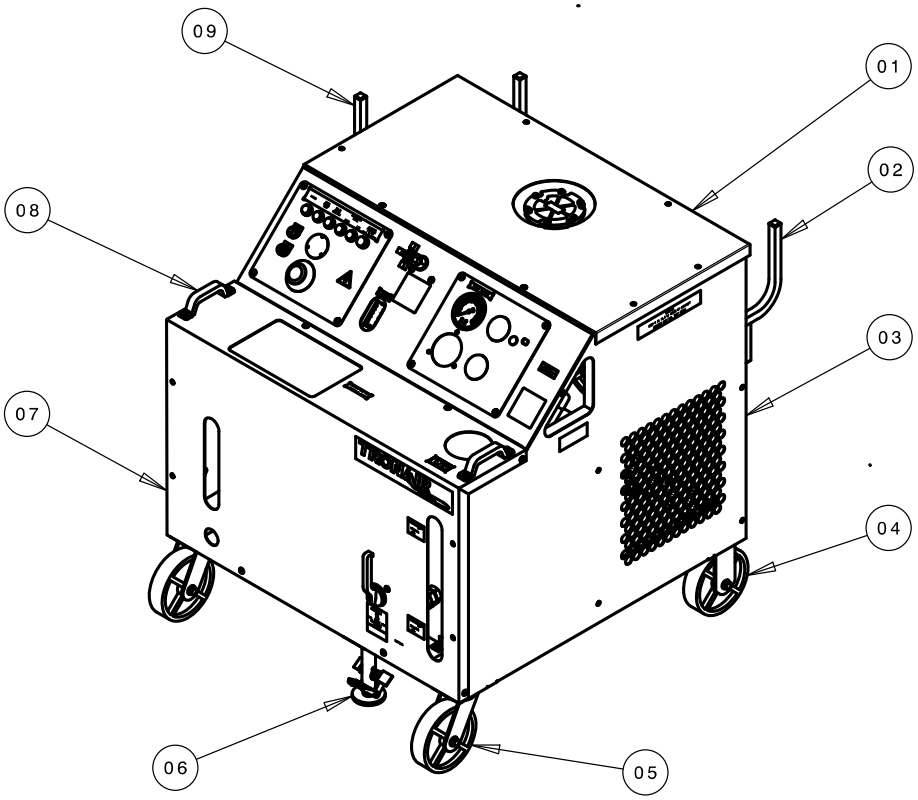

FIGURE 10.13 **– External Components**

PARTS LIST

Fluid Type: MIL-H-5606

Item	Part Number	Description	Qty
1	S-1889-01	Top Panel	1
2	Z-5772-01	Hanger	2
3	S-1887-01	Right Side Panel	1
4	U-1093	Rigid Caster	2
5	U-1094	Swivel Caster	2
6	H-1142	Floor Lock	1
7	S-1883-01	Front Panel	1
8	H-1780	Handle	1
9	Z-5549-01	Cord Hanger	1
Not Shown	S-1884-01	Left Side Panel	1
Not Shown	Z-5775-01	Frame	1

10.0 Maintenance continued on following page.

10.0 MAINTENANCE *(continued)*

10.14 ADDITIONAL FEATURES

10.14.1 50 ft (15.24 m) Hoses *(Option B)*

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

PARTS LIST

Fluid Type: MIL-H-5606

Part Number	Description	Qty
TF-1038-10*300	Pressure Hose, 25 ft (7.62 m)	1 per Option
TF-1039-02*300	Return Hose, 25 ft (7.62 m)	1 per Option
N-2011-10-S	Union, #16	1 per Option
N-2011-08-S	Union, #12	1 per Option

10.14 ADDITIONAL FEATURES *(continued)*

10.14.2 Dual System *(Option C)*

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

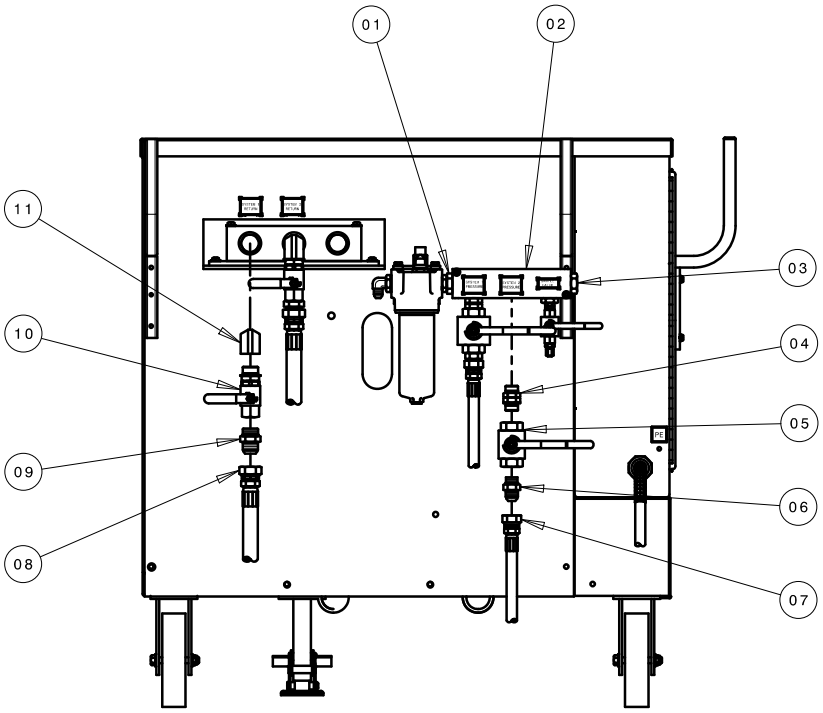

FIGURE 10.14.2 **– Dual System**

PARTS LIST

Fluid Type: MIL-H-5606

Item	Part Number	Description	Qty
1	N-2464-14-S-B	Union, Male Straight Thread #12 x #16	1
2	HC-1908	Pressure Manifold (Plated)	1
3	N-2053-10-S-B	Plug, Male Straight Thread #16	1
4	N-2464-08-S-B	Union, Male Straight Thread #12	1
5	HC-1768-04	Ball Valve	1
6	N-2007-18-S-B	Connector, Straight Thread #12	1
7	TF-1038-10*300	Pressure Hose Assembly, #12	1
8	TF-1039-02*300	Return Hose Assembly, #16	1
9	N-2007-24-S-B	Connector, Straight Thread #16	1
10	HC-1766-05	Ball Valve, #16 SAE	1
11	N-2638-06-S-B	Elbow, 90° #16 M-SAE x #16 F-SAE	1

10.0 Maintenance continued on following page.

10.14 ADDITIONAL FEATURES *(continued)*

10.14.3 Crossover Check *(Option D)*

Refer to Section ***10.6 Hydraulic Hoses*** concerning hose inspection. Annual calibration of instrumentation is recommended. See Section ***12.0 – Calibration of Instrumentation*** for details of gauge calibration.

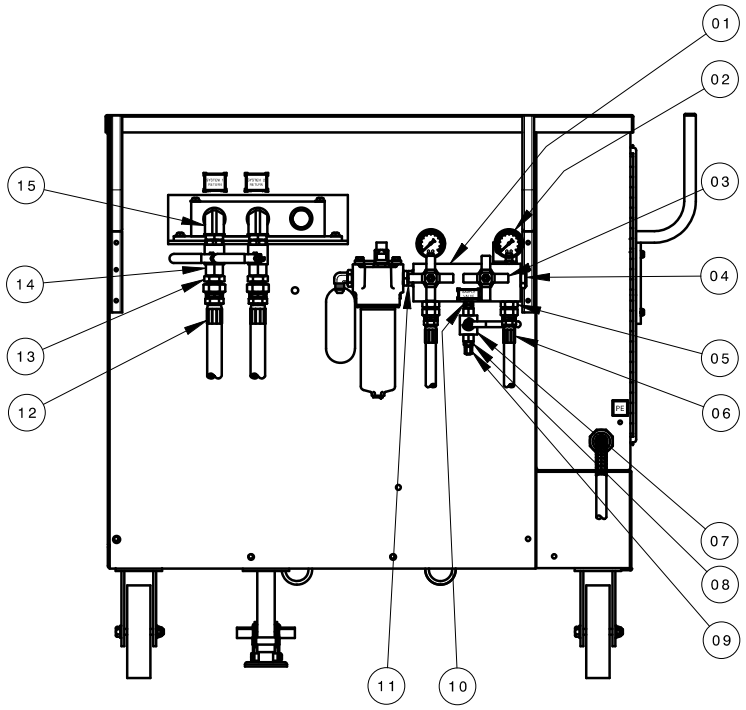

FIGURE 10.14.3 **– Crossover Check**

PARTS LIST

Fluid Type: MIL-H-5606

Item	Part Number	Description	Qty
1	J-3516	Crossover Check Manifold	1
2	HC-1257	Pressure Gauge	2
3	HC-1254-05	Cartridge Needle Valve	2
4	HC-1437	Check Valve	1
5	N-2007-18-S-B	Connector, Straight Thread	2
6	TF-1038-10*300	Pressure Hose Assembly	2
7	HC-1768-02	Ball Valve (#6)	1
8	N-2007-05-S-B	Connector, Straight Thread	1
9	N-2008-03-S	Cap, #4 Female	1
10	N-2464-05-S-B	Union, Straight Thread #6 SAE	1
11	N-2464-08-S-B	Union, Straight Thread #12 SAE	1
12	TF-1039-02*300	Return Hose Assembly	2
13	N-2007-24-S-B	Connector, Straight Thread	2
14	HC-1766-05	Ball Valve (#16)	2
15	N-2638-06-S-B	Elbow, 90° (#16 SAE)	2

10.14 ADDITIONAL FEATURES *(continued)*

10.14.4 Hour Meter *(Options E and F)*

The Hour Meter does not require regular general maintenance.

NOTE: ***Wire Hour Meter per Appendix – Electrical Schematic INS-1725. Reference Appendix – Wire Diagram INS-1747.***

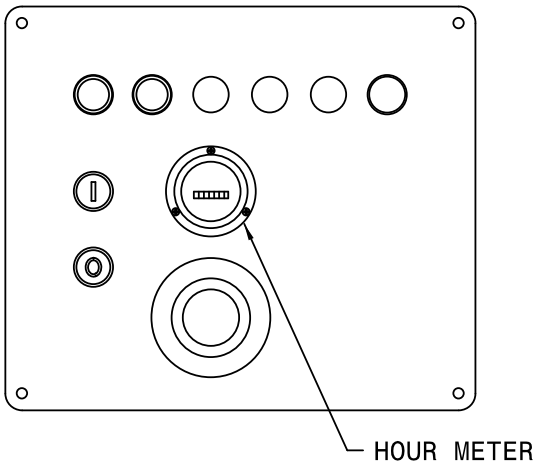

FIGURE 10.14.4 **– Hour Meter**

PARTS LIST

Part Number	Application	Description	Qty
EC-1577	50 Hz Operation	Hour Meter	1
EC-1578	60 Hz Operation	Hour Meter	1

10.14 Additional Features continued on following page.

10.14 ADDITIONAL FEATURES *(continued)*

10.14.5 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 ***11.0 – Provision of Spares*** for recommended spare fuses.

NOTE: ***Wire per Appendix – Electrical Schematic INS-1725. Reference Appendix – Wiring Diagram INS-1747. Reference Section 10.7.1 Electrical Panel (Page 35) for Panel Light.***

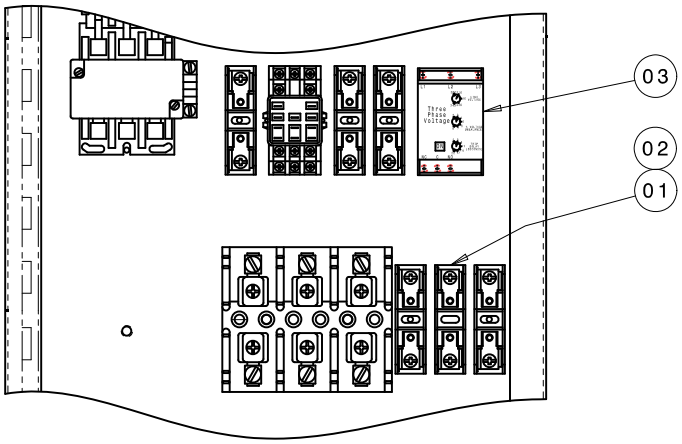

FIGURE 10.14.5 **– Voltage/Phase Monitor**

PARTS LIST

Item	Part Number	Description	Qty
1	EC-1420	Fuse Block, Single Pole	3
2	EC-1419-09	Fuse, KTK, 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.

10.14 ADDITIONAL FEATURES *(continued)*

10.14.6 Pyrometer *(Option K)*

Refer to Section ***12.6 – Analog Temperature Gauge*** when calibration of the pyrometer is desired.

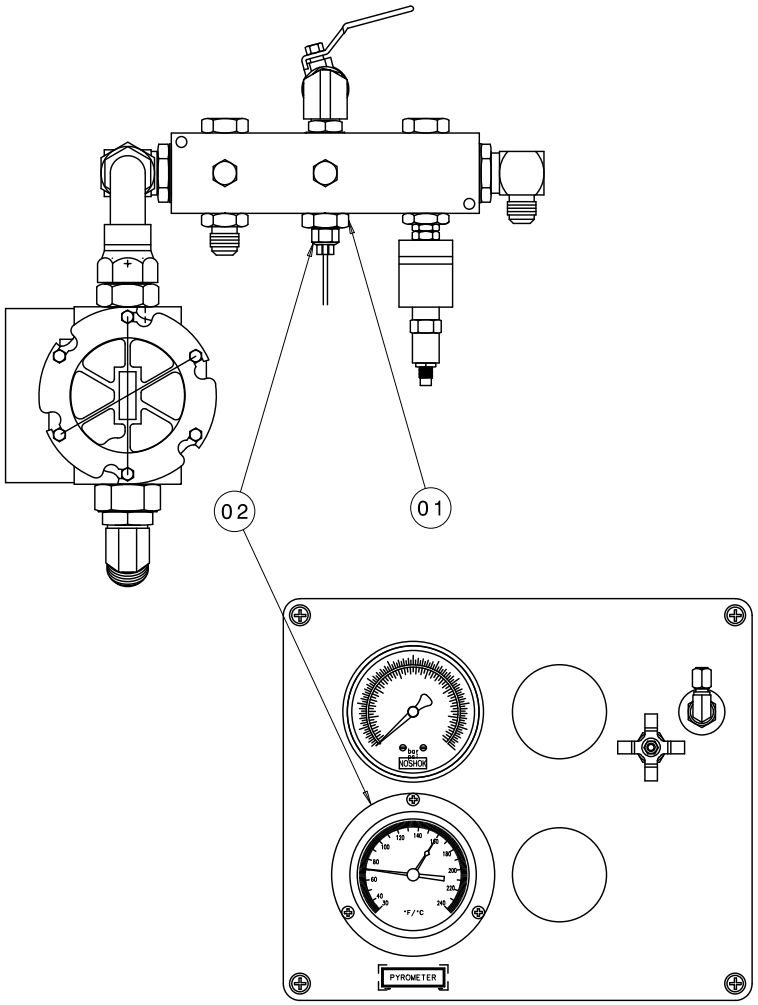

FIGURE 10.14.6 – **Pyrometer**

PARTS LIST

Fluid Type: MIL-H-5606

Item	Part Number	Description	Qty
1	N-2463-16-S-B	Reducer Fitting	1
2	HC-1769-01	Pyrometer	1

10.0 Maintenance continued on following page.

10.14 ADDITIONAL FEATURES *(continued)*

10.14.7 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 Appendix – Electrical Schematic INS-1725. Reference Appendix – Wiring Diagram INS-1747. Reference Section 10.7.1 Electrical Panel (Page 35) for Panel Light.

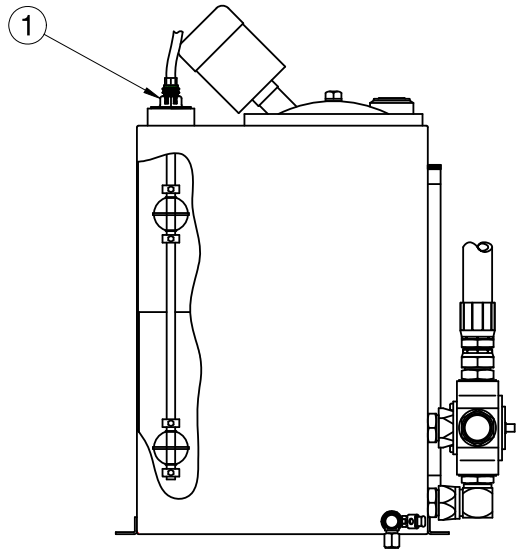

***FIGURE 10.14.7* – Electric Reservoir Level**

PARTS LIST

Item	Part Number	Description	Qty
1	EC-1798	Multi-Level Switch *(includes Plug-in Cable)*	1

This page left blank intentionally.

10.14 ADDITIONAL FEATURES *(continued)*

10.14.8 Hand Pump *(Option M)*

Refer to Section ***10.6 Hydraulic Hoses*** concerning hose inspection for general maintenance on Items 5, 10, 12, and 14 hose assemblies. Refer to Section ***10.5.3 – Hand Pump*** *(Optional)* ***Filter*** *.*

Reference Parts List on following page.

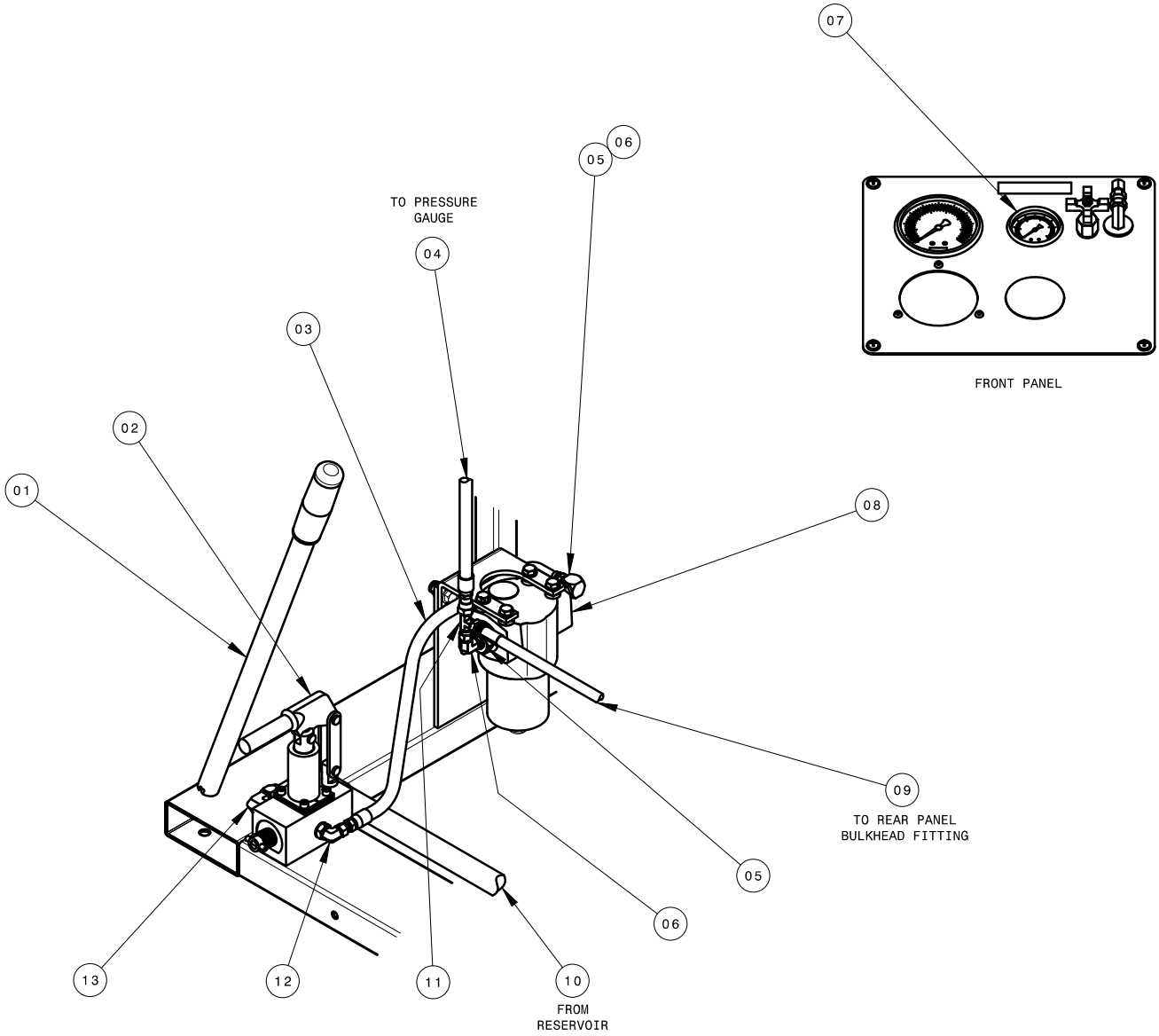

FIGURE 10.14.8 **– Hand Pump**

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

PARTS LIST

Fluid Type: MIL-H-5606

Item	Part Number	Description	Qty
1	H-1009-01	Pump Handle	1
2	HC-1778	Hand Pump, Two Stage	1
3	TF-1038-15*20.0	Hose Assembly, #4	1
4	TF-1038-16*38.5	Hose Assembly, #4	1
5	N-2463-10-S-B	Reducer Fitting	2
6	N-2001-06-S-B	Elbow, #8 SAE x #4 JIC Flare	1
7	HC-2146	Pressure Gauge	1
8	HC-1776	Pressure Filter	1
9	TF-1038-14*41.0	Hose Assembly, #4	1
10	TF-1038-08*15.5	Hose Assembly, #8	1
11	N-2016-03-S	Tee, Swivel Nut, #4	1
12	N-2001-05-S-B	Elbow, #6 SAE x #4 JIC Flare	1
13	N-2001-11-S-B	Elbow, #8 SAE x #8 JIC Flare	1
Not Shown	N-2002-03-S	Elbow, Bulkhead, #4 JIC	1
Not Shown	TF-1038-14*180	Assembly, Hose #4	1
Not Shown	N-2055-01-S	Reducer, Tube (6-4)	1
Not Shown	N-2014-05-S	Plug, #6	1

10.0 Maintenance continued on following page.

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

10.14.8.a Two Stage Pump with Relief

Reference Page 61 for Parts List.

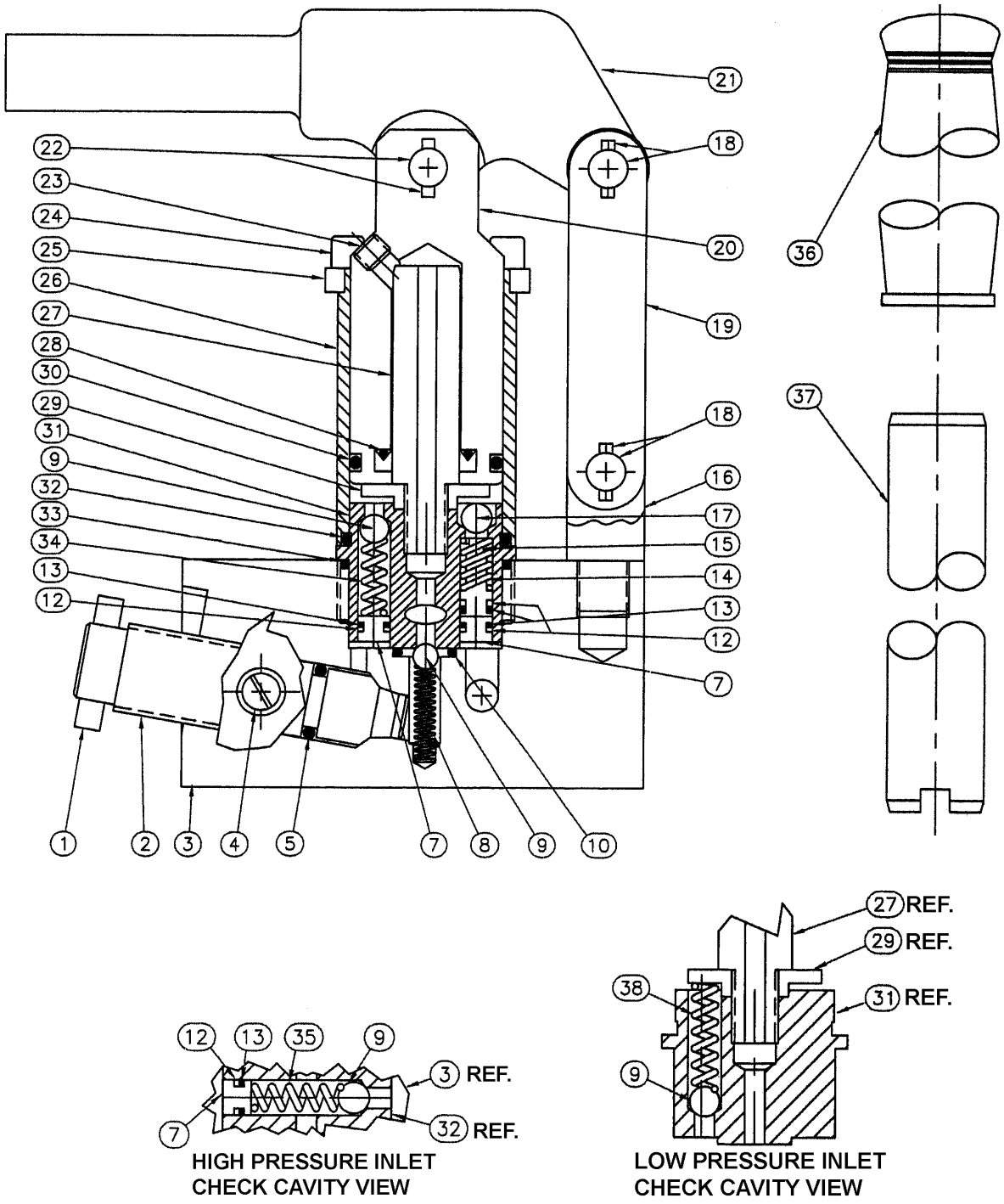

FIGURE 10.14.8.a **– Two Stage Pump with Relief**

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

PARTS LIST

Fluid Type: MIL-H-5606

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-1029	**Kit, Pump Seal**; *consists of:*	
5		O-ring, BUNA	1
10		O-ring, BUNA	1
12		Backup Ring (Teflon)	4
13		O-ring, BUNA	4
28		H.P. Piston Seal	1
30		O-ring, BUNA	1
32		O-ring, BUNA	1
33		O-ring, BUNA	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-3118	**Kit, Release Screw**; *consists of:*	
2		Screw, Release/Relief	1
4		Retainer, Release Screw	1

10.14. Additional Features continued on following page.

10.14 ADDITIONAL FEATURES *(continued)*

10.14.9 Calibration Port *(Option Q)*

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

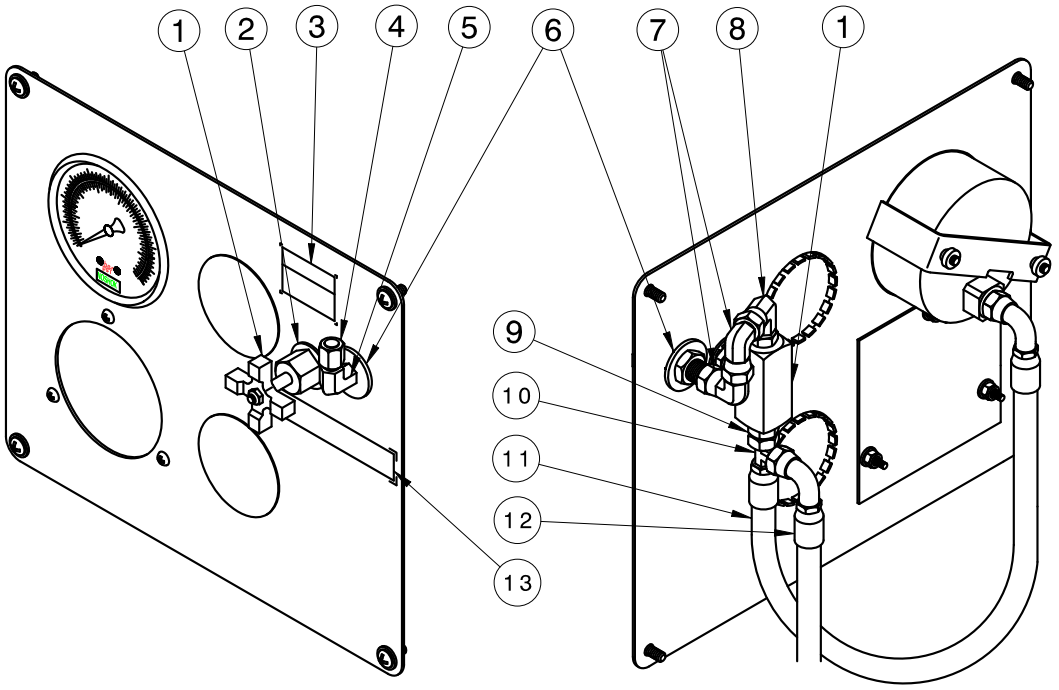

FIGURE 10.14.9 – **Calibration Port**

PARTS LIST

Fluid Type: MIL-H-5606

Item	Part Number	Description	Qty
1	HC-1900-01	Needle Valve	1
2	HC-1122	Kit, Panel Mounting (MVK-4)	1
3	V-1470	Label, Caution	1
4	N-2008-03-S	Cap, ¼, #4 JIC	1
5	N-2022-03-S	Elbow, Bulkhead Union with Locknut #4	1
6	G-1250-1080W	Flatwasher, 7/16 Wide	2
7	N-2002-03-S	Elbow, Swivel Nut #4	2
8	N-2049-07-S-B	Elbow, 90° Swivel & O-ring #4 x #6	1
9	N-2007-05-S-B	Connector, Straight Thread #4 JIC x #6 SAE	1
10	N-2016-03-S	Tee, Swivel Nut Run, #4	1
11	TF-1038-16*23.0	Hose Assembly, #4	1
12	TF-1038-16*23.0	Hose Assembly, #4	*Ref*
13	V-1888	Label, Shut-Off Calibration	1

10.14 ADDITIONAL FEATURES *(continued)*

10.14.10 Electric Filter Clogging Indicator *(Option R)*

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.

NOTES: 1) 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 10 gpm but not show a clogged condition when the flow rate is reduced to 5 gpm.

2) Wire per Appendix – Electrical Schematic INS-1725. Reference Appendix – Wiring Diagram INS-1747. Reference 10.7.1 Electrical Panel (Page 35) for Panel Light.

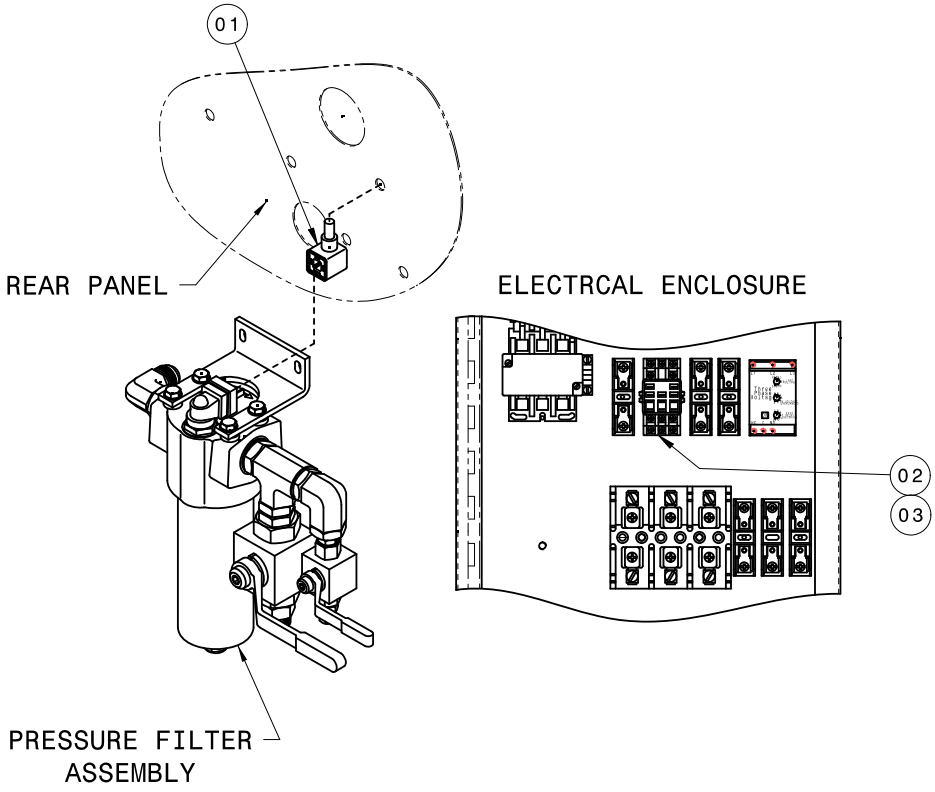

FIGURE 10.14.10 – **Electric Filter Clogged Indicator**

PARTS LIST

Item	Part Number	Description	Qty
1	EC-1778	DIN Connector Cable	1
2	EC-1677	Relay Socket	1
3	EC-1678	Relay	1

10.14 Additional Features continued on following page.

10.14 ADDITIONAL FEATURES *(continued)*

10.14.11 Electric Over-Temperature *(Option S)*

The Electric Over-Temperature switch does not require regular general maintenance. However, automatic shut down due to high fluid temperature is a indication that maintenance or training may be needed elsewhere.

NOTE: ***Wire per Appendix – Electrical Schematic INS-1725. Reference Appendix – Wiring Diagram INS-1747. Reference 10.7.1 Electrical Panel (Page 35) for Panel Light.***

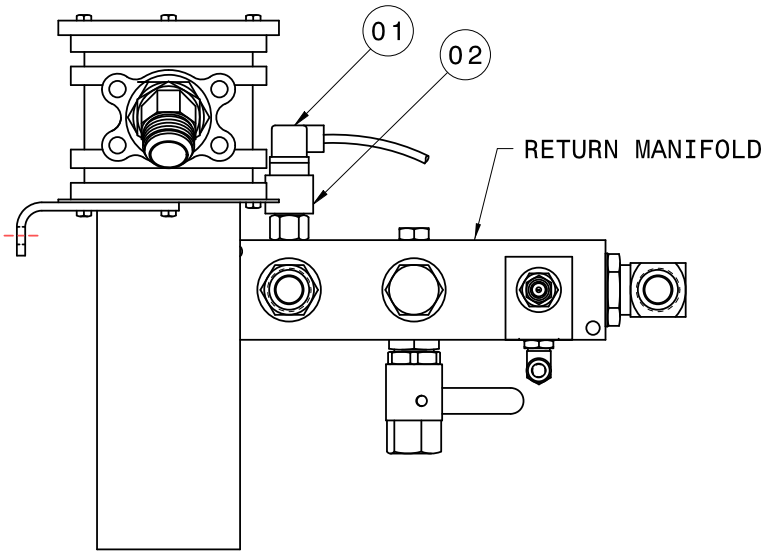

FIGURE 10.14.11 **– Electric Over-Temperature**

PARTS LIST

Fluid Type: MIL-H-5606

Item	Part Number	Description	Qty
1	EC-1778	DIN Connector Cable	1
2	EC-1782-01	Temperature Switch	1

10.14 ADDITIONAL FEATURES (*continued*)

10.14.12 Return Sight Gauge (Option U

Refer to Section ***10.6 Hydraulic Hoses*** concerning hose inspection. Annual calibration of instrumentation is recommended

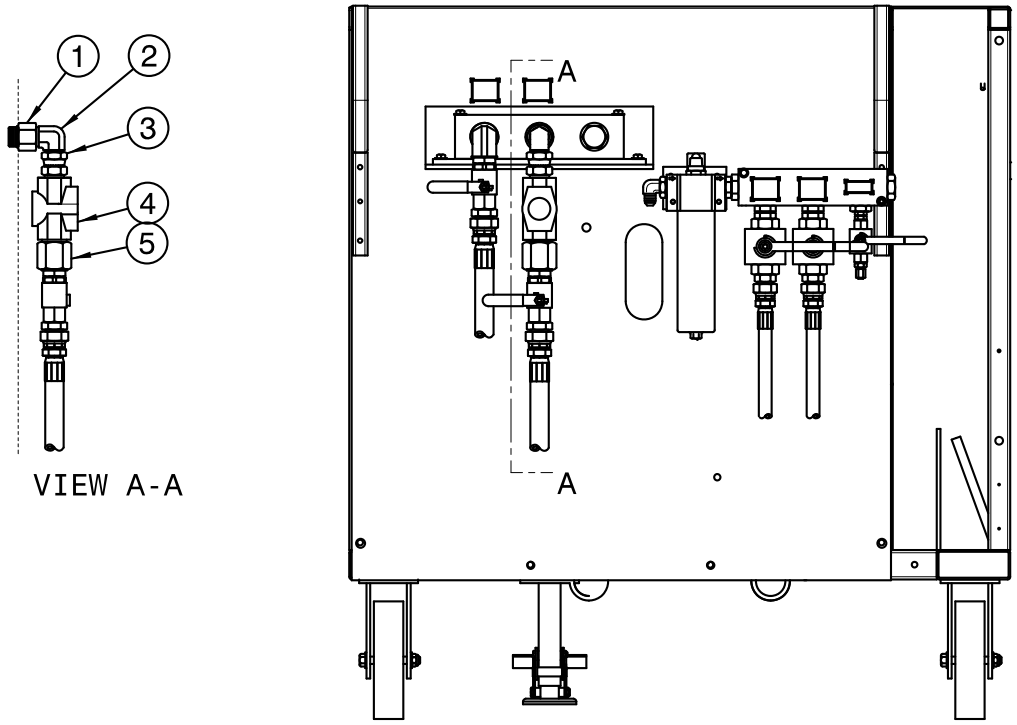

FIGURE 10.14.12 – **Return Sight Gauge**

PARTS LIST

Fluid Type: MIL-H-5606

Item	Part Number	Description	Qty
1	N-2202-15-S-B	Adapter, FEM Pipe, Str Thd (-16 x 1 NPT)	1
2	N-2005-23-S	Elbow, Male (-16 x NPT)	1
3	N-2030-11-S	Swivel, Female (-16 x 1 NPT)	1
4	HC-2261	Sightgauge, Flow 1” NPT	1
5	N-2226-08-S	Connector, Male Pipe	1

10.14 Additional Features continued on following page.

10.0 MAINTENANCE *(continued)*

10.15 REPLACEMENT LABELS PARTS LISTS

10.15.1 Base Unit

Part Number	Description	Qty
V-1001	"Made in USA"	1
V-1033-01	"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-1375	"PRESSURE INCREASE/FLOW INCREASE"	1
V-1882	Control Panel Lights	1
V-1884	"FLOWMETER"	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-1901	Hydraulic Schematic	1
V-1902	Electrical Schematic	1
V-1914	Reservoir Selector Valve	1
V-1918	"PE"	1
V-1919	"OPERATING INSTRUCTIONS . . ."	1

10.15.2 Fluid Label

Part Number	Description	Qty
V-1975	"MIL-H-5606 FLUID ONLY"	2

10.15.3 Filter Element Kit Labels

Fluid Type: MIL-H-5606

Part Number	Description	Qty
V-1905	"REPLACEMENT FILTER ELEMENT K-3493"	1
V-1904	"REPLACEMENT FILTER ELEMENT K-3492"	1
V-1916	"REPLACEMENT DESICCANT FILTER ELEMENT HC-1763"	1

10.15.4 Dual System *(Option C)* and Crossover Check *(Option D)* Labels

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

10.15.5 Pyrometer *(Option K)* Label

Part Number	Description	Qty
V-1886	"PYROMETER"	1

10.15 REPLACEMENT LABELS PARTS LISTS *(continued)*

10.15.6 Hand Pump *(Option M)* Labels

Fluid Type: MIL-H-5606

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

10.15.7 Calibration Port *(Option Q)* Labels

Part Number	Description	Qty
V-1470	"CAUTION . . ."	1
V-1888	"SHUT-OFF/CALIBRATION PORT"	1

10.15.8 Back-Pressure Valve with Sight Glass *(Option T)* Label

Part Number	Description	Qty
V-1987	"RETURN SYSTEM PRESSURE"	1

11.0 PROVISION OF SPARES

11.1 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

11.2 RECOMMENDED SPARE PARTS LISTS

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

11.2.1 Spare Electrical Parts

Part Number	Description	Qty
Refer to Section 10.11 Electrical Components Item 11	Fuse, Transformer Primary	2
EC-1542-04	Fuse, Transformer Secondary	1
Refer to Section 10.11 Electrical Components Item 2	Fuse, Heat Exchanger	3
EC-1419-09	Fuse, Phase Monitor *(Optional)*	3

11.2.2 Spare Parts

Fluid Type: MIL-H-5606

Part Number	Description	Qty
HC-1763	Desiccant Filter Element	1
K-1996	Kit, Gaskets and O-rings for Main Pump	1
K-3492	Kit, Pressure Filter Element	1
K-3493	Kit, Return Filter Element	1
K-2405	Kit, Shaft Seal and Retainer for Main Pump	1
K-3751	Kit, Hand Pump Filter Element *(Optional)*	1

12.0 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***.

12.1 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

12.2 ANALOG PRESSURE GAUGE – System Pressure

12.2.1 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 (3,500 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.

12.2.1 Self Calibration *(continued)*

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	940	1060	Increasing	
2000	1940	2060	Increasing	
3000	2940	3060	Increasing	
4000	3940	4060	Increasing	
5000	4940	5060	Increasing	
6000	5940	6060	Increasing	
5000	4940	5060	Decreasing	
4000	3940	4060	Decreasing	
3000	2940	3060	Decreasing	
2000	1940	2060	Decreasing	
1000	940	1060	Decreasing	
Allowable operating tolerance: +/- 1% of full scale (60 psig) at room temperature (70° F).				

12.0 Calibration Of Instrumentation continued on following page.

12.0 CALIBRATION OF INSTRUMENTATION *(continued)*

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

12.3.1 Self Calibration

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

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

HAND PUMP PRESSURE GAUGE (HC-2146)

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

12.0 CALIBRATION OF INSTRUMENTATION *(continued)*

12.4 ANALOG PRESSURE GAUGES (Crossover Check- *Option D Only*)

12.4.1 Self Calibration

An accurate pressure calibration gauge is required for calibration of the Crossover Check pressure gauges. See Section ***10.14.4 – Crossover Check*** for location. Follow the necessary steps below.

1. Shut off the HPU and disconnect it from the power source.
2. Remove the Crossover Check pressure gauges from the rear pressure manifold.
3. Attach calibration test equipment to each gauge and record gauge values at the designated increments.

CROSSOVER CHECK PRESSURE GAUGES (HC-1257 / HC-1928)

Applied Pressure (Crossover Check Pressure Gauges) (psig)	Minimum Acceptable (psig)	Maximum Acceptable (psig)	Gauge Movement (Direction)	Indicated Pressure (Calibration Gauge) (psig)
1000	925	1075	Increasing	
2000	1925	2075	Increasing	
3000	2925	3075	Increasing	
4000	3925	4075	Increasing	
5000	4925	5075	Increasing	
4000	3925	4075	Decreasing	
3000	2925	3075	Decreasing	
2000	1925	2075	Decreasing	
1000	925	1075	Decreasing	
Allowable operating tolerance: +/- 1.5% of full scale (75 psig) at room temperature (70° F).				

12.5 ANALOG TEMPERATURE GAUGE (Pyrometer- *Option K Only*)

12.5.1 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 ***10.13.7 – 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)
140	139	141	

13.0 IN SERVICE SUPPORT

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

14.0 GUARANTEES

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.

15.0 APPENDICES

I Hydraulic Schematic (INS-1602)
II Electrical Schematic (INS-1725)
III Wiring Diagram (INS-1747)
IV Lincoln Motor Manual
V Oilgear Pump Manual
VI Material Safety Data Sheet (MSDS) pertaining to Hydraulic Fluid
VII ANSI/B93.19M-1972 (R1993-Excerpt)
VIII Instrument Certification Notice

TRONAIR

APPENDIX I

Hydraulic Schematic (INS-1602)

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APPENDIX II

Electrical Schematic (INS-1725)

APPENDIX III

Wiring Diagram (INS-1747)

TRONAIR

APPENDIX IV

Lincoln Motor Manual

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

1. SAFETY DEPENDS ON YOU

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

2. RECEIVING AND INSPECTION

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

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

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

3. HANDLING

⚠ WARNING

FALLING EQUIPMENT can injure.

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

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

4. STORAGE

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

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

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

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

5. INSTALLATION

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

⚠ WARNING

MOVING PARTS can injure.

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

5.1 INSTALLATION – MECHANICAL

Base

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

Position

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

Drains

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

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

Drive – Power Transmission

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

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

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

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

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

5.2 INSTALLATION – ELECTRICAL

⚠ WARNING

ELECTRIC SHOCK can kill.

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

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

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

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

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

Properly ground the motor – See GROUNDING.

Terminal Box

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

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

Motor Connection

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

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

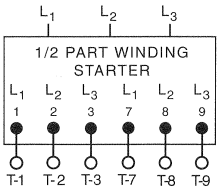
Number of Motor Leads	Number of Rated Voltages	Lead Numbers	YDS	PWS
3	Single	1-3	No	No
6	Single	1-3, 7-9	No	Yes
	Single	1-6	Yes	No
	Dual	1-6	Yes(1)	No
9	Dual	1-9	No	No
12	Single	1-12	Yes	Yes
	Dual	1-12	Yes	No(2)

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

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

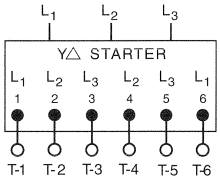
Connection Diagram 1

Single Voltage, 6 Leads
Part Winding Start Connection



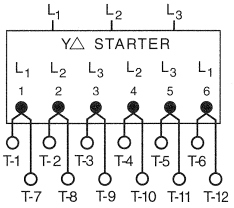
Connection Diagram 2

Single Voltage, 6 Leads
Y△ Start Connection



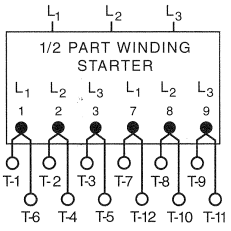
Connection Diagram 3

Single Voltage, 12 Leads
Y△ Start Connection



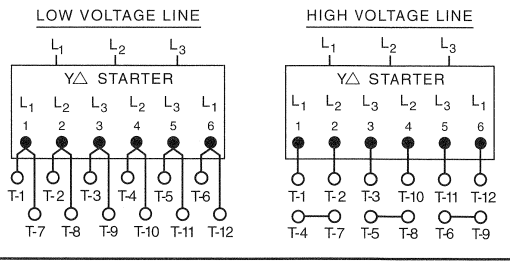
Connection Diagram 4

Single Voltage, 12 Leads
Part Winding Start Connection



Connection Diagram 5

Dual Voltage, 12 Leads
Y△ Start Connection



Space Heater (option)

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

Thermostat (option)

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

Table 1 — Thermostat Contact Ratings

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

Thermistor (option)

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

Brake (option)

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

GROUNDING

⚠ WARNING

ELECTRIC SHOCK can kill.

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

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

6. OPERATION

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

⚠ WARNING

MOVING PARTS can injure.

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

ELECTRIC SHOCK can kill.

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

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

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

7. MAINTENANCE

⚠ WARNING

ELECTRIC SHOCK can kill.

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

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

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

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

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

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

BEARING SYSTEM

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

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

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

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

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

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

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

Table 2 : Bearing Lubrication Intervals

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

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

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

⚠ CAUTION

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

PARTS

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

8. WHO TO CALL

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

9. WARRANTY

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

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

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

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

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

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

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

Lincoln™ MOTORS

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E-Mail: mailbox@lincolnmotors.com

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- indicates change since last printing.

TRONAIR

APPENDIX V

Oilgear Pump Manual

SERVICE INSTRUCTIONS

OILGEAR TYPE "PVWH", "PVWW" AND "PVW" OPEN LOOP VARIABLE DISPLACEMENT PUMPS

PURPOSE OF INSTRUCTIONS

These instructions are written to simplify your work when installing, operating and maintaining these Oilgear pumps. Your acquaintance with the construction, principle of operation and characteristics of these units will help you attain satisfactory performance, reduce down-time and increase the units life. Some units have been modified from those described in this bulletin and other changes may be made without notice.

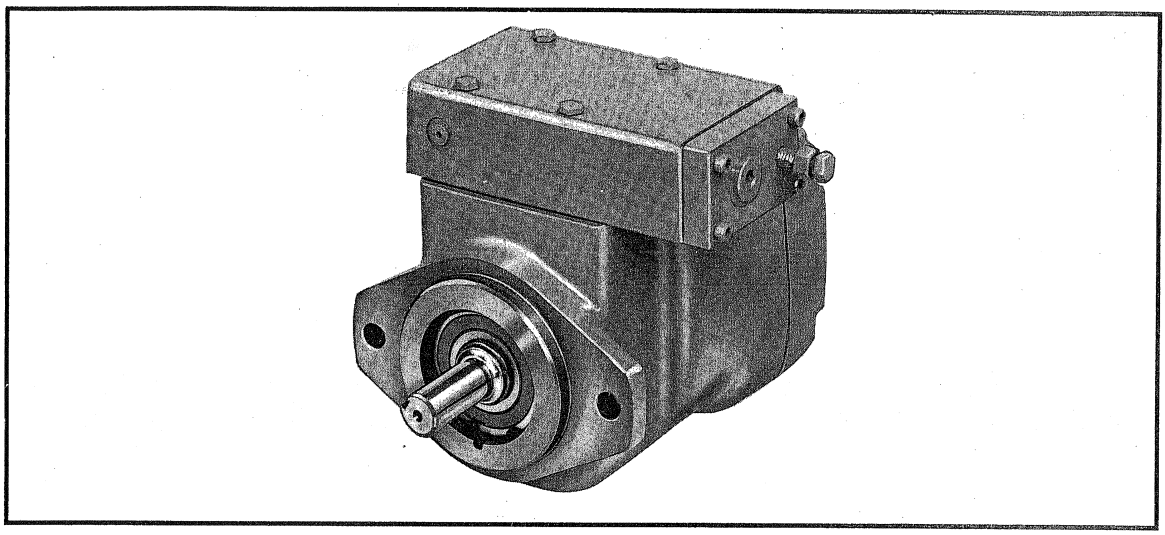


Figure 1. Typical Oilgear "PVWH" Open Loop Pump (55503R).

REFERENCE MATERIAL

Specifications, "PVWW" Pumps	Bulletin	47013
Specifications, "PVW" Pumps	Bulletin	47014
Specifications, "PVWH" Pumps	Bulletin	47015
Fluid Recommendations	Bulletin	90000
Contamination Evaluation Guide	Bulletin	90004
Filtration Recommendations	Bulletin	90007
Piping Information	Bulletin	90011
Pump Control Instructions		
Pressure Compensating Controls		
"CN & CL" Single Pressure	Bulletin	947515
"C2 & C3" Multiple Pressure	Bulletin	947518
"CU" Soft Start Pressure	Bulletin	947517
"CH" High-Low Pressure	Bulletin	947514
"HP" Horsepower Limiter	Bulletin	947513
Volume/Pressure Sensing Controls		
"CF" Single Pressure/Load Sense	Bulletin	947516
"2F" Dual Pressure/Load Sense	Bulletin	947512
"HF" Horsepower Limit/Load Sense	Bulletin	947511
Volume Controls		
"HN" Handwheel	Bulletin	947115
"MN & MS" Lever	Bulletin	947116
"RU" Solenoid, Two Volume	Bulletin	947815
"RS & RY" Solenoid Two Volume & Neutral	Bulletin	947816
Electronic		
"VU" Solenoid Operated Servo	Bulletin	947715
"VV" Servo Valve	Bulletin	947716

I. PREPARATION AND INSTALLATION

A. MOUNTING

PUMP WITHOUT RESERVOIR. The pump may be mounted in any position. But, for convenience the recommended mounting position is with the driveshaft axis on a horizontal plane and with case drain "Port 1" to the top side. Secure the unit to a rigid mounting surface. See section "B" on "Piping & Fittings".

THE OILGEAR COMPANY
2300 So. 51st. Street
Milwaukee, WI 53219

Re-Issued November, 1995

PUMP WITH RESERVOIR. These units are usually fully piped and equipped, although it may be necessary to connect to supercharge circuit when used. Mount reservoir on level foundation with reservoir bottom at least six (6) inches above floor level to facilitate fluid changes.

B. PIPING AND FITTINGS

See reference "Piping Information" bulletin and individual circuit diagram before connecting pump to system.

For "PVWH" and "PVW" Pumps using 150-300 SSU VISCOSITY FLUIDS, an inlet strainer is not required. Inlet should be unrestricted and have a minimum of fittings. See reference "Specification Bulletin" for minimum inlet "psia" requirements at selected input rpm. If suction line is used, it should reach within 1 to 2 times its diameter from the bottom of reservoir - do not "bottom-out" tubes in reservoir.

For "PVWW" Pumps using 27-30 SSU VISCOSITY FLUIDS, pumps should have a flooded inlet and an inlet filter should **not** be used. Inlet should not be restricted and have a minimum of fittings. Inlet velocity should not exceed 5 fps. (1,5 m/s).

Arrange case drain line so case remains full of fluid (non-siphoning) at less than 25 psi (1,7 bar) and case pressure must **not be 10 psi** (0,7 bar) **greater than inlet pressure.** Each drain line must be separate, unrestricted, full sized and connected directly to the reservoir below the lowest fluid level. Drain tubing should NOT incorporate a "suction break". Provisions for opening this line without draining (siphoning) reservoir should be made.

WARNING:

Running pump in "Neutral" position (zero delivery) for long periods of time without supercharge (or a case bleed thru circuit) can damage the pump.

System and pump must be protected against over-loads by separate high pressure relief valves. Install bleed valve(s) at highest point(s) in system. Consult The Oilgear Company for other recommendations.

C. 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:

Never start or stop unit under load unless system is approved by The Oilgear Company. It may be necessary to provide delivery bypass in some circuits.

D. DRIVE

See rotation direction plate on units' housing. Units are available for left hand (CCW) or right hand (CW) rotation but are **not** reversible. Use direct drive. Size and install coupling per manufacturer's instructions.

CAUTION:

Do not drive coupling onto pump driveshaft. If fit is too tight, it may be necessary to heat coupling (see manufacturer's instructions).

Misalignment of pump shaft to driveshaft should **not** exceed 0.005" (0,13 mm) Total Indicator Readout (TIR) in any plane.

E. FILTRATION

To assure long life from your hydraulic system, keep fluid clean at all times. See reference bulletins on "Filtration Recommendations" and "Contamination Evaluation". Oilgear recommends the use of a filter in an auxiliary (pilot) pump circuit. Replace filter element(s) when filter condition indicator reaches "change" area at normal fluid temperature. Drain and thoroughly clean filter case.

FOR 150-300 SSU VISCOSITY FLUID, use of ten micron filtration (Beta 10 of four or better) in pressure or return line is recommended.

FOR 27-30 SSU VISCOSITY FLUID, use of ten micron filtration (Beta 10 of fifteen or better) in pressure or return line is recommended. **Continuous filtration is required.**

F. FLUID COOLING

When pump is operating continuously at rated pressure or frequently at peak load, auxiliary cooling of fluid may be necessary. Fluid temperature should not exceed limits specified in referenced bulletin on "Fluid Recommendations".

G. AIR BREATHER

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

H. FLUID, FILLING AND STARTING RECOMMENDATIONS

"PVWH" and "PVW" Pumps use 150-300 SSU VISCOSITY FLUIDS, meeting or exceeding lubricating specifications of SAE 10W AP1 Engine Service Classifications - SC, CC or SE (or ISOVG32 thru 68) is recommended, viscosity range 150-300 SSU at 100°F (37,7°C). **For fire resistant fluids,** phosphate ester hydraulic fluids can be used in accordance with manufacturer's recommendations.

"PVWW" Pumps may use 27-30 SSU VISCOSITY FLUIDS, it is suggested you confirm your selection with your Oilgear representative before you specify the type of hydraulic fluid. High Water Content Fluids (HWCF) 95-5, water glycol and oil emulsion fluids can be used in accordance with fluid manufacturer's recommendations.

Refer to instruction plate on unit, reservoir, machine and/or referenced "Fluid Recommendations" bulletin. Pump all fluid into reservoir thorough a clean (see Section E for Beta ratings) filter. Fill reservoir to, but not above, "high level" mark on sight gage with hydraulic fluid. **Remove case drain line at the pump and fill pump case with hydraulic fluid.**

Turn driveshaft a few times by hand with a spanner wrench to be sure parts are free.

Table 1. TORQUE TO TURN SHAFT

SIZE UNIT	Approx. Torque to Turn Shaft	
	foot pounds	Nm
04, 06, 10	1.7 - 2.1	2,3 - 2,8
11, 15, 20	2.9 - 3.3	4,0 - 4,5
25, 34, 45, 60	7.9 - 8.3	10,8 - 11,3

With pump under "no load", or with pump control at "neutral" turn drive unit on and off several times before allowing pump to attain full speed. The system can usually be filled by running the pump and operating the control. Watch the fluid level in the reservoir and stop pump if the level reaches "low level" mark. Add fluid and start again. With differential (cylinder) systems, fluid must not be above "high level" when ram is retracted or below "low level" when extended. Bleed air from the system by opening air bleed petcocks at highest point in the system. Close connections or petcocks tightly when solid stream of fluid appears.

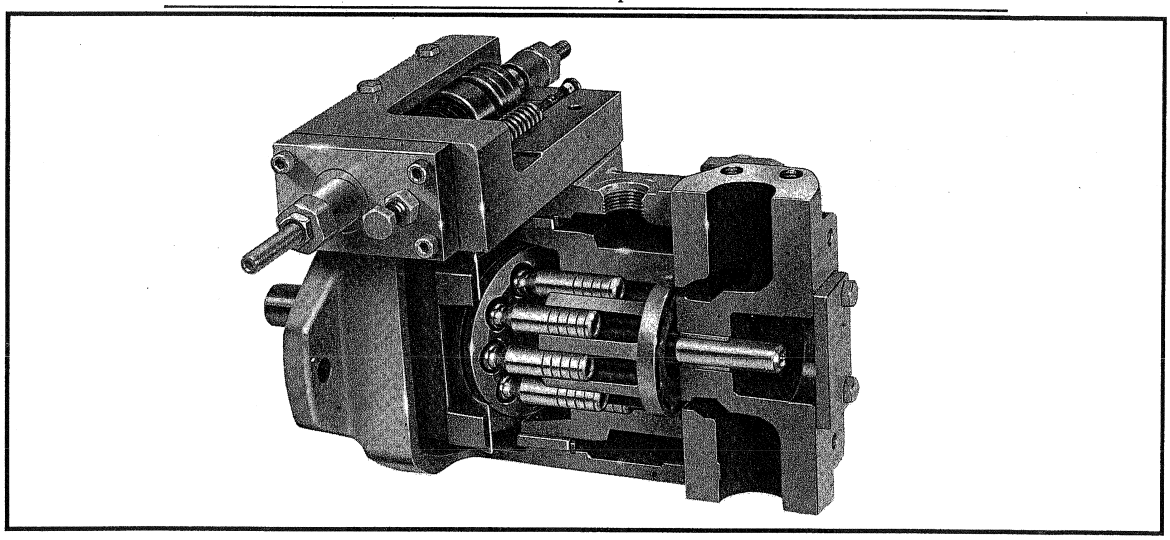


Figure 2. Cut-a-Way (cross section) of Typical "PVWH" Pump from the right side. (88050R)

II. CONSTRUCTION

Refer to Figures 2, 10 and 11. A driveshaft (1) runs through the centerline of pump housing (5), saddle block (8) and valve plate (22). Pump cylinder barrel (18) is splined to driveshaft. A bearing (3) supports the outboard end of the driveshaft and a bushing integral with the valve plate supports the inboard end. The pump cylinder barrel is carried in a journal type hydrodynamic cylinder bearing (12). The valve plate (22) has two crescent shaped ports. Pumping piston/shoe assemblies (15) in the cylinder barrel are held against a swashblock (11) by a shoe retainer (14). The shoe retainer is held in position by a fulcrum ball (16) which is forced outward by shoe retainer spring (17). The spring acts against the pump cylinder barrel forcing it against the valve plate while also forcing the piston shoe against the swashblock (11). The semi-cylinder shaped swashblock limits the piston stroke and can be swivelled in arc shaped saddle bearings (10A and 10B) which are pinned (9) into the saddle (8). The swashblock is swivelled by a control (covered in referenced material).

For **"PVWH"** Pumps **(only)**, the ("pressure" side) saddle bearing is force lubricated. A small hole in the face of the swashblock (11) provides "porting" for the hydrostatic balance fluid [of the piston/shoe assembly (15)] through the swashblock to a rectangular shaped groove milled in one of the two arc shaped swashblock faces, to lubricate the face of the mating saddle bearing. **"PVW" and "PVWW" Pumps are not provided with this feature.**

SEE PAGES 4 and 5 "III. PRINCIPLE OF OPERATION" and "IV. SPECIFICATIONS"

V. MALFUNCTIONS AND CAUSES

A. UNRESPONSIVE OR SLUGGISH CONTROL

1. See reference control instruction material.
2. Low control input (pilot) pressure for "R" and "V" volume type controls only.
3. Swashblock saddle bearings (10A & 10B) worn or damaged.

B. INSUFFICIENT PUMP VOLUME

1. Delivery limited by faulty control (see appropriate control instruction material).
2. Obstructed suction circuit or insufficient supercharge volume.
3. Insufficient drive motor speed.
4. Worn or grooved cylinder barrel (18) and/or valve plate (22) matching surfaces.
5. Worn piston/shoe assemblies (15) or piston bores in cylinder (18).
6. Worn or damaged piston shoe or swashblock (11).

C. IRREGULAR OR UNSTEADY OPERATION

1. Faulty control.
2. Fluid level in reservoir is low or supercharge is insufficient.
3. Air entering hydraulic system.
4. Worn axial piston pump.
5. Faculty output circuit components (cylinder, motors, valves, etc.).

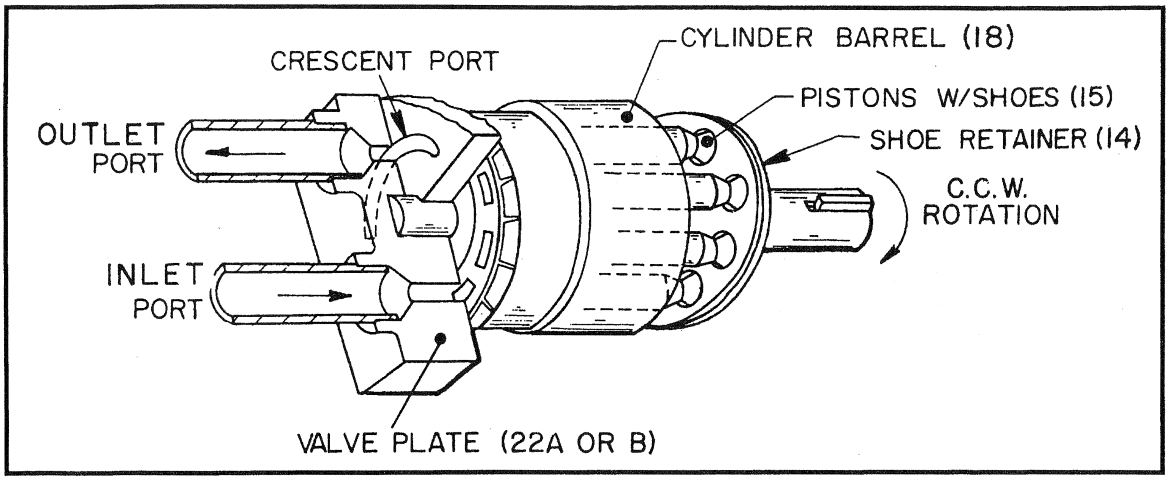


Figure 3. Type "PVWH" Pumping Mechanism (511783).

III. PRINCIPLE OF OPERATION

A ONE-WAY PUMP DRIVEN COUNTERCLOCKWISE (LEFT HAND), IS DESCRIBED.

See Figure 3. Turning the driveshaft rotates the splined cylinder barrel (18) which contains pumping pistons with swivel shoes (15). A shoe retainer (14), backed up by a spring (17) loaded fulcrum ball (16), holds piston shoes against a swashblock (11).

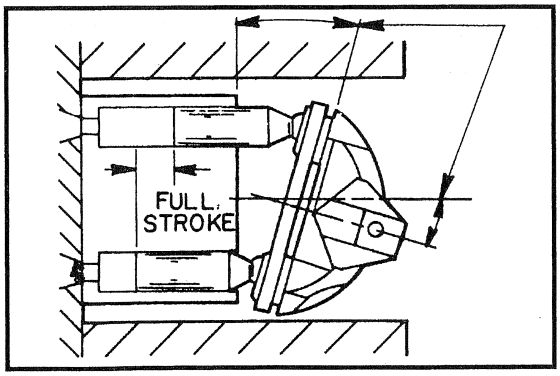


Figure 4. POSITION A Plan (Top) View, Swashblock Positioned for Full Delivery Port A. (511783)

SEE FIGURE 4. POSITION A. When the control positions the swashblock for full delivery from Port A, the swashblock face is at maximum angle (to the cylinder face). When cylinder is rotated, the piston move in and out of their bores as the shoes "ride" against the angled swashblock.

As the cylinder rotates, the individual piston bores are connected alternately to the lower (Port B) and upper (Port A) crescent shaped ports in the valve plate. While connected to the lower (suction) Port B, each piston moves outward, drawing fluid from Port B into the piston bore until it's outermost stroke is reached. At that point, the piston bore passes from the lower crescent port to the upper crescent port.

While rotating across the upper crescent, each piston moves across the angled swashblock face. Thus, each piston is forced inward. Each piston displaces fluid thru the upper crescent port to Port A until it's innermost stroke is reached. At that point, the piston bore passes from the upper to the lower crescent again and the operating cycle is repeated.

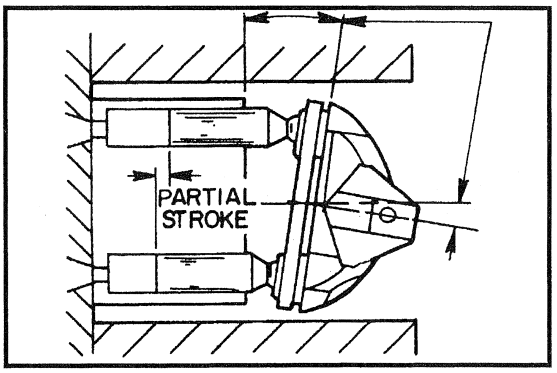


Figure 5. POSITION A/2 Plan (Top) View, Swashblock Positioned for Partial Delivery from Port A (511783).

SEE FIGURE 5. POSITION A/2. A study of the diagram will show that the degree of swashblock angle determines the length of the piston stroke (difference between outermost and innermost position) thereby determining the amount of delivery from the pump.

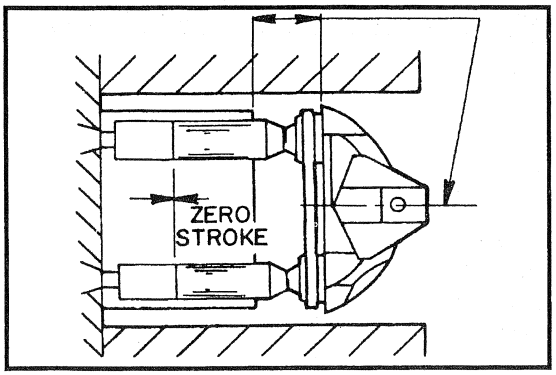


Figure 6 POSITION N, Plan (Top) View, Swashblock Positioned for "Neutral" (no stroke, no delivery) (511783).

SEE FIGURE 6. POSITION N. Neutral position results when the control centers the swashblock. The swashblock angle is now zero and swashblock face is now parallel to cylinder face. Therefore, no inward or outward motion of the pump piston exist as piston shoes rotate around the swashblock face. The lack of inward and outward motion results in no fluid being displaced from the piston bores to the crescents in the valve plate and consequently no delivery from pump ports.

IV. SPECIFICATIONS

See referenced material, pump control material and individual application circuits for exceptions.

Tables 2. NOMINAL PERFORMANCE DATA

"PVWH" AND "PVW" PUMPS with 150-300 SSU VISCOSITY FLUID

FRAME SIZE	UNIT SIZE	THEORETICAL MAXIMUM DISPLACEMENT		RATED CONTINUOUS PRESSURE		MAXIMUM PRESSURE		FLOW RATE at 1800 rpm, rated continuous pressure & 14.7 psia (1 bar_{abs}) inlet condition		MINIMUM INLET PRESSURE* psia (bar_{abs})			MAXIMUM SPEED†	POWER INPUT at rated continuous pressure and 1800 rpm	
		in^3/rev	ml/rev	psi	bar	psi	bar	gpm	l/min	1200 rpm	1500 rpm	1800 rpm	rpm	hp	kw
A	04	0.66	10,8	5000	344,8	5800	400,0	4.2	15,9	5.4 (,37)	5.7 (,39)	6.1 (,42)	3000	16.3	12,2
	06	0.86	14,1	4000	275,9	4500	310,3	5.9	22,4	5.5 (,38)	5.9 (,41)	6.4 (,44)	3000	17.7	13,2
	10	1.35	22,1	3000	206,9	3500	241,4	9.5	36,0	5.5 (,38)	6.0 (,41)	7.0 (,48)	3000	20.2	15,1
B	11	1.55	25,4	5000	344,8	5800	400,0	10.9	41,3	7.0 (,48)	7.3 (,50)	8.2 (,57)	3000	36.5	27,2
	15	2.06	33,8	3500	241,4	4000	275,9	14.7	55,7	7.0 (,48)	7.6 (,52)	8.4 (,58)	3000	35.5	26,5
	20	2.83	46,4	2500	172,4	3000	206,9	20.6	78,1	7.2 (,50)	7.9 (,54)	9.0 (,62)	2400	35.0	26,1
C	25	3.88	63,6	5000	344,8	5800	400,0	27.4	103,8	7.6 (,52)	8.5 (,59)	9.5 (,66)	2400	95.1	70,9
	34	4.67	76,5	3500	241,4	4000	275,9	33.7	127,7	8.0 (,55)	8.6 (,59)	9.6 (,66)	2400	80.4	60,0
	45	6.00	98,3	2500	172,4	3000	206,9	43.3	164,1	7.6 (,52)	8.6 (,59)	9.8 (,68)	2400	74.1	55,3
	60	7.94	130,2	1500	103,4	2000	137,9	58.2	220,3	8.0 (,55)	9.3 (,64)	14.5 (1,00)	1800	64,0	47,8

* For higher speeds see suction curves.

Higher speeds available - consult factory Note: Minimum speed 600 rpm

"PVWW" Pumps with 27-30 SSU VISCOSITY FLUID

FRAME SIZE	UNIT SIZE	THEORETICAL MAXIMUM DISPLACEMENT		RATED CONTINUOUS PRESSURE		MAXIMUM PRESSURE *		FLOW RATE at 1800 rpm, rated continuous pressure & 14,7 psia (1 bar_{abs}) inlet condition		MAXIMUM SPEED at 1800 rpm and 14.7 psia inlet condition	POWER INPUT at rated continuous pressure and 1800 rpm	
		in^3/rev	ml/rev	psi	bar	psi	bar	gpm	l/min	rpm	hp	kw
A	06	0.86	14,1	3000	206,9	3500	241,4	5.5	20,8	1800	12.9	9,6
	10	1.35	22,1	2000	137,9	2500	172,5	9.0	34,1	1800	13.3	9,9
B	15	2.06	33,8	3000	206,9	3500	241,4	12.7	48,1	1800	30.4	22,7
	20	2.83	46,4	2000	137,9	2500	172,5	20.3	76,9	1800	27.8	20,7
C	34	4.67	76,5	3000	206,9	3500	241,4	32.6	123,6	1800	68.4	51,0
	45	6.00	98,3	2000	137,9	2500	172,5	42.8	162,2	1800	59.7	44,5
	60	7.94	130,2	1200	82,7	1500	103,4	56.6	214,2	1800	47.0	35,1

* Higher pressure available— consult factory.

Note: Minimum speed 600 rpm

Table 3. NOMINAL DIMENSIONS and WEIGHTS without controls.

UNIT SIZE	LENGTH		WIDTH		HEIGHT		WEIGHT	
	in.	mm.	in.	mm.	in.	mm.	lbs.	kg.
04, 06 & 10	7.20	182,9	4.32	109,7	4.50	114,3	32	14,5
11, 15 & 20	8.50	215,9	4.80	147,3	6.11	155,2	68	30,9
25, 34, 45 & 60	10.44	265,2	6.76	171,7	7.18	182,4	103	46,8

See Page 3 for "V". Malfunctions and Causes"

D. LOSS OF PRESSURE

1. Worn piston pump.
2. Worn or grooved cylinder barrel (18) and/or valve plate (22) matching surfaces.
3. Worn piston/shoe assemblies (15) or piston bores in cylinder.
4. Faulty output circuit components.
5. Faulty control.

E. EXCESSIVE OR HIGH PEAK PRESSURE

1. Faulty output circuit components (pay particular atten tion to relief valves). **The use of a "spike" relief valve (fast acting) is recommended.**

F. EXCESSIVE NOISE

1. Pump incorrectly being stopped or started under load.
2. Low fluid level in reservoir or insufficient supercharge resulting in cavitation.
3. Air entering hydraulic system.
4. Fluid too cold or viscosity to high.
5. Suction line problem i.e.; obstruction in line, line too long, line diameter too small, too many bends and/or loops in line.
6. Broken or worn piston/shoe assembly (15).
7. Pump rotating in wrong direction.

G. EXCESSIVE HEATING

1. Operating pump above rated or peak pressure.
2. Low fluid level in reservoir or insufficient supercharge.
3. Air entering hydraulic system.
4. Worn piston pump.
5. Worn or grooved cylinder barrel (18) and/or valve plate (22) matching surfaces.
6. Faulty output circuit components (continuous blowing relief valve or "slip" through valves, cylinder, etc).
7. Insufficient cooling provision or clogged coolers.

VI. TESTING AND ADJUSTING

WARNING - Shut 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 pressure line before (up-stream from) pump relief valve or system high pressure relief valve will result in damage and could result in serious personal injury.**

A. PISTON PUMP

To check for worn piston pump, measurement of the leakage can be made from the case drain while the pump is under pressure, but pressure control (when used) is not "unloading". 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 gage in the pressure line, start pump, put it on stroke and stall (or block) output device to raise system pressure to maximum (as set by system relief valve). Read the flow meter, or time the case drain flow to fill a known size container and calculate the flow rate in terms of cubic inches per minute (cipm). The leakage should conform with Table 4 or 5. Additional leakage indicates wear, but does not become critical until it impairs performance.

B. CONTROL

Refer to applicable (referenced) pump control instructions material.

Table 4. **"PVWH" Pump** NOMINAL CASE SLIP vs. High Pressure at 1800 rpm (viscosities of 160 SSU).

PUMP	1500 psi		2500 psi		3000 psi		3500 psi		4000 psi		5000 psi	
	cipm	lpm	cipm	lpm	cipm	lpm	cipm	lpm	cipm	lpm	cipm	lpm
04											200	3,3
06									200	3,3	NA	NA
10					200	3,3	NA	NA	NA	NA	NA	NA
11											300	4,9
15							300	4,9	NA	NA	NA	NA
20			300	4,9	NA	NA	NA	NA	NA	NA	NA	NA
25											460	7,6
34							460	7,6	NA	NA	NA	NA
45			460	7,6	NA	NA	NA	NA	NA	NA	NA	NA
60	530	8,7	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table 5. **"PVWW & PVW" Pump** NOMINAL CASE SLIP vs. High Pressure at 1800 rpm (viscosity of 160 SSU).

PUMP SIZE	Case Slip at Full Stroke and Indicated Pressure									
	1500 psi/PVW 1200 psi/PVWW		2500 psi		3000 psi		3500 psi		4000 psi	
	cipm	lpm	cipm	lpm	cipm	lpm	cipm	lpm	cipm	lpm
06									150	2,5
10					150	2,5	NA	NA	NA	NA
15							230	3,8	NA	NA
20			230	3,8	NA	NA	NA	NA	NA	NA
34							350	5,7	NA	NA
45			350	5,7	NA	NA	NA	NA	NA	NA
60	390	6,4	NA	NA	NA	NA	NA	NA	NA	NA

VII. DISASSEMBLY

A. GENERAL

Refer to Figures 10 and 11. It will be advantageous to tag similar parts (particularly screws, plugs and o'rings) during disassembly to be certain they don't become confused with similar parts and to assure they will be returned to original location. Do not remove (locator) roll pins unless they are deformed or otherwise in need of replacement.

B. PREPARATION

For disassembly and assembly, a crane and/or sling capable of handling 200 lb. loads will be useful.

When disassembling or assembling unit, we recommend choosing an area where no traces of dust, sand or other abrasive particles, which could damage the unit, are in the air. We also recommend not working near welding, sand blasting, grinding benches and the like. Place all parts on a CLEAN surface. To clean parts which have been disassembled, it is important to use CLEAN solvents. All tools and gages should be CLEAN prior to working with these units and new CLEAN lint free rags used to handle and dry parts.

WARNING: NEVER attempt to remove or install any components or assemblies while unit and system is running. Always stop the pump, shut-off power and release pressure from the system before servicing or testing. Be sure provisions have been made so case drain line can be disconnected from unit without causing the line to drain (siphon) the reservoir.

Disconnect pump from drive motor and piping. Usually, it is necessary to remove the pump from it's mounting before the case can be drained.

After removing pump from mounting, but before disassembly, cap or plug all ports and clean the outside thoroughly to prevent entry of dust into the system.

Refer to Figure 10 and 11. Depending upon what part or parts are to be inspected, it may not be necessary to completely take apart all assemblies.

C. CONTROL GROUP

See reference material for applicable information on the control your unit is equipped with. Remove four hex. head cap screws and lift the control group assembly, with control pin, straight up from the top of the pump assembly. Control pin may or may not remain in the swashblock (11). Remove control gasket and o'rings from pump housing.

D. VALVE PLATE GROUP

If another unit is coupled to thru shaft units, it will be necessary to remove coupling (half) (180 or 190) before removing valve plate (22). Block unit on bench with driveshaft facing down. Remove valve plate (22) by alternately removing four hex head screws (25) and lifting straight up. Remove valve plate gasket (21) and o'ring (28).

E. ROTATING GROUP

WARNING: Extreme care must be taken not to damage cylinder wear surface (that matches against the valve plate), bearing diameters or piston shoes. The use of a sling, and/or assistance from others and use of proper lifting techniques are strongly recommended to prevent personal injury.

Place the pump in a horizontal position and remove the rotating group by turning shaft (1) slowly while pulling the cylinder barrel (18) from the housing.

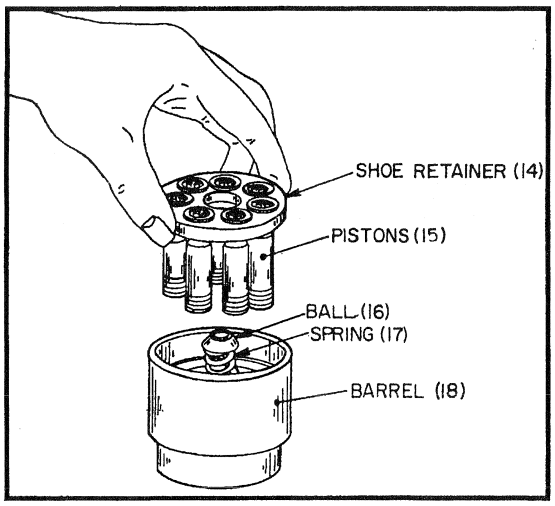


Figure 7. Rotating Group Disassembly (511783).

See Figure 7. Lift out shoe retainer (14) with piston/shoe assemblies (15) and remove fulcrum ball (16) and shoe retainer spring (17).

Remove retaining ring (13) and pull hydrodynamic cylinder bearing (12) from pump housing.

F. DRIVESHAFT GROUP

Remove drive key (2) if used and driveshaft bearing retainer ring (29). Grasp outboard end of driveshaft (1) and pull out from pump housing. Remove shaft retainer ring (4) and front driveshaft bearing (3). Remove seal retainer (6) and shaft seal (7) from housing only if necessary.

G. SWASHBLOCK GROUP

Reach inside the case and remove swashblock (11). **Note which saddle bearing is in the upper (10A) position and which is in the lower (10B) position.** Remove saddle bearings (10A and 10B) from the saddle (8) if necessary. If necessary, the saddle itself can be pulled out. On most units, the saddle is located by pin (20) and can be pulled from the housing. On early units, the saddle is located in the case by two dowel pins (not shown) and the saddle is secured to the case by two nylock socket head cap screws (not shown) which will have to be removed before the saddle can be withdrawn from the housing.

VIII. INSPECTION

Clean all parts thoroughly. Inspect all seals, and o'rings for hardening, cracking or deterioration and replace if necessary. Check all locating pins for damage and spring for cracking or signs of fatigue.

WARNING: Always wear safety goggles when using solvents or compressed air. Failure to wear safety goggles could result in serious personal injury.

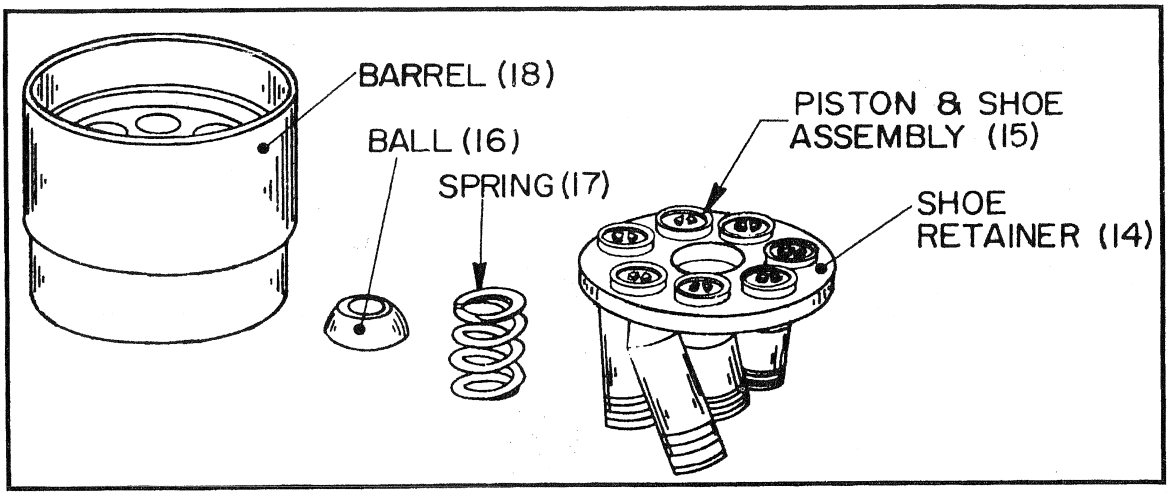


Figure 8. Rotating Group Inspection (511783)

A. CONTROL GROUP

See applicable reference material on pump controls. Be sure to carefully check control pin for cracks and/or signs of fatigue. Check fit of control pin in swashblock. It should be a slip fit without "side-play".

B. VALVE PLATE GROUP

Inspect the valve plate (22) surface that mates with the cylinder barrel (18) for excessive wear or scoring. Remove minor defects by lightly stoning the surface with a hard stone that is flat to within 0.001" (0,03mm). Be sure to stone lightly. Any excessive stoning will remove the hardened surface. If wear or damage is extensive, replace the valve plate (as part of Valve Plate Assembly Kit No. 79L or 79R) and cylinder barrel (18).

C. ROTATING GROUP

Inspect cylinder barrel (18) piston bores and the face that mates with valve plate for wear or scoring. Remove minor defects by lightly stoning the surface with a hard stone that is flat to within 0.001" (0,03 mm). Be sure to stone lightly. Any excessive stoning will remove the hardened surface. If defects can not be removed by this method, replace the cylinder barrel as part of Rotating Group Kit No. 73. Inspect hydrodynamic cylinder bearing (12) and matching cylinder barrel surface for galling, pitting, roughness, damage and replace if necessary.

Check all piston/shoe assemblies (15) to be sure they ride properly on the swashblock.

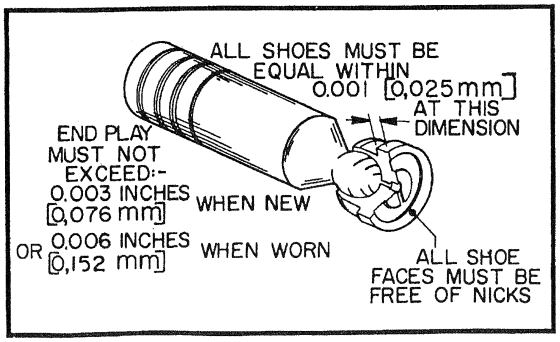


Figure 9. Piston and Shoe Inspection (511783).

See Figure 9. Piston shoes must pivot smoothly, but end play should not exceed 0.006" (0.152 mm). Check end play as follows: Place square end of piston on bench and hold down firmly. Pull on end of shoe with other hand and note end play. The shoe must rotate and pivot on the piston ball. Inspect each shoe face for nicks and scratches. Measure shoe thickness [the part held between shoe retainer (14) and swashblock (11)]. All shoes must be equal within 0.001" (0,025 mm). If a single piston/shoe assembly needs to be replaced, all piston/shoe assemblies must be replaced. Replace as part of Piston/Shoe Kit No. 87 . When installing a new rotating group kit, make sure pistons are free in their bores.

D. SWASHBLOCK GROUP

Inspect the swashblock (11) for wear or scoring. In the case of size 60 units, inspect the swashblock wearplate (11A). If damage is extensive, replace the swashblock and/or wearplate as part of Swashblock Kit No. 82.

"**PVWH**" Pumps **(only)**, check the very small holes in the face of the swashblock. This hole provides "porting" for the hydrostatic balance fluid (of the piston/shoe assembly) to be channelled through the swashblock to the face of the saddle bearing (providing pressure lubrication).

Compare saddle bearing (10A and 10B) thickness in worn area to thickness in an unworn area. Replace saddle bearings if difference is greater than 0.008 in (0,2mm). Check mating surface of swashblock for cracks or excessive wear. Swashblock movement in saddle bearings must be smooth. Replace as part of Saddle Bearing Kit No. 85.

E. DRIVESHAFT GROUP

Check shaft seal (7) for deterioration or cracks. Replace if necessary. Examine the sealing area of the shaft (1) for scoring or wear. Inspect shaft bearing (3) for roughness, galling, pitting or binding. Check shaft and splines for wear. If driveshaft is bent, scored or worn excessively or if bearing is bad, replace as part of Shaft and Bearing Kit No. 74K or 74S. Inspect bushing in valve plate (22). If replacement is necessary, the bushing is not available as a loose item, it is included when ordering Valve Plate Assembly Kit No. 79L or 79R.

IX. ASSEMBLY

Refer to Figures 10 and 11. The procedure for assembling the pump is basically the reverse order of disassembly. During assembly, install new gaskets seals and o'rings (Kit No. 77). Apply a thin film of CLEAN grease or hydraulic fluid to sealing components to ease assembly. If a new rotating group (Kit No. 73) is used, lubricate thoroughly with CLEAN hydraulic fluid. Apply fluid generously to all wear surfaces.

A. SWASHBLOCK GROUP

If removed, press shaft seal (7) into front of pump housing (5) and then place housing on bench with mounting flange side down. Place saddle block (8) into housing - center properly [a locating hole in the saddle and a pin (20) in the housing must match]. On early units, two dowel pins (not shown) locate the saddle and saddle is secured to housing by two nylock socket head cap screws.

The saddle bearings (10A and 10B) and swashblock (11) can now be installed. Check the swashblock faces that mate with the saddle bearings (10A and 10B). One of these faces has a rectangular groove cut into it. The groove should be on the control (upper) side of the swashblock for left hand driven pumps and on the (lower) side for right hand driven pumps.

For size **04, 06, 10 and 25 "PVWH"** Pumps **only**, the plastic backed saddle bearing should be positioned on pin (9) to mate with the rectangular groove milled in arc shaped swashblock (11). Place steel backed saddle bearing on pin (9) in other location.

For size **11, 15, 20, 34, 45 and 60 "PVWH"** Pumps **only**, both saddle bearings are steel backed. It is recommended they be put back in their original locations. If replacement saddle bearings are used - it makes no difference which is placed in which location.

For **all size "PVWW" and "PVW"** Pumps **only**, both bearings are the same. It is recommended they be put back in their original locations. If replacement saddle bearings are used - it makes no difference which is placed in which location.

NOTE: - Install saddle bearings on size 04 thru 20 with notched corners toward shaft and bearing. Does not apply to 25 thru 60 size.

Place the swashblock into the case and be sure the swashblock swivels in the saddle bearings. With new bearings, swivelling may be stiff (not always smooth).

Position the hydrodynamic bearing (12) into the case so the pin (in the bearing) will fit (per Table 6) a corresponding slot in the housing. The bearing should fit into place with little difficulty and be square to the axis of the pump. Tap bearing into place if necessary, using extreme care not to damage the bearing. Insert retaining ring (13) to hold bearing in place.

Table 6. HYDRODYNAMIC BEARING LOCATION PIN POSITION

Left Hand (CCW) Pumps = Pin at 8:00 o'clock position between saddle protrusion and pump housing.
Right Hand (CW) Pumps = Pin at 4:00 o'clock position between saddle protrusion and pump housing.

B. DRIVESHAFT GROUP

Place housing on its side with axis horizontal and then install seal retainer (6). Place front driveshaft bearing (3) onto driveshaft (1) and lock in place with shaft retaining ring (4). Lubricate shaft seal (7) and shaft, then insert driveshaft and bearing assembly into pump housing (5) and lock in place with driveshaft bearing retainer ring (29).

C. ROTATING GROUP

See Figure 7. Place the cylinder barrel (18), wear surface down, on a clean cloth. Place the shoe retainer spring (17) in the center of the barrel with the fulcrum ball (16) on top of it. Insert the pistons/shoe assemblies (15) into the shoe retainer (14). As a unit, fit the pistons into their bores in the cylinder barrel. **DO NOT FORCE.** If aligned properly, the pistons will fit smoothly.

WARNING: Assistance from others and proper lifting technique is strongly recommended to prevent personal injury while assembling larger sized pump rotating groups into the pump. The rotating group can now be carefully installed over the tail of the driveshaft (1) and into the pump housing (5). When installing the rotating group, support the weight of the cylinder barrel (18), as cylinder spline is passed over the tailshaft, to avoid scratching or damage. Push cylinder forward until the cylinder spline reaches the driveshaft spline and rotate the cylinder slightly to engage shaft splines. Continue to slide cylinder forward until it encounters the hydrodynamic cylinder bearing (12). Lifting the tailshaft slightly helps cylinder barrel (18) and cylinder bearing (12) engagement. Continue pushing cylinder forward until the piston shoes contact the swashblock. At this point, the back of the cylinder should be located slightly outside the back of the pump housing.

D. VALVE PLATE GROUP

Place pump housing on bench with open end facing up. Install new o'ring (28) and gasket (21) on housing. Make sure the tail end of shaft engages bushing while positioning the valve plate (22) on pins (19) and housing. Finger tighten hex head cap screw (25) closest to o'ring (28) first and then alternately tighten other cap screws per Table 7. On thru shaft units connected to another pump or device, install coupling half.

Table 7. TORQUES

SIZE UNIT	VALVE PLATE		CONTROL	
	Ft. Lbs.	N.m.	Ft. Lbs.	N.m.
04, 06, 10	15	20,4	8.3	11,3
11, 15, 20	37	50,3	8.3	11,3
25, 34, 45, 60	56	76,2	16.6	22,6

E. CONTROL GROUP

See reference material for applicable information on the control your unit is equipped with. See appropriate control reference for control group mounting. See Table 8 for Torques to secure control group to pump housing.

SEE SECTION "I. PREPARATION and INSTALLATION".

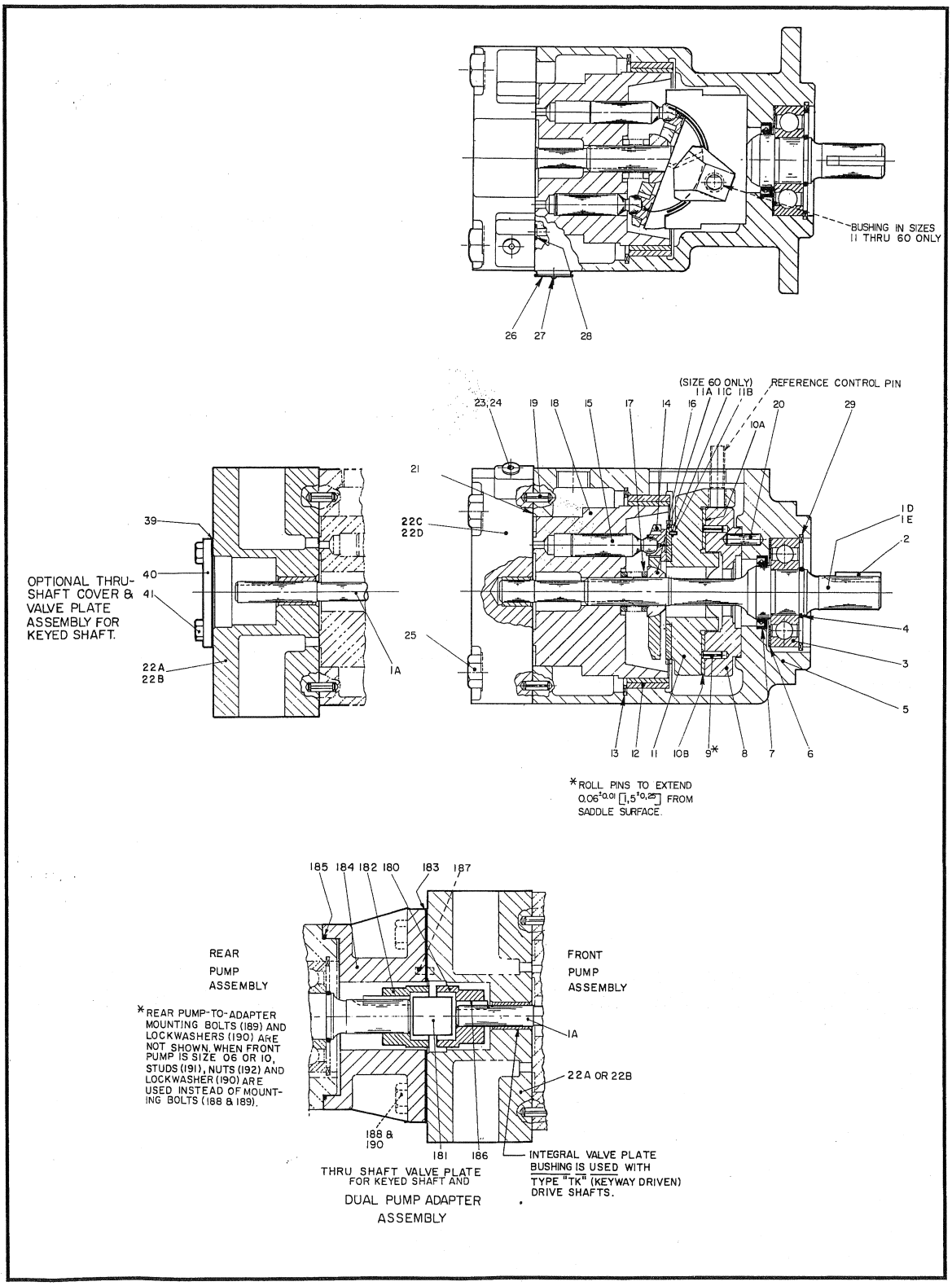


Figure 10. Parts Drawing, Basic "PVWH", "PVWW" and "PVW" Pumps without Controls. DS-SW-8A (511783)

X. PARTS LISTS

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

ITEM NO.	DESCRIPTION
1A	Driveshaft w/Keyway (side port)
1B	Driveshaft w/SAE Spline (side port)
1D	Driveshaft w/Keyway (rear port)
1E	Driveshaft w/SAE Spline (rear port)
2	Key, Driveshaft
3	Bearing, Front Driveshaft
4	Ring, Shaft Retainer
5	Housing, Pump
6	Retainer, Seal
7	Seal, Shaft
8	Block, Saddle (items 8 & 9 sold as an assembly)
9	Pin, Roll (items 8 & 9 sold as an assembly)
10A	Bearing, Upper Saddle
10B	Bearing, Lower Saddle
11	Swashblock
11A	Wearplate, Swashblock (size 60 only)
11B	Pin, Roll (size 60 "PVWH" only)
11C	Seal, O'ring (size 60 "PVWH" only)
12	Bearing, Cylinder Hydrodynamic
13	Ring, Retainer
14	Retainer, Shoe
15	Assembly, Piston/Shoe

ITEM NO.	DESCRIPTION
16	Ball, Fulcrum
17	Spring, Shoe Retainer
18	Barrel, Cylinder
19	Pin, Roll
20	Pin, Saddle Locating
21	Gasket, Valve Plate
22A	Valve Plate, Side Port/rear shaft, LH
22B	Valve Plate, Side Port/rear shaft, RH
22C	Valve Plate, Rear Port, LH
22D	Valve Plate, Rear Port, RH
23	Seal, O'ring
24	Plug, SAE Hollow Hex
25	Screw, Hex. Hd.
26	Nameplate, Identification
27	Screw, Drive
28	Seal, O'ring
29	Ring, Driveshaft Bearing Retainer
39	Gasket
40	Cover
41	Screw, Hex. Hd. Cap

DUAL PUMP ADAPTER AND COUPLING KITS

SIZE 04, 06 & 10

ITEM NO.	DESCRIPTION
*185	Seal, O'ring
*190	Lockwasher
*191	Stud
*192	Nut

*Used when 04, 06 or 10 is front pump in dual arrangement instead of bolts (188 and 189).

SIZE 11 THRU 60

ITEM NO.	DESCRIPTION
180	Coupling, Front
181	Key, Coupling
182	Coupling, Rear
183	Gasket, Adapter
184	Adapter
185	Seal, O'ring
186	Key, Coupling
187	Pin, Roll
188	Screw, Hex. Hd. Cap
189	Screw, Hex. Hd. Cap (not shown)
190	Lockwasher (not shown)
191	Coupling, Spline
192	Pin, Roll

O'RING SIZES

ARP 568 Uniform Size Number with Durometer

ITEM NO.	PUMP SIZE		
	04, 06, 10	11, 15, 20	25, 34, 45, 60
11C			"PVWH" 60 Only 006 - 70
23	902 - 90	902 - 90	902 - 90
28	010 - 90	010 - 90	*010 - 90 012 - 90
185	**	**	**

* Used on early units.
** Consult factory.

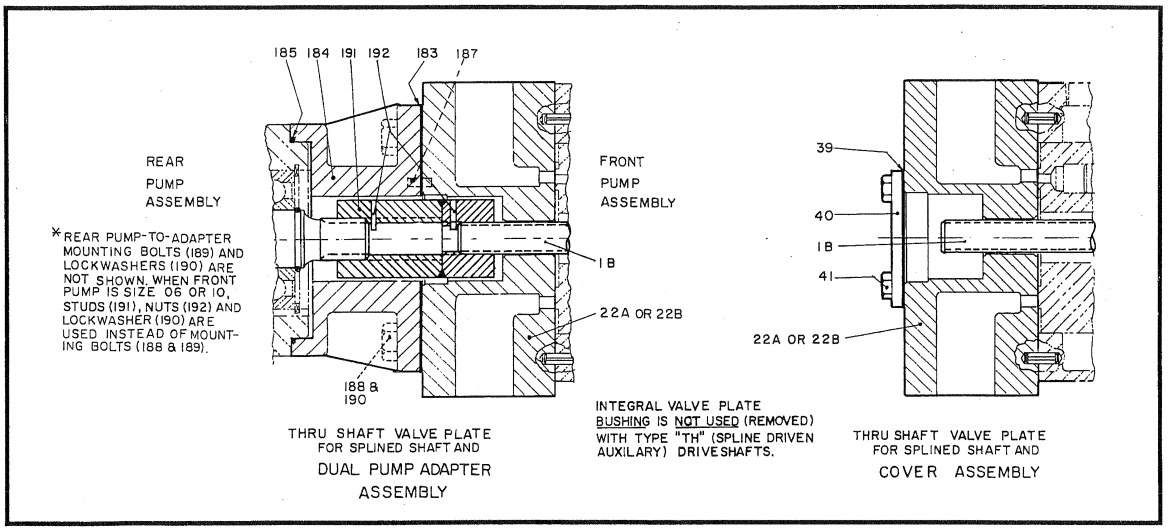


Figure 11. Parts drawing Showing Driveshaft w/SAE Spline Shaft (Side Ports) DS-SW-8A. (511783)

IT IS RECOMMENDED THAT SPARE OR REPLACEMENT PARTS BE ORDERED AS PART OF THE FOLLOWING KITS.

HOUSING & PINS
KIT No. 72

ITEM	DESCRIPTION
5	Housing, Pump
7	Seal, Shaft
19	Pin, Roll
20	Pin, Saddle Locating

ROTATING GROUP
Kit No. 73

14	Retainer, Shoe
15	Assembly, Piston/Shoe
16	Ball, Fulcrum
17	Spring, Shoe Retainer
18	Barrel, Cylinder

SHAFT & BEARING
Kit No. 74

1	Driveshaft
2	Key, Driveshaft
3	Bearing, Front Driveshaft
4	Ring, Front Driveshaft
6	Retainer, Seal
29	Ring, Driveshaft Bearing Retainer

GASKET & SEAL
Kit No. 77

7	Seal, Shaft
21	Gasket, Valve Plate
23	Seal, O'ring
28	Seal, O'ring

VALVE PLATE
Kit No. 79

21	Gasket, Valve Plate
22	Valve, Plate
23	Seal, O'ring
24	Plug, Hollow Hex
25	Screw, Hex. Hd.
28	Seal, O'ring

SCREWS, KEY & TAG
Kit No. 80

ITEM	DESCRIPTION
2	Key, Driveshaft
25	Screw, Hex. Hd.
26	Nameplate, Identification
27	Screw, Drive

ROTATING GROUP BEARING
Kit No. 81

12	Bearing, Cylinder Hydrodynamic
13	Ring, Retainer

SWASHBLOCK
Kit No. 82

11	Swashblock

SADDLE
Kit No. 84

8	Block, Saddle
9	Pin, Roll
10A	Bearing, Upper Saddle
10B	Bearing, Lower Saddle

SADDLE BEARING
Kit No. 85

10A	Bearing, Upper Saddle
10B	Bearing, Lower Saddle

NOTES:

SERVICE INSTRUCTIONS

Bulletin 947515

HYDURA TYPE "CN" AND "CL" PRESSURE COMPENSATOR CONTROLS FOR "PVW" PUMPS

PURPOSE OF INSTRUCTIONS:

These instructions have been prepared to simplify and minimize your work of operating HYDURA type "CN" and "CL" controlled units. This material will inform you as to basic construction, principle of operation and service part listings. Some controls may be modified for specific applications from those described in this bulletin and other changes may be made without notice.

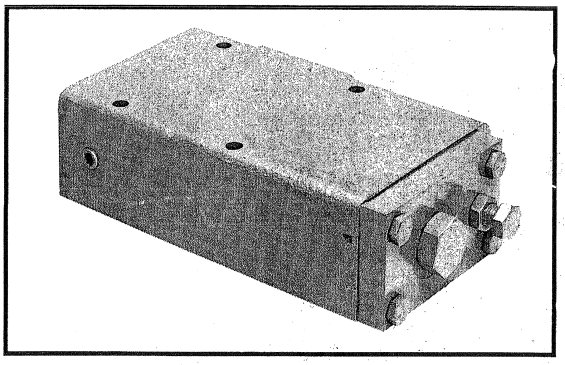
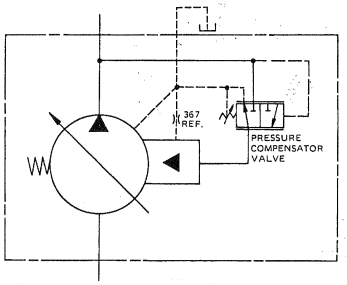


Figure 1. Typical "CN/CL" type control for HYDURA "PVW" pumps (55160).



ASA diagram for "CN/CL" control shown with typical pump.

I. PRINCIPLE OF OPERATION

Refer to figure 3. The pressure compensator control ensures maximum pump flow until the system reaches the controls preset pressure setting. The control then regulates the pump output flow to match the flow requirements of the system while maintaining the preset output pressure. When the system pressure exceeds the compensator control setting, or the system no longer requires flow, the control destrokes the pump while maintaining the preset pressure. "CN" controls can be adjusted from 750 psi (51,7 bar) working pressure up to the maximum pressure rating of the applicable pump, "CL" controls can be adjusted from 250 psi (17,2 bar) working pressure up to a maximum of 1500 psi (103,4 bar). Remote pressure compensating control option can be accomplished by using an adjustable sequence type valve (separate) remote from control.

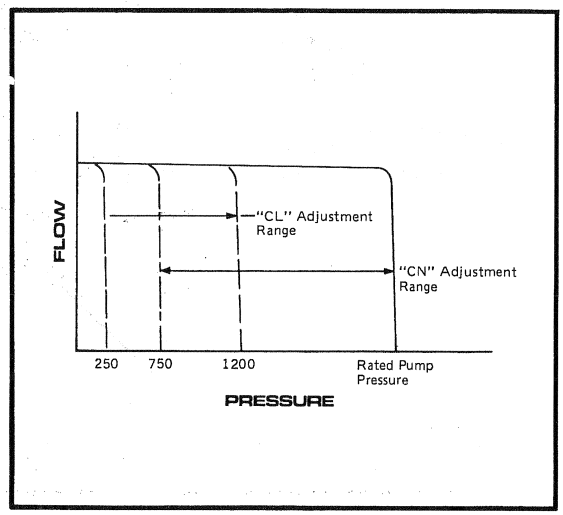


Figure 2. Curve indicating flow vs pressure for "CN/CL" type controls.

REFERENCE MATERIAL

DESCRIPTION	BULLETIN
Fluid Recommendations	90000
Filtration Recommendations	90007
"PVW" and "PVWH" Variable Delivery Pumps	947015

THE OILGEAR COMPANY
2300 So. 51st. Street
Milwaukee, Wisconsin 53219

Reissued: March, 1991

PARTS USED IN THIS ASSEMBLY ARE PER HYDURA SPECIFICATIONS. USE HYDURA PARTS TO INSURE COMPATIBILITY WITH ASSEMBLY REQUIREMENTS. WHEN ORDERING REPLACEMENT PARTS, INCLUDE TYPE DESIGNATION, SERIAL NUMBER STAMPED ON NAMEPLATE, ITEM NUMBER AND BULLETIN NUMBER. WHEN ORDERING O-RINGS AND SEALS, SPECIFY TYPE OF HYDRAULIC FLUID USED.

PARTS LIST

ITEM NO.	DESCRIPTION	ITEM NO.	DESCRIPTION
303	Screw, HHC Mounting	370	Spring, Control Piston
355	O-ring	371	Plug, Control
356	O-ring	372	Cover, Control Housing
357	Nut, Jam	373	Pin, Control Piston
358	Screw, Pressure Adjusting	374	Screw, SHC
359	Plug, SAE	375	O-ring
360	Plug, SAE	376	Assembly, Pressure Compensator Adjusting
361	Plug, SAE	380	O-ring
362	Piston, Control	381	Stop, Control Piston (Sizes 15-60 Only)
363	Spool, Pressure Compensator	382	Sleeve, Control Piston Stop (Sizes 34-60 Only)
364	Seat, Spring	390	Nut, Jam
365	Gasket, Cover	391	Stem, Minimum Volume Stop
366	Spring, Pressure Compensator	392	Adapter, Minimum And Maximum Volume Stem
367	Orifice, Control Piston (.040)	393	Stem, Maximum Volume Stop
368	Housing, Control	394	O-ring
369	Gasket, Control Housing		

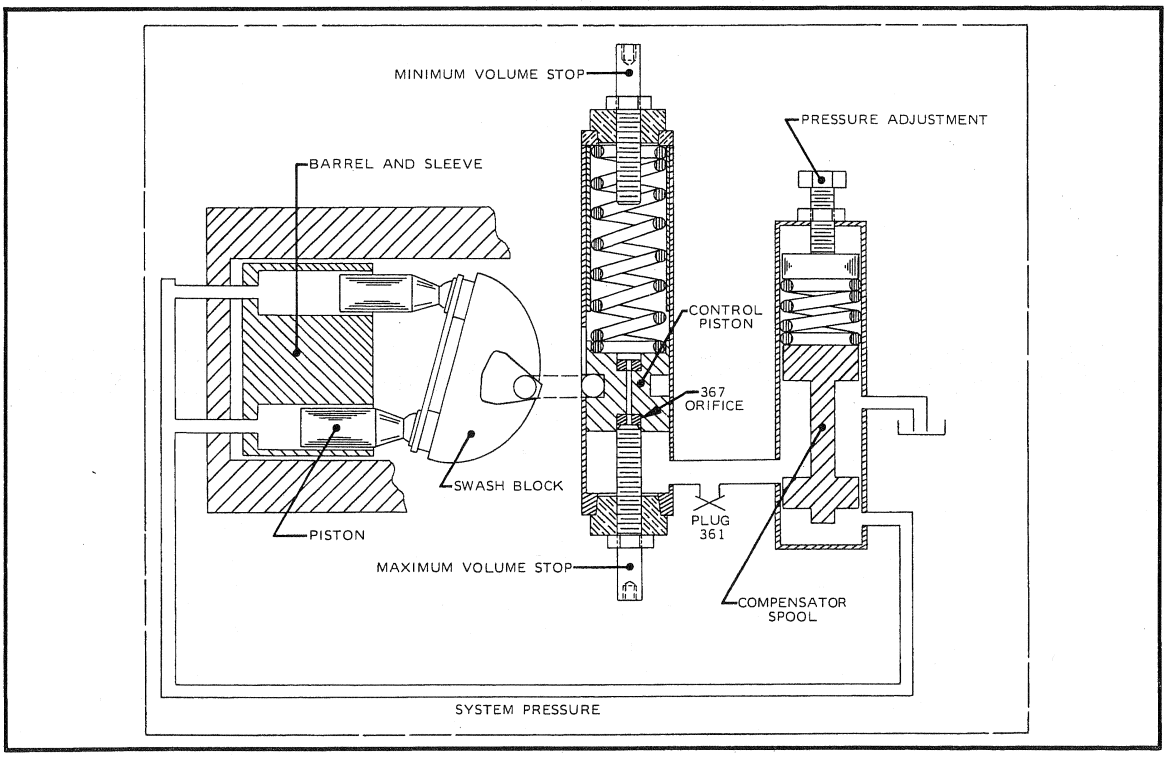


Figure 3. Diagram illustrating swashblock at full delivery and type "CN/CL" control at maximum volume stop.

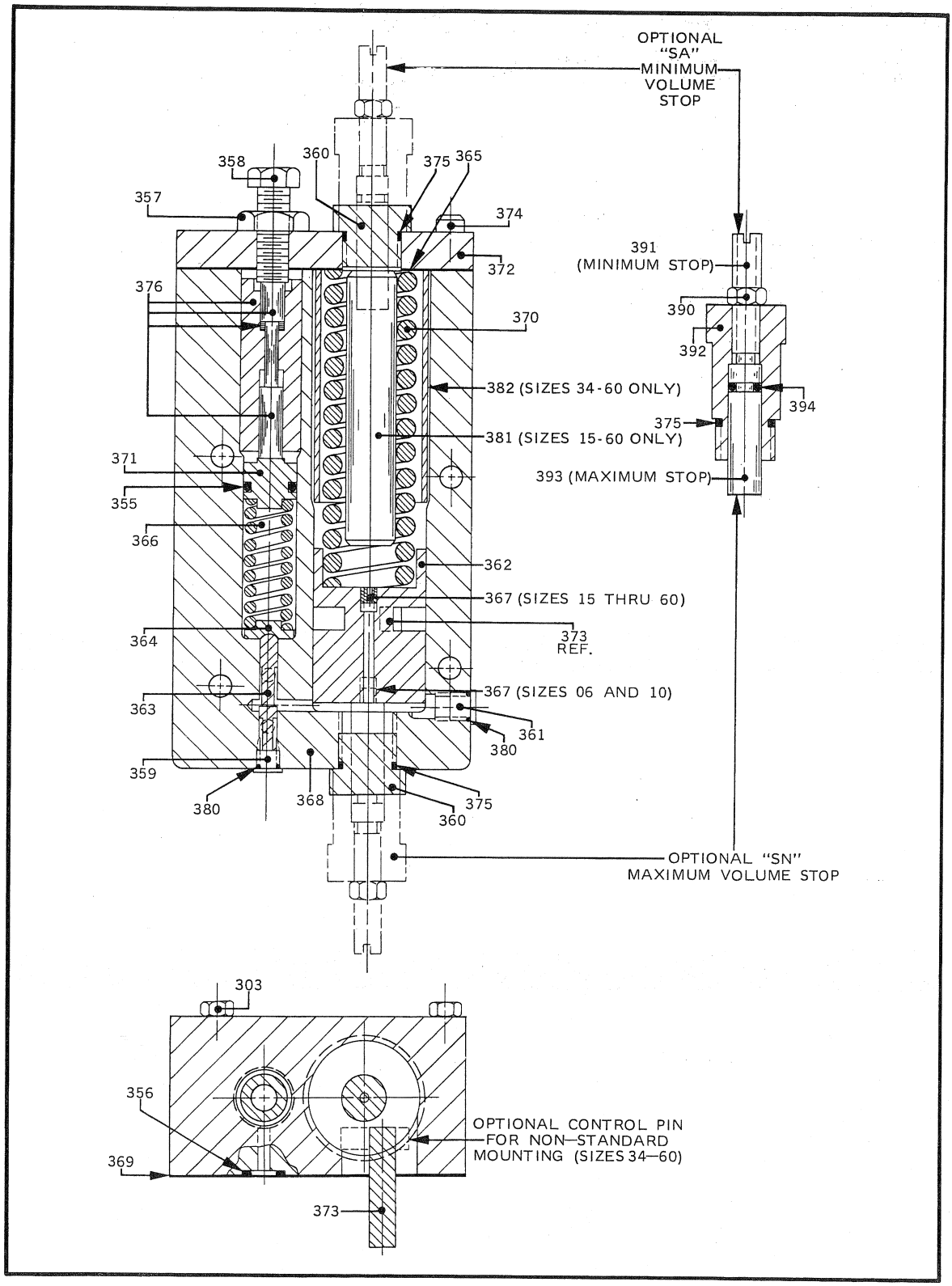


Figure 4. Parts drawing, HYDURA type "CN/CL" control (509820-B).

LINE MOUNTED REMOTE PRESSURE CONTROL FOR TYPE "CN/CL" PUMP CONTROLS

Refer to figure 5. Remote operation of "CN/CL" controls can be assomplished by installing a HYDURA remote compensator valve (Number LM-HSS-801-35) at the locations shown in the control circuit.

REMOTE PRESSURE CONTROL OPERATION:

When system pressure reaches the setting of the remote pressure compensating valve, the valve opens and ports fluid into the control piston chamber via the maximum volume stop hole. When a maximum volume stop is used, a plug (number 361 on "CN/CL" controls) must be removed to allow fluid to be ported to the control piston chamber. This fluid flow causes the pump to destroke and maintain system pressure.

MINOR CHANGES TO PUMP CONTROL:

The compensator setting on the pump control must be set at least 200 psi (13,8 bar) higher than the required maximum system pressure setting of the remote compensator valve. Doing this will prevent the pump compensator control from interacting with the remote adjustable compensator (sequence) valve.

NOTE:

Maximum volume stop adjusts from zero stroke to full stroke as follows:

SIZE	NUMBER OF TURNS
06/10	11 TURNS
15/20	14.5 TURNS
34/45/60	18 TURNS

REMOTE COMPENSATOR / MINIMIZING CASE LEAKAGE:

Refer to figure 6. To minimize case leakage and power loss, plug the drain port of the compensating spool (located on the underside of the control body) with a number 10-24 setscrew. This will result in maintaining the standard "CN" or "CL" control case leakage although response time will decrease slightly by a few milliseconds. Standard response time, if needed, can be obtained by installing a .040" orifice in the compensating spool drain instead of plugging it.

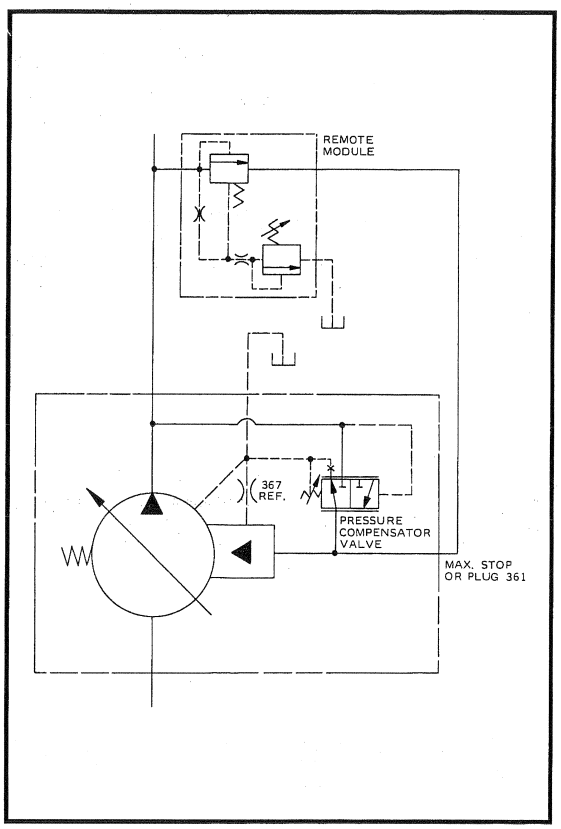


Figure 5. "CN/CL" control circuit with remote pressure control.

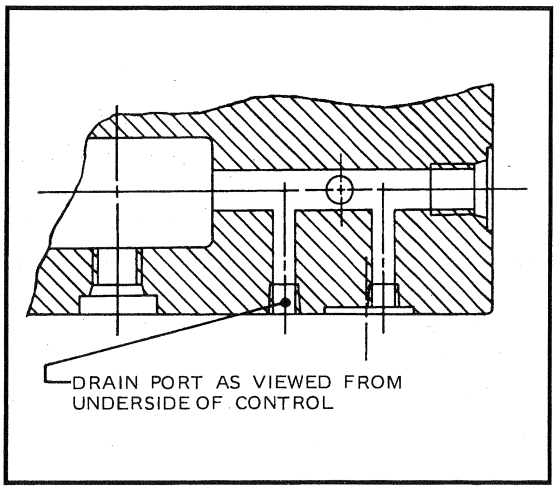


Figure 6. "CN/CL" control drain port location.

THE OILGEAR COMPANY
2300 So. 51st. Street
Milwaukee, Wisconsin 53219

Bulletin 947515

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APPENDIX VI

Material Safety Data Sheet (MSDS) Hydraulic Fluid

ExxonMobil

490110-00 MOBIL AERO HFA
MATERIAL SAFETY DATA BULLETIN

---

1. PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME: MOBIL AERO HFA
SUPPLIER: EXXONMOBIL OIL CORPORATION
3225 GALLOWS RD.
FAIRFAX, VA 22037

24 - Hour Health and Safety Emergency (call collect): 609-737-4411

24 - Hour Transportation Emergency:
CHEMTREC: 800-424-9300 202-483-7616
LUBES AND FUELS: 281-834-3296

Product and Technical Information:
Lubricants and Specialties: 800-662-4525 800-443-9966
Fuels Products: 800-947-9147
MSDS Fax on Demand: 613-228-1467
MSDS Internet Website: http://emmsds.ihssolutions.com/

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2. COMPOSITION/INFORMATION ON INGREDIENTS

CHEMICAL NAMES AND SYNONYMS: PET. HYDROCARBONS AND ADDITIVES

GLOBALLY REPORTABLE MSDS INGREDIENTS:

None.

OTHER INGREDIENTS:

Substance Name	Approx. Wt%
HYDROTREATED LIGHT NAPHTHENIC DISTILLATE (PETROLEUM) (64742-53-6)	85-95

See Section 8 for exposure limits (if applicable).

---

3. HAZARDS IDENTIFICATION

This product is considered hazardous according to regulatory guidelines (See Section 15).

EMERGENCY OVERVIEW: Red Liquid. DOT ERG No. : NA
POTENTIAL HEALTH EFFECTS: Low viscosity material-if swallowed may

enter the lungs and cause lung damage. Prolonged repeated skin contact with low viscosity materials may defat the skin resulting in possible irritation and dermatitis.

For further health effects/toxicological data, see Section 11.

---

4. FIRST AID MEASURES

EYE CONTACT: Flush thoroughly with water. If irritation occurs, call a physician.
SKIN CONTACT: Wash contact areas with soap and water. Remove contaminated clothing. Launder contaminated clothing before reuse. Discard shoes if material has penetrated to inside surfaces. High pressure accidental injection through the skin requires immediate medical attention for possible incision, irrigation and/or debridement.
INHALATION: Remove from further exposure. If respiratory irritation, dizziness, nausea, or unconsciousness occurs, seek immediate medical assistance and call a physician. If breathing has stopped, use mouth to mouth resuscitation.
INGESTION: Get medical assistance and call a physician immediately. Do not induce vomiting or give anything by mouth to an unconscious person.
NOTE TO PHYSICIANS: Material if ingested may be aspirated into the lungs and can cause chemical pneumonitis. Treat appropriately.

---

5. FIRE-FIGHTING MEASURES

EXTINGUISHING MEDIA: Carbon dioxide, foam, dry chemical and water fog.
SPECIAL FIRE FIGHTING PROCEDURES: Water or foam may cause frothing. Use water to keep fire exposed containers cool. Water spray may be used to flush spills away from exposure. Prevent runoff from fire control or dilution from entering streams, sewers, or drinking water supply.
SPECIAL PROTECTIVE EQUIPMENT: For fires in enclosed areas, fire fighters must use self-contained breathing apparatus.
UNUSUAL FIRE AND EXPLOSION HAZARDS: None.
COMBUSTION PRODUCTS: Fumes, smoke, carbon monoxide, sulfur oxides, aldehydes and other decomposition products, in the case of incomplete combustion.
Flash Point C(F): > 105(221) (ASTM D-93).
Flammable Limits (approx.% vol.in air) - LEL: NE, UEL: NE
NFPA HAZARD ID: Health: 1, Flammability: 1, Reactivity: 0

---

6. ACCIDENTAL RELEASE MEASURES

NOTIFICATION PROCEDURES: Report spills as required to appropriate authorities. U. S. Coast Guard regulations require immediate reporting of spills that could reach any waterway including intermittent dry creeks. Report spill to Coast Guard toll free number (800) 424-8802. In case of accident or road spill notify CHEMTREC (800) 424-9300.
PROCEDURES IF MATERIAL IS RELEASED OR SPILLED: Eliminate all ignition sources. Ventilate area. Adsorb on fire retardant treated sawdust, diatomaceous earth, etc. Shovel up with spark-resistant

shovel and remove to appropriate waste disposal facility in accordance with current applicable laws and regulations.
ENVIRONMENTAL PRECAUTIONS: Prevent spills from entering storm sewers or drains and contact with soil.
PERSONAL PRECAUTIONS: See Section 8

---

7. HANDLING AND STORAGE

HANDLING: Avoid prolonged repeated skin contact. Avoid inhalation of vapors or mists. Wash thoroughly after handling. High pressure injection under the skin may occur due to the rupture of pressurized lines. Always seek medical attention.
STORAGE: Do not store in open or unlabelled containers. Store away from strong oxidizing agents and combustible materials. Store in a cool, dry, well ventilated area away from heat.
SPECIAL PRECAUTIONS: Prevent small spills and leakages to avoid slip hazard.
EMPTY CONTAINER WARNING: Empty containers retain residue (liquid and/or vapor) and can be dangerous. DO NOT PRESSURIZE, CUT, WELD, BRAZE, SOLDER, DRILL, GRIND OR EXPOSE SUCH CONTAINERS TO HEAT, FLAME, SPARKS, STATIC ELECTRICITY, OR OTHER SOURCES OF IGNITION; THEY MAY EXPLODE AND CAUSE INJURY OR DEATH. Do not attempt to refill or clean container since residue is difficult to remove. Empty drums should be completely drained, properly bunged and promptly returned to a drum reconditioner. All containers should be disposed of in an environmentally safe manner and in accordance with governmental regulations.

---

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

OCCUPATIONAL EXPOSURE LIMITS: When mists/aerosols can occur, the following are recommended: 5 mg/m3(as oil mist)- ACGIH Threshold Limit Value (TLV), 10 mg/m3 (as oil mist)
- ACGIH Short Term Exposure Limit (STEL), 5 mg/m3 (as oil mist) - OSHA Permissible Exposure Limit (PEL)

VENTILATION: Use in well ventilated area. If mechanical ventilation is necessary, equipment should be explosion proof.
RESPIRATORY PROTECTION: Approved respiratory protective equipment must be used when vapor or mists concentrations exceed applicable standards. No special requirements under ordinary conditions of use and with adequate ventilation.
EYE PROTECTION: Normal industrial eye protection practices should be employed.
SKIN PROTECTION: If prolonged or repeated skin contact is likely, impervious gloves should be worn. Good personal hygiene practices should always be followed.

---

9. PHYSICAL AND CHEMICAL PROPERTIES

Typical physical properties are given below. Consult Product Data Sheet for specific details.

APPEARANCE: Liquid
COLOR: Red

ODOR: Mild
ODOR THRESHOLD-ppm: NE
pH: NA
BOILING POINT C(F): NE
MELTING POINT C(F): NA
FLASH POINT C(F): > 105(221) (ASTM D-93)
FLAMMABILITY (solids): NE
AUTO FLAMMABILITY C(F): NE
EXPLOSIVE PROPERTIES: NA
OXIDIZING PROPERTIES: NA
VAPOR PRESSURE-mmHg 20 C: NE
VAPOR DENSITY: NE
EVAPORATION RATE: NE
RELATIVE DENSITY, 15/4 C: 0.85
SOLUBILITY IN WATER: Negligible
PARTITION COEFFICIENT: NE
VISCOSITY AT 40 C, cSt: 13.8
VISCOSITY AT 100 C, cSt: 5.3
POUR POINT C(F): -70(-94)
FREEZING POINT C(F): NE
VOC: < 80.00 (Wt. %); 5.669 lbs/gal
NA=NOT APPLICABLE NE=NOT ESTABLISHED D=DECOMPOSES

FOR FURTHER TECHNICAL INFORMATION, CONTACT YOUR MARKETING REPRESENTATIVE

---

10. STABILITY AND REACTIVITY

STABILITY (THERMAL, LIGHT, ETC.): Stable.
CONDITIONS TO AVOID: Heat, sparks, flame and build up of static electricity. Protect from direct sunlight.
INCOMPATIBILITY (MATERIALS TO AVOID): Strong oxidizers.
HAZARDOUS DECOMPOSITION PRODUCTS: Product does not decompose at ambient temperatures.
HAZARDOUS POLYMERIZATION: Will not occur.

---

11. TOXICOLOGICAL DATA

---ACUTE TOXICOLOGY---
ORAL TOXICITY (RATS): Practically non-toxic (LD50: greater than 2000 mg/kg). ---Based on testing of similar products and/or the components.
DERMAL TOXICITY (RABBITS): Practically non-toxic (LD50: greater than 2000 mg/kg). ---Based on testing of similar products and/or the components.
INHALATION TOXICITY (RATS): Not established
EYE IRRITATION (RABBITS): Practically non-irritating. (Draize score: greater than 6 but 15 or less). ---Based on testing of similar products and/or the components.
SKIN IRRITATION (RABBITS): Practically non-irritating. (Primary Irritation Index: greater than 0.5 but less than 3). ---Based on testing of similar products and/or the components.

---SUBCHRONIC TOXICOLOGY (SUMMARY)---
Severely solvent refined and severely hydrotreated mineral base oils have been tested at Mobil Environmental and Health Sciences Laboratory by dermal application to rats 5 days/week for 90 days

at doses significantly higher than those expected during normal industrial exposure. Extensive evaluations including microscopic examination of internal organs and clinical chemistry of body fluids, showed no adverse effects.

---CHRONIC TOXICOLOGY (SUMMARY)---

The base oils in this product are severely solvent refined and/or severely hydrotreated. Chronic mouse skin painting studies of severely treated oils showed no evidence of carcinogenic effects. These results are confirmed on a continuing basis using various screening methods such as the Mobil Modified Ames Test and IP-346.

---

12. ECOLOGICAL INFORMATION

ENVIRONMENTAL FATE AND EFFECTS: This environmental assessment was conducted using information on the individual components as no test data was available for this specific formulation.

ECOTOXICITY: This material is not expected to be harmful to aquatic organisms.

MOBILITY: Dissolution of the higher molecular weight hydrocarbon components in water will be limited, but losses through sediment adsorption may be significant.

PERSISTENCE AND DEGRADABILITY: The majority of the components in this product are expected to be inherently biodegradable.

BIOACCUMULATIVE POTENTIAL: This product contains components with the potential to bio-accumulate.

---

13. DISPOSAL CONSIDERATIONS

WASTE DISPOSAL: Product is suitable for burning in an enclosed, controlled burner for fuel value or disposal by supervised incineration. Such burning may be limited pursuant to the Resource Conservation and Recovery Act. In addition, the product is suitable for processing by an approved recycling facility or can be disposed of at an appropriate government waste disposal facility. Use of these methods is subject to user compliance with applicable laws and regulations and consideration of product characteristics at time of disposal.

RCRA INFORMATION: The unused product, in our opinion, is not specifically listed by the EPA as a hazardous waste (40 CFR, Part 261D), nor is it formulated to contain materials which are listed hazardous wastes. It does not exhibit the hazardous characteristics of ignitability, corrosivity, or reactivity. The unused product is not formulated with substances covered by the Toxicity Characteristic Leaching Procedure (TCLP). However, used product may be regulated.

14. TRANSPORT INFORMATION

USA DOT: NOT REGULATED BY USA DOT.

RID/ADR: NOT REGULATED BY RID/ADR.

IMO: NOT REGULATED BY IMO.

IATA: NOT REGULATED BY IATA.

15. REGULATORY INFORMATION

US OSHA HAZARD COMMUNICATION STANDARD: Product assessed in accordance with OSHA 29 CFR 1910.1200 and determined to be hazardous.

EU Labeling: Product is not dangerous as defined by the European Union Dangerous Substances/Preparations Directives.

Symbol: Not applicable.

Risk Phrase(s): Not applicable.

Safety Phrase(s): S24-62.
Avoid contact with skin. If swallowed, do not induce vomiting: seek medical advice immediately and show this container or label.

Contains: Low Viscosity Oil.

Governmental Inventory Status: All components comply with TSCA, EINECS/ELINCS, AICS, METI, and DSL.

U.S. Superfund Amendments and Reauthorization Act (SARA) Title III:
This product contains no "EXTREMELY HAZARDOUS SUBSTANCES".

SARA (311/312) REPORTABLE HAZARD CATEGORIES:
CHRONIC ACUTE

This product contains no chemicals subject to the supplier notification requirements of SARA (313) toxic release program.

The following product ingredients are cited on the lists below:

CHEMICAL NAME	CAS NUMBER	LIST CITATIONS
TRIPHENYL PHOSPHATE (0.15%)	115-86-6	22

--- REGULATORY LISTS SEARCHED ---

1=ACGIH ALL	6=IARC 1	11=TSCA 4	16=CA P65 CARC	21=LA RTK
2=ACGIH A1	7=IARC 2A	12=TSCA 5a2	17=CA P65 REPRO	22=MI 293
3=ACGIH A2	8=IARC 2B	13=TSCA 5e	18=CA RTK	23=MN RTK
4=NTP CARC	9=OSHA CARC	14=TSCA 6	19=FL RTK	24=NJ RTK
5=NTP SUS	10=OSHA Z	15=TSCA 12b	20=IL RTK	25=PA RTK
				26=RI RTK

Code key: CARC=Carcinogen; SUS=Suspected Carcinogen; REPRO=Reproductive

16. OTHER INFORMATION

USE: AVIATION HYDRAULIC FLUID

NOTE: PRODUCTS OF EXXON MOBIL CORPORATION AND ITS AFFILIATED COMPANIES ARE NOT FORMULATED TO CONTAIN PCBS.

Health studies have shown that many hydrocarbons pose potential human health risks which may vary from person to person. Information provided on this MSDS reflects intended use. This product should not be used for other applications. In any case, the following advice should be considered:

INJECTION INJURY WARNING: If product is injected into or under the skin, or into any part of the body, regardless of the appearance of the wound or its size, the individual should be evaluated immediately by a physician as a surgical emergency. Even though initial symptoms from high pressure injection may be minimal or absent, early surgical treatment within the first few hours may significantly reduce the ultimate extent of injury.

Precautionary Label Text:

CONTAINS LOW VISCOSITY OIL

CAUTION!

LOW VISCOSITY MATERIAL-IF SWALLOWED, MAY BE ASPIRATED AND CAN CAUSE SERIOUS OR FATAL LUNG DAMAGE. MAY CAUSE NOSE, THROAT AND LUNG IRRITATION, DIZZINESS, NAUSEA, LOSS OF CONSCIOUSNESS.

PROLONGED, REPEATED SKIN CONTACT MAY CAUSE IRRITATION.

Keep away from heat, sparks, and flame. Avoid breathing vapor. Avoid contact with skin or clothing. Keep container closed. Use with adequate ventilation.

FIRST AID: If inhaled, remove to fresh air. If not breathing, give artificial respiration, preferably mouth-to-mouth. If breathing is difficult, give oxygen. Call a physician immediately. In case of contact, wash skin with soap and water. Remove contaminated clothing. Call a physician if irritation persists. Wash or dispose of contaminated clothing. If swallowed, seek immediate medical attention. Do not induce vomiting. Only induce vomiting at the instruction of a physician.

For industrial use only. Not intended or suitable for use in or around a household or dwelling.

Empty container may contain product residue, including flammable or explosive vapors. Do not cut, puncture, or weld on or near container. All label warnings and precautions must be observed until container has been thoroughly cleaned or destroyed.

Refer to product Material Safety Data Bulletin for further safety and health information.

****
For Internal Use Only: MHC: 1* 1* NE 1* 1*, MPPEC: C, TRN: 490110-00, ELIS: 400275, CMCS97: 970584, REQ: MIAMI, SAFE USE: C
EHS Approval Date: 12AUG2003
****

Prepared by: ExxonMobil Oil Corporation
Environmental Health and Safety Department, Clinton, USA

TRONAIR

APPENDIX VII

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.*"

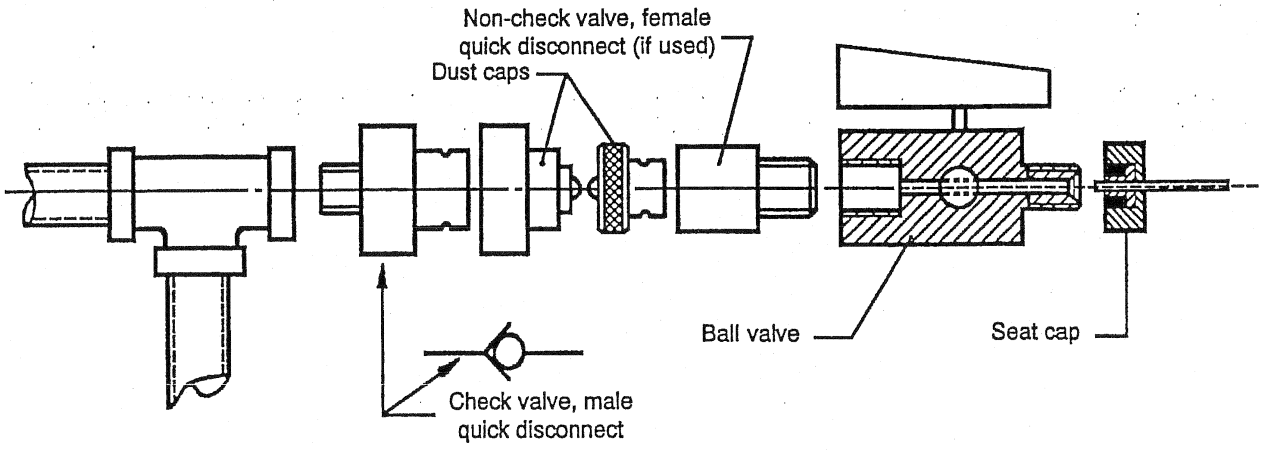

Figure 1 — Typical field type sampling device

APPENDIX VIII

Instrument Certification Notice

Instrument Certification Notice

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

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

Note that Tronair, Inc. does not supply certificates of calibration on 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.

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