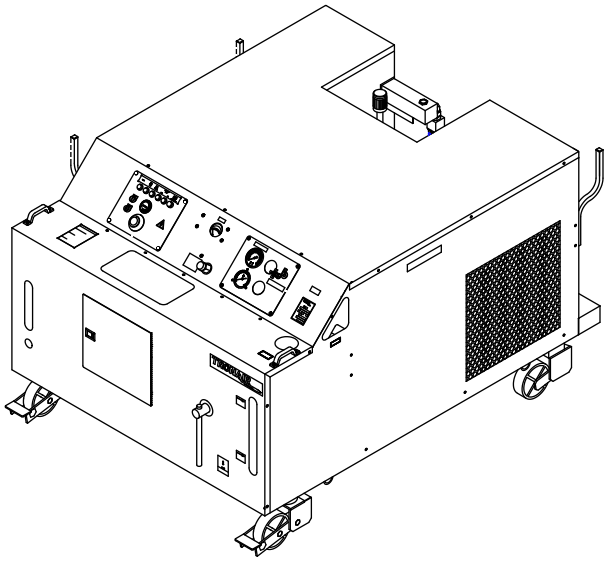
Operation & Service Instructions



Model: 5933
Hydraulic Power Unit

CE

01/2016 – Rev. 03

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REVISION	DATE	TEXT AFFECTED
01	11/2013	Original Release
02	09/2014	Major revision
03	01/2016	Modified Parts Lists

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

1.0 PRODUCT INFORMATION

1.1 DESCRIPTION

Hydraulic Power Unit
Model Number: 5933
Fluid Type: Aviation Phosphate Ester, Type IV

1.2 MODEL & SERIAL NUMBER

Reference nameplate on unit.

1.3 MANUFACTURER

TRONAIR, Inc.
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1.4 FUNCTION

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

1.5 REQUIREMENTS

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

2.0 SAFETY INFORMATION

2.1 USAGE AND SAFETY INFORMATION

The HPU provides pressurized hydraulic fluid for performing aircraft maintenance.

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

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

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

2.2 EXPLANATION OF WARNING & DANGER SIGNS

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

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

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

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

2.3 COMPONENT SAFETY FEATURES

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

2.0 SAFETY INFORMATION *(continued)*

2.4 FUNCTIONAL SAFETY FEATURES

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

2.5 PERSONAL PROTECTION EQUIPMENT

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

2.6 SAFETY GUIDELINES

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

2.7 GENERAL COMMENTS

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

The HPU must be used in accordance with the Operator Manual 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	380	460	575
Full Load Amps	192	171	137
Locked Rotor Amps	1218	1085	869
Recommended Fuse Size	225	200	175
Maximum Fuse Size	250	250	200

50 Hz Applications			
Voltage	380	415	440
Full Load Amps	208	190	179
Locked Rotor Amps	1320	1206	1129
Recommended Fuse Size	250	225	225
Maximum Fuse Size	300	250	250

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 ***6.3.1 Front Panel Controls*** for reservoir fill location. NOTE: Leave the Reservoir Selector Valve in the Aircraft Reservoir position (as shipped) until the Hydraulic Power Unit reservoir has been filled.

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 the proper electrical plug onto the electrical cord. Read ***5.0 Training*** and ***6.0 Operation*** of this manual and become familiar with control locations. Reference ***3.0 Electrical Power and Protection Requirements Table*** for power requirements and fuse sizes. Follow instructions in ***6.4.1 Pump Rotation Checking Procedure***.

WARNING!

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

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

Some reasons for imbalance are:

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

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

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 Operator Manual.
- The employer of the operator shall provide all necessary training.

6.2 NUMERICAL VALUES

6.2.1 Fluid Type

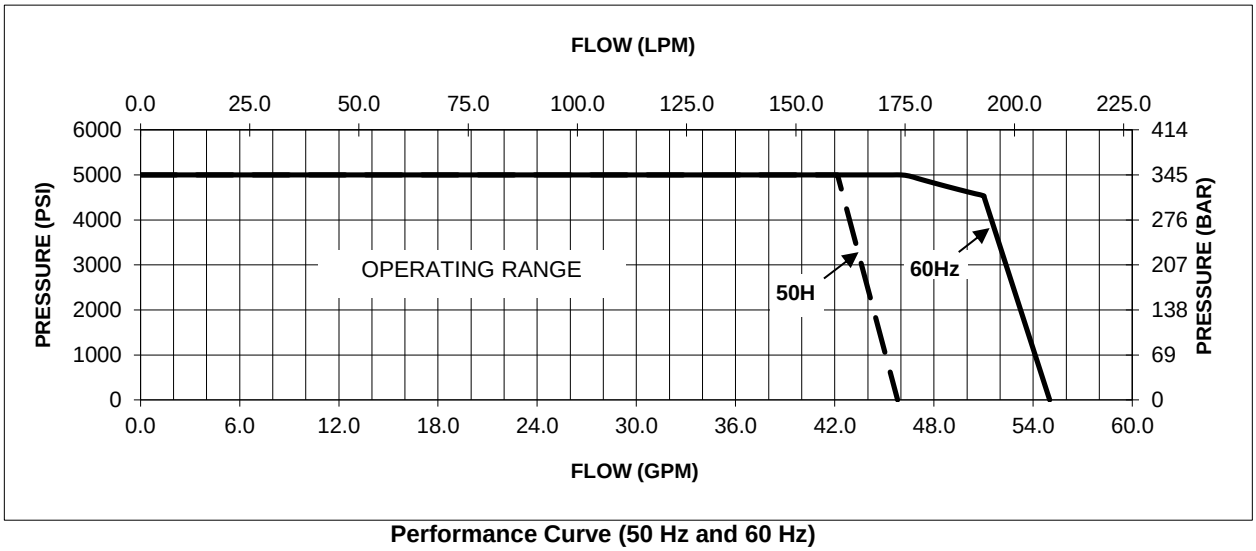
Model: 5933
Fluid Type: Aviation Phosphate Ester, Type IV

6.2.2 Physical

- Weight (Dry): 6,500 lbs (2950 kg) Estimated
- Dimensions:
  - Width: 80.3 in (204 cm) Add 6.0 in (15.2 cm) for Dual System
  - Height: 68 in (173 cm)
  - Depth: 105 in (266 cm) Add 11 in (25 cm) for trailer option
- Power Cord: 50 ft (15.24 m) long
- Pressure Hoses:
  - 25 ft (7.62 m)..... Standard Length
  - 50 ft (15.24 m)..... Optional Length
  - -16 (1 in, 25.4 mm)..... Working Diameter
- Return Hoses:
  - 25 ft (7.62 m)..... Standard Length
  - 50 ft (15.24 m)..... Optional Length
  - -24 (1½ in, 38.1 mm)..... Working Diameter
- Hand Pump Hose:
  - 15 ft (4.57 m)..... Standard Length
  - -4 (¼ in, 6.35 mm)..... Working Diameter

6.2.3 Motor Driven Hydraulic Pump

- A pressure compensated, adjustable maximum volume piston pump.
- Maximum flow at 60 Hz..... 50 gpm (189 lpm)
- Maximum flow at 50 Hz..... 41 gpm (155 lpm)
- Maximum operating pressure at 50 Hz and 60 Hz ..... 5,000 psi (345 bar)
- System pressure relief valve setting..... 5,250 psi (362 bar)
- Performance Curve for 50 Hz and 60 Hz



Performance Curve (50 Hz and 60 Hz)

6.2 Numerical Values continued on following page.

6.2 NUMERICAL VALUES *(continued)*

6.2.4 Electric Motor

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

MOTOR POWER REQUIREMENTS

60 Hz Applications	
Voltage	**Full Load Amps**
380	192
460	171
575	137

50 Hz Applications	
Voltage	**Full Load Amps**
380	208
415	190
440	179

6.2.5 Filters

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

6.2.6 Hand Pump *(Option M)*

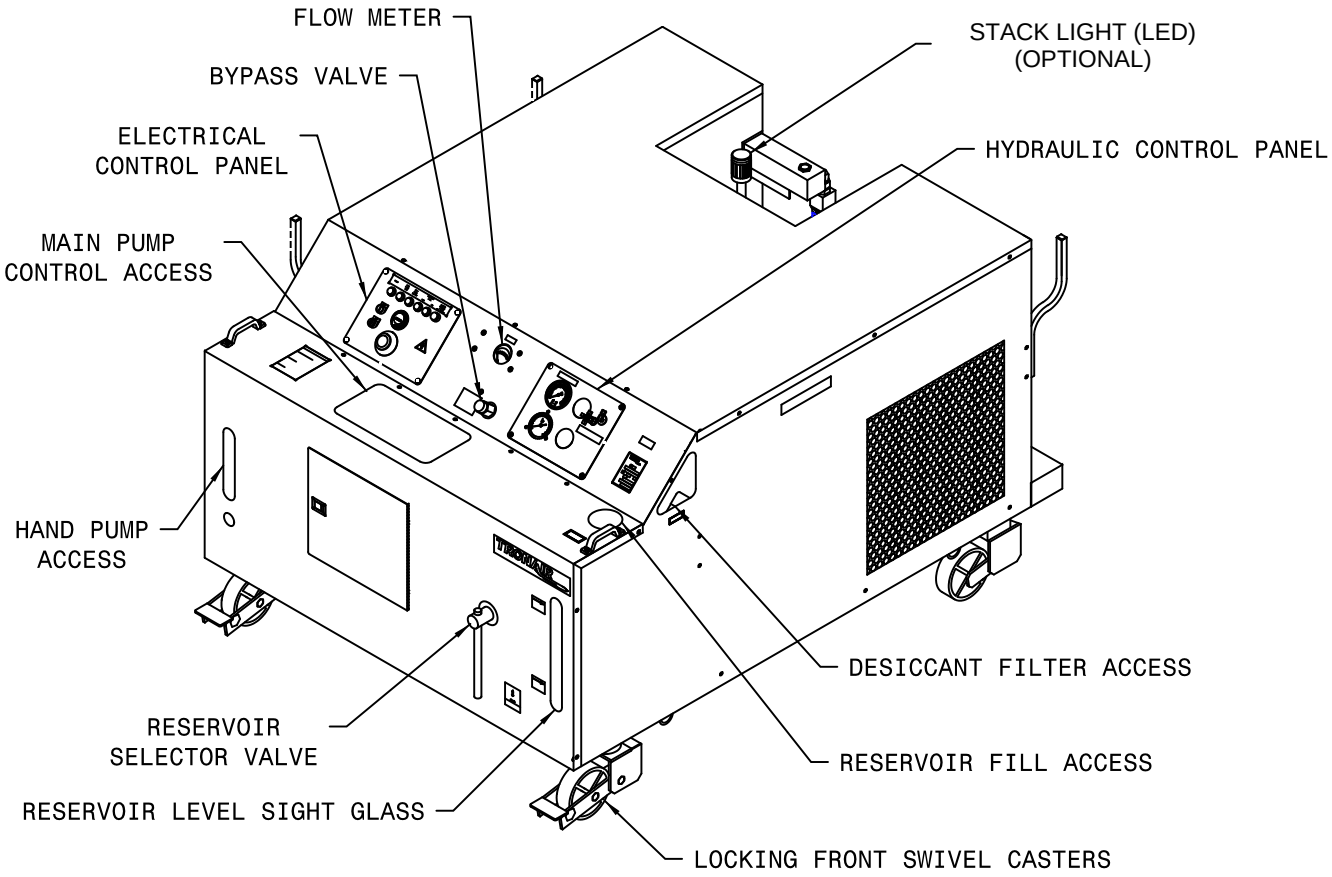
Two stage hand pump, low pressure stage 0–500 psi (0–34.47 bars) and 500–5,000 psi (34.47–344.74 bar) high pressure stage. Pump automatically changes stage internally based on system pressure.

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

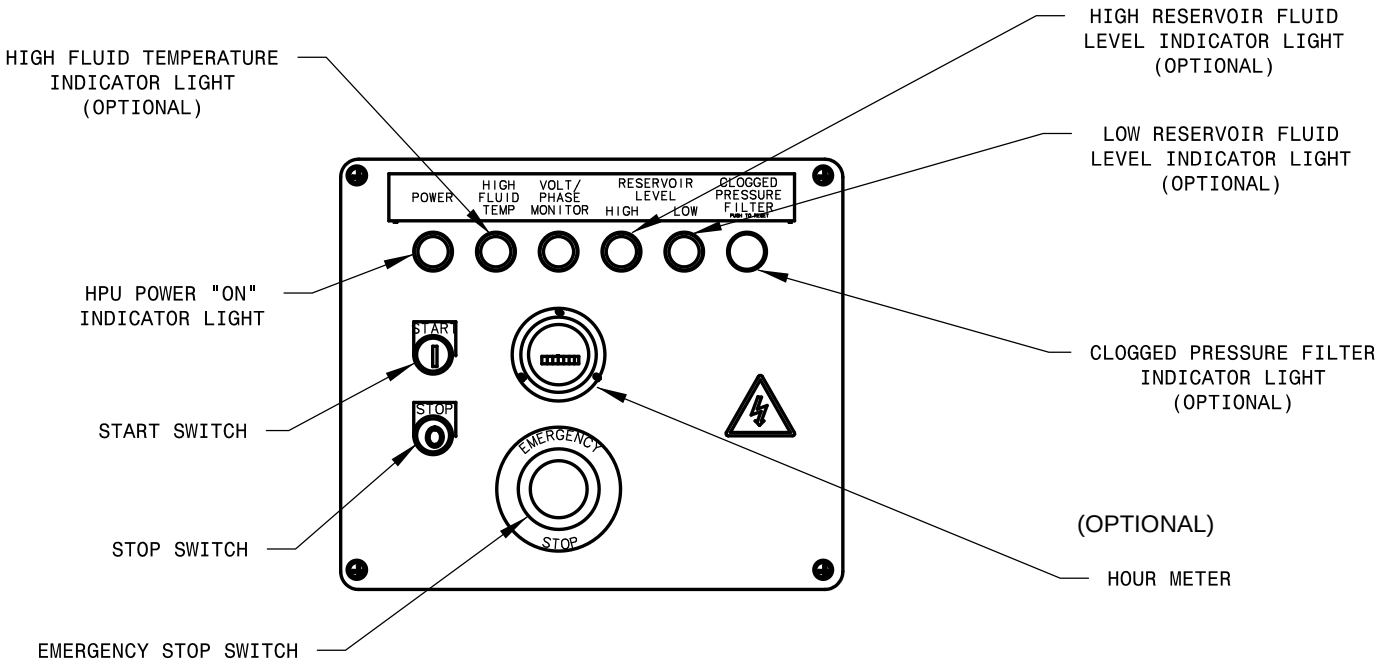


Electrical Control Panel	See Section 6.3.2
Hydraulic Control Panel	See Section 6.3.3
Bypass Valve	For loading and unloading the motor driven hydraulic pump
Flowmeter	Displays the flow from the motor driven hydraulic pump
Pump Control Access	See 6.3.5 - Hydraulic Pump Controls
Reservoir Selector	For selecting 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
Locking Swivel Caster	Locking/unlocking, foot actuated and released locking front caster
Stack Light *(Option SL)*	Displays green LED light when unit is running

6.3.2 Location & Layout of Controls continued on following page.

6.3 LOCATION & LAYOUT OF CONTROLS *(continued)*

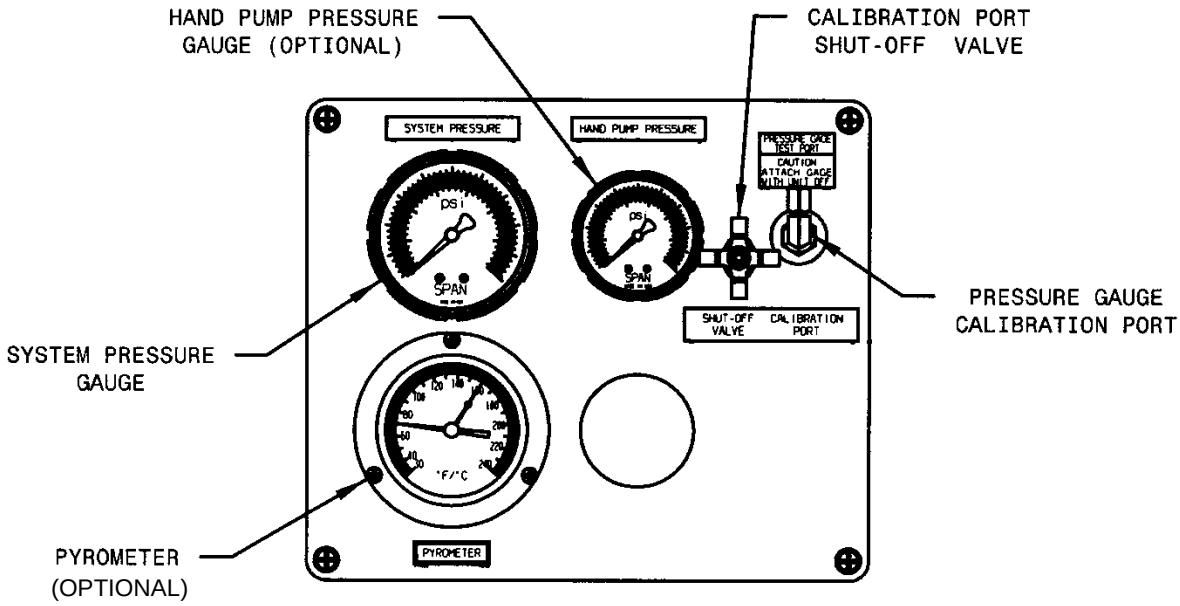
6.3.2 Electrical Control Panel



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
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)*

6.3.3 Hydraulic Control Panel

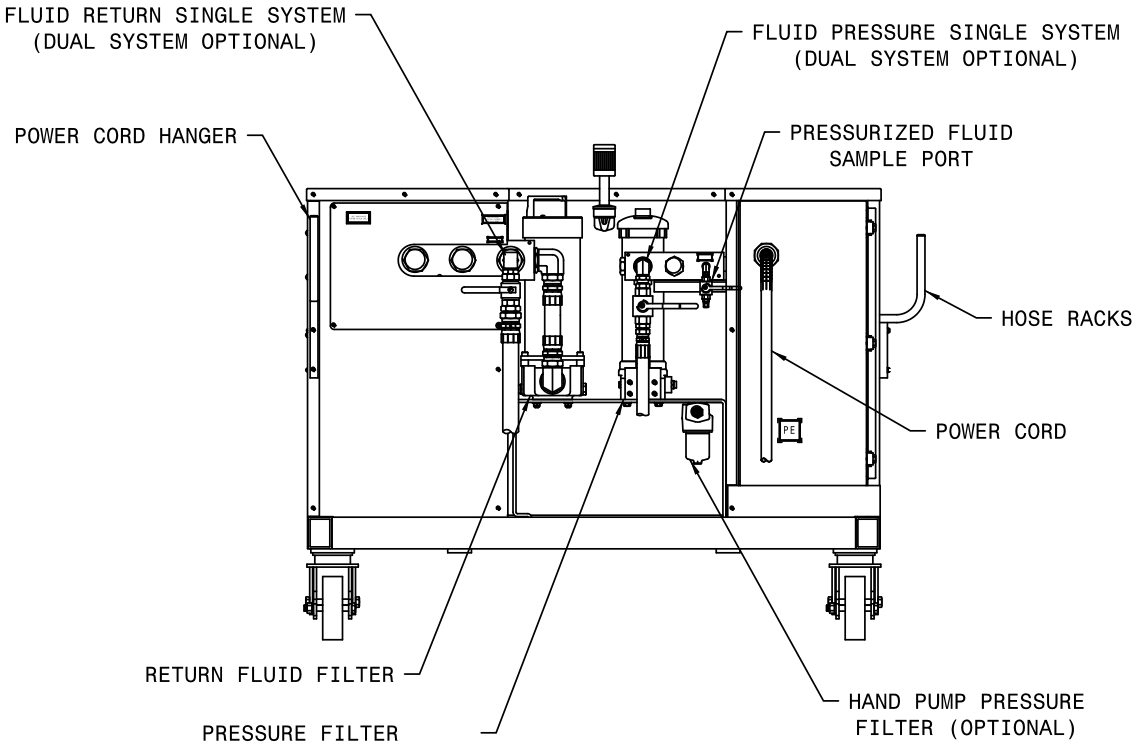


System Pressure Gauge	Displays the system pressure on an analog fluid dampened gauge
Pyrometer *(Option K)*	Displays the fluid temperature in the return system on an analog gauge. A warning indicator preset to 160° F (71° C) warns of high operating temperature
Pressure Gauge Calibration Port	Allows for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

6.3 Location & Layout of Controls continued on following page.

6.3 LOCATION & LAYOUT OF CONTROLS *(continued)*

6.3.4 Rear Panel Controls



(WITH OPTIONAL CLOGGING INDICATOR)

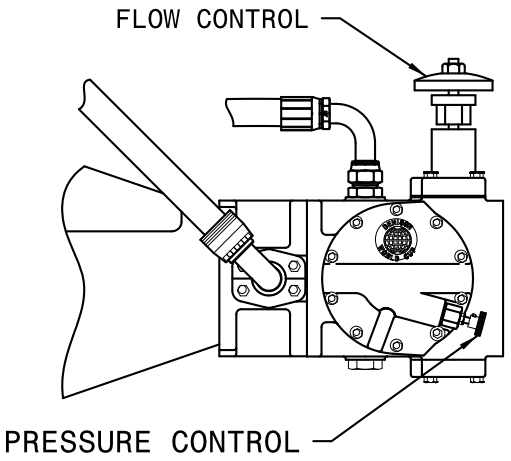
* Fluid Pressure System	The source of pressurized fluid from the HPU that flows to the aircraft pressure system through the pressure hose
* Fluid Return System	Fluid returning to the HPU from the aircraft that flows through the return hoses
Pressure Fluid Filter	Filters the pressurized fluid before it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

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

6.3 LOCATION & LAYOUT OF CONTROLS *(continued)*

6.3.5 Hydraulic Pump Controls

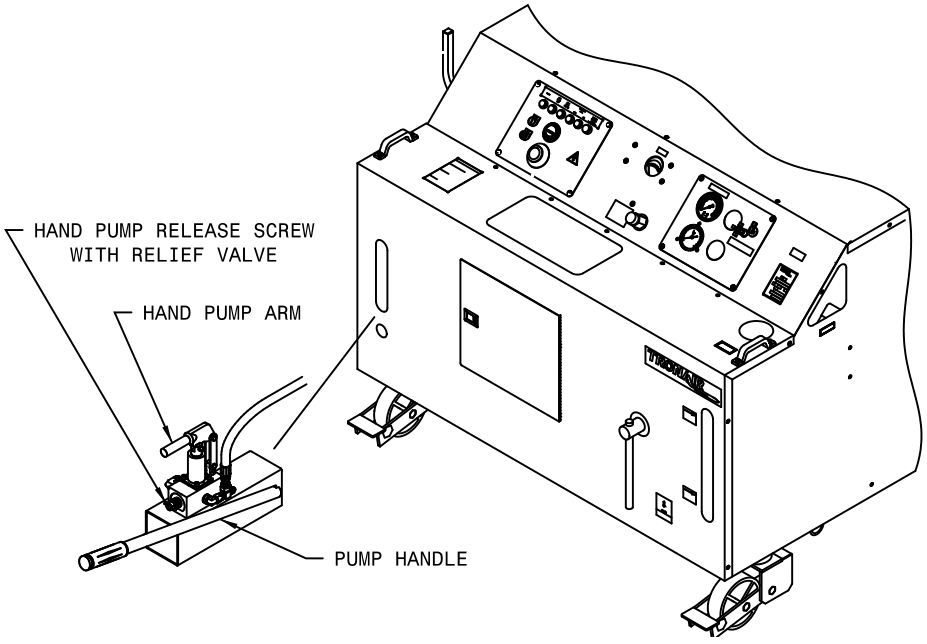
The hydraulic pump flow control and pressure control are located through the pump control access door.



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

6.3.6 Hand Pump Controls ***(****Option M)*

Reference 6.8 Hand Pump Operation



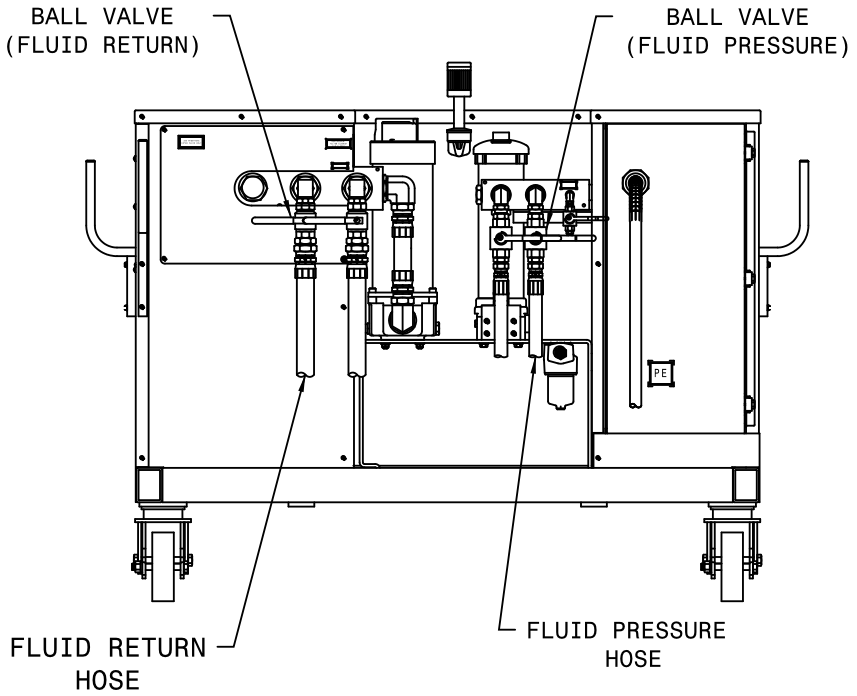
Pump Handle	Located inside the front access door is the hand pump handle used for opening and closing the hand pump relief screw and stroking the hand pump arm
Hand Pump Relief Screw	Accessed through the front panel opening, this screw allows opening and closing of the hand pump hydraulic circuit using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

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



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

WARNING!

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

6.0 OPERATION *(continued)*

6.4 START UP PROCEDURES

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

To check rotation (with or without Phase Monitor):

a. Close the fluid pressure ball valve(s) at the rear of the HPU. Reference ***6.3.4*** for location of ball valve.
b. Open the bypass valve on the instrument panel fully counter-clockwise.
c. Set the flow control on the pump to maximum flow (fully counter-clockwise).
d. Place the reservoir selector valve in HPU Reservoir position.
e. Remove the pump/motor coupling guard. Reference ***Figure Pump/Motor Coupling Access***.

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

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

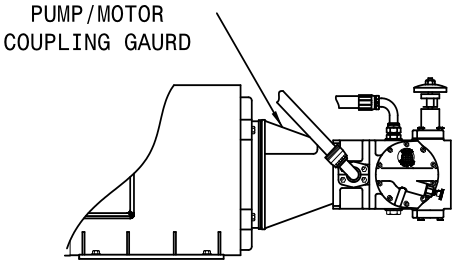


FIGURE 6.4.1
Pump/Motor Coupling Access

f. Verify that the unit has been prepared for use by connecting electrical leads and servicing the reservoir. (Reference ***4.0 Preparation Prior to First Use***)
g. Keeping hands clear of the pump/motor coupling area, momentarily press the start button and immediately press the stop button.
h. Observe direction of rotation of the pump/motor coupling. When the Operator is facing the front panel, the pump/motor coupling should be rotating in a clockwise direction.
i. If the pump/motor coupling is rotating in a counter-clockwise direction, change any two of the three leads at the plug. Observe direction of rotation to verify that pump/motor is rotating in a clockwise direction.
j. Replace the pump/motor coupling guard.

6.4.2 Initial Start Up of the HPU

a. Unit must be prepared per ***4.0 Preparation Prior to First Use*** and ***6.4.1 Pump Rotation Check Procedure (First Time Use or Change of Electrical Supply Only)*** before starting the HPU.
b. Operator must be familiar with this manual and be properly trained prior to starting the HPU.
c. Close the fluid pressure ball valve(s) at the rear of the HPU. Reference ***Figure 6.3.4*** for location of ball valve.
d. Open the bypass valve on the instrument panel fully counter-clockwise.
e. Set the flow control on the pump to maximum flow (fully counter-clockwise).
f. Place the reservoir selector valve in HPU Reservoir position.
g. Press the start switch; the flowmeter should show full flow immediately. If no flow displays on the flow meter, press the stop switch immediately and reference ***9.2 No Flow*** in Trouble Shooting section.
h. Adjust the flow down to approximately 10–20 gpm (38–76 liters/minute).
i. Close the bypass valve, adjust the pressure control until 3,000 psi (206.84 bar) is displayed on the pressure gauge. (If no pressure displays on the system pressure gauge after adjusting the pressure control, reference ***Trouble Shooting 9.4 No Pressure or Reduced Pressure)***.
j. Open the bypass valve; press the stop switch

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

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 Preliminary adjustments for operation continued on following page.

6.5 PRELIMINARY ADJUSTMENTS FOR OPERATION *(continued)*

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.

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

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

6.6 BLEEDING AIR FROM SYSTEM *(continued)*

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.

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.

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

WARNING!

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

6.8 HAND PUMP OPERATION *(Option M)*

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

6.8.1 To Operate the Hand Pump

a. Remove the pump handle from inside the front access door. (Reference ***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 (***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.

6.9 SAMPLE VALVE

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

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

6.0 Operation continued on following page.

6.0 OPERATION *(continued)*

6.10 EMERGENCY SHUT DOWN PROCEDURE

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

6.11 DESCRIPTION OF ALARM SYSTEMS

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

6.11.1 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***.

6.11.2 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.

6.11.3 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 10.5.1 Pressure Filter Element) for maintenance procedure. Pressing the clogging filter indicator light will reset the light and the light will turn off.

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

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 8,000 lb (3,629 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.

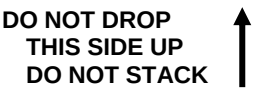
NOTE: Be sure the forks are long enough to reach the frame cross members for stability during lifting. Spread the forks to their maximum width for stability. Reference Figure 8.0 – HPU on Forklift.

7.3 PACKAGING PROTECTION

No special packaging material for cushioning or suspension is required.

7.4 LABELING OF PACKAGING

Packaging should be labeled as follows:



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

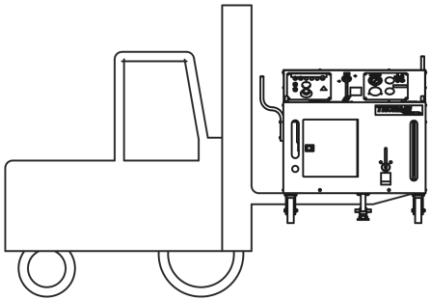
- Weight (Dry)**:** 6,000 lbs (2,722 kg) *Estimated*
- Dimensions**:** Width: 80.3 in (204 cm) Add 6.0 in (15.2 cm) for Dual System.
  Height: 68 in (173 cm)
  Depth: 105 in (266 cm) Add 11 inches (28 cm) for trailer option

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 HPU on Forklift.

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



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
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 *(Option S)*	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.

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

9.3 REDUCED FLOW

Possible Cause	Solution
Flow control set too low	Increase flow setting
Pressure adjustment is set too low	Slightly increase pressure setting
Pressure compensator control is reducing pump output	When system pressure exceeds the compensator control setting, or when the system no longer requires flow, the control de-strokes the pump while maintaining the preset pressure
Pump inlet is not receiving enough fluid (cavitation)	Follow the procedure for “Air in pump inlet lines” in section 9.2
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

9.4 NO PRESSURE or REDUCED PRESSURE

Possible Cause	Solution
Pressure adjustment is set too low	Increase pressure adjustment
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

9.0 TROUBLE SHOOTING *(continued)*

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 Appendix for Electrical Schematic INS-1665)
Bypass valve or rear ball valve is being used in a partially closed	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

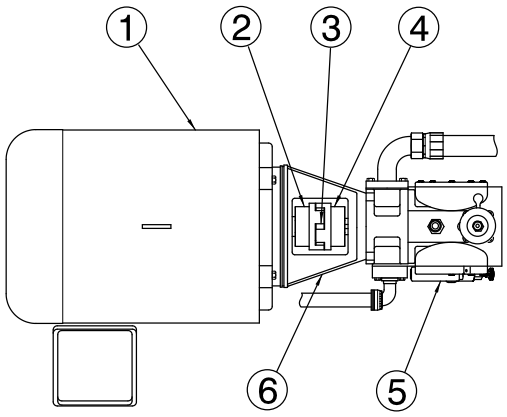
10.1 GENERAL

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* – 10.15** 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 Appendix – Lincoln Motor Manual*** for details.



Parts List

Item	Part Number	Description	Qty
1	Reference table below	Electric Motor	1
2	H-2552-33	Coupling (Motor Half)	1
3	H-2551	Spider (Hytrel)	1
4	H-2552-24	Coupling (Pump Half)	1
5	*Reference 10.3 and 10.3.1*	Motor Driven Hydraulic Pump	1
6	HC-2055-02	Pump/Motor Adapter	1

60 Hz Applications	
Voltage	**Part Number**
380	EC-1224-22
460	EC-1224-23
575	EC-1224-24

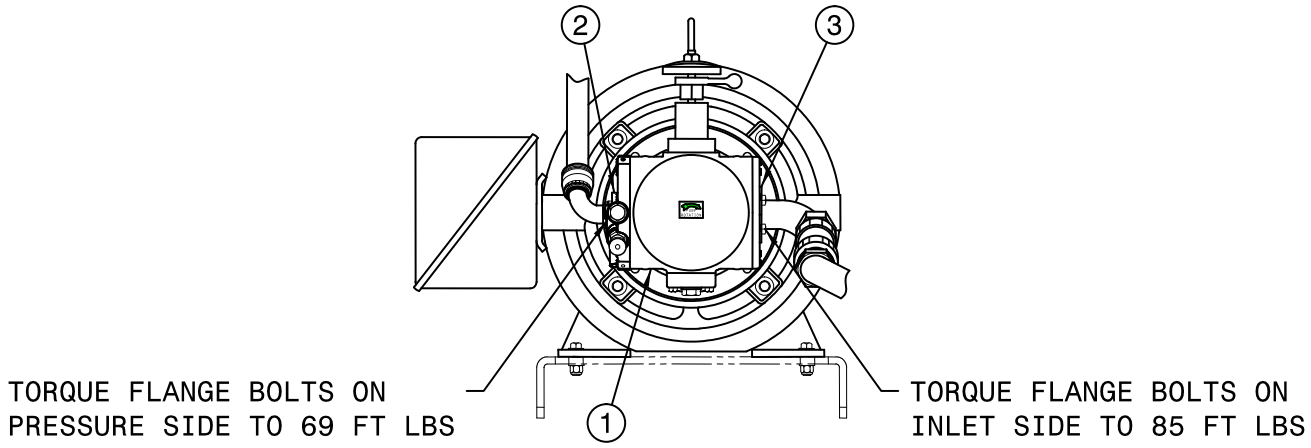
50 Hz Applications	
Voltage	**Part Number**
380	EC-1224-23
415	EC-1224-23
440	EC-1555-08

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 ***Appendix VI – Oilgear Pump Manual*** for further details.

10.3.1 Motor Driven Hydraulic Pump Replacement Parts



Parts List

Fluid Type: Aviation Phosphate Ester, Type IV

Item	Part Number	Description	Qty
1	♦ HC-1426-01	Assembly, Hydraulic Pump	1
2	HC-2664-03-S-E	Kit, Flange *(Pressure Side)*	1
3	N-2674-07	Kit, Flange *(Inlet Side)*	1
Not Shown	N-2007-29-S-E	Fitting, Connector *(Case Drain Port)*	1

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

10.3.2 Motor Driven Hydraulic Pump Replacement Kits List

Fluid Type: Aviation Phosphate Ester, Type IV

Part Number	Description
K-2753	Kit, Shaft and Bearing Assembly
♦K-2754	Kit, Shaft Seal

♦ ***Requires K-2938 Seal Tool Kit. Call Tronair for Details.***

10.4 HYDRAULIC FLUID

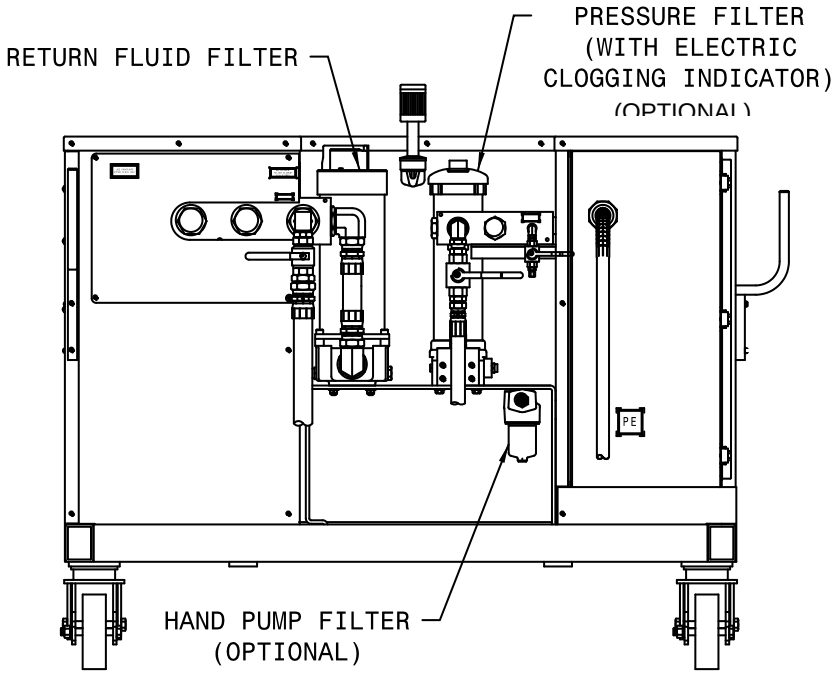
Any time an unusual color, smell or visual indicator is noticed with the hydraulic fluid, a sample analysis should be performed to determine the condition of the fluid. (See ***6.9 – Sample Valve Operation***)

Refer to the manufacturer of the specific fluid for your unit to obtain additional information:
Model Number: 5933
Fluid Type: Aviation Phosphate Ester, Type IV

10.0 Maintenance continued on following page.

10.0 MAINTENANCE *(continued)*

10.5 FILTERS

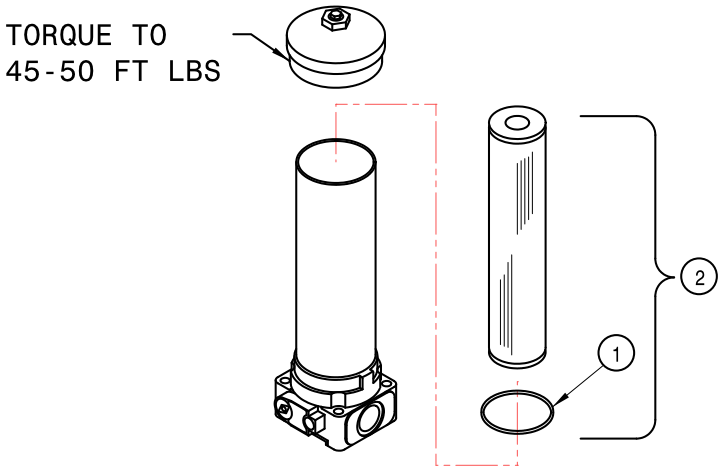


10.5.1 Pressure Filter Element

Replace the filter element any time the clogged filter indicator light is triggered.

Replace the filter element annually to ensure proper cleanliness of the hydraulic system. This is a minimum requirement.

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



Parts List

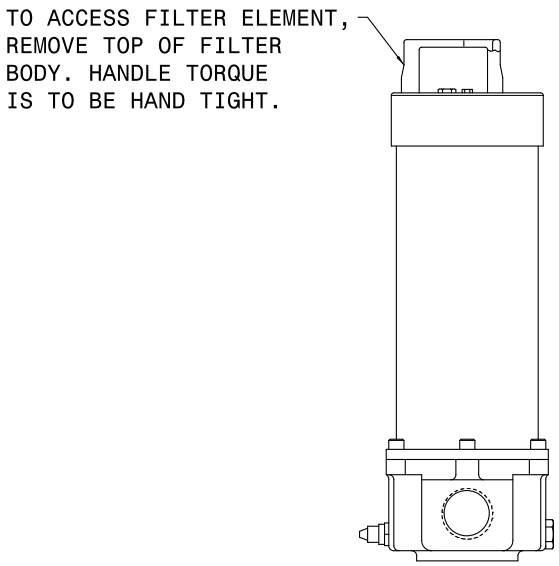
Fluid Type: Aviation Phosphate Ester, Type IV

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

10.5 FILTERS *(continued)*

10.5.2 Return Filter Element

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



Parts List

Fluid Type: Aviation Phosphate Ester, Type IV

Item	Part Number	Description	Qty
Not Shown	HC-2006-257	O-ring (Bowl)	1
Not Shown	♦ K-3587	Kit, Replacement Filter Element	1

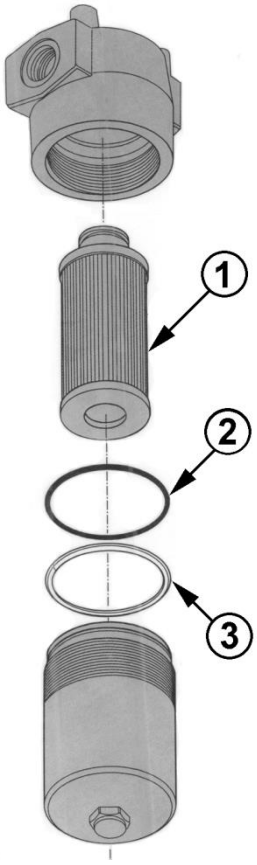
♦ ***HC-2006-257 O-ring is included in Kit.***

10.5 Filters continued on following page.

10.5 FILTERS *(continued)*

10.5.3 Hand Pump *(Option M)* Filter Element

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



Parts List

Fluid Type: Aviation Phosphate Ester, Type IV

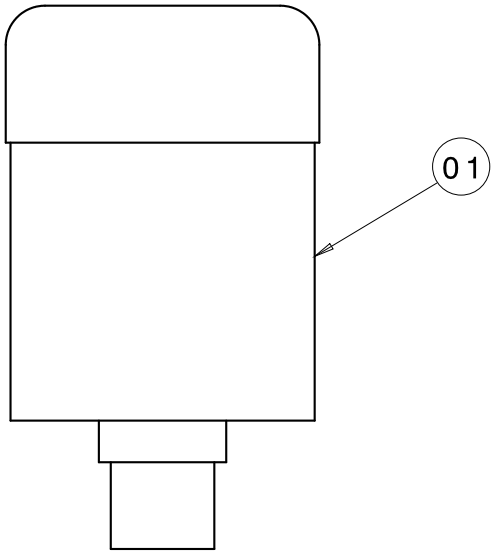
Item	Part Number	Description	Qty
2 & 3	K-3797	O-ring and Backup Ring	1
1, 2, 3	K-3752	Kit, Replacement Filter Element	1

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).

NOTE: See 6.3.1 Front Panel Controls for Desiccant Filter access location.



Parts List

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

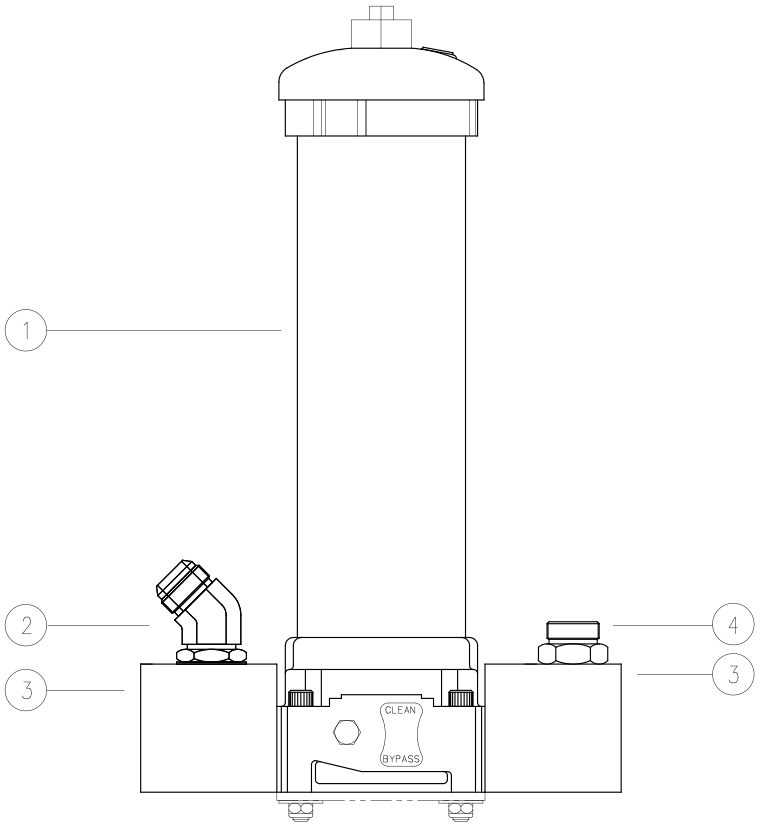
10.5 Filters continued on following page.

10.5 FILTERS (*continued*)

10.5.5 Pressure Filter Assembly (with Electric Filter Clogging Indicator – *Optional)*

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

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



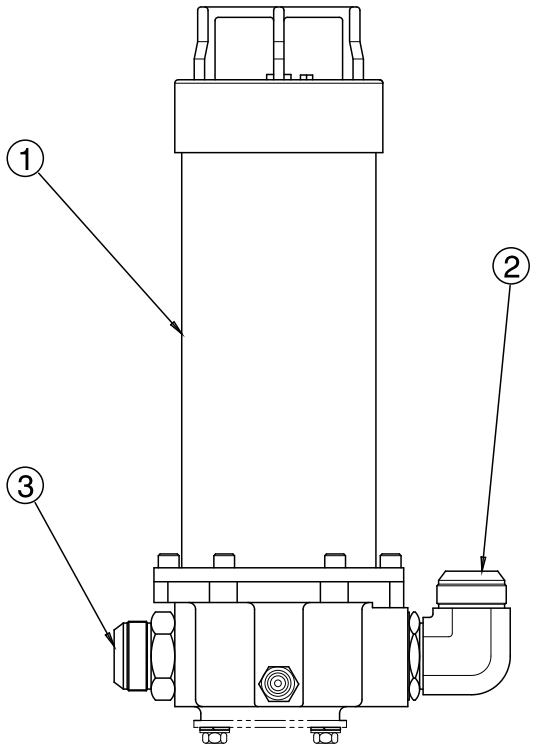
Parts List

Fluid Type: Aviation Phosphate Ester, Type IV

Item	Part Number	Description	Qty
1	HC-2053	Filter, Pressure (Phosphate Ester)	1
2	N-2974-S-E	Elbow, 45º Straight Thread	1
3	HC-2106	Flange, Elbow	2
4	N-2507-25-S-E	Connector, #20 SAE x #20 Ferulok	1

10.5 FILTERS *(continued)*

10.5.6 Return Filter Assembly



Parts List

Fluid Type: Aviation Phosphate Ester, Type IV

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

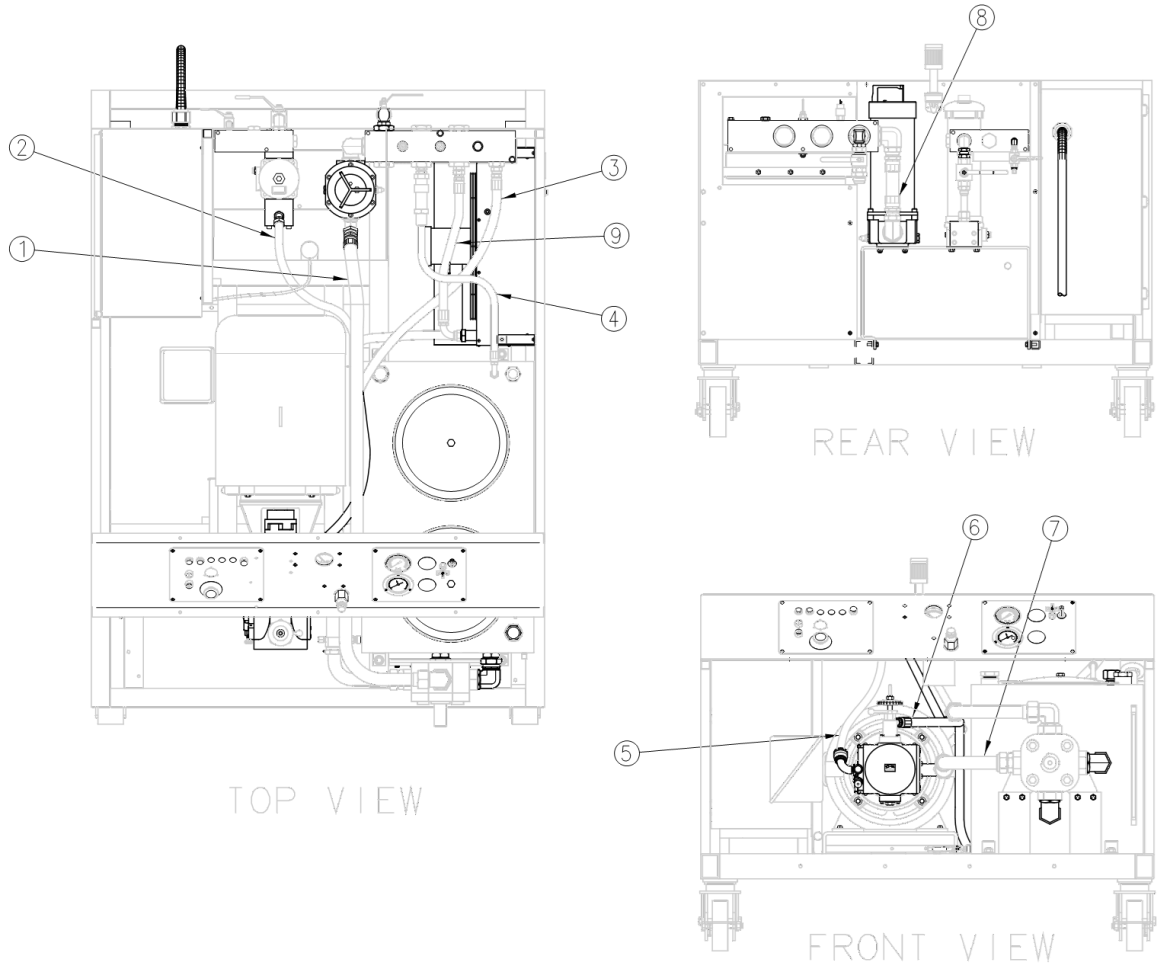
10.0 Maintenance continued on following page.

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.

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



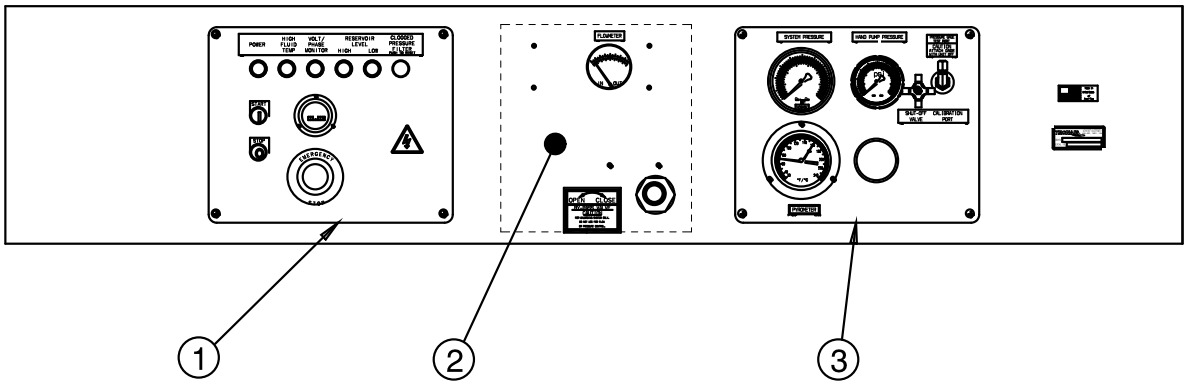
Parts List

Fluid Type: Aviation Phosphate Ester, Type IV

Item	Part Number	Description	Qty
1	TF-1041-18*59.0	Assembly, Hose #32	1
2	TF-1117-37-57.5	Assembly, Hose #16	1
3	TF-1041-04*70.5	Assembly, Hose #24	1
4	TF-1041-16*37.5	Assembly, Hose #16	1
5	TF-1117-37-98.0	Assembly, Hose #16	1
6	TF-1041-32-110	Assembly, Hose #20	1
7	TF-1040-38*17.2	Assembly, Hose #32	1
8	TF-1041-18*11.7	Assembly, Hose #32	1
9	TF-1041-54*29.0	Assembly, Hose #20	1
Not Shown	TF-1117-16*300	External Pressure Hose	1
Not Shown	TF-1041-04*300	External Return Hose	1

10.0 MAINTENANCE *(continued)*

10.7 INSTRUMENT PANEL



Parts List

Fluid Type: Aviation Phosphate Ester, Type IV

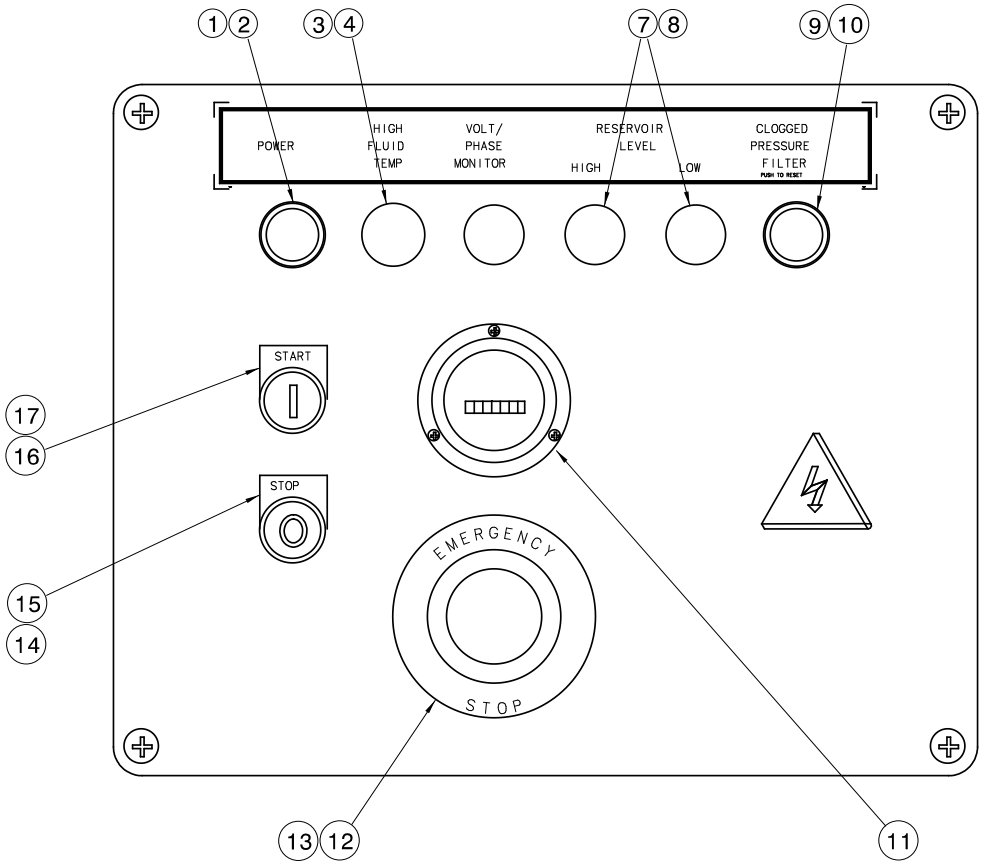
Item	Part Number	Description	Qty
1	See Section 10.7.1	Electric Panel	1
2	See Section 10.7.3	Control Block	1
3	See Section 10.7.2	Hydraulic Panel	1

10.7 Instrument Panel continued on following page.

10.7 INSTRUMENT PANEL *(continued)*

10.7.1 Electric Panel

The Electric Panel does not require regular general maintenance.



Parts List

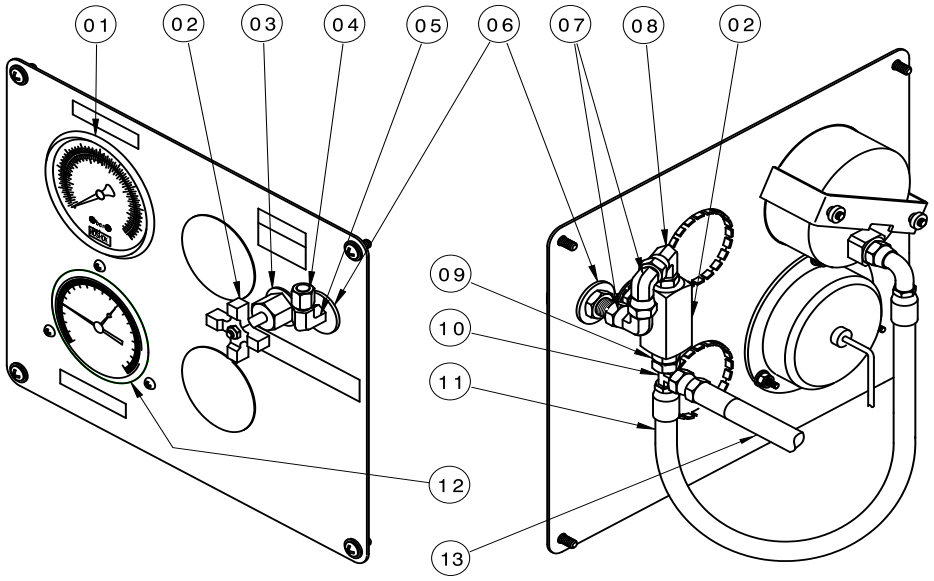
Fluid Type: Aviation Phosphate Ester, Type IV

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

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.



Parts List

Fluid Type: Aviation Phosphate Ester, Type IV

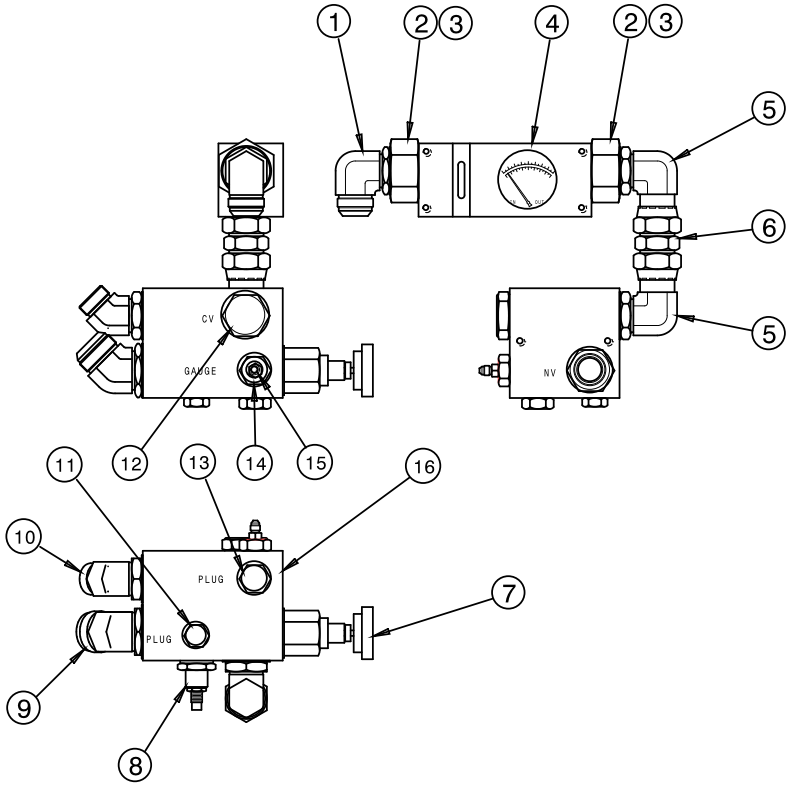
Item	Part Number	Description	Qty
1	HC-2145	Gauge, Pressure	1
2	HC-1900-02	Valve, Needle	1
3	HC-1122	Kit, Panel Mounting	1
4	N-2008-03-S	Cap, ¾ JIC	1
5	N-2022-03-S	Elbow, Bulkhead Union #4	1
6	G-1250-1080W	Flatwasher, 7/16 Wide	1
7	N-2002-03-S	Elbow, 90° Swivel Nut #4	2
8	N-2049-07-S-E	Elbow, 90° Swivel 6-4	1
9	N-2007-03-S-E	Connector, Straight Thread	1
10	N-2016-03-S	Tee, Swivel Nut Run #4	1
11	TF-1040-42*24.0	Assembly, Hose	1
12	HC-2268-02	Gauge, Pyrometer *(Optional)*	1
13	TF-1040-42*32.0	Assembly, Hose	1

10.7.3 Control Block Assembly continued on following page.

10.7 INSTRUMENT PANEL *(continued)*

10.7.3 Control Block Assembly

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



Parts List

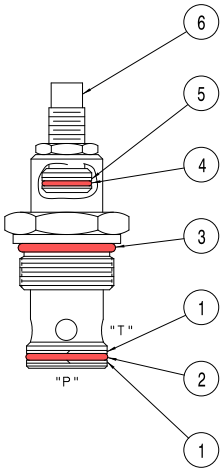
Fluid Type: Aviation Phosphate Ester, Type IV

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

10.7.3 Control Block Assembly *(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.



Parts List

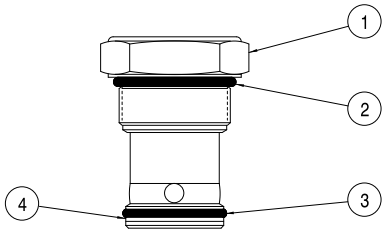
Fluid Type: Aviation Phosphate Ester, Type IV

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

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

10.7.3.b Check Valve

The Check Valve does not require regular general maintenance.



Parts List

Fluid Type: Aviation Phosphate Ester, Type IV

Item	Part Number	Description	Qty
1	HC-2103	Check Valve *(Phosphate Ester)*	1
2	HC-2013-920	O-ring, Series 3	1
3	HC-2006-124	O-ring, Series 2	1
4	HC-2020-124	Backup Ring	1

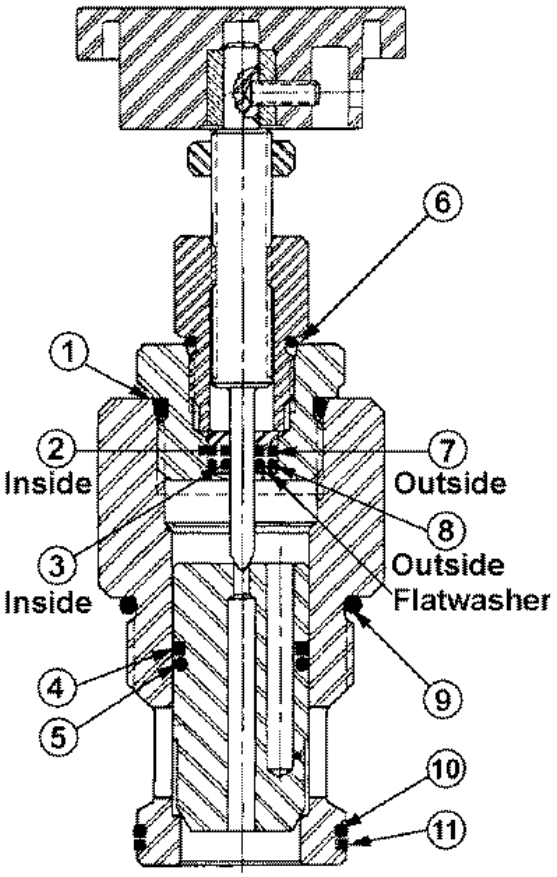
♦ ***Item 1 consists of Items 2 – 4***

10.7.3 Control block assembly continued on following page.

10.7.3 Control Block Assembly *(continued)*

10.7.3.c Bypass Valve

The Bypass Valve does not require regular general maintenance.



Parts List

Fluid Type: Aviation Phosphate Ester, Type IV

Item	Part Number	Description	Qty
1	HC-2013-914	O-ring, Series 3	1
2	HC-2020-008	Ring, Backup (Teflon)	1
3	HC-2006-008	O-ring, Series 3	1
4	HC-2020-019	Ring, Backup (Teflon)	1
5	HC-2006-019	O-ring, Series 2	1
6	HC-2013-908	O-ring, Series 3	1
7	HC-2020-012	Ring, Backup (Teflon)	1
8	HC-2006-012	O-ring, Series 2	1
9	HC-2013-920	O-ring, Series 3	1
10	HC-2006-028	O-ring, Series 2	1
11	HC-2020-028	Ring, Backup (Teflon)	1
♦ 12	HC-2214	Valve, Needle *(Phosphate Ester)*	1

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

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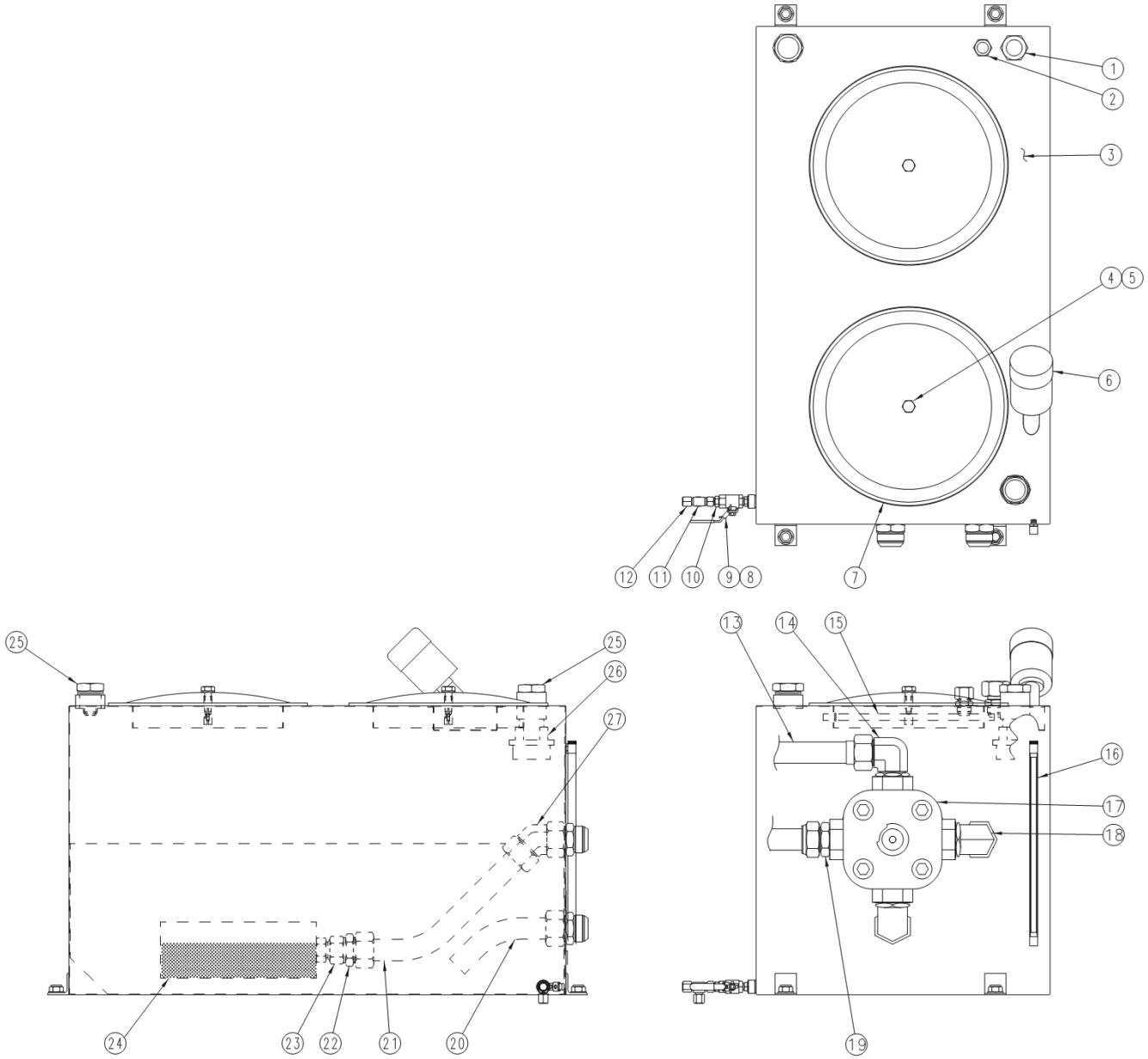
10.0 MAINTENANCE *(continued)*

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.



10.8 RESERVOIR ASSEMBLY *(continued)*

Parts List

Fluid Type: Aviation Phosphate Ester, Type IV

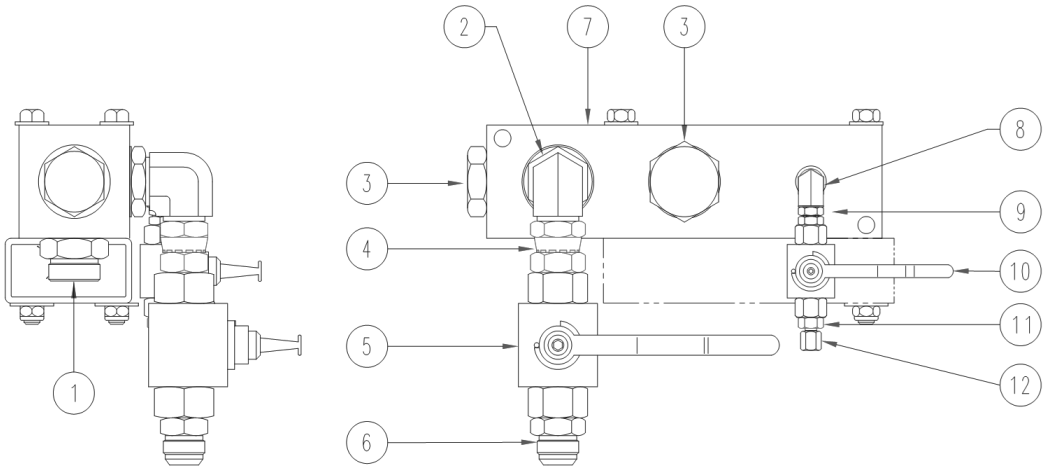
Item	Part Number	Description	Qty
1	N-2008-12-S	Cap, #24	1
2	N-2008-10-S	Cap, #16	1
3	H-2553	Reservoir, 150 gallon (567.8 lt) Stainless Steel	1
4	H-1735-02	Washer, Nylon	2
5	G-1100-110024	Bolt, Hex Head, Grade 5, 5/8 –11 x 2 1/2" long	2
6	HC-1763	Filter, Desiccant	1
7	H-2562	Assembly, Cover	2
8	HC-2013-908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

10.0 Maintenance continued on following page.

10.0 MAINTENANCE *(continued)*

10.9 PRESSURE MANIFOLD ASSEMBLY

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



Parts List

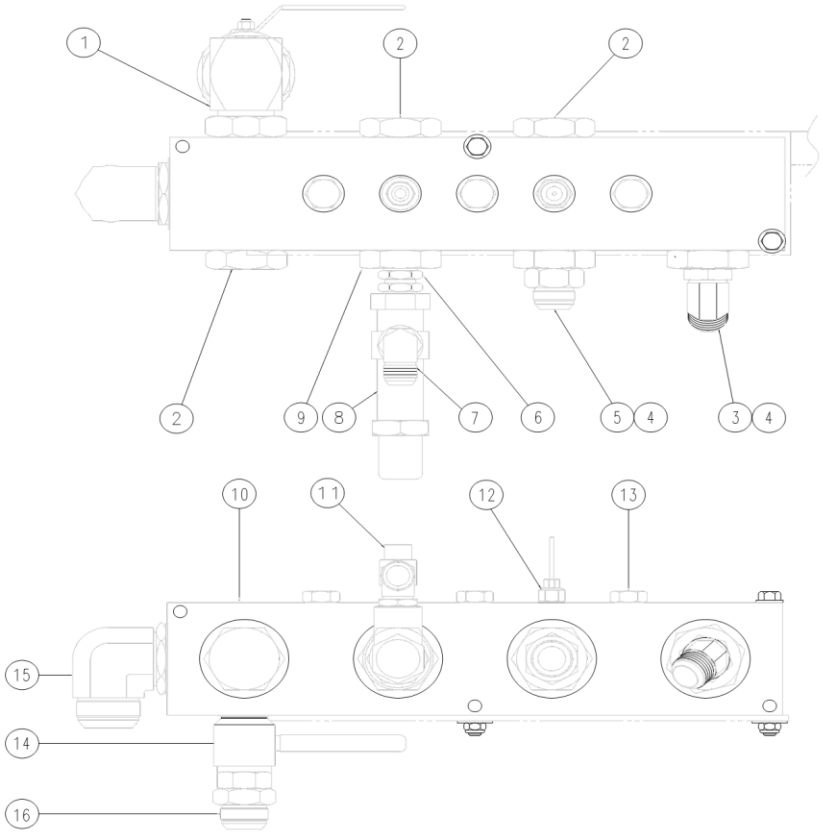
Fluid Type: Aviation Phosphate Ester, Type IV

Item	Part Number	Description	Qty
1	N-2678-21-S-E	Connector, Straight Thread (-20)	1
2	N-2630-20-S-E	Elbow, 90° ORFS	1
3	N-2053-11-S-E	Plug, O-ring Hex Head	2
4	N-2650-06-S-E	Connector, ORFS Swivel	1
5	HC-1771-05	Valve, Ball *(Phosphate Ester)*	1
6	N-2975-S-E	Connector, Straight Thread	1
7	HC-2054	Manifold, Pressure	1
8	N-2661-02-S-E	Elbow, Straight Thread	1
9	N-2464-05-S-E	Union, Straight Thread	1
10	HC-1771-02	Valve, Ball *(Phosphate Ester)*	1
11	N-2007-05-S-E	Connector, Straight Thread	1
12	N-2008-03-S	Cap	1

10.0 MAINTENANCE *(continued)*
10.10 RETURN MANIFOLD ASSEMBLY

The Return Manifold does not require regular general maintenance.

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



Parts List

Fluid Type: Aviation Phosphate Ester, Type IV

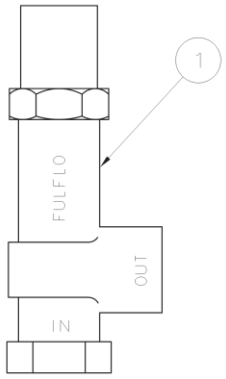
Item	Part Number	Description	Qty
1	N-2666-09-S-E	Elbow, Straight Thread	1
2	N-2053-13-S-E	Plug, O-ring Hex Head	3
3	N-2042-14-S-E	Connector, Straight Thread	1
4	N-2463-28-S-E	Fitting, Reducer/Expander	2
5	N-2007-30-S-E	Connector, Straight Thread	1
6	N-2464-26-S-E	Union, Straight Thread	1
7	N-2001-24-S-E	Elbow, Straight Thread	1
8	HC-2202	Valve, Pressure Relief *(Phosphate Ester)*	1
9	N-2463-26-S-E	Fitting, Reducer/Expander	1
10	HC-2049	Manifold, Return	1
11	EC-1782-02	Switch, Temperature *(Optional)*	1
12	HC-2268-02	Gauge, Pyrometer *(Optional)*	1
13	N-2053-08-S-E	Plug, O-ring Hex Head	3
14	HC-2058-03	Valve, Ball	1
15	N-2001-33-S-E	Elbow, Straight Thread	1
16	N-2007-32-5-E	Connector, Straight Thread	1

10.0 Maintenance continued on following page.

10.10 RETURN MANIFOLD ASSEMBLY *(continued)*

10.10.1 Return System Pressure Relief Valve

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



Parts List

Fluid Type: Aviation Phosphate Ester, Type IV

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

♦ ***Included with Item 1***

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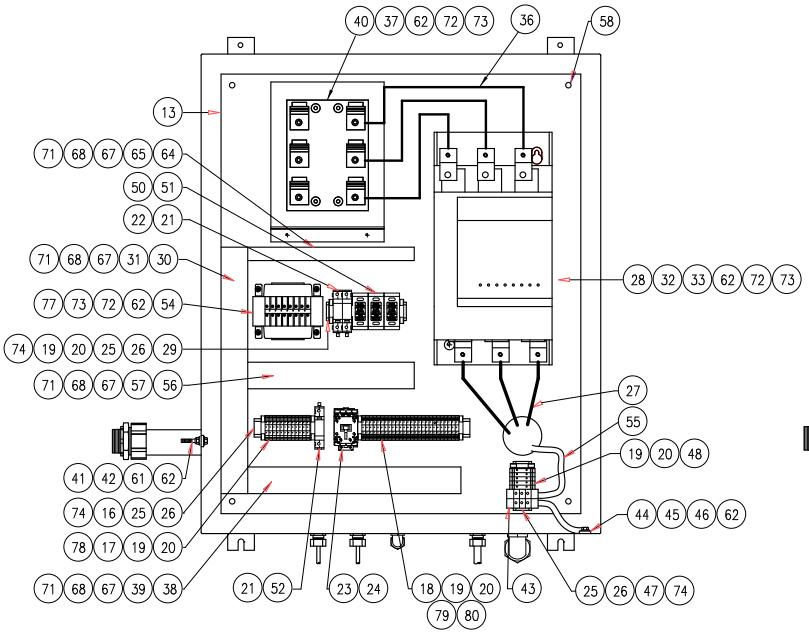
10.0 MAINTENANCE *(continued)*

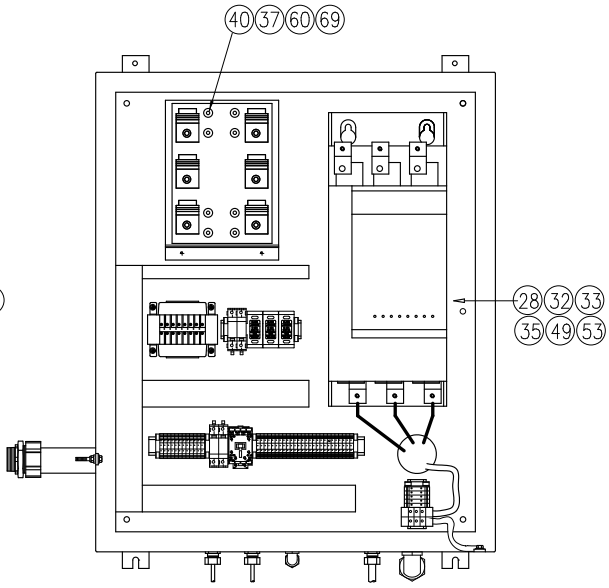
10.11 ELECTRICAL COMPONENTS

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

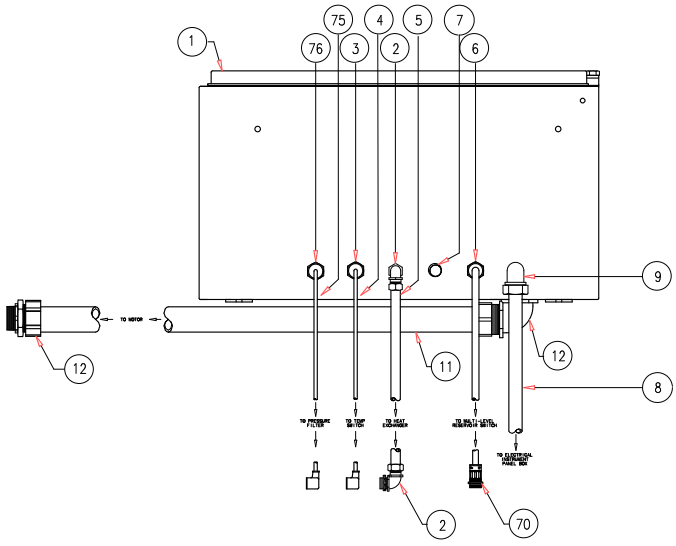
Reference following pages for component descriptions.



100 HP ASSEMBLY



150 HP ASSEMBLY



10.11 ELECTRICAL COMPONENTS *(continued)*

Parts List

Item	Part Number	Description	Qty
1	Z-5312-01	Enclosure, Electrical	Ref
2	EC-1168-01	Elbow, 90º Conduit ⅜" (½" HUB)	2
3	EC-1175-05-A	Connector, Power Cable	1
4	EC-1778	Cable, Din Connector	1
5	EC-1540-01*60.0	Conduit, Flexible Wiring, ⅜"	1
6	EC-1175-08-A	Connector, Power Cable	Ref
7	H-2432-06	Plug, Sheetmetal	2
8	EC-1540-04*60.0	Conduit, Flexible Wiring, 1"	1
9	EC-1168-04	Elbow, 90º Conduit	2
11	EC-1758-08*48.0	Conduit, Flexible Wiring, 2 ½"	1
12	EC-1168-08	Elbow, 90º Conduit 2 ½"	2
13	S-1767	Panel, Inner	Ref
16	EC-1695	Rail, Din	1
17	EC-1956-03	Block, IEC Terminal (Blue)	10
18	EC-1956-02	Block, IEC Terminal (Red)	26
19	EC-1959	Anchor, IEC End	7
20	EC-1960-01	Barrier, IEC End	3
21	EC-1541-01	Fuseholder, Modular IEC Class CC	4
23	EC-1591-04	Latch, Mechanical	1
24	EC-1564	Relay, Control	1
25	G-1159-103505	SCR, RD HD CR Rec, #10 - 32 x ⅝ LG	8
26	G-1250-1030N	Flatwasher, #10 Narrow	8
27	EC-1284-12*96.0	Wire, Power Ground (1/0 AWG)	4
29	EC-1694	Rail, Din	1
30	EC-1710-19*16.0	Duct, Wire	1
31	EC-1711-05*16.0	Duct, Cover	1
32	EC-1724	Kit, Terminal Lug	2
33	EC-1746	Kit, IEC Terminal Cover	2
35	G-1154-107714	SCR, BUT SOC HD CAP, ⅜ - 24 x 1 ½ LG	6
36	EC-1284-12*12.0	Wire, Power (1/0 AWG)	3
37	EC-2109	Fuseblock, Class J	1
38	EC-1710-19*16.0	Duct, Wire 2" x 2"	1
39	EC-1711-05*16.0	Duct, Cover	1
41	EC-1432-04	Lug, Ground	1
42	G-1159-105516	SCR, RD HD CR Rec, ¼ - 28 x 1 ¾ LG	1
43	EC-1957	Block, IEC Ground	2
44	EC-1532-04	Lug, Ground	2
45	G-1180-105006	SCR, HH Self-Tapping, ¼ - 20 x 1 ¼ LG	Ref
46	EC-1284-12*12.0	Wire, Chassis Ground (1/0 AWG)	1
47	EC-1600	Rail, Din	1
48	EC-1958	Block, IEC Ground	
49	G-1250-1070N	Flatwasher, ⅜ Narrow	6

10.11 Electrical components continued on following page.

10.11 ELECTRICAL COMPONENTS *(continued)*

Parts List

Item	Part Number	Description	Qty
50	EC-1596-01	Fuse, Class J	3
51	EC-1557-01	Fuse, Class J	3
52	EC-1542-14	Fuse, Class CC (Secondary)	1
53	G-1251-1070R	Lockwasher, ⅜ Regular	6
54	EC-1804-04	Transformer, Control (250VA)	1
55	EC-1284-12*72.0	Wire, Power Ground (1/0 AWG)	1
56	EC-1710-19*12.0	Duct, Wire	1
57	EC-1711-05*12.0	Duct, Cover	1
58	G-1202-1075	ESN, ⅜ - 24	6
60	G-1154-106006	SCR, BUT SOC HD CAP	4
61	G-1202-1055	ESN, ¼ - 28	1
62	G-1250-1050N	Flatwasher, ¼ Narrow	31
64	EC-1710-09*12.0	Duct, Wire	1
65	EC-1711-03*12.0	Duct, Cover	1
67	G-1159-102005	SCR, RD HD CR Rec, #8 - 32 x 5/8 Lg	29
68	G-1250-1020N	Flatwasher, #8 Narrow	53
69	G-1250-1060R	Flatwasher, 5/16	4
70	EC-1783	Switch, Multi-Level	Ref
71	G-1251-1020R	Lockwasher, #8 Regular	9
72	G-1159-105505	SCR, RD HD CR Rec, ¼ - 28 x 5/8 Lg	22
73	G-1251-1050R	Lockwasher, ¼ Regular	22
74	G-1251-1030R	Lockwasher, #10 Regular	8
75	EC-1815	Cordset, 3 Pin Mini	1
76	EC-1175-06-A	Connector, Power Cable	1
77	EC-1826	Guard, Finger Touchproof	1
78	EC-1961-04	Jumper, Center	1
79	EC-1961-02	Jumper, Center	3
80	EC-1961-01	Jumper, Center	1
Not Shown	EC-1666	Harness, Wiring	1

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

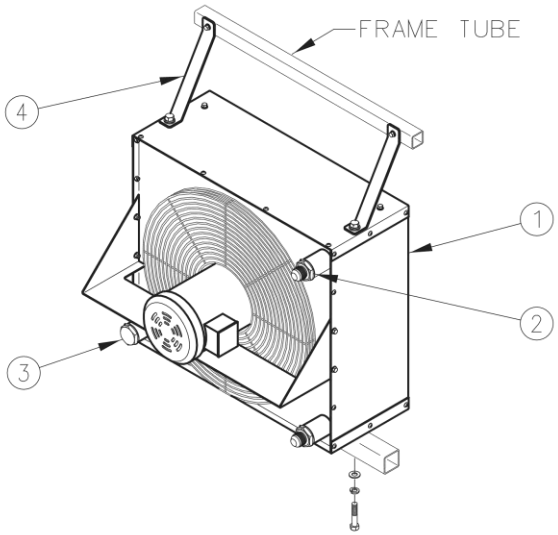
Item	60 Hz Applications			Description	Qty
	380 V	460 V	575V		
22	EC-1726-14	EC-1726-11	EC-1726-08	Fuse, Class CC Rejection Type	2
28	EC-1975	EC-1975	EC-1689	Controller, Softstart Motor	1
40	EC-1556-11	EC-1556-10	EC-1556-08	Fuse, Class J	3
Not Shown	EC-1578	EC-1578	EC-1578	Hourmeter	Ref

Item	50 Hz Applications			Description	Qty
	380 V	415 V	440V		
22	EC-1726-14	EC-1726-13	EC-1726-12	Fuse, Class CC Rejection Type	2
28	EC-1690	EC-1690	EC-1690	Controller, Softstart Motor	1
40	EC-1556-12	EC-1556-11	EC-1556-11	Fuse, Class J	3
Not Shown	EC-1577	EC-1577	EC-1577	Hourmeter	Ref

10.0 MAINTENANCE *(continued)*

10.12 HEAT EXCHANGER ASSEMBLY

The Heat Exchanger Assembly does not require regular general maintenance.



Parts List

Fluid Type: Aviation Phosphate Ester, Type IV

Item	Part Number	Description	Qty
1	Reference Table below	Heat Exchanger	1
2	N-2007-28-S-E	Connector, , #20 SAE x #20 JIC	1
3	N-2066-20-S-E	Plug, O-ring #20	1
4	J-3464-01	Strap	2

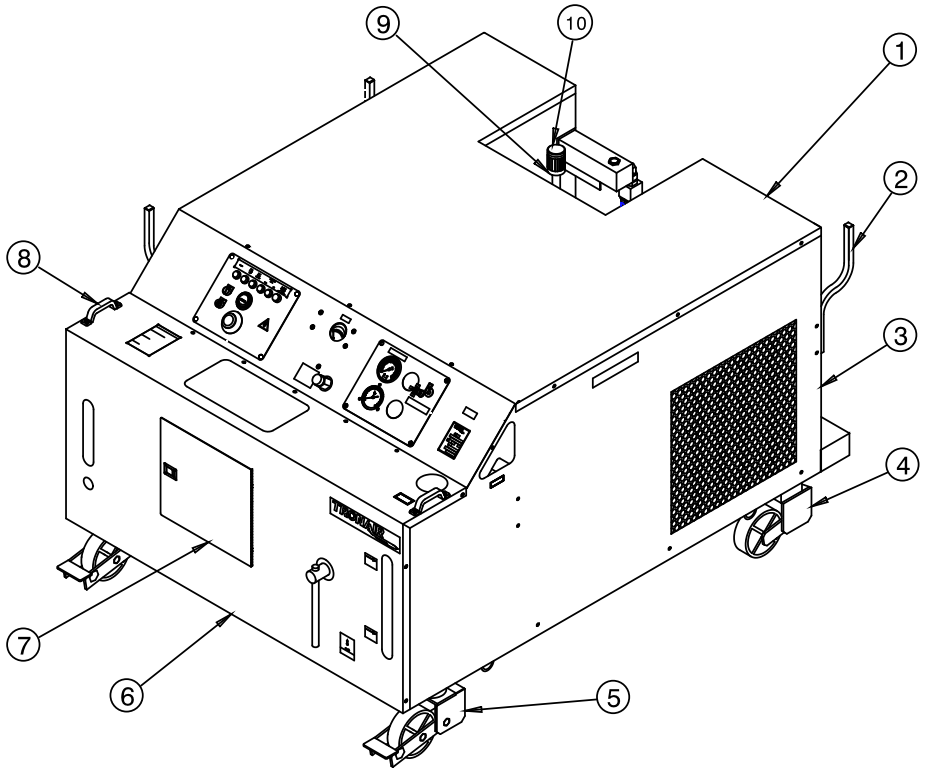
Voltage	Frequency	Part Number
380V	60 Hz	HC-2138-01
460V	60 Hz	HC-2138-01
575V	60 Hz	HC-2138-02
380V	50 Hz	HC-2138-01
415V	50 Hz	HC-2138-01
440V	50 Hz	HC-2138-01

10.0 Maintenance continued on following page.

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.



Parts List

Item	Part Number	Description	Qty
1	S-1799-01	Top Panel	1
2	Z-5549-01	Hanger	3
3	Z-5382-01	Right Side Panel	1
4	U-1102	Rigid Caster	2
5	U-1101	Swivel Caster	2
6	Z-5380-01	Front Panel	1
7	Z-5397	Front Access Door	1
8	H-1780	Handle	2
9	EC-1794	Box, Vertical Mount Junction	1
10	EC-1791	Light, Pole Mounted Stack	1
Not Shown	Z-5383-01	Left Side Panel	1
Not Shown	S-1804-01	Return Manifold Access Panel	1
Not Shown	S-1896-01	Skirt Panel (under Electrical Box)	1
Not Shown	S-1798-01	Back Panel	1

10.0 MAINTENANCE *(continued)*

10.14 ADDITIONAL FEATURES

10.14.1 50 ft (15.2 m) Hoses *(Option B)*

Refer to Section 10***.6 Hydraulic Hoses*** concerning hose inspection.

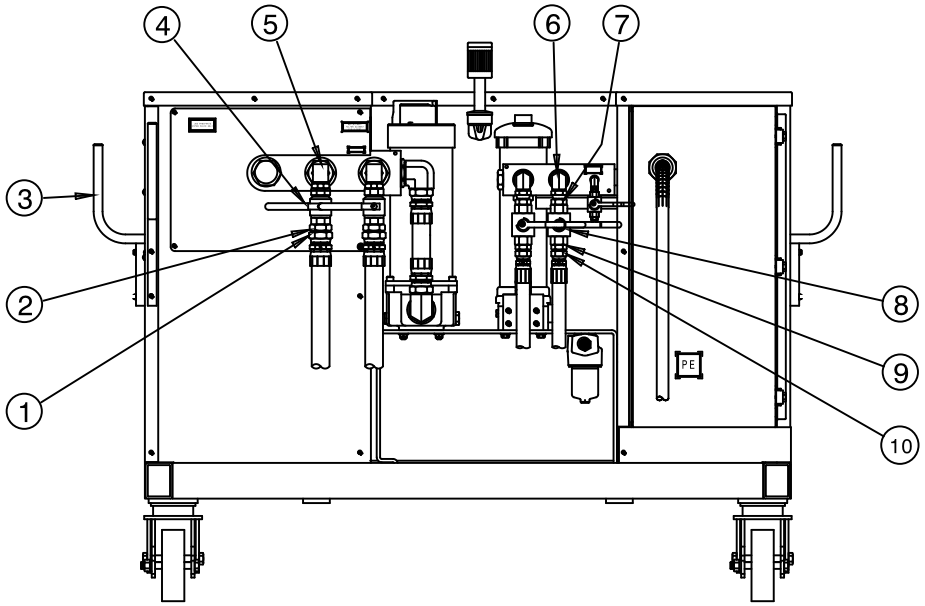
Parts List

Fluid Type: Aviation Phosphate Ester, Type IV

Part Number	Description	Qty
TF-1117-17-300	Pressure Hose, 25 ft/7.6 m	1 per Option
TF-1041-04*300	Return Hose, 25 ft/7.6 m	1 per Option
N-2011-10-S	Union, #16	1 per Option
N-2011-12-S	Union, #24	1 per Option

10.14.2 Dual System *(Option C)*

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



Parts List

Fluid Type: Aviation Phosphate Ester, Type IV

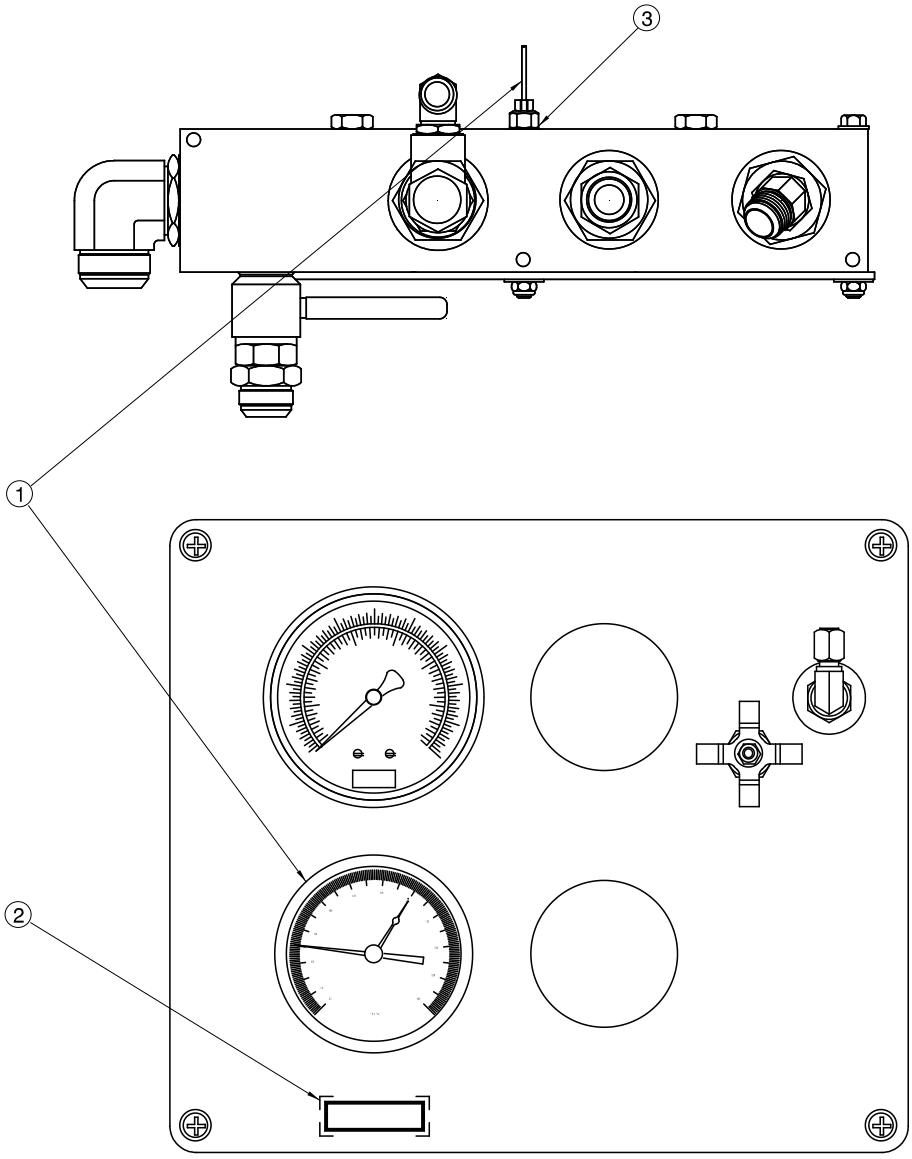
Item	Part Number	Description	Qty
1	TF-1041-04*300	Assembly, Hose #24	1
2	N-2007-32-S-E	Connector, Straight Thread	1
3	Z-5549-01	Weldment, Hose Hanger	2
4	HC-2058-03	Valve, Ball	1
5	N-2666-09-S-E	Elbow, Straight Thread #32	1
6	N-2630-20-S-E	Elbow, Straight Thread	1
7	N-2650-06-S-E	Union, #16 Straight Thread	1
8	HC-1771-05	Valve, Ball	1
9	N-2975-S-E	Connector, Straight Thread	1
10	TF-1117-17-300	Assembly, Hose #16	1

10.14 Additional Features continued on following page.

10.14 ADDITIONAL FEATURES *(continued)*

10.14.3 Pyrometer *(Option K)*

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



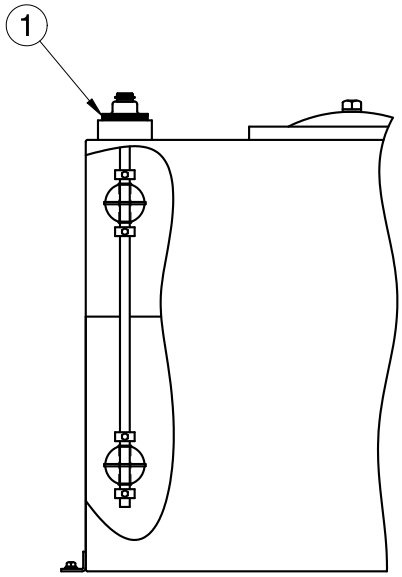
Parts List

Item	Part Number	Description	Qty
1	HC-2268-02	Pyrometer	1
2	V-1886	Label, Pyrometer	1
3	HC-2013-908	O-Ring	1

10.14 ADDITIONAL FEATURES (*continued*)
10.14.4 Electric Reservoir Level *(Option L)*

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

NOTE: Wire per Electrical Schematic INS-1665. Reference Wiring Diagram INS-1661. Reference 10.7.1 Electrical Panel for Panel Light.



Parts List

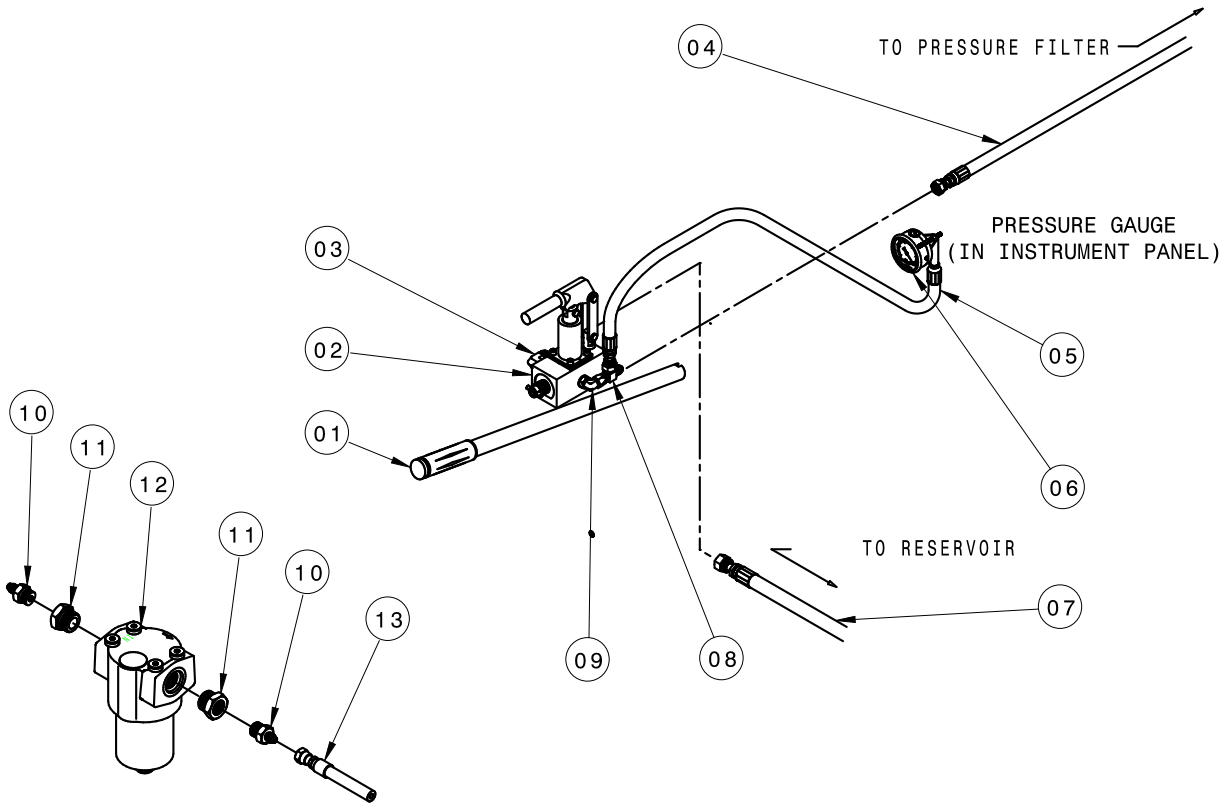
Item	Part Number	Description	Qty
1	EC-1783	Multi-Level Switch (includes Plug-in Cable)	1

10.14 Additional Features continued on following page.

10.14 ADDITIONAL FEATURES *(continued)*

10.14.5 Hand Pump *(Option M)*

Refer to Section ***10.6 Hydraulic Hoses*** concerning hose inspection for general maintenance on Items 4, 5, 7 and 13 hose assemblies. Refer to Section ***10.5.3 – Hand Pump (Optional) Filter*** .



Parts List

Fluid Type: Aviation Phosphate Ester, Type IV

Item	Part Number	Description	Qty
1	H-1009-01	Pump Handle	1
2	HC-1779	Hand Pump, Two Stage	1
3	N-2001-11-S-E	Elbow, #8 SAE x #8 JIC Flare	1
4	TF-1041-05*66.0	Hose Assembly, #4	1
5	TF-1041-05*54.0	Hose Assembly, #4	1
6	HC-2146	Pressure Gauge	1
7	TF-1041-25*32.5	Hose Assembly, #8	1
8	N-2016-03-S	Tee, Swivel Nut, #4	1
9	N-2001-05-S-E	Elbow, #6 SAE x #4 JIC Flare	1
10	N-2007-06-S-E	Fitting, Male Connector	1
11	N-2463-10-S-E	Reducer Fitting	2
12	HC-1777	Pressure Filter	1
13	TF-1041-05*180	Hose Assembly, #4	1

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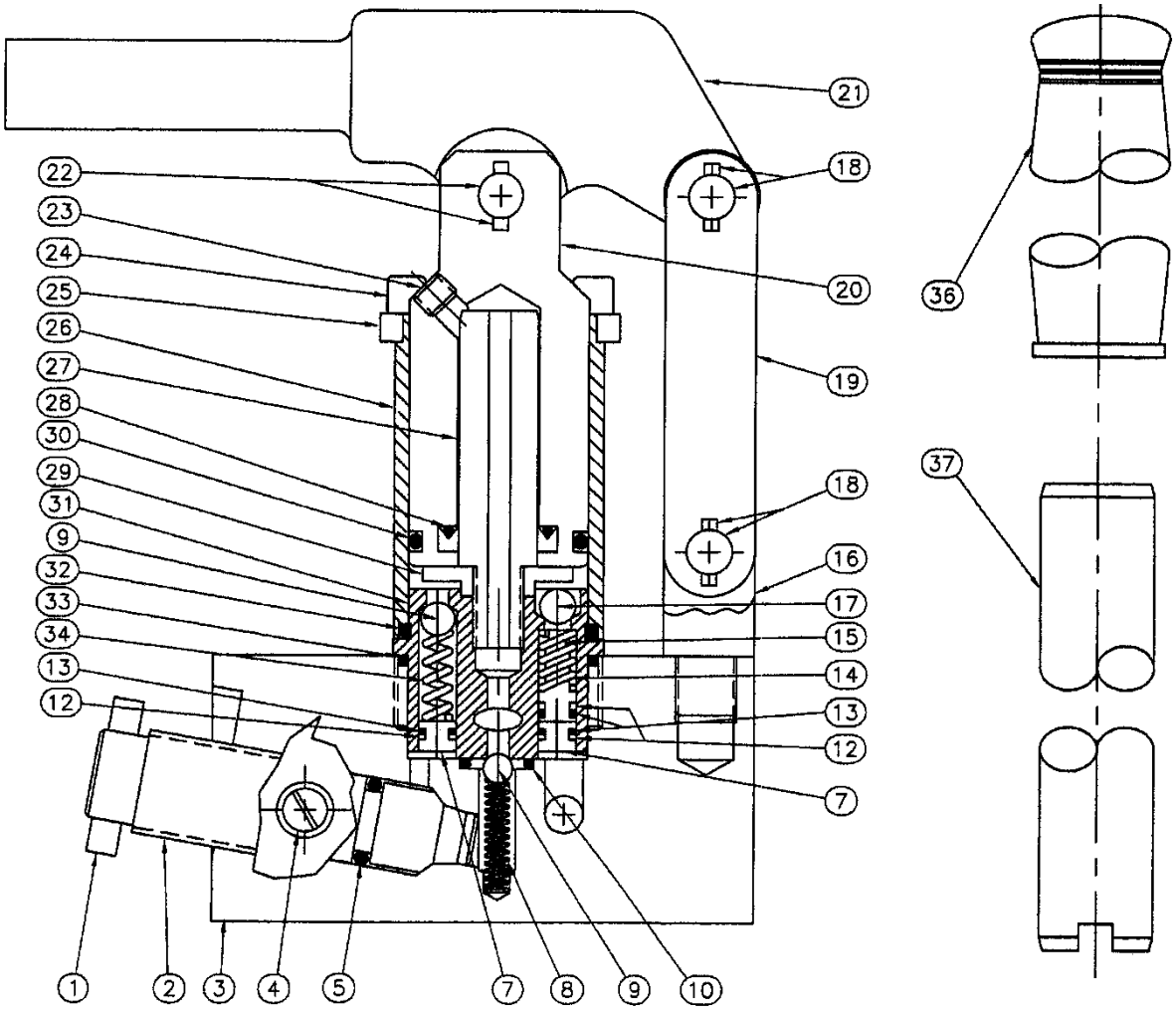
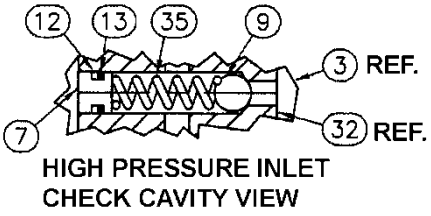
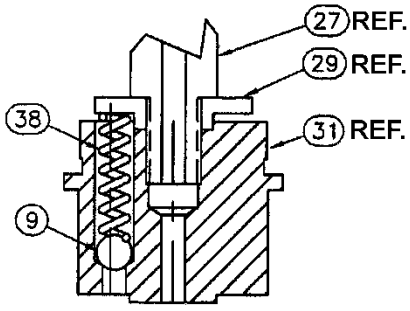
10.14.5 Hand Pump *(Option M) (continued)*

10.14.5.a Two Stage Pump with Relief





HIGH PRESSURE INLET
CHECK CAVITY VIEW



LOW PRESSURE INLET
CHECK CAVITY VIEW

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

Parts List

Fluid Type: Aviation Phosphate Ester, Type IV

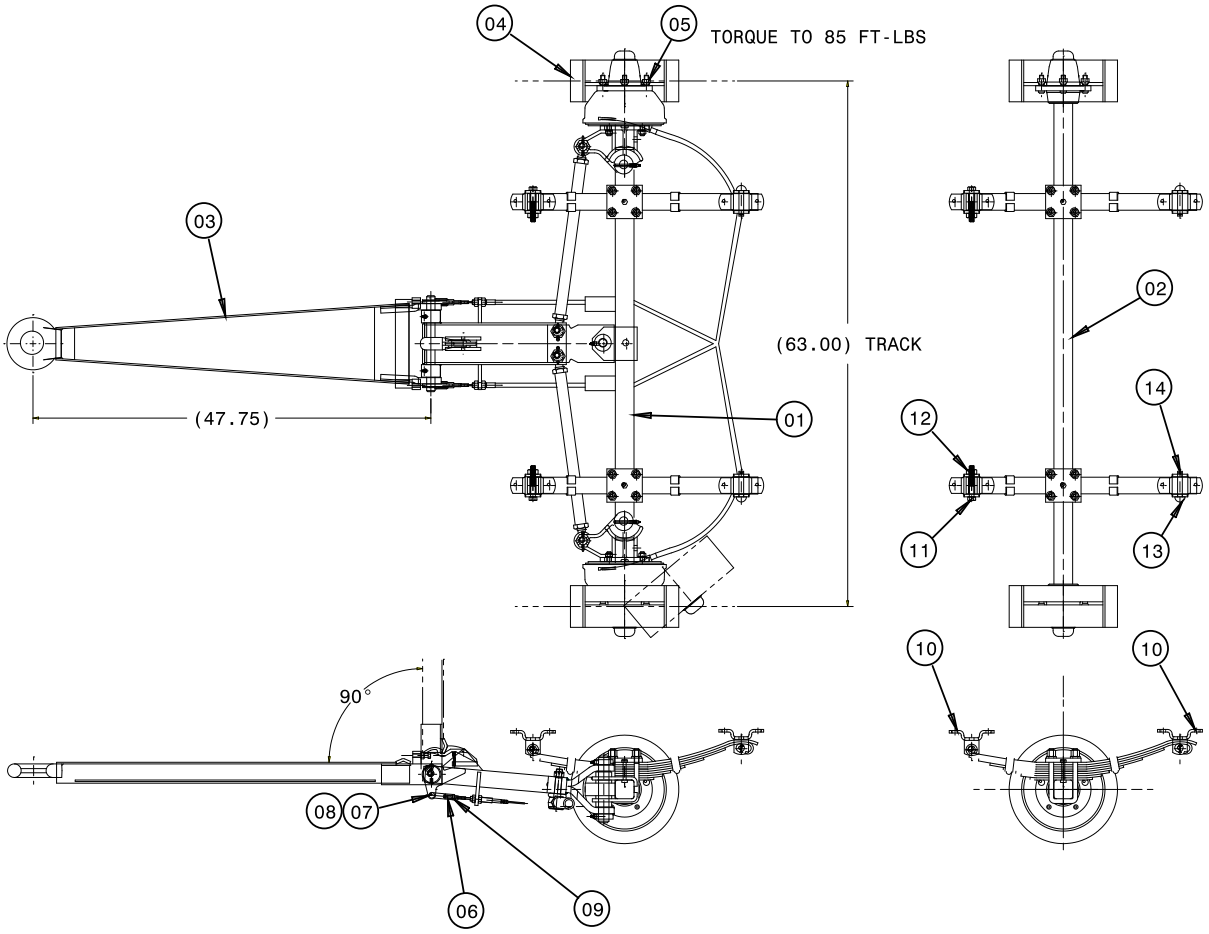
Item	Part Number	Description	Qty
1	519-000	Pin	1
3	CXC-990022-001	Body	1
7	505-001	Plug, Valve Body	3
15	571-121	Piston, Bypass Assembly	1
16	508-000	Pivot	1
20	566-125	Piston L.P	1
23	583-120	Plug	1
24	09-ADDF-04-20 X 56	Tie Rod	4
25	582-125	Flange	1
26	563-121	Tube	1
27	562-125	H.P. Piston	1
29	564-120	Retainer	1
31	560-120	Valve Body	1
36	H-1223	Grip, Handle	1
37	H-1009-01	Handle with Grip	1
	HK-1095	**Kit, Internal Parts**; *consists of*:	
6	*(Not Shown)*	Ball, Release	0
8		Spring, Outlet Check	1
9		Ball, Check	4
14		Spring, Bypass	1
17		Ball, Bypass	1
34		Spring, L.P. Outlet	1
35		Spring, H.P. Outlet	1
38		Spring, Intake L.P	1
	HK-1030	**Kit, Pump Seal**; *consists of:*	
5		O-ring, EPR	1
10		O-ring, EPR	1
12		Backup Ring (Teflon)	4
13		O-ring, EPR	4
28		H.P. Piston Seal	1
30		O-ring, EPR	1
32		O-ring, EPR	1
33		O-ring, EPR	1
	HK-1068	**Kit, Pump Linkage**; *consists of:*	
18		Pin Linkage Assembly	2
19		Strap	2
21		Handle Bracket	1
22		Clevis Pin Assembly	1
	HK-3117	**Kit, Release Screw**; *consists of:*	
2		Screw, Release/Relief	1
4		Retainer, Release Screw	1

10.14 Additional Features continued on following page.

10.14 ADDITIONAL FEATURES (*continued*)

10.14.6 Towing Trailer (*Option N*)

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



Parts List

Item	Part Number	Description	Qty
1	9-2196	Assembly, Front Axle	1
2	18-2146	Assembly, Rear Axle	1
3	47-3504	Assembly, Drawbar	1
4	1-3761	Assembly, Wheel & Tire	4
5	4603-1	Nut, Wheel ½-20 UN	20
6	5205	Yoke	2
7	5206	Pin, Yoke	2
8	4800-2	Pin, Cotter 3/32 x 0.75	2
9	4601-47	Nut, Hex 3/8 -24 NF	2
10	4251	Bracket, Spring	8
11	4901-19	Bolt, Grade 5, 9/16 -12 UN x 3.75" long	4
12	4601-33	Nut, Hex, 9/16 -12 UN	4
13	5403-1	Rivet	4
14	4800-3	Pin, Cotter, 1/8 x 1" long	4

10.14 ADDITIONAL FEATURES (*continued*)

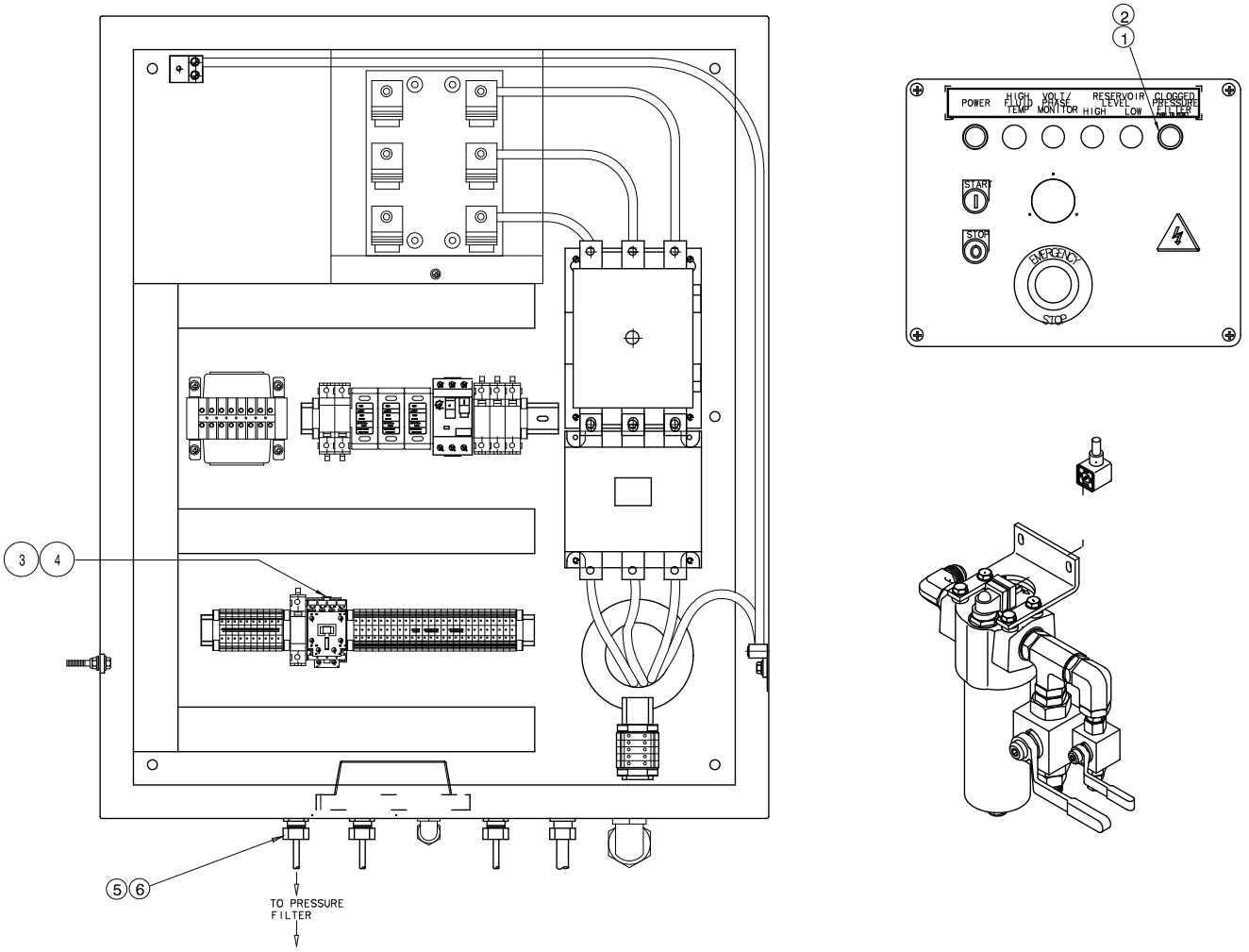
10.14.7 Electric Filter Clogging Indicator *(Option R)*

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

NOTES: 1) Higher flow rates will result in higher differential pressures.

Example: The clogging indicator may sense a 50 psi differential pressure at a flow rate of 10 gpm but not show a clogged condition when the flow rate is reduced to 5 gpm.

2) Wire per Appendix – Electrical Schematic. Reference Appendix – Wiring Diagram.



Parts List

Item	Part Number	Description	Qty
1	EC-1952	Indicator, IEC Push-To-Reset (Amber)	1
2	EC-1944	Block, IEC Push-To-Reset (Amber)	1
3	EC-1591-04	Latch, Mechanical	1
4	EC-1564	Relay, Control	1
5	EC-1815	Cord Set	1
6	EC-1175-06-A	Connector, Power Cable	1

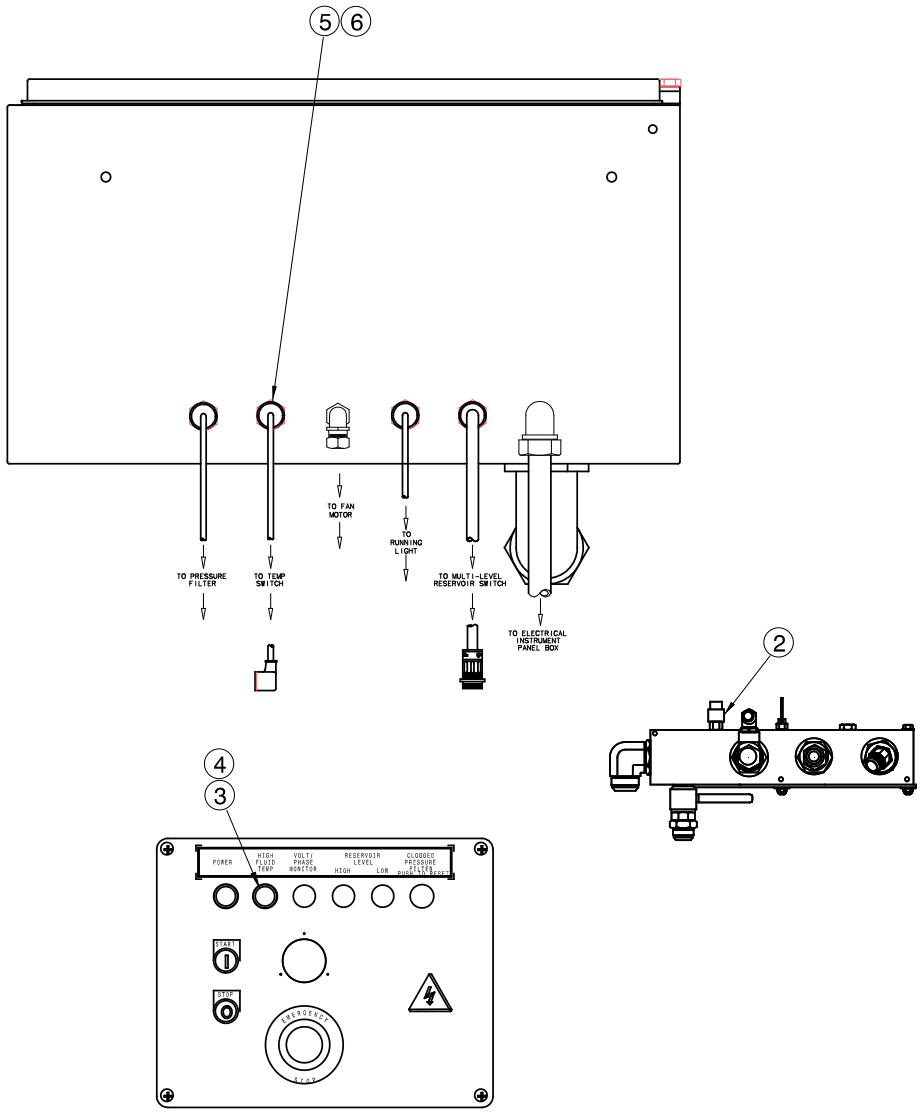
10.14 Additional Features continued on following page.

10.14 ADDITIONAL FEATURES (*continued*)

10.14.8 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. Reference Appendix – Wiring Diagram.

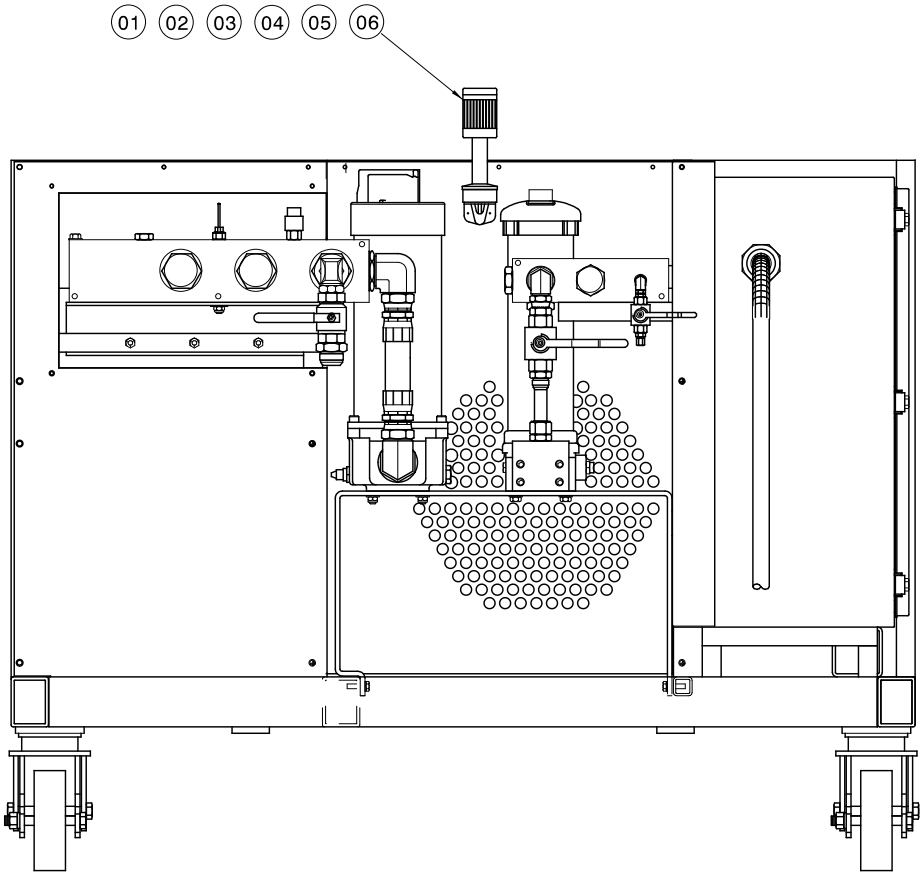


Parts List

Item	Part Number	Description	Qty
2	EC-1782-02	Switch, Temperature	1
3	EC-1945-03	Indicator, IEC Pilot Light (Amber)	1
4	EC-1951-MN5W	Block, IEC Pilot Light (White)	1
5	EC-1175-06-A	Connector, Power Cable	1
6	EC-2198	Cable, Din Connector	1

10.14 ADDITIONAL FEATURES (*continued*)

10.14.9 Stack Light *(Option SL)*



Parts List

Item	Part Number	Description	Qty
1	Z-5664	Assembly, Vertical Stack Light	1
2	H-1901-20	Grommet, ½	1
3	G-1159-103506	Screw, Round Head CRS REC 10-32	2
4	G-1439-1035-S	Nutsert, Open End 10-32	2
5	G-1250-1030N	Flatwasher, 10 Narrow	2
6	EC-1170-06*96.0	Cable, Electrical	1

10.0 Maintenance 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-1348	"FLOW (Increase)"	1
V-1349	"PRESSURE (Increase)"	1
V-1365	"SYSTEM PRESSURE"	1
V-1366	"HPU BY-PASS VALVE"	1
V-1374	"ROTATION"	1
V-1470	"CAUTION…"	1
V-1882	Control Panel Lights	1
V-1883	"HOUR METER"	1
V-1884	"FLOWMETER"	1
V-1886	"PYROMETER"	1
V-1888	"SHUT-OFF/CALIBRATION PORT"	1
V-1893	"SAMPLE VALVE"	1
V-1894	"PRESSURE"	1
V-1895	"RETURN"	1
V-1896	"MAXIMUM OIL LEVEL"	1
V-1897	"MINIMUM OIL LEVEL"	1
V-1898	"PRESSURE and FLOW CONTROLS INSIDE"	1
V-1900	"WARNING KEEP 5 FT CLEAR…"	2
V-1914	Reservoir Selector Valve	1
V-1918	"PE"	1
V-1919	"OPERATING INSTRUCTIONS…"	1

10.15.2 Fluid Labels

Fluid Type: Aviation Phosphate Ester, Type IV

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

10.15.3 Filter Element Kit Labels

Fluid Type: Aviation Phosphate Ester, Type IV

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

10.15 REPLACEMENT LABELS PARTS LISTS *(continued)*

10.15.4 Dual System *(Option C)* Labels

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

10.15.5 Hand Pump *(Option M)* Labels

Part Number	Description	Qty
V-1887	"HAND PUMP PRESSURE"	1
V-1915	"HAND PUMP"	1
V-1989	"REPLACEMENT FILTER ELEMENT K-3752"	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 22	Fuse, Transformer Primary	2
EC-1542-12	Fuse, Transformer Secondary	1

11.2.2 Spare Parts

Fluid Type: Aviation Phosphate Ester, Type IV

Part Number	Description	Qty
HC-1763	Desiccant Filter Element	1
K-3588	Kit, Pressure Filter Element	1
K-3587	Kit, Return Filter Element	1
K-3752	Kit, Hand Pump Filter Element *(Optional)*	1
♦ K-2754	Kit, Shaft Seal	1

♦ ***Seal Tool Kit: K-2938 required. Call Tronair for details.***

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.
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-2145)

Applied Pressure (System Pressure Gauge) (psig)	Minimum Acceptable (psig)	Maximum Acceptable (psig)	Gauge Movement (Direction)	Indicated Pressure (Calibration Gauge) (psig)
1,500	1,425	1,575	Increasing	
3,000	2,925	3,075	Increasing	
4,500	4,425	4,575	Increasing	
6,000	5,925	6,075	Increasing	
7,500	7,425	7,575	Increasing	
6,000	5,925	6075	Decreasing	
4,500	4,425	4,575	Decreasing	
3,000	2,925	3,075	Decreasing	
1,500	1,425	1,575	Decreasing	
Allowable operating tolerance: +/- 1% of full scale (60 psig) at room temperature (70° F).				

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).			

12.4 ANALOG TEMPERATURE GAUGE *(Pyrometer)*

12.4.1 Self Calibration

An accurate temperature calibration gauge is required for calibration of the Pyrometer. The pyrometer bulb is located in the return manifold (rear of unit) and can be accessed by removal of the HPU top panel. See ***Figure 10.7.2 – Pyrometer*** for location. Follow the necessary steps below.

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

The Temperature Value Must Be:

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

13.0 IN SERVICE SUPPORT

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

14.0 GUARANTEES/LIMITATION OF LIABILITY

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

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

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

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

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

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

15.0 APPENDICES

APPENDIX I	Declaration of Conformity
APPENDIX II	Hydraulic Schematic (INS-1660)
APPENDIX III	Electrical Schematic (INS-2238)
APPENDIX IV	Wiring Diagram (INS-1664, INS-2237)
APPENDIX V	Lincoln Motor Manual
APPENDIX VI	Denison Pump Manual – Premier Series P07
APPENDIX VII	Material Safety Data Sheet (MSDS) pertaining to Hydraulic Fluid
APPENDIX VIII	ANSI/B93.19M-1972 (R1993-Excerpt)
APPENDIX IX	Instrument Certification Notice
APPENDIX IX	Declaration of Conformity

TRONAIR®

APPENDIX I

Declaration
Of
Conformity

Declaration of Conformity

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

Mobile Hydraulic Power Unit
(Electric Motor Driven)

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

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

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

David L. Kidd

Quality Assurance Representative

1740 Eber Rd
Holland, OH 43528-9794
USA

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

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

TRONAIR®

APPENDIX II

Hydraulic Schematic
(INS-1660)

TRONAIR®

APPENDIX III

Electrical Schematic
(INS-2238)

TRONAIR®

APPENDIX IV

Wiring Diagram
(INS-1664, INS-2237)

TRONAIR®

APPENDIX V

Lincoln Motor Manual

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

1. SAFETY DEPENDS ON YOU

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

2. RECEIVING AND INSPECTION

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

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

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

3. HANDLING

⚠ WARNING

FALLING EQUIPMENT can injure.

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

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

4. STORAGE

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

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

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

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

5. INSTALLATION

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

⚠ WARNING

MOVING PARTS can injure.

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

5.1 INSTALLATION – MECHANICAL

Base

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

Position

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

Drains

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

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

Drive – Power Transmission

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

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

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

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

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

5.2 INSTALLATION – ELECTRICAL

⚠ WARNING

ELECTRIC SHOCK can kill.

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

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

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

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

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

Properly ground the motor – See GROUNDING.

Terminal Box

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

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

Motor Connection

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

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

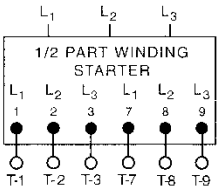
Number of Motor Leads	Number of Rated Voltages	Lead Numbers	YDS	PWS
3	Single	1-3	No	No
6	Single	1-3, 7-9	No	Yes
	Single	1-6	Yes	No
	Dual	1-6	Yes(1)	No
9	Dual	1-9	No	No
12	Single	1-12	Yes	Yes
	Dual	1-12	Yes	No(2)

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

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

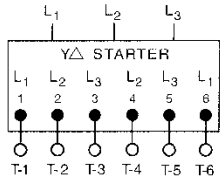
Connection Diagram 1

Single Voltage, 6 Leads
Part Winding Start Connection



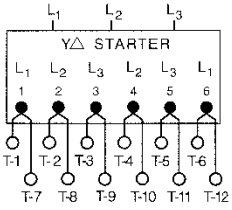
Connection Diagram 2

Single Voltage, 6 Leads
Y△ Start Connection



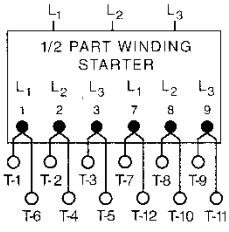
Connection Diagram 3

Single Voltage, 12 Leads
Y△ Start Connection



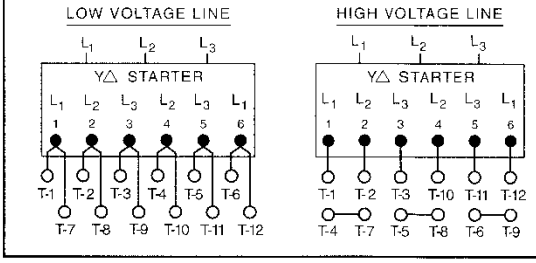
Connection Diagram 4

Single Voltage, 12 Leads
Part Winding Start Connection



Connection Diagram 5

Dual Voltage, 12 Leads
Y△ Start Connection



Space Heater (option)

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

Thermostat (option)

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

Table 1 — Thermostat Contact Ratings

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

Thermistor (option)

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

Brake (option)

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

GROUNDING

⚠ WARNING

ELECTRIC SHOCK can kill.

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

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

6. OPERATION

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

⚠ WARNING

MOVING PARTS can injure.

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

ELECTRIC SHOCK can kill.

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

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

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

7. MAINTENANCE

⚠ WARNING

ELECTRIC SHOCK can kill.

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

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

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

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

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

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

BEARING SYSTEM

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

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

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

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

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

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

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

Table 2 : Bearing Lubrication Intervals

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

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

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

⚠ CAUTION

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

PARTS

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

8. WHO TO CALL

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

9. WARRANTY

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

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

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

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

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

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

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

Lincoln™ MOTORS

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

IM566-A December 1999

- indicates change since last printing.

TRONAIR®

APPENDIX VI

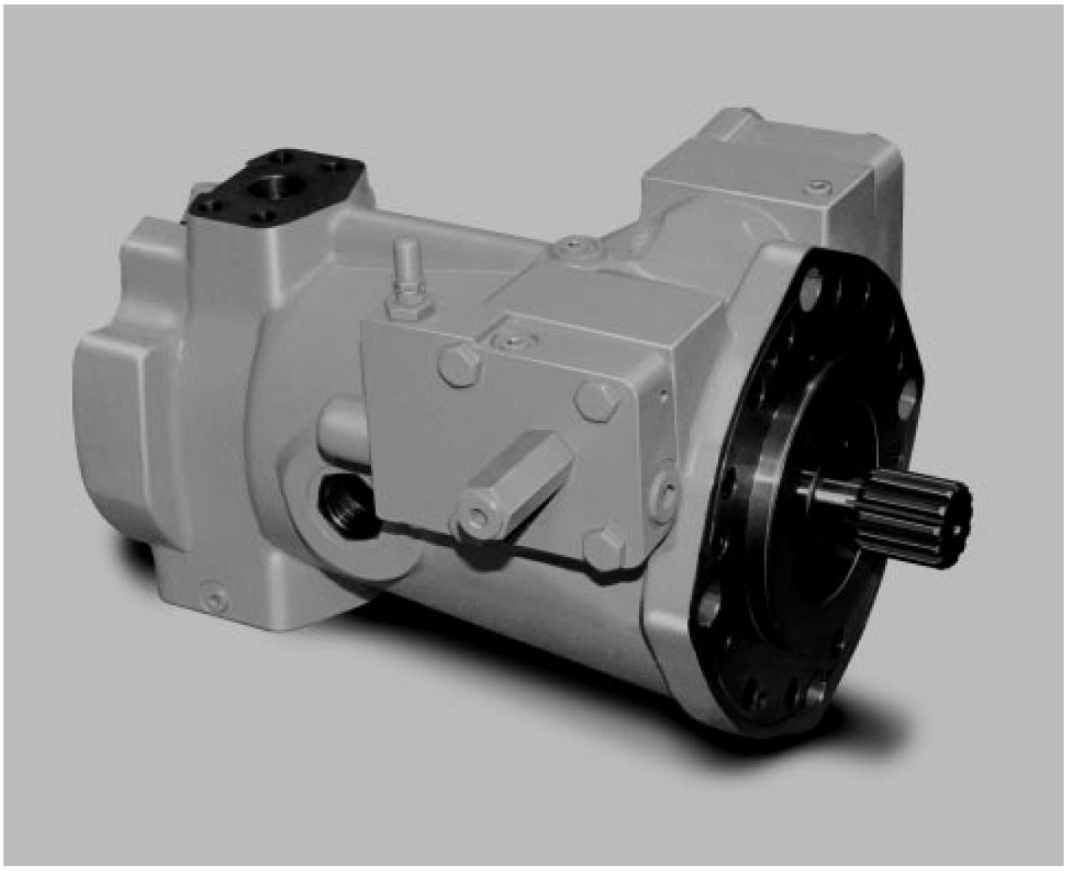
Denison Pump Manual
Premier Series P07

DENISON HYDRAULICS

open circuit piston pumps

Premier series P07 & 110 C-mod.

service information



Publ. LT2-00038-2 replaces S1-AM0018 Revised 5/03

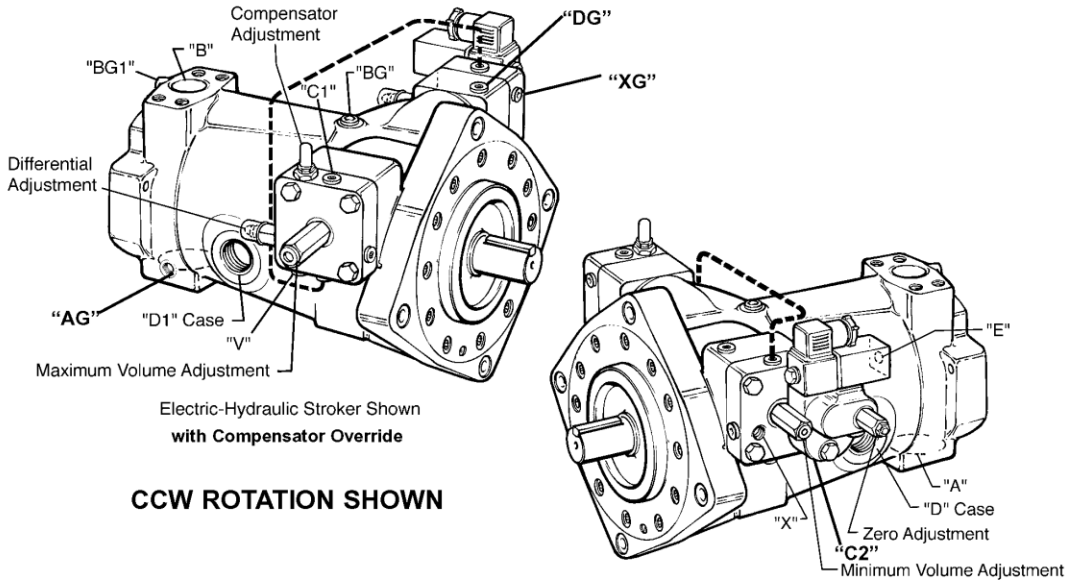
DENISON Hydraulics

Internet http://www.denisonhydraulics.com E-mail: denison@denisonhydraulics.com

CONTENTS

Seal kit P07 S22-15646-0
.....P110 S22-15647-0

The shaft seal and all "O" rings necessary for total seal replacement may be obtained by ordering Seal Kit . These seals are suitable for petroleum base fluids. For fire resistant fluids contact **DENISON HYDRAULICS**, Inc. or their authorized distributors to obtain the appropriate seal kit number.



Electric-Hydraulic Stroker Shown
with Compensator Override

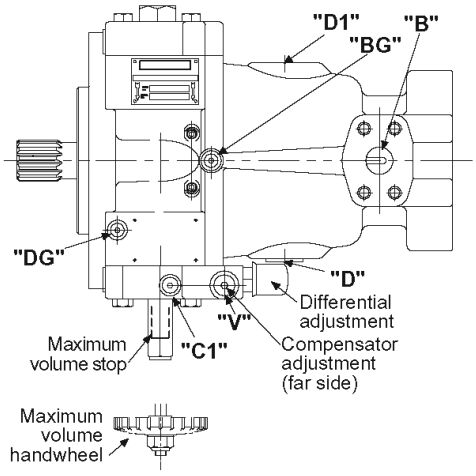
CCW ROTATION SHOWN

FLUID CONNECTIONS

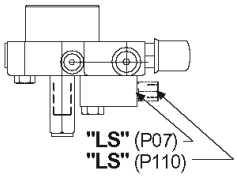
DESCRIPTION	P07	P110
PORT A .....INLET	3" SAE CODE 61 5/8-11 SCREWS	3" SAE CODE 61 M16-2 SCREWS
PORT B .....SYSTEM	1-1/4" SAE CODE 62 1/2-13 SCREWS	1-1/4" SAE CODE 62 M14-2 SCREWS
PORT C1 .....OFF-STROKE CYLINDER GAGE	SAE-4	1/4 BSPP
PORT C2 .....ON-STROKE CYLINDER. GAGE	SAE-4	1/4 BSPP
PORT D .....CASE DRAIN	SAE-16	1 BSPP
PORT D1 .....CASE DRAIN	SAE-16	1 BSPP
PORT DG.....DRAIN GAGE, AIR BLEED PORT	SAE-4	3/8 BSPP
PORT AG.....INLET GAGE	SAE-4	1/4 BSPP
PORT BG.....SYSTEM GAGE	SAE-4	1/4 BSPP
PORT BG1....ALTERNATE SYSTEM GAGE	SAE-6	1/4 BSPP
PORT E .....ELECTROHYDRAULIC STROKER SERVO SUPPLY	SAE-4	1/4 BSPP
PORT H .....HYDRAULIC STROKER SIGNAL	SAE-4	1/4 BSPP
PORT LS ....LOAD SENSING LINE	SAE-4	1/4 BSPP
PORT V .....COMPENSATOR, TORQUE LIMITER, LOAD SENSING VENT	SAE-8	3/8 BSPP
PORT V1 .....SERVO VENT	SAE-4	1/4 BSPP
PORT X .....SERVO SUPPLY	SAE-6	3/8 BSPP
PORT XG.....SERVO GAGE	SAE-10	1/2 BSPP

PRIMARY CONTROLS

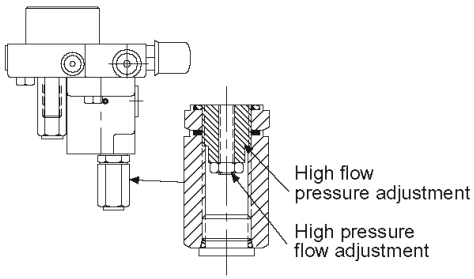
CLOCKWISE ROTATION



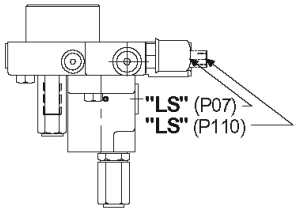
"C1", "C2" COMPENSATOR



"L1", "L2" LOAD SENSING

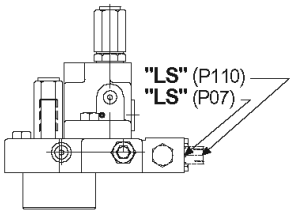


"J1/K1", "J2/K2" TORQUE LIMITER

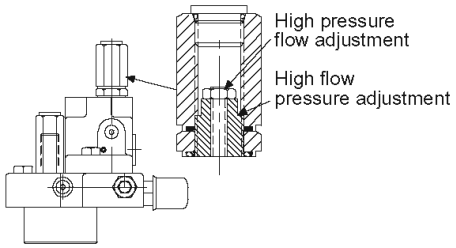


"V1/W1", "V2/W2" LOAD SENSING TORQUE LIMITER

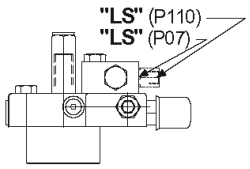
COUNTERCLOCKWISE ROTATION



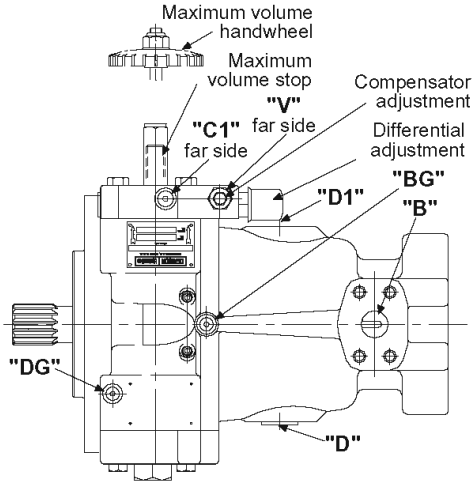
"V1/W1", "V2/W2" LOAD SENSING TORQUE LIMITER



"J1/K1", "J2/K2" TORQUE LIMITER



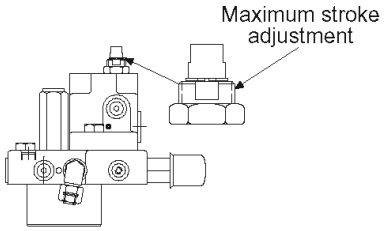
"L1", "L2" LOAD SENSING



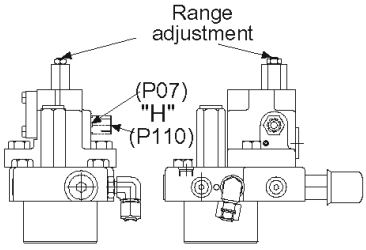
"C1", "C2" COMPENSATOR

PRIMARY CONTROLS

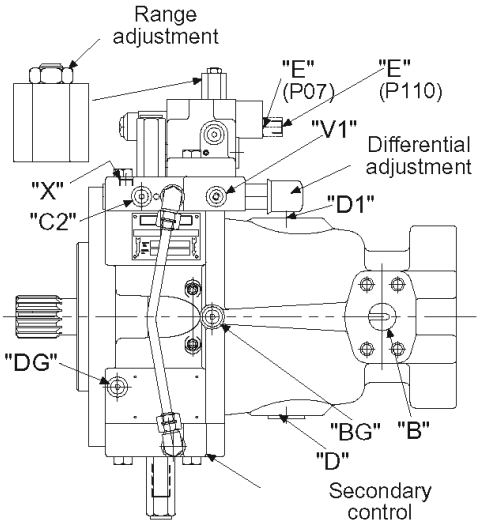
CLOCKWISE ROTATION



"R" ROTARY SERVO

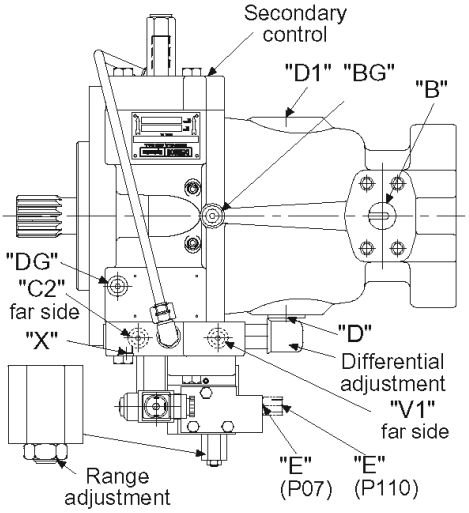


"H" HYDRAULIC STROKER

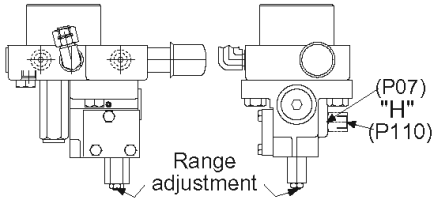


"E" ELECTROHYDRAULIC STROKER

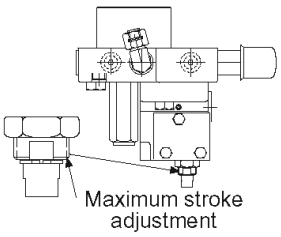
COUNTERCLOCKWISE ROTATION



"E" ELECTROHYDRAULIC STROKER



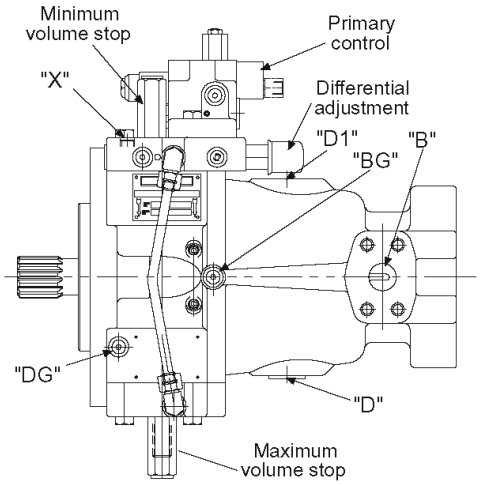
"H" HYDRAULIC STROKER



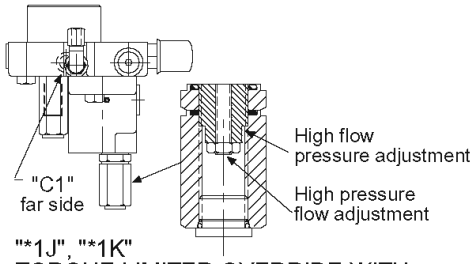
"R" ROTARY SERVO

SECONDARY CONTROLS

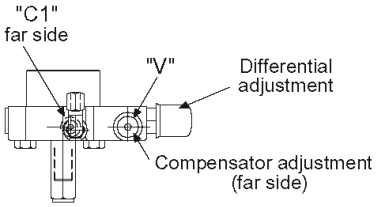
CLOCKWISE ROTATION



"*10"
CONTROL CAP WITH MAXIMUM VOLUME STOP

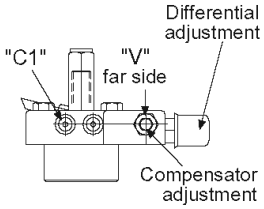


"*1J", "*1K"
TORQUE LIMITER OVERRIDE WITH MAXIMUM VOLUME STOP

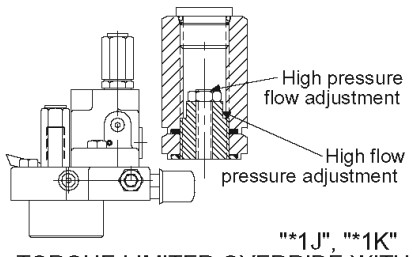


"*1P"
COMPENSATOR OVERRIDE WITH MAXIMUM VOLUME STOP

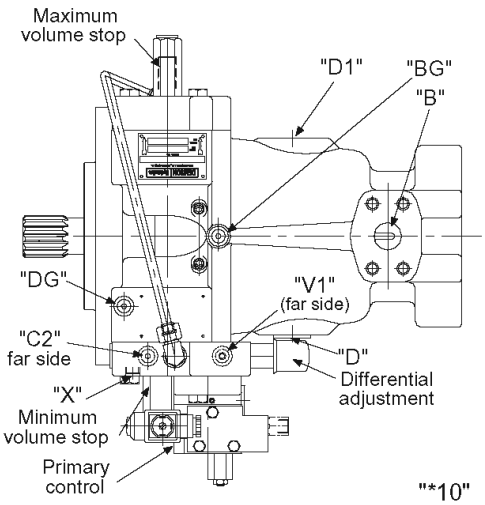
COUNTERCLOCKWISE ROTATION



"*1P"
COMPENSATOR OVERRIDE WITH MAXIMUM VOLUME STOP



"*1J", "*1K"
TORQUE LIMITER OVERRIDE WITH MAXIMUM VOLUME STOP



"*10"
CONTROL CAP WITH MAXIMUM VOLUME STOP

START UP PROCEDURE FOR NEW INSTALLATION

- Read and understand the instruction manual. Identify components and their function.
- Visually inspect components and lines for possible damage.
- Check reservoir for cleanliness. Drain and clean as required
- Check fluid level and fill as required with filtered fluid at least as clean as that recommended. Fill pump case with clean oil prior to starting. If pump is mounted vertically with shaft up, bleed air from case by removing plug from port "DG" till fluid runs clear.
- Check alignment of drive.
- Check oil cooler and activate it, if included in circuit. Check fluid temperature
- Reduce pressure settings of compensator and relief valve. Make sure accurate pressure readings can be made at appropriate places.
- If solenoids are in system, check for actuation.
- Start pump drive. Observe for correct shaft rotation. Make sure pump fills properly.
- Bleed system of air. Recheck fluid level.
- Cycle unloaded machine at low pressure and observe actuation (at low speed, if possible).
- Increase pressure settings gradually in steps. Check for leaks in all lines, especially in pump inlet lines.
- Make correct pressure adjustments.
- Gradually increase speed. Be alert for trouble as indicated by changes in sounds, system shocks and air in fluid.
- Equipment is operational.

Component problems and circuit problems are often interrelated. An improper circuit may operate with apparent success but will cause failure of a particular component within it. The component failure is the effect, not the cause of the problem. This general guide is offered to help in locating and eliminating the cause of problems by studying their effects.

Effect of Trouble	Possible Cause	Fault Which Needs Remedy
pump		
noisy	air in system	leak in suction line. low fluid level. turbulent fluid. return lines above fluid level. gas leak from accumulator. excessive pressure drop in the inlet line from a pressurized reservoir. suction line strainer acting as air trap.
	cavitation in rotating group.	fluid too cold, too viscous, or too heavy. shaft speed too high. suction line strainer too small, or strainer too dirty. operating altitude too high. boost pressure too low. inlet flow too small for dynamic conditions.
	misaligned shaft.	faulty installation. distortion in mounting. axial interference. faulty coupling. excessive overhung loads.
	mechanical fault in pump.	piston and shoe looseness or failure. bearing failure. incorrect port plate selection or index. eroded or worn parts in the displacement control.
erosion on barrel ports and port plate.	air in fluid.	see noisy pump above.
	cavitation.	see noisy pump above.
high wear in pump.	excessive loads.	reduce pressure settings. reduce speeds.
	contaminant particles in fluid.	improper filter maintenance. filters too coarse. introduction of dirty fluid to system. reservoir openings. improper reservoir breather. improper line replacement.
	Improper fluid.	fluid too thin or thick for operating temperature range. breakdown of fluid with time/temperature/shearing effects. incorrect additives in new fluid. destruction of additive effectiveness with chemical aging
	improper repair.	incorrect parts, procedures, dimensions, finishes.
	unwanted water in fluid.	condensation. faulty breather/strainer. heat exchanger leakage. faulty clean-up practice. water in makeup fluid.
pressure shocks.	cogging load.	mechanical considerations.
	worn relief valve.	needed repairs.
	worn compensator.	needed repairs.
	slow response in check valves.	replace or relocate.
	excessive decompression energy rates.	improve decompression control.
	excessive line capacitance. (line volume, line stretch, accumulator effects).	reduce line size or lengths. eliminate hose.
	barrel blow-off.	re-check pump holddown,rotating group, drain pressure.
heating of fluid.	excessive pump leakage.	recheck case drain flow and repair as required. fluid too thin. improper assembly, port timing.
	relief valve.	set too low (compared to load or to compensator). instability caused by back pressure, worn parts.
	compensator.	set too high (compared to relief). worn parts.
	pump too large for fluid needs.	select smaller pump displacement.
	heat exchanger.	water turned off, too hot or too little flow. fan clogged or restricted. efficiency reduced by mud or scale deposits. intermittent hydraulic fluid flow.
	reservoir.	too little fluid. improper baffles. insulating air blanket that prevents heat rejection. heat pickup from adjacent equipment..

Effect of Trouble	Possible Cause	Fault Which Needs Remedy
Compensator, Compensator Override		
Low system pressure	Compensator malfunction	Dirt in spool orifice Damaged cone or seat Broken differential spring Improperly adjusted differential spring
Failure to compensate	Differential adjustment	Differential set too high
Sluggish response	Differential adjustment	Differential set too low
Wide pressure fluctuations (hunting)	Excessive line capacitance	Install check valve near pump outlet
Load Sensing Control		
Low system pressure	Compensator malfunction	Dirt in spool orifice Damaged cone or seat Broken differential spring Improperly adjusted differential spring
Failure to compensate	Differential adjustment	Differential set too high
Sluggish response	Differential adjustment Modulating valve	Differential set too low Air in load sensing line
Wide pressure fluctuations (hunting)	Excessive line capacitance	Install check valve near pump outlet
	Modulating valve	Air in load sensing line
Excessive pressure drop across control valve	Differential adjustment	Differential set too high
Poor control of flow	Differential adjustment	Differential set too low
Torque Limiter, Torque Limiter Override		
Torque setting erratic	Torque limiter cap malfunction	Sticking pin
Torque incorrect at high flows	Incorrect torque setting	Outer adjustment screw
Torque incorrect at low flows	Incorrect torque setting	Inner adjustment screw
Too much torque variation	Wrong torque limiter for range	Replace inner/outer springs with correct springs
Low system pressure	Compensator malfunction	Dirt in spool orifice Damaged cone or seat Broken differential spring Improperly adjusted differential spring
Failure to compensate	Differential adjustment	Differential set too high
Sluggish response	Differential adjustment	Differential set too low
Wide pressure fluctuations (hunting)	Excessive line capacitance	Install check valve near pump outlet
Rotary Servo		
Failure to stroke	Differential adjustment	Differential set too low
Goes to full	Differential adjustment	Differential set too high
Sluggish response	Low servo pressure	Check servo pressure
Strokes in steps	Servo cap malfunction	Sticking pin Wear on linkages or input cam surface
Hydraulic Stroker		
Failure to stroke	Differential adjustment	Differential set too low
Goes to full	Differential adjustment	Differential set too high
Strokes in steps	Servo cap malfunction	Wear on linkages, Sticking stroker piston
Electric Stroker		
Failure to stroke	Differential adjustment	Differential set too low
Goes to full Excessive hysteresis	Differential adjustment Electric proportional valve	Differential set too high Change dither on electrical signal
No response	Electric proportional valve	Faulty wiring, Filter screen plugged
Strokes in steps	Servo cap malfunction	Wear on linkages Sticking stroker piston
Instability	Air in control	Bleed air from control Check for air in servo supply

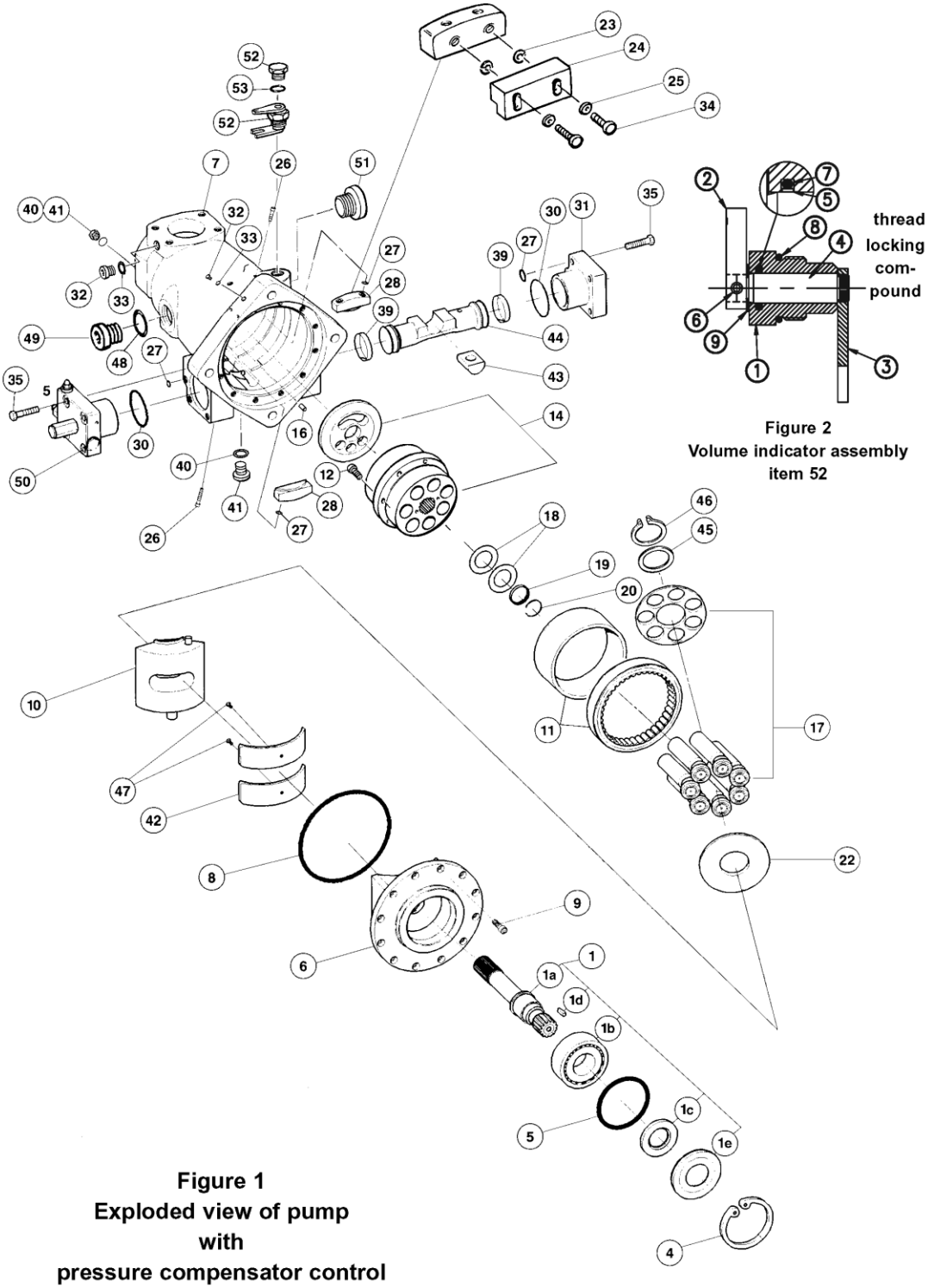


Figure 2
Volume indicator assembly
item 52

Figure 1
Exploded view of pump
with
pressure compensator control

Disassembly
Disassemble only as far as necessary to replace or repair worn parts.

If the pump has a rear drive, the mounting adapter and coupling must be removed prior to pump disassembly *Refer to figure 3 page 16.*
Clean outside surface of the pump before disassembly. Disassembly area should be clean. A suitable surface should be used capable of supporting the pump weight of 177 lbs, 80,3 Kg.

Refer to illustration, see figure 1 and 2
1. Remove plug (49) and drain oil from pump. Position pump with shaft up.
2. Wind maximum volume screw CW (ref item (50), item 1 page 27) so that piston (44) bottoms out. This positions the cam at approximately zero displacement allowing removal of the drive shaft.
3. Remove socket head cap screws (9). If disassembling PQ Control version, remove tubing and pass thru fitting (56).
4. Remove cradle assembly (6) from the housing. The threaded hole in end of the shaft is provided for lifting this assembly. Threaded hole is 3/8-16 for P07, M10 for ISO and M12 for DIN shaft.
5. Remove snap ring (4).
6. Remove screws (47) to remove cam bearing (42).
7. Remove shaft (1), bearing, and seal retainer. Support flat face of the rocker cradle and press end of shaft opposite the bearing end.
8. Remove the shaft seal (1c) from the retainer (1e) if necessary.
9. Remove retaining ring (20).
10. Press bearing off shaft if necessary. Press against bearing inner race.
11. If pump contains a volume indicator assembly (52): *Refer to. Figure 2*: Remove indicator pointer (2), retaining ring (9) and pivot nut (1) from pump housing. Remove pivot shaft and fork assembly (3) and (4) through the hole.
11. Remove two screws (34), two washers (25), clearance bearing (24), and two washers (23) from retainer (28).
12. Wind maximum volume screw CCW until piston (44) bottoms out.
13. Remove control cap (50) and control cap (31). (*Refer to controls section for control disassembly).*
14. The piston must be moved outward (away from pump center) to remove cam assembly.
15. Lift cam assembly (10) from pump. (Link (43), pistons and shoes and retainer plate(17), wear plate (22), and hold-down (45 and 46) are part of the cam assembly.)
16. Remove slide link (43), retaining ring (45), thrust washer (46), pistons, shoes & retainer assembly (17) and wear plate (22). The pins for the slide link and for the indicator have been pressed into the rocker cam and should not be removed.
17. Remove two screws (26), and two retainers (28).
18. Remove Belleville washers (18) and barrel stop (19).
19. Attach tool (T-1) (pg. 76) to barrel assembly (14-1). (Two M6 screws are required.) Lift barrel from port plate and housing.
20. The inner race of bearing (11) has a light press fit with barrel. Do not remove the inner race unless bearing needs to be replaced. If replacement is necessary, remove seven socket head cap screws (12). Replace with 5/16-18 UNC x 6 1/2 in. long soc hd cap screws. Rest assembly on the extended screws. Press barrel from inner race. Care must be taken to avoid damage to barrel face.
21. Remove port plate ref. see item (14), and alignment pin (16), from port block.

The barrel bearing outer race (11) should only be removed from housing if worn, damaged or closer inspection is needed. A bearing puller should be used for removal.

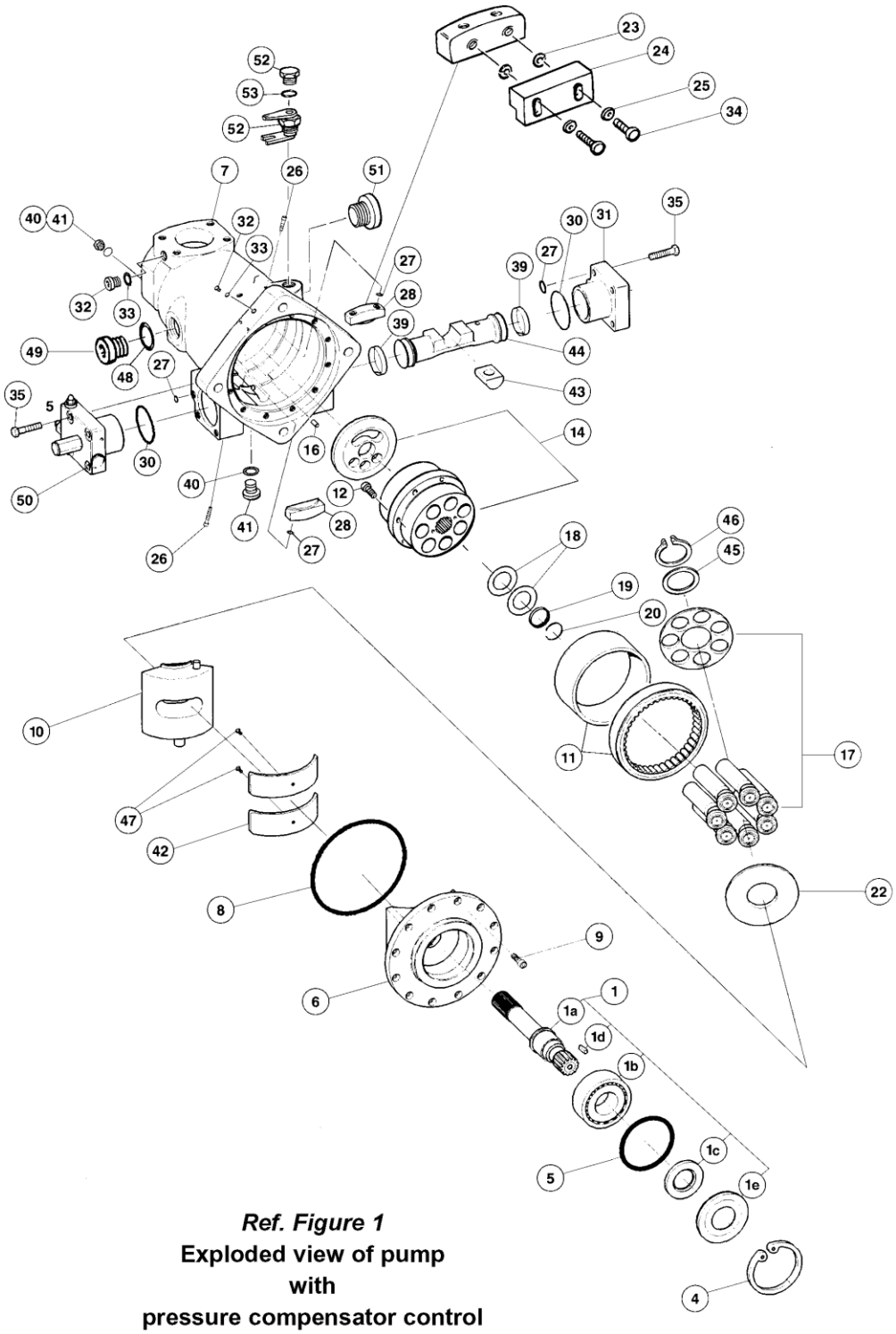
REWORK LIMITS OF WEAR PARTS

item	maximum rework from original dimension	minimum dimension after rework
wear plate	.005", 0,127 mm	.184", 4.674 mm
piston shoe face(pocket)	*	.4175", 10,605 mm

*shoe face pocket depth must be .004", 0,10 mm minimum

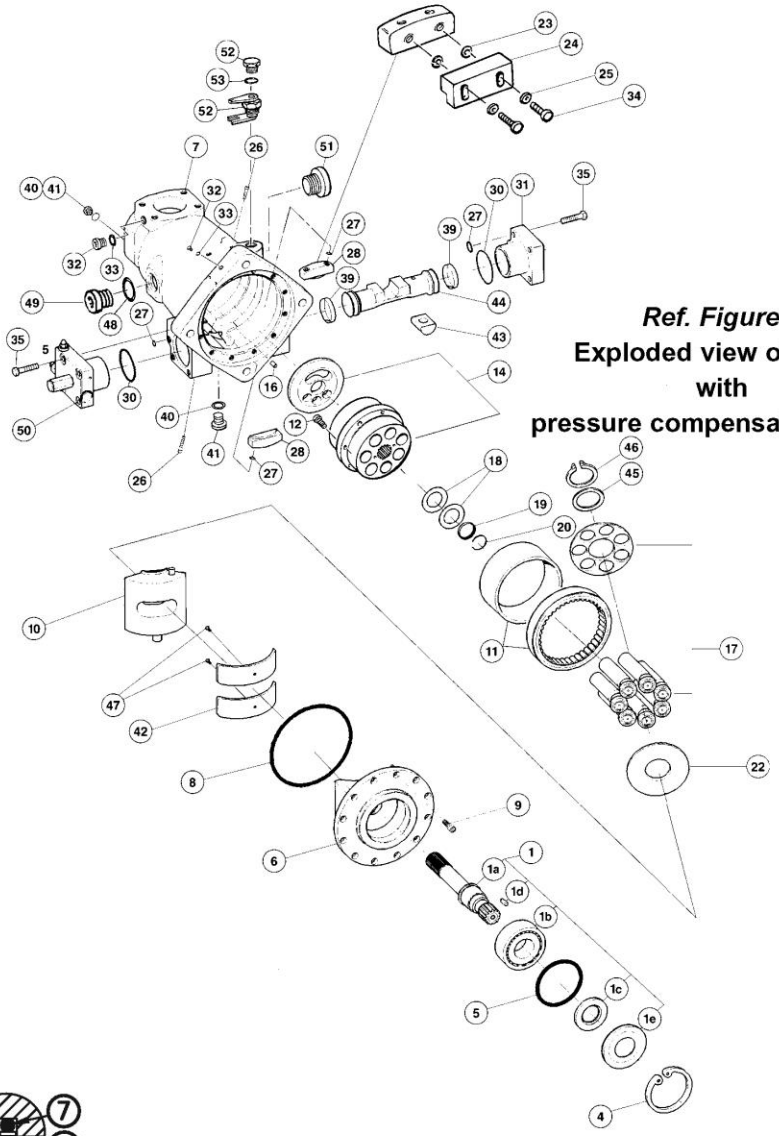
WEAR PLATE
The wear plate finish must be 10 µin., 0,25 µm minimum, flat within .0005", 0,0127 mm and parallel to the backside within .001", 0,0254 mm total indicator reading.

PISTON SHOE
The piston shoe wear face finish must be 45 µin., 1,143 µm min, and must be lapped in a set with the retainer plate. All shoe sole thicknesses to be within .001", 0,0254 mm after lapping. The maximum permissible shoe and piston axial looseness is .010", 0,254 mm.

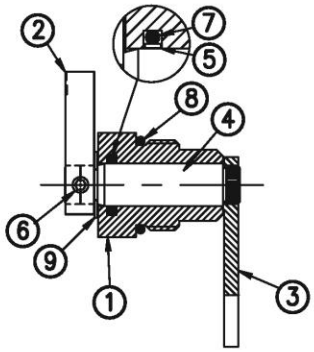


Ref. Figure 1
Exploded view of pump
with
pressure compensator control

item	description	part no. P07-SAE	part no. P110-ISO	qty.
1	shaft assembly			1
	keyed, no rear drive	S22-15337	S22-15598	
	a (shaft)	032-91829	032-92197	
	b (bearing)	230-82216	230-82216	
	c (seal)	620-82080	230-82080	
	d (key)	033-71514	032-91429	
	e (seal retainer)	032-91835	032-91835	
	keyed, with rear drive	S22-16027	S22-16028	
	a (shaft)	032-92525	032-92526	
	b (bearing)	230-82216	230-82216	
	c (seal)	620-82080	230-82080	
	d (key)	033-71514	032-91429	
	e (seal retainer)	032-91835	032-91835	
	splined, no rear drive	S22-15338	S22-15599	
	a (shaft)	032-91828	032-92198	
	b (bearing)	230-82216	230-82216	
	c (seal)	620-82080	230-82080	
	e (seal retainer)	032-91835	032-91835	
	splined, with rear drive	S22-16025	S22-16026	
	a (shaft)	032-92524	032-92527	
	b (bearing)	230-82216	230-82216	
	c (seal)	620-82080	230-82080	
	e (seal retainer)	032-91835	032-91835	
			P110-DIN	
	keyed, no rear drive		S22-15673	
	a (shaft)		032-92255	
	b (bearing)		230-82216	
	c (seal)		620-82080	
	d (key)		032-92246	
	e (seal retainer)		032-91835	
	keyed, with rear drive		S22-16030	
	a (shaft)		032-92529	
	b (bearing)		230-82216	
	c (seal)		620-82080	
	d (key)		032-92246	
	e (seal retainer)		032-91835	
	splined, no rear drive		S22-15602	
	a (shaft)		032-92212	
	b (bearing)		230-82216	
	c (seal)		620-82080	
	e (seal retainer)		032-91835	
	splined, with rear drive		S22-16029	
	a (shaft)		032-92528	
	b (bearing)		230-82216	
	c (seal)		620-82080	
	e (seal retainer)		032-91835	
4	retainer	356-65086	356-65086	1
5	O-ring, 70 S-1 ARP 155	671-00155	671-00155	1
6	cradle	032-92446	032-92477	1
7	housing, no rear drive	032-92473	032-92579	1
	housing, with rear drive	032-92481	032-92580	
8	O-ring, 70 S-1 ARP 263	671-00263	671-00263	1
9	screw, SHC	361-11213	361-11213	14
10	cam assembly	S22-15903	S22-15903	1
11	bearing	032-92449	032-92449	1
12	screw, SHC	361-10234	361-10234	7
14	barrel & port plate assembly CW	S22-16145	S22-16145	1
	barrel & port plate assembly CCW	S22-16146	S22-16146	



Ref. Figure 1
Exploded view of pump with pressure compensator control



Ref. figure 2
Indicator Assembly (52)
S22-16262

PARTS LIST FOR INDICATOR ASSEMBLY

item	description	part no.	qty.
1	Pivot nut	032-92491	1
2	Indicator	033-70624	1
3	fork	032-92653	1
4	pivot shaft	032-92492	1
5	glyd ring	679-00030	1
6	Soc. setscrew, 10-32 x 3/16	312-09030	1
7	O-ring, 70 S-1 ARP 114	671-00114	1
8	O-ring, 90 S-1 ARP 914	691-00914	1
9	Retaining ring	356-65070	1

item	description	part no. P07-SAE	part no. P110-ISO	qty.
16	dowel pin	324-21610	324-21610	1
17	pistons, shoes,retainer assembly	S22-16039	S22-16039	1
	(17-1) retainer plate (1 req'd)	032-92453	032-92453	
	(17-2) pistons and shoes (7 req'd)	S22-16031	S22-16031	
18	Belleville washer	032-91827	032-91827	2
19	stop	032-91824	032-91824	1
20	retaining ring	032-91825	032-91825	1
22	wear plate	032-92452	032-92452	1
23	lockwasher	348-10016	348-10016	2
24	bearing	032-91602	032-91602	1
25	washer	345-10012	345-10012	2
26	screw, SHC	361-08200	361-08200	4
27	O-ring, 90 S-1 ARP 013	691-00013	691-00013	6
28	cam/bearing retainer	032-92470	032-92470	2
30	O-ring, 70 S-1 ARP151	671-00151	671-00151	2
31	***off stroke control side (see page 17)***			1
	buck-up cap (comp, torque limiter, load sensing)	S22-15447	S22-15447	
	electric stroker	S22-16204	S22-16203	
	hydraulic stroker	S22-16202	S22-16201	
	rotary servo	S22-16200	S22-16199	
32	plug	488-35061	447-00032	2
33	O-ring, 90 S-1 ARP 904	691-00904	none	3
34	screw, SHC	361-08704	361-08704	2
35	Screw, HHC, M12 x 1,75 x 55 mm lg.	363-12205	363-12205	*
	Screw, HHC, M12 x 1,75 x 75 mm lg.(E,H,R,J,K)	363-12220	363-12220	*
	Screw, HHC, M12 x 1,75 x 85 mm lg. (L)	363-12233	363-12233	*
39	ring (qty. 1 for servo, electric & hydraulic stroker)	032-91816	032-91816	2
	ring (servo, electric & hydraulic stroker)	032-91811	032-91811	1
40	O-ring, 90 S-1 ARP 906	691-00906	none	2
41	plug	488-35041	447-00032	2
42	bearing	032-92454	032-92454	2
43	slide link	032-91823	032-91823	1
44	control piston (compensator, torque limiter)	032-91836	032-91836	1
	control piston (servo, electric & hydraulic stroker)	032-91848	032-91848	
45	bearing	032-91830	032-91830	1
46	retainer, white, .062", 1,57 mm thick	032-91853	032-91853	1
	retainer, red, .064", 1,63 mm thick	033-91854	033-91854	
	retainer, green, .067", 1,70 mm thick	033-91855	033-91855	
	retainer, yellow, .069", 1,75 m thick	033-91856	033-91856	
	retainer, blue, .071", 1,80 mm thick	033-91857	033-91857	
47	screw, FHSHCS	316-50001	316-50001	2
48	O-ring, 90 S-1 ARP 916	691-00916	none	1
49	plug	488-35024	447-01016	1
50	***on stroke control side (see page 17)***			1
	compensator (C1)	S22-15394	S22-15623	
	compensator (C2)	S22-15626	S22-15633	
	low torque limiter (J1)	S22-15401	S22-15624	
	low torque limiter (J2)	S22-15627	S22-15634	
	high torque limiter (K1)	S22-15629	S22-15631	
	high torque limiter (K2)	S22-15635	S22-15636	
	load sensing (L1)	S22-15402	S22-15625	
	load sensing (L2)	S22-15628	S22-15637	
	low torque limiter w/load sensing (V1)	S22-16186	S22-16188	
	low torque limiter w/load sensing (V2)	S22-16195	S22-16196	
	high torque limiter w/load sensing (W1)	S22-16187	S22-16189	
	high torque limiter w/load sensing (W2)	S22-16197	S22-16198	
	compensator override	S22-16205	S22-16206	
	low torque limiter override	S22-16207	S22-16208	
	high torque limiter override	S22-16209	S22-16210	
	max. volume screw, servo	S22-15325	S22-15613	
51	shipping plug	449-00019	449-00613	
52	plug	488-35030	488-35030	1
	indicator assembly *(see figure 2)*	S22-16262	S22-16262	
53	O-ring, 90 S-1 ARP 914	691-00914	691-00914	1

*qty and size depends on control (31) and (50). see controls section, starting pg 25

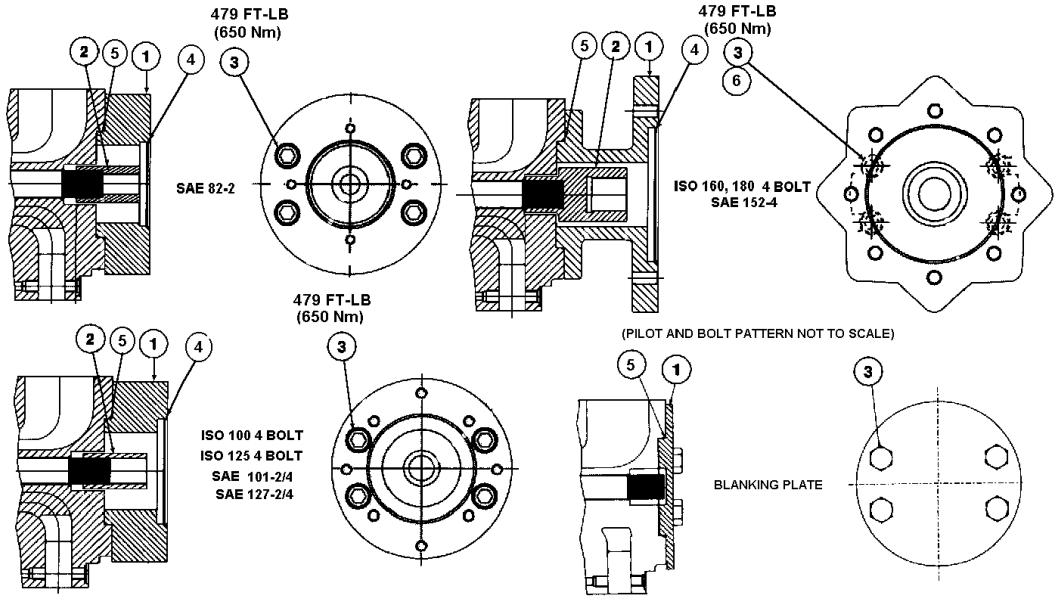


Figure 3

			SAE REAR DRIVES						
		code →	A	G	B	Q	C	N	D
		flange →	SAE 82-2	SAE 82-2	SAE101-2/4	SAE101-2/4	SAE127-2/4	SAE127-2/4	SAE152-4
		coupling →	16-4	22-4	22-4	25-4	32-4	38-4	44-4
item	part	qty	("A")	(modified "A")	("B")	("B-B")	("C")	("C-C")	("D")
1	adapter	1	032-91900	032-91900	032-91309	032-91309	032-91308	032-91649	032-91282
2	coupling	1	032-91901	032-92377	032-91361	032-91362	032-91363	032-91648	032-91634
3	screw	4	361-16304--8	361-16304-8	361-16304-8	361-16304-8	361-16304-8	361-16304--8	361-16304--8
4	O-ring	1	671-00152	671-00152	671-00155	671-00155	671-00159	671-00159	671-00163
5	O-ring	1	671-00159	671-00159	671-00159	671-00159	671-00159	671-00159	671-00159
6	washer	4							350-10109-
	assembly		S22-15372	S22-15809	S22-12867	S22-12868	S22-12869	S22-12920	S22-12870

			ISO REAR DRIVES					
		code →	Z	Y	X	T	U	L
		flange →	ISO 100	ISO 125	ISO 160	ISO 180	ISO 180	ISO 180
		coupling →	ISO K25N	ISO K32N	ISO K40N	ISO K40N	ISO K50N	DIN 40-18
item	part	qty						
1	adapter	1	032-91383	032-91384	032-91385	032-92162	032-92162	032-92162
2	coupling	1	032-91391	032-91390	032-91389	032-91389	032-91388	032-92345
3	screw	4	361-16304-8	361-16304-8	361-16304-8	361-16304-8	361-16304-8	361-16304-8
4	O-ring	1	671-00155	671-00159	671-00164	671-00167	671-00167	671-00167
5	O-ring	1	671-00159	671-00159	671-00159	671-00159	671-00159	671-00159
6	washer	4			350-10109	350-10109	350-10109	350-10109
	assembly		S22-12872	S22-12873	S22-12874	S22-15740	S22-15570	S22-15933

note: code M item (1) blanking plate part no. 032-91468 item (3) blanking plate screws 363-16210-8

ROTATION CONVERSION

The following parts and assembly are required for changing shaft rotation:

• A different barrel and port plate assembly is required. The barrel and port plate are matched assemblies, and should not be ordered separately. The reference part numbers are:

CW - Barrel and Port Plate Assembly S22- 16145
CCW - Barrel and Port Plate Assembly S22- 16146

• The control piston must be reversed to position it correctly to the control caps. *See step 9 pg. 20)*

• The control caps location are reversed. ***see illustrations below.***

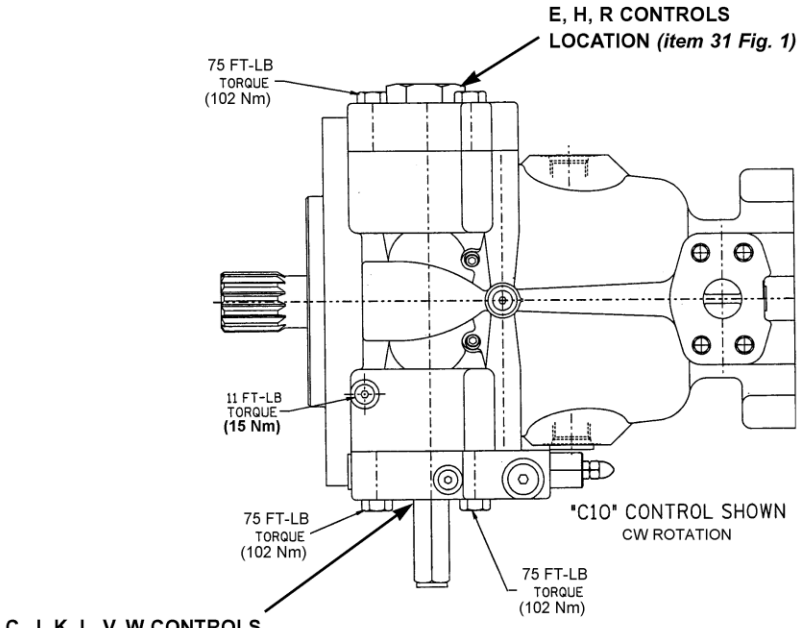


Figure 4

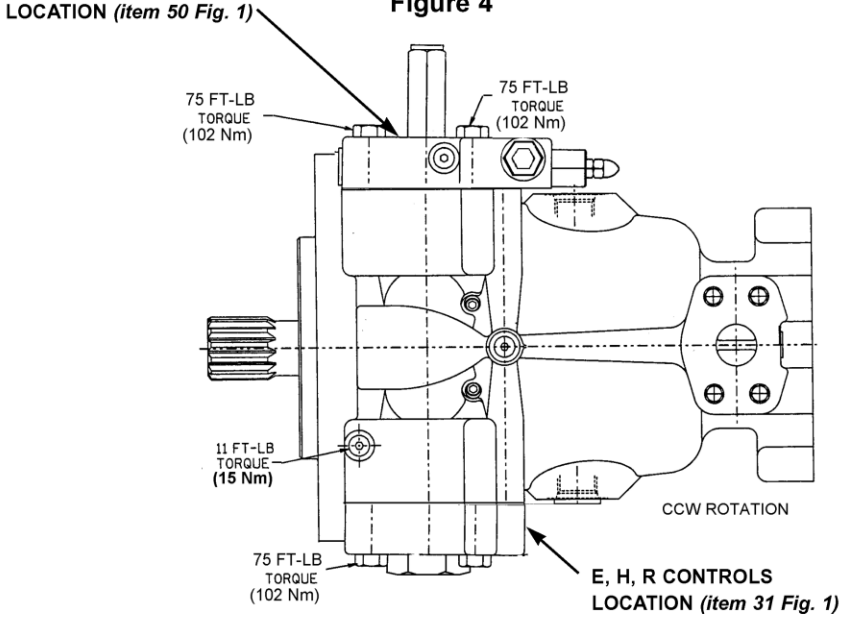
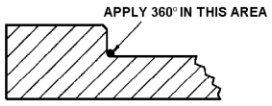


Figure 5

CONTROL ORIENTATION VERSUS PUMP ROTATION

SHAFT SEAL REPLACEMENT

See illustration Remove worn or damaged seal from retainer. Clean gasket sealant from retainer.



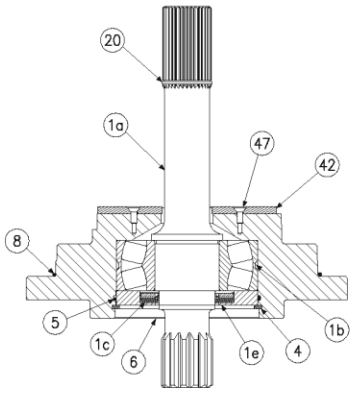
Install new seal by applying gasket sealant to retainer and pressing seal in retainer.

SEAL KITS P07 S22-15646-0
. . . . . P110 S22-15647-0

The shaft seal and all "O" rings necessary for total seal replacement may be obtained by ordering the Seal Kit . These seals are suitable for petroleum base fluids. For fire resistant fluids contact **DENISON HYDRAULICS**, Inc. or their authorized distributors to obtain the appropriate seal kit number.

SHAFT ASSEMBLIES *(see parts list, item (1) on page 13)*
The following assemblies include shaft, key when applicable, bearing and seal:

	P07-SAE #	P110-ISO #
Keyed, no rear drive assembly	S22-15337	S22-15598
Keyed, with rear drive assembly	S22-16027	S22-16028
Splined, no rear drive assembly	S22-15338	S22-15599
Splined, with rear drive assembly	S22-16025	S22-16026
		P110-DIN #
Keyed, no rear drive assembly		S22-15673
Keyed, with rear drive assembly		S22-16030
Splined, no rear drive assembly		S22-15602
Splined, with rear drive assembly		S22-16029



PRE-ASSEMBLY
Depending on the repairs, many steps in this section may not be applicable.

The assembly area should be clean and the environment such that foreign matter will not be introduced to the pump during assembly. All parts must be absolutely clean and free from rust, contamination, lint, or any other foreign matter. Critical surfaces must be free of dings or scratches. All "O" rings and seals must be clean and carefully examined for cuts or other damage before installation.

During assembly, occasional reference will be made to the use of lubricating oil for proper assembly. It is important that any oil used be compatible with the seals and fluid to be used in operation. Compatibility is also necessary for grease which should be used on all "O" rings to ensure proper assembly without damage.

THREAD LOCKING AND SEALANT
Several screws require a thread locking compound for locking in position. When thread locking compound is required use Loctite® #242 or equivalent. Where hydraulic sealant is specified, use Loctite® Hydraulic Sealant or equivalent. Where gasket sealant is specified, use Loctite® Master Gasket or equivalent.

ASSEMBLY
Refer to illustration, see figure 1. See page 26 for tightening torque on plugs

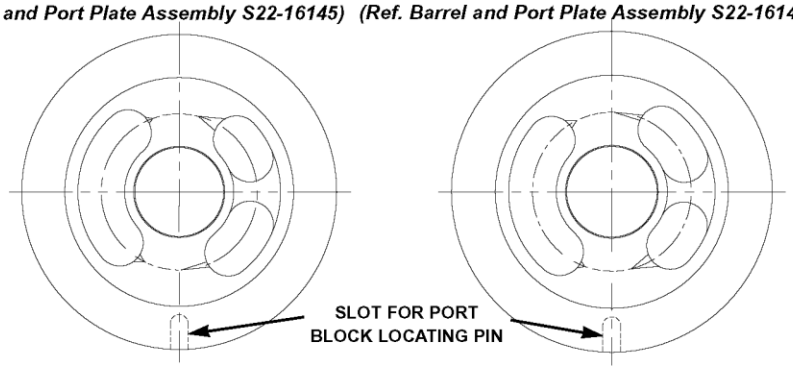
1. Place the port block end of the housing (7) on a suitable surface capable of supporting the pump weight of 177 lbs, 80,3 Kgs.

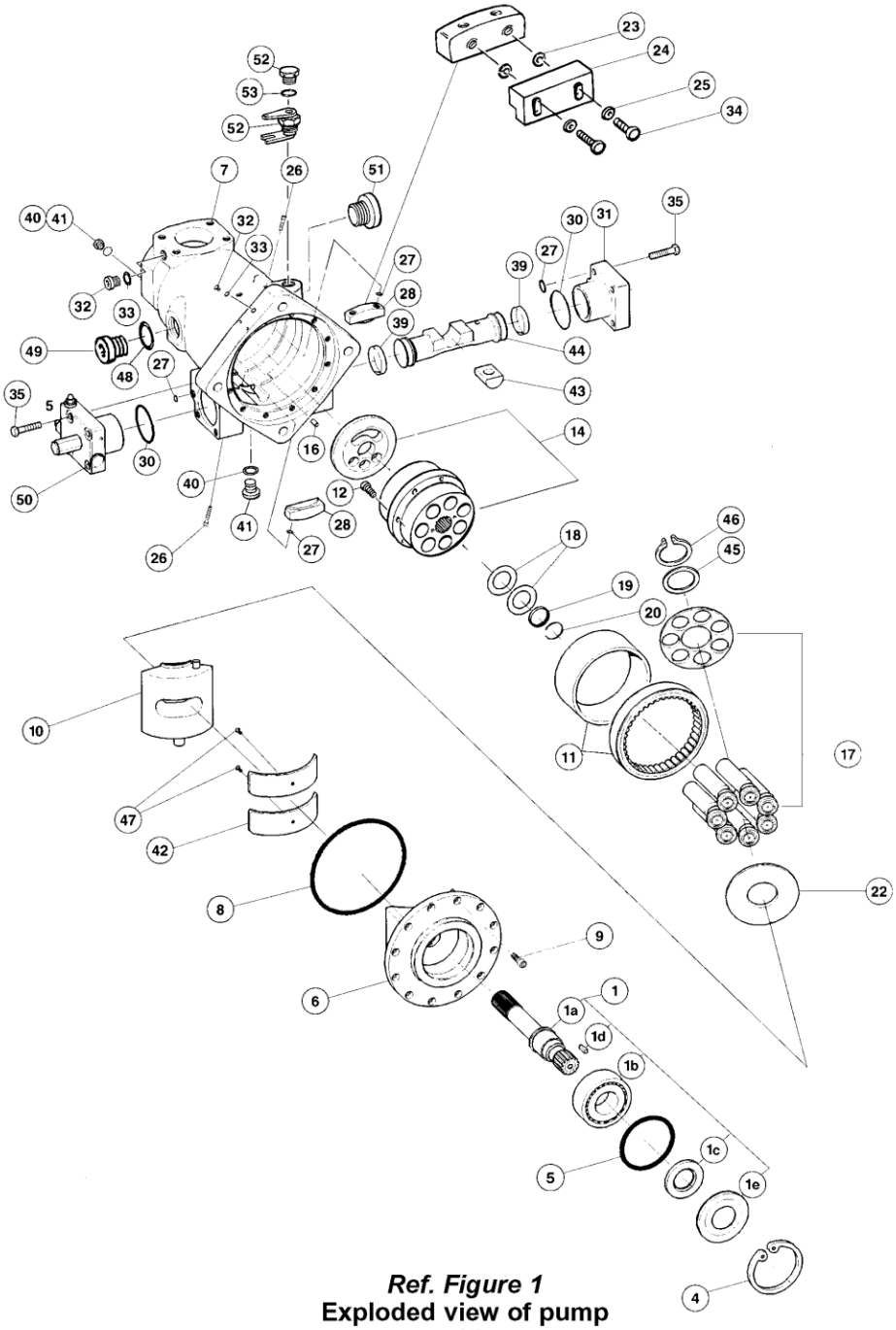
2. Install plugs (41) with "O" rings into port block. Install plugs (32) with "O" rings into port block.

3. Install pin (16) in port block. Position port plate (14) on port block and over pin. To view correct port plate for shaft rotation specified. ***See illustration, below***

Port Plate for CW Shaft Rotation
(Ref. Barrel and Port Plate Assembly S22-16145)

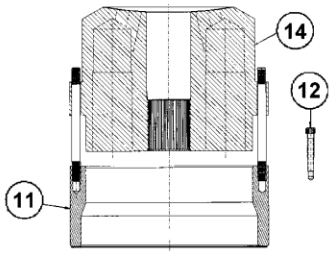
Port Plate for CCW Shaft Rotation
(Ref. Barrel and Port Plate Assembly S22-16146)





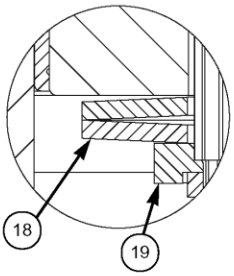
Ref. Figure 1
Exploded view of pump
with
pressure compensator control

4. Press bearing outer race (11) into housing (7).



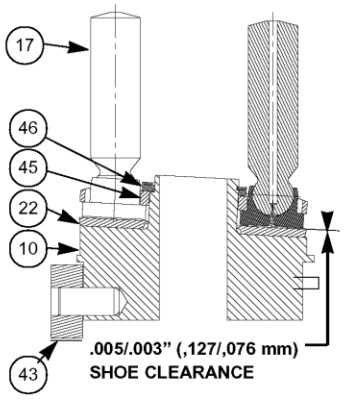
BARREL AND INNER RACE ASSEMBLY

5. Thread seven M8-1,25 studs into bearing inner race. Lower barrel (14) over studs and seat. If the inner race is heated to 150°F, 65°C, barrel will slide into position without force. If race is not heated, longer screws (12) can be used to draw the race and barrel together. Insert screws (12) and torque to 30 lbs ft., 40 Nm. ***See illustration***
6. Apply oil to face of port plate and inner bearing race. Attach tool T-1 to barrel with two M6 screws. Carefully lower barrel assembly into housing engaging inner race into rollers of outer bearing race, barrel may then be lowered until it has seated on port plate.
7. Insert two "O" rings (27) into each retainer (28). Apply thread locking compound to two screws (26) and secure retainer to housing. Torque to 84 lbs-in., 9,5 Nm.
8. Apply thread locking compound to two screws (26) and assemble the other retainer on opposite side of housing. Torque to 84 lbs-in., 9,5 Nm.
9. Assemble the two piston rings (39) on control piston (44). Insert control piston (44) into housing bore that is used with the control caps. ***For CW shaft rotation***, the long end of the piston must be positioned to the right. ***(Ref. fig.1***) ***For CCW rotation***, the long end of the piston is to the left.
10. Position Belleville washers (18) on barrel, ***See illustration.*** To insure proper pump operation and correct barrel holddown force they must be assembled exactly as shown. Place barrel stop (19) on Belleville washers and center the washers and stop on barrel.

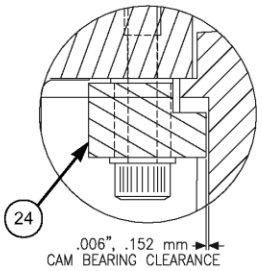


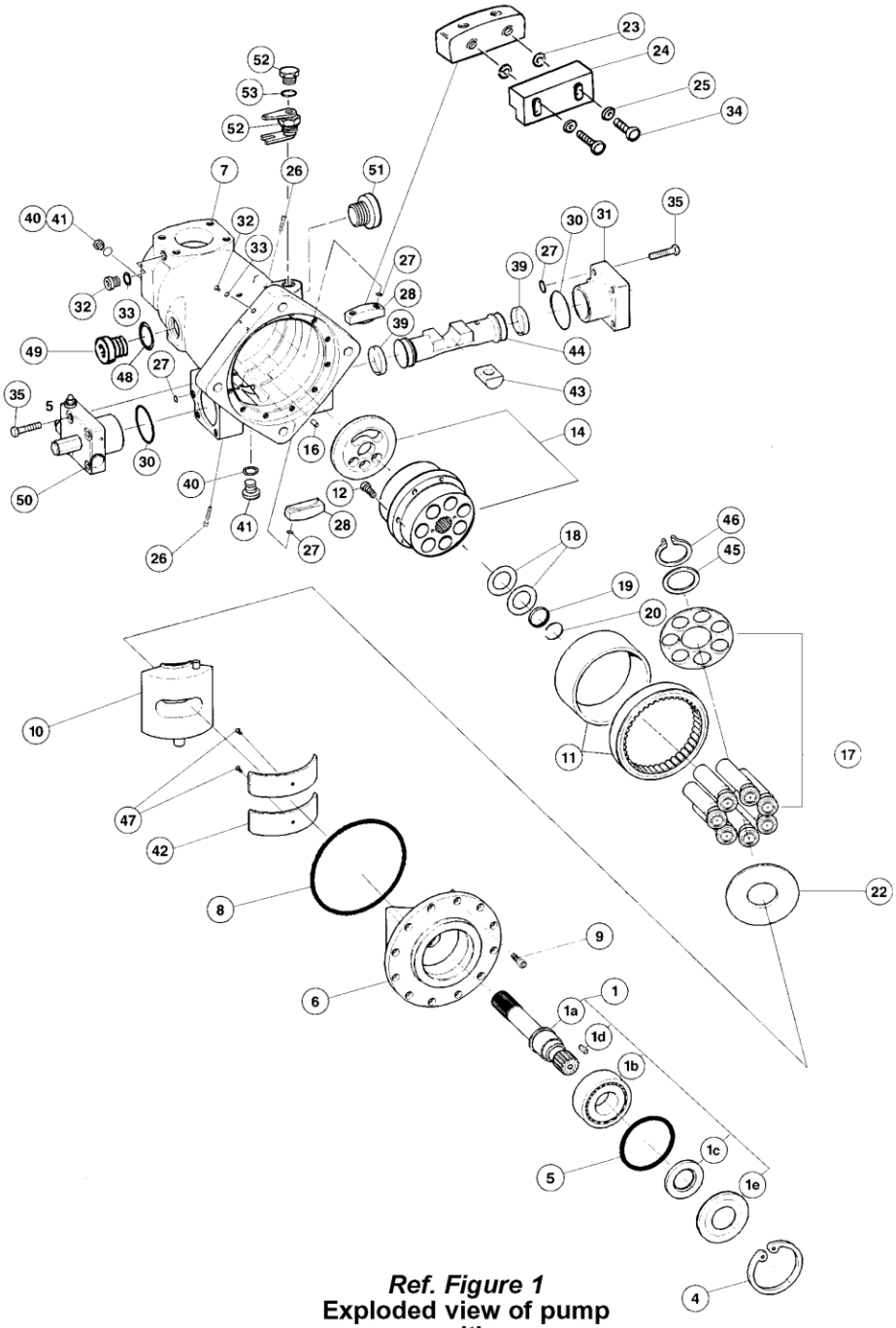
CAM ASSEMBLY

11. Set cam assembly (10) on suitable surface protecting cam surfaces from damage during assembly. ***See illustration***
12. Place wear plate (22) on cam.
13. Position pistons-shoes-retainer assembly (17) over center post and against wear plate.
14. Install thrust washer (45) over center post.
15. Six different retainers (46) are available for setting the shoe holddown. Each retainer is marked: ***white dot*** .062", 1,57 mm thick, ***red dot*** .064", 1,63 mm thick, ***green dot*** .067", 1,70 mm thick, ***yellow dot*** .069", 1,75 mm thick, and ***blue dot*** .071", 1,80 mm thick. Install the thickest retainer *with the dot side up,* that will fit in the groove on the center post and allow a clearance of .003"-.005", 0,076-0,127 mm between the shoe and wear plate. **A .003", 0,076 mm feeler gage must go** completely under any shoe, and a **.005", 0,127 mm feeler gage must not go** under any shoe while holding a piston and lifting tightly against the shoe retainer. The piston and shoe assembly must be free to rotate easily by hand. Rotate 360° to confirm there is no binding and that each shoe is free in the retainer plate. Oil the assembly thoroughly.



16. Install slide link (43) on rocker cam pin as shown.
17. Oil barrel bores before installing cam assembly. The piston must be moved outward *(away from pump center)* so that clearance is provided for installing the rocker cam assembly. Lower cam assembly into the housing with the slide link positioned so it will engage into the control piston (44). The seven pistons (17) must first be engaged into the barrel bores. Next the slide link (43) must engage into the control piston (44). Continue lowering rocker cam assembly until it is seated on cam/bearing retainers(28).
18. Apply thread locking compound to two screws (34) and assemble clearance-bearing (24) to cam-bearing retainer (28) using the screws (34), two washers (25) and two washers (23). Move rocker cam to the right until it is against stop. ***Set clearance*** between clearance bearing (24) and cam at .006", 0,152 mm. Torque screws to 6 lbs-ft., 8,1 Nm maintaining the .006", 0,152 mm clearance.
19. Adjust piston (44) toward the *off stroke* control side (31). This will place the cam at approximately zero displacement and provide clearance for the shaft installation.



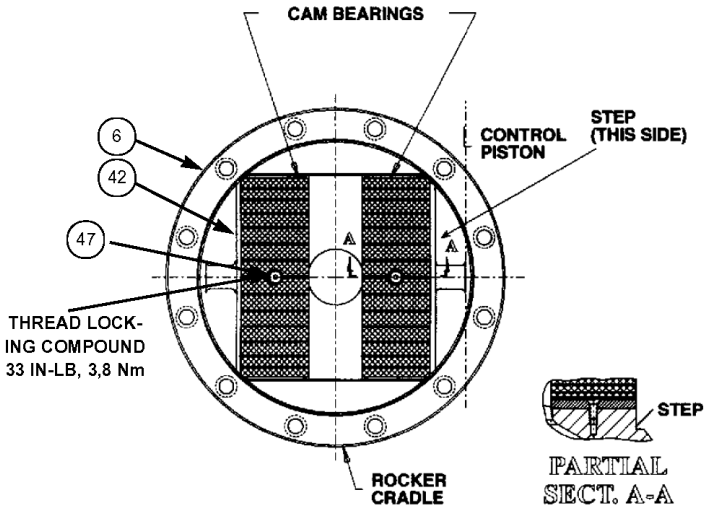


Ref. Figure 1
Exploded view of pump with pressure compensator control

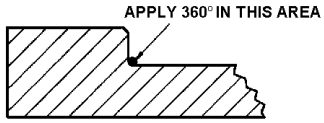
- Continued -

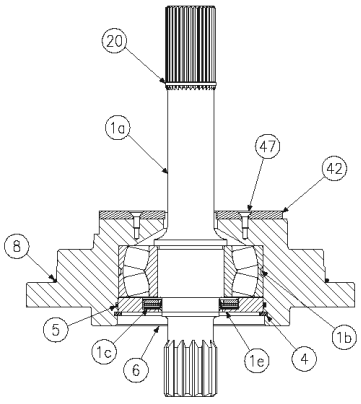
Rocker cradle assembly

20. Apply thread locking compound to two screws (47) and assemble two cam bearings (42) to cradle (6). Torque to 33 lbs-in., 3,8 Nm.

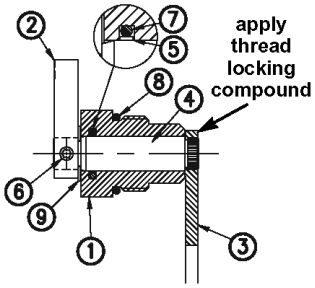


21. Press bearing (1b) on shaft (1a). Press on inner race only.
22. Apply over 360° bead of gasket sealant to seal retainer (1e) per following sketch. Press shaft seal (1c) into seal retainer (1e).
23. Install shaft seal and retainer on shaft using Tool T-3 to protect seal.
24. Install "O" ring (5) in cradle (6).
25. Press seal retainer and bearing and shaft assembly into bore of cradle (6) using Tool T-2.
26. Install snap ring (4) to cradle.
27. Install "O" ring (8) to rocker cradle.





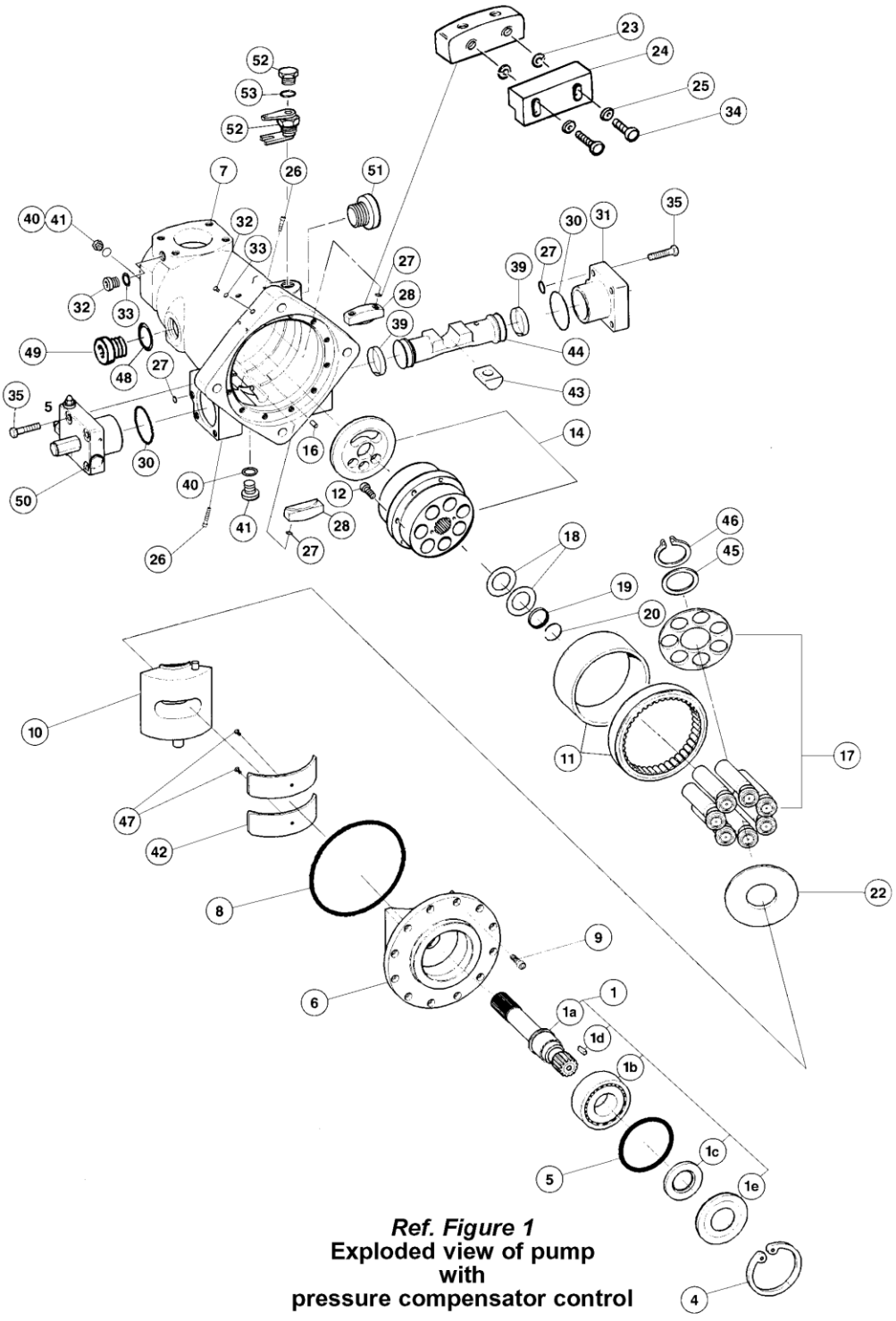
28. Install retaining ring (20) on shaft.
29. Center Belleville washers and barrel stop. Lower rocker cradle assembly into pump housing with the step in the rocker cradle correctly positioned so that clearance is provided for slide link (43). The threaded hole in the end of shaft should be used to support the assembly. SAE shafts use 3/8-16 threads, ISO shafts use M10 threads, DIN shafts use M12 threads. The shaft spline must first engage the splined barrel stop (19), thru the Belleville washers (18) and engage the barrel spline. The assembly will then rest on the cam.
30. Install socket head cap screws (9) as shown. Torque evenly to 57 ft-lb (77 Nm). Install case drain plug (49) and shipping plug (51). If pump does not contain displacement indicator, install plug (52) and "O" ring (53) in indicator hole.



ref. Figure 2
Indicator assembly

INDICATOR ASSEMBLY OPTION

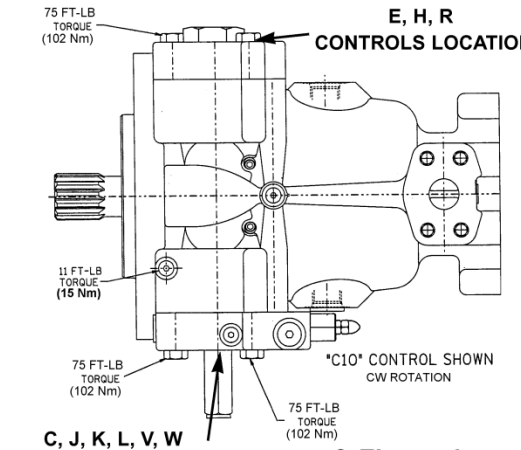
See figure 2. To install indicator assembly, loosen setscrew (6), remove indicator (2) and slide shaft out of nut (1). Guide fork into indicator hole in housing to engage the pin on the hanger. a 1/4-20 SHCS or threaded rod may be used to hold the shaft. Slide nut (1) over shaft and tighten nut in threaded hole. Pull shaft out to slip retaining ring (9) into groove in shaft. Use maximum volume stop to set pump on zero displacement (10.2 turns from full). Install indicator, set pointer on "0" and lock in position.



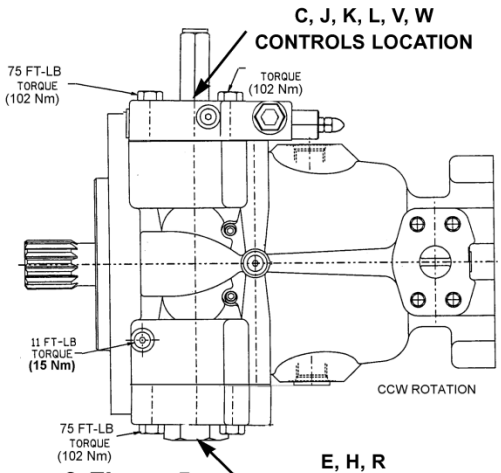
Ref. Figure 1
Exploded view of pump with pressure compensator control

CONTROLS ASSEMBLY

Install control cap assemblies (50) and (31). The control caps must be positioned on the housing for either CW or CCW pump rotation. See figures 4 & 5 for correct orientation. The control piston (44) was assembled previously for the correct pump rotation. Install eight hex head cap screws (35) into caps and torque to housing with 75 lbs-ft., 102 Nm.

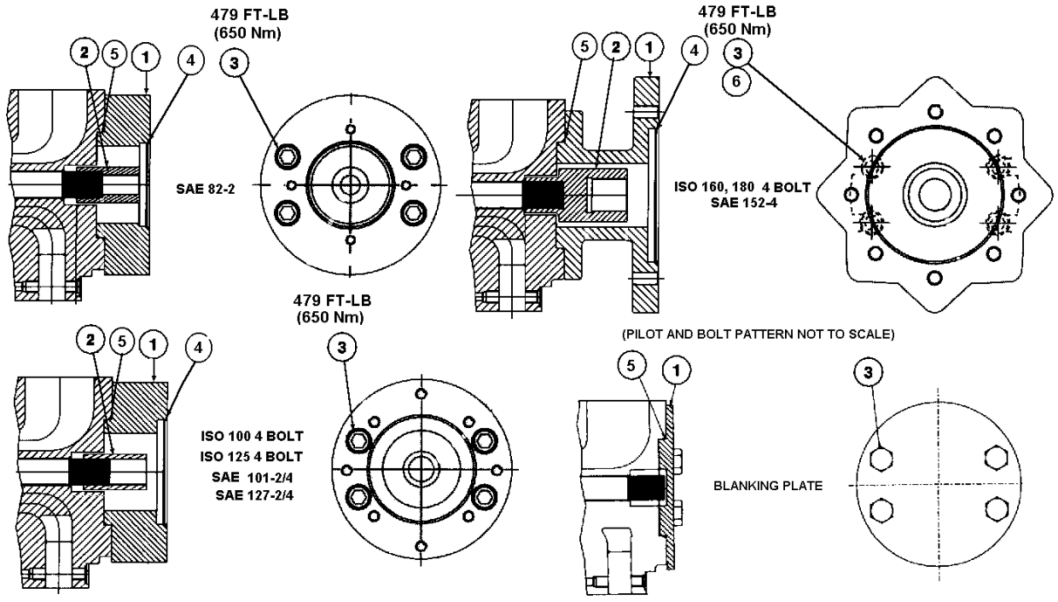


ref. Figure 4



ref. Figure 5

If the pump has a rear drive feature, assemble coupling and adapter. ***See illustration, figure 3.***



Ref. Figure 3

GENERAL

The instructions contained in this manual cover complete disassembly and reassembly of the controls. Before proceeding with the disassembly or reassembly of any unit, this manual should be studied in order to become familiar with proper order and parts nomenclature

DESCRIPTION OF OPERATION

A pilot operated valve spool and sleeve combination is the core of the control function. For the compensator, torque limiter and load sensing controls, system pressure is applied to the input port of a three-way valve, and to one end of the valve spool. A small orifice feeds this pressure to the other end of the spool, and limits pilot flow to approximately 115 in^3/minute, 1,9 lpm. A spring on this end biases the spool to normally port the control piston to pump case. This control piston links to the pump cam. On the opposite end of the control piston a small buck-up piston connects to system pressure. This force, pump timing forces, and a spring combine to put the pump on stroke.

PRESSURE COMPENSATOR

A spring-loaded cone and seat connected to the spring end of the three-way spool establishes an adjustable pressure limit on this end of the spool. When system pressure reaches this value, flow through the spool creates a pressure difference across the spool. At approximately 250 psi, 17,2 bar difference, the spool shifts toward the spring, re-directing the control piston port to system pressure. This pressure applied to the control piston overcomes the forces putting the pump on stroke, causing the pump to reduce displacement. When the pump pressure drops, the spool meters to maintain the pump pressure at approximately 250 psi, 17,2 bar above the controlled pressure on the spring side. The spring end of this three-way spool may also be connected to a remote pressure control, through the vent port, "V".

LOAD SENSING CONTROL

In the load sensing control, the system load pressure is applied to a modulating valve which establishes the compensator vent pressure at 200 psi, 13,8 bar above load pressure. Adding the differential pressure across the compensator spool to this pressure, the pump outlet pressure is approximately 350 psi to 450 psi, 24,1 to 31 bar above load pressure. There is essentially no flow in the sensing line, and the pump supplies the flow required to develop 350 psi to 435 psi, 24,1 to 30 bar across the.metering valve to the load.

TORQUE LIMITER

The input torque is limited to a set value with the torque limiter control. To limit input torque, pump displacement is reduced when pressure increases, and vice versa. This is accomplished by controlling the compensator pilot pressure with a linkage to the pump stroking piston.

The compensator vent connects to one end of a pin which is spring loaded on the other end. The pin slides through a spool which is positioned by a linkage to the control piston. Vent flow passes through the pin to a cross drilled hole, which is opened or blocked by the motion of the spool. As system pressure increases, the pin moves against the springs till the cross drilled passage opens, venting the compensator and causing the pump to reduce displacement. As displacement reduces, the sleeve follows, closing the cross drilled passage and establishing control at a higher pressure. For any pressure, there is a corresponding pump displacement. The position of the spool is controlled by the pressure acting against two springs, one which is always in contact with the pin, and the other which comes in contact as pressure increases, providing an increase in spring rate as pressure increases

TORQUE LIMITER WITH LOAD SENSING

A modulating valve is mounted to a torque limiter body to provide a load sensing control with torque limiting and pressure compensator override

ROTARY SERVO CONTROL

The rotary servo control is mounted on the off-stroke side of the control piston. Servo pressure is connected to the input port of a four-way valve, and to the end of this valve spool. A drilling and orifice connects to the opposite end of the spool. One cylinder port connects to the "off stroke" end of the control piston, while the other cylinder port connects to the "on stroke" end of the control piston, through the control on the opposite side.

A rotatable shaft converts to a linear motion on a pin. A sleeve over the pin is driven by a linkage to the control piston. The sleeve/pin combination meters pilot flow from the four-way valve controlling the shifting of the four-way valve, in such a manner that the four-way valve shifts to hold the cylinder position to the corresponding position for the input rotation.

HYDRAULIC STROKER

In the hydraulic stroker, a spring loaded piston is attached to the pin. A control pressure of 50 psi, 3,45 bar causes the piston to commence to move against the spring, to position the pin in proportion to the control pressure, and thus cause the pump to stroke in proportion to control pressure. Full displacement is achieved at 225 psi, 15,5 bar.

ELECTRIC STROKER

By mounting an electrically modulated pressure control valve on the hydraulic stroker to establish the control pressure, pump displacement is controlled by an electrical signal. For a 24 volt coil, the pump commences to stroke at approximately 175 mA electrical signal, and will be at full displacement at approximately 275 mA.

PRESSURE COMPENSATOR AND TORQUE LIMITER OVERRIDE

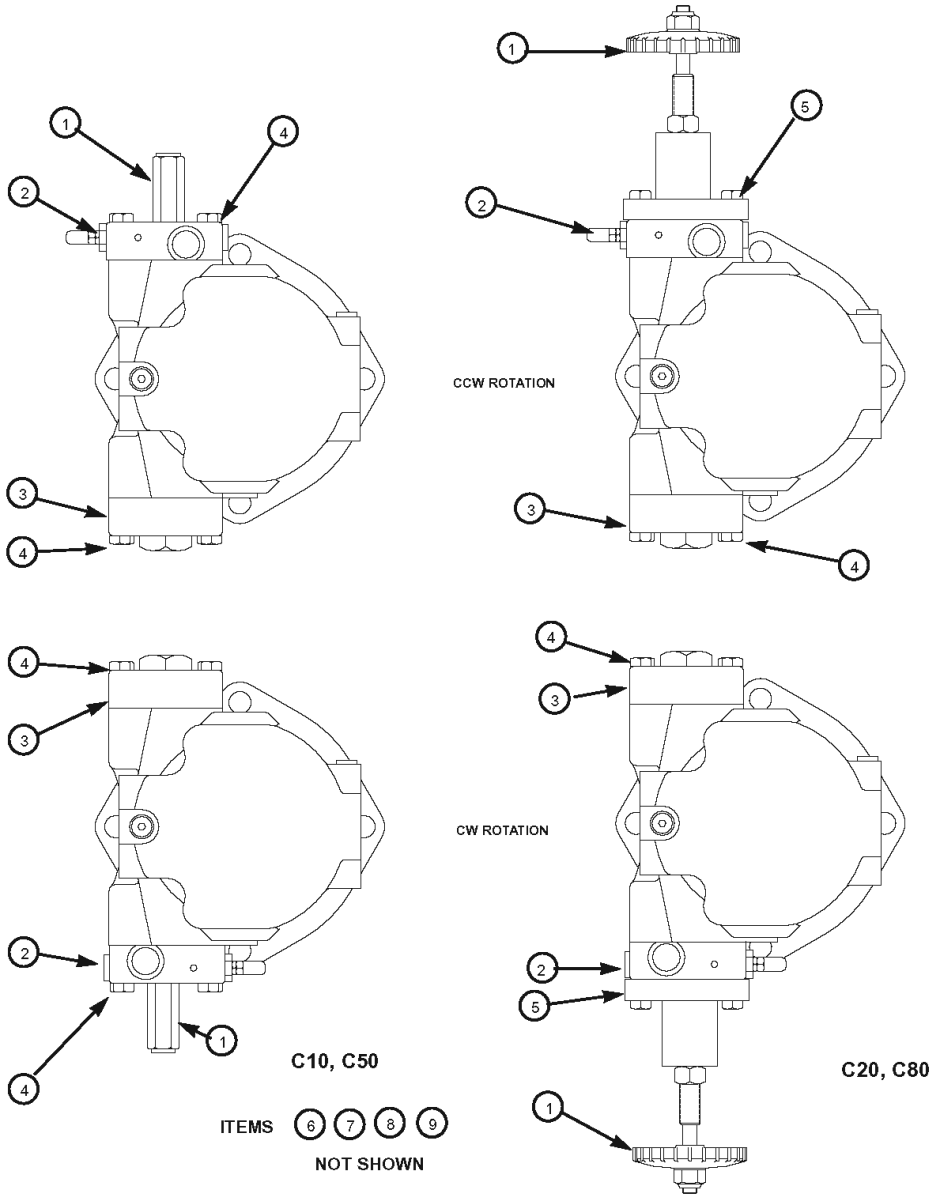
An override pressure compensator or a torque limiter control mounts on the smaller diameter of the control piston, opposite the servo, hydraulic or electric stroker. In the normal position, the spool in the override control connects this piston to the control valve on the opposite side, allowing control by the stroker. When system pressure or torque exceed the override setting, this spool connects system pressure to the smaller diameter control piston, to override the rotary servo, hydraulic or electric stroker command and reduce displacement according to the compensator or torque limiter setting. Override pressure must be sufficient to overcome servo pressure acting on the larger diameter piston.

TIGHTENING TORQUE FOR HYDRAULIC PLUGS

PORT SIZE	ft-lbs	Nm
SAE-4	11	15
SAE-6	18	24
SAE-8	46	62
SAE-10	75	102
SAE-14	130	175
SAE-16	135	183
1/4 BSPP	18	24
3/8 BSPP	18	24
1/2 BSPP	93	126
1" BSPP	146	198

PORT SIZES

DESCRIPTION	P07 C MOD	P110 C MOD
PORT C1 ..... OFF-STROKE CYLINDER GAGE	SAE-4	1/4 BSPP
PORT C2 ..... ON-STROKE CYLINDER GAGE	SAE-4	1/4 BSPP
PORT D ..... CASE DRAIN	SAE-20	1-1/4 BSPP
PORT D1 ..... CASE DRAIN	SAE-20	1-1/4 BSPP
PORT DG..... DRAIN GAGE, AIR BLEED PORT	SAE-4	3/8 BSPP
PORT AG..... INLET GAGE	SAE-4	1/4 BSPP
PORT BG..... SYSTEM GAGE	SAE-4	1/4 BSPP
PORT BG1.... ALTERNATE SYSTEM GAGE	SAE-6	1/4 BSPP
PORT E ..... ELECTROHYDRAULIC STROKER SERVO SUPPLY	SAE-4	1/4 BSPP
PORT H ..... HYDRAULIC STROKER SIGNAL	SAE-4	1/4 BSPP
PORT LS .... LOAD SENSING LINE	SAE-4	1/4 BSPP
PORT V ..... COMPENSATOR, TORQUE LIMITER, LOAD SENSING VENT	SAE-8	3/8 BSPP
PORT V1 ..... SERVO VENT	SAE-4	1/4 BSPP
PORT X ..... SERVO SUPPLY	SAE-6	3/8 BSPP
PORT XG..... SERVO GAGE	SAE-10	1/2 BSPP



PRESSURE COMPENSATOR
parts list

ITEM	DESCRIPTION	P07 PART NO.	P110 PART NO.	QTY. C10/50	QTY. C20/80
1	Maximum Stop (Fig. 7)	S22-15467	S22-15467	1	—
	Maximum Handwheel (Fig. 8)	S22-15448	S22-15448	—	1
2	*Compensator Control (Fig. 6)	S22-15394	S22-15623	1	
	*Compensator Control (Fig. 6)	S22-15626	S22-15633		1
3	Buck Up Cap (Fig. 9)	S22-15447	S22-15447	1	1
4	Screw-H.H.C.,M12 x 55 mm	363-12205	363-12205	8	6
5	Screw-H.H.C., M12 x 75 mm	363-12220	363-12220	—	2
6	Control Piston	032-91836	032-91836	1	1
7	O-Ring, 90 S-1 ARP 013	691-00013	691-00013	2	2
8	O-Ring, 70 S-1 ARP 151	671-00151	671-00151	2	2
9	Piston Ring	032-91816	032-91816	2	2

*Include items 1, 4, 5, 7 and 8

COMPENSATOR DISASSEMBLY

1. **See Figure 6.** Back off maximum volume screw or handwheel to full displacement. Remove maximum volume screw or handwheel assembly.
2. Remove bolts holding cap to pump.
3. Remove plug (15) and attached parts. Remove spring (11) and spool (18).
4. Remove adjusting plug (2) and attached parts. Remove seal piston (5). Note: a 10-24 screw may be used to assist in pulling the piston. Remove spring (7) and cone (8).
5. Do not remove sleeve in body (1). Sleeve is pressed into cap and finished to size. If sleeve or cap is worn, replace the cap-sleeve assembly (1).
6. Examine seat (10) for wear. Do not remove unless damaged.

ASSEMBLY

See page 26 for tightening torque on plugs

1. Install Avseal plugs (9) and .047", 1,19 mm. orifice (19) in body.
2. Press seat (10) into bore squarely against shoulder in bore.
3. Install spool (18) into bore as shown. Install spring (11) over end of spool. Install O-ring (6) on seal piston (16). Lubricate and install into plug (15). Install plug (15) into cap. Install screw (3), nut (4) and plastic cap (17).
4. Install O-ring (6) on seal piston (5).
5. Lubricate O-ring and install cone (8), spring (7) and seal piston into bore in cap (1), being careful that cone enters seat (10). Install remaining parts. Torque plugs (12) and (21)
6. Note proper location for cap on pump (pg. 24). Install O-rings on interface between cap and pump control pad.
7. Install cap on pump control pad, guiding the control piston into the bore. Install maximum volume stop assembly.
8. Torque mounting bolts to 75 lbs.• ft., 102 N m.

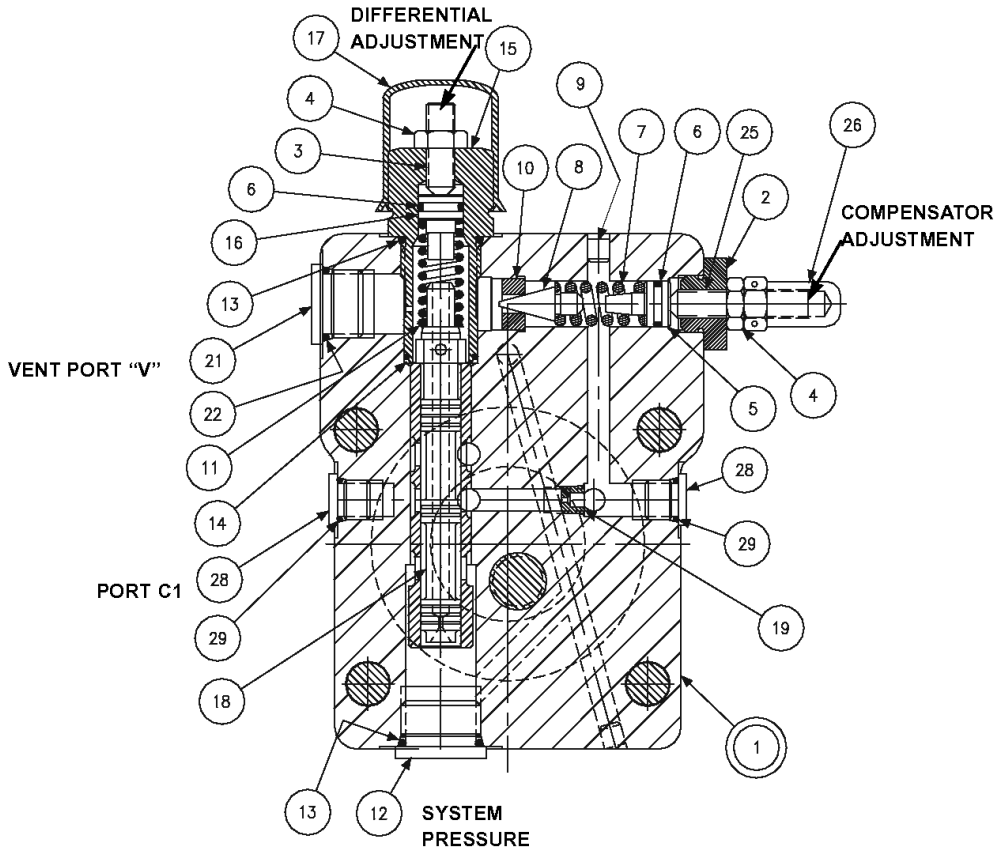


FIGURE 6

PARTS LIST FOR FIGURE 6

P07 C10 compensator S22-15394
P110 C10 compensator S22-15623
P07 C20 compensator S22-15626
P110 C20 compensator S22-15633

ITEM	DESCRIPTION	P07 PART NO.	QTY.	P110 PART NO.	QTY.
1	Cap-Sleeve Assembly	S22-15321	1	S22-15604	1
2	Adjusting Plug	032-91814	1	032-91814	1
3	Socket Setscrew 5/16-24 x 1	312-13160	1	312-13160	1
4	Nut, 5/16-24	335-13100	2	335-13100	2
5	Seal Piston	031-59367	1	031-59367	1
6	O-Ring, 90 S-1 ARP 012	691-00012	2	691-00012	2
7	Spring	032-91798	1	032-91798	1
8	Cone	036-12288	1	036-12288	1
9	Avseal Plug	447-00026	2	447-00026	2
10	Seat	036-11692	1	036-11692	1
11	Spring	033-71086	1	033-71086	1
12	Plug	488-35055	1	447-01008	1
13	O-Ring, 90 S-1 ARP 910	691-00910	2	691-00910	1
14	O-Ring, 90 S-1 ARP 017	691-00017	1	691-00017	1
15	Plug	031-57368	1	031-57368	1
16	Seal Piston	032-91305	1	032-91305	1
17	Cap	449-00612	1	449-00612	1
18	Spool	032-59482	1	032-59482	1
19	Orifice Plug, .047", 1.19 mm.	033-25528	1	033-25528	1
21	Plug	488-35018	1	447-00032	1
22	O-Ring, 90 S-1 ARP 908	691-00908	1	-	-
25	Setscrew 5/16-24 x 1-1/4	312-13180	1	312-13180	1
26	Acorn Nut	036-33474	1	036-33474	1
28	Plug	488-35061	2	447-01004	2
29	O-ring, 90 S-1 ARP 904	691-00904	2	-	-

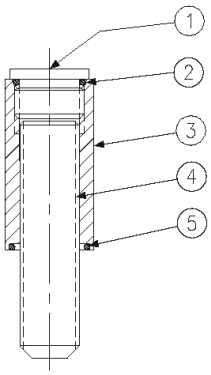


Figure 7
maximum volume stop

PARTS LIST FOR FIGURE 7
maximum volume stop S22-15467

ITEM	DESCRIPTION	PART NO.	QTY.
1	Plug 8HP5N-S	488-35018	1
2	O-Ring, 90 S-1 ARP 908	691-00908	1
3	Nut, M16 Hex	032-91822	1
4	Screw, Soc. Set	311-50001	1
5	O-Ring,70 S-1 ARP 115	671-00115	1

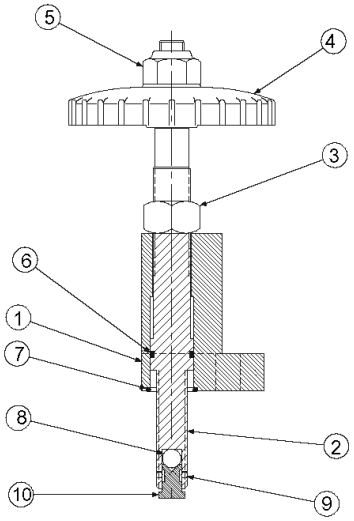


Figure 8
Handwheel maximum volume stop

PARTS LIST FOR FIGURE 8
handwheel S22-15448

ITEM	DESCRIPTION	PART NO.	QTY.
1	Bracket	032-92056	1
2	Screw	032-92057	1
3	Nut, Hex	333-25000	1
4	Handwheel	031-59911	1
5	Nut, Elastic Stop 1/2-13	331-20100	1
6	O-Ring, 90 S-1 ARP 115	691-00115	1
7	O-Ring, 90 S-1 ARP-118	691-00118	1
8	Ball	201-12001	1
9	Ball	201-04001	2
10	Seat	032-92058	1

MAXIMUM VOLUME HANDWHEEL DISASSEMBLY

1. **See Fig. 8.** Remove the two screws holding the bracket (1) to the control cap.
2. Turn the handwheel counter-clockwise to remove the stop screw from the control cap.
3. Remove nut (5) and handwheel (4) from the stop screw (2).
4. Remove nut (3). Screw (2) may now be slipped through the bracket (1) to examine parts and to replace O-ring (6).
5. Seat (10) pivots and rotates on ball (8) and is retained by pressing two balls (9) into screw (2). Replace assembly if damaged.

ASSEMBLY

1. Install ball (8) and seat (10) in screw (2).
2. Press balls (9) into screw (2) to retain seat
3. Install O-ring (6) on screw (2). Lubricate O-ring and slide screw into bracket (1). Install remaining parts.
4. Turn handwheel clockwise into cap till the screw contacts the control piston.
5. Install and torque the assembly screws to 75 ft-lb, 102 Nm.

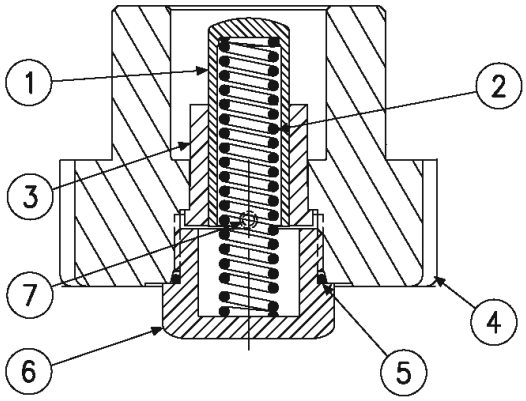


FIGURE 9
Buck-up cap assembly

PARTS LIST FOR FIGURE 9
buck-up cap S22-15447

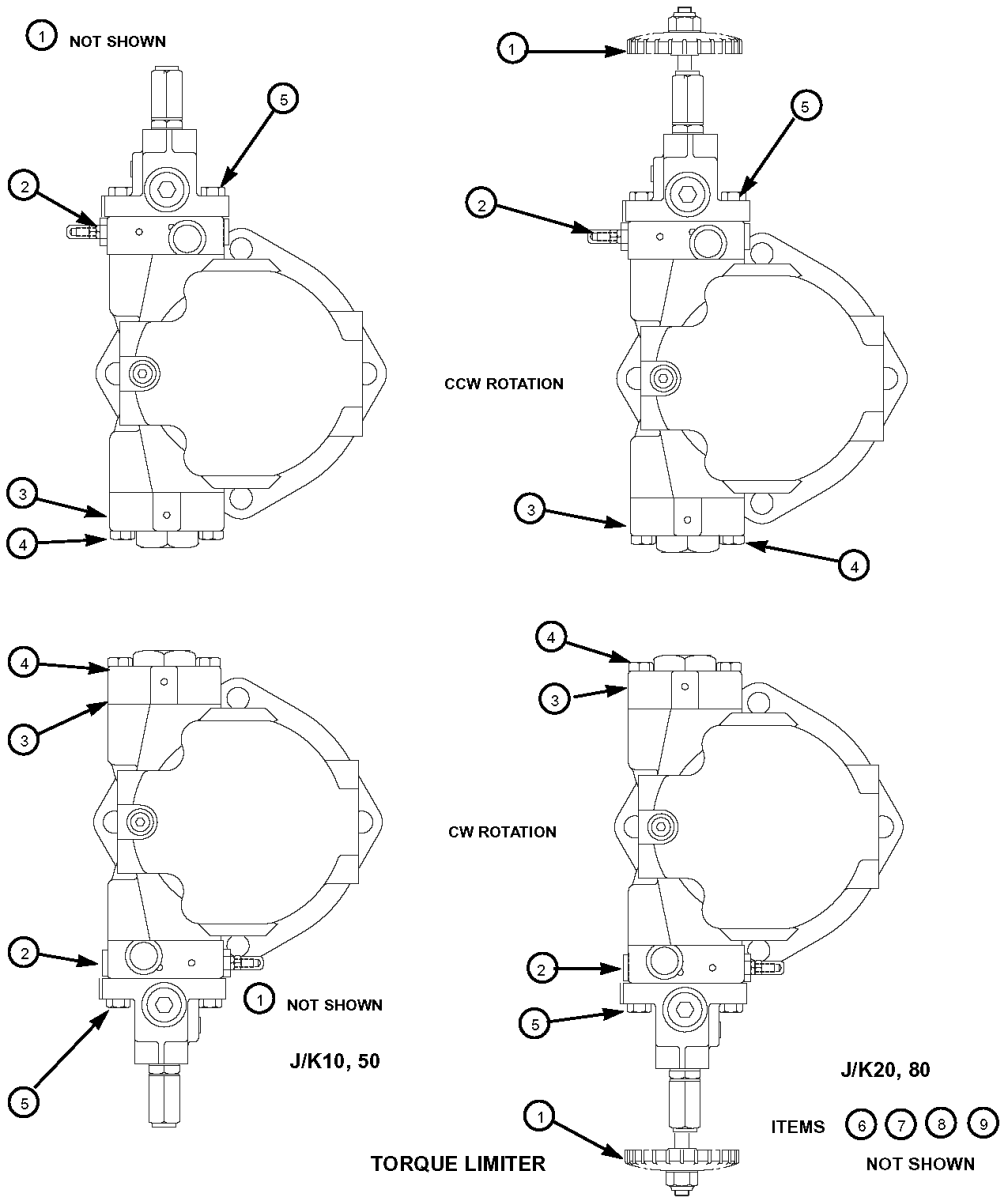
ITEM	DESCRIPTION	PART NO.	QTY.
1	Piston	032-92202	1
2	Spring	032-92205	1
3	Sleeve	032-92203	1
4	Control Cap	032-91832	1
5	O-Ring	691-00920	1
6	Plug	032-92204	1
7	Avseal Plug	447-00026	1

BUCK-UP CAP DISASSEMBLY

1. **See Figure 9.** Set maximum volume stop to full displacement. Remove 4 screws holding cap to pump. Caution! Spring load could cause injury!
2. Remove cap assembly from pump.
3. Remove and examine spring (2) and piston (1). If sleeve (3) is worn, press it out and replace.

ASSEMBLY

1. Install Avseal plug (7) into cap. Press sleeve (3) into cap to shoulder. Install piston (1), O-ring (5) and plug (6) into cap.
2. Install O-rings on interface between cap and pump control pad. Install spring (2)) into control piston.
   Install cap assembly on pump housing as indicated on page 17 Fig. 5, guiding the control piston into the bore.
3. Torque the assembly bolts to 75 ft-lb, 102 Nm. Torque plug (7) to 225 lb-ft, 305 Nm.



PARTS LIST
torque limiter

ITEM	DESCRIPTION	P07 PART NO	P110 PART NO.	QUANTITY J10	K10	J20	K20
1	Maximum Stop (Fig. 7)	S22-15467	S22-15467	1	1	—	—
	Maximum. Handwheel (Fig. 8)	S22-15448	S22-15448	—	—	1	1
2	*Low Torque Limiter (J10)(Fig. 11)	S22-15401	S22-15624	1	—	—	—
	*Low Torque Limiter (J20)(Fig. 11)	S22-15627	S22-15634	—	—	1	—
	*High Torque Limiter(K10)(Fig. 11)	S22-15629	S22-15631	—	1	—	
	*High Torque Limiter (K20)(Fig. 11)	S22-15635	S22-15636	—	—	—	1
3	Buck Up Cap (Fig. 9)	S22-15447	S22-15447	1	1	1	1
4	Screw-H.H.C., M12 x 55 mm	363-12205	363-12205	6	6	4	4
5	Screw-H.H.C., M12 x 80 mm	363-12220	363-12220	2	2	4	4
6	Control Piston	032-91836	032-91836	1	1	1	1
7	O-Ring, 90 S-1 ARP 013	691-00013	691-00013	2	2	2	2
8	O-Ring, 70 S-1 ARP 151	671-00151	671-00151	2	2	2	2
9	Piston ring	032-91816	032-91816	2	2	2	2

*Include items 1, 4, 5, 7 and 8

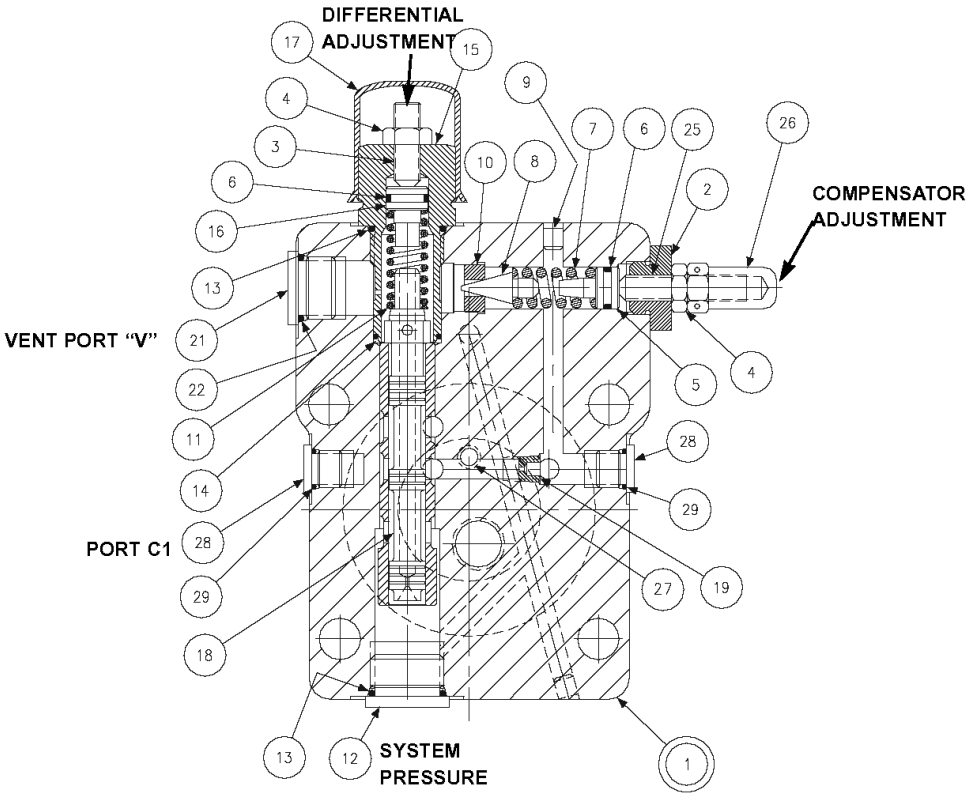


FIGURE 10
TORQUE LIMITER CAP

PARTS LIST FOR FIGURE 10
P07 torque limiter cap S22-15407
P110 torque limiter cap S22-15607

ITEM	DESCRIPTION	P07 PART NO.	QTY	P110 PART NO.	QTY
1	Cap-Sleeve Assembly	S22-15408	1	S22-15608	1
2	Adjusting Plug	032-91814	1	032-91814	1
3	Socket Setscrew 5/16-24 x 1	312-13160	1	312-13160	1
4	Nut, 5/16-24	335-13100	2	335-13100	2
5	Seal Piston	031-59367	1	031-59367	1
6	O-Ring, 90 S-1 ARP 012	691-00012	2	691-00012	2
7	Spring	032-91798	1	032-91798	1
8	Cone	036-12288	1	036-12288	1
9	Avseal Plug	447-00026	2	447-00026	2
10	Seat	036-11692	1	036-11692	1
11	Spring	033-71086	1	033-71086	1
12	Plug	488-35055	1	447-01008	1
13	O-Ring, 90 S-1 ARP 910	691-00910	2	691-00910	1
14	O-Ring, 90 S-1 ARP 017	691-00017	1	691-00017	1
15	Plug	031-57368	1	031-57368	1
16	Seal Piston	032-91305	1	032-91305	1
17	Cap	449-00612	1	449-00612	1
18	Spool	032-59482	1	032-59482	1
19	Orifice, .047", 1.19 mm.	033-25528	1	033-25528	1
21	Plug	488-35018	1	447-00032	1
22	O-ring, 70 S-1 ARP 908	691-00908	1	-	-
25	Setscrew 5/16-24 x 1-1/4	312-13180	1	312-13180	1
26	Nut, Acorn 5/16-24	036-33474	1	036-33474	1
27	O-Ring, 70 S-1 ARP 008	671-00008	1	671-00008	1
28	Plug	488-35061	2	447-01004	2
29	O-ring 90 S-1 ARP 904	691-00904	2	-	-

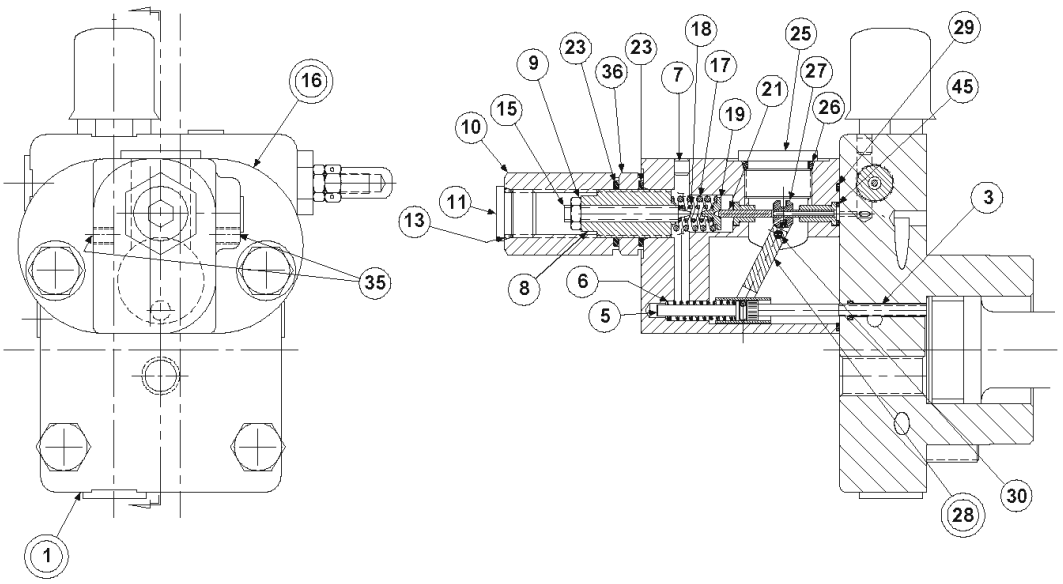


FIGURE 11

Torque Limiter

PARTS LIST FOR FIGURE 11

P07 code J10,J50 S22-15401
P07 code J20,J80 S22-15627
P07 code K10K50, S22-15629
P07 code K20K80, S22-15635
P110 code J10J50, S22-15624
P110 code J20,J80 S22-15634
P110 code K10K50, S22-15631
P110 code K20,K80 S22-15636

ITEM	DESCRIPTION	P07 PART NO.	P110 PART NO.	QTY. J	QTY. K
1	Cap (Figure 10)	S22-15407	S22-15607	1	1
3	Screw	032-91461	032-91461	1	1
5	Clevis pin	321-40000	321-40000	1	1
6	Spring, Compression	032-92100	032-92100	1	1
7	Plug, Avseal	447-00026	447-00026	1	1
8	Screw	032-91445	032-91445	1	1
9	Nut, Hex Jam 1/4-20 UNC	340-00038	340-00038	1	1
10	Hex Nut, 3/4-16 UNF	032-91449	032-91449	1	1
11	Plug, 8HP N-S	488-35018	488-35018	1	1
14	O-Ring, 90 S-1 ARP 908	691-00908	691-00908	1	1
15	Screw, Primary Adjusting	032-91446	032-91446	1	1
16	Body assembly	S22-15396	S22-15396	1	1
17	Outer Spring – J Version	032-91440	032-91440	1	—
	Outer Spring – K Version	032-91440	032-91440	—	1
18	Inner Spring – J Version	032-92240	032-92240	1	—
	Inner Spring – K Version	032-91441	032-91441	—	1
19	Spring Retainer	032-91819	032-91819	1	1
21	Spool	032-91438	032-91438	1	1
23	O-ring, 70 S-1 ARP 118	671-00118	671-00118	2	2
25	Plug, 12 HP5N-S	488-35014	488-35014	1	1
26	O-Ring, 90 S-1 ARP 912	691-00912	691-00912	1	1
27	Sleeve	032-91437	032-91437	1	1
28	Arm assembly	S22-15520	S22-15520	1	1
29	O-Ring, 70 S-1 ARP 035	671-00035	671-00035	1	1
30	Dowel Pin, 1/8 Dia. x 1.50 Lg.	324-20824	324-20824	1	1
35	Screw, SHC 10-32 x 1/4	312-09041	312-09041	2	2
36	Nut	032-91645	032-91645	1	1
45	O-Ring, 70 S-1 ARP 010	671-00010	671-00010	1	1

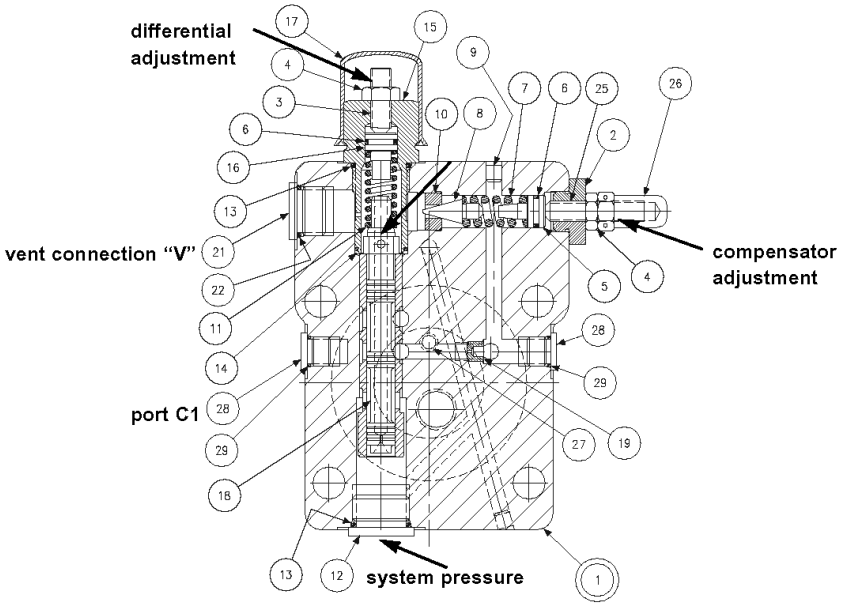
DISASSEMBLY

1. **See Figure 11.** Remove 2 screws holding torque limiter body (16) to cap assembly (1).
2. Remove all parts from torque limiter body (16) except pin (30) and arm assembly (28). It is not necessary to remove these parts unless broken or worn. Examine parts for wear or damage.
3. Remove screw (3). Examine head for excessive wear, and body for smooth sealing surface with O-ring.
4. Remove maximum stop handwheel assembly or maximum stop screw assembly.
5. Remove cap assembly (1).
6. **See Figure 10.** Remove plug (15) and attached parts. Remove spring (11) and spool (18).
7. Remove adjusting plug (2) and attached parts. Remove spring (7) and cone (8).
8. Do not remove sleeve in body (1). Sleeve is pressed into cap and finished to size. If sleeve or cap is worn, replace the cap-sleeve assembly (1).
9. Examine seat (10) for wear. Do not remove unless damaged.

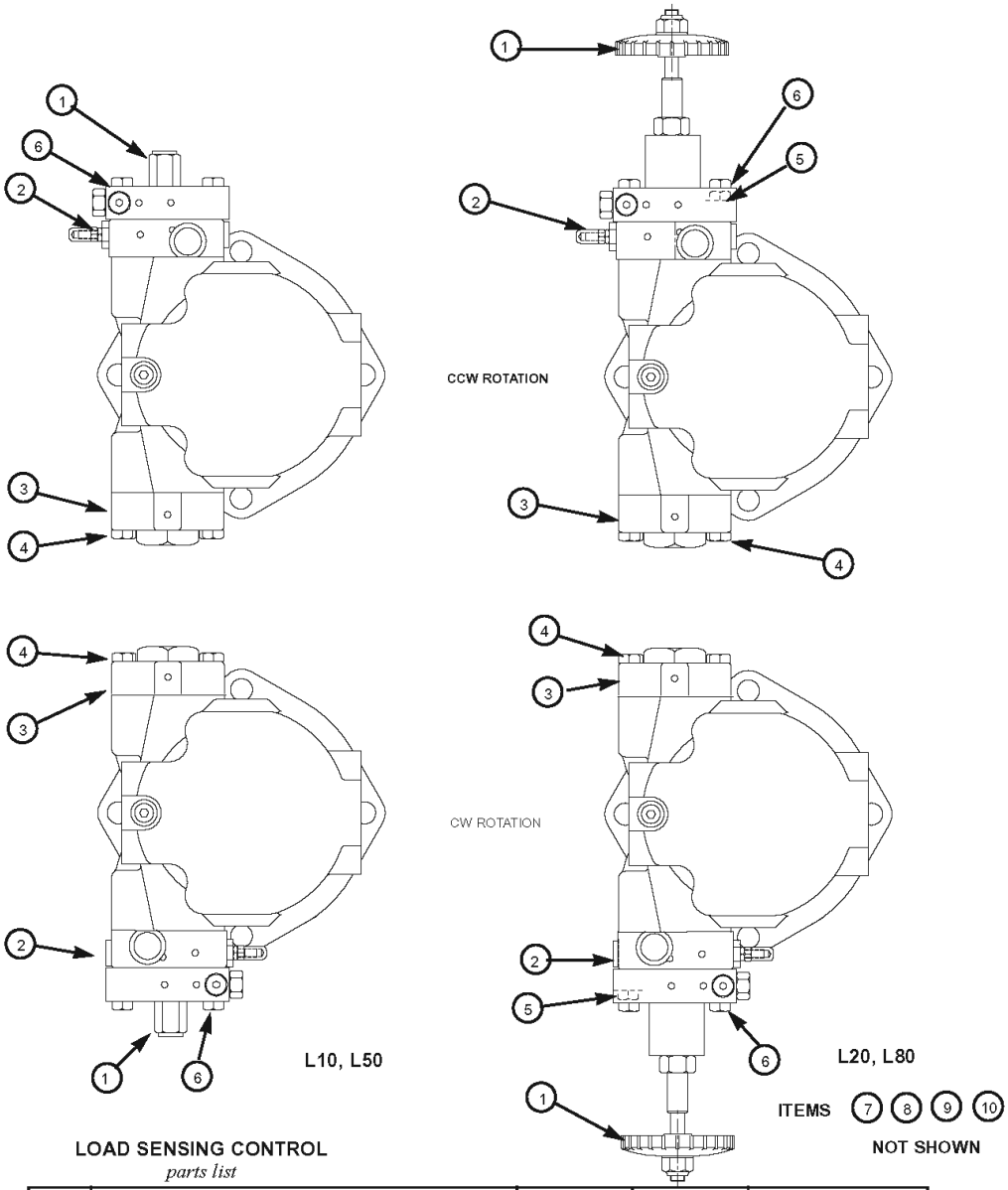
ASSEMBLY

See page 26 for tightening torque on plugs

1. **See Figure 10.** Install Avseal plugs (9) and .047", 1,19 mm. orifice (19) in body.
2. Press seat (10) into bore squarely against shoulder in bore.
3. Install spool (18) into bore as shown. Install spring (11) over end of spool. Install O-ring (6) on seal piston (16). Lubricate and install into plug (15). Install plug (15) into cap. Install screw (3), nut (4) and acorn nut (17). Install plug (12), (21) and (28). Torque plugs.
4. Install O-ring (6) on seal piston (5). Lubricate O-ring and Install cone (8), spring (7) and seal piston (5) into bore in cap (1), being careful that cone enters seat (10). Install adjusting plug (2), screw (25), nut (4) and acorn nut (26).
5. Carefully install O-ring (27) in the cap.
6. Note proper location for control cap (pg. 24). Install O-rings on interface between cap and pump control pad. Install cap, guiding control piston into bore. Torque mounting screws to 75 lb.•ft., 102 Nm.
7. Install maximum volume handwheel or screw assembly. Set stop to clear control piston.
8. **See Figure 11.** Apply thread locking compound on threads of screw (3), lubricate the shank, thread through the cap into the control piston, and torque to 5 lb.•ft., 6,8 Nm
9. Measure height from control cap to top of screw. With control piston at full displacement, dimension must be 1.50 +/- .03 in., 38,1 +/- 0,76 mm.
10. Press dowel (30) into body (16), through the link assembly (28), to 1/4", 6,35 mm below surface. Apply hydraulic sealant to threads of screws (35) and install over dowel (30).
11. While sleeve (27) is engaged into dowel on link (28), slide spool (21) into bore of body (16), and through sleeve (27). Spool (21) must move freely and easily at all positions of the link (28).
12. Assemble remaining parts per drawing. While spring retainer is engaging clevis pin (5) under dowel of link (28), slide the other opening of spring retainer over the top of the screw (3). Attach body assembly (16) to cap (1) and torque screws to 75 lb.•ft., 102 Nm.



Ref. Figure 10
Torque limiter cap



LOAD SENSING CONTROL
parts list

ITEM	DESCRIPTION	P07 PART NO.	P110 PART NO.	QTY. L10, L50	QTY. L20, L80
1	Maximum Volume Stop (Fig. 7)	S22-15467	S22-15467	1	—
	Maximum Volume Handwheel (Fig. 8)	S22-15448	S22-15448	—	1
2	*Load Sensing Control (L1*)(Fig. 12)	S22-15402	S22-15625	1	—
2	*Load Sensing Control (L2*)(Fig. 12)	S22-15628	S22-15637	—	1
3	Buck Up Cap (Fig. 9)	S22-15447	S22-15447	1	1
4	Screw-H.H.C.,M12 x 55 mm	363-12205	363-12205	6	4
5	Screw-H.H.C., M12 x 80 mm	363-12225	363-12225	—	2
6	Screw-H.H.C. M12 x 90 mm	363-12240	363-12240	2	2
7	Control Piston	032-91836	032-91836	1	1
8	O-Ring, 90 S-1 ARP 013	691-00013	691-00013	2	2
9	O-Ring, 70 S-1 ARP 151	671-00151	671-00151	2	2
10	Piston Ring	032-91816	032-91816	2	2

*Include items 1 (Maximum Volume Stop), 4, 6, 8 and 9

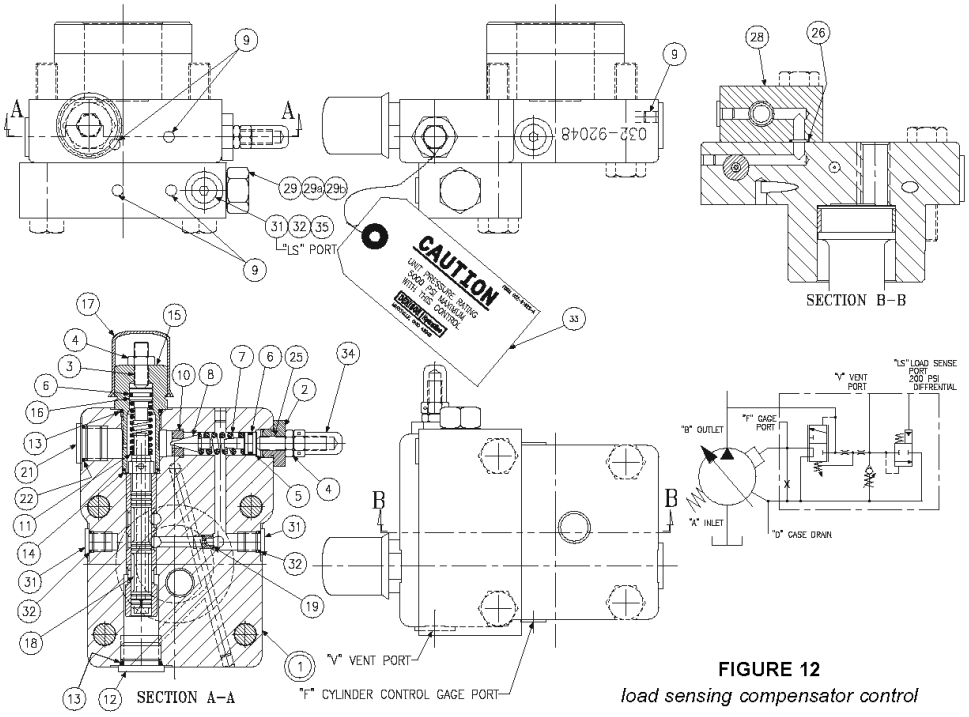


FIGURE 12
load sensing compensator control

PARTS LIST FOR FIGURE 12
LOAD SENSING COMPENSATOR
P07 L1 S22-15402*
P07 L2 S22-15628*
P110 L1 S22-15625*
P110 L2 S22-15637*

ITEM	DESCRIPTION	P07 PART NO.	P07 QTY	P110 PART NO.	P110 QTY
1	Cap-Sleeve Assembly	S22-15143	1	S22-15176	1
2	Adjusting Plug	032-91814	1	032-91814	1
3	Socket Setscrew	312-13160	1	312-13160	1
4	Nut, 5/16-24	335-13100	2	335-13100	2
5	Seal Piston	031-59367	1	031-59367	1
6	O-Ring, 90 S-1 ARP 012	691-00012	2	691-00012	2
7	Spring	032-91798	1	032-91798	1
8	Cone	036-12288	1	036-12288	1
9	Avseal Plug	447-00026	5	447-00026	5
10	Seat	036-11692	1	036-11692	1
11	Spring	033-71086	1	033-71086	1
12	Plug, SAE-8, 1/2 BSPP	488-35055	1	447-01008	1
13	O-Ring, 90 S-1 ARP 910	691-00910	2	691-00910	1
14	O-Ring, 90 S-1 ARP 017	691-00017	1	691-00017	1
15	Plug	031-57368	1	031-57368	1
16	Seal Piston	032-91305	1	032-91305	1
17	Cap	449-00612	1	449-00612	1
18	Spool	032-59482	1	032-59482	1
19	Orifice, .047", 1,19 mm.	033-25528	1	033-25528	1
21	Plug, SAE-10, 1/2 BSPP	488-35018	1	447-00032	1
22	O-Ring, 90 S-1 ARP 908	691-00908	1	-	-
25	Setscrew 5/16-24 x 1-1/4	312-13180	1	312-13180	1
26	O-Ring, 70 S-1 ARP 011	671-00011	2	671-00011	2
28	Body-Valve	032-91620	1	032-91620	1
29	Isolation Valve Cartridge	517-00063-5	1	517-00063-5	1
29-A	O-Ring 90 S-1 ARP 017	691-00017	2	691-00017	2
29-B	O-Ring 90 S-1 ARP 015	691-00015	1	691-00015	1
31	Plug, SAE-4, 1/4 BSPP	488-35061	2	447-01004	2
32	O-Ring, 90 S-1 ARP 904	691-00904	2	691-00904	1
33	Tag, Caution	032-91622	1	032-91622	1
34	Nut, Acorn	036-33474	1	036-33474	1
35	Adapter	-	-	032-91507	1

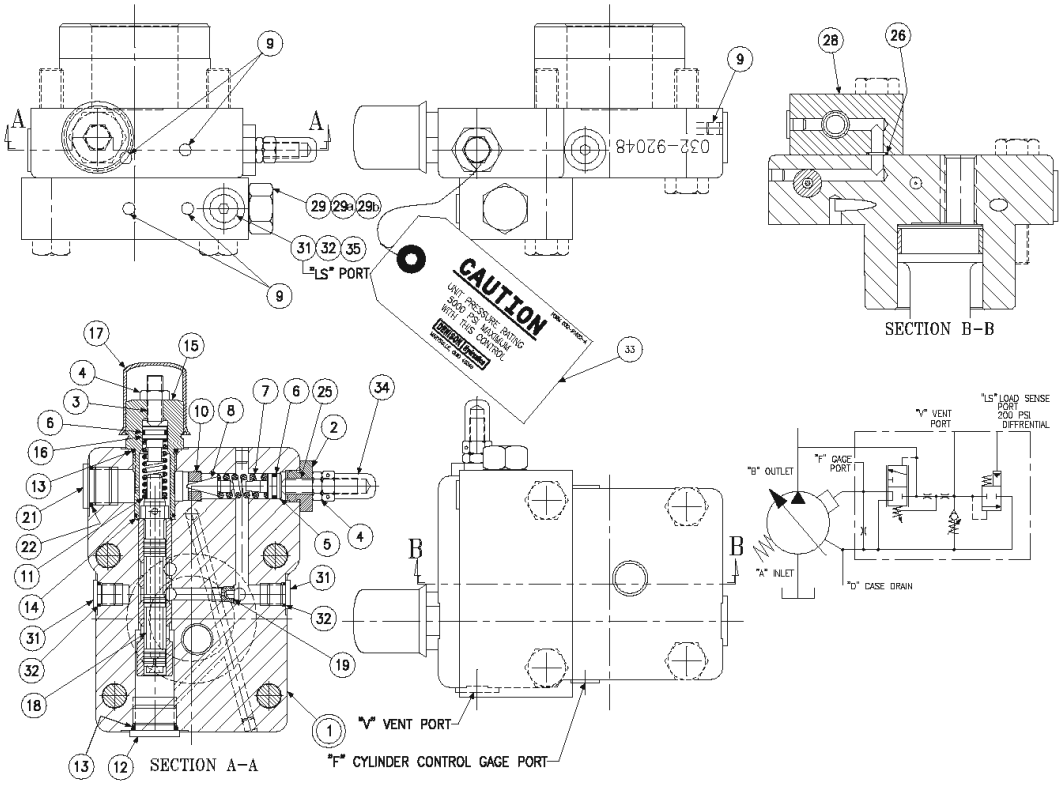
DISASSEMBLY

1. **See Figure 12** Back off maximum volume screw or handwheel to full displacement. Remove maximum volume assembly.
2. Remove bolts holding cap to pump.
3. Remove isolation valve (29) from block (28). Remove plug (15) and attached parts. Remove spring (11) and spool (18).
4. Remove adjusting plug (2) and attached parts. Remove seal piston (5). Note: a 10-24 screw may be used to assist in pulling the piston. Remove spring (7) and cone (8).
5. Do not remove sleeve in body (1). Sleeve is pressed into cap and finished to size. If sleeve or cap is worn, replace the cap-sleeve assembly (1).
6. Examine seat (10) for wear. Do not remove unless damaged.

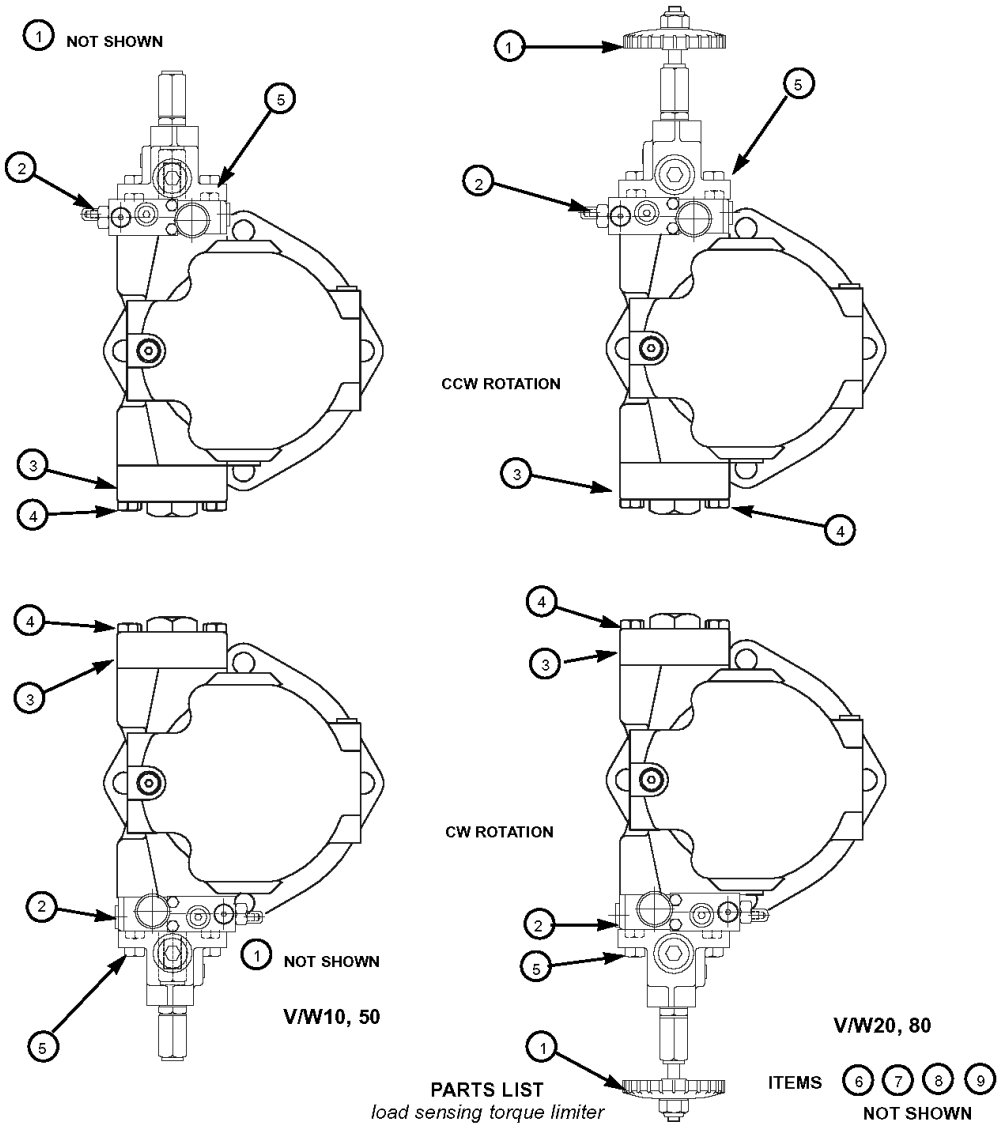
ASSEMBLY

See page 26 for tightening torque on plugs

1. Install Avseal plugs (9) and.047", 1,19 mm. orifice (19) in body.
2. Press seat (10) into bore squarely against shoulder in bore.
3. Install plug (12) and spool (18) into bore as shown. Install spring (11) over end of spool. Install O-ring (6) on seal piston(16). Lubricate and install into plug (15). Install plug (15) into cap. Install screw (3), nut (4) and cover (17).
4. Install O-ring (6) on seal piston (5).
5. Lubricate O-ring and install cone (8), spring (7) and seal piston into bore in cap (1), being careful that cone enters seat (10). Install remaining parts in body (1).
6. Install O-rings (29-a) and (29-b) on valve (29). See Figure 13, page 40. Observe that backup ring on inside groove is toward the outside, the one on the middle groove is toward the inside, and the one on the outside groove is toward the outside. Lubricate and install valve (29) in block (28), being careful to avoid damaging the O-rings. Torque to 50 lb.• ft., 67,8 Nm.
7. For the P110 only, install O-ring (32) on adapter (35). Install adapter in block (28). Install plug (31) in adapter (35). For the P07 only, install O-ring (32) on plug (31). Install plug (31) in block (28).
8. Note proper location for cap on pump (page 24). Install O-rings on interface between cap and pump control pad. Install O-rings (26) in block (28).
9. Install on pump control pad, guiding the control piston into the bore. Install maximum volume stop parts.
10. Torque mounting bolts to 75 lb.• ft., 102 Nm.



Ref. Figure 12
load sensing compensator control



PARTS LIST
load sensing torque limiter

ITEM	DESCRIPTION	P07 PART NO	P110 PART NO.	QUANTITY V10*	W10*	V20**	W20**
1	Maximum Volume Stop (Fig. 7)	S22-15467	S22-15467	1	1	—	—
	Maximum Volume Handwheel (Fig. 8)	S22-15448	S22-15448	—	—	1	1
2	***Low Torque Limiter Load Sensing (V10)(Fig. 13)	S22-16186	S22-16188	1	—	—	—
2	***Low Torque Limiter Load Sensing (V20)(Fig. 13)	S22-16195	S22-16196	—	—	1	—
	***High Torque Limiter Load Sensing (W10)(Fig. 13)	S22-16187	S22-16189	—	1	—	—
	***High Torque Limiter Load Sensing (W20)(Fig. 13)	S22-16197	S22-16198	—	—	—	1
3	Buck Up Cap (Fig. 9)	S22-15447	S22-15447	1	1	1	1
4	Screw-H.H.C., M12 x 55 mm	363-12205	363-12205	6	6	4	4
5	Screw-H.H.C., M12 x 80 mm	363-12225	363-12225	2	2	4	4
6	Control Piston	032-91836	032-91836	1	1	1	1
7	O-Ring, 90 S-1 ARP 013	691-00013	691-00013	2	2	2	2
8	O-Ring, 70 S-1 ARP 151	671-00151	671-00151	2	2	2	2
9	Piston ring	032-91816	032-91816	2	2	2	2

* Also V50, W50 **Also V80, W80 ***Includes items 1, 4, 5, 7 and 8

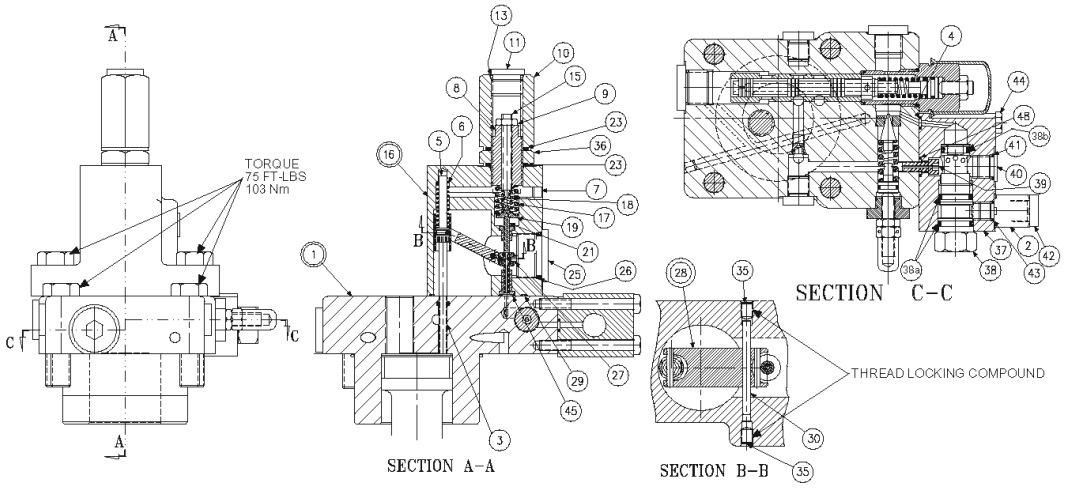


FIGURE 13

Load Sensing Torque Limiter

PARTS LIST FOR FIGURE 13
P07 code V10, V50, S22-16186
P07 code W10, W50, S22-16187
P110 code V10, V50, S22-16188
P110 code W10, W50, S22-16189

ITEM	DESCRIPTION	P07 PART NO.	P110 PART NO.	QTY. V	QTY. W
1	Cap (Figure 14)	S22-16177	S22-16179	1	1
2	Adapter	-	032-91507	1	1
3	Screw	032-91461	032-91461	1	1
5	Clevis pin	321-40000	321-40000	1	1
6	Spring, Compression	032-92100	032-92100	1	1
7	Plug, Avseal	447-00026	447-00026	1	1
8	Screw	032-91445	032-91445	1	1
9	Nut, Hex Jam 1/4-20 UNC	340-00038	340-00038	1	1
10	Hex Nut, 3/4-16 UNF	032-91449	032-91449	1	1
11	Plug, SAE-8	488-35018	488-35018	1	1
13	O-Ring, 90 S-1 ARP 908	691-00908	691-00908	1	1
15	Screw, Primary Adjusting	032-91446	032-91446	1	1
16	Body assembly	S22-15396	S22-15396	1	1
17	Outer Spring – V Version	032-91440	032-91440	1	—
	Outer Spring – W Version	032-91440	032-91440	—	1
18	Inner Spring – V Version	032-92240	032-92240	1	—
	Inner Spring – W Version	032-91441	032-91441	—	1
19	Spring Retainer	032-91819	032-91819	1	1
21	Spool	032-91438	032-91438	1	1
23	O-ring, 70 S-1 ARP 118	671-00118	671-00118	2	2
25	Plug, 12 SAE-12	488-35014	488-35014	1	1
26	O-Ring, 90 S-1 ARP 912	691-00912	691-00912	1	1
27	Sleeve	032-91437	032-91437	1	1
28	Arm assembly	S22-15520	S22-15520	1	1
29	O-Ring, 70 S-1 ARP 035	671-00035	671-00035	1	1
30	Dowel Pin, 1/8 Dia. x 1.50 Lg.	324-20824	324-20824	1	1
35	Screw, SHC 10-32 x 1/4	312-09041	312-09041	2	2
36	Nut	032-91645	032-91645	1	1
37	Body, load sense	032-92359	032-92359	1	1
38	Valve, modulating	517-00063-5	517-00063-5	1	1
38a	O-ring, 90 S-1 ARP 017	691-00017	691-00017	2	2
38b	O-ring, 90 S-1 ARP 015	691-00015	691-00015	1	1
39	Screw, special	033-70908	033-70908	1	1
40	Plug, SAE-6	488-35003	488-35003	1	1
41	O-ring, 90 S-1 ARP 906	691-00906	691-00906	1	1
42	Plug, SAE-4, 1/4 BSPP	488-35013	447-01004	1	1
43	O-ring, 90 S-1 ARP 904	691-00904	691-00904	1	1
44	Screw, HHC, 1/4-20x2-1/4	306-40187	306-40187	2	2
45	O-Ring, 70 S-1 ARP 010	671-00010	671-00010	1	1
48	O-Ring, 70 S-1 ARP 012	671-00012	671-00012	1	1

DISASSEMBLY

1. **See Figure 13.** Remove 2 screws holding torque limiter body (16) to cap assembly (1).
2. Remove all parts from torque limiter body (16) except pin (30) and arm assembly (28). It is not necessary to remove these parts unless broken or worn. Examine parts for wear or damage.
3. Remove screw (3). Examine head for excessive wear, and body for smooth sealing surface with O-ring.
4. Remove maximum stop handwheel assembly or maximum stop screw assembly.
5. Remove modulating valve (38) from body (37). Remove body (37) from cap assembly (1) Note plug (40) must be removed to remove special screw (39). Remove cap assembly (1).
1. **See Figure 14**. Remove plug (15) and attached parts. Remove spring (11) and spool (18).
2. Remove adjusting. plug (2) and attached parts. Remove seal piston (5). Note: a 10-24 screw may be used to assist in pulling the piston. Remove spring (7) and cone (8).
3. Do not remove sleeve in body (1). Sleeve is pressed into cap and finished to size. If sleeve or cap is worn, replace the cap-sleeve assembly (1).
4. Examine seat (10) for wear. Do not remove unless damaged.

ASSEMBLY

See page 26 for tightening torque on plugs

1. **See Figure 14.** Install Avseal plug (9) and .047", 1,19 mm. orifice (19) in body.
2. Press seat (10) into bore squarely against shoulder in bore.
3. Install plug (12) and spool (18) into bore as shown. Install spring (11) over end of spool. Install O-ring (6) on seal piston(16). Lubricate and install into plug (15). Install plug (15) into cap. Install screw (3), nut (4) and cover (17).
4. Install O-ring (6) on seal piston (5).
5. Lubricate O-ring and install cone (8), spring (7) and seal piston into bore in cap (1), being careful that cone enters seat (10). Install remaining parts in body (1)
6. Note proper location for cap on pump (pg.24). Install O-rings on interface between cap and pump control pad
7. Install on pump control pad, guiding the control piston into the bore. Install maximum volume stop or handwheel parts.
8. **See Figure 13.** Install block (37) on cap (1) with O-rings (4) and (48). Use special screw (39) through the block.
7. Install O-rings (38a) and (38b) on valve (38). Observe that backup ring on inside groove is toward the outside, the one on the middle groove is toward the inside, and the one on the outside groove is toward the outside. Lubricate and install valve (38) in block (37), being careful to avoid damaging the O-rings. Torque to 50 lb.• ft., 67,8 Nm.
7. For the P110 only, install O-ring (43) on adapter (2). Install adapter in block (37). Install plug (31) in adapter (35). For the P07 only, install O-ring (43) on plug (42). Install plug (42) in block (37).
8.. Apply thread locking compound on threads of screw (3), lubricate the shank, thread through the cap into the control piston, and torque to 5 lb.•ft., 6,8 Nm
9. Measure height from control cap to top of screw. With control piston at full displacement, dimension must be 1.50 +/- .03 in., 38,1 +/- 0,76 mm.
10. Press dowel (30) into body (16), through the link assembly (28), to 1/4", 6,35 mm below surface. Apply hydraulic sealant to threads of screws (35) and install over dowel (30).
11. While sleeve (27) is engaged into dowel on link (28), slide spool (21) into bore of body (16), and through sleeve (27). Spool (21) must move freely and easily at all positions of the link (28).
12. Assemble remaining parts per drawing. While spring retainer is engaging clevis pin (5) under dowel of link (28), slide the other opening of spring retainer over the top of the screw (3). Attach body assembly (16) to cap (1) and torque mounting screws to 75 lb.•ft., 102 Nm.

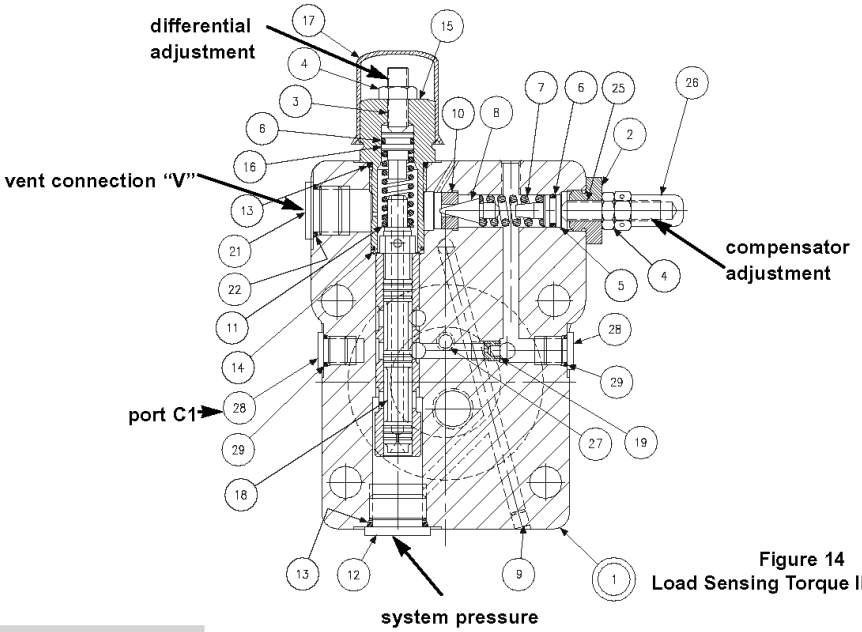
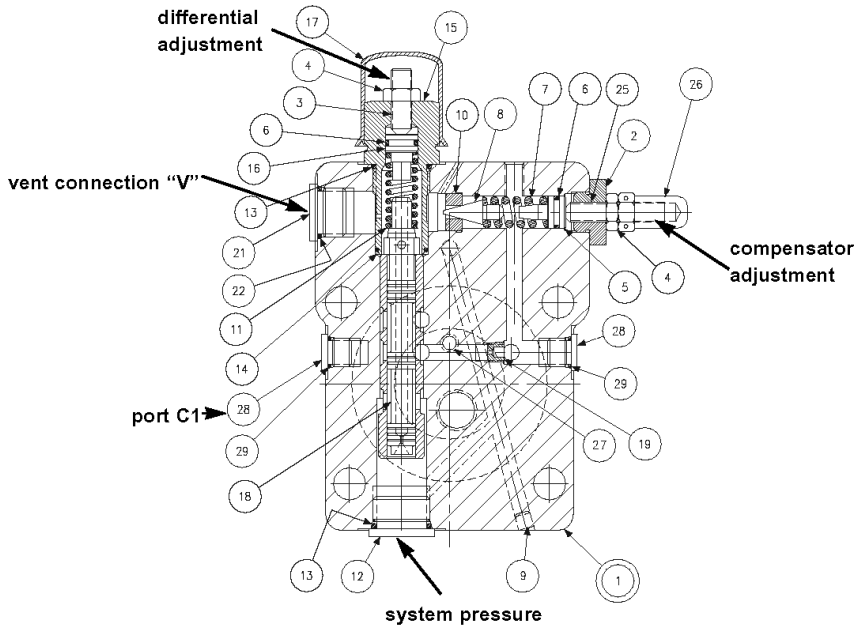


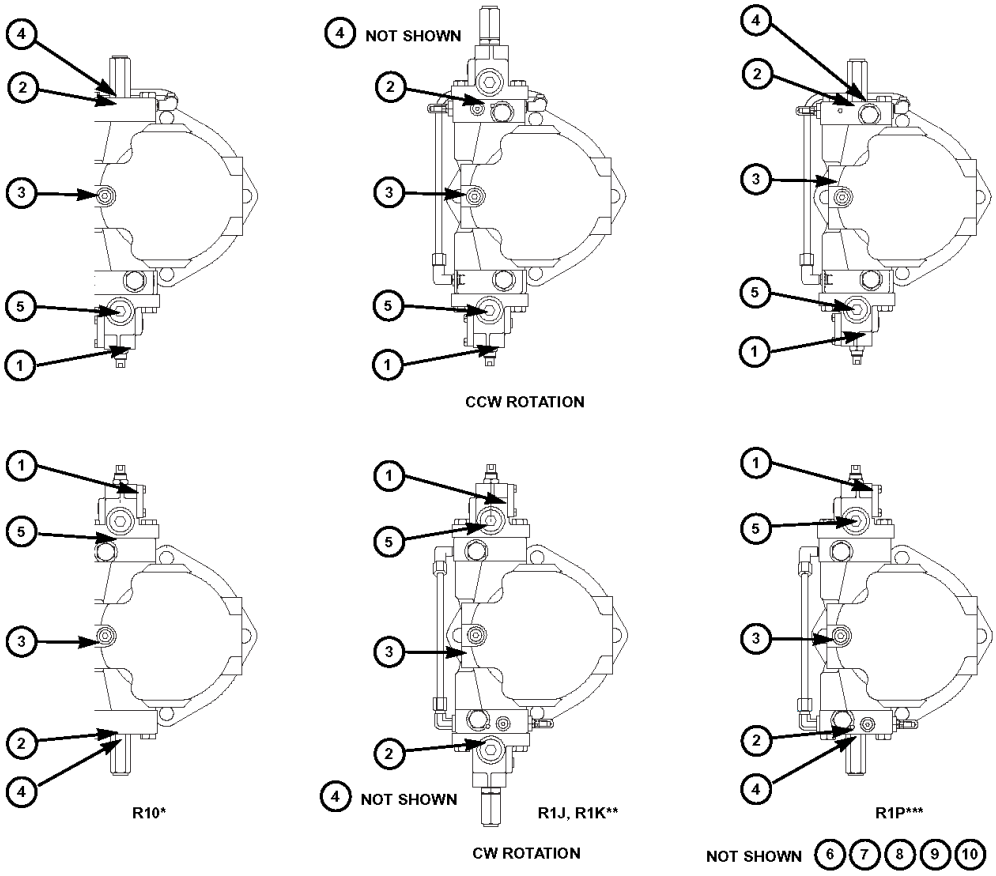
Figure 14
Load Sensing Torque limiter cap



Ref. Figure 14
Load Sensing Torque limiter cap

PARTS LIST FOR FIGURE 14
P07 load sensing torque limiter cap
S22-16177
P110 load sensing torque limiter cap
S22-16179

ITEM	DESCRIPTION	P07 PART NO.	P07 QTY	P110 PART NO.	P110 QTY
1	Cap-Sleeve Assembly	S22-16178	1	S22-16180	1
2	Adjusting Plug	032-91814	1	032-91814	1
3	Socket Setscrew 5/16-24 x 1	312-13160	1	312-13160	1
4	Nut, 5/16-24	335-13100	2	335-13100	2
5	Seal Piston	031-59367	1	031-59367	1
6	O-Ring, 90 S-1 ARP 012	691-00012	2	691-00012	2
7	Spring	032-91798	1	032-91798	1
8	Cone	036-12288	1	036-12288	1
9	Avseal Plug	447-00026	1	447-00026	1
10	Seat	036-11692	1	036-11692	1
11	Spring	033-71086	1	033-71086	1
12	Plug	488-35055	1	447-01008	1
13	O-Ring, 90 S-1 ARP 910	691-00910	2	691-00910	1
14	O-Ring, 90 S-1 ARP 017	691-00017	1	691-00017	1
15	Plug	031-57368	1	031-57368	1
16	Seal Piston	032-91305	1	032-91305	1
17	Cap	449-00612	1	449-00612	1
18	Spool	032-59482	1	032-59482	1
19	Orifice, .047", 1.19 mm.	033-25528	1	033-25528	1
21	Plug	488-35018	1	447-00032	1
22	O-ring, 70 S-1 ARP 908	691-00908	1	-	-
25	Setscrew, 5/16-24 x 1-1/4	312-13180	1	312-13180	1
26	Nut, Acorn 5/16-24	036-33474	1	036-33474	1
27	O-Ring, 70 S-1 ARP 008	671-00008	1	671-00008	1
28	Plug	488-35061	2	447-01004	2
29	O-ring 90 S-1 ARP 904	691-00904	2	-	-



PARTS LIST

rotary servo

ITEM	DESCRIPTION	P07 PART NO.	P110 PART NO.	QUANTITY R10*	R1J**	R1K**	R1P***
1	#Rotary Servo (Fig. 15)	S22-16200	S22-16199	1	1	1	1
2	#Control Cap (Fig.26)	S22-15325	S22-15613	1	—	—	—
	#Low Torque Override (Fig. 29)	S22-16207	S22-16208	—	1	—	—
	#High Torque Override (Fig. 29)	S22-16209	S22-16210	—	—	1	—
	#Compensator Override (Fig. 27)	S22-16205	S22-16206	—	—	—	1
3	Tube Assembly, CW rotation (Fig. 24)	S22-16035	S22-16037	1	1	1	1
	Tube Assembly, CCW rotation (Fig. 25)	S22-16036	S22-16038				
4	Screw-H.H.C., M12 x 55 mm	363-12205	363-12205	6	4	4	6
5	Screw-H.H.C., M12 x 80 mm	363-12225	363-12225	2	4	4	2
6	Control Piston	032-91848	032-91848	1	1	1	1
7	O-Ring, 90 S-1 ARP 013	691-00013	691-00013	2	2	2	2
8	O-Ring, 70 S-1 ARP 151	671-00151	671-00151	2	2	2	2
9	Piston Ring	032-91816	032-91816	1	1	1	1
10	Piston Ring	032-91811	032-91811	1	1	1	1

*Also R50
**Also R5J, R5K
***Also R5P
#Includes items 4, 5, 7 and 8

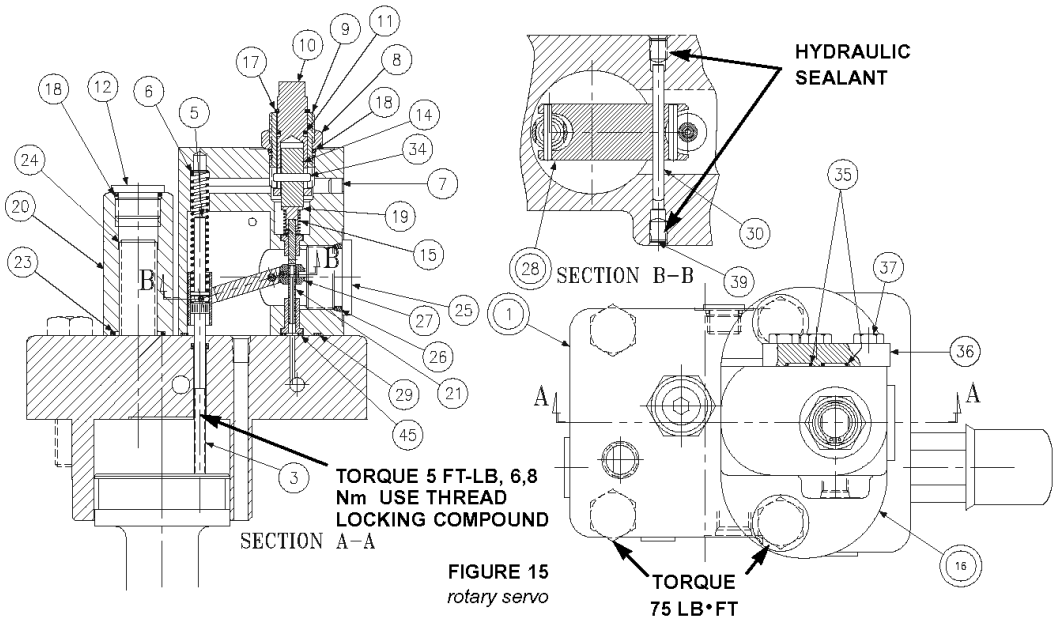


FIGURE 15
rotary servo

PARTS LIST FOR FIGURE 15
ROTARY SERVO
P07 S22-16200
P110 S22-16199

ITEM	DESCRIPTION	P07 PART NO.	P07 QTY.	P110 PART NO.	P110 QTY.
1	Cap (Figure 16)	S22-16063	1	S22-16064	1
3	Screw	032-91461	1	032-91461	1
5	Pin, Clevis	321-40000	1	321-40000	1
6	Spring, Compression	032-92100	1	032-92100	1
7	Plug, Avseal	447-00026	1	447-00026	1
8	Locknut	492-15116	1	492-15116	1
9	Cam	032-91515	1	032-91515	1
10	Shaft	032-91514	1	032-91514	1
11	O-Ring, 90 S-1 ARP 012	691-00012	1	691-00012	1
12	Plug, 10HP5N-S	488-35055	1	488-35055	1
13	O-Ring, 90 S-1 ARP 910	691-00910	1	691-00910	1
14	Slide Pin	032-91513	1	032-91513	1
15	Spring	225-92105	1	225-92105	1
16	Body	S22-15393	1	S22-15393	1
17	Retaining Ring	356-31050	1	356-31050	1
18	O-Ring, 90 S-1 ARP 908	691-00908	1	691-00908	1
19	Spring Retainer	032-91516	1	032-91516	1
20	Nut, M16	032-91822	1	031-91049	1
21	Spool	032-91438	1	032-91438	1
23	O-Ring, 70 S-1 ARP 118	671-00115	1	671-00115	1
24	Setscrew, M16(2P)x80mm	311-50001	1	311-50001	1
25	Plug, 12 HP5N-S	488-35014	1	488-35014	1
26	O-Ring, 90 S-1 ARP 912	691-00912	1	691-00912	1
27	Sleeve	032-91437	1	032-91437	1
28	Arm assembly	S22-15520	1	S22-15520	1
29	O-Ring, 70 S-1 ARP 035	671-00035	1	671-00035	1
30	Dowel Pin, 1/8 Dia x 1.50 Lg.	324-20824	1	324-20824	1
33	O-Ring, 70 S-1 ARP 904	671-00904	1	671-00904	1
34	Dowel Pin, 1/8 x 5/8	324-20810	1	324-20810	1
35	O-Ring, 70 S-1 ARP 011	671-00011	2	671-00011	2
36	Plate	032-91510	1	032-91510	1
37	Screw, HHC,1/4-20 x 3/4	306-40142	3	306-40142	3
38	Plug, SAE-4	488-35061	1	488-35061	1
39	Screw, SHC 10-32 x 1/4	312-09041	2	312-09041	2
45	O-Ring, 70 S-1 ARP 010	671-00010	1	671-00010	1

DISASSEMBLY

1. **See Figure 15.** Remove 2 screws holding body (16) to cap assembly (1).
2. Remove all parts from body (16) except pin (30) and arm assembly (28). It is not necessary to remove these parts unless broken or worn. Examine parts for wear or damage.
3. Remove screw (3). Examine head for excessive wear, and body for smooth sealing surface with O-ring.
4. **See Figure 16.** Remove tube lines to cap assembly.
5. Remove screws holding cap assembly to pump body.
6. Remove cap assembly (1). Remove plug (4) with attached parts. Remove spring (11) and spool (6).
7. Do not remove sleeve in body (1). Sleeve is pressed into cap and finished to size. If sleeve or cap is worn, replace the cap-sleeve assembly (1).
8. Remove screw (13) and nut (14). Push a rod through the cap to remove the retainer (7).

ASSEMBLY

See page 26 for tightening torque on plugs

1. **See Figure 16.** Install Avseal plug (9) in cap.
2. Install spool (6) into bore as shown. Install spring (11) over end of spool.
3. Install O-ring (8) on spring retainer (7). Install retainer (7), screw (13) and nut (14) in plug (4).
4. Install O-rings (10) and (15) on plug (4). Install plugs (4) and (12) in body (1). Install .047", 1,19 mm orifice (19), and .071", 1,98 mm orifice (20), and plugs (2) and (17). Torque plugs. Install O-ring (21) in cap.
5. Turn screw (13) in until spring retainer (17) contacts spring (11). Turn an additional 1-1/2 turns and lock in position.
6. Note proper location for control on pump (pg. 24). Install O-rings on interface between cap and pump control pad. Install cap on pump control pad, guiding the control piston into the bore.
7. Torque two assembly bolts to 75 lb.•ft., 102 N m.
8. **See Figure 15.** Apply thread sealing compound on threads of screw (3), lubricate the shank, thread through the cap into the control piston, and torque to 5 lb.• ft., 6,78 N m.
9. Install minimum stop screw (24) and turn clockwise to by two springs, one which is always in contact with the pin, and the other comes in contact as pressure increases, to provide an increase in spring rate as pressure increases. Stroke pump to full displacement.. Measure height from control cap to top of screw (3). With control piston at full displacement, dimension must be ..74 +/- .03 in., 18,8 +/- 0,76 mm.
   Back out minimum stop screw (24) till there is no contact with control piston.
10. Press dowel (30) into body (16), through the link (28), to 1/4 in., 6,35 mm below surface. Apply hydraulic sealant to threads of screws (39) and install over dowel (30).
11. Press spool (21) into retainer (19). Caution: do not use excessive force.
12. While sleeve (27) is engaged into dowel on link (28), slide above spool assembly with spring (15) into bore of body (16), and through sleeve (27). Spool (21) must move freely and easily at all positions of the link (28).
13. Press dowel (34) through slide pin (14), while inside shaft (10). Dowel (34) must evenly extend from both sides of slide pin (14).
14. Assemble all other components into body (16) per Figure 15. Torque plug (12)
15. While spring retainer is engaging clevis pin (5) under dowel of link (28), slide the other opening of spring retainer over the top of the screw (3). Attach body assembly (16) to cap (1) with two screws and torque to 75 lb.• ft., 103 N m.

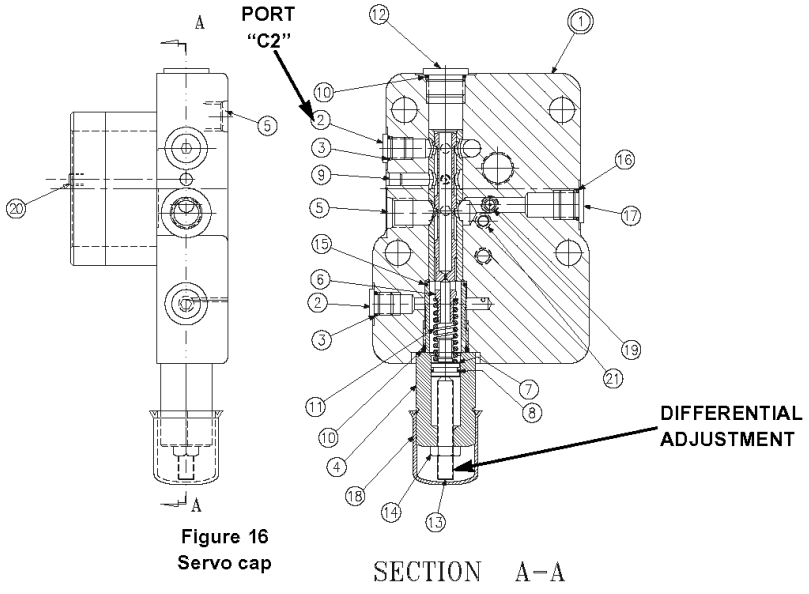
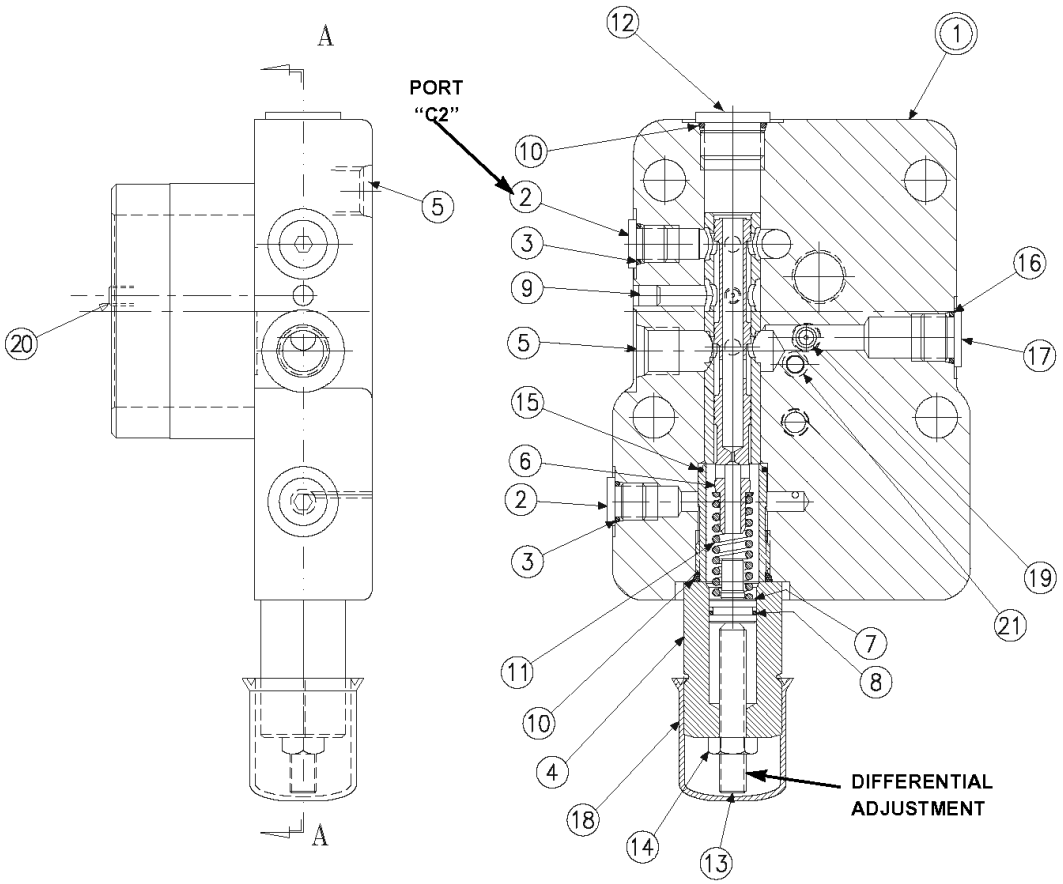


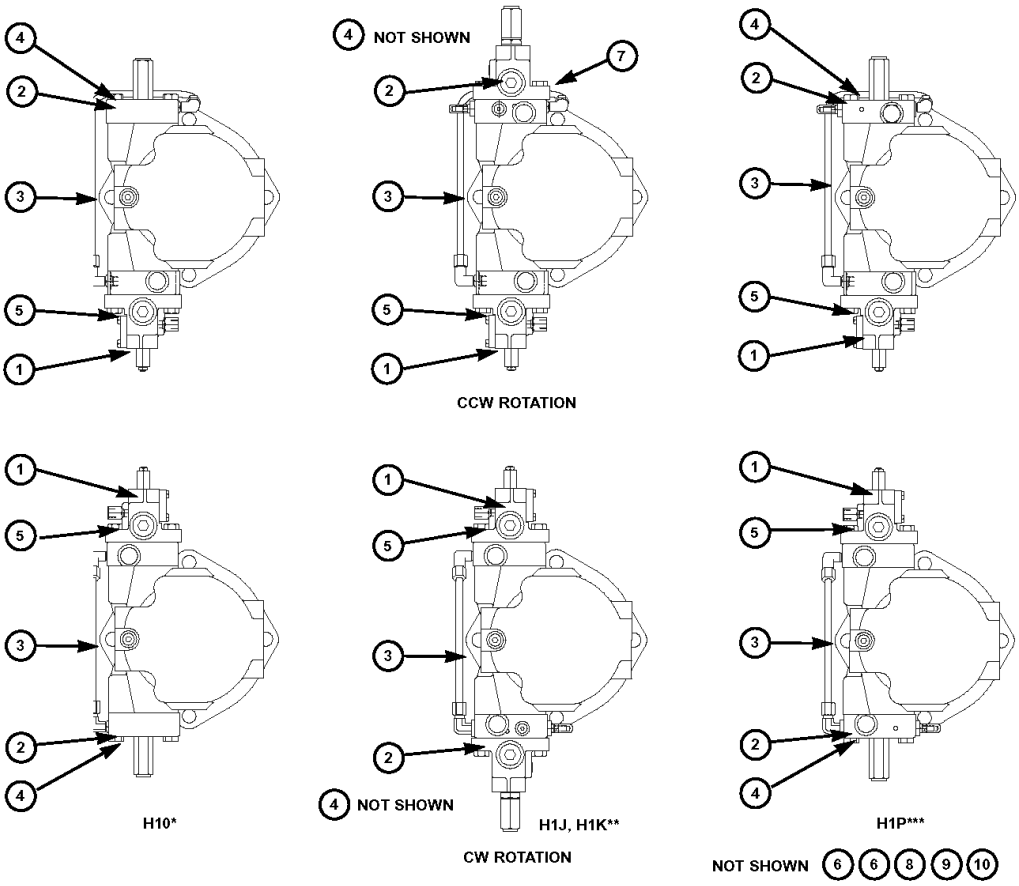
Figure 16
Servo cap



Ref. Figure 16
Servo cap

PARTS LIST FOR FIGURE 16
P07 servo cap S22-16063
P110 servo cap S22-16064

ITEM	DESCRIPTION	P07 PART NO.	P07 QTY	P110 PART NO.	P110 QTY.
1	Cap/Sleeve	S22-16065	1	S22-16066	1
2	Plug, SAE-4, 1/4 BSPP	488-35061	2	447-01004	1
3	O-ring, 90 S-1 ARP 904	691-00904	2	--	-
4	Plug	032-91861	1	032-91861	1
5	Plug	449-00015	1	449-00599	1
6	Spool	032-92409	1	032-92409	1
7	Spring retainer	032-92550	1	032-92550	1
8	O-Ring, 90 S-1 ARP 013	691-00013	1	691-00013	1
9	Avseal Plug	447-00026	1	447-00026	1
10	O-Ring, 90 S-1 ARP 910	691-00910	2	691-00910	1
11	Spring	032-92098	1	032-92098	1
12	Plug, SAE-10, 1/2 BSPP	488-35018	1	447-01008	1
13	Screw, 5/16 -24 x 2	312-35062	1	312-35062	1
14	Nut, 5/16-24	335-13100	1	335-13100	1
15	O-Ring, 90 S-1 ARP 017	691-00017	1	691-00017	1
16	O-Ring, 90 S-1 ARP 906	691-00906	1	--	
17	Plug, SAE-6, 3/8 BSPP	488-35041	1	447-00032	1
18	Cap	449-00612	1	449-00612	1
19	Orifice, .047", 1,19 mm	033-25528	1	033-25528	1
20	Orifice, .078", 1,98 mm	032-92399	1	032-92399	1
21	O-Ring, 70 S-1 ARP 008	671-00008	1	671-00008	1



PARTS LIST
hydraulic stroker

ITEM	DESCRIPTION	P07 PART NO.	P110 PART NO.	QUANTITY H10*	H1J**	H1K**	H1P***
1	#Hydraulic Stroker (Fig. 17)	S22-16202	S22-16201	1	1	1	1
2	#Control Cap (Fig.26)	S22-15325	S22-15613	1	—	—	—
	#Low Torque Override (Fig. 29)	S22-16207	S22-16208	—	1	—	—
	#High Torque Override (Fig. 29)	S22-16209	S22-16210	—	—	1	—
	#Compensator Override (Fig. 27)	S22-16205	S22-16206	—	—	—	1
3	Tube Assembly, CW rotation (Fig. 24)	S22-16035	S22-16037	1	1	1	1
	Tube Assembly, CCW rotation (Fig. 25)	S22-16036	S22-16038				
4	Screw-H.H.C., M12 x 55 mm	363-12205	363-12205	6	4	4	6
5	Screw-H.H.C., M12 x 80 mm	363-12225	363-12225	2	4	4	2
6	Control Piston	032-91848	032-91848	1	1	1	1
7	O-Ring, 90 S-1 ARP 013	691-00013	691-00013	2	2	2	2
8	O-Ring, 70 S-1 ARP 151	671-00151	671-00151	2	2	2	2
9	Piston Ring	032-91816	032-91816	1	1	1	1
10	Piston Ring	032-91811	032-91811	1	1	1	1

*Also H50
**Also H5J, H5K
***Also H5P
#Includes items 4, 5, 7 and 8

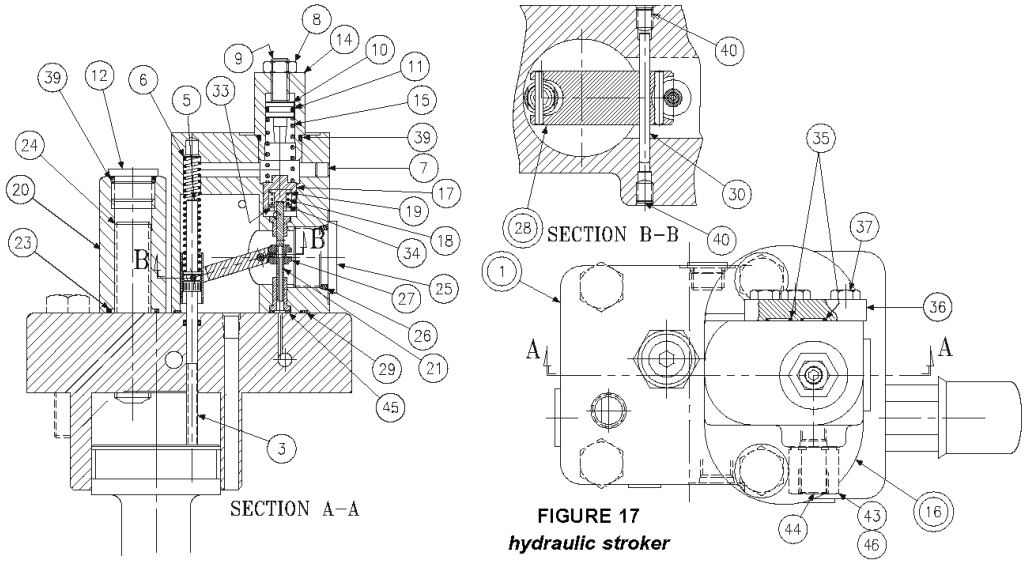


FIGURE 17
hydraulic stroker

PARTS LIST FOR FIG. 17
P 07 hydraulic stroker S22-16202
P 110 hydraulic stroker S22-16201

ITEM	DESCRIPTION	P07 PART NO.	QTY.	P110 PART NO.	QTY
1	Cap (Figure 16)	S22-16063	1	S22-16064	1
3	Screw	032-91461	1	032-91461	1
5	Clevis pin	321-40000	1	321-40000	1
6	Spring, Compression	032-92100	1	032-92100	1
7	Plug, Avseal	447-00026	1	447-00026	1
8	Nut, 5/16-24	335-13100	1	335-13100	1
9	Setscrew, 5/16-24 x 1-1/4	312-13180	1	312-13180	1
10	Seal Piston	032-91918	1	032-91918	1
11	O-Ring, 90 S-1 ARP 012	691-00012	1	691-00012	1
12	Plug, 10HP5N-S	488-35055	1	488-35055	1
14	Spring Cap	032-91511	1	032-91511	1
15	Spring	225-92101	1	225-92101	1
16	Body	S22-15393	1	S22-15393	1
17	Spool	032-91512	1	032-91512	1
18	Spring	225-92109	1	225-92109	1
19	Spring Retainer	032-91516	1	032-91516	1
20	Nut, 3/4-10	031-91049	1	031-91049	1
21	Spool	032-91438	1	032-91438	1
23	O-Ring,70 S-1 ARP 118	671-00118	1	671-00118	1
24	Socket Setscrew, 3/4-10 x 3	311-26320	1	311-26320	1
25	Plug, SAE-12	488-35014	1	488-35014	1
26	O-Ring, 90 S-1 ARP 912	691-00912	1	691-00912	1
27	Sleeve	032-91437	1	032-91437	1
28	Arm assembly	S22-15520	1	S22-15520	1
29	O-Ring, 70 S-1 ARP 035	671-00035	1	671-00035	1
30	Dowel Pin, 1/8 Dia x 1.50 Lg.	324-20824	1	324-20824	1
33	Retaining, Ring	356-30037	1	356-30037	1
34	Washer	032-91517	1	032-91517	1
35	O-Ring, 70 S-1 ARP 011	671-00011	2	671-00011	2
36	Plate	032-91510	1	032-91510	1
37	Screw, HHC,1/4-20 x 3/4	306-40142	3	306-40142	3
39	O-Ring, 90 S-1 ARP 908	691-00908	1	691-00908	1
40	Screw, SHC 10-32 x 1/4	312-09041	2	312-09041	2
43	Fitting	-	-	032-91507	1
44	Seal	-	-	449-00603	1
45	O-Ring, 70 S-1 ARP 010	671-00010	1	671-00010	1
46	O-ring, 90 S-1 ARP 904	-	-	691-00904	1

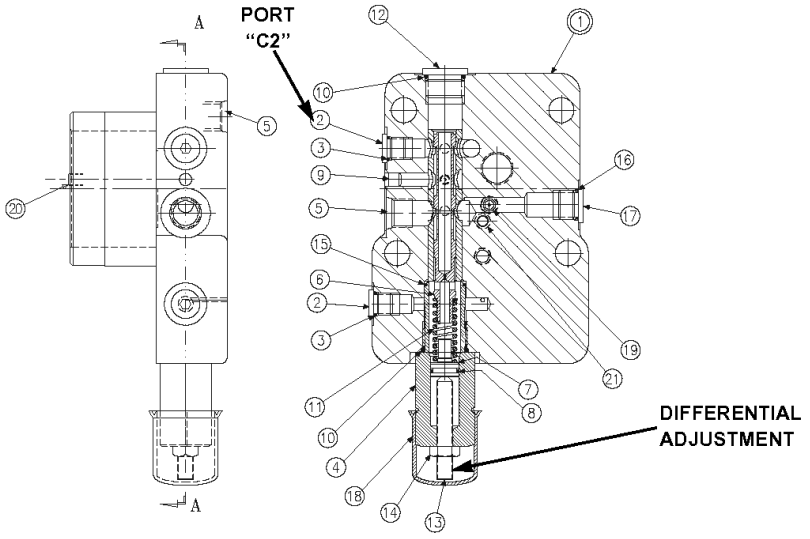
DISASSEMBLY

1. **See figure 17.** Remove 2 screws holding body (16) to cap assembly (1).
2. Remove all parts from body (16) except pin (30) and arm assembly (28). It is not necessary to remove these parts unless broken or worn. Examine parts for wear or damage.
3. Remove screw (3). Examine head for excessive wear, and body for smooth sealing surface with O-ring.
4. **See figure 16.** Remove tube lines to cap assembly.
5. Remove screws holding cap assembly to pump body.
6. Remove cap assembly (1). Remove plug (4) with attached parts. Remove spring (11) and spool (6).
7. Do not remove sleeve in body (1). Sleeve is pressed into cap and finished to size. If sleeve or cap is worn, replace the cap-sleeve assembly (1).
8. Remove screw (13) and nut (14). Push a rod through the cap to remove the retainer (77).

ASSEMBLY

See page 26 for tightening torque on plugs

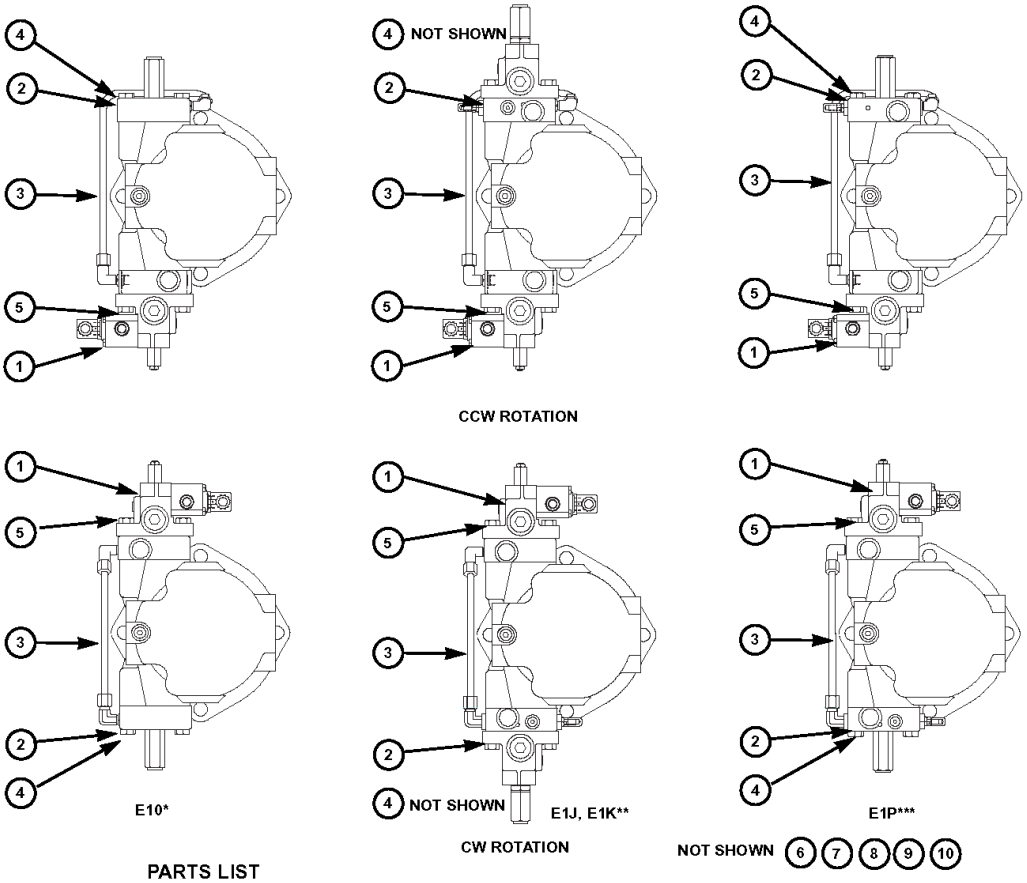
1. **See figure 16.** Install Avseal plug (9) in cap.
2. Install spool (6) into bore as shown. Install spring (11) over end of spool.
3. Install O-ring (8) on spring retainer (7). Install retainer (7), screw (13), and nut (14) in plug (4).
4. Install O-rings (10) and (15) on plug (4). Install plugs (4) and (12) in body (1). Install .047", 1,19 mm orifice (19), and .071", 1,98 mm orifice (20) and plugs (2).and (17). Torque plugs. Install O-ring (21) in cap.
5. Turn screw (13) in until spring retainer (7) contacts spring (11). Turn an additional 1-1/2 turns and lock in position.
6. Note proper location for control on pump (pg. 24). Install O-rings on interface between cap and pump control pad. Install cap on pump control pad, guiding the control piston into the bore.
7. Torque two assembly bolts to 75 lb.•ft., 102 Nm.
8. **See figure 17.** Apply thread locking compound on threads of screw (3), lubricate the shank, thread through the cap into the control piston, and torque to 5 lb.•ft., 6,78 Nm.
9. Install minimum stop screw (24) and turn clockwise to stroke pump to full volume. Measure height from control cap to top of screw (3). With control piston at full displacement, dimension must be .74 +/- .03 in., 18,8 +/- 0,76 mm. Back out minimum stop screw (24) till there is no contact with control piston.
10. Press dowel (30) into body (16), through the link (28), to 1/4", 6,35 mm below surface. Apply hydraulic sealant to threads of screws (40) and install over dowel (30).
11. Press spool (21) into retainer (19). Caution: do not use excessive force. Place spool/retainer assembly into spool (17) with spring (18) and washer (34). Secure with retaining ring (33).
12. While sleeve (27) is engaged into dowel on link (28), slide above spool assembly into bore of body (16), and through sleeve (27). Spool (21) must move freely and easily at all positions of the link (28).
13. Assemble all other components into body (16) per above drawing. Torque plug (12).
14. While spring retainer is engaging clevis pin (5) under dowel of link (28), slide the other opening of spring retainer over the top of the screw (3). Attach body assembly (16) to cap (1) with two screws and torque to 75 lb.-ft., 102 Nm.
15. Install tubing assembly (Figure 24, 25).



SECTION A–A

ref. Figure 16

SERVO CAP



PARTS LIST
electrohydraulic stroker

ITEM	DESCRIPTION	P07 PART NO.	P110 PART NO.	QUANTITY E10*	E1J**	E1K**	E1P***
1	#Electrohydraulic Stroker (Fig. 18)	S22-16057	S22-16060	1	1	1	1
2	#Control Cap (Fig.26)	S22-15325	S22-15613	1	—	—	—
	#Low Torque Override (Fig. 29)	S22-16207	S22-16208	—	1	—	—
	#High Torque Override (Fig. 29)	S22-16209	S22-16210	—	—	1	—
	#Compensator Override (Fig. 27)	S22-16205	S22-16206	—	—	—	1
3	Tube Assembly, CW rotation (Fig. 24)	S22-16035	S22-16037	1	1	1	1
	Tube Assembly, CCW rotation (Fig. 25)	S22-16036	S22-16038				
4	Screw-H.H.C., M12 x 55 mm	363-12205	363-12205	6	4	4	6
5	Screw-H.H.C., M12 x 80 mm	363-12225	363-12225	2	4	4	2
6	Control Piston	032-91848	032-91848	1	1	1	1
7	O-Ring, 90 S-1 ARP 013	691-00013	691-00013	2	2	2	2
8	O-Ring, 70 S-1 ARP 151	671-00151	671-00151	2	2	2	2
9	Piston Ring	032-91816	032-91816	1	1	1	1
10	Piston Ring	032-91811	032-91811	1	1	1	1

*Also E50
**Also E5J, E5K
***Also E5P
#Includes items 4, 5, 7 and 8

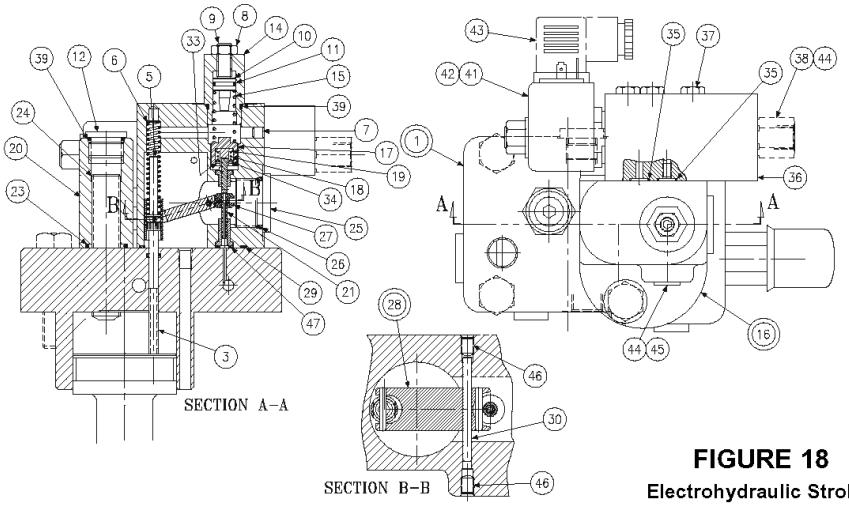


FIGURE 18
Electrohydraulic Stroker

PARTS LIST FOR FIGURE 18
P07 electrohydraulic stroker
S22-16204
P110 electrohydraulic stroker
S22-16203

ITEM	DESCRIPTION	P07 PART NO.	P07 QTY.	P110 PART NO.	P110 QTY.
1	Cap (Figure 16)	S22-16063	1	S22-16064	1
3	Screw	032-91461	1	032-91461	1
5	Clevis pin	321-40000	1	321-40000	1
6	Spring, Compression	032-92100	1	032-92100	1
7	Plug, Avseal	447-00026	1	447-00026	1
8	Nut, 5/16-24	335-13100	1	335-13100	1
9	Setscrew, 5/16-24 x 1-1/4	312-13180	1	312-13180	1
10	Seal Piston	032-91918	1	032-91918	1
11	O-Ring, 90 S-1 ARP 012	691-00012	1	691-00012	1
12	Plug, SAE-8	488-35018	1	488-35018	1
14	Spring Cap	032-91511	1	032-91511	1
15	Spring	225-92101	1	225-92101	1
16	Body	S22-15393	1	S22-15393	1
17	Spool	032-91512	1	032-91512	1
18	Spring	225-92109	1	225-92109	1
19	Spring Retainer	032-91516	1	032-91516	1
20	Nut, M16	031-91822	1	031-91822	1
21	Spool	032-91438	1	032-91438	1
23	O-Ring,70 S-1 ARP 115	671-00115	1	671-00115	1
24	Socket Setscrew, M16	311-50001	1	311-50001	1
25	Plug, SAE-12	488-35014	1	488-35014	1
26	O-Ring, 90 S-1 ARP 912	691-00912	1	691-00912	1
27	Sleeve	032-91437	1	032-91437	1
28	Arm assembly	S22-15520	1	S22-15520	1
29	O-Ring, 70 S-1 ARP 035	671-00035	1	671-00035	1
30	Dowel Pin, 1/8 Dia x 1.50 Lg.	324-20824	1	324-20824	1
33	Retaining Ring	356-30037	1	356-30037	1
34	Washer	032-91517	1	032-91517	1
35	O-Ring, 70 S-1 ARP 011	671-00011	2	671-00011	2
36	Block	032-91509	1	032-91509	1
37	Screw, 1/4-20 x 2-1/4	306-40187	3	306-40187	3
38	Adapter	-	-	032-91507	1
39	O-Ring, 90 S-1 ARP 908	691-00908	1	691-00908	1
41	Proportional Pressure Valve	517-00095	1	517-00095	1
42	Coil, 24VDC Coil, 12VDC	517-00096 517-00097	1	517-00096 517-00097	1
43	Connector	167-01008-8		167-01008-8	1
44	O-Ring, 90 S-1 ARP 904	691-00904	1	691-00904	2
45	Plug, SAE-4	488-35061	1	488-35061	1
46	Screw, SHC 10-32 x 1/4	312-09041	2	312-09041	2
47	O-Ring, 70 S-1 ARP 010	671-00010	1	671-00010	1

DISASSEMBLY

1. **See Figure 18.** Remove 3 screws (37) holding block (36) to body (16).
2. Remove 2 screws holding body (16) to cap assembly (1).
3. Remove all parts from body (16) except pin (30) and arm assembly (28). It is not necessary to remove these parts unless broken or worn. Examine parts for wear or damage.
4. Remove screw (3). Examine head for excessive wear, and body for smooth sealing surface with O-ring.
5. **See Figure 16.** Remove tube lines to cap assembly.
6. Remove screws holding cap assembly to pump body.
7. Remove cap assembly (1). Remove plug (4) with attached parts. Remove spring (11) and spool (6).
8. Do not remove sleeve in body (1). Sleeve is pressed into cap and finished to size. If sleeve or cap is worn, replace the cap-sleeve assembly (1).
9. Remove screw (13) and nut (14). Push a rod through the cap to remove the retainer (7).

ASSEMBLY

See page 26 for tightening torque on plugs

1. **See Figure 16.** Install Avseal plug (9) in cap.
2. Install spool (6) into bore as shown. Install spring (11) over end of spool.
3. Install O-ring (8) on spring retainer (7). Install retainer (7), screw (13), and nut (14) in plug (4).
4. Install O-rings (10) and (15) on plug (4). Install plugs (4) and (12) in body (1). Install .047", 1,19 mm orifice (19), and .071", 1,98 mm orifice, (20) and plugs (2) and (17). Torque plugs. Install O-ring (21) in cap.
5. Turn screw (13) in until spring retainer (7) contacts spring (11). Turn an additional 1-1/2 turns and lock in position.
6. Note proper location for control on pump (pg 24). Install O-rings on interface between cap and pump control pad. Install cap on pump control pad, guiding the control piston into the bore.
7. Torque two assembly bolts to 75 lb.• ft., 102 N m.
8. **See Figure 18.** Apply thread locking compound on threads of screw (3), lubricate the shank, thread through the cap into the control piston, and torque to 5 lb.• ft., 6.78 N • m.
9. Install minimum stop screw (24) and turn clockwise to stroke pump to full volume. Measure height from control cap to top of screw (3). With control piston at full displacement, dimension must be .74 +/- .03 in., 18,8 +/- 0,76 mm. Back out minimum stop screw (24) till there is no contact with control piston.
10. Press dowel (30) into body (16), through the link (28), to 1/4, 6,35 mm below surface, apply hydraulic sealant to threads of screws (46) and install over dowel (30).
11. Press spool (21) into retainer (19). Caution: do not use excessive force. Place spool/retainer assembly into spool (17) with spring (18) and washer (34). Secure with retaining ring (33).
12. While sleeve (27) is engaged into dowel on link (28), slide above spool assembly into bore of body (16), and through sleeve (27). Spool (21) must move freely and easily at all positions of the link (28).
13. Install proportional valve (41) in block. Torque to 20 ft.• lbs., 27 N m.
14. Install coil on proportional valve. Torque to 20-25 in.• lbs., 2,2-2,8 N m maximum
15. Assemble all other components into body (16) per above drawing. Torque the plug (12).
16. While spring retainer is engaging clevis pin (5) under dowel of link (28), slide the other opening of spring retainer over the top of the screw (3). Attach body assembly (16) to cap (1) with two screws and torque to 75 lb.• ft., 102 N m.

17 Install tubing assembly (Figure 24, 25).

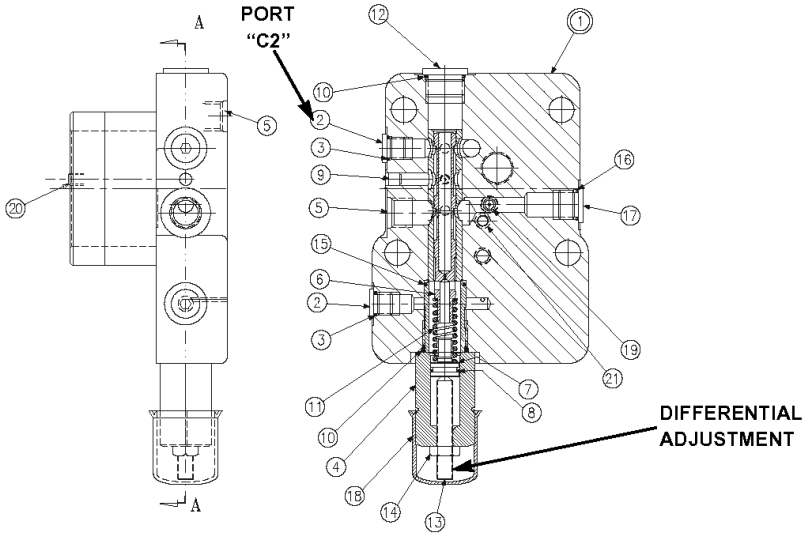
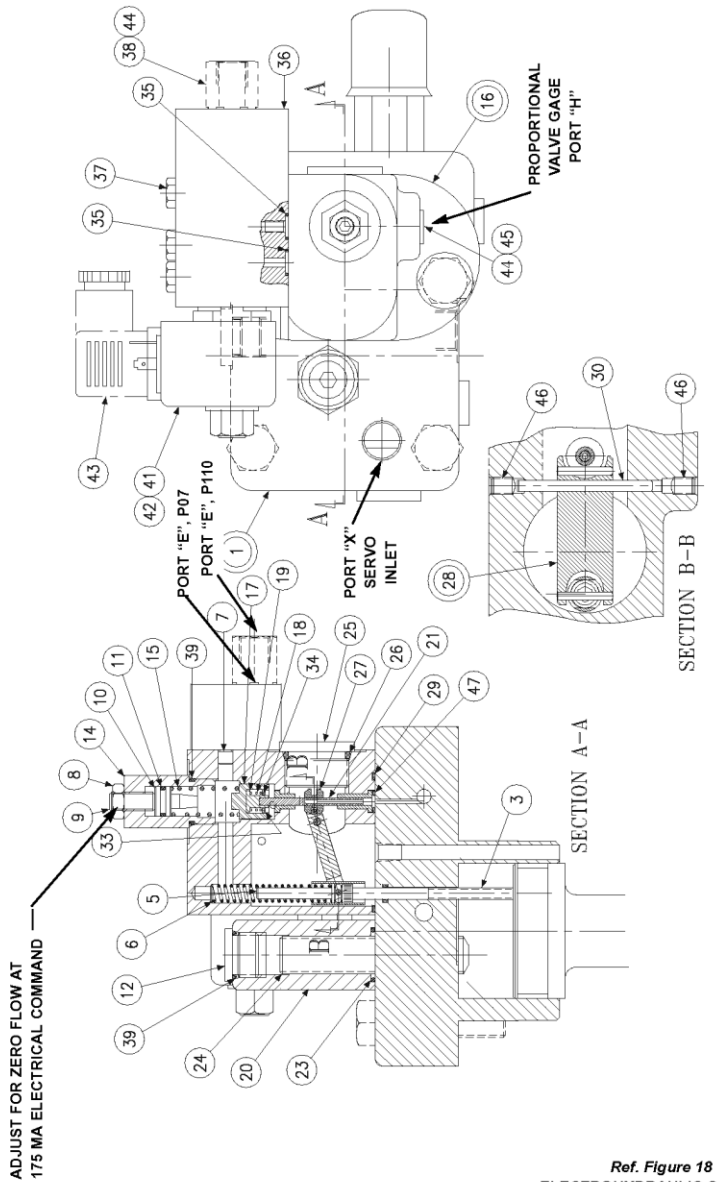


Figure 16
Servo cap



Ref. Figure 18
ELECTROHYDRAULIC STROKER

PQ CONTROL
IN PROCESS OF DEVELOPMENT

PQ CONTROL
IN PROCESS OF DEVELOPMENT

PQ CONTROL
IN PROCESS OF DEVELOPMENT

PQ CONTROL
IN PROCESS OF DEVELOPMENT

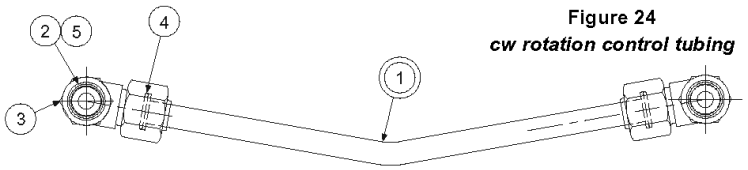


Figure 24
cw rotation control tubing

PARTS LIST FOR FIGURE 24
cw rotation control tubing S22-16035 (P07) S22-16037 (P110)

ITEM	DESCRIPTION	PO7 PART NO.	P110 PART NO.	QTY.
1	Servo tube w/nut & sleeve	S22-16032	S22-16077	1
2	O-ring, 90 S-1	691-00906	691-00113	2
3	Elbow fitting	492-15382	492-15426	2
4	O-ring, 90 S-1 ARP 012	691-00012	691-00012	2
5	Fitting retaining ring	-	492-15417	2

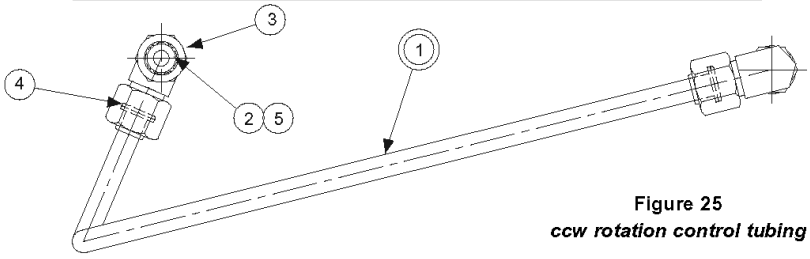
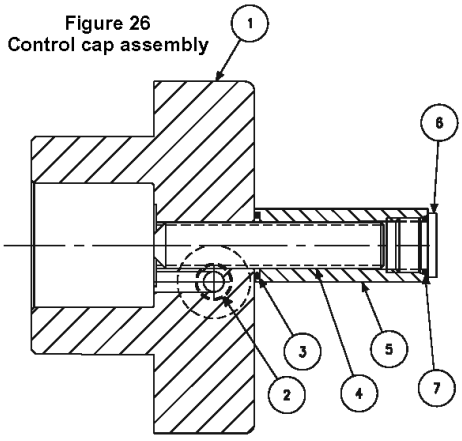


Figure 25
ccw rotation control tubing

PARTS LIST FOR FIGURE 25
ccw rotation control tubing S22-16036 (P07) S22-16038 (P110)

ITEM	DESCRIPTION	PO7 PART NO.	P110 PART NO.	QTY.
1	Servo tube w/nut & sleeve	S22-16076	S22-16078	1
2	O-ring, 90 S-1	691-00906	691-00113	2
3	Elbow fitting	492-15382	492-15426	2
4	O-ring, 90 S-1 ARP 012	691-00012	691-00012	2
5	Fitting retaining ring	-	492-15417	2

Figure 26
Control cap assembly



CONTROL CAP DISASSEMBLY

1. **See Figure 26.** Remove nut (5) and maximum volume screw (4).
2. Remove 4 screws holding cap to pump.
3. Remove cap assembly from pump.

ASSEMBLY
See page 26 for tightening torque on plugs

1. Install O-rings on interface between cap and pump control pad. Install cap on pump housing as indicated on the applicable view (pg. 24), guiding the control piston into the bore.
2. Torque the assembly bolts to 75 lb.• ft., 102 Nm.
3. Install screw (4) in cap. Install O-ring (3) on nut (5). Install nut (5) on screw.
4. Adjust screw till pump is slightly on stroke and lock nut (5).
5. Install O-ring (7) on plug (6). Install plug in nut (5). Torque plug (6).

PARTS LIST FOR FIGURE 26
P07 control cap assembly S22-15325
P110 control cap assembly S22-15613

		P07		P110	
ITEM	DESCRIPTION	PART NO.	QTY.	PART NO.	QTY.
1	Control Cap	032-91842	1	032-92229	1
2	Plug	449-00015	1	449-00599	1
3	O-ring, 70 S-1 ARP 115	671-00115	1	671-00115	1
4	Screw, M16	311-50001	1	311-50001	1
5	Nut, M16	031-91822	1	031-91822	1
6	Plug, SAE-8	488-35018	1	488-35018	1
7	O-ring 90 S-1 ARP 908	691-00908	1	691-00908	1

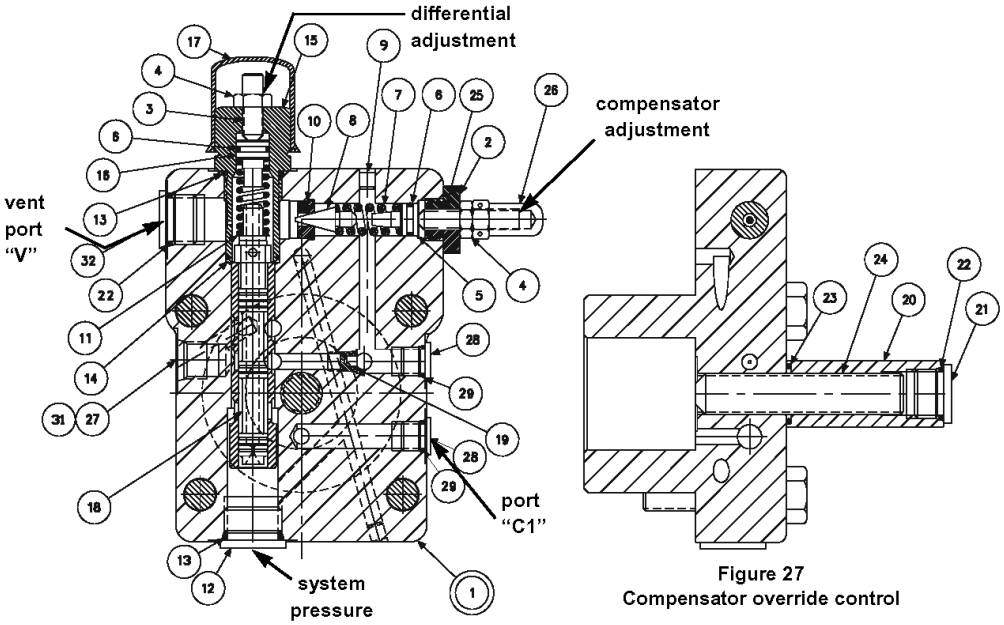


Figure 27
Compensator override control

PARTS LIST FOR FIGURE 27
compensator override control
P07 compensator override S22-16205
P110 comp. override S22-16206

ITEM	DESCRIPTION	P07 PART NO.	P07 QTY.	P110 PART NO.	P110 QTY
1	Cap-Sleeve Assembly	S22-16043	1	S22-16044	1
2	Adjustment Plug	032-91814	1	032-91814	1
3	Socket Setscrew 5/16-24 x 1	312-13160	1	312-13160	
4	Nut, 5/16-24	335-13100	2	335-13100	2
5	Seal Piston	031-59367	1	031-59367	1
6	0-Ring, 90 S-1 ARP 012	691-00012	2	691-00012	2
7	Spring	032-91798	1	032-91798	1
8	Cone	036-12288	1	036-12288	1
9	Avseal Plug	447-00026	2	447-00026	2
10	Seat	036-11692	1	036-11692	1
11	Spring	225-92101	1	225-92101	1
12	Plug, SAE-10, 1/2 BSPP	488-35055	1	447-01008	1
13	O-Ring, 90 S-1 ARP 910	691-00910	2	691-00910	1
14	O-Ring, 90 S-1 ARP 017	691-00017	1	691-00017	1
15	Plug	031-57368	1	031-57368	1
16	Seal piston	032-92480	1	032-92480	1
17	Cap	449-00612	1	449-00612	1
18	Spool	032-92549	1	032-92549	1
19	Plug, 1/16 NPTF	431-90104	1	431-90104	1
20	Nut, M16	032-91822	1	032-91822	1
21	Plug	488-35018	1	488-35018	1
22	O-ring, 90 S-1 ARP 908	691-00908	2	691-00908	1
23	O-ring, 70 S-1 ARP 115	671-00115	1	671-00115	1
24	Socket. Setscrew, M16	311-50001	1	311-50001	1
25	Socket Setscrew 5/16-24	312-13180	1	312-13180	
26	Acorn Nut	036-33474	1	036-33474	1
27	Plug	449-00015		449-00599	1
28	Plug, SAE-4, 1/4 BSPP	488-35061	2	447-01004	2
29	O-ring, 90 S-1 ARP 904	691-00904	2	447-00032	2
31	Orifice	035-40489	1	035-40489	1
32	Plug, SAE-8, 3/8 BSPP	488-35018	1	447-00032	1

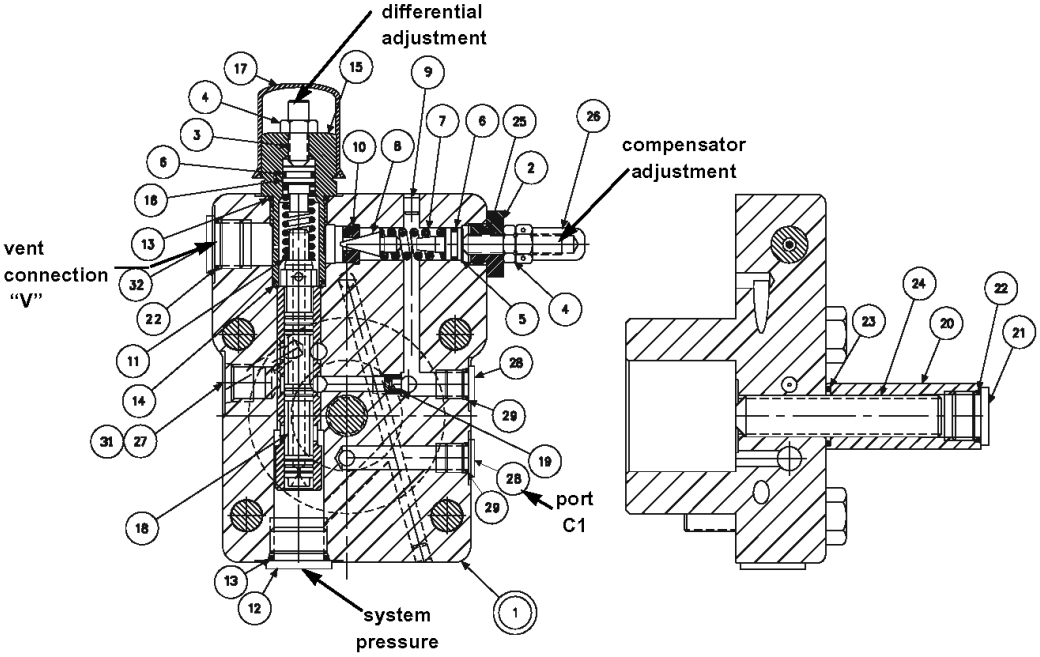
DISASSEMBLY

1. **See Figure 27.** Remove tube line to cap.
2. Remove maximum volume stop assembly (items 20, 21, 22, 23, 24).
3. Remove cap assembly.
4. Remove plug (15) and attached parts. Remove spring (11) and spool (18).
5. Remove adjusting plug (2) and attached parts. Remove seal piston (5). Note: a 10-24 screw may be attached to assist in pulling the piston. Remove spring (7) and cone (8).
6. Do not remove sleeve in body (1). Sleeve is pressed into cap and finished to size. If sleeve, snout or cap is worn, replace the cap-sleeve assembly (1).
7. Examine seat (10) for wear. Do not remove unless damaged.

ASSEMBLY

See page 26 for tightening torque on plugs

1. Install Avseal plugs (9) in body. Install .032", 0,81 mm orifice (31) as indicated. Install plug (19) as shown.
2. Press seat (10) into bore to shoulder in bore.
3. Install spool (18) into bore as shown. Install spring (11) over end of spool. Install O-ring (6) on seal piston (16). Lubricate and install into plug (15). Install O-rings (13) and (14) on plug (15). Install plug (15) into cap. Install screw (3), nut (4) and cover (17).
4. Install O-ring (6) on seal piston (5).
5. Lubricate O-ring and install cone (8), spring (7) and seal piston into bore in cap (1), being careful that cone enters seat (10).
6. Install remaining parts. Torque plugs (12) (21) (28) and (32).
7. Note proper location for cap on pump (pg. 24). Install O-rings on interface between cap and pump control pad.
8. Install cap assembly on pump, guiding the control piston into the bore.
9. Torque mounting bolts to 75 lb.•ft., 102 Nm.
10. Install tubing assembly (Figure 24, 25).



Ref. Figure 27
COMPENSATOR OVERRIDE CONTROL

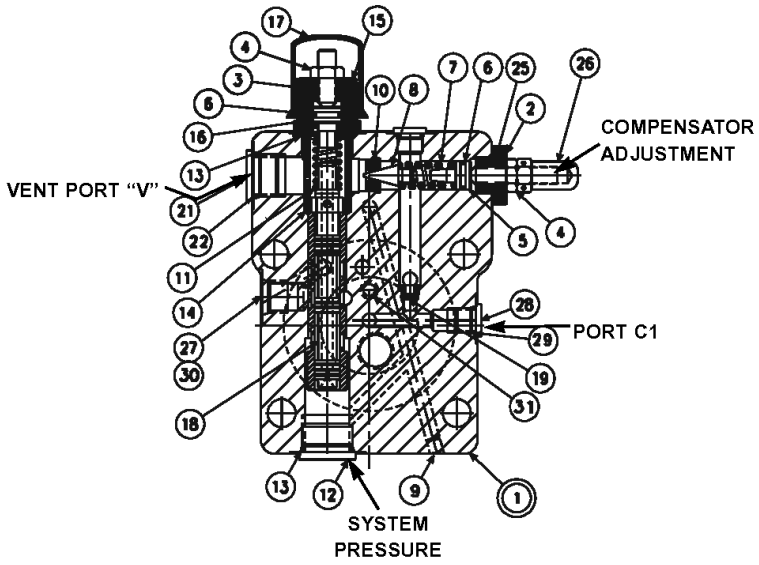


FIGURE 28
torque limiter override cap

PARTS LIST FOR FIGURE 28
torque limiter override cap
P07 cap S22-16049
P110 cap S22-16050

ITEM	DESCRIPTION	P07 PART NO.	QTY.	P110 PART NO.	QTY
1	Cap-Sleeve Assembly	S22-16045	1	S22-16046	1
2	Adjustment. Plug	032-91814	1	032-91814	1
3	Socket Setscrew 5/16-24 x 1	312-13160	1	312-13160	1
4	Nut, 5/16-24	335-13100	2	335-13100	2
5	Seal Piston	031-59367	1	031-59367	1
6	0-Ring, 90 S-1 ARP 012	691-00012	2	691-00012	2
7	Spring	032-91798	1	032-91798	1
8	Cone	036-12288	1	036-12288	1
9	Avseal Plug	447-00026	2	447-00026	2
10	Seat	036-11692	1	036-11692	1
11	Spring	225-92101	1	225-92101	1
12	Plug, SAE-10, 1/2 BSPP	488-35055	1	447-01008	1
13	O-Ring, 90 S-1 ARP 910	691-00910	2	691-00910	1
14	O-Ring, 90 S-1 ARP 017	691-00017	1	691-00017	1
15	Plug	031-57368	1	031-57368	1
16	Seal Piston	032-92480	1	032-92480	1
17	Cap	449-00612	1	449-00612	1
18	Spool	032-92549	1	032-92549	1
19	Plug	431-90104	1	431-90104	1
21	Plug, SAE-8, 3/8 BSPP	488-35018	1	447-00032	1
22	O-ring 90 S-1 ARP 908	691-00908	1	-	
23	Socket Setscrew	312-13180	1	312-13180	1
25	Acorn Nut	036-33474	1	036-33474	1
26	Plug	449-00015	1	449-00599	1
28	Plug, SAE-4, 1/4 BSPP	488-35061	2	447-01004	2
29	O-ring, 90 S-1 ARP 904	691-00904	2	-	-
30	Orifice, .032", 0,81 mm	035-40489	1	035-40489	1
31	O-Ring, 70 S-1 ARP 008	671-00008	1	671-00008	1

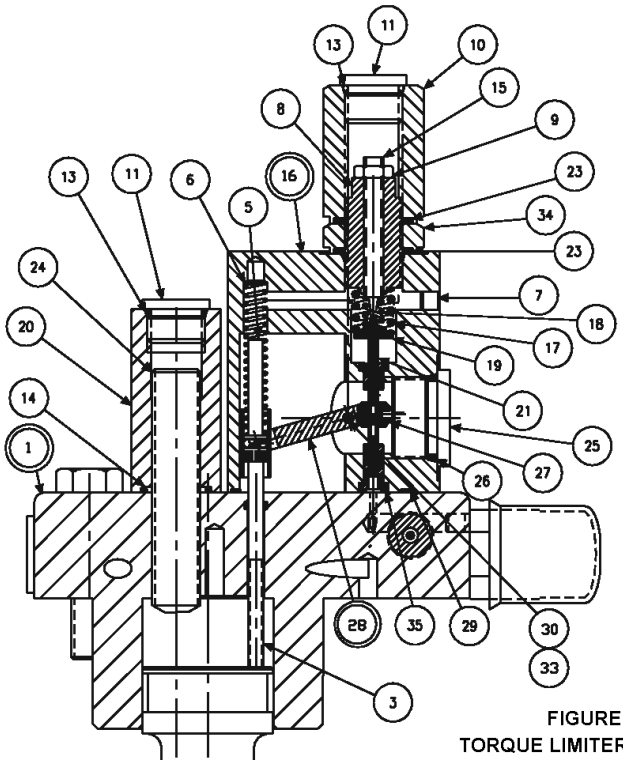


FIGURE 29
TORQUE LIMITER OVERRIDE

PARTS LIST FOR FIGURE 29
torque limiter override
P07 code J, S22-16207
P07 code K, S22-16209
P110 code J, S22-16208
P110 code K, S22-16210

ITEM	DESCRIPTION	P07 PART NO.	P110 PART NO.	QTY. **J	QTY. **K
1	Cap (Figure 28)	S22-16049	S22-16050	1	1
3	Screw	032-91461	032-91461	1	1
5	Clevis pin	321-40000	321-40000	1	1
6	Spring, Compression	032-92100	032-92100	1	1
7	Plug, Avseal	447-00026	447-00026	1	1
8	Screw	032-91445	032-91445	1	1
9	Nut, Hex Jam 1/4-20 UNC	340-00038	340-00038	1	1
10	Hex Nut, 3/4-16 UNF	032-91449	032-91449	1	1
11	Plug, SAE-8	488-35018	488-35018	2	2
13	O-Ring, 90 S-1 ARP 908	691-00908	691-00908	2	2
14	O-ring, 70 S-1 ARP115	671-00115	671-00115	1	1
15	Screw, Primary Adjustment	032-91446	032-91446	1	1
16	Body assembly	S22-15396	S22-15396	1	1
17	Outer Spring – J Version	032-91440	032-91440	1	—
	Outer Spring – K Version	032-91440	032-91440	—	1
18	Inner Spring – J Version	032-92240	032-92240	1	—
	Inner Spring – K Version	032-91441	032-91441	—	1
19	Spring Retainer	032-91819	032-91819	1	1
20	Nut, M16 hex	032-91822	032-91822	1	1
21	Spool	032-91438	032-91438	1	1
23	O-ring, 70 S-1 ARP 118	671-00118	671-00118	2	2
24	Socket Setscrew, M16	311-50001	311-50001	1	1
25	Plug, SAE-12	488-35014	488-35014	1	1
26	O-Ring, 90 S-1 ARP 912	691-00912	691-00912	1	1
27	Sleeve	032-91437	032-91437	1	1
28	Arm assembly	S22-15520	S22-15520	1	1
29	O-Ring, 70 S-1 ARP 035	671-00035	671-00035	1	1
30	Dowel Pin	324-20824	324-20824	1	1
33	Screw, SHC 10-32 x 1/4	312-09041	312-09041	2	2
34	Nut	032-91645	032-91645	1	1
35	O-Ring, 70 S-1 ARP 010	671-00010	671-00010	1	1

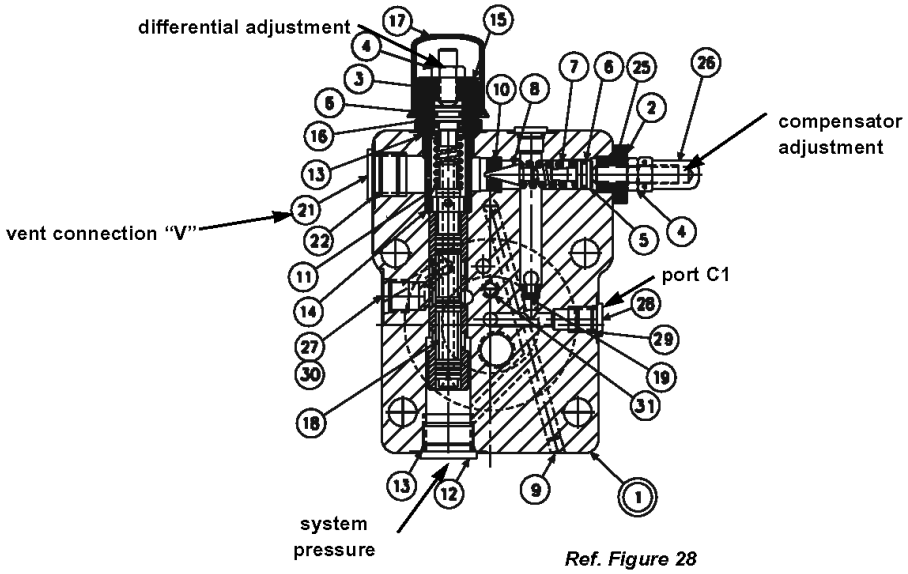
Disassembly

1. **See figure 29.** Remove 2 screws holding torque limiter body (16) to cap assembly (1).
2. Remove all parts from torque limiter body (16) except pin (30) and arm assembly (28). It is not necessary to remove these parts unless broken or worn. Examine parts for wear or damage.
3. Remove screw (3). Examine head for excessive wear, and body for smooth sealing surface with O-ring.
4. See figure 28. Remove maximum volume stop assembly (items 11, 13, 14, 20, 24).
5. Remove cap assembly (1).
6. Remove plug (15) and attached parts. Remove spring (11) and spool (18).
7. Remove adjusting plug (2) and attached parts. Remove seal piston (5). Note: a 10-24 screw may be attached to assist in pulling the piston. Remove spring (7) and cone (8).
8. Do not remove sleeve in body (1). Sleeve is pressed into cap and finished to size. If sleeve, snout or cap is worn, replace the cap-sleeve assembly (1).
9. Examine seat (10) for wear. Do not remove unless damaged.

Assembly

See page 26 for tightening torque on plugs

1. **See figure 28.** Install Avseal plugs (9), plug (19), .032", 0,81 mm orifice (30).
2. Press seat (10) into bore squarely against shoulder in bore.
3. Install spool (18) into bore as shown. Install spring (11) over end of spool. Install O-ring (6) on seal piston (16). Lubricate and install into plug (15). Install O-rings (13) and (14) on plug (15) Install plug (15) into cap. Install screw (3), nut (4) and cover (17).
4. Install O-ring (6) on seal piston (5).
5. Lubricate O-ring and install cone (8), spring (7) and seal piston into bore in cap (1), being careful that cone enters seat (10). Install adjustment plug (2), screw (25), nut (4), and acorn nut (26).
6. Install plugs (12), (21) and (28) and torque.
7. Carefully install O-ring (31) into the cap.
8. Note proper location for cap (pg. 24). Install O-rings on interface between cap and pump control pad. Install cap assembly on pump, guiding the control piston into the bore. Torque two mounting screws to 75 lb.•ft., 102 Nm.
9. Install maximum stop screw (24), nut (20), O-ring (14) and plug (11) with O-ring (13).
10. **See figure 29.** Apply thread locking compound on threads of screw (3), lubricate the shank, thread through the cap into the control piston, and torque to 5 lb.•ft., 6,78 Nm.
11. Measure height from control cap to top of screw. With control piston at zero displacement, dimension must be . .74 +/- .03 in., 18,8 +/- 0,76 mm.
12. Press dowel (30) into body (16), through the link assembly (28), to 1/4", 6,35 mm below surface. Apply hydraulic sealant to threads of screws (33) and install over dowel (30).
13. While sleeve (27) is engaged into dowel on link (28), slide spool (21) into bore of body (16), and through sleeve (27). Spool (21) must move freely and easily at all positions of the link (28).
14. Assemble remaining parts per drawing. Torque plug (11).
15. While spring retainer is engaging clevis pin (5) under dowel of link (28), slide the other opening of spring retainer over the top of the screw (3). Attach body assembly (16) to cap (1) and torque assembly screws to 75 lb.•ft., 102 Nm.
16. Install tubing assembly (Figure 24, 25).



Ref. Figure 28

Torque limiter override cap

Test Conditions: (If using service facility test stand)

Fluid: Mobil 4259 DE (ISO V6-32 or equivalent)
RPM: 1450 or 1750 ± 50 RPM
Inlet Temperature: 120° F ± 10° F., 49° C ± 4° C
Inlet Condition: Atmospheric to + 5 psi, 0,345 bar
Case Pressure: 25 psi ±5 psi, 1,72 bar ± 0,345 bar

Mount pump on test stand, or customer system. System line must have a relief valve. Connect system lines and case drain line. Fill pump case with clean oil. If pump is mounted vertically with the shaft up, vent the case by removing the plug from port "DG" to purge trapped air. To check for external leaks, install a check or relief valve in the case drain line to build 25 psi, 1,72 bar case pressure. Dry all oil from exterior of pump. If leaks are detected at any time, they shall be repaired before proceeding.

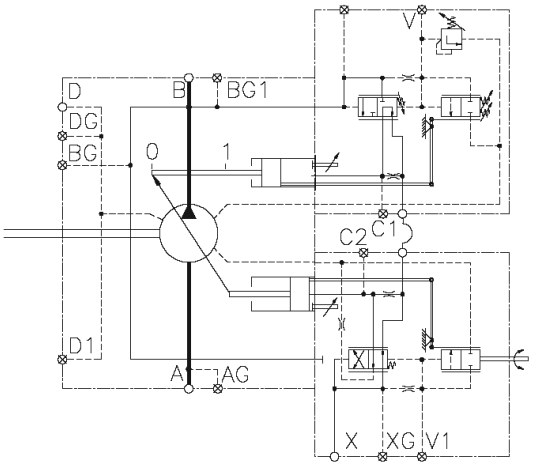
Adjust maximum volume stop to full displacement by backing off screw or handwheel CCW until there is no contact with control piston.

ROTARY SERVO TEST

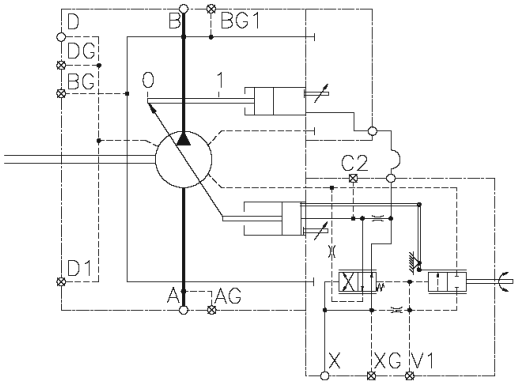
The rotary servo mounts on the minimum displacement side of the pump. It utilizes a rotating shaft containing a cam to position a pin, and a sleeve positioned by a feedback link to the control cylinder. The sleeve/pin combination meters pilot flow to position a 4-way valve. This valve is ported to both ends of the control cylinder. The 4-way spool directs oil to/from the control cylinder such that it moves in a direction to maintain the metered position between the sleeve and spool. The pump displacement is thus established by the position of the shaft.

A compensator or torque limiter override may be installed on the on-stroke side of the control piston. When the set pressure or torque is reached, system pressure is directed into the piston to reduce displacement, overriding the servo commanded position.

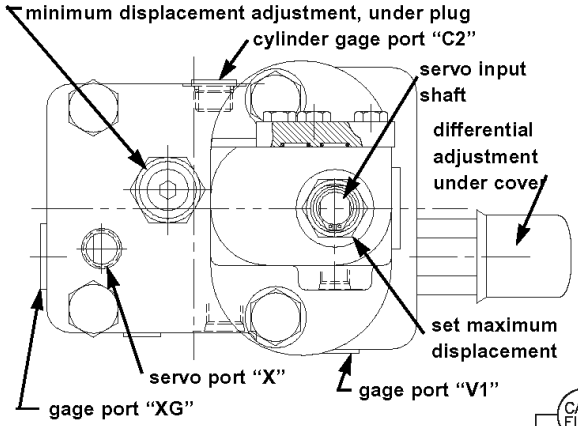
Before testing the rotary servo, disable the compensator or torque limiter override, if applicable, by turning the compensator differential adjustment fully in. **CAUTION:** System must contain a relief valve to limit system pressure. System relief valve should be set to minimum pressure.



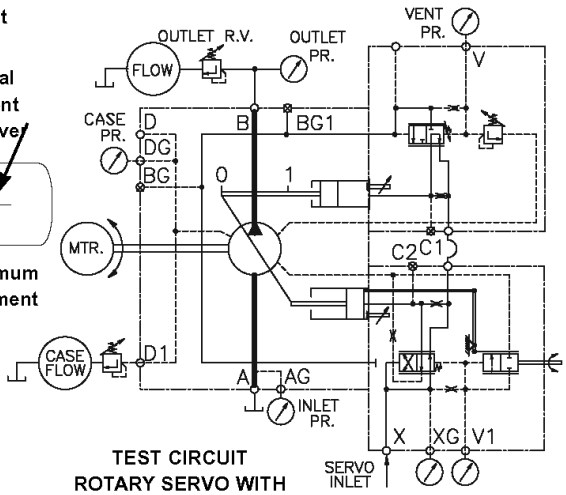
HYDRAULIC CIRCUIT
ROTARY SERVO TORQUE
LIMITER OVERRIDE



HYDRAULIC CIRCUIT
ROTARY SERVO



ROTARY SERVO CONTROL CAP



TEST CIRCUIT
ROTARY SERVO WITH
COMPENSATOR OVERRIDE

ROTARY SERVO TEST *(continued)*

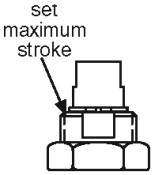
Plumb servo supply (5 gpm, 19 lpm minimum at 1500 psi, 103 bar maximum) to control port "X".

Thread minimum displacement adjustment so that pump is on stroke.

Install gages on servo pressure gage port XG and on gage port V1, capable of measuring pressure difference to 10 psi, 0,69 bar. Gages must be adequate for servo pressure.

Turn servo differential adjustment screw in till solid, then seven turns out.

Start pump. Adjust rotary servo shaft till pump is at some displacement between zero and full. Adjust differential pressure by adjusting the differential screw until the difference in pressure readings between port XG and V1 is 250 +/-10 psi, 17,2 +/- 0,7 bar. Install cover over differential adjustment. Remove gages and plug gage ports.

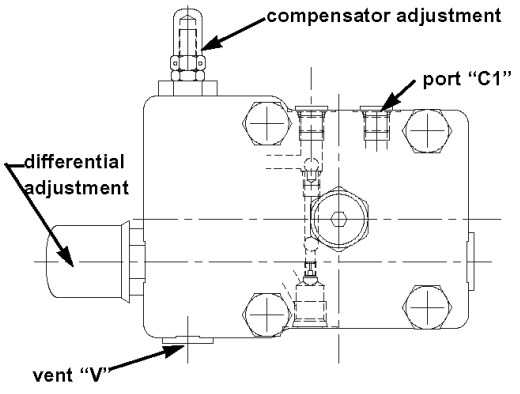


With rotary servo shaft rotated fully clockwise, adjust maximum volume adjustment on servo until output flow is at the full displacement position. Lock in place.

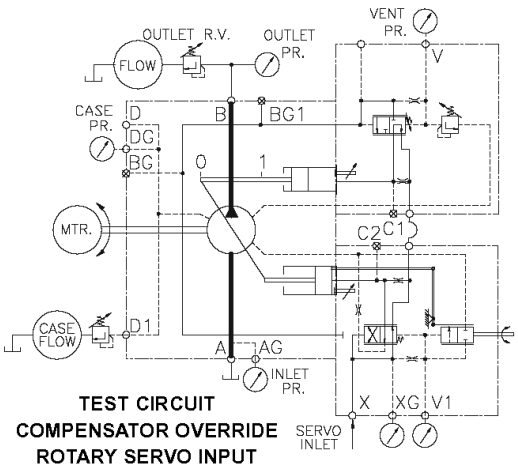
Fully rotate servo shaft counter-clockwise. Pump flow should go towards zero displacement. Back out minimum volume stop until pump is at zero displacement. Lock in place.

Rotate shaft clockwise and counterclockwise at various outlet pressures. Pump displacement should follow shaft rotation between full and zero displacement smoothly and proportionally. Full to zero or zero to full displacement should be achieved in no more than .3 second.

Proceed to **COMPENSATOR TEST (pg. 66), TORQUE LIMITER TEST (pg. 70),** or **FINAL PUMP TEST (pg. 75),** as applicable.



COMPENSATOR OVERRIDE CAP



TEST CIRCUIT
COMPENSATOR OVERRIDE
ROTARY SERVO INPUT

COMPENSATOR TEST

Outlet relief valve should be set to minimum pressure.

If the pump contains a servo, hydraulic or electrohydraulic stroker control, test that control first, (pg. 64, 68 or 69) then set the control to give full displacement on the pump.

Install gages on outlet pressure and "V" capable of measuring pressure difference to 10 psi, 0,69 bar. Gages must be adequate for outlet pressure.

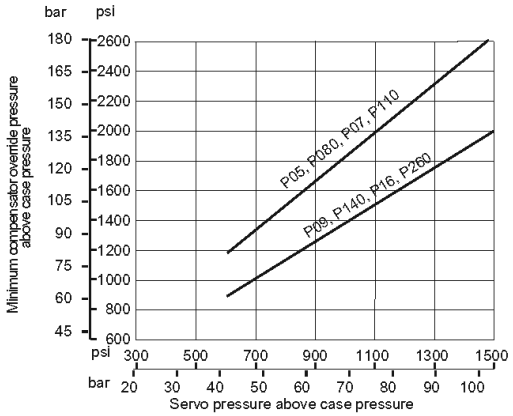
If testing pump with load sensing compensator or torque limiter control, the test stand must include a gage on the line from "LS" capable of measuring pressure difference to 10 psi, 0,69 bar and the other components shown in the load sensing test circuit. Open speed control valve fully, and close load valve to first test the compensator function.

Turn compensator adjustment screw CCW until there is no contact with spring, then adjust 1/2 turn CW after contact is made with spring.

Turn differential adjustment screw out till there is no contact with spring, then in 1-1/2 turns. (Approximately one nut width exposure of screw thread)

Start prime mover. Observe for correct rotation. Pump should be at full displacement at minimum pressure.

Adjust outlet relief valve until compensator destrokes pump to zero displacement. Adjust differential pressure across ports XG and V1 to 250+- 10 psi, 17,2 +- 0,7 bar. Compensator pressure should be approximately 1000 psi, 69 bar with the 1/2 turn pre-adjustment. Note: With servo type controls, minimum compensator pressure will be higher, depending on the servo supply pressure. See chart below.

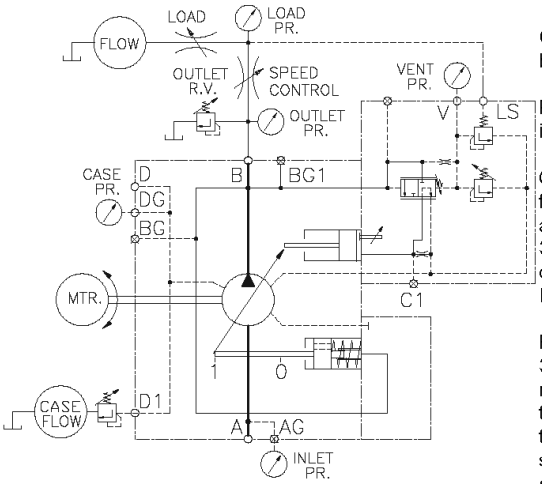


Raise compensator from minimum to maximum outlet pressure. At each condition, increase the outlet pressure until the pump fully de-strokes. At no time should the outlet pressure vary over 150 psi, 10,3 bar from the compensator setting. The control should be steady and stable at all conditions.

Calculate compensator leakage by subtracting leakage flow at full flow from leakage flow fully compensated. Compensator leakage: 5 gpm, 18.9 lpm. maximum

Reduce outlet pressure to 150 psi, 10,3 bar below the compensator setting. Pump should return to full displacement. Repeat two or more times. Compensator settings should be repeatable. Proceed to **FINAL PUMP TEST (pg. 75)**, or **LOAD SENSING TEST (below)** if applicable.

LOAD SENSING TEST



TEST CIRCUIT LOAD SENSING

Caution: Load sensing control is limited to 5000 psi, 345 bar maximum pressure.

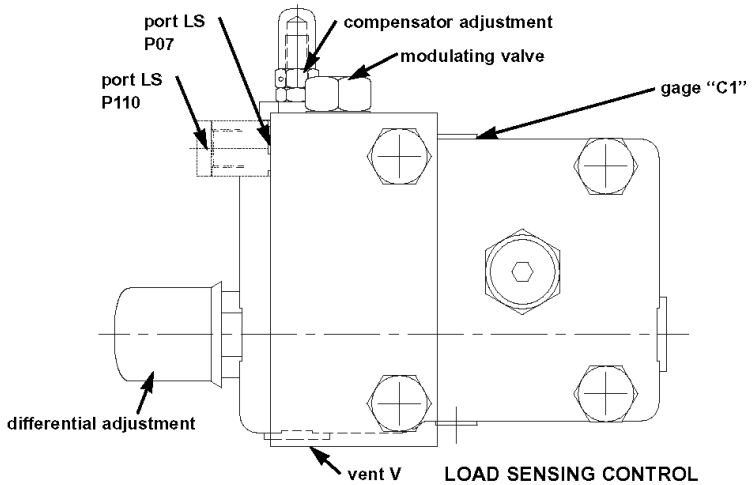
Pump should be connected to speed control valve, load sensing line and load valve as shown.

Close the speed control valve. Check the pressure difference from outlet pressure to load pressure. Using the differential adjustment, set this pressure difference to 450 psi ± 25 psi, 31,0 ± 1,72 bar or shop order requirement. Caution: Too low or too high a setting will cause the control to malfunction. Install cap on differential adjustment.

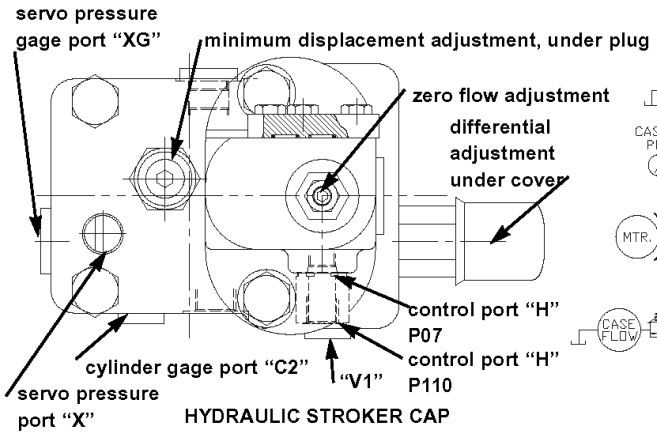
Fully open the speed control valve. Set the compensator to 3000 psi, 207 bar, and 5000 psi, 345 bar. (One turn of adjustment equals approximately 2000 psi, 138 bar.) At each condition, increase the outlet pressure by closing the load valve until the pump fully de-strokes. At no time should the outlet pressure vary more than 150 psi, 10,3 bar from the compensator setting. The control should be steady and stable at all conditions.

With pump at full flow and 5000 psi, 345 bar outlet pressure, close speed control valve till flow reduces slightly. Note flow. Open load valve slowly, to drop outlet pressure toward minimum. Flow shall remain constant within 2 gpm, 7,6 lpm at all pressures.

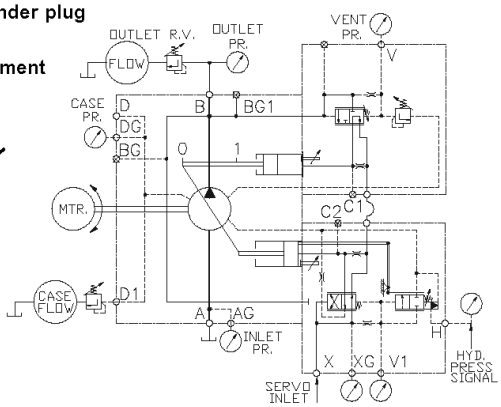
Adjust the speed control valve till flow is at a low value. Note flow. Raise and lower outlet pressure by closing and opening the load valve. Flow shall remain constant within 2 gpm, 7,6 lpm. Proceed to **FINAL PUMP TEST (pg. 75).**



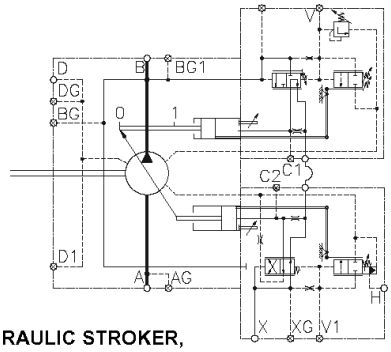
LOAD SENSING CONTROL



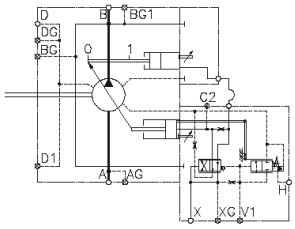
HYDRAULIC STROKER CAP



TEST CIRCUIT
HYDRAULIC STROKER
COMPENSATOR OVERRIDE



HYDRAULIC STROKER,
TORQUE LIMITER OVERRIDE



HYDRAULIC STROKER

HYDRAULIC STROKER TEST

Before testing hydraulic stroker, disable the compensator or torque limiter override, if applicable, by turning the compensator differential adjustment fully in. (See compensator or torque limiter test). **CAUTION:** System must contain a relief valve to limit outlet pressure. Outlet relief valve should be set to minimum pressure.

Plumb servo supply (5 gpm, 19 lpm minimum at 1500 psi, 103 bar maximum) to control port "X". Plumb adjustable hydraulic pressure (50 to 350 psi, 3,45 to 24 bar) to control port "H".

Thread minimum displacement adjustment screw so that pump is on stroke.

Install gages on servo pressure gage port XG and on gage port V1, capable of measuring pressure difference to 10 psi, 0,69 bar. Gages must be adequate for servo pressure.

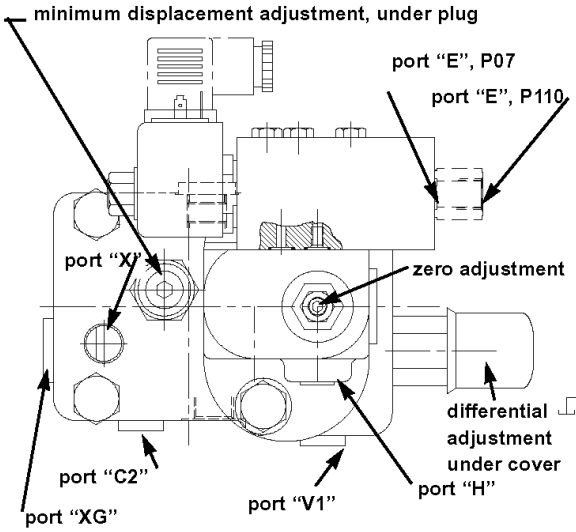
Turn hydraulic stroker differential adjustment screw in till solid, then out 7 turns.

Start pump. Apply hydraulic control signal to port "H" till pump is at some displacement between zero and full. Adjust differential pressure by adjusting the differential screw until the difference in pressure readings between port XG and V1 is 250 psi, 17,2 bar. Install cover over differential adjustment.

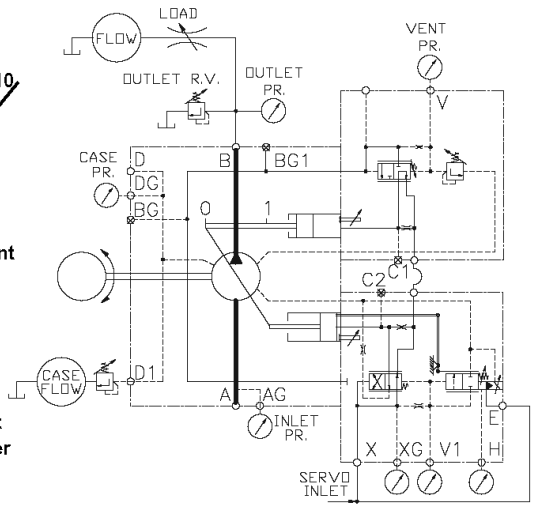
Set signal pressure to 50 psi, 3,45 bar. Back out zero volume stop and set zero flow adjustment until pump is at zero displacement. Lock both adjustments in place.

Slowly increase and decrease signal pressure between 0 and 275 psi, 19,0 bar several times at minimum and maximum operating outlet pressure. Pump displacement should follow control pressure smoothly and proportionally. Rapidly adjust signal pressure between 0 and 275 psi, 19,0 bar. Full to zero or zero to full displacement should be achieved in no more than 0,3 second.

Proceed to **COMPENSATOR TEST (pg. 66), TORQUE LIMITER TEST (pg. 70),** or **FINAL PUMP TEST (pg. 75),** as applicable.



ELECTROHYDRAULIC STROKER CAP



TEST CIRCUIT
ELECTROHYDRAULIC STROKER
COMPENSATOR OVERRIDE

ELECTROHYDRAULIC STROKER TEST

Before testing electrohydraulic stroker, disable the compensator or torque limiter override, if applicable, by turning the compensator differential adjustment fully in. (See compensator or torque limiter test) **CAUTION:** System must contain a relief valve to limit outlet pressure. Outlet relief valve should be set to minimum pressure.

Plumb servo supply (5 gpm, 19 lpm minimum at 1500 psi, 103 bar maximum) to control port "X", and to the electric stroker port, "E"

Install gages on servo pressure gage port XG and on gage port V1, capable of measuring pressure difference to 10 psi, 0,69 bar. Gages must be adequate for servo pressure.

Thread zero volume stop screw so that pump is on stroke.

Turn electrohydraulic stroker differential adjustment screw in till solid, then 7 turns out.

Start pump. Observe for correct rotation. Adjust current to proportional valve till pump is at some displacement between zero and full. Adjust differential pressure by adjusting the differential screw until the difference in pressure readings between port XG and V1 is 250 psi, 17,2 bar. Install cover over differential adjustment.

Adjust current to 170 mA. Back out zero volume stop and set zero flow adjustment until pump is at zero displacement. Lock both adjustments in place. If pump fails to respond, measure pressure at port "H", pressure to be 50 psi, 3,45 bar minimum, for 170 mA current with 24 V. coil. Remove gage after checking, to avoid unstable operation.

Increase current to 300 mA. Pump should go to full displacement. Set maximum volume screw on opposite control cap for full displacement.

Increase and decrease the amperage between 0 and 300 mA several times at minimum to maximum outlet pressure. Pump displacement should follow amperage smoothly and proportionally. Full to zero or zero to full displacement should be achieved in .3 second. Adjust amperage up to 225 mA from zero displacement, then adjust down from full displacement to 225 mA. The flows at the two 225 mA settings shall not vary more than 2 gpm, 7,6 lpm from each other.

Proceed to **COMPENSATOR TEST (pg. 66), TORQUE LIMITER TEST (pg. 70),** or **FINAL PUMP TEST (pg. 75),** as applicable.

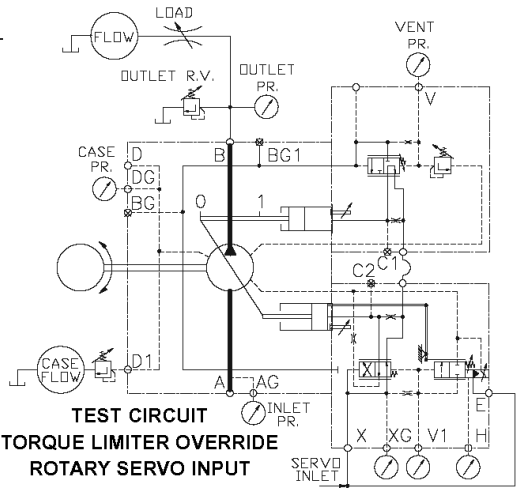
TORQUE LIMITER AND TORQUE LIMITER OVERRIDE TEST

The torque limiter design is a compensator with a means of varying pump displacement with pressure in this manner: The compensator vent port applies pressure to a pin. The pin moves against two independently adjustable springs. A sleeve, sliding over the pin, opens or closes the vent passage, to control the compensator pressure. The sleeve is connected through a linkage to the control piston. As pressure increases, the displacement must reduce, and vice versa, to provide approximate constant torque.

Install gages on outlet pressure and "V" capable of measuring pressure difference to 10 psi, 0,69 bar. Gages must be adequate for outlet pressure.

Turn compensator adjustment screw out to remove spring load, then 1/2 turn in.

Turn differential adjustment screw out till there is no contact with spring, then in 1-1/2 turns. (Approximately one nut width exposure of screw thread)



TEST CIRCUIT
TORQUE LIMITER OVERRIDE
ROTARY SERVO INPUT

If the pump contains a servo, hydraulic or electrohydraulic stroker control, test that control first (pg. 64, 68 or 69) then set the control to give full displacement on the pump. **CAUTION:** System must contain a relief valve to limit outlet pressure. Outlet relief valve should be set at 500 psi, 34,5 bar.

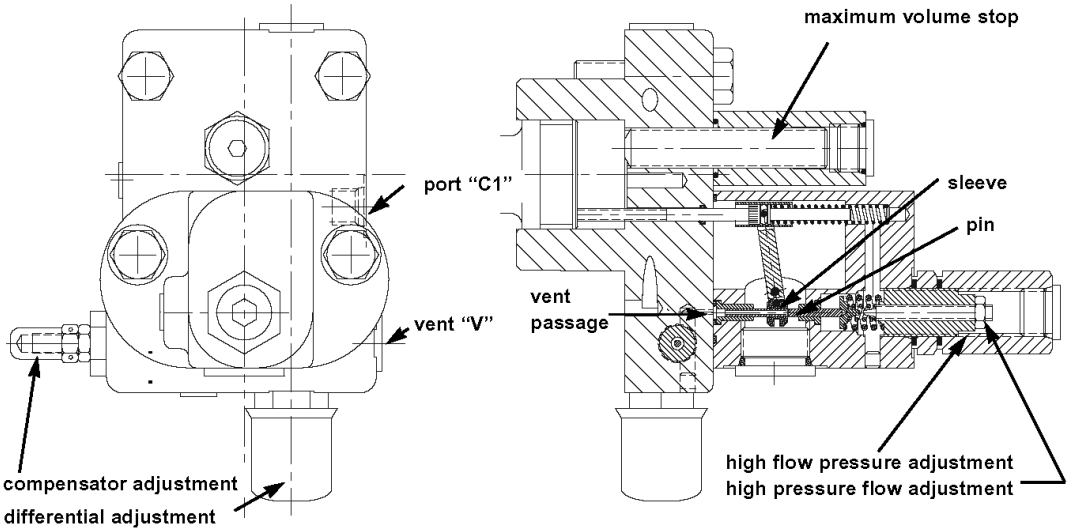
To test and set compensator function, disable torque limiter in this manner: Back out high pressure flow adjustment screw (inner) to remove all load. Turn in high flow pressure adjustment screw (outer) to go solid. Caution! do not apply over 10 in.•lb, 1,2 Nm torque to avoid damage to internal parts!

Start prime mover with outlet relief set at 500 psi, 34,5 bar. Apply a load to the pump.

Pump should be at full displacement at 500 psi, 34,5 bar.

Increase outlet pressure until compensator de-strokes pump to zero displacement. Note minimum compensated pressure versus servo pressure in chart on page 66. Set compensator to minimum compensated pressure.

Adjust compensator differential spool pressure to 250 psi, 17,2 bar. This is accomplished by adjusting the differential screw until the difference in pressure readings between the outlet pressure and compensator vent "V" gages installed in the compensator cap is 250 psi, 17,2 bar. Install cover over differential adjustment.



TORQUE LIMITER

Set the compensator to 3000 psi, 207 bar, 6000 psi, 414 bar, and 7250 psi, 500 bar. (One turn approximately equals 2000 psi, 138 bar)

At each condition, increase the outlet pressure until the pump fully de-strokes. At no time should the outlet pressure vary more than 150 psi, 10,3 bar from the compensator setting. The control should be steady and stable at all conditions.

Reduce outlet pressure below the compensator setting. Pump should return to full displacement. Repeat two or more times. Compensator setting should be repeatable.
Set compensator adjustment to at least 500 psi, 34,5 bar above the maximum outlet pressure.

TORQUE LIMITER TEST AND ADJUSTMENT
Set the torque limiter by using the formula:

HP=P•Q/(Eff.•1714), or P=HP(Eff.*1714)/Q, or Q=HP(Eff*1714)/P
where P = Pressure in psi
Q = flow in GPM
Eff. = overall efficiency

or kW = P•Q/(Eff.• 600), or P=kW(Eff*600)/Q, or Q=kW(Eff*600)/P
where P = pressure in Bar
Q = flow in lpm
Eff. = overall efficiency

calculate these two values:

a. Outlet pressure at full pump flow.
b. Pump flow at full outlet pressure.

1. Set outlet to pressure (a) calculated above. Back out high pressure flow adjusting screw (inner screw) to remove all load. Set the high flow pressure adjusting screw (outer) so that pump just commences to de-stroke.

2. Set the system to the required maximum outlet pressure. Set high pressure flow adjusting screw (inner) to obtain the calculated flow (b) at full outlet pressure.

Note: Electric motor current or engine load may be used instead of calculated flows to set power. In step 1, set the high flow adjustment to achieve the rated motor current or engine load. In step 2, set the high pressure adjustment to achieve the rated motor current or engine load.

Proceed to **FINAL PUMP TEST** (**pg. 75**)

LOAD SENSING TORQUE LIMITER

Caution: Load sensing control is limited to 5000 psi, 345 bar maximum pressure.

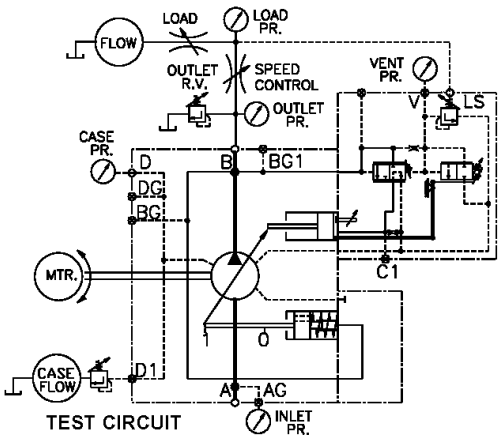
Pump should be connected to speed control valve, load sensing line and load valve as shown.

Install gages on outlet pressure and "V" capable of measuring pressure difference to 10 psi, 0,69 bar. Gages must be adequate for outlet pressure.

Turn compensator adjustment screw out to remove spring load, then 1/2 turn in.

Turn differential adjustment screw out till there is no contact with spring, then in 1-1/2 turns. (Approximately one nut width exposure of screw thread)

To test and set compensator and load sensing function, disable torque limiter in this manner: Back out high pressure flow adjustment screw (inner) to remove all load. Turn in high flow pressure adjustment screw (outer) to go solid. Caution! do not apply over 10 in.•lb, 1,2 Nm torque to avoid damage to internal parts!



TEST CIRCUIT LOAD SENSING TORQUE LIMITER

Start prime mover with outlet relief set at 500 psi, 34,5 bar. Apply a load to the pump.

Pump should be at full displacement at 500 psi, 34,5 bar.

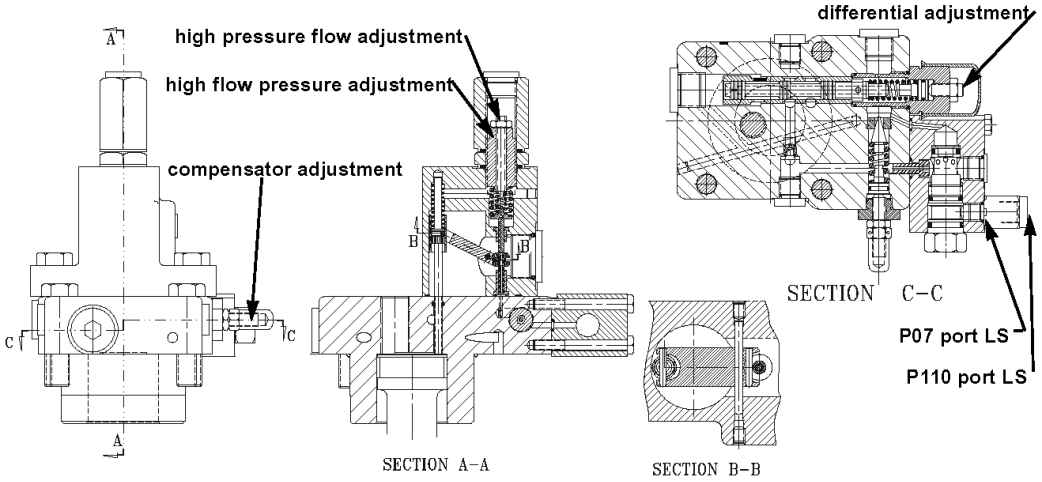
Increase outlet pressure until compensator de-strokes pump to zero displacement. Note minimum compensated pressure versus servo pressure in chart on page 58. Set compensator to minimum compensated pressure.

Adjust compensator differential spool pressure to 250 psi, 17,2 bar. This is accomplished by adjusting the differential screw until the difference in pressure readings between the outlet pressure and compensator vent "V" gages installed in the compensator cap is 250 psi, 17,2 bar. Install cover over differential adjustment.

Close the speed control valve. Check the pressure difference from outlet pressure to load pressure. Using the differential adjustment, set this pressure difference to 450 psi ± 25 psi, 31,0 ± 1,72 bar or shop order requirement. Caution: Too low or too high a setting will cause the control to malfunction. Install cap on differential adjustment.

Fully open the speed control valve. Set the compensator to 3000 psi, 207 bar, and 5000 psi, 345 bar. (One turn of adjustment equals approximately 2000 psi, 138 bar.) At each condition, increase the outlet pressure by closing the load valve until the pump fully de-strokes. At no time should the outlet pressure vary more than 150 psi, 10,3 bar from the compensator setting. The control should be steady and stable at all conditions.

With pump at full flow and 5000 psi, 345 bar outlet pressure, close speed control valve till flow reduces slightly. Note flow.



Open load valve slowly, to drop outlet pressure toward minimum. Flow shall remain constant within 2 gpm, 7,6 lpm at all pressures.

Adjust the speed control valve till flow is at a low value. Note flow. Raise and lower outlet pressure by closing and opening the load valve. Flow shall remain constant within 2 gpm, 7,6 lpm.

Fully open the speed control valve.
Set the torque limiter by using the formula:

HP=P•Q/(Eff.•1714), or P=HP(Eff.*1714)/Q, or Q=HP(Eff*1714)/P

where P = Pressure in psi
Q = flow in GPM
Eff. = overall efficiency

or kW = P•Q/(Eff.• 600), or P=kW(Eff*600)/Q, or Q=kW(Eff*600)/P

where P = pressure in Bar
Q = flow in lpm
Eff. = overall efficiency

calculate these two values:

a. Outlet pressure at full pump flow.
b. Pump flow at full outlet pressure.

1. Set outlet to pressure (a) calculated above. Back out high pressure flow adjusting screw (inner screw) to remove all load. Set the high flow pressure adjusting screw (outer) so that pump just commences to de-stroke.

2. Set the system to the required maximum outlet pressure. Set high pressure flow adjusting screw (inner) to obtain the calculated flow (b) at full outlet pressure.

Note: Electric motor current or engine load may be used instead of calculated flows to set power. In step 1, set the high flow adjustment to achieve the rated motor current or engine load. In step 2, set the high pressure adjustment to achieve the rated motor current or engine load.

Proceed to **FINAL PUMP TEST (pg. 75)**

PQ CONTROL
IN PROCESS OF DEVELOPMENT

FINAL PUMP TEST
Operate the pump with the following outlet pressures for the times indicated.

3000 psi ± 100 psi, 207 bar ± 6,9 bar	2 minutes minimum
5000 psi ± 100 psi, 345 bar ± 6,9 bar	1 minute minimum
6000 psi ± 100 psi, 414 bar ± 6,9 bar	1 minute minimum

While breaking in, destroke the pump several times at each pressure setting, by either reducing compensator setting, servo/stroker command, or Q command to PQ control, as applicable.

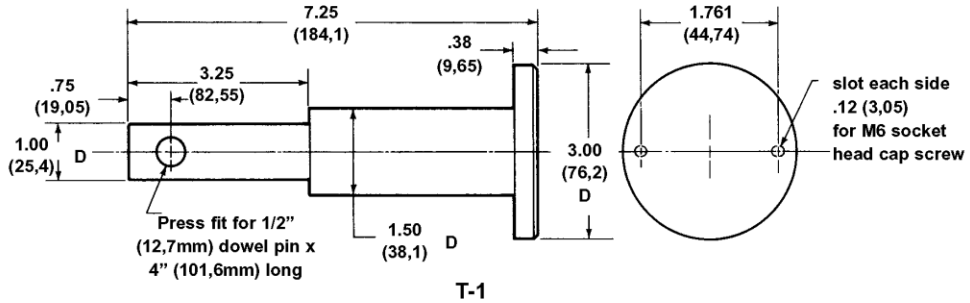
	FULL DISPLACEMENT REQUIREMENTS AT 6000 PSI, 414 BAR			
PUMP SERIES	**MINIMUM OUTPUT FLOW**		**MAX CASE DRAIN FLOW**	
	GPM	**LPM**	**GPM**	**LPM**
P07/P110 @ 1750 RPM	47.0	178	3.0	11,4
P07/P110 @ 1450 RPM	41.3	156	3.0	11,4

Raise compensator setting from minimum to maximum outlet pressure. **Caution:** Load sensing control is limited to 5000 psi, 345 bar maximum pressure.

At each condition, increase the outlet pressure until the pump fully de-strokes. At no time should the outlet pressure vary over 150 psi, 10,3 bar from full to zero flow. The control should be steady and stable at all conditions.

Reduce outlet pressure to 150 psi, 10,3 bar below the compensator setting. Pump should return to full displacement. Repeat two or more times. Compensator settings should be repeatable. Set compensator at 1000 psi ± 100 psi, 69 bar ± 6,9 bar standard, or desired value.

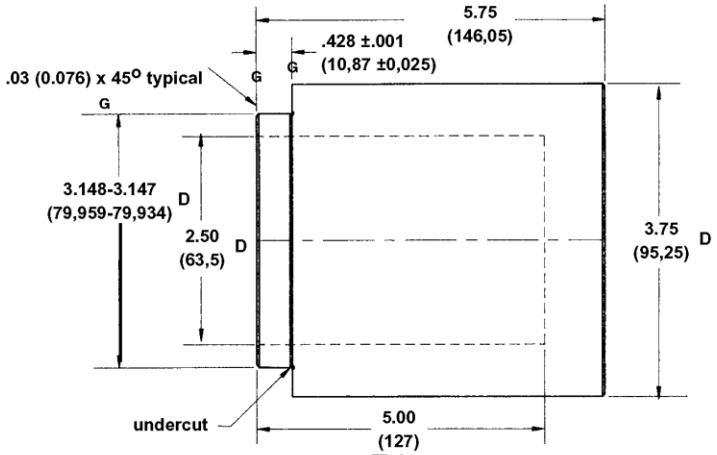
Check for leaks. NO external leaks are permitted. The shaft seal can be dry or damp. (Damp: A very small amount of oil at the seal and shaft joint, but NOT running onto the seal face).



T-1

(Lifting tool)

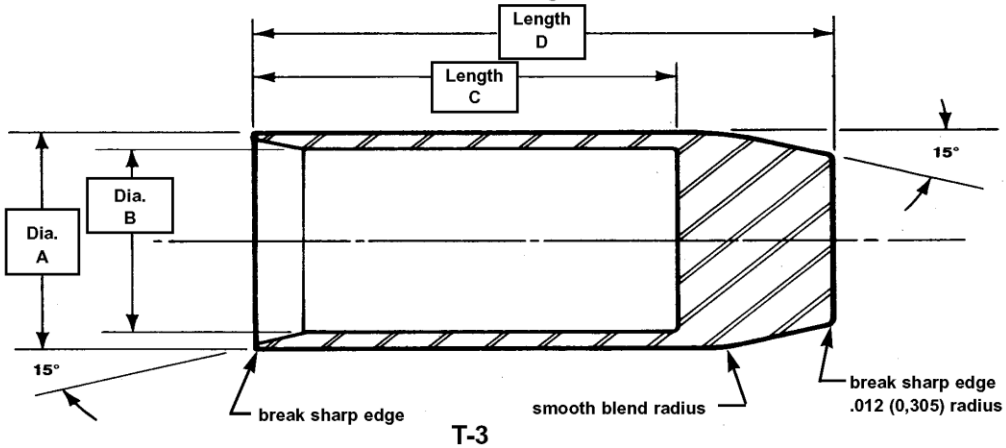
barrel & inner race assembly



T-2

(installation tool)

retainer & shaft bearing in cradle



T-3

(installation tool)

shaft seal over shaft

Shaft	A		B		C		D	
	in.	mm	in.	mm	in.	mm	in.	mm
P07 keyed	1.878/1/880	47,70/47,75	1.755/1.760	44,58/44,70	3.00	76,2	4.50	114,3
P07 splined	1.878/1/880	47,70/47,75	1.725/1.730	43,82/43,94	3.00	76,2	4.50	114,3
P110 (all)	1.878/1/880	47,70/47,75	1.580/1.582	40,13/40,18	3.25	82,5	4.75	120,6

Specification	Term	P07	P110
• displacement at maximum angle	$in^3/rev.$	6.7	6.7
	cm^3/rev	109,8	109,8
• pressure continuous	psi	6000	6000
	bar	420	420
• pressure intermittent (not to exceed 6 sec./minute)	psi	7250	7250
	bar	500	500
• speed, @ atmospheric inlet	rpm	2450	2450
maximum with boost	rpm	3000	3000
• rotating inertia	lbs/in^2	92	92
	$kg.m^2$	0,027	0,027
• compensator response off-stroke	sec.	0.100	0,100
on-stroke	sec.	0.150	0,150
• compensator adjustment	psi/turn	2000	2000
	bar/turn	138	138
• minimum compensating pressure (comp, torque limiter)	psi	250	250
	bar	17,2	17,2
• minimum compensating pressure (override controls) (at 800 psi, 55,2 bar servo)	psi	1500	1500
	bar	103	103
• typ. servo & stroker response @ 800 psi, 55,2 bar servo pressure, zero to full displacement and vice versa	sec.	<0.2	<0.2
• servo flow required for this response	gpm	5	5
	l/min	19	19
• minimum servo pressure	psi	800	800
	bar	55	55
• maximum servo pressure	psi	1500	1500
	bar	103	103
• electric stroker nominal coil resistance (24v. coil)	ohms	41	41
• electric stroker nominal coil resistance (12v. coil)	ohms	10	10
• handwheel turns, full to zero displacement	turns	9,3	9,3
• torque to turn handwheel @ 1000 psi,, 70 bar	in-lbs	100	100
	Nm	11	11
• torque to turn handwheel @ 7250 psi,, 500 bar	in-lbs	225	225
	Nm	25,4	25,4
• rotary servo shaft rotation, 0 to full displacement	degrees	49-54°	49-54°
• torque to turn rotary servo shaft	in-lbs	20	20
	Nm	2,3	2,3
• maximum/minimum case pressure (continuous)	psi	25/3	25/3
	bar	1,7/0,2	1,7/0,2
• maximum/minimum case pressure (intermittent)	psi	50/3	50/3
	bar	3,4/0,2	3,4/0,2
• input mounting-4 bolt flange	SAE	152-4 (D)	
	ISO 3019/2		180 B4HW
• input shaft, keyed	SAE	44-1 (D)	
• input shaft, splined	SAE	44-4 (D)	
• input shaft, keyed ISO 3019/2	ISO		G40N
• input shaft, splined ISO 3019/2	ISO		K40N
• input shaft, keyed DIN	DIN		6885 40 mm
• input shaft, splined DIN	DIN		5480 40 mm
• weight	pounds	177	177
	kg.	80,3	80,3

GENERAL

The **DENISON HYDRAULICS** P07/P110 Series is a variable displacement open circuit axial piston pump with advance pumping and control concepts.

MOUNTING

This pump is designed to operate in any position. The pump shaft must be in alignment with the shaft of the prime mover and should be checked with a dial indicator. The mounting pad or adapter into which the pump pilots must be concentric with the pump shaft to prevent bearing failure. This concentricity is particularly important if the shaft is rigidly connected to the prime mover without a flexible coupling.

SHAFT INFORMATION

Splined: The shafts will accept a maximum misalignment of .006", 0.15 mm TIR. Angular misalignment at the male and female spline axis must be less than 0.001 in. per in. radius, 0.001 mm per mm. The coupling interface must be lubricated. DENISON HYDRAULICS recommends lithium molydisulfide or similar grease. The female coupling should be hardened to 27-34 Rc. and must conform to SAE J498B (1971) class 1 flat root side fit. (P07), ISO 4156 fillet root side fit module 1,00 or DIN 5480 (9H) flat root side fit module 2.00 as applicable. (P110)

Keyed: High strength heat treated keys must be used. Replacement keys must be hardened to 27-34 Rc. The key corners must be chamfered .030"-.040", 0.75-1.00 mm at 45° to clear radii that exist in the keyway.

PORTING INFORMATION

See port identification section for port locations and sizes.

The maximum case pressure is 25 psi, 1.7 bar continuous, 50 psi, 3.4 bar intermittent. Case pressures must never exceed inlet pressure by more than 25 psi, 1.7 bar. When connecting case drain line make certain that drain plumbing passes above highest point of the pump before returning to the reservoir, if not, install a 5 psi, 0.3 bar case pressure check valve to be certain the case is filled with oil at all times.

The case drain line must be of sufficient size to prevent back pressure in excess of 25 psi, 1,7 bar and returned to the reservoir below the surface of the oil as far from the supply suction as possible. All fluid lines, whether pipe, tubing, or hose must be of adequate size and strength to assure free flow through the pump. An undersize inlet line will prevent the pump from reaching full speed and torque. An undersized outlet line will create back pressure and cause improper operation. Flexible hose lines are recommended. If rigid piping is used, the workmanship must be accurate to eliminate strain on the pump port block or to the fluid connections. Sharp bends in the lines must be eliminated wherever possible. All system piping must be cleaned with solvent or equivalent before installing pump. Make sure the entire hydraulic system is free of dirt, lint, scale, or other foreign material.

CAUTION: Do not use galvanized pipe. Galvanized coating can flake off with continued use.

INLET CONDITIONS AT SEA LEVEL, FULL DISPLACEMENT

SPEED	GAGE PRESSURE				ABS. PRESS.	
rpm	psig	bar	in. hg	mm hg	psi	bar
1200	-3	-0,2	-6.1	-155	11.7	0.8
1800	-3	-0,2	-6.1	-155	11.7	0.8
2100	-3	-0,2	-6.1	-155	11.7	0,8
2450	0	0	0	0	0	1,01
3000	6.3	0,44	12.8	326	22.1	1,52

NOTE: Inlet conditions apply for petroleum base fluids. Contact **DENISON HYDRAULICS** for inlet conditions with other fluids.

RECOMMENDED FLUIDS

See DENISON HYDRAULICS bulletin **SPO-AM305** for more information

MAINTENANCE

This pump is self-lubricating and preventative maintenance is limited to keeping system fluid clean by changing filters frequently. Keep all fittings and screws tight. Do not operate at pressures and speeds in excess of the recommended limit. If the pump does not operate properly, check the troubleshooting chart before attempting to overhaul the unit. Overhauling is relatively simple and may be accomplished by referring to the disassembly, rework limits of wear parts and assembly procedures.

FLUID CLEANLINESS

Fluid must be cleaned before adding to the system, and continuously during operation by filters that maintain a cleanliness level of NAS 1638 Class 8. This approximately corresponds to ISO 17/14.

Ordering Code P07/110 - 02R1C - C10 - 00 - M2

Pump service

Displacement, max*
07 - 6.7 in³/rev.
110 - 109,8 cm³/rev.

Shaft
02-Keyed -SAE 44-1 (D) *(P07)*
- ISO 3019/2 G40N *(P110)*
03-Splined -SAE 44-4 (D) *(P07)*
- ISO 3019/2 K40N *(P110)*
06-Keyed - DIN 6885 40mm *(P110)*
07-Splined DIN 5480 40mm *(P110)*

Shaft rotation
(viewed from shaft end)
R-CW (standard, high speed)
L-CCW (standard, high speed)

Fluid class
1-compatible with Buna N
4-compatible with EPR
5-compatible with Viton

Design letter

Primary controls
C-Pressure compensator
E-Electric stroker
H-Hydraulic stroker
J-Low torque limiter *1100-1850 lbs-in., 124-209Nm
K-High torque limiter *over 1850 lbs-in., 209 Nm
L-Load sensing
R-Rotary servo
V- Low torque limiter with Load sensing *1100-1850 lbs-in., 124-209Nm
W- High torque limiter with Load sensing *over 1850 lbs-in., 209 Nm
X- 24 VDC PQ high response (pending)

* Minimum torque values to maintain 5000 psi, 345 bar at 1800 rpm. Consult DENISON Hydraulics for minimums at lesser pressures and speeds.

Omit-Standard model
M2- Special modification to standard units
NP- No paint

Modification
O No pump mounted
1- Auxiliary pump (only) with M- modification (user must advise attitude of rear pump/s mounting. For ordering two *standard* or three or more units refer to ordering code for multiple units)

Rear drive mounting
(Appropriate coupling and seals are included)
O-None
M-Rear drive blanking plate
A-SAE 82-2 (A) flange, SAE 16-4 (A) shaft
G-SAE 82-2 (A) flange, SAE 22-4 (B) shaft
B-SAE 101-2/4 (B) flange, SAE 22-4 (B) shaft
Q-SAE 101-2/4 (B) flange, SAE 25-4 (BB) shaft
C-SAE 127-2/4 (C) flange, SAE 32-4 (C) shaft
N-SAE 127-2/4 (C) flange, SAE 38-4 (CC) shaft
D-SAE 152-4 (D) flange, SAE 44-4 (D&E) shaft
Z-ISO 3019/2 (100 B4HW) flange, K25N shaft
Y-ISO 3019/2 (125 B4HW) flange, K32N shaft
X-ISO 3019/2 (160 B4HW) flange, K40N shaft
T-ISO 3019/2, (180 B4HW) flange, K40N shaft
L-ISO 3019/2, (180 B4HW flange, DIN 40-18 shaft

Secondary controls
O-None
P-*Pressure compensator override
J-*Torque limiter override (low) 1100-1850 in-lbs., 124-209 Nm
K-*Torque limiter override (high) over 1850 in-lbs., 209 Nm
*(*E, H & R primary controls only)*

Primary control options
1-Standard maximum volume screw, without indicator
2-Handwheel maximum volume control without indicator (available on C, J, K, L, V & W primary controls only)
3-Maximum volume screw with cam position potentiometer (pending)
4-Maximum volume screw with cam position LVDT (pending)
5-Maximum volume screw with cam position indicator
6-Handwheel maximum volume control with cam position potentiometer (pending)
7-Handwheel maximum volume control with cam position LVDT (pending)
8-Handwheel maximum control with cam position indicator (available on C, J, K, L, V & W primary controls only)

Available control combinations
C10, C20, C50, C80
E10, E50, E1P, E5P,
E1J, E5J, E1K, E5K,
H10, H50, H1P, H5P,
H1J, H5J, H1K, H5K
R10, R50, R1P, R5P,
R1J, R5J, R1K, R5K
J10, J20, J50, J80
K10, K20, K50, K80
L10, L20, L50, L80
V10, V20, V50, V80
W10, W20, W50, W80

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DENISON Hydraulics

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TRONAIR®

APPENDIX VII

Material Safety Data Sheet (MSDS) Hydraulic Fluid

Solutia Inc.

Material Safety Data Sheet

1. PRODUCT AND COMPANY IDENTIFICATION

Product name: SKYDROL® LD4 Fire resistant hydraulic fluid

Reference Number: 000000000183 Date: 03/18/2003

Company Information:

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

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

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

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

2. COMPOSITION/INFORMATION ON INGREDIENTS

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

3. HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW

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

WARNING STATEMENTS

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

POTENTIAL HEALTH EFFECTS

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

Refer to Section 11 for toxicological information.

4. FIRST AID MEASURES

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

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

5. FIRE FIGHTING MEASURES

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

Hazardous products of combustion: None known;

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

Unusual fire and explosion hazards: None known

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

6. ACCIDENTAL RELEASE MEASURES

Personal precautions: Use personal protection recommended in section 8.

Environmental precautions: Keep out of drains and water courses.

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

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

7. HANDLING AND STORAGE

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

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

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

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

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

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

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

9. PHYSICAL AND CHEMICAL PROPERTIES

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

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

10. STABILITY AND REACTIVITY

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

11. TOXICOLOGICAL INFORMATION

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

Acute animal toxicity data

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

Components

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

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

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

12. ECOLOGICAL INFORMATION

Environmental Toxicity:

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

Environmental fate

Biodegradation

Readily biodegradable.

13. DISPOSAL CONSIDERATIONS

US EPA RCRA Status:	This material when discarded is not a hazardous waste as that term is defined by the Resource, Conservation and Recovery Act (RCRA), 40 CFR 261.
Disposal considerations:	Incineration Recycle
Miscellaneous advice:	This product meets the criteria for a synthetic used oil under the U.S. EPA Standards for the Management of Used Oil (40 CFR 279). Those standards govern recycling and disposal in lieu of 40 CFR 260 -272 of the Federal hazardous waste program in states that have adopted these used oil regulations. Consult your attorney or appropriate regulatory official to be sure these standards have been adopted in your state. Recycle or burn in accordance with the applicable standards. Local, state, provincial, and national disposal regulations may be more or less stringent. This product should not be dumped, spilled, rinsed or washed into sewers or public waterways.

14. TRANSPORT INFORMATION

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

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

15. REGULATORY INFORMATION

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

CERCLA Reportable Quantity:

Not applicable

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

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

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

16. OTHER INFORMATION

Product use: Hydraulic fluids and additives

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

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

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

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APPENDIX VIII

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

AMERICAN NATIONAL STANDARD

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

AMERICAN NATIONAL STANDARDS INSTITUTE • A NATIONAL STANDARD FOR FLUID POWER

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

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

SPONSOR

National
FLUID POWER
Association

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

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

0 Introduction

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

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

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

1 Scope

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

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

2 References

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

ISO 5598, *Fluid power — Vocabulary.*

3 Definitions

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

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

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

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

4 Graphic symbols

Graphic symbols used are in accordance with ISO 1219.

5 Rules

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

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

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

6 Sampling device

Note — Take normal precautions to safeguard personnel and equipment.

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

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

6.1.2 Provide a dust cap for the item in 6.1.1.

6.1.3 Use the remaining equipment only for sampling.

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

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

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

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

7 Sampling procedure

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

7.2 Open the ball valve.

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

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

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

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

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

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

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

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

8 Identification statement

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

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

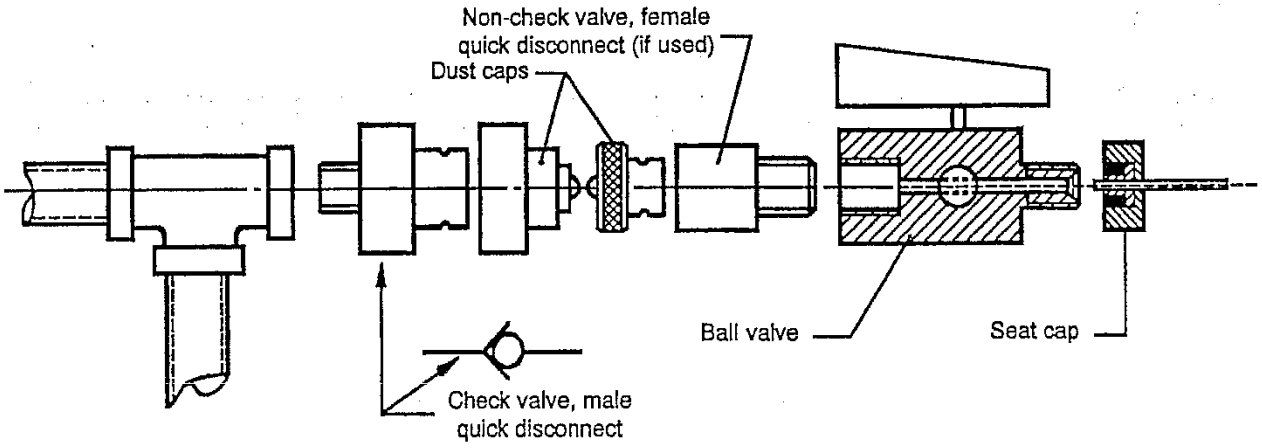

Figure 1 — Typical field type sampling device

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APPENDIX IX

Instrument Certification Notice

Instrument Certification Notice

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

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

Note that Tronair, Inc. does not supply certificates of calibration on flow meters or pyrometers unless requested at the time of placed order. These instruments are considered reference indicators only and are not critical to the test(s) being performed on the aircraft.

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APPENDIX IX

Declaration of Conformity

Declaration of Conformity

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

Mobile Hydraulic Power Unit
(Electric Motor Driven)

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

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

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

David L. Kidd

Quality Assurance Representative

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